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Historical Radiological Assessment – Supplemental Technical Memorandum

Naval Station Treasure Island
San Francisco, California

July 1, 2014

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PREPARED FOR:

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REVIEW AND APPROVAL

Project Manager: _____ Date: July 1, 2014

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ACRONYMS AND ABBREVIATIONS

µCi	Microcuries
AEC	Atomic Energy Commission
AN/PDR	Army Navy/Portable Detector Radiation
AOI	Area of Interest
Br	Bromine
BRAC	Base Realignment and Closure
CCSF	City and County of San Francisco
CDPH	California Department of Public Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chemical of concern
cpm	Counts per minute
Cs	Cesium
CSM	Conceptual Site Model
DRMO	Defense Reutilization and Marketing Office
DTSC	Department of Toxic Substances Control
FOSL	Finding of suitability to lease
FOST	Finding of suitability to transfer
FS	Feasibility study
FSS	Final status survey
GGIE	Golden Gate International Exposition
HPS	Hunters Point Shipyard
HRA	Historical radiological assessment
HRASTM	Historical radiological assessment supplemental technical memorandum
IDW	Investigation-derived waste
IR	Installation Restoration
IRP	Installation Restoration Program
K	Potassium
LCS	Landing Craft Ship
LLRW	Low-level radioactive waste
LLRO	Low-level radiological object
m^2	Square meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual

ACRONYMS AND ABBREVIATIONS (CONTINUED)

MDC	Minimum detectable concentration
Na	Sodium
NARA	National Archives and Records Administration
NAVSTA TI	Naval Station Treasure Island
Navy	Department of the Navy
NDRC	National Defense Research Committee
NRDL	Naval Radiological Defense Laboratory
NTCRA	Non-time-critical removal action
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
pCi/g	Picocurie per gram
Ra	Radium
RADIAC	Radiation Detection, Indication, and Computation
RASO	Radiological Affairs Support Office
RCA	Radiologically Controlled Area
rem	Roentgen
RHB	Radiological Health Branch
ROD	Record of decision
SFUSD	San Francisco Unified School District
Shaw	Shaw Environmental, Inc.
Sr	Strontium
SU	Survey unit
SWDA	Solid waste disposal area
Tetra Tech	Tetra Tech EM Inc.
Th	Thorium
TI	Treasure Island
TIDA	Treasure Island Development Authority
USACE	U.S. Army Corps of Engineers
U.S.C.	*United States Code*
UST	Underground storage tank
VSP	Visual Sample Plan
WWII	World War II
YBI	Yerba Buena Island

EXECUTIVE SUMMARY

This technical memorandum supplements the findings of the "Final Treasure Island Naval Station Historical Radiological Assessment (HRA), Former Naval Station Treasure Island (NAVSTA TI), San Francisco, California," (Weston Solutions, Inc. 2006). The intent of the HRA was to provide a comprehensive history of radiological operations by the Department of the Navy (Navy) and its contractors at NAVSTA TI before the time it was published in February 2006. This HRA Supplemental Technical Memorandum (HRASTM) documents the findings of additional investigation relative to historical operations involving use of and/or disposal of radioactive materials associated with the Treasure Island (TI) portion of former NAVSTA TI since the original HRA was completed. This additional investigation included research of historical records and review of reports documenting intrusive investigations conducted at NAVSTA TI after the HRA was published. Yerba Buena Island, part of NAVSTA TI, was not included in the original HRA and is not included in this technical memorandum.

As a result of additional intrusive investigation after the HRA was developed, it was confirmed that some areas, including disposal areas, contained radiologically contaminated waste. Therefore, additional research was warranted to further understand the radiological materials that were found and disposal processes for the radioactive waste. Additionally, the conceptual site models (CSM) presented in the original HRA had to be updated and refined to address the origin and impact of the radiological material that was found. The updated CSMs, historical research, and a review of activities at TI since the original HRA was published are in this HRASTM. Research for this HRASTM included review of all past TI projects having a radiological component, aerial photographs, geological reports, field activity logs, base-wide soil sample and scanning locations for radiological materials, radioactive waste disposal records, and various efforts supporting establishment of TI-specific background values for radium (Ra)-226.

Naval operational history was reviewed for a complete assessment of radiological activities at TI. TI was divided into eight Areas of Interest (AOI) to facilitate review of areas of TI with aerial photos from different years in detail and side-by-side. Changes in land use were assessed to determine the potential for activities that may have resulted in radioactive contamination and migration pathways. This review was carried out in coordination with the Navy's Radiological Affairs Support Office (RASO) and included a review of documents at the Navy's RASO office in Yorktown, Virginia; files consisting of building plans and other drawings and documents in the Caretaker Site Office at Building 1; and documents from the former TI Museum related to the Golden Gate International Exposition (GGIE), currently in Building 449 on TI.

As a result of the research discussed in this HRASTM, activities identified involving the use and disposal of the radioisotopes Ra-226, cesium (Cs)-137, and thorium (Th)-232 which resulted in the designation of new radiologically impacted areas. Ra-226 is associated with such uses as radioluminescent paints and sources, Cs-137 with use in sealed sources, and Th-232 in optical coatings and glass.

Please see Appendix A for general discussion regarding nuclear health physics, including alpha and beta particles.

A radiologically impacted site is one that has, or had, the potential for radioactive contamination, based on historical information, in excess of natural background or fallout levels. The designation as radiologically impacted does not confirm that radioactive contamination is present, but only that the possibility exists and must be investigated. A non-impacted site is one not classified as impacted and with no possibility of containing residual radioactivity in excess of natural background or fallout levels. The new radiologically impacted areas identified in the HRASTM include:

- Building 3 and the associated sanitary sewer system were identified as impacted based on ship repair activities and the presence of a former optical shop in the building during World War II (WWII). Building 3 was previously identified in the HRA as non-impacted.

- Site 6, Building 570, and a surrounding laydown area were identified as impacted based on remedial activities in association with the Site 12 Solid Waste Disposal Areas (SWDA). These areas were not addressed in the HRA.

- A probable WWII era salvage yard was identified as impacted based on the potential for scrap metal recycling activities adjacent to former Building 327 during WWII.

- Both former sites of the training ship mock-up, known as the USS *Pandemonium*, were identified as impacted based on a reevaluation of existing data after the HRA. Note that one of the USS *Pandemonium* sites, the northwest site, is also designated as impacted in this HRASTM because of its location within the Site 12 housing area (another newly impacted site).

- A salvage yard known as Lot 69 was identified as impacted based on the handling of salvage materials in that area.

- A former storage area that includes Sites 30 and 31 was identified as impacted based on investigatory results obtained after the HRA.

- Building 342 and the associated outside storage yard were identified as impacted based on investigatory results obtained after the HRA.

- The area surrounding Building 461 and the building itself was identified as impacted based on the potential for contamination resulting from this building's use in conjunction with radiological training activities.

- A portion of a recreation field associated with a former gyro compass repair shop was identified as impacted because of potential impacts associated with the gyro compass repair function. Note that the recreation field is also designated as impacted in this HRASTM because of its location within the Site 12 housing area (another newly impacted site).

- This HRASTM expands the radiologically impacted area for the Site 12 SWDAs to include the entire Site 12 to account for investigatory results obtained after the HRA. The radiologically impacted area in Site 12 includes the soil and subsurface, but does not include the housing structures.

Sites designated as radiologically impacted in the prior HRA or in this HRASTM will be addressed following the recommended action protocols outlined in Section 7.4 of the 2006 HRA.

No further action is necessary to address the potential for radiological contamination at TI that are not designated radiologically impacted. No evidence has been found to warrant further radiological investigation of areas that are not impacted.

1.0 INTRODUCTION

This Historical Radiological Assessment Supplemental Technical Memorandum (HRASTM) documents the findings of additional investigation relative to radiological operations and disposal at the Treasure Island (TI) portion of former Naval Station Treasure Island (NAVSTA TI) (Figure 1). Yerba Buena Island (YBI), part of former NAVSTA TI, is not included in the scope of this HRASTM. This HRASTM supplements the findings of the "Final Treasure Island Naval Station Historical Radiological Assessment (HRA), NAVSTA TI, San Francisco, California" (Weston Solutions Inc. 2006). The intent of the HRA was to provide a comprehensive history of radiological operations by the Department of the Navy (Navy) and its contractors at NAVSTA TI before it was published in February 2006. Additional details of the original HRA are discussed in Section 2.3. The purpose, methodologies employed, and organization of this HRASTM are further discussed below.

1.1 PURPOSE

The HRASTM format and content are designed to be responsive to concerns expressed by the California Department of Public Health (CDPH) and to augment the original HRA with new information obtained through additional research and from review and consideration of new data that became available through site investigations since the HRA was finalized. The new information was used to update conceptual site models (CSM) for radiologically impacted areas as requested by CDPH and to update the list of areas designated as impacted. The updated CSMs, research of historical documents, and a review of activities that occurred at TI since the original HRA was published are presented in this HRASTM. Figure 2 shows all the areas that are considered radiologically impacted based on the results of the 2006 HRA and this HRASTM. Details regarding specific Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) investigations or remedial efforts after this HRASTM is issued will be documented in project-specific reports or additional technical memoranda.

A radiologically impacted site is one that, based on historical information, has, or had, the potential for radioactive contamination in excess of natural background or fallout levels. The designation as radiologically impacted does not confirm that radioactive contamination is present, but only that the possibility exists and must be investigated. A non-impacted site is one not classified as impacted and with no possibility of containing residual radioactivity in excess of natural background or fallout levels.

1.2 TECHNICAL MEMORANDUM PREPARATION METHODOLOGIES AND RESEARCH FINDINGS

This section discusses investigative methodologies used to conduct research and the findings that resulted from that research.

1.2.1 Technical Memorandum Preparation Methodologies and Research Findings

This HRASTM was prepared based on a thorough research effort and visual inspections of the facilities on NAVSTA TI. Research included all past projects under the NAVSTA TI Installation Restoration (IR) Program (IRP); review of records in archives including files from the former TI Museum in Building 449; NAVSTA TI and 12th Naval District Files at The National Archives and Records Administration (NARA) files in San Bruno and Riverside, California; as well as NARA files located in College Park, Maryland. Navy internal files were also reviewed at the Radiological Affairs Support Office (RASO) in Yorktown, Virginia, and internal files in the Caretaker Site Office at Building 1 on NAVSTA TI. In addition to the archival record reviews, extensive Internet searches were conducted and former NAVSTA TI personnel were located and interviewed.

The following historical radiological operations were reviewed during the HRA and reexamined for this HRASTM:

- Operational training of personnel on the calibration, maintenance, and operation of radiation monitoring instruments.
- Training personnel on radiological monitoring and decontamination of ships and airplanes.
- Berthing of Operation Crossroads ships, or other ships exposed to atomic fallout from subsequent aboveground atomic bomb tests, before those ships were given final radiological clearance.

Additional naval operations and other previously un-reviewed records were examined. Reviews were done for all projects having a radiological component in the NAVSTA TI IRP. This review included work at the Building 233 area and the associated sewer systems, Sites 6, 12, 31, 32, and 33, and other efforts supporting development of background values for radium (Ra)-226. Specific records that support findings in this document are referenced within the following text of this technical memorandum. The types of files reviewed to support this HRASTM included:

- The 2006 Final HRA and all associated references
- NAVSTA TI plan maps and files
- Archived photographs
- Aerial photographs
- Newspaper articles and guidebooks from the 1939-1940 Golden Gate International Exposition (GGIE)
- Real property records and correspondence

- NAVSTA TI, 12th Naval District, and other documents archived at NARA sites
- Historical base maps
- Copies of the NAVSTA TI base newsletter, the *Masthead*
- Geological reports for TI
- IRP documents
- Field activity logs, work plans and other materials associated with intrusive environmental remediation work

New information or files found during research that adds to the body of knowledge of former operations at NAVSTA TI and, in particular, operations related to the radiological history of NAVSTA TI, are further discussed below and have been included in Appendix D for reference. In addition, extensive web searches were conducted during the research of this HRASTM.

Archival research included locating and contacting people who had specific knowledge of radiological and related operations at NAVSTA TI. Archival documents were reviewed to compile a list of individuals who may have such knowledge, and commercial web search engines were used to locate those individuals. Interviews with individuals who were located and who consented to providing information have been included in Appendix B that provides details of the interviews that were conducted.

1.2.2 Technical Memorandum Research Findings

The research identified new information that differs from the conclusions of the HRA in these areas:

- The 2006 HRA concluded that it was unlikely that low level radiological objects (LLRO) had been disposed of in the solid waste disposal areas (SWDA) located in Site 12, but recommended radiation monitoring during soil excavations in these areas. This HRASTM identifies the housing area within Site 12 as radiologically impacted. Radiation monitoring conducted during remedial activities after the HRA was published found that LLROs had been disposed of in the SWDAs. In addition, LLROs were found at various locations in the housing area. The CSM developed in conjunction with this HRASTM presumes the LLROs originated in the SWDAs and were moved away from the SWDAs by grading activities associated with construction of the housing areas.

- New findings demonstrate that ship repair activities occurred at NAVSTA TI during World War II (WWII), though the HRA concluded that "…NAVSTA TI's mission was training and not the maintenance and repair of ships..." While it is unclear precisely when these ship repair activities ceased, they were significantly reduced immediately after WWII. Repair activities were primarily done alongside Piers 11 through 16. Inside shop work was done in Building 3 (Navy 1946a).

- Potential areas have been identified where scrap metal from ship repair during WWII was processed or stored; these areas were designated as impacted. The ship repair generated scrap materials that were recycled. The probable locations for these recycling activities during WWII have been designated as impacted because, on other bases, these types of areas have historically been found to have radium contamination incidental to their operations.

- An area referred to as Lot 69 was identified as having been a Supply Department Salvage Yard. Salvage yards have often been linked with the potential for disposal of unregulated LLROs and have historically been found to have radium contamination incidental to their operations.

- Research identified the presence of an optical shop on the roof of Building 3. The optical shop had sinks that drained to the sanitary sewer system. The presence of such a shop is notable, as these shops have historically been found on other bases to have radium and thorium contamination associated with their operations. Radium and thorium were used for their radioluminescent properties in optical sighting devices and rangefinders during the WWII period.

- Remedial activities conducted at Site 12 after the 2006 HRA was published resulted in the creation of additional radiologically impacted sites — Site 6, Building 570, and its surrounding area.

- Research identified a radiological counting room in Building 342. The presence of a counting room suggests that samples may have been handled without encapsulation and warrants designating the building and associated exterior areas as radiologically impacted.

- A more conservative interpretation of existing data in the HRA resulted in designating both sites where a training ship mock-up, known as the USS *Pandemonium,* was located as impacted.

- An incinerator on the northern side of TI may have been used to dispose of LLROs.

- Building 168 and the surrounding area were identified as radiologically impacted as a result of a reevaluation of the potential for radiological contamination from operations in the building when it was used as a gyro compass repair shop.

- Two additional "rubbish" disposal areas were identified from older geotechnical reports; they are located in the Site 12 housing area that has been designated as radiologically impacted because LLROs were found in other debris disposal areas.

In addition to the above revised findings, research revealed additional detail regarding the radiological history of TI as discussed in the remainder of this document and below.

One particular focus of research was to obtain additional detail regarding the purpose and use of the radium foils that have been found buried in the SWDAs. About 75 radium foils have been found to date, as detailed in Table 1. The foils typically read about 1 roentgen (rem) on contact with the LLRO and range between 12 to 15 millirem 1 foot away from the LLRO. The foils are about the size of a dime and are octagonal or hexagonal in shape, as can be seen in Photo 1 below. The evidence suggests that they would have been buried in the SWDAs sometime between 1942 and 1955, when evidence of the SWDAs can no longer be found in photographs. The Society for the History of Navy Medicine and the curators of both the National Atomic Testing Museum in Las Vegas, Nevada, and the Museum of Science and Energy in Oakridge, Tennessee, were contacted to try to obtain additional information regarding the purpose and use of the radium foils found buried in the SWDAs at TI.

Photo 1 Radium Foils

Considering the amount of radioactivity associated with the foils, the most likely former use of the foils is as a calibration source for a high range gamma Radioactivity Detection, Identification and Computation (RADIAC) set, though the exact use of these foils cannot be confirmed with certainty. Research has identified one radiac set, an Army Navy/Portable Detector Radiation (AN/PDR)-18 that utilized high-level radium sources for calibration, as detailed in the Navy's instruction book for the radiac (Navy 1951a). This radiac and others like it would have likely been used in the Atomic Warfare School (later named the Nuclear, Biological and Chemical Warfare school) for training on TI (for a complete discussion of schools on TI see the HRA [Weston Solutions, Inc. 2006]). While the calibration source in the referenced instruction book does not exactly match the foils found in the SWDAs, the post-war 1940s was a period of intense development for radiation monitors and multiple manufacturers were developing many different models during that time frame. A later version of the RADIAC, an AN/PDR-18A, is shown in Photo 2 which was obtained from the Oak Ridge Associated University's web site. In that

photo a check source of the approximate size and shape of the radium foils found buried in the SWDAs on TI can be seen. It is the conclusion of this HRASTM that the most likely use of the foils that have been found on NAVSTA TI would have been as calibration or check sources in association with a high-range radiac utilized in conjunction with the above schools. They were likely disposed of as excess in the early 1950s as radium use as check sources was phased out.

Other potential uses suggest by various parties that were investigated during research as potentially being related to the foils included a medical device, the radium plaque adaptometer (Navy 1943); the Metascope (National Defense Research Committee [NDRC] 1946); and the Icaroscope (NDRC Undated). All of these were eliminated as being associated with the foils as no evidence was found that any of these instruments were ever used at NAVSTA TI. The radium plaque adaptometer was used for testing the night vision of sailors and while it apparently used radium no evidence has been found that the radium was in the form of the foils. The Navy discontinued use of the radium plaque adaptometer in 1951 (Navy 1951c). Similarly, the Metascope, a device for detecting infrared waves, used radium in some models, but the radium was on gold foil unlike the foils found on NAVSTA TI. The Icaroscope was a device use for viewing objects against a bright background. It was originally developed for viewing attacking airplanes coming out of the sun. No evidence of the use radium foils in this device has been found.

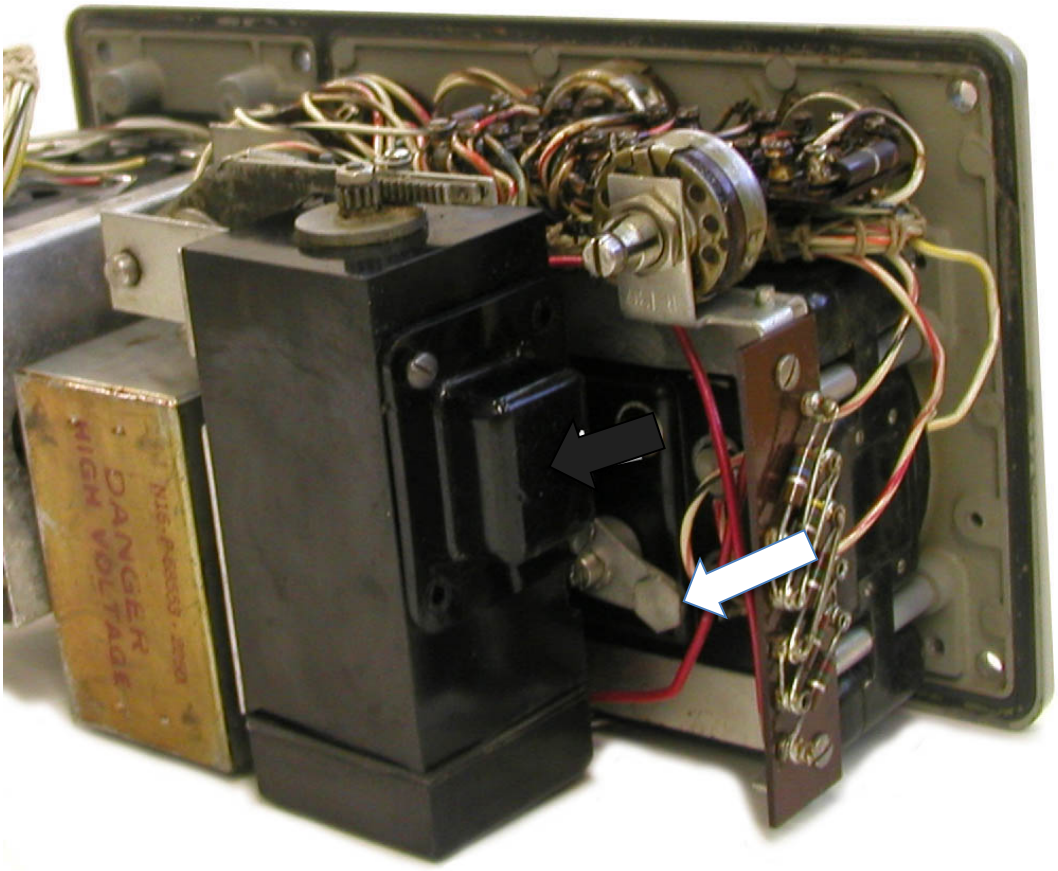


Photo 2 Hexagonal check source in AN/PDR-18A – white arrow

1.3 TECHNICAL MEMORANDUM ORGANIZATION

A detailed review of the facility background was done using the information acquired through the file research and is presented in Section 2.0. For this HRASTM, TI was divided into eight Areas of Interest (AOI) to allow the side-by-side comparison of aerial photographs from different times and to facilitate the discussion that focuses on the changes in land use as it relates to the likelihood of potential contamination and migration pathways. Section 2.0 presents conclusions regarding the designation of specific areas as impacted or non-impacted by radiological constituents. Sections 3.0 and 4.0 discuss the previous radiological operations and IRP activities on TI, and Section 5.0 discusses the CSMs developed as part of this HRASTM to evaluate the potential releases of contamination in impacted areas. Section 6.0 presents the findings and recommendations, and Section 7.0 lists the references used in this report.

Figures and Table 1 are provided at the end of the report. Appendix A provides general health physics information. Appendix B provides summaries of interviews conducted during research for the HRASTM. Appendix C provides comments received on the draft of this document and the Navy's responses to those comments. Appendix D contains the references used in the HRASTM, and is provided on DVD only.

2.0 FACILITY BACKGROUND

This section describes the NAVSTA TI facility, summarizes its history, and discusses the previous HRA.

2.1 FACILITY DESCRIPTION

NAVSTA TI is in the San Francisco Bay (Figure 1), at mid-span of the San Francisco-Oakland Bay Bridge. NAVSTA TI consists of two islands: YBI, a naturally occurring island, and TI, a manmade island built on submerged land (Figure 1). This HRASTM addresses the manmade portion of NAVSTA TI, referred to as TI. TI was divided into eight AOIs based on the nature of available photographic coverage and to facilitate refining the analysis and discussion in this HRASTM (Figure 2). The property on YBI has not been included in this HRASTM because CDPH concurred that areas on YBI subject to future property transfers are not radiologically contaminated (CDPH 2011b).

2.2 FACILITY HISTORY

Military activities at NAVSTA TI date back to 1866, before the construction of TI, when the U.S. government took possession of YBI for defensive fortifications. YBI was occupied by the U.S. Department of the Army until 1896, when the Navy assumed operations. The Navy operated the first West Coast naval training station on YBI until 1923, when these activities were transferred to an alternative location in San Diego, California. The portion of NAVSTA TI that is the subject of this HRASTM was built on submerged lands in San Francisco Bay.

When California came into the Union on September 9, 1850, it acquired title to the submerged land and tideland in San Francisco Bay. The land where NAVSTA TI was constructed is in the City and County of San Francisco (CCSF) and north of YBI. In 1933, the State of California granted the CCSF the parcel of land currently containing the NAVSTA TI for construction of a public airport, wharf and dock facilities, and for use as an airfield (Cal Stats of 1933 Chapter 912, August 21, 1933). At that time, seaplanes and land-based airplanes were regularly used in air transportation. The parcel of land (to be filled by dredge material) was a 4,500- by 8,000-foot rectangle. The CCSF was authorized to reclaim, fill, and raise the submerged land. The CCSF received the right to construct a bridge or causeway between the lands to be filled and YBI.

In 1935, the state granted the CCSF the right to use TI for expositions and fairs. From February 1936 through August 1937, the U.S. Army Corps of Engineers (USACE) conducted construction activities on the 403-acre, man-made TI on behalf of the CCSF in preparation for the GGIE. The Yerba Buena Shoals, a 735-acre reef extending north from YBI, was used as the foundation for this work. To build the island, the USACE constructed a perimeter of rock and filled it with millions of tons of silt dredged from the bay and delta (Lee 1969). The GGIE opened in early 1939 and ended in late 1940. The Navy reviewed documents from the GGIE and found limited evidence of the use or presence of radioactive materials during the period prior to Navy ownership of TI. The uses of radioactive materials were limited to the Hall of Science and do not warrant designating the former Hall of Science area as radiologically impacted, as is further discussed in Section 2.2.3. This record was the only found regarding the use or presence of radioactive materials during the GGIE; however, it does not preclude the presence of radioluminescent materials in association with common items such as watches or on instruments associated with the Pan American Clippers.

In response to a request by the Navy, the CCSF leased NAVSTA TI to the Navy in 1941 for the duration of WWII. On February 7, 1942, under the authority of this lease, TI became a major naval station, processing approximately 12,000 military personnel per day for service overseas and on their return to the U.S. In parallel with operations under the lease, Congress enacted the Naval Appropriations Act, Public Law 441, 77th Congress. This act appropriated funds for the acquisition of TI. Congress also passed the Second War Powers Act of 1942, Public Law 507, 77th Congress, March 27, 1942. This act further broadened the Government's right to condemn land. The Government filed a complaint in condemnation and a declaration of taking on April 17, 1942, in the U.S. District Court in San Francisco, captioned “United States of America v 380 acres of tideland and submerged lands,” Civil No. 22164G. The state and the CCSF were named as defendants. Both the state and CCSF contested the condemnation that was ultimately settled, and the Final Judgment in the case was filed April 3, 1944, granting the government the lands described in the condemnation action in fee simple absolute.

During WWII, NAVSTA TI was used primarily for training, administration, housing, as an urgent care hospital, as a repair yard for small vessels, and other support services to the U.S. Pacific Fleet. After the war ended in 1945, the CCSF agreed to trade the deed for TI to the Navy in exchange for government-owned land south of San Francisco, where the San Francisco International Airport was eventually built. Major naval organizations at TI included the U.S. Naval Station itself, which provided varied support for elements of the U.S. Pacific Fleet and administers to the island's many tenant commands and units; Headquarters offices of the

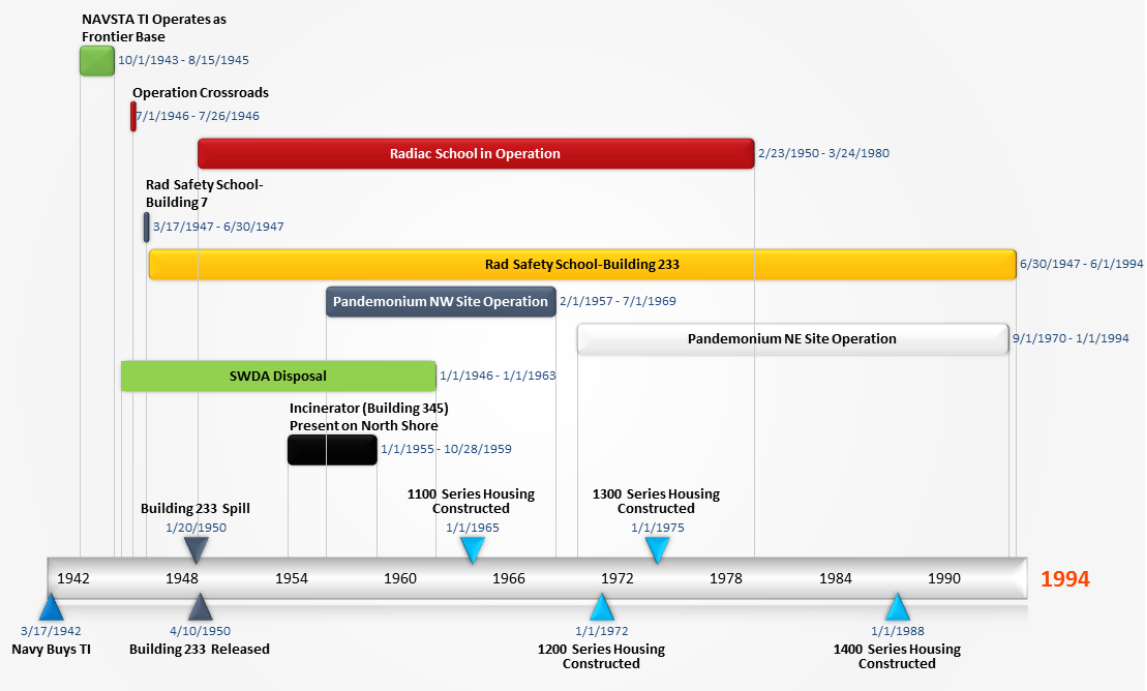
Commandant Twelfth Naval District and the Commander; Western Sea Frontier; the Navy Regional Naval Schools Command; the Navy Regional Finance Center; and the Naval Training Center.

In 1993, the Defense Base Realignment and Closure (BRAC) Commission recommended closure of NAVSTA TI pursuant to the Defense Base Closure and Realignment Act of 1990 (Pub. L. 101-510, Title XXIX, Title 10 *United States Code* § 2687 note). NAVSTA TI was closed on September 30, 1997. CCSF is the target recipient of remaining untransferred NAVSTA TI property. In general, many changes to NAVSTA TI have occurred from the start of construction in 1936 to the present. Many of the original exposition buildings no longer exist. The exposition center was replaced by numerous other buildings, parking areas and open space. Family housing replaced the ammunition storage area and former rubbish disposal areas documented in various geotechnical reports (Navy 1965; McCreary Koretsky Engineers 1965). Numerous piers were demolished, especially along the eastern side of NAVSTA TI. Only one major pier, constructed in the late 1980s in the southeast corner of TI, remains.

At the start of WWII, NAVSTA TI was designated a "Section Base" with limited repair capability. The designation and the repair capability were upgraded later in the war to a "Frontier Base," and TI became one of the largest Frontier Bases by supplementing similar repair facilities around the bay area that were overloaded. The Frontier Base took on the important job of completely servicing inshore and offshore operations and voyage and transient repairs for all crafts up to and including 2,200-ton destroyers (Navy 1946a). Further evidence of the magnitude of repair work is provided by Masthead articles that refer to the amount of scrap metal from repair activities at 200,000 pounds per month (Navy 1945a) and the complete replacement of an engine room on LCS 119 (Landing Craft Ship) that was struck by a Japanese Kamikaze (Navy 1945b). Wartime recycling activities, particularly related to ship repair, have historically included radiological impacts to the locations, thus their evaluation in this HRASTM. In addition to ship repair work, evidence was found regarding an optical shop in association with the "Section/Frontier Base" (Navy 1944a, 1945c, 1951b, Undated). Former Navy optical shops at other bases have been found to contain residual radium and thorium contamination. The optical shop on NAVSTA TI was located on the roof of Building 3.

This HRASTM primarily differs from the conclusions of the 2006 HRA as it confirms the presence of LLROs at the SWDAs and at a few other locations within the housing area on TI and it finds that ship repair activities occurred at NAVSTA TI during WWII. After Victory Over Japan Day, August 15, 1945, the designation of Frontier Base was disestablished and NAVSTA TI was designated as a U.S. Navy Small Craft Facility whose previous functions continued on a reduced scale.

The timeline below provides an overview of milestones and operational periods of significance to the radiological history of NAVSTA TI:



Note: (1) The start and end dates for SWDA disposal are based on U.S. Environmental Protection Agency estimates (Weston Solutions, Inc. 2006). Other data suggest disposal in the SWDAs began prior to 1946 and disposal concluded circa 1956.

2.2.1 AOI 1: Seaplane Lagoon Area

AOI 1 consists of half of the causeway between TI and YBI and the land from California Avenue (formerly named 2nd Street) south toward the Seaplane Lagoon (Figure 3). The infrastructure improvements on the uplands in this parcel have not changed substantively since construction for the GGIE in 1939 and 1940, except Building 180 and piers that were built appurtenant to the uplands. Land between buildings in this parcel has remained developed with landscaping or paved surfaces throughout the Navy's ownership. One site in AOI 1 (Building 3) was identified in the HRA as a non-impacted site because, despite the historical storage of instrument check sources in the building, there were no reports the check sources had leaked in the building. This HRASTM concludes that, unrelated to those historical check sources, Building 3 is appropriately designated as radiologically impacted because of the magnitude of ship repair activities historically associated with this building during WWII and the presence of an optical repair shop on the roof of Building 3. Further discussion regarding Building 3 is provided below.

The primary structures in AOI 1 consist of Buildings 1, 2, 3, and 180. Building 1 functioned as an administration building during the GGIE and still does.

The Yerba Buena Club and "Treasure Garden" were built for the GGIE. The Yerba Buena Club was demolished and replaced with a parking lot soon after the end of the GGIE. The Treasure Garden was demolished and Building 180 was constructed in its place beginning in 1942

(see 4 June 1942 aerial photograph on Figure 3). Building 180 was initially used as a hangar and later for transportation shops. Building 2 was the "Hall of Air Transportation" during the GGIE and appears to have continued as a "hanger" through WWII (the building is labeled "Hanger" on a 1946 map [Navy 1976] and Pan American World Airways operated "clippers" from TI throughout the war). Photos 3 and 4 depict the interior of Hangar 2 after the war and show that it remained as relatively open space (a radar facility was built in the building in 1953, and the building was used as a Naval Reserve facility in 1963).

Hangar 3 was the Palace of Fine and Decorative Arts during the GGIE. It is evident from the records reviews and Photo 5 that Building 3 was configured to conduct inside shop work associated with the repair activities associated with the "Section/Frontier Base" operations. Building 3 has been designated as radiologically impacted in this HRASTM because of the potential for those historical ship repair activities to have involved radioactive deck markers and gauges painted with radioluminescent paint. Evidence was found regarding the potential for an optical shop associated with the "Section/Frontier Base" on NAVSTA TI (Navy Undated). Former Navy optical shops at other bases have been found to contain residual radium contamination. The optical shop was on the roof of Building 3 as shown on Photo 6. The plan elevation and details show the presence of sinks and drains in the optical shop and these drains are considered impacted from the point of origin in the shop downstream to the sewer outfall. It is apparent that the 6-inch sanitary sewer line shown on Photo 7 was added sometime after 1943 as it is not shown in earlier drawings. It is therefore likely added in association with the construction of the optical shop (Navy 1944a). As noted in the handwritten note on the plan elevation and details, the optic shop was demolished in 1969. Part of the drain line serving the shop was removed along with the shop, but the majority of the line leading to the pump station remains. There were a number of ship repair piers and two floating dry-docks by the war's end that were dedicated to this activity (see Figure 3, 20 February 1945 aerial photograph). Ship repair activities appear to have ceased sometime in the 1950s; however, it is not clear exactly when these activities ceased.

After WWII, the U.S. began aboveground tests of atomic weapons in the summer of 1946. After the two nuclear weapons detonations of the first of these tests, the Operation Crossroads test series, many of the target ships and support ships were contaminated with radioactive fallout. They were initially decontaminated near the test site by washing down and stripping paint above the waterline and then returned to the continental U.S. for additional decontamination and clearance from radiological restrictions. In the San Francisco Bay area, returning ships were surveyed and underbodies and sea water systems were decontaminated at Hunters Point Shipyard (HPS) and at Mare Island Naval Shipyard by sand blasting and flushing. A radiological history of the ships known to have berthed at NAVSTA TI was provided in the 2006 HRA. The HRA identified at least four Operation Crossroads ships were berthed at NAVSTA TI after they had been decontaminated at HPS and before they were given final clearance. Three of the ships were berthed at NAVSTA TI before they were given operational clearance and one was berthed at Yerba Buena Island, but after having been monitored for radiological contamination. The three TI piers identified as being used for berthing Operation Crossroads ships have all been demolished. The HRA concluded that there is no likelihood of contamination at TI as a result of the berthing of Operation Crossroads ships (Weston Solutions, Inc. 2006).

Even though the HRA did not identify any evidence that returning Operation Crossroads ships had been berthed at TI prior to decontamination, the potential remained a concern with the

overseeing regulatory agencies. As a result, a key research area for this HRASTM was information related to the berthing of Operation Crossroads ships at TI and, in particular, any information that would indicate ships that had been contaminated in an aboveground atomic test either during Operation Crossroads or later tests. Twelfth Naval District records were reviewed for ship movements and berthing following aboveground tests, but no evidence counter to the conclusion of the HRA was found.

On February 25, 2014, an on-line news article asserted that a contaminated barge, YFNB-29, was repaired at NAVSTA TI based on a document the reporters had found during archival research. The evidence would suggest that the assertion is not correct, and this paragraph is included in the HRASTM to correct the record regarding the claim in the news article. As background, barge YFNB-29 was used as a platform to gather fallout resulting from Operation Redwing. Operation Redwing was a United States series of 17 nuclear test detonations from May to July 1956. The tests were conducted at Bikini and Enewetak atolls, and the general objective was to obtain data sufficient to characterize the fallout, interpret the aerial and oceanographic survey results, and check fallout-model theory. According to declassified reports, the Naval Radiological Defense Laboratory (NRDL) that was located at HPS was involved in the instrumentation and testing of fallout from the bomb tests. The source of the document (a drawing showing the locations and levels of radioactive contamination on the barge) is unclear; however, similar documents were found in the HPS archives for other vessels used in the Operation Redwing tests. There is no reference in the identified document to NAVSTA TI. It should be noted that NAVSTA TI had no radiological repair capability and, by 1956, ship repair capacity was limited. Furthermore, the Code 288 referred to in the title block of the document was a designation for a Hunters Point Naval Shipyard department, and the document and information contained within it implies that work on the barge would have been performed at HPS.

Photo 3 Interior of Hangar 2, 1953, showing radar building

Photo 4 Interior of Hangar 2, 1963, label on photo states "Naval Reserve"

Photo 5 Interior of Hangar 3 during WWII repair shop for Frontier Base

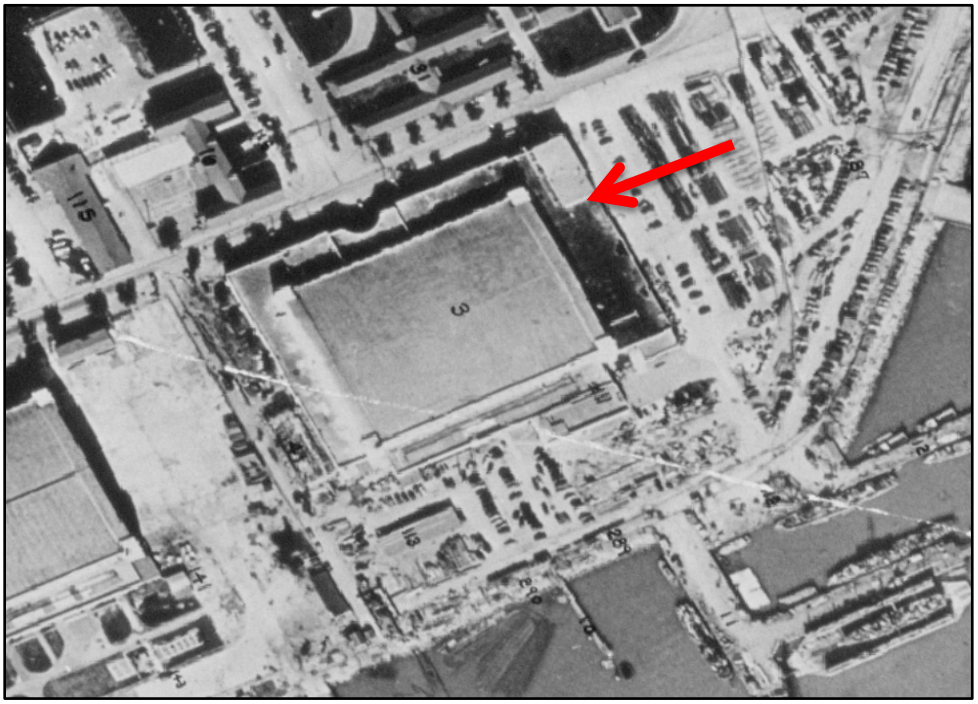


Photo 6 1945 photo showing the presence of the optical shop on the north corner of the Building 3 roof

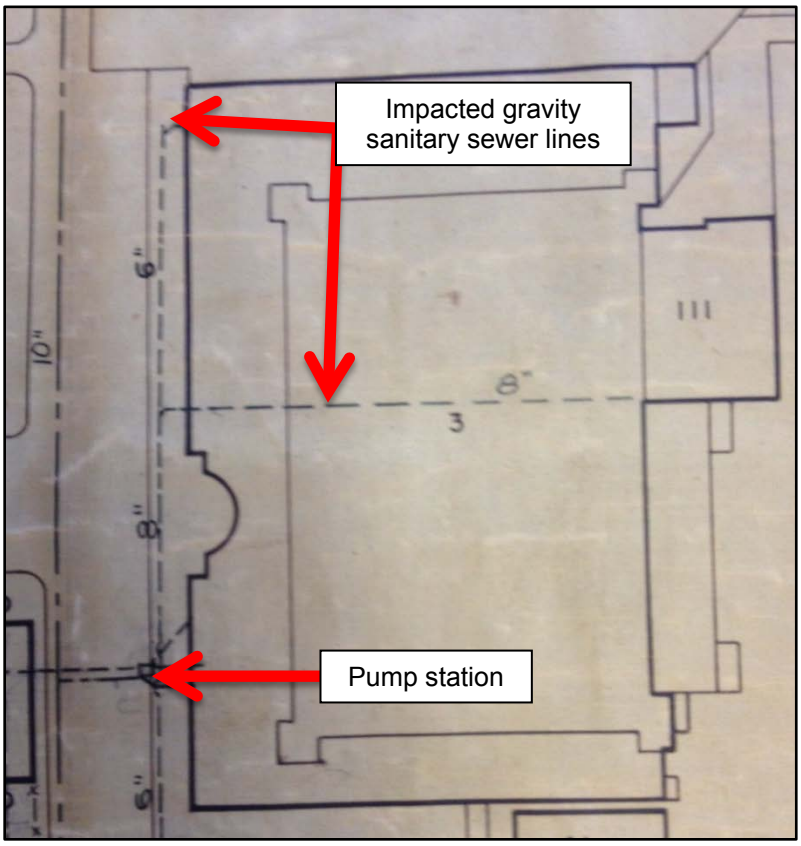


Photo 7 Showing sanitary sewer line in 1946 drawing

2.2.2 AOI 2: Former Hospital Area

AOI 2 consists of the former hospital area and is bounded by the Hospital Barracks and 5th Street to the north, by San Francisco Bay to the east, on the south by California Avenue (formerly 2nd Street), and by H Avenue to the west. Only one site in AOI 2 (Building 233) was identified in the HRA as a radiologically impacted site. The findings of this HRASTM for AOI 2 are consistent with those of the HRA.

AOI 2 is shown in Figure 4 and is composed of three general areas: the hospital area, an open area associated with piers 15 and 16; and the waterfront (Federal Building area). Except for the Federal Building, the GGIE structures in this area (Photo 8) were demolished prior to 1942. By early 1942, the Lake of the Nations had been filled in and construction of the hospital buildings was nearing completion (see Photo 9 and Figure 4). The Lake of the Nations was filled in before Navy operations began, and the footprint of the entire area was developed early in the war and before other Navy operations were expanded on the island. As a result, there is little likelihood that any debris associated with Navy operations would have been disposed of in this area or that any debris would have contained radioactive items associated with those later Navy operations. The Navy recently completed remedial action, including radiological surveys and samples, at the Waterline Replacement Area, Site 33 (Figure 4). Data support the conclusion that soil and asphalt samples from the five separate excavation areas at Site 33 are free of non-naturally occurring Ra-226 contamination. The excavation areas are also free of cesium (Cs)-137 and strontium (Sr)-90 contamination. Therefore, Site 33 was not classified as impacted in this HRASTM.

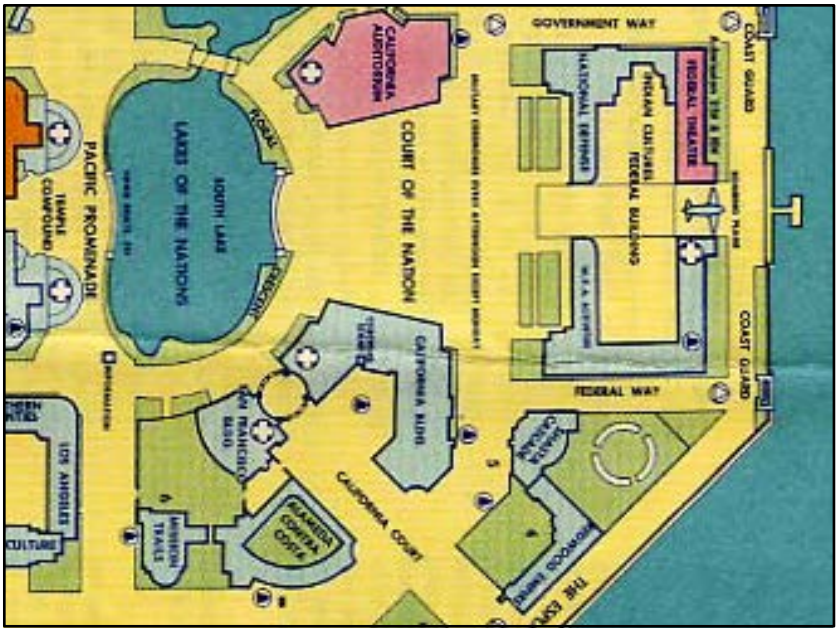


Photo 8 1939 Map of GGIE showing the vicinity of the future hospital area

Photo 9 Early 1942 oblique aerial photo of AOI 2

Building 233 was constructed in 1944 adjacent to the Federal Building (Building 7) and was used beginning in 1947 for the Radiation Safety School. Building 233 was the site of a radium sulfate spill in 1950, documented in the HRA, and was designated as impacted in the HRA. Building 233, the soil around the building, and storm sewers and a sanitary sewer line associated with the building, are currently being remediated. Building 233 has been demolished and building debris disposed of as low-level radioactive waste (LLRW) (Shaw Environmental, Inc. [Shaw] 2014). The soil around the building and parts of the foundation will be characterized and disposed of. A report will be issued documenting a Final Status Survey (FSS) for the site. AOI 2 was built out by the end of WWII and, because it was already developed by that time, there is little likelihood for debris to be disposed of in the AOI during that period. After the end of WWII through the end of the 1950s, there was little change in this area but, beginning in the 1960s and thereafter, structures were periodically demolished and replaced with open grassy areas, or in one case, a ball field. There is no evidence of any debris disposal in AOI 2 during this period or additional radiological activities other than those already documented in the HRA.

2.2.3 AOI 3: Island Core Area

AOI 3 consists of the Island Core area and is bounded by 9th Street to the north, by H Avenue to the east, on the south by California Avenue, and by San Francisco Bay to the west. The HRA concluded that there were no radiologically impacted sites in AOI 3. The findings of this HRASTM for AOI 3 are consistent with those of the HRA.

As part of the research associated with this HRASTM, the Navy conducted web searches for documents from the GGIE and found limited evidence of the use or presence of radioactive materials during the period prior to Navy ownership of TI. Identified uses of radioactive materials included small quantities of irradiated sodium and polonium in cloud chambers, the use of "red spheres" of artificially produced radioactive material in an exhibit called the "radioactive

man," and radium in a projection electroscope at the World's Fair Hall of Science (University of California Berkeley 1940). The "artificially" produced isotopes of sodium and polonium had short half-lives, as would also be expected for the radioactive man red spheres. In addition, the quantities of radioactive material used for cloud chambers would have been de minimis. The radium used in conjunction with the projection electroscope would logically have been returned to the University of California after the GGIE ended. The Hall of Science itself was used as a barracks during the war years and was demolished after the war. The Hall of Science area does not warrant designation as a radiologically impacted site because the isotopes had short half-lives, were likely returned to the University of California after the GGIE, and the building itself was demolished in the 1940s.

During Navy operations, AOI 3 (Figure 5) was historically composed of barracks and administrative areas (Buildings 117, 118, 137, 139, 147, 148, 149, 150, 151, 152, 170, 171, 172, 173, 174, 175, 177, 178, and 179). The area was dominated by four large L-shaped halls during the GGIE (Photo 10). These halls were used as barracks, Buildings 452 and 453, during WWII, and additional barracks and other classroom room and administrative facilities were built around them during the war (see Photo 11 and 1942 and 1947 aerial photographs on Figure 5). Following the war, the halls were demolished and the land was unused until the star barracks were built in the late 1960s. Available aerial photographs do not show the former footprint of the GGIE halls being used for laydown areas or debris disposal areas during the period from when the hall was demolished until construction of the star barracks. The fact that area was not used for laydown or debris disposal is to be expected, as these open areas were surrounded by barracks and administrative areas during this period, making it unlikely that such debris disposal would occur in an active area of the base.

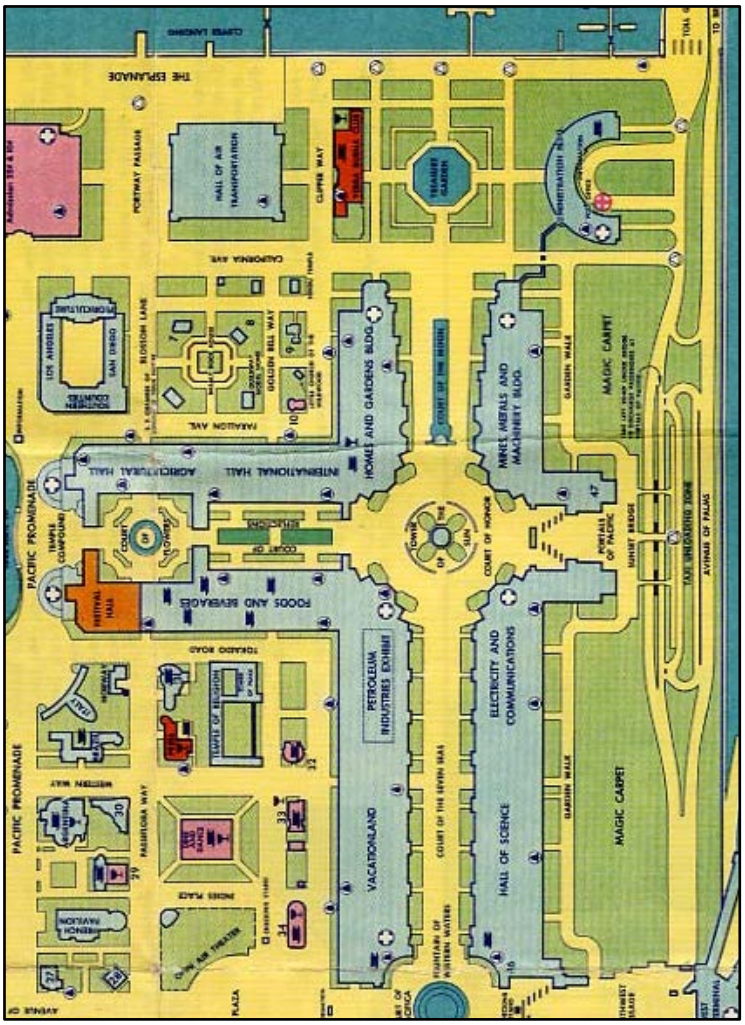


Photo 10 Map showing halls of GGIE

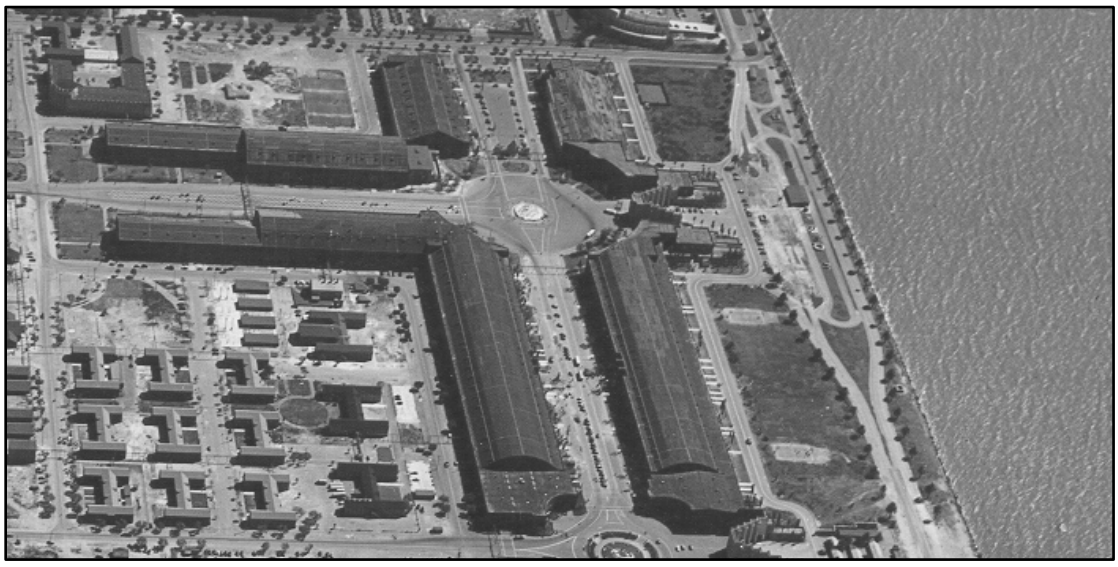


Photo 11 1943 photo of AOI 3

2.2.4 AOI 4: Southwestern Community Area

AOI 4 consists of an area generally associated with community functions during former Navy operations. This area is bounded by 9th Street on the north, by San Francisco Bay on the east, on the south by 5th Street, and by H Avenue on the west. The HRA concluded that in AOI 4, there were two radiologically impacted sites, Buildings 343 and 344. This HRASTM finds that Building 342 in AOI 4 and a former salvage yard known as "Lot 69" should also be considered radiologically impacted.

AOI 4 is shown on Figure 6. Immediately after the GGIE, the Lake of the Nations and all GGIE structures in this AOI were demolished, except the former Hall of Western States and U.S. Army Encampment facilities (Photos 12 and 13). During Navy operations, the area was historically composed of community related functions such as barracks, classrooms, athletic fields, tennis courts, a Navy Exchange, gymnasium, theatre, library, laundry, Enlisted Men's club, Chief Petty Officer club and a heating plant. A large supply warehouse, Building 260, dominated the site (Figure 6).

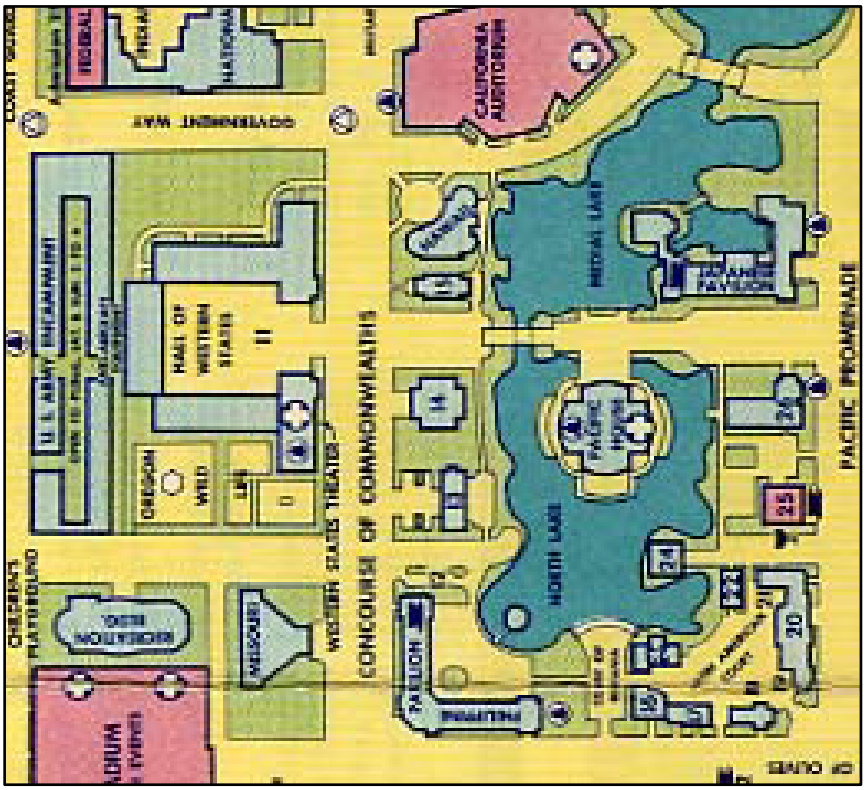


Photo 12 Vicinity of AOI 4 during the GGIE

Photo 13 1942 photograph of AOI 4

After WWII in 1948 and 1949, the former GGIE Hall of Western States and Army encampment were demolished and a picnic area and tennis courts were constructed in the footprint (Figure 6). Based on reviewed base maps, sometime between 1962 and 1968, a Supply Department salvage yard was established east of the tennis courts (see Photo 14 and Figure 6). By 1996, this salvage yard area was referred to as Lot 69 and was listed as a Hazardous Waste Accumulation Area in the Spill Prevention Control and Countermeasures Plan. The northern, larger part of Lot 69 was the nonhazardous storage or staging area for furniture and non-hazardous tools waiting to be disposed of by the Defense Reutilization and Marketing Office (DRMO). South of the lot is a transfer station for solid waste. A general inventory of waste stored in the hazardous waste accumulation area consisted of waste oils, flammables, corrosives, and other regulated materials such as rags, latex paints, and empty paint and flammables containers. Because this area was used as a salvage yard and based on the lack of any other radiological information associated with this site, this HRASTM identifies this salvage yard (Lot 69) as impacted because salvage yards are often linked with the potential for disposal of unregulated LLROs.

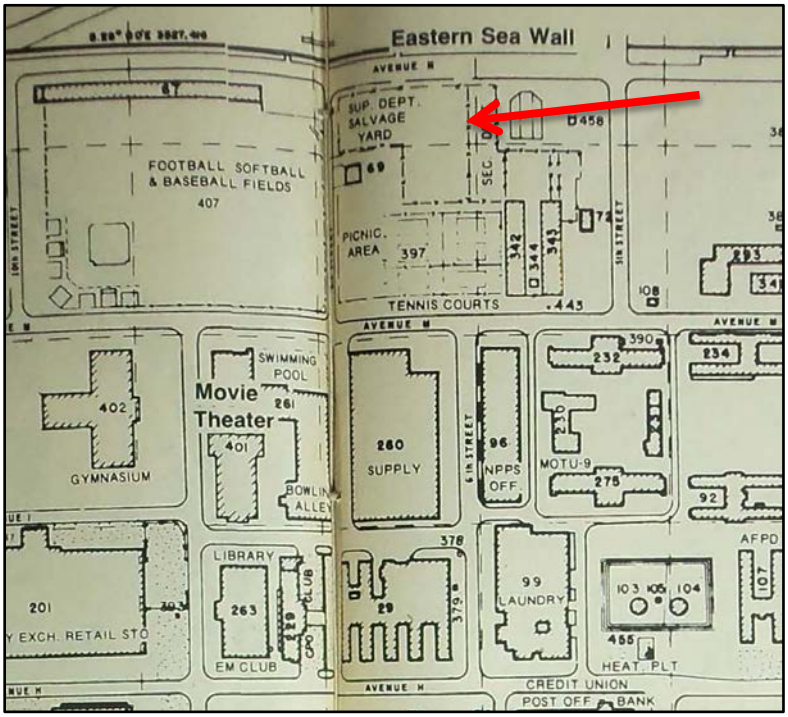


Photo 14 1969 base map showing the Supply Department Salvage Yard

This HRASTM identifies Building 342 and surrounding area (Figure 6) as impacted based on new information indicating that prior use of the building was as a radiological counting room. The counting room would have been used to process samples that may have been handled without encapsulation and warrants designating the building as radiologically impacted. Buildings 343 and 344 were identified as impacted in the HRA. An FSS was recommended for the storeroom in Building 343 and for Building 344. These FSS reports were completed in 2008 (Tetra Tech EC, Inc. 2008a, 2008b). The California Environmental Protection Agency's Department of Toxic Substances Control (DTSC) concurred with the unrestricted release of Buildings 343 and 344 on January 16, 2009, and the CDPH concurred with unrestricted use on November 12, 2008 (DTSC 2009). Based on the FSS reports for Buildings 343 and 344 and DTSC acceptance of unrestricted release of these buildings, no further action is required for these buildings at the time of this HRASTM. The radioactive materials license for the Buildings 342, 343, and 344 compound indicates that the paved area to the rear of the buildings was used for outdoor monitoring exercises with sealed sources. This area has been designated as impacted to allow for the possibility of outside spills or leaks.

2.2.5 AOI 5: Northeastern Community Area

AOI 5 consists of the area referred to as the "Northeastern Community Area" during Navy operations. This AOI is bounded by 13th Street on the north, by San Francisco Bay on the east, 9th Street on the south, and about a block west of H Avenue on the west (Figure 7). The HRA concluded that there were no impacted sites in AOI 5, and the findings of this HRASTM for AOI 5 are consistent with those of the HRA, except Building 570 and an associated outdoor storage area outside the building.

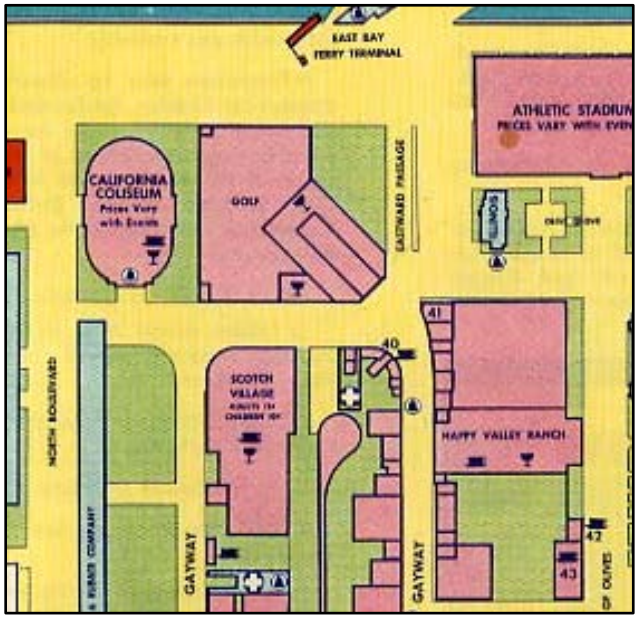


Photo 15 Map of AOI 5 area during the GGIE

After the GGIE, all the facilities shown in Photo 15 were demolished and two parallel runways were constructed (see 1942 aerial photograph on Figure 7). Improvements consisting of a ball field, and related structures were completed so the entire site was developed with facilities by the end of the war (see 1947 aerial photograph on Figure 7). Based on a review of aerial photographs and the 1969 base map, the majority of the wartime structures remained in place in this AOI until the early 1970s when the old barracks began to be dismantled. A firefighting training school was constructed in the southeastern quadrant of this AOI in the late 1980s. File and aerial photograph reviews have not revealed the likelihood of any operations that would cause the area to be designated as impacted, except the Building 570 area discussed below.

Photo 16 Portable gamma spectrometers in Building 570

Building 570 and the surrounding fenced yard was designated as impacted in this HRASTM as a result of the handling and storage of radiologically contaminated items and soil samples (collected from other impacted TI sites) in the building and fenced yard area. Previous and current radiological subcontractors (such as New World Technology, Shaw Environmental, Inc. [now Chicago Bridge & Iron], Gilbane, and Environmental Management System) have used or currently use this area. Use of the area included handling samples from radiologically controlled areas (RCA) and the use of gamma spectrometers in Building 570 (Photo 16 above). These spectrometers were used for quick-turnaround laboratory analysis of soil samples and LLROs found in the SWDAs. The LLROs and soil samples were stored in conex boxes (storage or shipping container) in the fenced compound surrounding Building 570. The use of this area to store radiological materials continues in association with the non-time-critical removal action (NTCRA) in the Site 12 SWDAs.

2.2.6 AOI 6: Sewage Treatment Area

AOI 6 consists of the area referred to as the "Sewage Treatment Area." This area is bounded by San Francisco Bay to the north and east 13th Street on the south, and Avenue I (inclusive of Building 292) to the west (Figure 8). The HRA concluded that there were no impacted sites in AOI 6. The findings of this HRASTM differ from the HRA for AOI 6 by identifying four separate and contiguous areas as radiologically impacted. These four areas are discussed further below and include:

- The former USS *Pandemonium* Site II (NE),
- A potential salvage yard where metal recycling was done during WWII,
- An area referred to as the Site 6 RCA where radioactive materials associated with radiological remedial activities at Site 12 were handled and stored, and
- The area surrounding and including Building 461 that was constructed as part of a new damage control school complex in the late 1960s.

AOI 6 is shown on Figure 8 and Photo 17. The GGIE structures shown on Photo 17 were demolished immediately after the GGIE, except for the warehouse (Building 62) shown in the upper right side of the photo, which is still there. As discussed in the HRA, the USS *Pandemonium* Site II (NE) was in AOI 6 after the USS *Pandemonium* was moved there in 1969 from the west side of the island (USS *Pandemonium* Site I, AOI 8). The HRA concluded that Site II (NE) was not impacted because:

> *"Sealed Cs-137 sources were used for fallout simulation. Leak tests of the Cs-137 sources confirmed there was no leakage. The short-lived liquid isotopes decayed away within three months of last use (1969). There were no reports of instrument check source leakage."*

Although no new information regarding this USS *Pandemonium* Site II (NE) location was found, the HRASTM more conservatively identifies this location to be impacted because of the

potential for contamination to have been spread there or in the surrounding area from the known use of instrument check sources consisting of bagged radium gauges. The use of these gauges was documented in the HRA (HRA reference TI-HRA-57). After the HRA, and unrelated to the USS *Pandemonium* Site II, a removal action was completed in 2009 at Site 32 that included the footprint of the USS *Pandemonium* Site II. This removal was done to address contaminants of concern that included polychlorinated biphenyls (PCB), dioxins, pesticides, total petroleum hydrocarbons, and metals. Much of the soil surrounding the USS *Pandemonium* Site II (NE) was removed during the removal action, including the foundation for the ship, to depths ranging from 2 to 12 feet below ground surface (Shaw 2011a). Radiological sampling was not part of this action, although some screening occurred when excavated soil was delivered to landfills. Landfills typically screen incoming truckloads of soil for radioactivity with sensitive portal monitors and will refuse loads if the delivery causes the portal monitor to sound an alarm. There are no reports that radiological portal monitors had sounded an alarm when the landfills accepted the waste from the removal action at Site 32. The HRASTM identifies the area generally bounded by Site 32 to be impacted, including the holding tanks that remain on site and were associated with the USS *Pandemonium* Site II (NE) operations, and a former office/training buildings (Buildings 461 and 462).

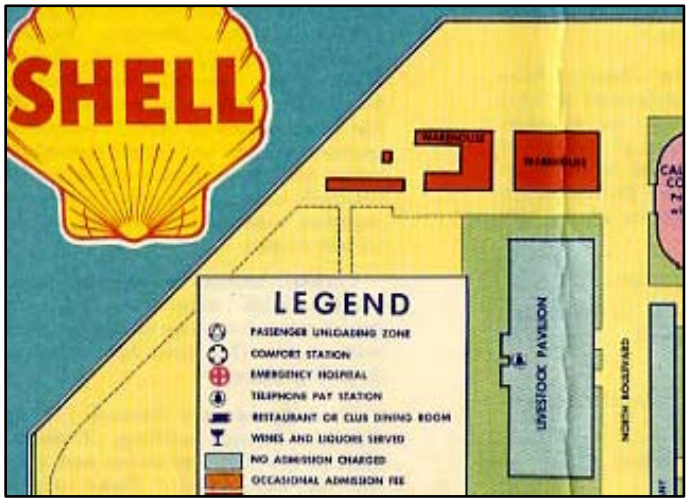


Photo 17 Vicinity of AOI 6 during the GGIE

As noted in Section 2.2, ship repair was ongoing throughout WWII. Those activities generated significant amounts of scrap metal, as evidenced by a *Masthead* article that referred to the amount of scrap metal from repair as 200,000 pounds per month (Navy 1945a). This same article contained a photograph (Photo 18) showing in-progress salvage operations for scrap metal. Salvage yards are typically a concern at ship repair facilities, as there is a potential for impacted sites from processing waste that contains unregulated radioisotopes such as Ra-226. While it is not clear exactly where the salvage area was, it is likely that the area would have been in the open area just south of Building 327 that was identified as a "Salvage Building" in the HRA. Photo 19 is a 1945 aerial photograph of this area and suggests that the area south of Building 327 is likely the pictured salvage yard based on the presence of the buildings in the background of Photo 18. Therefore, this area has been designated as impacted in this HRASTM. As shown on Figure 8, Building 327 was demolished in the 1960s and the impacted salvage yard area is now in the footprint of the sewage treatment plant that was constructed in 1961.

Photo 18 *Masthead* photo showing welders cutting up scrap metal for salvage

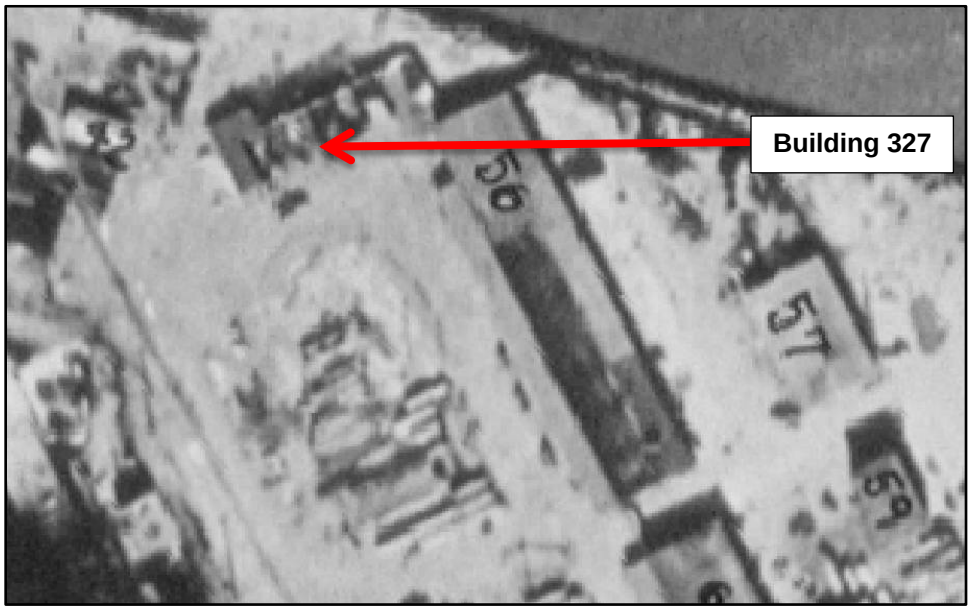


Photo 19 Building 327 and probable salvage yard directly to the south

The third area in AOI 6 to be designated as impacted in this HRASTM is Site 6, an area used for stockpiling, truck loading, and truck decontamination operations in association with previous trenching and removal actions in Site 12 (Figure 8). Based on a review of the work plans for the exploratory trenching and removal actions at Site 12, records indicate that the use of this impacted area for processing soil from the SWDAs began in 2007, after the HRA was finalized in 2006 (Shaw 2012b). Based on the work plans, the soil removed and investigation-derived waste (IDW) from prior trenching actions and removal actions in Site 12 were transported to Site 6 (IT Corporation 2001). During these operations, some potentially radiologically contaminated soil was reportedly transported from SWDA Westside (formerly named A&B) in Site 12 to the Site 6 area in an end loader bucket and in a manner that was not in conformance with established procedures. In response to this incident, the transportation routes were subjected to gamma walkover surveys (CDPH 2011a). Additionally, bins containing radioactively contaminated soil that were filled in Site 12 were emptied at Site 6 and resurveyed (Shaw 2013a, 2013b). This was due to elevated readings on the exterior of the bins which prevented their transport over public roads. Scanning of the material yielded numerous LLROs. Site 6 has since been treated as an RCA by the Navy and its contractors and is considered operationally impacted. Site 6 will be subjected to an FSS following its use as a low-level radiological waste storage area, which is being relocated north of the site. Part of the site is also associated with the historical recycling area to the east.

The fourth area in AOI 6 to be designated as impacted is Building 461 and the surrounding area that was constructed as part of a new damage control school complex in the late 1960s. This area was designated as radiologically impacted to account for the possibility that radioactive materials associated with the former USS *Pandemonium* training complex may have been used in or around the building.

2.2.7 AOI 7: Northern Housing Area of Interest

AOI 7 consists of an area referred to as the "Northern Housing Area of Interest." This area is bounded by 13th Street and a former runway on the south, by San Francisco Bay to the west and north, and by Avenue I to the east (Figure 9), and the area is wholly contained in Site 12. The HRA concluded that the SWDA areas within AOI 7 were radiologically impacted. The findings of this HRASTM differ from the HRA for AOI 7 by identifying the entire housing area (exclusive of the housing structures and the school complex along 12th Street) as radiologically impacted. In addition, this HRASTM provides additional detail regarding AOI 7, including the presence of additional rubbish disposal areas, a salvage yard, and a burn area, and details regarding grading and construction activities in AOI 7.

During the GGIE in 1939 and 1940, the area that now encompasses AOI 7 was unpaved and used for vehicle parking (Photo 20). The Navy constructed ammunition bunkers along the northern portion of AOI 7 after the Navy took over the lease of NAVSTA TI, as seen on the aerial photographs shown on Figure 9. The bunker complex was expanded further throughout the war, and in late 1944 a magazine was established on TI for servicing destroyers and smaller craft. This magazine continued in use until June 1946, when the function was turned over to facilities at Mare Island Naval Shipyard and Port Chicago, Concord Naval Weapons Station (Navy 1946b). It is unclear if the ammunition bunkers were used for ammunition storage after

June 1, 1946, but presumably at least some bunkers continued to be used to store blank rounds and other ordnance required for NAVSTA TI operations after WWII.

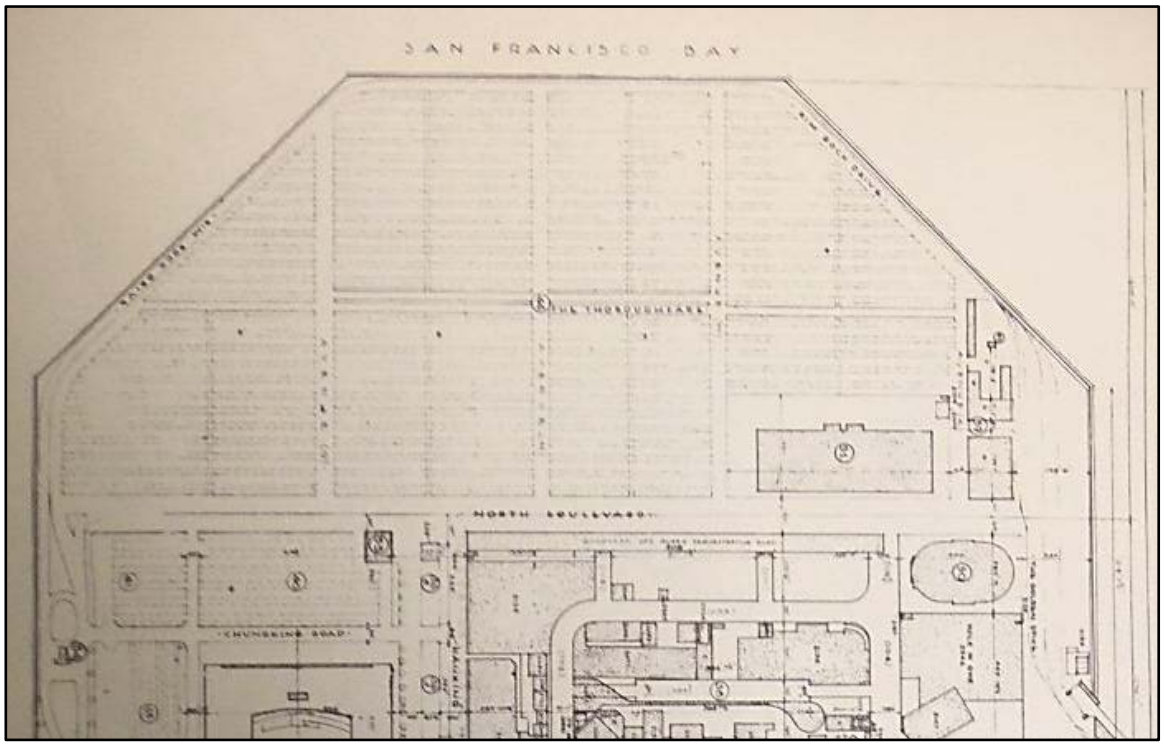


Photo 20 Map of the GGIE showing the parking areas on the north end of TI

In addition to the ammunition bunkers, the other important features in this area of Site 12 include a large recreation field along the southern boundary of AOI 7 (24 March 1947 aerial photograph (Figure 9), an incinerator (Photo 26), a historical burn area (Figure 9), portions of a former salvage yard area currently referred to as SWDA Bigelow Court, two former rubbish disposal areas, and SWDAs that were discussed in the HRA.

The CSM for the housing area provides that grading associated with construction of the housing disturbed and redistributed LLROs or contamination from the SWDAs to areas outside of the SWDAs and throughout the housing area. Housing structures themselves have not been impacted because movement of the LLROs would not have affected the structures themselves. Historical soil movement within the housing area was reviewed as part of this HRASTM. As seen on Figures 9 and 10, the housing area was built in phases over time. The 1100 series housing area was constructed in 1965; the 1200 series housing area was constructed in 1972; the 1300 series housing area was constructed in 1974 and 1975; and the 1400 series housing area was constructed in 1988 (see timeline in Section 2.2). In particular, soil movement and grading associated with construction of the housing areas was reviewed. This review was conducted to better identify the process that may have distributed the LLROs from the SWDAs to areas outside of those SWDAs (Navy 1965).

The grading plans for the 1100 series and 1200 series housing areas that were constructed first in 1965 identify five features of interest: areas where rubbish disposal took place, areas covered by existing structures, areas covered by pavement, open areas, and areas outside of the fenced boundary lines of the housing project areas. A Navy record drawing provides grading instructions for the 1100 series (Building numbers 1101 through 1149, as shown on Figure 9) (Navy 1965) and a soil investigation provides recommendations for the 1200 series (Building numbers 1201 through 1254, as shown on Figure 9) (McCreary Koretsky Engineers 1965). The grading instructions for both the 1100 and 1200 series housing are the same and provided the following requirements that could have resulted in excavation of LLROs from the SWDAs or rubbish disposal areas and thus depositing them elsewhere within the footprint of the housing areas:

- **Areas where rubbish disposal took place:** This category includes the SWDAs along the perimeter of the island and two non-contiguous areas located within AOI 7, as shown on Figure 9. According to the construction plans, these areas were to be excavated to an elevation not higher than +2 feet above sea level. The grade exposed by the excavation was then compacted by equipment, the rubbish thoroughly mixed with clean sand from adjacent excavations, after which it was to be replaced in the excavation by tamping with heavy equipment, and crushing to eliminate voids. Large pieces of debris that would not reduce to a small size by the weight of the equipment were to be removed. Rubbish was not to be placed within 2 feet of the base of foundations, and clean sand or earth from the bunker demolitions, was to be placed over the reworked fill and compacted. This process would have likely displaced some rubbish outside of the defined rubbish areas during the process of excavation, mixing, compaction, and refilling to grade. It is assumed that excavated materials would have been stockpiled within the project boundary shown in Photo 21 for the 1100 series housing; and Photos 22 and 23 for the 1200 series housing. These grading activities had the potential to distribute rubbish from the rubbish disposal areas anywhere within the combined project areas and contractors work and storage areas. In addition, recent work has found isolated cases where rubbish remains within 2 feet of the base of the foundations, despite the grading plan requirements.

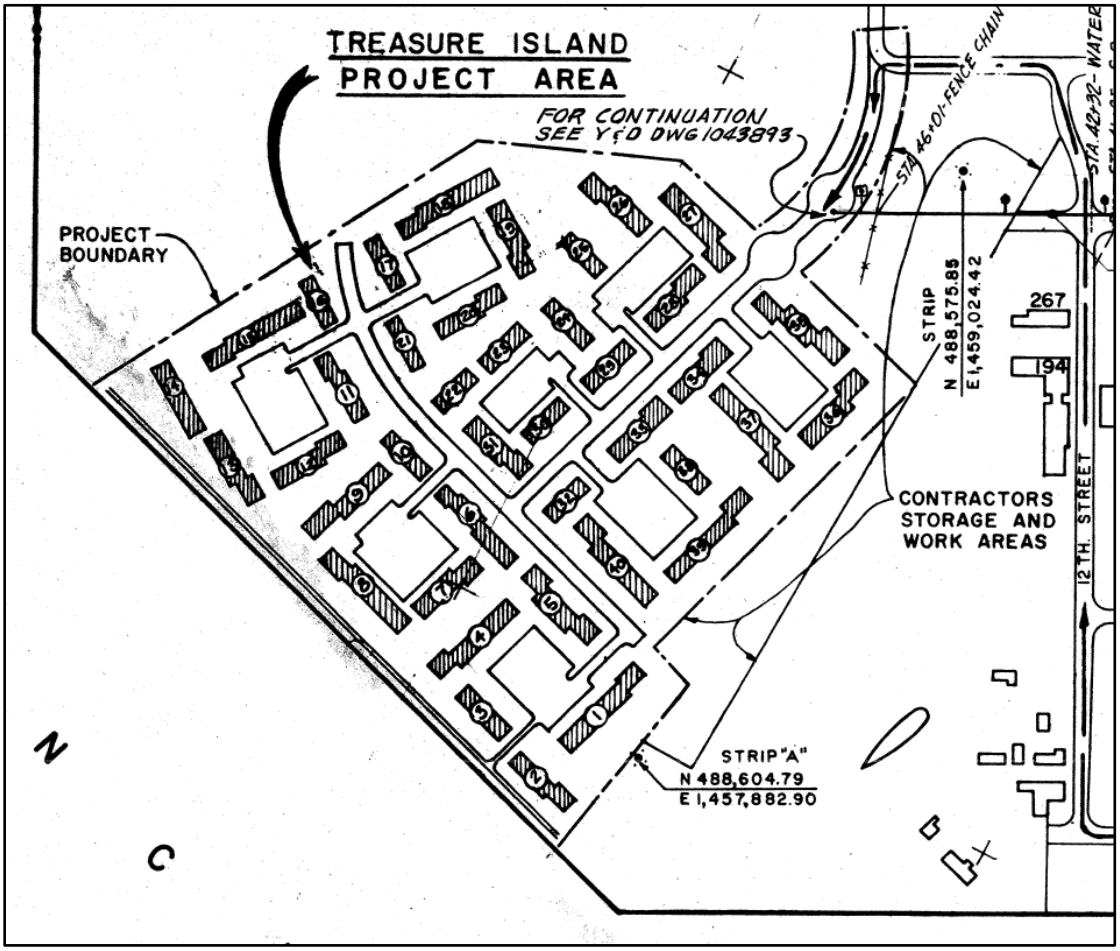


Photo 21 1100 Series housing project boundary and contractors storage and work areas (Navy 1965)

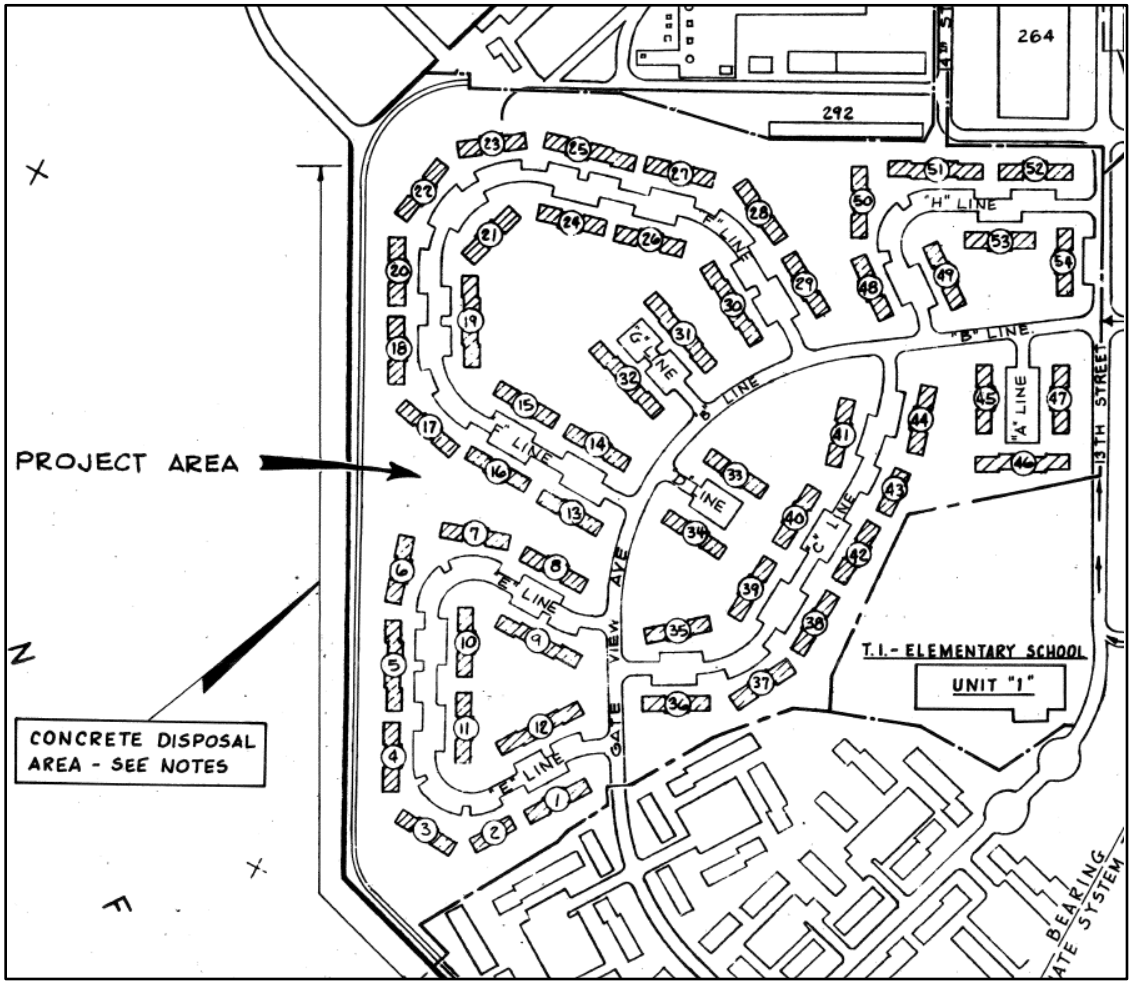


Photo 22 1200 Series housing project boundary (Navy 1968)

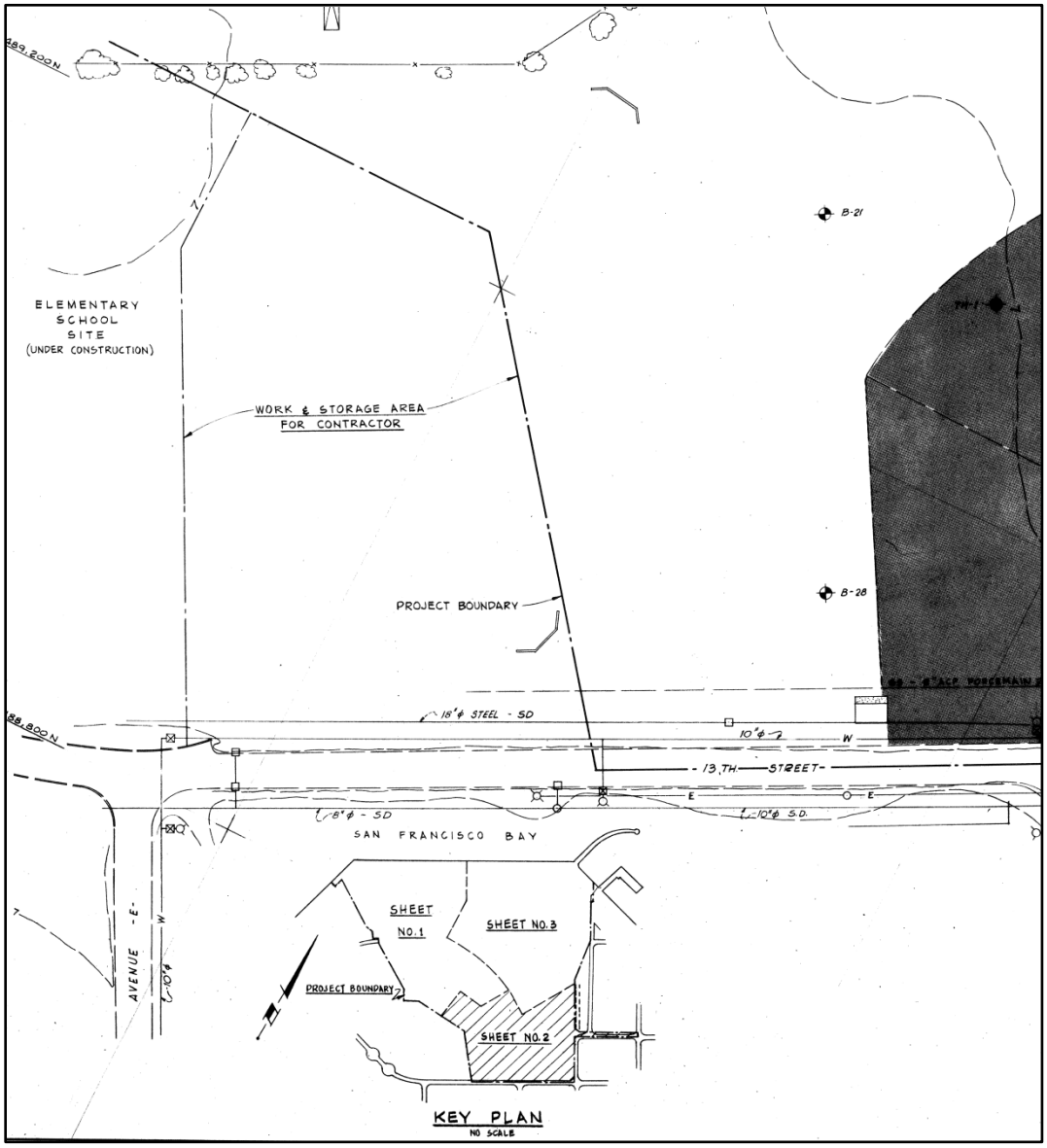


Photo 23 1200 Series housing contractors storage and work areas (Navy 1968)

- **Areas covered by existing structures**: This category refers to the ammunition bunkers formerly located in AOI 7. There were two sets of bunkers on the property: small bunkers built immediately after the Navy acquired the property in early 1942 (Photo 24), and larger pile-supported bunkers built in 1944 (Photo 25). The concrete portion of the bunkers was to be either removed from the site, broken into pieces not exceeding a 1 foot maximum dimension, and placed in reworked fills at a depth not less than 2 feet below the base of foundations; or broken into pieces smaller than a cubic yard and deposited along the seawall adjacent to the 1200 series housing (Navy 1968). Earth materials obtained from bunker demolition were allowed to be placed in fills (Navy 1965). Because the larger bunkers were supported by piles, the plans called for digging down at least 6 feet around the bunkers and breaking or cutting off the pilings. These excavations within the rubbish disposal areas had the potential to bring rubbish to the surface.

Photo 24 1942 Aerial photograph showing smaller ammunition storage bunkers on the north end of the Island

Photo 25 1942 Aerial photograph showing larger ammunition storage bunkers on the north end of the island

- **Areas covered by pavement and open areas:** These areas were addressed in the same manner as "Areas where rubbish disposal took place" discussed above (be excavated to an elevation not higher than +2 feet above sea level. The grade exposed by the excavation was then compacted by passage of equipment…").

- **Areas outside of the fenced boundary lines of the housing project area:** A former elementary school is located in the south-central portion of AOI 7. The school consists of an open area and Buildings 33-E, 33-F, 33-G, and 33-H. This area has not been impacted because it has functioned as a playing field since the early 1940s. Aerial photographs show that it remained undisturbed after construction of the 1100 series housing part because the project boundary between the 1100 series housing and the current school site was fenced and prevented housing grading from disturbing the future school site. After construction of the 1100 series housing, Buildings 33-E and 33-F of the elementary school were constructed and then the 1200 series housing was built along the northern and eastern boundaries of the school site. Once again, fenced boundaries prevented grading from adjacent housing site from impacting the school site south of the 1200 series housing.

A large incinerator, identified as Building 345 and shown in Photo 26, was present from approximately 1951 to 1952 (Navy 1952) until October 28, 1959, when it was demolished, according to Navy property records (Navy 1959). The incinerator was located in the same footprint as SWDA North Point (formerly named 1231/1233) and, more specifically, close to the foundation of housing unit 1231. There is no evidence that LLROs may have been disposed of in the incinerator, but disposal of such LLROs in incinerators has been noted at other military sites from the same era. For this reason, research associated with this HRASTM focused on obtaining more information regarding disposal of incinerator ash. No information could be found regarding disposal of the ash, and no evidence was found regarding disposal of the ash on TI. This HRASTM concludes it is likely the incinerator ash was disposed of offsite and it is unlikely that LLROs were disposed of in the incinerator. This conclusion is based on the fact that the quantity of ash created by an incinerator the size of Building 345 and operated for 9 years would have been significant; however, no evidence of significant ash disposal has been found on TI. In addition, if LLROs were disposed of in the incinerator, then the ash would contain radioactivity, and it is reasonable to expect that incidental ash containing radioactive contamination from incinerator operations would have been spilled in the immediate area of the incinerator. That ash would be visible in excavations, would result in an increase in area radiation levels, and LLROs found in the area would show evidence of being charred or burned. However, the opposite was found, supporting the conclusion that radioactive material was unlikely to have been disposed of in the incinerator. Ash has not been found in excavations associated with exploratory trenching conducted in 2003 (with the exception of one notation of burned wood and ash in the excavated spoils from 0 to 2 feet from trench 1229F-1) (Shaw 2004) or during NTCRA trenching conducted in 2007 (Shaw 2012b). In addition, no general increase in background radiation readings was noted in the 2007 NTCRA. Furthermore, the LLROs that were found in the general area of Building 1231 (two LLROs found at a depth of 6 inches to 1 foot below ground surface) showed no evidence of charring, as can be seen in Photo 27 from the post-construction summary report for SWDAs Bayside (formerly named 1207/1209) and North Point (Shaw 2012b).

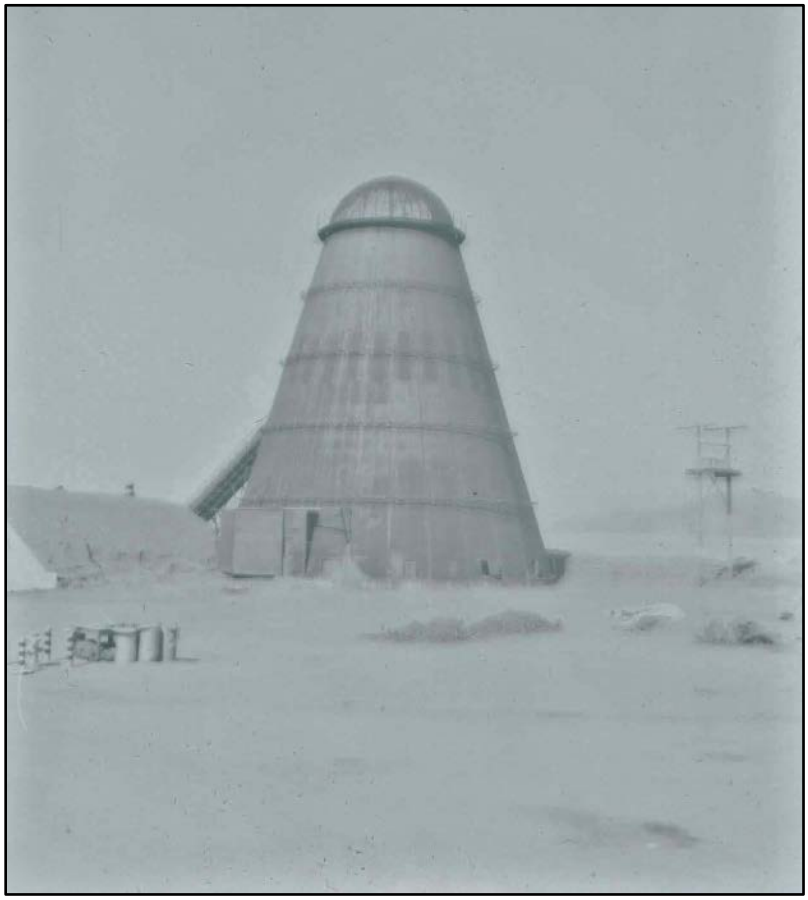


Photo 26 Photograph of incinerator

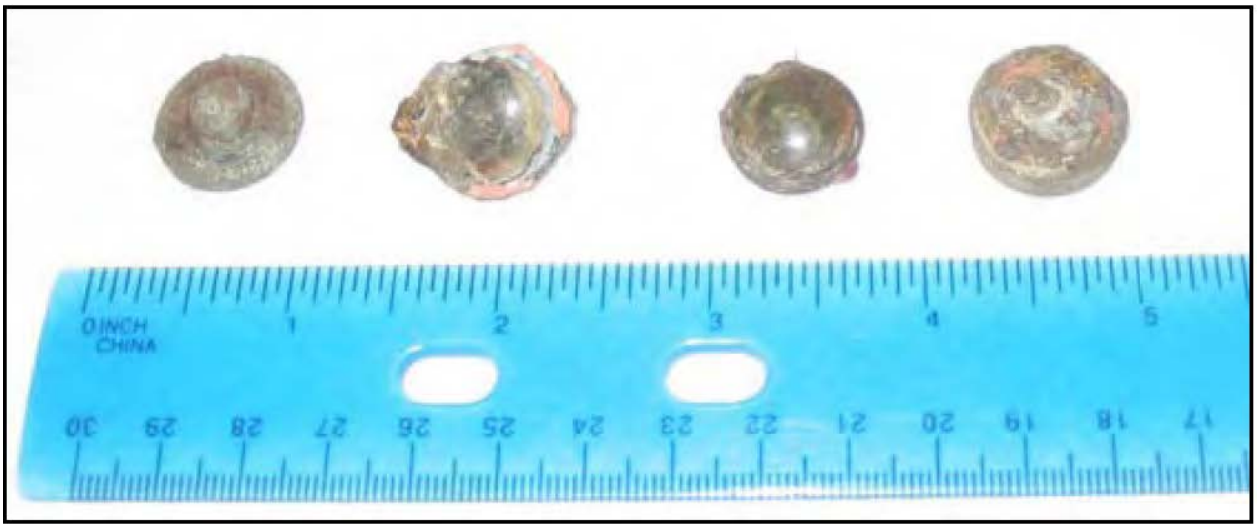


Photo 27 Low-level radiological objects found at SWDAs Bayside and North Point in 2007

Also within AOI 7 were playing fields and a storage/salvage yard. The playing fields were in the southeastern corner and remained in use until housing was constructed in 1969 (see 1947 and 1968

aerial photographs on Figure 9), making it unlikely that any disposal activity would have taken place on the playing fields. In 2009, the Navy conducted a gamma walkover survey of the common area in the North Point Drive housing loop (Navy 2009). All gamma readings during the survey were within background levels, except at one location between Buildings 1244 and 1246. A metallic object about 4 inches round and 1.5 inches deep was thought to be a radioactive gauge and was discovered between the housing units, in the footprint of the former ball field. This gauge likely was transported from a SWDA during construction associated with the housing area.

The storage/salvage yard was in the southwestern corner of AOI 7 and remained in use until housing was constructed in 1966 (see 1947 aerial photograph on Figure 9). The 1947 aerial photo shows this storage/salvage yard being used for storage; a 1962 base map clearly labels it as a "Supply Salvage Yard" (Photo 28). As discussed in a *Masthead* news article, the salvage yard would "receive large, prefabricated sections of steel decking, gun platforms, etc., from the repair and overhaul work at the Industrial Shops" in addition to other scrap steel (Navy 1945a). Salvage yards are typically a concern at ship repair facilities, as there is potential for impacted sites from processing waste containing unregulated radioisotopes such as Ra-226. No records could be found to suggest this area served as a salvage yard during the period when ship repair was ongoing (WWII). This use is evidenced by the fact that a structure is pictured in the immediate background of the salvage yard during the WWII period (Photo 18), and there were no such structures in the area of this storage/salvage yard during the WWII period (Figure 9, 1947 photo inset).

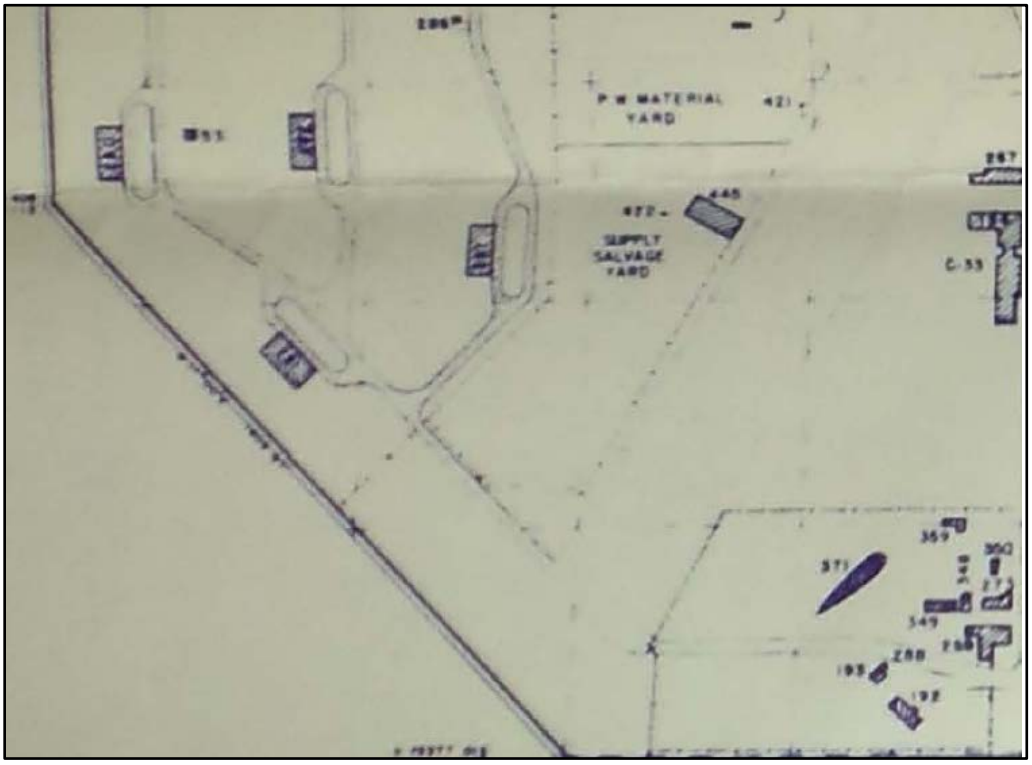


Photo 28 Supply Salvage Yard shown in 1962 base map

Site 12, named the Old Bunker Area and often referred to as the TI housing area, contained a historical burn area (Figure 9). This historical burn area contained wood burn debris near the surface adjacent to Building 1203 (see the trench log for trench 1203A-1 [Shaw 2004]). Site 12 currently contains two-story residential buildings (about 900 housing units) that were constructed with slab-on-grade foundations, with back yards and four to eight residential units per building (Figure 9). Site 12 is flat, consisting of open grassy areas between buildings, paved roads, and parking areas. In 2002, the site boundary was expanded to include all existing residential areas that are encompassed by AOI 7 and AOI 8. Although all of Site 12 has been designated as impacted and further investigation will be done throughout Site 12, various lines of evidence exist to suggest the movement of LLROs outside of the SWDAs by grading was limited within AOI 7 as follows:

- Only 12 (2 percent) of the 610 recovered LLROs have been found outside of the footprint of the SWDAs.

- The footprint of the former playing fields was developed early in the Navy's occupancy and remained in use until housing was constructed in the 1960s. The continuity and type of use limit the possibility of debris disposal prior to grading associated with construction of housing.

- There is no evidence that the footprint of the former storage/salvage yard in Site 12 was a salvage yard during the WWII period when ships were repaired at NAVSTA TI.

- Site 12 was subjected to extensive trenching operations that included radiological screening in 2003 (Shaw 2004). The screening consisted of monitoring the removed soils with a gamma scintillation detector. Once soils were excavated, all four sidewalls of the trench were also monitored and gamma readings were recorded on the trench log forms (Shaw 2003). No data points related to excavated material have indicated the presence of radioactive contamination that would be considered above ambient or would warrant further characterization or concern for worker protection based on the monitoring and action levels prescribed in project procedures. These gamma readings were intended to monitor the immediate health and safety of Shaw's workers in the field and were essentially qualitative. The scope of the Site 12 investigation did not include radiological concerns with respect to site remediation (which would have required the collection of much higher-quality data and be based on more rigorous assessments of risk) (Shaw 2005). Although these data cannot be used to conclusively eliminate the possibility of radiological contamination or characterize subsurface conditions within Site 12, they provide qualitative information on the absence of radiological contamination or LLROs.

- Based on a 1945 aerial photograph, Site 12 also contains portions of an approximately 175,000-square-foot former storage yard overlapping Halyburton Court and SWDA Bigelow Court (TriEco-Tt 2012) (portions of SWDA Bigelow Court are also found in AOI 8). The identity of specific materials stored at the former storage yard prior to the construction of housing is not known. SWDA Bigelow Court is a debris disposal area planned for a remedial action in 2014. However, the former storage yard differs from the SWDAs because waste was not intentionally disposed of in this area. Results from sampling in 2000 indicated soils in the former storage yard area contained PCBs and polycyclic aromatic hydrocarbons (PAH) at concentrations in excess of the action levels protective of human health. Based on these results, the Navy performed a removal action in the former storage yard area. Excavations were from 2.5 to 4 feet deep in the footprint shown in Photo 29 (purple cross-hatched area). While no screening for radiological material was done, the excavated soil was replaced with clean soil from an off-base source. The excavation was not backfilled completely to the final grade because additional removal is necessary in the area near Building 1100. There will be additional excavation in the SWDA Bigelow Court area, as shown in Photo 30 (green area), because in previous investigations between 1995 and 2003, concentrations of dioxins, lead, and PAHs exceeded their action levels and these chemicals of concern may pose a threat to current and future residents and utility workers. There will be screening for radiological materials during the removal action.

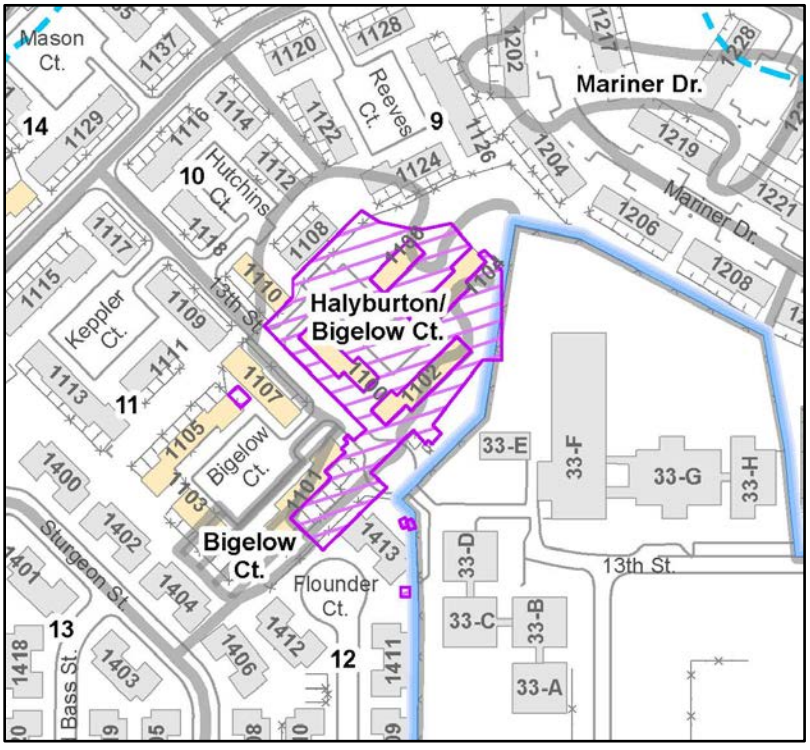


Photo 29 Showing excavated areas at Halyburton and SWDA Bigelow Courts

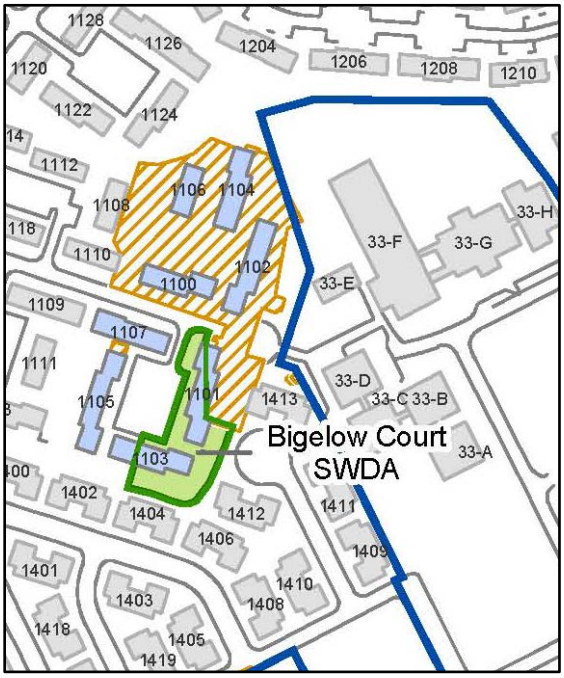


Photo 30 Showing planned excavation area (green) at SWDA Bigelow Court and adjacent to previous Halyburton Court excavation area (gold)

- In 2009, the Navy conducted gamma walkover surveys of the North Point and Bayside areas outside of the areas of the SWDAs of Site 12 (Photo 31). One point source anomaly was discovered during these surveys between housing units 1244 and 1246 that are outside the SWDAs. A gauge was removed from within 1 foot of the ground surface for disposal. No other anomalies were discovered outside the existing SWDAs during those surveys (Navy 2009).

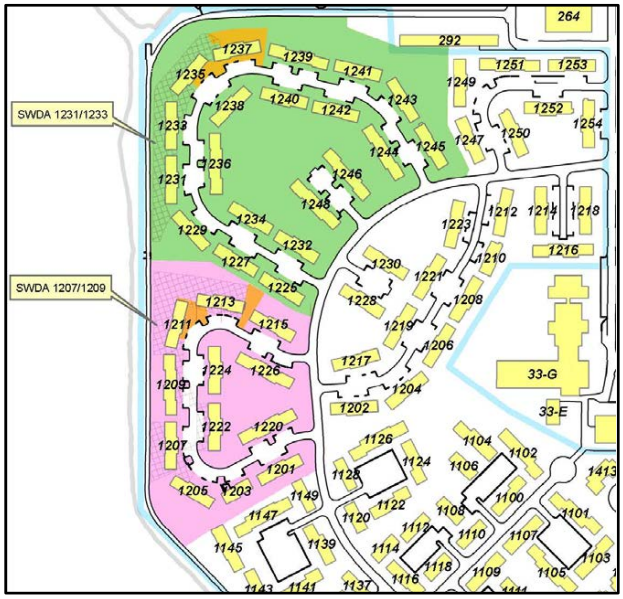


Photo 31 Showing North Point (green) and Bayside (pink) areas subjected to gamma walkover surveys

- In 2011, the California Department of Public Health Radiological Health Branch (CDPH RHB) conducted field surveys on April 5 to 7, 2011, outside of the Site 12 RCAs that were established in association with remedial activities at the SWDAs (CDPH 2011a). The CDPH RHB did not identify any anomalies around the SWDAs other than five areas immediately adjacent to the RCA, where dose levels exceeding public exposure standards were identified. The Navy's contractor immediately expanded the fenced area to include the areas of elevated readings in the RCA. The Navy conducted additional investigations between May 30 and June 5, 2013, of the five anomalies identified by the CDPH RHB in April 2011 (Tetra Tech EC, Inc. 2014). During the investigation, a small fragment of a radioactive foil was recovered at one of the five locations and approximately 3 inches below the ground surface; no other LLROs or areas of elevated soil contamination were found. The recovered LLRO was moved to a designated storage container within the Building 570 compound and is pending off-site disposal (Tetra Tech EC 2014).

- In 2013, CDPH RHB conducted field surveys in open areas outside of housing in Site 12 between March 11 and 22 and identified five anomalous locations with readings above background (CDPH 2013). The Navy immediately conducted additional investigation at those five locations on March 20 and 21, 2013. During the investigation, LLROs were recovered at two of the five locations at 6 inches and 10 inches below ground surface. Both LLROs were moved to a designated storage container within the Building 570 compound and are pending off-site disposal (Tetra Tech EC, Inc. 2014). No LLROs or areas of elevated soil contamination were found associated with the other three elevated locations identified by CDPH RHB (Tetra Tech EC, Inc. 2014).

- The Navy is currently conducting a radiological survey of accessible land areas, including private fenced back yards and paved roadways in Site 12 and selected transportation routes in and near Site 12. Excluded from the scope of the survey are the fenced areas containing SWDAs and vertical structures. While these surveys and related analysis are under way, nine discrete locations with elevated readings were further investigated and LLROs were recovered from the housing area.

- The Navy is currently conducting a surface and subsurface sampling program for the 1400 series housing in Site 12 to develop a definitive and comprehensive data set to determine if the site is impacted by historical Navy radiological activities. The 1400 series housing site was divided into 10 survey units (SU) following Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidelines, ranging from 6,381 square meters (m^2) to 9,325 m^2 of total area. Visual Sample Plan: A Tool for Design and Analysis of Environmental Sampling (VSP), Version 6.5 (Pacific Northwest National Laboratory 2013), was used to develop a sampling plan for the 10 site SUs. A total of 480 samples have been analyzed by gamma spectroscopy. Each Ra-226 result was compared with the project screening criterion of 1.69 picocuries per gram (pCi/g), and none of the results exceeded the screening criterion (report in preparation).

Two new non-contiguous "Rubbish Disposal Areas" were identified during research associated with this HRASTM (Photo 32). Review of historic exploratory trenches exposed loose rubbish buried approximately 4 feet below grade (McCreary, Koretsky Engineers 1965; Navy 1965). The recommendation of the geotechnical report was to remove the rubbish to an elevation of not higher than ± 2 feet, project datum, mix the rubbish with clean sand, and compact the mixture by tamping with heavy equipment. Rubbish disposal areas are considered radiologically impacted based on the correlation between rubbish disposal and LLROs found at other such sites on TI.

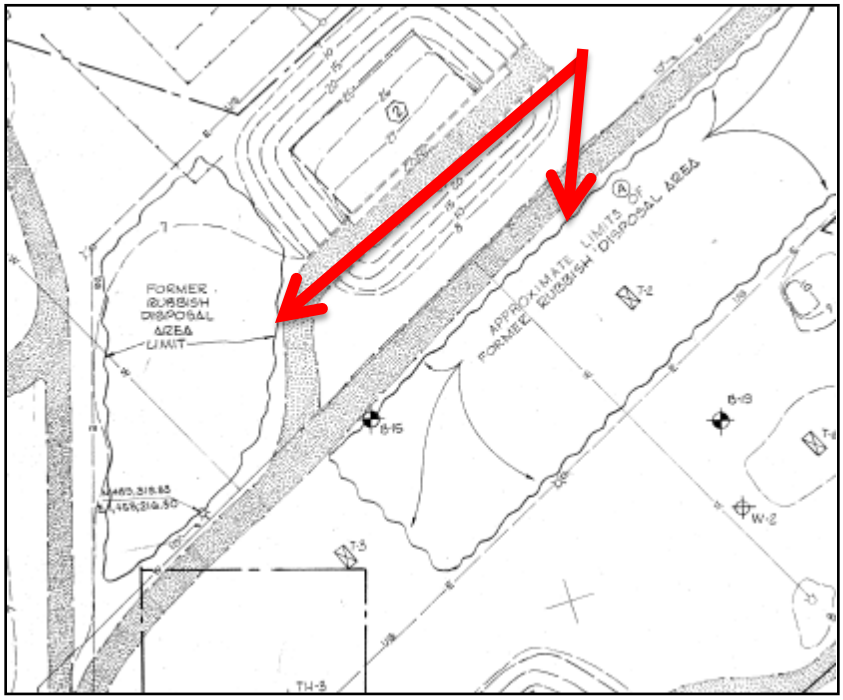


Photo 32 Two rubbish disposal areas
(Note: The lower rubbish disposal area is only partially shown)

2.2.8 AOI 8: Southern Housing Area

AOI 8 consists of an area referred to as the "Southern Housing Area," bounded by Avenue F to the east, 9th Street on the south, and San Francisco Bay to the west (Figure 10). The HRA concluded that the SWDA areas within AOI 8 were radiologically impacted sites. The findings of this HRASTM differ from the HRA for AOI 8 by identifying the entire housing area (exclusive of the footprint surrounding Building 157, a fire station) as radiologically impacted. In addition, this HRASTM provides additional detail regarding AOI 8 including an approximately 175,000-square-foot former storage yard overlapping SWDA Bigelow Court (portions of SWDA Bigelow Court are also located in AOI 7). The HRASTM also designates a former gyro compass repair shop, and a former storage area including Sites 30 and 31 as radiologically impacted. During the GGIE in 1939 and 1940, the northern portion of the area that now encompasses AOI 8 was unpaved and used for vehicle parking, the southern portion of the site was an attraction called the Cavalcade of the Golden West, and the southeastern portion contained part of the amusement park known as the "Gayway" (Photo 33). After the Navy took over the lease of NAVSTA TI, all the GGIE structures in AOI 8 were demolished, except Buildings 155 and 166 (the northernmost buildings of the GGIE exhibit palaces), and a runway was constructed over the northern portion of the site (see 1942 aerial photograph on Figure 10). The AOI was developed or was otherwise in use for laydown areas by the end of the war (see 1947 aerial photograph on Figure 10).

Buildings 156, 224, and 225 were used as gun sheds and a garage. Therefore, it is presumed that the open areas in the southwest quadrant of AOI 8 would have been used for laydown or parking

areas related to these functions during WWII, except the open area around Buildings 269 and 273 that was used for chemical warfare training. The area north of this quadrant and south of the runway appears to have been used for parking. None of these functions or areas was found to have supported activities that would cause them to be designated as radiologically impacted. One open area in the general location of Sites 30 and 31 can be seen on Figure 10 in use as an outdoor storage or laydown area in the 1947 aerial photograph. By 1963, the USS *Pandemonium* Site I (NW) is visible in the aerial photograph, and a number of buildings have been demolished. The 1975 and 2000 aerial photographs show the progression of housing construction on the site. By 2000, all GGIE structures in AOI 8 were demolished and only two WWII era structures remain, Buildings 225 and 257.

This HRASTM considers the former USS *Pandemonium* Site I (NW) as a radiologically impacted area based on a more conservative interpretation of existing information in the 2006 HRA. In addition, this area would also be considered impacted as a result of historical grading activities associated with the housing. Historical aerial photographs show the exhibit structures in AOI 8 were removed after the GGIE ended in 1940. The Navy used the area as a fenced storage area during and after WWII, until it was developed as an elementary school in the 1960s. In April 2002, an as-built drawing from 1989 was discovered indicating that the Navy Public Works Center installed an 8-inch water line down the middle of 11th Street. A note on the as-built drawing for the water line project identified an "old trash dump." Subsequently, a multi-phase investigation and removal action at Site 31 was conducted to delineate the nature and extent of the buried debris. The removal action at Site 31 included monitoring for radiological contamination and a detection of Ra-226 in the sidewall of the excavation was discovered. The detection was the only instance of radiological contamination noted. This HRASTM includes a former storage area around Sites 30 and 31 as a radiologically impacted area.

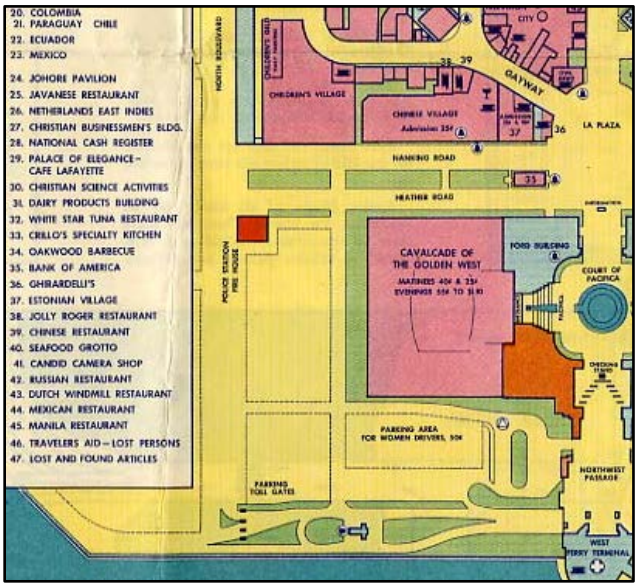


Photo 33 AOI 8 during the GGIE

As discussed in the HRA, the USS *Pandemonium* Site I (NW) was originally in AOI 8, as shown in the 1963 aerial photograph on Figure 10. The training ship mock-up was first put into service

in 1957 and remained in service at this location until July 1969. The gravel-surfaced fenced-off training area was approximately 400 by 600 feet. The area was ultimately regraded and housing was constructed after the USS *Pandemonium* Site I (NW) was relocated in 1969. According to the geotechnical report associated with the housing, it was speculated that the holding tanks used to store contaminated water from training activities were likely "…broken down below grade. While the tank walls have been broken down below grade, it is possible that the base slabs and lower wall portions were left in place and backfilled" (Lowry & Associates 1971).

The radioactive water containing short-lived isotopes was initially allowed to soak into the soil. Later, radioactive water from the decontamination training was collected in the two sub-grade concrete tanks and stored until the short-lived isotopes had decayed. When the radioactivity was within allowable limits, the water was discharged to the San Francisco Bay through a 6-inch pipe. Decontamination training initially used only sealed sources of Cs-137 to simulate radioactive fallout. In 1963, a radioactive material license was granted by the Atomic Energy Commission (AEC) to also use short-lived liquid radioisotopes (bromine [Br]-80, Br-82, sodium [Na]-24, and potassium [K]-42) to more realistically simulate radioactive fallout. Survey instruments containing radioactive check sources were used during the training exercises. The Cs-137 sealed sources were leak tested and were demonstrated to be intact. Because of the short life of the Br-80, Br-82, Na-24, and K-42 isotopes, and because there were periodic leak checks of the Cs-137 sealed sources, this site was designated as non-impacted in the HRA. As noted above, this HRASTM considers the USS *Pandemonium* Site I (NW) area as a radiologically impacted area based on both grading associated with construction of housing and a more conservative estimate that the documented use of unlicensed instrument check sources could have resulted in a spread of contamination. Previous Navy RASO technical assistance visits noted the practice of using non-regulated radium devices as check sources (HRA reference TI-HRA-57), so this HRASTM assumes that such a practice was likely the case at both USS *Pandemonium* Site I (NW) and Site II (NE) locations and may have resulted in a release of radioactive contamination.

At the time of the HRA, no radioactive material had been found in the SWDAs, and the HRA recommended "radiation monitoring during soil excavation of the known solid waste disposal areas." After the 2006 HRA, LLROs were found in each of the SWDAs, with the exception of the SWDA Bigelow Court debris disposal area (which is currently under investigation), confirming the report of radiological disposal at TI. The referenced report is a geotechnical report containing the statement that "discussions with station personnel during our investigation revealed that portions of the proposed construction area have been used for the disposal of debris…and that radioactive and poisonous wastes had been buried west of the abandoned landing strip in a future construction area" (McCreary Koretsky Engineers 1965). No other reports have been found that specifically suggest disposal of radiological waste at Treasure Island. This HRASTM designated the Site 12 housing area (exclusive of the footprint surrounding Building 157, a fire station) as radiologically impacted because, consistent with the CSM, grading associated with construction of housing could have distributed LLROs away from the SWDAs and into the housing areas.

In June 2010, radiological screening was done on a sidewall of an open excavation at Site 31. Elevated count rates were detected (11,000 counts per minute [cpm]) with a contact static

reading of 20,000 cpm. The laboratory background count rate for the detector (Ludlum 44-10) used in the scan survey was 4,517 cpm. After the static reading, approximately 3 inches of soil were removed from the excavation sidewall. A second contact static reading yielded 40,000 cpm. On April 26, 2011, three soil samples were collected near the radiological anomaly at Site 31. Analytical results indicated Ra-226 was present at concentrations exceeding the cleanup goal of background + 1 pCi/g above the mean background concentration in the reference background area; the highest of the three samples collected was 10.8 pCi/g of Ra-226. The remaining excavated material as well as previously stockpiled soil from the excavations was all radiologically scanned. The five gallon bucket of material containing the elevated samples was the only LLRW discovered during the removal actions.

Based on the elevated readings, Site 31 was designated as radiologically impacted; adjacent Site 30 and historical storage yards north and south of Sites 30 and 31 are designated by this HRASTM as radiologically impacted (Shaw 2012a). The entire area is planned for a final status survey.

At the time of the GGIE, a portion of the current recreation field area in the southernmost section of AOI 8 contained Building 168 that was exposition Palace G (General Motors Building). With the exception of Building 168, no known activities occurred on the recreation field that would cause it to be designated as radiologically impacted. A Navy sanitary sewer system map from that period indicates that Building 168 was not serviced by the sanitary sewer system (Navy 1944b) and, therefore, no sinks, drains, or toilets are presumed to have existed in the building.

After the GGIE, Buildings 304, 305, 306, and 326 were constructed on the current site of the recreation field. All buildings have since been demolished. Buildings 304 and 305 were restrooms, Building 306 was a supply office and storage area, and Building 326 was a storage building and gun shed (Weston Solutions, Inc. 2006). After the Navy occupied the property in 1941, Building 168 was used as a gyro compass repair shop from 1942 to about 1948 (see Photo 42). During that time, it is likely that materials painted with radioluminescent paint containing Ra-226 were handled. In 2011, the CDPH RHB collected radiological soil samples and conducted surveys of the current recreation field (CDPH 2012), and as a follow up, the Navy collected soil samples in February 2012 within the recreation field (TestAmerica 2012). Both the CDPH RHB and Navy investigations concluded that additional sampling was warranted based on laboratory analysis indicating elevated levels of Ra-226 and Th-232. Therefore, the area is designated as radiologically impacted as part of the larger housing area as shown on Figure 10.

Although all of Site 12 has been radiologically impacted, the Building 157 area that lies within it has not been impacted. Building 157 is located in AOI 8 and has not been impacted because there is neither any evidence that would indicate it as having been affected by grading associated with the housing nor is there other evidence that radiological materials were used with the footprint of Building 157 area. The following lines of evidence support the conclusion that the Building 157 area was not used for burial of rubbish and not impacted by grading associated with construction of housing in Site 12:

- The Building 157 area did not lay within the project boundaries for construction of housing in Site 12, as shown in Photos 21, 22, and 34 and as shown in the construction as-built drawings (Navy 1965, 1968, 1975, 1988). As a result, it is unlikely that grading activities would have affected Site 20.

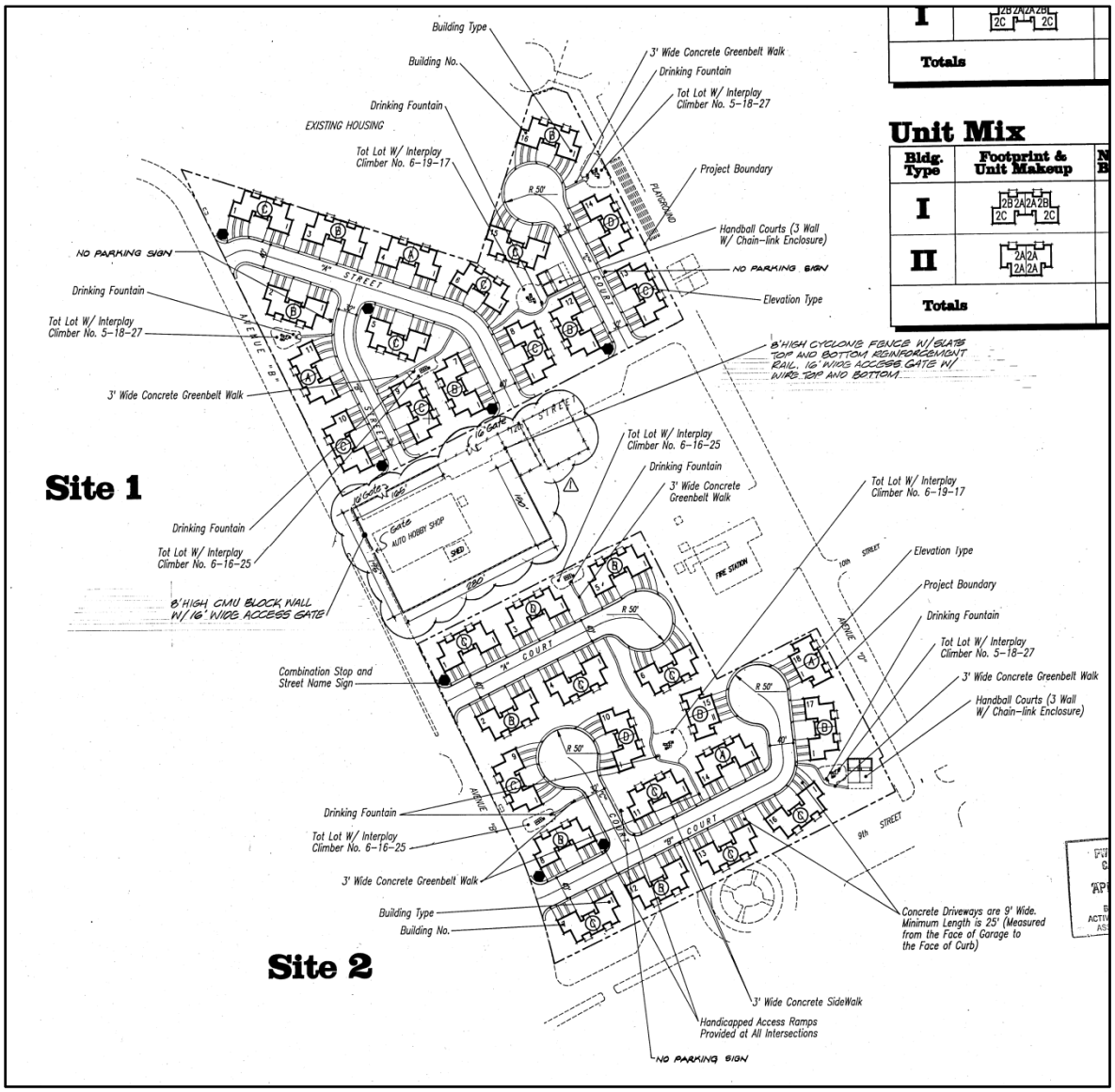


Photo 34 1400 Series project boundaries and fencing/concrete block wall

- The Building 157 area that occupies a rectangular footprint in the south eastern portion of the housing in AOI 8 was built during WWII and is currently fenced. That same fence line can be seen in Photo 35 just prior to the construction of the 1400 series housing. The fact that the fence line was in place prior to the construction of the housing and that it remains in place today makes it unlikely that grading activities associated with the construction of housing would have impacted the fire station.

Photo 35 Fenced Compound surrounding Fire Station, Building 157

2.3 HISTORICAL RADIOLOGICAL ASSESSMENT (HRA)

The Final HRA for NAVSTA TI was published in February 2006 (Weston Solutions Inc. 2006). The HRA provided a comprehensive history of radiological operations by the Navy and its contractors at NAVSTA TI. The HRA was prepared pursuant to the Navy's IRP that encompasses the Navy's BRAC Program, and in accordance with CERCLA and the Superfund Amendments and Reauthorization Act of 1986. The format and content of the HRA followed the guidelines for an HRA established in the Multi-Agency Radiation Survey and Site Investigation Manual (TI-HRA-3).

The primary purpose of the original HRA was to designate sites as radiologically impacted or non-impacted. A radiologically impacted site is one that has, or at one time had, the potential for radioactive contamination, based on historical information, in excess of natural background or fallout levels. In many instances, designation as radiologically impacted does not confirm that radioactive contamination is present, but only that the possibility exists and must be investigated. Sites that were designated as radiologically impacted in the original HRA are shown on Figure 2.

A non-impacted site is one, based on historical documentation or results of previous radiological survey information, where there is no reasonable possibility for residual radioactive contamination. If new historical information becomes available or contamination is found at a non-impacted site, the site would be re-designated as radiologically impacted.

To designate sites as radiologically impacted or non-impacted, the HRA defined the extent of past radiological operations, assessed the likelihood of potential contamination and potential contamination migration pathways, and recommended future actions. Historical radiological operations examined at NAVSTA TI included:

- Training personnel on the calibration, maintenance, and operation of radiation monitoring instruments.
- Training personnel on radiological monitoring, and decontamination of ships and airplanes.
- Berthing of Operation Crossroads ships before the ships were given final radiological clearance or other ships exposed to atomic fallout from subsequent aboveground atomic bomb tests.

Overall, the HRA's review of previous radiological activities, cleanup actions, and release surveys did not identify any imminent threat or substantial risk to human health or the environment of NAVSTA TI or the local community.

3.0 PREVIOUS RADIOLOGICAL OPERATIONS

This section describes the previous use and disposal of materials during radiological operations at NAVSTA TI.

3.1 USE OF RADIOACTIVE MATERIALS

The island was divided into logical AOIs as shown on Figure 2 to investigate the possibility that debris containing radiological materials (such as radioluminescent devices or contaminated debris) was inadvertently or intentionally disposed of on the upland portion of the TI property. Each of these AOIs was reviewed chronologically by reviewing aerial photographs to determine if there was an opportunity during that time for any debris disposal that could contain radioactive materials. Figures 3 through 10 were developed to show each AOI at different times with respect to development of the area. The results of that aerial photograph review are discussed in Section 2.0.

New information was discovered during research for this HRASTM that ship repair took place at NAVSTA TI during the WWII period. In association with ship repair, an optical shop was operated in Building 3. It is likely that unregulated radioactive materials including Ra-226 and thorium (Th)-232 were handled in association with those repair activities. Radiologically contaminated soil and LLROs were discovered to have been disposed of in the SWDAs in Site 12 based on intrusive investigations conducted after the final HRA. In addition, LLROs have been found outside of the SWDAs in various locations within the housing area at Site 12. The locations of LLROs found outside of SWDAs to date are shown on Figure 11.

3.2 DISPOSAL PRACTICES FOR RADIOACTIVE MATERIALS

As documented in the HRA, licensed radioactive materials were properly disposed of at a site off of NAVSTA TI. Based on new information obtained since the final HRA, it is clear that unregulated radioactive material or debris containing unregulated radioactive material was buried in the locations designated as radiologically impacted SWDAs in the HRA. This new information is based on the results of radiological surveys and removal actions in the SWDAs as well as the recommendation in the HRA. Based on elevated gamma scan readings in an excavation at Site 31, the potential exists that unregulated radioactive material or debris containing unregulated radioactive material was disposed of at Site 31, which raises the possibility that additional disposal sites may exist.

4.0 RECENT REMEDIATION ACTIVITIES/PRACTICES

This section addresses work that was done at newly designated radiologically impacted sites and non-impacted sites since the final HRA. Newly identified radiologically impacted sites are discussed in Section 4.1. Sites designated as non-impacted in the HRA are in Section 4.2 and, if appropriate, an updated status is provided. Radiological work done outside the identified radiologically impacted and non-impacted sites is discussed in Section 4.3.

4.1 RADIOLOGICALLY IMPACTED SITES

This section addresses work done at sites designated as radiologically impacted. This section includes sites designated as radiologically impacted at the time of the HRA and sites that were designated as radiologically impacted as part of the HRASTM evaluation. These sites include the former Building 233; Buildings 343 and 344; the entirety of Site 12 and SWDAs Westside, Bayside, and North Point; Building 3 and the associated sanitary sewer system downstream of Building 3; Building 570; former USS *Pandemonium* Sites I and II; a probable former salvage yard site; a waste and clean soil stockpile/loading and decontamination site; a former storage area (Sites 30 and 31); Building 342; a former supply department salvage yard (Lot 69); and Building 461.

4.1.1 Radiologically Impacted Sites Identified in the HRA

This section addresses work at sites designated as radiologically impacted at the time of the HRA. These sites include the former Building 233, Buildings 343 and 344, and SWDAs Westside, Bayside, and North Point.

4.1.1.1 Building 233

Building 233 was the location of the RADIAC Instrument Calibration School. In 1950, a spill of radium sulfate was reported in one of the laboratories in Building 233. Students unknowingly tracked the radiological material throughout the building before the spill was discovered. The NRDL decontaminated and cleaned up the building. Although the floor was decontaminated at the time, the Navy has performed remedial activities and surveys to ensure the 1950 cleanup

meets current standards. Contamination was found throughout the building, which has been demolished and disposed of as LLRW. At the time this report was prepared, the building and foundation have been removed, surface contamination was remediated, and the existing contamination related to storm drains and sewer lines associated with the former building is being characterized. A characterization and FSS work plan will summarize details regarding the site remediation.

A radiological assessment of Building 233 was done and a survey report was issued (Tetra Tech EC, Inc. 2008c). The scoping survey indicated that at least some of the building interior, exterior, and piping was radiologically impacted. It was recommended that the piping be removed and fully surveyed for release during building demolition. A scoping survey of the building completed in September 2007 found contamination under paint in interior areas and areas of elevated readings outside the building. The building was demolished in January 2011 and, at the time of this HRASTM, the Navy is preparing to perform the FSS and complete characterization and remediation of the sanitary and storm sewer systems associated with the building and the surrounding area in accordance with MARSSIM (Revision 1 August 2000).

4.1.1.2 Buildings 343 and 344

Building 343 is one of the three buildings that made up the RADIAC school from the 1950s to the 1970s. The closeout survey by the Navy in a storeroom of Building 343 detected two alpha wipe survey points above release limits. Although these survey points were decontaminated, the HRA found that they had not been adequately investigated and recommended an FSS for the building. Building 344 was the location of a 1988 investigation of contamination in a waste container. The radioactive contamination was cleaned up and disposed of at a location off of NAVSTA TI. Surveys demonstrated that the areas were decontaminated to meet the Navy standards at the time. The HRA recommended an FSS for Building 344.

A MARSSIM FSS of Buildings 343 and 344 occurred in September 2007. In 2008, FSS reports were prepared for Buildings 343 and 344 (Tetra Tech EC, Inc. 2008a, 2008b). The survey reports regarding Buildings 343 and 344 indicated that the results for both buildings met the release criteria and the buildings could be released for unrestricted use. DTSC and CDPH concurred that unrestricted release for Buildings 343 and 344 was appropriate (DTSC 2009).

4.1.1.3 SWDAs Westside, Bayside, and North Point

An NTCRA began in March 2007 at SWDAs Westside, Bayside, and North Point (Shaw 2007a, 2012b). During the NTCRA, several hundred radiological items ranging in Ra-226 content from 0.4 to 6,400 microcuries (µCi) were found in all of the SWDAs. Table 1 lists all LLROs found in Site 12 to date. All LLROs found have either sent off site or are being held pending disposal off site at a low-level radioactive waste disposal site. LLROs are retained on TI until sufficient quantities have been collected and shipment logistics have been arranged. Additional remediation of SWDAs Bayside and North Point is necessary to support free release of the area. As part of this HRASTM, all of the Site 12 housing area that includes SWDAs Westside, Bayside, and North Point was designated as radiologically impacted (see Section 4.1.2.10).

4.1.2 Radiologically Impacted Sites Identified in this HRASTM

This section addresses work at sites not designated as radiologically impacted at the time of the HRA, but that were subsequently designated as radiologically impacted in this HRASTM. These sites include Building 3, Building 570, both former USS *Pandemonium* Sites I and II, a probable former salvage yard site, a waste and clean soil stockpile/loading and decontamination site, a former storage area (Sites 30 and 31), the asphalted area outside and east of Building 342, the former supply department salvage yard (Lot 69), Building 461 and the area surrounding, and all of the TI housing area the includes former USS *Pandemonium* Site I (NW), Building 168 (a former gyro compass repair shop), SWDA Bigelow Court debris disposal area, a burn area, and two non-contiguous rubbish disposal areas.

4.1.2.1 Building 3

Building 3 was designated as non-impacted in the HRA, and it was subsequently designated as impacted in this HRASTM. In association with other IRP work, a treatability study was done to evaluate cleanup alternatives for contaminated groundwater at Site 21 and operated between August 2005 and August 2010 (Shaw 2011b). Site 21 was originally a 400- by 75-foot-wide area along the shoreline. The site boundary was expanded to include portions of Building 3 and the open area between the building and the shoreline because a dip tank to clean aircraft parts was reportedly located at the southeastern corner of Building 3. The treatability study report was completed in March 2011. A record of decision (ROD) was completed in February 2013, and groundwater monitoring is ongoing. The Site 21 work is not expected to have affected the radiological status of this building. Building 3 has now been designated as radiologically impacted based on the extensive ship repair efforts that occurred in the building during WWII and the presence of the optical shop on the northeastern corner of the roof. The adjacent Building 111 has not been designated as radiologically impacted, as that building's use was restricted to a fire station and firehouse. Since the designation of Building 3 as radiologically impacted, the Navy has conducted a survey of the building roof where the former optical repair shop was located and surveys of the interior of the sanitary sewer system associated with the prior optical shop. The preliminary results of the roof survey and interior of the sanitary sewer system found no surface radiological contamination (report in preparation).

4.1.2.2 Building 570

Building 570 was not identified in the HRA as a radiologically impacted or non-impacted site. Building 570 has been used as an office trailer and laydown area by Navy contractors (Shaw Environmental Inc., Tetra Tech, Environmental Management Services, New World Technology, and Gilbane) in association with remedial activities on NAVSTA TI, including those at Site 12. Building 570 and the surrounding storage yard is now designated as radiologically impacted as discussed in Sections 2.2.5 and 5.2.3 because removal actions in the Site 12 SWDAs that occurred after the HRA involved LLROs and radiologically contaminated soil. Soil samples were stored and counted in the Building 570 area and LLROs were stored in conex boxes in the smaller fenced yard of Building 570 (Photo 36).

Photo 36 Conex boxes used for storage of LLROs in the Building 570 compound

4.1.2.3 USS Pandemonium Site II (NE)

The USS *Pandemonium* Site II (NE) was designated as a non-impacted site in the HRA. No radiological related work has been conducted at the site of the USS *Pandemonium* Site II (NE) (Figure 8) since the HRA. The former training and storage area includes Buildings 461, 462, and 463 (see Figure 8, AOI 6) and is mostly in Site 32. The area has been used as a parking area for vehicles and forklifts, a storage area for hazardous materials and hazardous wastes, a tear gas training area, and as storage for former training facilities. A concrete pad, north of Building 463, formerly held an electrical transformer. The USS *Pandemonium* Site II (NE) is now considered radiologically impacted based on a more conservative estimate of the potential for contamination to have resulted from unlicensed instrument check sources or failure to comply with procedures. The site was also used for radiological decontamination training. The Damage Control School that included a previous site for the USS *Pandemonium* was relocated from the northwestern area (see Section 4.1.2.10.4) to the northeastern area of the base in March 1970. The USS Pandemonium Site II (NE) was removed from the training site and sold for scrap metal prior to the HRA.

After the 2006 HRA was issued, a remedial investigation report for Site 32 recommended a feasibility study (FS). A PCB remediation that also addressed arsenic under the Toxic Substances Control Act was done at Site 32 in March 2010. During this removal, the bulk of the remaining USS *Pandemonium* (NE) infrastructure was removed and portions of the site were excavated between 2 and 12 feet deep (Photo 37). Approximately 790 tons of Class 1 (hazardous) soil was excavated from Site 32 and taken to the Chemical Waste Management, Inc., facility in Kettleman City, California. Approximately 12,700 tons of Class 2 (nonhazardous) soil was excavated from Site 32 and disposed of at the Altamont Landfill in Livermore, California. Concrete and asphalt was broken up and recycled. No liquid waste (wastewater) was generated during field activities; soil excavated from below the water table was dried before it was

transported off-site (Shaw 2011a). Radioactive isotopes were not chemicals of concern at the time of the removal action; however, during excavation work and as a health and safety procedure at that time, the contractor did periodic radiological scans on the hands and feet of personnel and on rubber tires of heavy equipment demobilizing from the site. All scans were done with a Ludlum Model 3 survey meter with a Ludlum 449 or Eberline HP-260 probe. No elevated radiation was detected (Shaw 2011a).

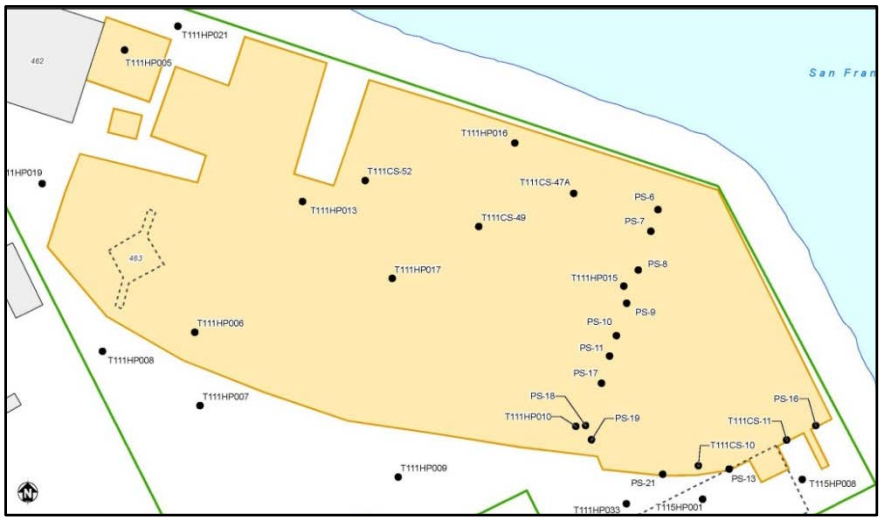


Photo 37 Site 32 excavation footprint (Tan shaded area)

The former USS *Pandemonium* (NE) holding tanks and discharge piping are all that remains of the former ship mock-up and associated infrastructure (Photo 38). This site is currently being characterized with a scoping survey consisting of a gamma walkover survey and solid samples from the holding tanks. The preliminary results of the Site 32 asphalt areas and holding tanks found no surface radiological contamination pending the results of holding tank wall samples (concrete) that were collected in areas of elevated alpha counts (report in preparation).

Photo 38 USS *Pandemonium* Site II holding tanks after interim removal action in 2011

4.1.2.4 Former Salvage Yard Site

The Former Salvage Yard was not identified in the HRA as a radiologically impacted or non-impacted site. No radiological related or other IRP work has been conducted at the Former Salvage Yard site (Figure 8) since the HRA. The site is considered radiologically impacted based on the historical propensity for former salvage yards that handled industrial debris to be radiologically contaminated. The former WWII era salvage yard is in the footprint of the current wastewater treatment plant, as shown in Photo 39 and overlaps the open area directly north of the plant (Site 6).

Photo 39 Current photo of TI waste water treatment plant

4.1.2.5 Waste and Clean Soil Stockpile/Loading and Decontamination Site

The Waste and Clean Soil Stockpile/Loading and Decontamination Site was not identified in the HRA as a radiologically impacted or non-impacted site. The Waste and Clean Soil Stockpile/Loading and Decontamination Site was used as a laydown area by a Navy contractor in association with remedial activities on NAVSTA TI, including those at Site 12. This area is also known as the Site 6 RCA. As discussed in Sections 2.2.6 and 5.2.3, after the HRA, removals in the Site 12 SWDAs involved removal of LLROs and radiologically contaminated soil. Both contaminated and clean soil associated with the Site 12 removals were transported to the Waste and Clean Soil Stockpile/Loading and Decontamination Site temporary storage and, in the case of contaminated soil, repacked for shipment. In late 2012 and early 2013, intrusive activities associated with the aboveground storage tank and UST 240 were conducted within the Site 6 area at NAVSTA TI. A corrective action involving an excavation up to 8 feet in depth was

conducted and 800 cubic yards of soil was excavated and screened for radioactivity. This excavation was conducted utilizing radiological controls because Site 6 had been radiologically impacted (Engineering/Remediation Resources Group, Inc. 2013). During the corrective action, no radiation readings were found above background levels or above the specified release criteria for excavated soil.

4.1.2.6 Former Storage Areas and Sites 30 and 31

The Former Storage Areas and Sites 30 and 31 were not identified in the HRA as radiologically impacted or non-impacted sites. The Former Storage Area consists of the combined footprints of Sites 30 and 31 (Figure 10) and areas north and south of the IR sites. No radiological or other intrusive activities related to the IRP have occurred at Site 30 or the areas north and south of the IR sites since the HRA; however, radiological scoping surveys are planned for the former storage areas and Site 30 in 2014. A time-critical removal action was performed at Site 30 in July 2002. The objective was to remove debris-contaminated soil from areas that (1) were not already covered with a substantial pavement barrier, (2) contained concentrations of lead exceeding the residential preliminary remediation goal of 400 milligrams per kilogram, or (3) contained dioxin toxicity equivalence concentrations exceeding the guideline of DTSC's School Property Evaluation and Cleanup Division of 19.5 nanograms per kilogram. A total of approximately 200 cubic yards of soil was removed from Site 30 during this removal action.

The FS report for Site 31 was finalized in March 2007. The proposed plan/draft remedial action plan was finalized on September 18, 2008, and the public meeting was held on October 7, 2008. The record of decision/remedial action plan was finalized on August 5, 2009. A final soil remediation work plan was submitted January 28, 2010. The soil remediation field work (referred to as Phase I) began in February 2010 and continued through July 2010. This work involved removing soil in the footprints shown in Photo 40. The site is considered radiologically impacted based on the historical propensity for former salvage yards that handled industrial debris to be radiologically contaminated. Elevated radioactivity above background was discovered in the remedial excavation. Laboratory testing confirmed the presence of non-naturally occurring Ra-226, possibly from a deteriorated metal object (though no physical LLRO was observed in the sample). The results of this investigation will be reported in the forthcoming remedial action completion report and FSS for Site 31.

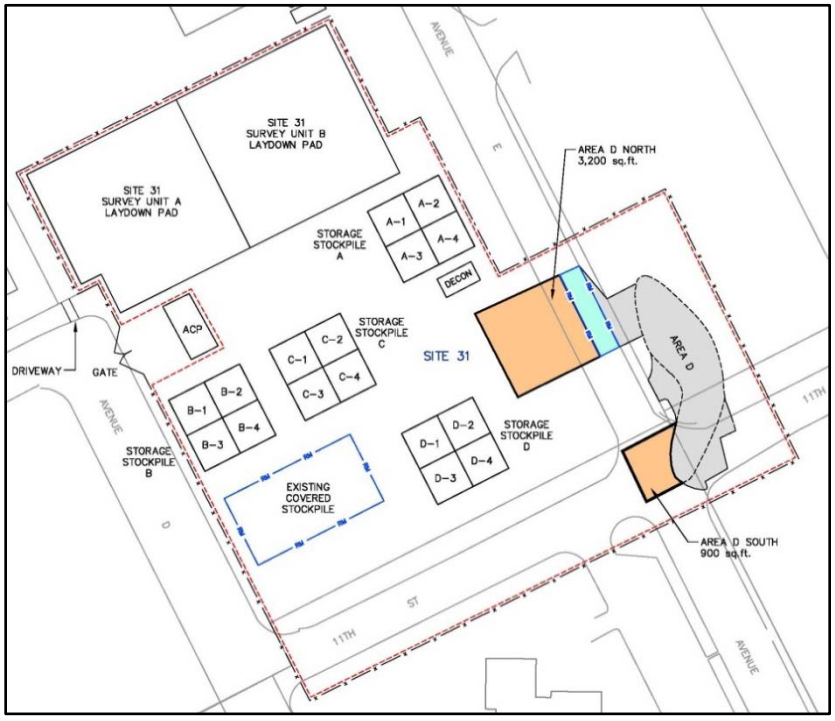


Photo 40 Site 31 Phase II excavation areas (colored portions)

4.1.2.7 Building 342

Building 342 was identified in the HRA as a non-impacted site. It is a metal, one-story building built on a concrete foundation, completed in 1951. As originally configured, this building of approximately 8,000 square feet contained three laboratories of equal size. The building was used for instrument calibration and instruction. Laboratories were used to conduct training exercises and calibrate instruments with sources in fixed locations. The radiation beams from the sealed sources were controlled in specific directions. As stated in the HRA, periodic leak tests of all sealed sources were required by operational procedures. The use of the building was gradually reduced, and the last use of radioactive sources was in 1972. No leakage was reported; however, this HRASTM recommends the building and the fenced yard area outside of the building be considered impacted based on the possibility that prior use may have resulted in contamination (Photo 41). No intrusive work has been done at the site of Building 342 since the HRA, but radiological surveys are planned for 2014/2015.

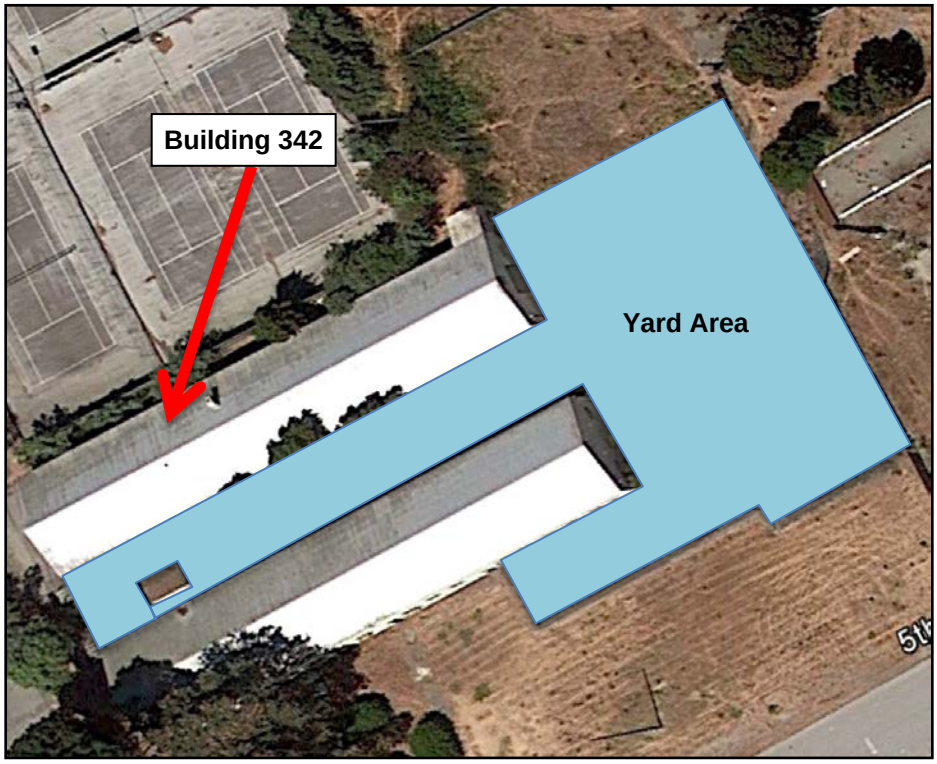


Photo 41 Building 342 and associated yard area

4.1.2.8 Former Supply Department Salvage Yard (Lot 69)

The former supply department salvage yard (Lot 69) was not identified as a radiologically impacted site in the HRA. No records of the storage, release, or disposal of LLROs on Lot 69 were found during the research for this HRASTM. This HRASTM identifies Lot 69 as being radiologically impacted because of its former use as a salvage yard and experience with other salvage yard facilities. No intrusive work has been done at Lot 69 since the HRA, but radiological surveys are planned for 2014/2015.

4.1.2.9 Building 461 Area

Building 461 was identified in the HRA as a non-impacted site. Building 461 was constructed in 1970 and is part of the newer Damage Control School complex that included Buildings 462 and 463 and the training ship mockup, USS *Pandemonium*, after it was moved from the northwest corner of NAVSTA TI. The building was used for Damage Control School classrooms, office space, fire training, and storage of RADIAC instruments with attached check sources that were maintained in the building for use during decontamination exercises on the USS *Pandemonium* (Weston Solutions, Inc. 2006). No check source leakage was reported. This HRASTM recommends the building and surrounding area be considered impacted based on the possibility that training operations may have resulted in residual radioactive contamination. No intrusive work has been done at the Building 461 area since the HRA, but radiological surveys of the building are planned for 2014.

4.1.2.10 Site 12 Housing Area

The HRA concluded that it was unlikely that LLROs had been disposed of in the SWDAs located in Site 12, but recommended radiation monitoring during soil excavations in these areas. This HRASTM identifies the entire footprint of the housing area as radiologically impacted, with the exception of Site 20, as discussed above in Section 2.2.8. The vertical structures (buildings, carports, utility poles, and fences) within Site 12 have not been radiologically impacted. Radiologically contaminated soil and LLROs were discovered to have been disposed of in the SWDAs in Site 12 based on intrusive investigations conducted after the final HRA. In addition, LLROs have been found outside of the SWDAs in various locations within the housing area in Site 12. The locations of LLROs found outside of SWDAs to date are shown on Figure 11. As discussed in Sections 5.2.1 and 5.2.3, CSMs have been developed to account for the LLROs that have been found, presumably resulting from Repair/Solid Waste Disposal and optical shop operations or from spills or contamination from handling contaminated soils from Site 12 SWDAs. These CSMs are shown on Figures 12, 13, and 16. The CSMs address the potential for radioactive contamination originating at the SWDAs that then was spread during grading associated with housing construction or during transport of contaminated soil through Site 12.

After the HRA was published, the following work has occurred within Site 12 to either radiologically characterize or address radiological issues within the site. (The gyro compass repair shop and SWDA Bigelow Court debris disposal area are discussed separately in the following subsections.)

- The CDPH RHB conducted towed array gamma surveys of roadways and areas outside of the Site 12 RCAs that were established in association with the remedial activities at the SWDAs on April 5 to 7, 2011 (CDPH 2011a). This survey found five locations immediately outside of a controlled area with dose rates significantly greater than the annual radiation dose limit (100 millirems/year) for the public; CDPH RHB did not identify any other anomalies around the SWDAs. The Navy immediately adjusted the RCA boundary to include the elevated CDPH readings within the RCA. The CDPH RHB survey also found areas on the roadways of Site 12 with elevated gamma radiation levels that were not previously identified by the Navy as potentially impacted areas. CDPH RHB recommended further investigation of the elevated gross gamma levels found on the streets of Site 12 and the diffused elevated areas of gross gamma measurements around the perimeter of the RCA to characterize the source isotopes.

- The CDPH RHB conducted surveys in open areas outside of housing units in Site 12 in March 2013 (CDPH 2013). As discussed above in Section 2.2.7, those surveys identified five locations with elevated readings. The Navy immediately investigated the five locations, and LLROs were recovered from two of the locations; no LLROs were found at the other three locations identified by CDPH RHB (Tetra Tech EC, Inc. 2014).

- The Navy conducted a radiological survey of accessible land areas, including private fenced back yards and paved roadways in Site 12 and selected transportation routes in and near Site 12. Nine discrete locations with elevated readings in the housing area were further investigated and LLROs were recovered. These gamma walkover surveys are designed to be protective of the public and identify whether any LLROs exist that contribute an unacceptable dose. In addition, the interiors of the housing units are being scanned to determine if LLROs are present beneath the slab foundations. The Navy commenced scanning of the interiors of the housing units in June 2014 and is planned to end in September 2014. The Navy is also conducting a surface and subsurface sampling program for the 1400 series housing in Site 12 to develop a definitive and comprehensive data set to determine if the site is impacted by historical Navy radiological activities. Background surface soil samples were collected from 20 random non-impacted locations at TI. These 20 samples were analyzed for Ra-226 using gamma spectroscopy; the mean Ra-226 concentration in these 20 soil samples is 0.69 pCi/g. The soil screening criterion for Ra-226 is 1 pCi/g above the mean reference area background Ra-226 concentration. To ensure sufficient sampling densities, the 1400 series housing site was divided into 10 SUs following MARSSIM guidelines, ranging from 6,381 m^2 to 9,325 m^2 of total area. The software program VSP, Version 6.5 (Pacific Northwest National Laboratory 2013), was used to develop a sampling plan for the 10 site SUs. A total of 480 samples were analyzed by gamma spectroscopy. Each Ra-226 result was compared with the project screening criterion of 1.69 pCi/g. None of the results exceeded the screening criterion (report in preparation).

Within Site 12 are specific areas that warrant designation as radiologically impacted for reasons in addition to the potential for grading to have spread contamination originating from the SWDAs. These areas are the gyro compass repair shop, SWDA Bigelow Court debris disposal area, rubbish disposal areas, and a burn area. These areas are further discussed in the subsections that follow. Figure 18 provides information on the amount of "cut" or "fill" resulting from grading activities in Site 12.

4.1.2.10.1 Gyro Compass Repair Shop and Recreation Field

At the time of the GGIE, a portion of the current recreation field area contained Building 168 that was the exposition building Palace G (General Motors Building). After the GGIE, Buildings 304, 305, 306, and 326 were constructed on the current site of the recreation field. All buildings in that area have since been demolished. Buildings 304 and 305 were restrooms, Building 306 was a supply office and storage area, and Building 326 was a storage building and gun shed (Weston Solutions, Inc. 2006). After Navy assumed occupancy of the property in 1941, Building 168 was used as a gyro compass repair shop from 1942 to about 1948 (Photo 42). During that time, it is likely that materials painted with radioluminescent paint containing Ra-226 were handled. The gyro compass shop was subsequently demolished. A Navy sanitary sewer system map reviewed from that period indicates that Building 168 was not serviced by the sanitary sewer system (Navy 1944b) and, therefore, no sinks, drains, or toilets are presumed to have existed in the building.

In 2003, the Navy investigated debris and chemicals of concern (COC) in soil in the common areas of Site 12 of NAVSTA TI, including the 9th Street recreation field. The original scoped investigation was done from August 4, 2003, through September 16, 2003, and subsequent step-out investigations occurred on October 15 and 16, 2003. The scope of work included excavating 581 exploration trenches, seven step-out trenches, and seven step-out hand auger locations, logging the trenches for debris sampling, and analyzing soil for COCs, backfilling and restoring trench locations, and sampling, profiling, and disposing of IDW. This investigation was not intended to address the potential for radiological isotopes as a COC, but for health and safety reasons, a sodium iodide scintillation detector for measuring gamma radiation was passed over the excavation sidewalls and excavated spoils to measure gamma radiation levels. An action level of two times background was established for imposing additional control measures in the Site Health and Safety Plan Addendum (Shaw 2003), and no trenches in the recreation field exceeded that limit (Shaw 2005).

Photo 42 Location of impacted area of recreation field

The recreation field was used as an area to establish background radiation levels. As a result, in 2011, the CDPH RHB collected radiological soil samples and conducted surveys of the area (CDPH 2012). In February 2012, the Navy collected soil samples in the recreation field (TestAmerica 2012). Both the CDPH RHB and Navy investigations concluded that additional sampling was warranted based on laboratory analysis indicating elevated levels of Ra-226 and Th-232.

4.1.2.10.2 SWDA Bigelow Court Debris Disposal Area

Based on a 1945 aerial photograph, Site 12 contains an approximately 175,000-square-foot former storage yard overlapping Halyburton and SWDA Bigelow Courts (TriEco-Tt 2012). The identity of specific materials stored at the former storage yard prior to the construction of housing is not known. No evidence of debris disposal was found during prior excavations in the Halyburton Court area. Bigelow Court was designated as an SWDA; however, that designation is now viewed as inappropriate as the term "SWDA" has evolved to imply that household or industrial waste was intentionally disposed of in the area. The only waste found in SWDA Bigelow Court was limited construction debris. SWDA Bigelow Court is planned for a remedial action of non-radiological contaminants of concern in 2014. That remedial action will consist of additional excavation in the SWDA Bigelow Court area, as shown in Photo 29 (green area), because concentrations of dioxins, lead, and PAHs exceeded their action levels in previous investigations between 1995 and 2003, and these COCs may pose a threat to current and future residents and utility workers. Because the SWDA Bigelow Court area was designated as a SWDA and construction debris was found in the subsurface, SWDA Bigelow Court would be identified as radiologically impacted for those reasons alone in addition to the potential for LLROs to be present from grading (Photo 43). In preparation for the remedial action in this area, two residential buildings (1101 and 1103) have been demolished (Figure 10). Radiological surveys were conducted in both buildings prior to demolition. An elevated reading was recorded on the concrete slab floor in one unit at Building 1101. This elevated reading indicated the potential presence of a LLRO beneath the slab. Because of this discovery and other public concerns regarding subsurface radiological contamination, the Navy announced its intent to conduct interior surveys of all of the Site 12 housing units to ensure the safety of the residents. The Navy commenced scanning of the interiors of the housing units in June 2014 and is planned to end in September 2014.

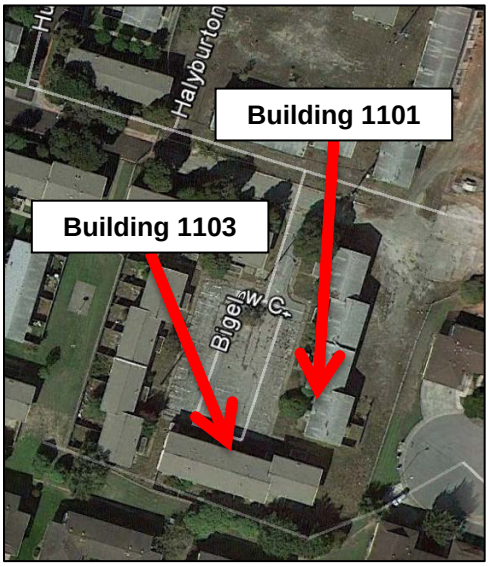


Photo 43 Radiologically impacted area of SWDA Bigelow Court

4.1.2.10.3 Rubbish Disposal Areas and Burn Area

Two non-contiguous "Rubbish Disposal Areas" and a separate "Burn Area" were identified during research associated with this HRASTM. Exploratory trenches exposed loose rubbish buried approximately 4 feet below grade (McCreary, Koretsky Engineers 1965; Navy 1965). These rubbish disposal areas and the burn area are shown as radiologically impacted areas on Figure 9. The recommendation of the geotechnical report was to remove the rubbish to an elevation of not higher than ±2 feet, project datum, mix the rubbish with clean sand, and compact the mixture by tamping with heavy equipment. These areas have been identified as radiologically impacted based on the correlation between rubbish disposal, burning, and LLROs found at other such sites on TI. In addition to the rubbish disposal areas, the TI housing area contained a historical burn area (Figure 9) discussed above in Section 2.2.7. This historical burn area contained wood burn debris near the surface adjacent to Building 1203 (see the trench log for trench 1203A-1; Shaw 2004). No intrusive excavation work has been done in any of these areas since the HRA.

4.1.2.10.4 USS Pandemonium Site I (NW)

The USS *Pandemonium* Site I (NW) was designated as non-impacted in the HRA. Since the HRA, radiological intrusive work has been done in the portion of SWDA Westside that overlies the USS *Pandemonium* Site I (NW) (Figure 10). The entire USS *Pandemonium* Site I (NW) is now considered radiologically impacted based on a more conservative estimate of the potential for contamination to have resulted from unlicensed instrument check sources or failure to comply with procedures regarding leak checking of licensed sources.

4.2 RADIOLOGICALLY NON-IMPACTED SITES

This section addresses work completed since the final HRA at sites designated as radiologically non-impacted in the HRA. Sites that were designated non-impacted in the HRA and that are designated as radiologically impacted in this HRASTM are discussed in Section 4.1.

4.2.1 Former Pier 13

Pier 13 was demolished well before the time of the HRA, so no additional work has been done there since the HRA.

4.2.2 Former Building 7 West Wing

Building 7, including the west wing, was demolished, and no additional work has been done there since the final HRA.

4.2.3 Former Pier 21

Pier 21 was demolished well before the time of the HRA, so no additional work has been done there since the HRA.

4.2.4 Former Buildings 226 and 228

Building 226 and 228 were two identical Bachelor Officer's Quarters. They were multi-story, "E"-shaped structures constructed about 1944. Building 226 was demolished by 1966, and Building 228 was demolished by 1968 (Weston Solutions, Inc. 2006). No IRP intrusive work has been done at the locations of the former Buildings 226 and 228 since the HRA.

4.2.5 Former Building 273

Building 273 was a small, single-story building (Quonset hut type) on a concrete foundation with a concrete and wood superstructure and a corrugated iron roof. It was built in 1944 and was identified on maps and Public Works data as the Chemical Warfare School Decontamination Building. The building was demolished in 1977, and the site was redeveloped with multi-family housing. No intrusive IRP work has been done at the former location of Building 273 since the final HRA.

4.3 OTHER SIGNIFICANT RADIOLOGICALLY-RELATED WORK

This section presents other significant radiological work done after the final HRA.

4.3.1 Site 12 Trenching

The Navy did trenching and sampling throughout Site 12. These trenching investigations began concurrently with the HRA, but the analysis was not completed until after the final HRA was published. The results of the trenching are briefly summarized here because of their significance with respect to the radiological status of Site 12. Although these data cannot be used to conclusively eliminate the possibility of or characterize subsurface conditions within Site 12, they provide qualitative information on the absence of radiological contamination. The Navy excavated 581 exploration trenches, seven step-out trenches, and seven step-out hand auger locations to evaluate potential risks to human health and to make decisions about further remediation at Site 12 (Shaw 2004). The trenching investigation specifically excluded areas previously remediated or that were scheduled for future remediation (the SWDAs) and streets, sidewalks, and parking areas. During the investigation, the trenches and excavated soil were surveyed in the field for gamma radiation for health and safety reasons. As each trench was excavated, a Shaw technician used a Ludlum Model 44-10 2- by 2-inch sodium iodide scintillation counter to take field readings of the trench sidewalls and the excavated soil. The low levels of radioactivity found in these surveys were determined to be caused by natural soil materials (Shaw 2005). While the trenching work was not sufficient or intended to be the basis for radiological release of the site, the extensive nature of the trenching and the fact that the health and safety radiological scanning of the trench sidewalls, bottoms, and removed material found no issues of concern support the fact that higher reading LLROs such as the octagonal foils are not widespread in the soil within the housing area.

4.3.2 CDPH Scans Outside of the Site 12 SWDAs

The CDPH RHB performed scans in areas near the SWDAs, but noted the scans were cursory and were not intended to support conclusions. The survey consisted of a towed array that used 2- by 2-foot sodium-iodide detectors with global positioning system capabilities. The survey was done to assess the radiation exposure along publicly accessible roads in Site 12 and to ensure there are no health and safety risks. The CDPH RHB also did gamma walkover surveys in intervals around the fence line of the RCA at Site 12 (CDPH 2011a). During the gamma walkover survey, CDPH RHB identified five locations with elevated counts — four outside the fence and one under the fence that constituted the RCA for SWDA Westside. The Navy expanded the fence line to encompass these areas in the expanded boundaries of the RCA. Eighty-four out of thousands of locations had been identified above the background level on the roadways, and CDPH considered the elevated locations to be representative of naturally occurring isotopes found in asphalt.

In addition to the April 2011 surveys, the CDPH RHB conducted field surveys in open areas outside of housing in Site 12 in 2013 (CDPH 2013). As discussed above in Section 2.2.7, those surveys identified five locations with elevated readings (Figure 11). The Navy immediately investigated the five locations, and LLROs were recovered from two of the locations; no LLROs were found at the other three locations identified by CDPH RHB and excavated soil was characterized and disposed of (Tetra Tech EC, Inc. 2014).

4.3.3 Site 33

The Waterline Replacement Area, Site 33, was not addressed in the 2006 HRA. However, investigatory activities later found buried debris at the site. Therefore, Site 33 was radiologically characterized during the remedial action in 2012 (Figure 4). The characterization included gamma scans and static surveys of the soil and asphalt. Samples were collected and analyzed that demonstrated the concentration of Ra-226 was less than the release criterion. Sampling was also conducted for Cs-137 and Sr-90. Concentrations of Cs-137 were less than the laboratory minimum detectable concentration (MDC) in every sample. The laboratory MDCs for Cs-137 are less than or in the range of Cs-137 fallout concentrations in surface soil samples collected from undisturbed, non-impacted, background locations in California (McArthur and Miller 1989). In addition, concentrations of Sr-90 were less than the laboratory MDC in every sample. Based on the characterization of radionuclide soil and asphalt samples from five separate excavation areas at Site 33, it was confirmed that Site 33 is free of Ra-226, Cs-137, and Sr-90 contamination (Shaw 2012b).

5.0 CONCEPTUAL SITE MODEL

The purpose of this section is to discuss the CSM for radiologically impacted sites. A CSM is an effective tool for defining site dynamics, streamlining any future risk evaluations, and developing any further actions at a site. The purpose of the CSM is to aid in understanding and describing potential exposure pathways that may be at a site. A CSM typically includes:

- Suspected sources and types of contaminants
- Contaminant release and transport mechanisms
- Affected media
- Rate of contaminant release and transport (if possible)
- Known and possible routes of migration
- Known and potential exposure pathways
- Known and potential human and ecological receptors

While the HRA did not specifically identify CSMs in association with the radiologically impacted sites, the elements of a CSM were discussed in Section 7.3 of the HRA.

5.1 EXISTING CONCEPTUAL SITE MODEL

Section 8.3.1 of the HRA discussed impacted sites, either under specific subheadings in the text or in the section narrative.

5.2 UPDATE TO CONCEPTUAL SITE MODEL

This HRASTM developed CSMs in the form of flowcharts and figures to better communicate the postulated mechanism that may have disposed of or distributed radioactive materials or contamination on the site. The radiologically impacted sites identified in the HRA were based on the potential for contamination or LLROs to be present because of former spills (such as Building 233 and associated sewer drain), former storage of radioactive material (such as at Buildings 342, 343, and 344), and the potential on-site disposal and dispersion of unregulated radioactive materials in Site 12.

The research done for this HRASTM identified that, contrary to the findings of the HRA, ship repair activities occurred at NAVSTA TI during the WWII period and the potential for radiologically impacted areas exists at NAVSTA TI in association with those activities. This HRASTM provides a CSM for Repair/Solid Waste Disposal Operations/activities associated with the former optical repair shop to address the potential for these activities to have impacted the site. CSMs are provided (1) to account for spills such as the one that occurred at Building 233, or that may have occurred at either of the USS *Pandemonium* locations; and (2) to account for the potential for spills to have occurred in association with remedial activities within Site 12 where radioactive waste and contaminated soils have been disposed of. Each of these CSMs is discussed further in the subsections below.

5.2.1 CSM for Repair/Solid Waste Disposal Operations

A CSM has been developed to account for radioactive waste that may have resulted from Repair/Solid Waste Disposal and optical shop operations. This CSM is shown in Figure 12 in the form of a flowchart and pictorially in Figure 13. The CSM addresses the potential for radioactive contamination at Building 3 in AOI 1 (Figure 3), the potential for radioactive contamination at a potential former salvage yard in AOI 6 (Figure 8), and both the LLROs and contamination found in the SWDAs in AOIs 7 and 8 (Figures 9 and 10).

5.2.1.1 Suspected Sources and Types of Contaminants

The potential radionuclides of concern at Building 3 in AOI 1 (Figure 3) include both Ra-226 and Th-232. Ra-226 may have been present in Building 3 in the form of gauges or deck markers found on hull plating or for components such as gauges associated with ship repair. Ra-226 and Th-232 have been commonly found in optical repair shops in conjunction with radioluminescent painted pointers in rangefinders, thorium oxide in optical lenses, or thorium fluoride used in treating the surfaces of optical lenses.

Significant waste would have been generated during repairs in addition to the potential handling of LLROs from repairs in Building 3 (see Section 2.2.6). This waste may have included LLROs such as deck markers or gauges that could have been disposed of on site. Radioactive waste-contaminated soil and LLROs have been identified during previous investigations, and the greatest concentrations are localized in the four SWDAs (Figures 9 and 10). LLROs have been found in areas adjacent to these SWDAs because of the grading and site preparation for construction of the housing units, including mixing and spreading the solid waste material with fill and surface soil in and outside the known SWDAs. Ra-226 is the radionuclide of concern, and the items found in these areas included radioactive foils, buttons, deck markers, gauges and other debris. The deck markers and gauges are likely related to waste from ship repair during WWII. Based on the research conducted to date, the source of the radioactive foils and buttons is unclear; however, the source of the deck markers found in the SWDAs was likely related to ship repair. Scrap metal salvage yards represent other areas potentially impacted by LLROs associated with ship repair (Figure 6).

5.2.1.2 Affected Media

Media affected by the suspected sources and types of contaminants from the Repair/Solid Waste Disposal and optical shop operations CSM include structures, surface soil, sanitary sewers, subsurface soil, and groundwater.

5.2.1.3 Contaminant Release, Transport Mechanisms, and Known Migration Routes

The potential contaminant release and transport mechanisms from the CSM for Repair/Solid Waste Disposal Operations (Figure 12) are spilling and dumping, dispersion during waste processing, leaching from disposal areas, and contaminant infiltration and migration through the

soil. The areas that are now referred to as SWDAs were created as a result of debris dispersion during earthwork operations prior to construction of the housing at Site 12 (Figures 9 and 10). This re-grading spread the localized contaminant-containing soil over the ground surface and potentially in areas away from the original sources. Consequently, soil contamination was observed in Site 12 during previous investigations.

5.2.1.4 Human Receptors and Exposure Pathways

Potential human receptors that may be present at the radiologically impacted sites were identified as follows, in conjunction with the CSM for Repair/Solid Waste Disposal Operations (Figure 12) and the 2011 TI/YBI Redevelopment Land Use Plan prepared for the Treasure Island Development Authority (TIDA):

- Building 3 (Figure 3): commercial/industrial workers and construction workers.
- Potential Former Salvage Yard (Figure 8): commercial/industrial workers and construction workers.
- SWDAs (Figure 9 and 10): residents, commercial/industrial workers (in the event an alternative commercial/industrial land use is implemented), recreational users, and construction workers.
- Former Storage Yard (Sites 30 and 31) (Figure 10): residents, commercial/industrial workers (in the event an alternative commercial/industrial land use is implemented), recreational users, and construction workers.

5.2.1.5 Ecological Receptors and Exposure Pathways

NAVSTA TI has poor quality terrestrial wildlife habitat because the island is predominantly covered with urbanized areas. The areas identified as radiologically impacted do not contain significant habitat, so no significant impacts to ecological receptors was identified. However, if quality terrestrial wildlife habitat is constructed in the future, the owner would be required by Site 6-related land use restrictions to evaluate the suitability of that habitat for wildlife.

5.2.2 CSM for Incidental Release in Association with Training Operations

A CSM was developed to account for radioactive contamination that may have resulted from potential incidental releases in association with training/operations. This CSM is shown on Figure 14 in the form of a flowchart and pictorially for three specific sites (Building 233 and USS *Pandemonium* sites) on Figures 15 and 16. The CSM addresses the potential for radioactive contamination in AOI 2 (Building 233, Figure 3), the potential for radioactive contamination in AOI 4 (Buildings 342, 343, and 344, Figure 5), AOI 6 (former USS *Pandemonium* Site II, Figure 8), and AOI 8 (former USS *Pandemonium* Site I, Figure 10).

Building 233 was identified as radiologically impacted in the HRA, and a pictorial CSM is provided as Figure 15. The building has since been demolished and remedial activities are

ongoing. Similarly, Buildings 343 and 344 were identified as radiologically impacted in the HRA and were subsequently surveyed and released for unrestricted use. The locations of former USS *Pandemonium* Sites I and II are discussed below.

5.2.2.1 Suspected Sources and Types of Contaminants

The potential radionuclides of concern for USS *Pandemonium* Sites I and II (AOIs 6 and 8 on Figures 8 and 10), are Cs-137 associated with sealed sources and Ra-226 associated with radioluminescent gauges used as check sources. Both of the former USS *Pandemonium* locations were identified as non-impacted in the HRA; however, as discussed in Sections 2.2.6 and 2.2.8, this HRASTM has designated them as radiologically impacted based on a re-evaluation of existing information.

5.2.2.2 Affected Media

Media affected by the suspected sources and types of contaminants from the CSM for Incidental Releases from training operations include structures and buildings, surface soil, subsurface soil, discharge piping, and groundwater.

5.2.2.3 Contaminant Release, Transport Mechanisms, and Known Migration Routes

The CSM for potential contaminant release and transport mechanisms from the potential incidental releases in association with training and operations are the dispersion of loose surface contamination from handling of the gauges that are documented for use as check sources at the USS *Pandemonium* Site II (NE) in AOI 6. (It is presumed that similar check sources were used at the USS *Pandemonium* Site I [NW] in AOI 8; however, no records to that effect have been located.)

5.2.2.4 Human Receptors and Exposure Pathways

Potential human receptors that may be present at the radiologically impacted sites were identified as follows, in conjunction with the CSM for Incidental Releases from Training/Operations and based on the 2011 TI/YBI Redevelopment Land Use Plan prepared for TIDA:

- Building 233 (Figure 4): residents, recreational users, and construction workers.
- USS *Pandemonium* Site I (NW) (Figure 10): residents, commercial/industrial workers (in the event an alternative commercial/industrial land use is implemented), recreational users, and construction workers.
- USS *Pandemonium* Site II (NE) (Figure 8): commercial/industrial workers and construction workers.

5.2.2.5 Ecological Receptors and Exposure Pathways

The receptors and exposure pathways are the same as those for the CSM described in Section 5.2.1.5.

5.2.3 CSM for Spills/Contamination Resulting from Handling of Contaminated Soils from Site 12 SWDAs

A CSM has been developed to account for radioactive contamination that may have resulted from spills or contamination from handling contaminated soils from Site 12 SWDAs. This CSM is shown on Figure 17 in the form of a flowchart. The CSM addresses the potential for radioactive contamination originating at the SWDAs to have been spread during transport through Site 12, or in handling at the Building 570 area in AOI 5 (Figure 7), and the potential for radioactive contamination at the Waste and Clean Soil Stockpile/Loading and Decontamination Site in AOI 6 (Figure 8).

5.2.3.1 Suspected Sources and Types of Contaminants

The potential radionuclide of concern for the Building 570 area and the Waste and Clean Soil Stockpile/Loading and Decontamination Site is Ra-226 based on the radioisotopes found in soil and LLROs previously removed from the SWDAs in Site 12. These areas are newly identified as radiologically impacted based on the known handling of radioactive materials originating in the Site 12 SWDAs. The discovery of LLROs in the SWDAs occurred after the HRA was published.

5.2.3.2 Affected Media

Media affected by the suspected sources and types of contaminants from the CSM for Spills/Contamination Resulting from Handling of Contaminated Soils from Site 12 include roadways and surrounding surface soil.

5.2.3.3 Contaminant Release, Transport Mechanisms, and Known Migration Routes

The potential contaminant release and transport mechanisms from this CSM are dispersion of loose surface contamination during handling, hauling, and storing contaminated soil and LLROs originating in the Site 12 SWDAs.

5.2.3.4 Human Receptors and Exposure Pathways

Potential human receptors that may be present at the radiologically impacted sites were identified based on the 2011 TI/YBI Redevelopment Land Use Plan prepared for the TIDA as follows:

- Building 570 area (Figure 7): recreational users and construction workers.

- Waste and Clean Soil Stockpile/Loading and Decontamination Site (Figure 8): commercial/industrial workers and construction workers.

5.2.3.5 Ecological Receptors and Exposure Pathways

The receptors and exposure pathways are the same as those for the CSM described in Section 5.2.1.5.

6.0 FINDINGS AND RECOMMENDATIONS

This section provides findings and recommendations for sites designated as radiologically impacted in the HRA or in this HRASTM. Additional data requirements are presented and property suitable for transfer is identified

6.1 RADIOLOGICALLY IMPACTED SITES

This section provides findings and recommendations for sites designated as radiologically impacted in the HRA or in this HRASTM. The findings and recommendations in this section were developed in conformance with Sections 7.3 and 7.4 of the HRA that provides background and guidance on assessing media, migration pathways, and recommendations (Weston Solutions, Inc. 2006).

6.1.1 Radiologically Impacted Sites Identified in the HRA

This section provides findings and recommendations for sites designated as radiologically impacted in the HRA. Changes, if any, in the following categories are noted: Site Description, Former Uses, Current Uses, Radionuclides of Concern, Previous Radiological Investigations, Contamination Potential, Potential Migration Pathways, and Recommended Actions. Where information is unchanged from the HRA, it is not repeated.

6.1.1.1 Building 233

Building 233 is the former location of the RADIAC Instrument Calibration School. The CSM presented in Section 5.2.2 applies to this location. In the HRA, Building 233 and the Building 233 drain lines were presented separately as radiologically impacted. The HRA recommended a characterization survey of both floors of the building and the crawl space beneath it. Scoping surveys of the sanitary drains were recommended to include the first sanitary sewer manhole downstream from Building 233.

A final scoping survey report was issued for the building and the associated drain lines in January 2007. The scoping survey for the drain lines indicated that at least some of the building piping is radiologically contaminated. It was recommended that the piping be removed and fully surveyed for release during building demolition. The building was demolished in January 2011. At the time of this HRASTM, the Navy is completing characterization, remediation, and an FSS for the building footprint, exterior areas and associated storm drains, and the sanitary sewer

system associated with the building and the surrounding area. Investigation of Building 233 since the 2006 HRA identified radiological contamination throughout the building and surrounding areas, in the storm drains and sanitary sewer system, and this HRASTM identified those sewer systems downstream of Building 233 as radiologically impacted (see Figure 2).

As a result of the information obtained from the field work completed to date, no changes to the subcategories of information for Building 233 in Section 8.3.1.5 of the HRA are necessary. However, the boundaries of the impacted area have been expanded to account for new findings from the investigation to date. The new boundaries have been established to include the open areas bounded by the former Building 7 and the adjacent roadways (4th street and Avenue M). These boundaries are intended to incorporate the likely area that would have been established as an RCA boundary during the cleanup of the 1950 spill. These boundaries also contain a storm drain inlet near Building 233 that was found to be contaminated, as well as the sanitary sewer lines and storm drain lines that lead from the building.

6.1.1.2 Buildings 343 and 344

Buildings 343 and 344 are two of the three buildings that made up the RADIAC school from the 1950s through the 1970s. The HRA recommended that Buildings 343 and 344 undergo an FSS. Radiological surveys for Buildings 343 and 344 were done in September 2007, and the FSS reports were issued in 2008. The Buildings 343 and 344 survey reports identified that Buildings 343 and 344 survey results met the release criteria, and the buildings could be released to unrestricted use. DTSC and CDPH concurred that unrestricted release for Buildings 343 and 344 was appropriate, so no further action is required for these buildings. As a result of the information obtained from the work completed to date, no changes to the subcategories of information for Buildings 343 and 344 in Sections 8.3.1.2 and 8.3.1.3 of the HRA are necessary.

The third building, that was historically associated with the RADIAC school, Building 342, is discussed further in Section 6.1.2, below.

6.1.1.3 Site 12

The HRA identified the contamination potential from solid waste disposal or incineration and recommended radiation monitoring during excavation of identified SWDAs. After results from an ongoing, non-time-critical removal action and other investigations had been received, the SWDAs were found to be contaminated with LLROs or contamination containing Ra-226. In addition, some of those LLROs and contamination were likely spread outside of the SWDAs elsewhere in the housing area. As a result of the information obtained from the field work completed to date, all of Site 12 has been radiologically impacted, with the exception of a firehouse area (Building 157). The CSM that applies to this area is discussed in Section 5.2.1. The new boundaries have been established to include all of Site 12 because grading affected the entire site. As-built plans indicate that grading would not have extended beyond the Site 12 boundaries, as those project boundaries were fenced. The firehouse area has not been impacted because existing fencing visible in aerial photographs would have precluded that area from being altered by grading. The following changes have been made to the subcategories of information for Site 12 that were in Section 8.3.1.4 of the HRA:

Site Description - What is now known as Installation Restoration 12 on the northern end of NAVSTA TI was once a disposal area for trash and debris. Discrete solid waste disposal areas have been identified. Parts of Site 12 were used for storage of ammunition in bunkers and also for the disposal and incineration of refuse. Later, portions of the site were used for material storage. Beginning in the 1960s, the area was developed for military housing. It is believed that over the course of development of the northern portion of the island for residential use, some of the debris and ash has been incorporated into fill material or otherwise scattered as a result of site grading operations (**TI-HRA-91**). General waste disposal took place around and in-between bunkers. Waste disposal operations continued until approximately 1963. Intrusive investigation has identified the presence of LLROs and contamination containing Ra-226 (Weston 2006*).*

Contamination Potential – Change "Unlikely" to "Likely"

Contaminated Media

Surface Soil – Change "None" to "Medium"
Subsurface Soil – Change "None" to "High"
Groundwater – Change "None" to "Low"

Potential Migration Pathways

Groundwater – Change "None" to "Low"
Subsurface Soils – Change "None" to "High"

Recommended Actions – Change "Perform radiation monitoring during soil excavation of the known solid waste disposal areas." to "Complete a characterization survey and remediate known areas of radiological contamination and complete a gamma walkover survey for areas outside of radiologically impacted SWDA boundaries in Site 12. Complete an FSS after remediation is complete."

6.1.2 Radiologically Impacted Sites Identified in this HRASTM

This section provides findings and recommendations at sites that were not designated as radiologically impacted at the time of the HRA, but were designated as radiologically impacted in this HRASTM. These sites include Building 3, Building 570 area, former USS *Pandemonium* Sites I (NW) and II (NE), three former salvage yard sites, a waste and clean soil stockpile/loading and decontamination site, a former storage area that includes Sites 30 and 31, and Building 342, the area surrounding Building 461, an area currently used as a playground formerly used as a gyro compass repair shop, SWDA Bigelow Court debris disposal area (Photo 58), and two separate non-contiguous areas formerly used as rubbish disposal areas (Photo 59). Sewer lines are discussed under potential migration pathways for each of the impacted areas below. Where storm or sanitary sewers are identified as potential migration pathways, only those portions of the sewer lines located within the footprint of the radiologically impacted area are considered impacted unless shown otherwise on Figures 2 through 10.

6.1.2.1 Building 3

Photo 44 Northeast side of Building 3

Site Description – Building 3 is one of the original buildings constructed on TI for the 1939 GGIE. It is a large general warehouse building with both arched and flat roofs. The building covers approximately 145,000 square feet. This building was designated as non-impacted in the HRA. An optical repair shop was located on the roof of the northern corner of the building. The CSM that applies to this building is discussed in Section 5.2.1. The boundaries for the impacted site have been established to be contiguous with the perimeter of the building based on the fact that if contamination exists, it would most likely have been deposited during shop activities within the building. The sanitary sewer leading from the former optical repair shop has also been radiologically impacted to account for the potential that non-regulated radiological substances could have been disposed of in the drains.

Former Uses – Palace of Fine and Liberal Arts, port control office, ships repair shops, optical repair shop, training school, and equipment repair. The Damage Control HT "A" school administration and offices maintained radiation survey instruments with check sources. There were no reports of leaking check sources.

Current Uses – Leased out for multiple uses.

Potential Radionuclides of Concern – Ra-226 from ship repair, and Ra-226 and Th-232 from the former optical repair shop.

Previous Radiological Investigations – None

Contamination Potential – Likely the drains leading from the former optical repair shop; unlikely for the remainder of the building.

Contaminated Media

Surface Soil – Low
Subsurface Soil – Medium
Sediment – High
Surface Water – None
Groundwater – None
Air – None
Structures – Low
Drainage Systems – High

Potential Migration Pathways

Surface Soil – None
Subsurface Soil – Medium
Sediment – High
Surface Water – None
Groundwater –None
Air – None
Structures – Low
Drainage Systems – High

Recommended Actions – Scoping survey of floor spaces and investigation of sanitary and storm sewer drains downstream of the former optical repair shop to the outfalls. Scoping survey of building roof, former location of optical shop, and any remaining access routes to the optical shop.

Photo 45 Location of Building 3

6.1.2.2 Building 570

Photo 46 Building 570 area and location

Site Description – Building 570 was constructed in 1988. It is a single story slab-on-grade metal building. The building covers approximately 3,000 square feet. This area was not identified as radiologically impacted in the HRA, but is now identified as radiologically impacted to account for the potential that it has been operationally impacted in association with other remedial activities. The CSM that applies to this site is discussed in Section 5.2.3. The boundaries of the site are based on the existing fenced perimeter shown in Photo 46.

Former Uses – Operations training facility

Current Uses – The Building 570 area has been used as an office trailer and laydown area by the Navy in association with remedial activities on NAVSTA TI, including those at Site 12. As discussed in Sections 2.2.5 and 5.2.3, removals in the Site 12 SWDAs after the HRA involved LLROs and soil contaminated with radiological constituents. Soil samples were stored and analyzed for radioisotopes in the Building 570 area. LLROs were stored in conex boxes in a smaller fenced yard in the Building 570 area.

Potential Radionuclides of Concern – Ra-226

Previous Radiological Investigations – None

Contamination Potential – Likely

Contaminated Media

Surface Soil – Low
Subsurface Soil – None
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – Low
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – None
Sediment – None
Surface Water – None
Groundwater –None
Air – None
Structures – Low
Drainage Systems – Low

Recommended Actions – Conduct an FSS of structures and yard.

6.1.2.3 USS Pandemonium Site II (NE)

Photo 47 USS *Pandemonium* Site II (NE)

Site Description – The USS *Pandemonium* training ship was moved to the northeast corner of NAVSTA TI in 1969, where it remained until it was demolished in 1996. The training ship was part of the new Damage Control School complex that included Buildings 461, 462, and 463. Access to the area was by the tear-gas decontamination building (462). An 8-foot-high fence separated the training area from the rest of the island. The CSM for this site is discussed in Section 5.2.2. Use of the mock-up ship ended in 1992, though the mock-up remained until 1996. The training ship was used to simulate radioactive fallout using short-lived isotopes, as discussed in Section 2.2.6, and Cs-137 sources for fixed locations. (A short-lived isotope is one with such a short half-life that it decays to a negligible quantity in a matter of hours or perhaps days.) Two below-grade concrete holding tanks collected the wash-down water when short-lived isotopes were decontaminated in the USS *Pandemonium*. The wash-down water was released to the bay through a 6-inch pipe after sufficient time transpired for the isotopes to have decayed away. Ra-226-containing gauges were used as check sources during training, as discussed in Section 2.2.6. The USS *Pandemonium* Site II (NE) was designated as non-impacted in the HRA. As discussed in Section 2.2.6, this site was part of a removal action completed in 2009 at Site 32. The removal was done to address contaminants of concern that included PCB, dioxins, pesticides, total petroleum hydrocarbons, and metals. The boundaries for this site include the interior of Building 461 and are otherwise contiguous with Site 32, except on the southeastern end where the boundary is established by the presence of a former building. The area west and north is also impacted, as discussed below, and the area to the east is the San Francisco Bay.

Former Uses – Damage Control School decontamination training area (after July 1969). Although the mock-up ship remained until 1996, the use of the mock-up ended in 1992. No radiological-related work has been conducted at the site of the former USS *Pandemonium* Site II (NE) (Figure 8) since the HRA. Decontamination training used sealed sources of Cs-137 to simulate radioactive fallout and also used short-lived liquid

radioisotopes (Br-82, Br-80, Na-24, and K-42) to more realistically simulate radioactive fallout. Survey instruments containing radioactive check sources were used during the training exercises. The Cs-137 sealed sources were leak tested and demonstrated to be intact. The licensed check sources were also required to be leak tested on a periodic basis; however, unlicensed check sources would not have required leak testing. No reports of leakage were found during the HRA and this HRASTM. The short-lived isotopes were last used at this location in 1972 and have decayed away and are no longer present.

Current Uses – None

Potential Radionuclides of Concern – Ra-226, Cs-137

Previous Radiological Investigations – None

Contamination Potential – Unlikely

Contaminated Media

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – Low
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater –None
Air – None
Structures – None
Drainage Systems – Low

Recommended Actions – Complete a scoping survey of the subsurface soil and former holding tanks, structures, and ground surface in the USS *Pandemonium* Site II (NE) area and a gamma walkover survey of the roadways and areas not previously subject to gamma walkover surveys.

Photo 48 Location of former USS *Pandemonium* Site II (NE)

6.1.2.4 Former Salvage Yard

Photo 49 Location of Former Salvage Yard

Site Description – As noted in Section 2.2, ship repair was ongoing throughout WWII. Those activities generated significant amounts of scrap metal, which was potentially processed in the open area and south of Building 327 that was identified as a Salvage Building in the HRA. The CSM for this salvage yard is discussed in Section 5.2.1. Building 327 was demolished in the 1960s, and the radiologically impacted area is now beneath the footprint of the sewage treatment plant that was constructed in 1984. This area was not identified as radiologically impacted in the HRA. The boundaries for the area have been established to be contiguous with the outline of the sewage treatment plant, which overlays the former Building 327 area. The southern portion of the sewage

treatment plant has also been included in the footprint of the impacted area because soil from the former salvage yard could have been displaced anywhere within the footprint of the sewage treatment plant during construction.

Former Uses – Salvage

Current Uses – The area is now the site of the NAVSTA TI sewage treatment facility.

Potential Radionuclides of Concern – Ra-226

Previous Radiological Investigations – None

Contamination Potential – Unlikely

Contaminated Media

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – Low
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – Low

Recommended Actions – Complete a scoping survey of the ground surface in the sewage plant area.

6.1.2.5 Waste and Clean Soil Stockpile/Loading and Decontamination Site

Photo 50 Waste and Clean Soil Stockpile/Loading and Decontamination Site

Site Description – The Waste and Clean Soil Stockpile/Loading and Decontamination Site is an open area in AOI 6 (Figure 8) and shown in Photo 50. This area was not identified as radiologically impacted in the HRA. The CSM for the area is discussed in Section 5.2.3, and the boundaries of the impacted area have been established to include the open areas between Site 12 and the sewage treatment plant, except for the fenced area between Site 6 and 12 to the south. This entire area is deemed as potentially operationally impacted in association with remedial activities.

Former Uses – A number of WWII-era training and administrative buildings were located in this area. All buildings were demolished.

Current Uses – The Waste and Clean Soil Stockpile/Loading and Decontamination Site is currently used by a Navy contractor in association with remedial activities at Site 12 on NAVSTA TI. Contaminated and other soil removed from the SWDAs has been repackaged and stored in the area for off-site disposal.

Potential Radionuclides of Concern – Ra-226

Previous Radiological Investigations – In-process surveys have been conducted in association with Navy operations related to the stockpiling of soil from Site 12 removal actions.

Contamination Potential – Likely

Contaminated Media

Surface Soil – Low
Subsurface Soil – Low

Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – None
Sediment – None
Surface Water – None
Groundwater – None
Air – Low
Structures – None
Drainage Systems – None

Recommended Actions – Complete an FSS of the ground surface in the Waste and Clean Soil Stockpile/Loading and Decontamination Site.

6.1.2.6 USS Pandemonium Site I (NW)

Photo 51 USS *Pandemonium* Site I (NW)

Site Description – This radiologically impacted site is wholly contained within Site 12, which has been separately impacted as discussed above; however, it also warrants and is further discussed in this section. The USS *Pandemonium* training ship was constructed in 1956. The CSM for this area is discussed in Section 5.2.2. The training ship was commissioned for use in February 1957 and remained in service in the northwest corner until July 1969. The fenced-off, gravel-surfaced training area was approximately 400 by 600 feet. The area enclosed eight buildings, two old aircraft, the USS *Pandemonium*

mock-up ship, and a paved road. During testing of the radioactive spreader device for short-lived isotopes, the radioactive water was allowed to soak into the soil. Later, radioactive water from the decontamination training was collected in two below-grade concrete tanks and stored until the short-lived isotopes had decayed. When the radioactivity was within allowable limits, the water was discharged to the bay through a 6-inch pipe. The USS *Pandemonium* Site I (NW) was moved from this area in 1969 to the northeast corner of NAVSTA TI. The location of the former USS *Pandemonium* Site I (NW) has since been converted into multiple family military housing units. As discussed in Section 2.2.8, the former holding tanks have likely been partially demolished, leaving the floor of the tank. The USS *Pandemonium* Site I (NW) was designated as non-impacted in the HRA. The boundaries for this site are as shown on Figure 2; however, the boundaries are approximate because the site lies with the impacted area of Site 12.

Former Uses – Nuclear, Biological, and Chemical Warfare School. Decontamination training area. Decontamination training initially used only sealed sources of Cs-137 to simulate radioactive fallout. In 1963, a radioactive material license was granted by the AEC to use short-lived liquid radioisotopes (Br-82, Br-80, Na-24, and K-42) to more realistically simulate radioactive fallout. Survey instruments containing radioactive check sources were used during the exercises. The Cs-137 sealed sources were leak tested and demonstrated to be intact. The licensed check sources were required to be leak tested on a periodic basis; however, unlicensed check sources would not have required leak testing. No reports of leakage were found during the HRA and this HRASTM. The short-lived isotopes were last used at this location in 1969, have decayed away, and are no longer present. It is likely that check sources such as the gauges containing Ra-226 may have been used during training. This site is adjacent to and contiguous with SWDA Westside, discussed in Section 6.1.1.3.

Current Uses – Multi-family housing

Potential Radionuclides of Concern – Ra-226, Cs-137

Previous Radiological Investigations – None

Contamination Potential – Unlikely

Contaminated Media

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – Low
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater –None
Air – None
Structures – Low
Drainage Systems – Low

Recommended Actions – Complete a scoping survey of the subsurface soil and former holding tanks, structures, and ground surface in the USS *Pandemonium* Site I (NW) area and a gamma walkover survey of the roadways and areas not previously subject to gamma walkover surveys.

Photo 52 Location of former USS *Pandemonium* Site I (NW)

6.1.2.7 Former Storage Area and Sites 30 and 31

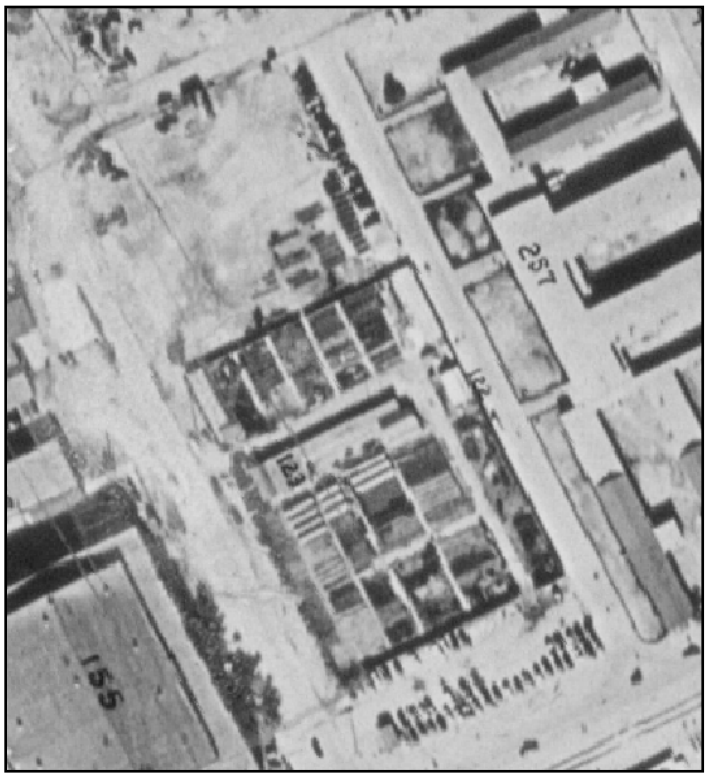


Photo 53 Storage yard area circa 1945

Site Description – The Former Storage Area that includes Sites 30 and 31 is a former open area in AOI 10 (Figure 10) and shown in Photo 53. The area is composed of two former storage areas north and south of Sites 30 and 31 and the IRP sites that are discussed further below. This area was not identified as radiologically impacted in the HRA. The CSM that applies to this area is discussed in Section 5.2.1. The boundaries for the area are based on the historical extent of storage area according to a review of aerial photographs.

Storage Area North of Site 31. This area was bordered by a runway to the north, avenues D and E to the west and east, and Site 31 to the south. The site, appearing as bare soil in a 1942 aerial photo, can be seen being used as a laydown area adjacent to the runway (Figure 10, June 1942 photo). It currently contains elementary school buildings and paved surfaces.

Site 30. Currently referred to as the Daycare Center, it is south of the TI Elementary School, at the corner of Avenue D and 11th Street. As part of the environmental baseline survey prepared to support leasing the daycare center, the Navy reviewed a 1989 as-built drawing of the water lines in the area. The drawing noted the comment "buried trash" along 11th Street. In 2002, a series of investigations identified various types of wastes (including buried burned debris associated with historical practices) that contained lead at concentrations exceeding the site soil screening level. Based on these findings, the Navy completed a time-critical removal action in July 2002. Additional burned debris was found, and analytical results for soil samples showed the presence of dioxins, lead,

arsenic, and vanadium. The Navy continued to investigate the area to delineate the extent of the burned debris and dioxin contamination. Some of the soil containing burned debris was not accessible and could not be removed. In January 2003, the Navy installed a 6-inch concrete pad adjacent to the daycare center to cover the 1,400-square-foot area around and between the locations that contain elevated concentrations of dioxin in the subsurface soil. The concrete pad is a protective barrier to prevent contact with the soil.

Site 31. The formerly asphalt-covered playground south of the TI Elementary School is referred to as the former South Storage Yard and is at the corner of Avenue E and 13th Street. In 2002, the Navy investigated the area because of its former use as a storage yard and because of the reference to an "old trash dump" noted on a 1989 as-built drawing for the 11th Street water line replacement project. An initial investigation found construction and burned debris. The initial investigation of the soil found lead, PCBs, and dichlorodiphenyltrichloroethane with concentrations above the site soil screening levels. These chemicals may have been associated with fuel leaks or other releases from items that were stored in the former storage yard area. The site was designated as a CERCLA site in September 2003. The ROD was finalized on August 5, 2009. A final soil remediation work plan was submitted on January 28, 2010, and the soil remediation field work (referred to as Phase I) began in February 2010 and continued through July 2010. The Navy prepared another work plan for Phase II soil remediation work in January 2012 after an excavation sidewall was discovered with Ra-226 readings above background. This work plan added Ra-226 as a radioisotope of concern. At the time of this HRASTM, the Navy has finished the soil remediation at Site 31 and the site has been restored and radiologically down posted. The remedial action completion report is being prepared.

Storage Area South of Site 30. This area was bordered by Site 30 to the north, avenues D and E to the west and east, and 9th street to the south. The site, appearing as bare soil in a 1942 aerial photo, can be seen being used as a laydown area (Figure 10, March 1947 photo). It currently contains a number of bungalows and paved surfaces.

Former Uses – Site 30 was undeveloped until the Navy's former Daycare Center was built in 1985. After NAVSTA TI closed, the TI Daycare Center was leased to the CCSF under a finding of suitability to lease (FOSL) on July 29, 1997. The daycare center opened on March 17, 2003. Site 31 was used during the 1970s as a storage yard; however, the nature of and operations at the storage yard are unknown. In the late 1970s, the area was paved over and developed as a playground for the elementary school. Based on the FOSL and the restrictions it identified, the Navy entered into a lease agreement with the San Francisco Unified School District (SFUSD) on May 13, 1996, for the elementary school and associated playground. The school had originally been constructed by SFUSD in approximately 1968 when the military housing was built and was operated under a previous agreement with the Navy until the 1996 lease agreement.

Current Uses – The northern portion of the storage area is currently occupied by the elementary school. Site 30 remains in use as a Daycare Center. Site 31 is currently fenced, is undergoing remediation, and being used as a laydown area associated with the remediation. The southern portion of the former storage area is a parking lot and contains several bungalows and a large paved parking lot.

Potential Radionuclides of Concern – Ra-226

Previous Radiological Investigations – The northern and southern portion of the storage area – None; Site 30 **–** None; Site 31 **–** NTCRA. During the Phase I removal action, a small volume of soil with elevated radioactivity suggesting the presence of non-naturally occurring Ra-226 was discovered in the sidewall of the Site 31 excavation. Laboratory testing confirmed the presence of Ra-226 at concentrations exceeding the cleanup goal (document forthcoming). The contaminated soil was removed and no LLROs were found in association with the elevated background.

Contamination Potential – Likely

Contaminated Media

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – None

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – None

Recommended Actions – Complete an FSS after remediation is finished.

Photo 54 Former storage yard location (including Sites 30 and 31)

6.1.2.8 Building 342

Photo 55 Building 342 area

Site Description – Building 342 was constructed in 1951. It is a single story, slab-on-grade approximately 8,000-square-foot metal building and a fenced yard area alongside of and to the rear (east) of the building (Photo 55). This area was not identified as radiologically impacted in the HRA. The 1972 license description states that "Building 342 houses two labs belonging to RADIAC Maintenance School and one lab

that belongs to Underway Replenishment School. Lab #1 is not in use. Lab #2 contains RADIAC storage spaces, a workshop and a counting lab. Lab #3 contains equipment for demonstrating underway replenishment [sic] techniques." The HRA designated 342 as non-impacted because, as stated in the HRA, nothing but sealed sources was used inside and outside of the building and in the fenced yard area. However, classifying the site as radiologically impacted is warranted because the license says there was a counting room (Navy 1972) and because of the possibility that unlicensed sources may have been used in training by the Navy. The boundaries for the site are based on impacting the entire interior of Building 342 and the associated fenced yard area surrounding the eastern ends of Buildings 342 and 344, Photo 41.

Former Uses – RADIAC instruction, counting, and RADIAC calibration.

Current Uses – None, unoccupied

Potential Radionuclides of Concern – Ra-226, Cs-137

Previous Radiological Investigations – None

Contamination Potential – Low

Contaminated Media

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – Low
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – Low

Recommended Actions – Do a scoping and an FSS of the structure, and a scoping survey of the sanitary sewer line that services the building out to the nearest sump.

6.1.2.9 Former Supply Department Salvage Yard (Lot 69)

Photo 56 Location of Former Salvage Yard (Lot 69)

Site Description – As noted in Section 2.2, sometime between 1962 and 1968, a Supply Department Salvage Yard was established east of the tennis courts (see above Photo 56 and Figure 6). By 1996, this salvage yard area was referred to as Lot 69 and was listed as a Hazardous Waste Accumulation Area in the Spill Prevention Control and Countermeasures Plan. The northern, larger part of Lot 69 was the nonhazardous storage or staging area for furniture and nonhazardous tools waiting to be disposed of by the DRMO. South of the lot is a transfer station for solid waste. A general inventory of waste stored in the hazardous waste accumulation area consisted of waste oils, flammables, corrosives, and other regulated materials such as rags, latex paints, and empty paint and flammable containers. this HRASTM identifies this salvage yard (Lot 69) as impacted because salvage yards are often linked with the potential for disposal of unregulated LLROs; this conclusion is reached because this area was used as a salvage yard and based on the lack of any other radiological information associated with this site. The CSM for this yard is discussed in Section 5.2.1. The boundaries of the site are based on the existing fence line.

This area was not identified as radiologically impacted in the HRA.

Former Uses – Salvage

Current Uses – The area is now used as a storage area for nonhazardous materials.

Potential Radionuclides of Concern – Ra-226

Previous Radiological Investigations – None

Contamination Potential – Unlikely

Contaminated Media

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – Low

Recommended Actions – Perform a scoping survey of the ground surface in the salvage yard area.

6.1.2.10 Building 461 Area

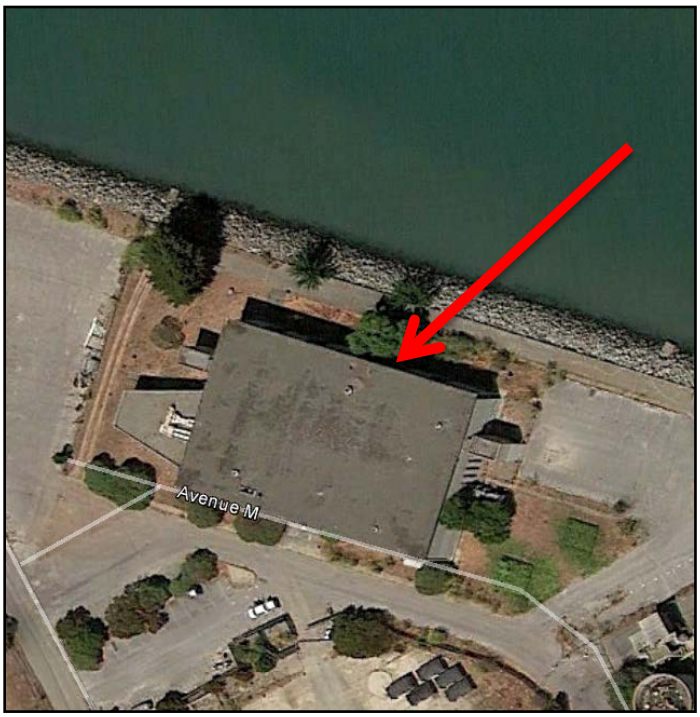


Photo 57 Location of Building 461

Site Description – Building 461 and the area around it was identified in the HRA as a non-impacted site. Building 461 was constructed in 1970 and is part of the Damage Control School complex that included Buildings 462 and 463 and the training ship mockup, USS *Pandemonium*, after it was moved from the northwest corner of NAVSTA TI. The building was used for Damage Control School classrooms, office space, fire training, and storage of RADIAC instruments with attached check sources that were maintained in the building for use during decontamination exercises on the USS *Pandemonium* (Weston Solutions, Inc. 2006). There were no reports of leaking check sources. However, this HRASTM recommends the building and associated area be considered impacted based on the possibility that unlicensed Ra-226 check sources may have been used or stored on site. No intrusive work has been done at the site of Building 461 since the HRA. The CSM for this site is discussed in Section 5.2.2, and the boundaries for site consist of exterior walls for Building 461.

Former Uses – Training

Current Uses – Leased to TIDA.

Potential Radionuclides of Concern – Ra-226

Previous Radiological Investigations – None

Contamination Potential – Unlikely

Contaminated Media

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – Low

Recommended Actions – Perform an FSS of Building 461 and the surrounding ground surface.

6.1.2.11 Site 12 Other Radiological Impacted Sites

This section provides findings and recommendations for sites located within Site 12 (that has now been classified as radiologically impacted) that would otherwise be designated as radiologically impacted in this HRASTM based on site history independent of the potential for LLROs to be present as a result of grading. These sites include the former USS *Pandemonium* Site I (NW) (Photo 51), an area that is currently a playground that was formerly used as a gyro compass repair shop (Photo 42), an area formerly associated with debris disposal and referred to as SWDA Bigelow Court (Photo 59), and two separate non-contiguous areas formerly used as rubbish disposal areas (Photo 60), and a burn area.

6.1.2.11.1 Gyro Compass Repair Shop and Recreation Field

Photo 58 Recreation field located at southern end of housing area

Site Description – At the time of the GGIE, a portion of the current park area (Photo 58) contained Building 168 that was exposition building Palace G (General Motors Building). With the exception of Building 168, no known activities occurred on the recreation field that would have caused it to be designated as radiologically impacted.

After the GGIE, Buildings 304, 305, 306, and 326 were constructed on the current site of the recreation field. All buildings have since been demolished. Buildings 304 and 305 were restrooms, Building 306 was a supply office and storage area, and Building 326 was a storage building and gun shed (Weston Solutions, Inc. 2006). After the Navy occupied the property in 1941, Building 168 was used as a gyro compass repair shop from 1942 to about 1948. During that time, it is likely that materials painted with radioluminescent paint containing Ra-226 were handled. The gyro compass repair shop was subsequently demolished. A Navy sanitary sewer system map reviewed from that period indicates that Building 168 was not serviced by the sanitary sewer system (Navy 1944b) and, therefore, no sinks, drains, or toilets are presumed to have existed in the building. The absence of sinks in the building is further evidence that painting with radioluminescent paint was unlikely in this building. The rest of the site remained open space until it was developed as the recreation area in association with the nearby housing in 1974. Records indicate that the recreation field was likely developed by NAVSTA TI personnel (Navy 1974). At that time, 1.5 inches of topsoil was brought in along with sufficient soil to build a 5-foot-tall soil mound in the area of the current basketball court. This mound, along with several concrete slabs, was apparently removed in 1988 when the basketball court was constructed. This HRASTM identifies the portion of the recreation field associated with elevated gamma readings and the former footprint of the gyro compass repair shop as impacted because CDPH RHB requested this area be designated as impacted based on elevated radiation levels. There also is lack of sufficient radiological information associated with

this site to explain the levels. This area was not identified as radiologically impacted in the 2006 HRA. The CSM for this site is discussed in Section 5.2.1 and the boundaries of the impacted area are consistent with the footprint of the former gyro compass repair shop.

Former Uses – GGIE (General Motors Building), gyro compass repair shop

Current Uses – Recreation field

Potential Radionuclides of Concern – Ra-226, Th-232

Previous Radiological Investigations – In 2003, the Navy investigated debris and COCs in soil in the common areas of Site 12, including the 9th Street recreation field. The original scoped investigation was done from August 4, 2003, through September 16, 2003, and subsequent step-out investigations were done on October 15 and 16, 2003. The scope of work included excavating 581 exploration trenches, seven step-out trenches, and seven step-out hand auger locations, logging the trenches for debris sampling, and analyzing soil for COCs, backfilling and restoring trench locations, and sampling, profiling, and disposing of IDW. This investigation was not intended to address the potential for radiological isotopes as a COC, but for health and safety reasons, a sodium iodide scintillation detector for measuring gamma radiation was passed over the excavation sidewalls and excavated spoils to measure gamma radiation levels. An action level of two times background was established for imposing additional control measures in the site health and safety plan addendum (Shaw 2003), and no trenches in the recreation field exceeded that limit (Shaw 2005).

In 2011, the CDPH RHB collected radiological soil samples and conducted surveys of the recreation field (CDPH 2012), and in February 2012, the Navy collected soil samples in the recreation field (TestAmerica 2012). Both the CDPH RHB and Navy investigations concluded that additional sampling was warranted based on laboratory analysis indicating elevated levels of Ra-226 and Th-232.

Contamination Potential – Unlikely

Contaminated Media

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – None
Air – None
Structures – None
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None

Groundwater – None
Air – None
Structures – None
Drainage Systems – Low

Recommended Actions – Perform a scoping survey including soil sampling of the ground surface in the impacted area.

6.1.2.11.2 SWDA Bigelow Court Debris Disposal Area

Photo 59 SWDA Bigelow Court Area

Site Description – SWDA Bigelow Court was identified in the HRA as a non-impacted site. The site is a former storage yard that overlapped both the Halyburton Court and SWDA Bigelow Court area; see Section 4.1.2.10.2. Halyburton Court was the subject of a previous removal action for non-radiological contaminants of concern, and the SWDA Bigelow Court area is the site of a planned future removal action to address concentrations of dioxins, lead, and PAHs that exceed action levels. Because the SWDA Bigelow Court area has been designated as a debris disposal area, it is identified as radiologically impacted in this HRASTM. The CSM for this site is the same as the surrounding housing area and is discussed in Section 5.2.1. Buildings 1101 and 1103 have been demolished and the Navy has begun excavating areas planned for removal based on non-radiological contamination. The boundaries of the SWDA Bigelow Court Area are based on the prior excavations for chemical contamination conducted in this area.

Former Uses – Storage Yard

Current Uses – Housing, leased to TIDA

Potential Radionuclides of Concern – Ra-226

Previous Radiological Investigations – None

Contamination Potential – Likely

Contaminated Media

Surface Soil – Medium
Subsurface Soil – Medium
Sediment – None
Surface Water – Low
Groundwater – Low
Air – None
Structures – None
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Medium
Subsurface Soil – Medium
Sediment – None
Surface Water – None
Groundwater – None
Air – Low
Structures – None
Drainage Systems – Low

Recommended Actions – Do radiological monitoring of future removal action and a FSS of the ground surface of the excavation.

6.1.2.11.3 Two Rubbish Disposal Areas and a Former Burn Area

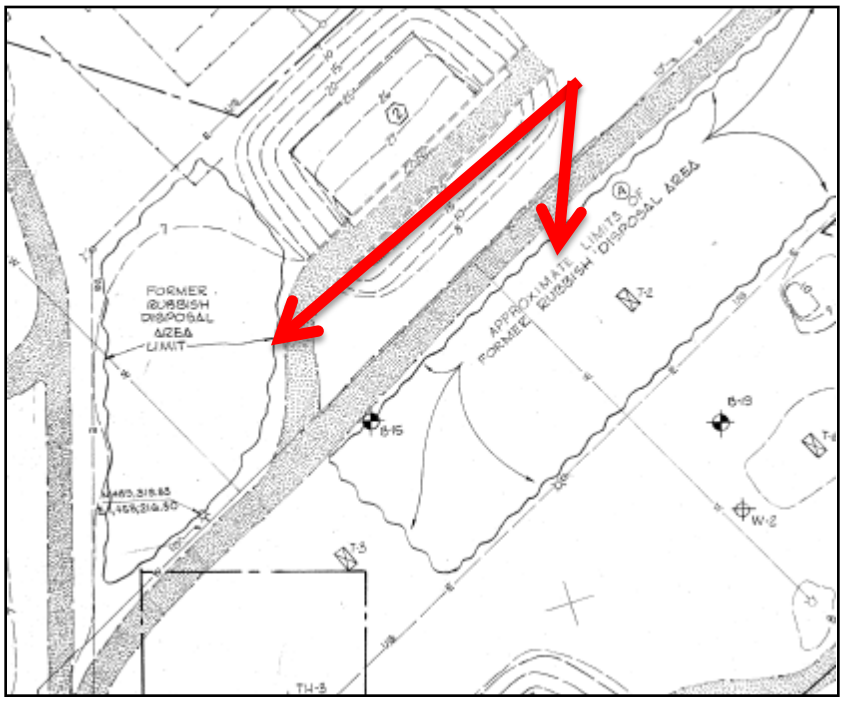


Photo 60 Two rubbish disposal areas

Site Description – Two non-contiguous "Rubbish Disposal Areas" and a separate "Burn Area" were identified during research associated with this HRASTM. Exploratory trenches exposed loose rubbish buried approximately 4 feet below grade (McCreary, Koretsky Engineers 1965; Navy 1965). These rubbish disposal areas and the burn areas are shown as radiologically impacted areas on Figure 9. The recommendation of the geotechnical report was to remove the rubbish to an elevation of not higher than ±2 feet project datum, mix the rubbish with clean sand, and compact the mixture by tamping with heavy equipment. These areas have been identified as radiologically impacted based on the correlation between rubbish disposal, burning, and LLROs found at other similar sites on TI. In addition to the rubbish disposal areas, the TI housing area contained a historical burn area (Figure 9) discussed above in Section 2.2.7. This historical burn area contained wood burn debris near the surface adjacent to Building 1203 (see the trench log for trench 1203A-1; Shaw 2004). The CSM for these areas is discussed in Section 5.2.1, and the boundaries are based on the historical geotechnical reports.

Former Uses – Rubbish disposal

Current Uses – Housing, leased to TIDA

Potential Radionuclides of Concern – Ra-226

Previous Radiological Investigations – None

Contamination Potential – Likely

Contaminated Media

Surface Soil – Low
Subsurface Soil – Moderate
Sediment – None
Surface Water – Low
Groundwater – Low
Air – None
Structures – None
Drainage Systems – Low

Potential Migration Pathways

Surface Soil – Low
Subsurface Soil – Low
Sediment – None
Surface Water – None
Groundwater – Low
Air – Low
Structures – None
Drainage Systems – Low

Recommended Actions – Perform radiological monitoring of future removal action and a scoping survey of the ground surface and subsurface soils.

6.2 FINDING OF SUITABILITY TO TRANSFER AREAS

The purpose of a finding of suitability to transfer (FOST) is to identify property that is environmentally suitable for transfer and to identify any specific notices, restrictions, or covenants that are required. All areas of NAVSTA TI subject to the prior HRA and this HRASTM are suitable for transfer with respect to potential impacts on human health and the environment from exposure to radiological contamination, provided (1) they have not been designated as radiologically impacted in either of these documents, and (2) they are clear of other CERCLA issues that would prevent transfer. Only Buildings 343 and 344 have reached regulatory closure for radiological concerns, as they have been released for unrestricted use (DTSC 2009). Therefore, these "radiologically impacted" buildings are suitable for transfer. No radiological related notices, restrictions, or covenants are required for the FOST areas.

No further action is necessary to address the potential for radiological contamination at areas on TI that are (1) not designated as radiologically impacted, or (2) designated as non-impacted in both the HRA and this HRASTM. The probability that contamination would pose an unacceptable human health risk is minimal and no evidence has been found to warrant further investigation of those areas in areas that are not designated as radiologically impacted or are designated as non-impacted.

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FIGURES

LEGEND

- Freeway
- Highway
- Major Road
- Railroads
- Rivers

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Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 1

**LOCATION MAP
TREASURE ISLAND
AND THE
SAN FRANCISCO BAY AREA**

2012-05-29 C:\GIS\Treasure_Is\TI_AOIs_03-2012\fig-1_TI_SF-CA_Location-Map.mxd TriEco-SD chris.lynch

San Francisco Bay

Former Supply Department Salvage Yard (Lot69)

Bldg 342

Bldg 342 Yard Area

Bldg 343 & Bldg 344

Bldg 342 Sanitary Sewer Line

Bldg 233 Area

Bldg 233

Bldg 233 Storm Line

Pandemonium Site II (NE)

Bldg 570 Site

IR Site 24

IR Site 32

Former Salvage Yard and Current Sewage Treatment Plant

IR Site 6

Waste & Clean Soil Stockpile and Truck Loading & Decon Site

Bldg 461

IR Site 33

Bldg 3 Sanitary Sewer Line

IR Site 21

Former Lake of the Nations

Bldg 3 Site

SWDA North Point

Former Incinerator

SWDA Bayside

Historic Burn Area

IR Site 12

Rubbish Area

SWDA Bigelow Court

SWDA Westside

Pandemonium Site I (NW)

Storage Areas and Sites 30 & 31

Playground and Gyro Compass Repair Shop

Avenue of the Palms

AOI 1

AOI 2

AOI 3

AOI 4

AOI 5

AOI 6

AOI 7

AOI 8

Clipper Cove

Avenue M

Avenue N

Avenue I

Avenue H

Avenue D

Avenue C

Avenue B

Avenue F

Gateview Ave.

Bayside Dr.

North Point St.

Exposition Dr.

California Ave.

4th St.

5th St.

6th St.

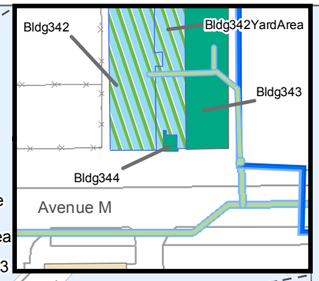
9th St.

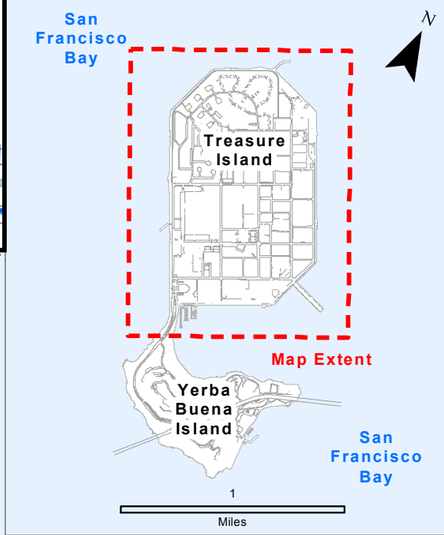
11th St.

13th St.

1st St.

3rd St.





LEGEND

- Newly Identified Radiologically Impacted Site
- Newly Identified Radiologically Impacted Sewer or Storm Line
- 2006 HRA Radiologically Impacted Site Where Recent Surveys Have Not Found Low Level Radiological Contamination. Site Released.
- 2006 HRA Radiologically Impacted Site Where Recent Surveys Have Found Low Level Radiological Contamination or Objects
- Area of Interest
- IR Site
- Radiologically Impacted Soil Site With Non-Radiologically Impacted Building/Structure
- Building
- Former Lake of the Nations
- Fence
- Road

Note: Areas are not radiologically impacted unless specifically identified.

HRA Historical Radiological Assessment
IR Installation Restoration
SWDA Solid Waste Disposal Area

250 0 250 500
Feet

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Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 2

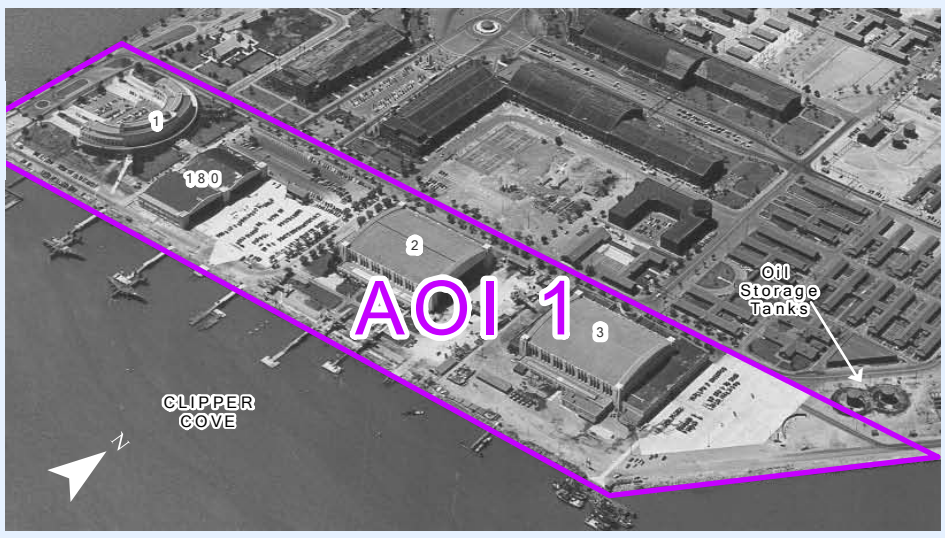
NEWLY IDENTIFIED RADIOLOGICALLY IMPACTED AREAS

2014-06-25 \\DISKSTATION\TriEcoProjects\NAVFAC - AECRU V\BRAC 2\Treasure Island\CTO-0003_Treasure_Island\Treasure_Is_GIS\TI_HRASTM_2012\Fig02\fig-2_TI_Areas_of_Interest_rev-39.mxd TriEco-Tt clynch

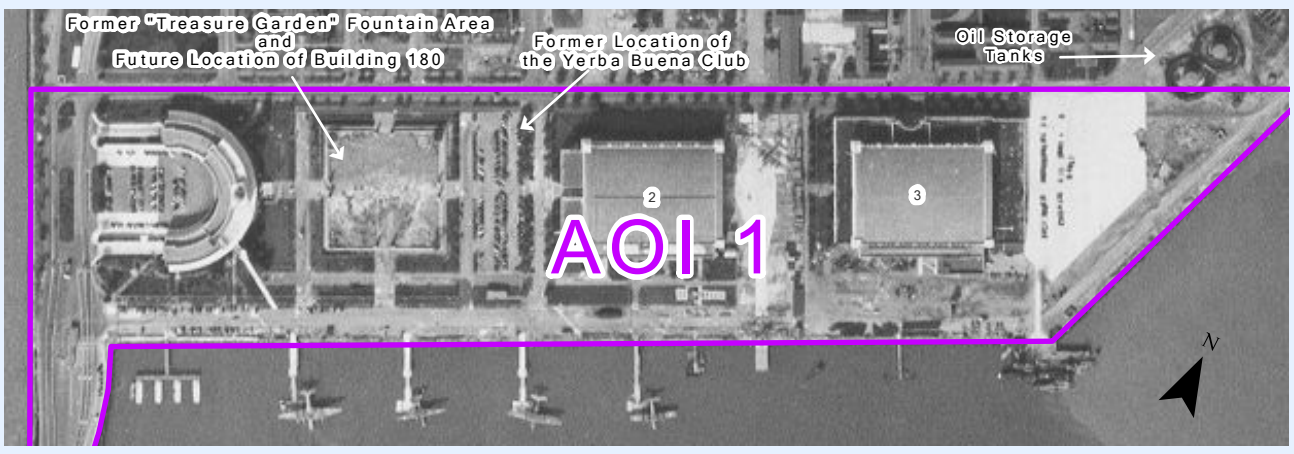
NOTES:
-Treasure Island was leased by Navy on 31 February 1941. The Navy took title to Treasure Island on 17 April 1942.
-Infrastructure was essentially built out and predominately paved since beginning of operations when licensed or unlicensed radioactive materials would have been handled.
-No significant construction occurred during the war period with the exception of piers. Building 180 represents the only significant infrastructure change within this footprint subsequent to the World's Fair. During the World's Fair, the footprint of Building 180 was referred to as the "Treasure Garden" and contained a fountain. In the 4 June 1942 photo (bottom left) the fountain has been demolished and site preparations for Building 180 are underway.
-Building 3 is considered impacted due to the level of repair operations that were conducted during WWII which may have involved the handling of radium containing devices.
-In addition, an optical shop which likely handled radioactive materials was located on the roof of Building 3.
-Oil storage tanks on southeast corner of Treasure Island were removed shortly after the end of the WWII.

Seaplane Lagoon Area of Interest 1
15 August 2000 (not to scale)

Seaplane Lagoon Area of Interest 1
24 March 1947 (not to scale)

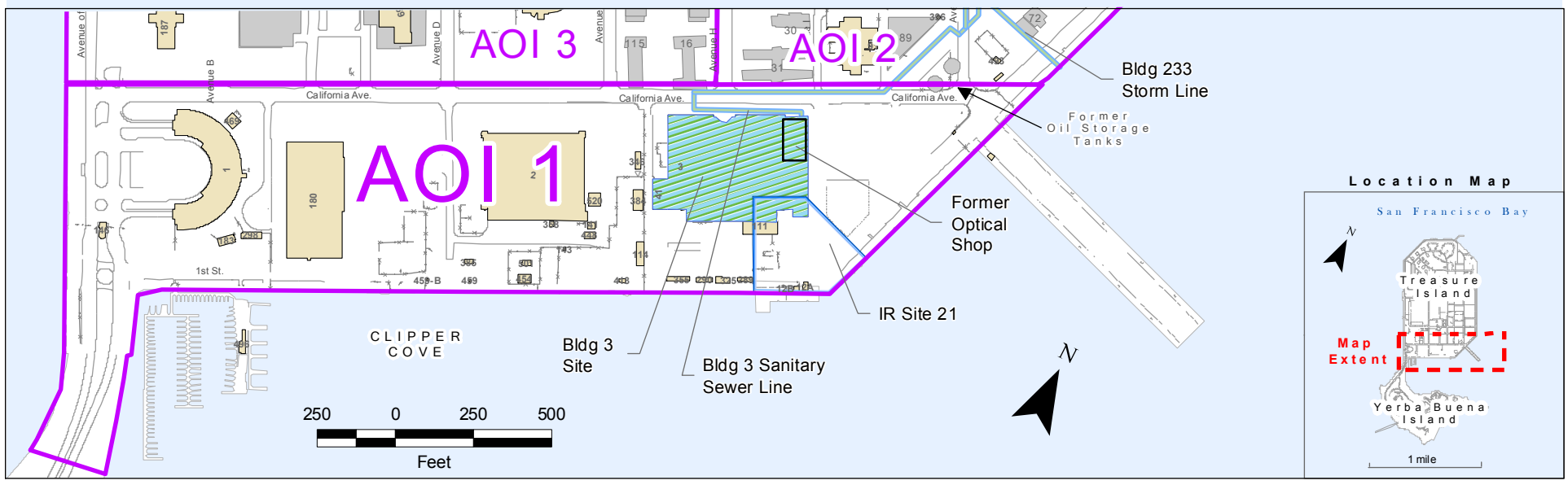


Seaplane Lagoon Area of Interest 1
ca. 1943 (not to scale)



Seaplane Lagoon Area of Interest 1
04 June 1942 (not to scale)

Seaplane Lagoon
Area of Interest 1
20 February1945
(not to scale)



LEGEND

- Area of Interest
- IR Site
- Newly Identified Radiologically Impacted Site
- Newly Identified Radiologically Impacted Sewer or Storm Line
- Existing Building (as of 19 June 2011)
- Demolished Building
- Road
- Fence

Note: Areas are not radiologically impacted unless specifically identified.

IR Installation Restoration

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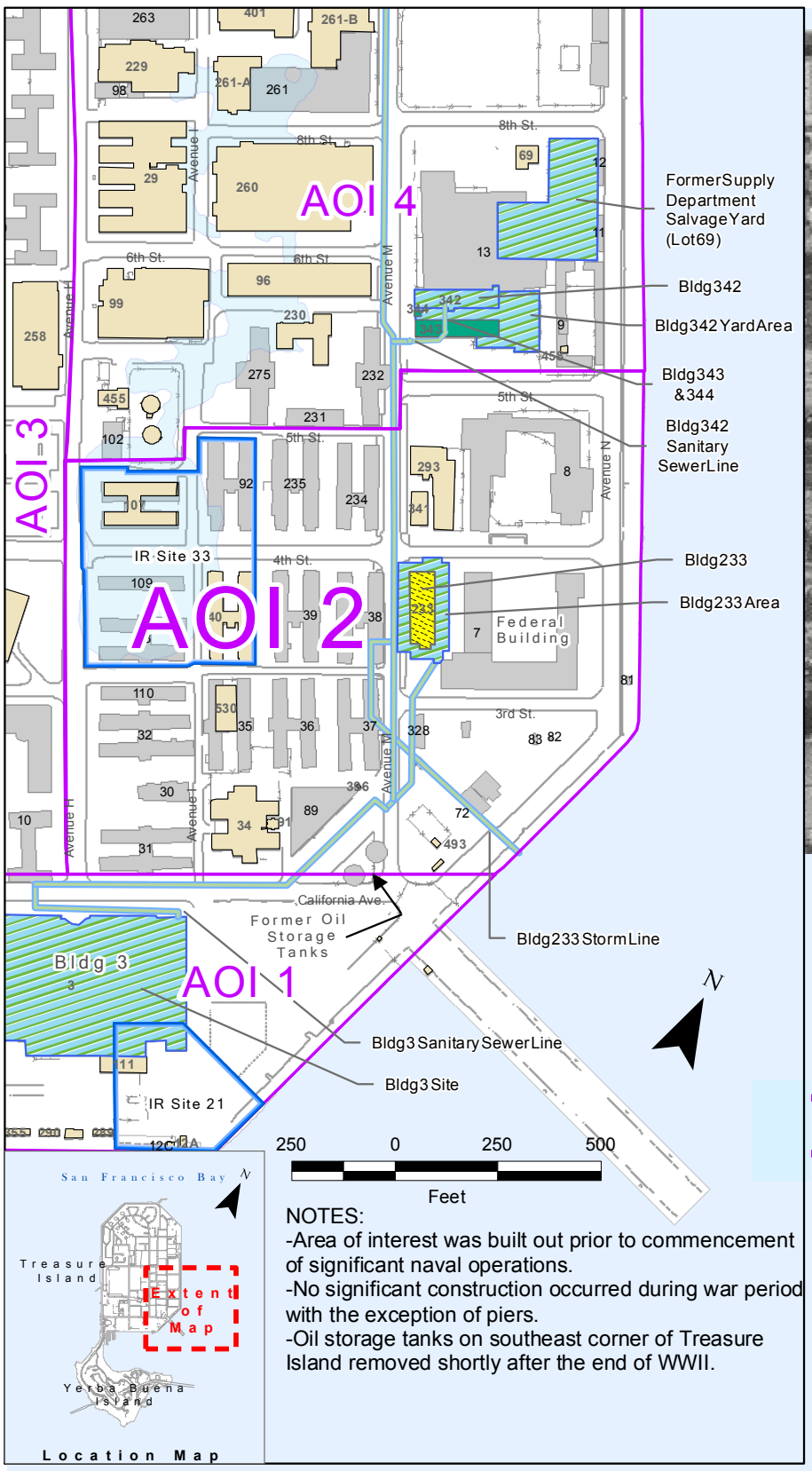
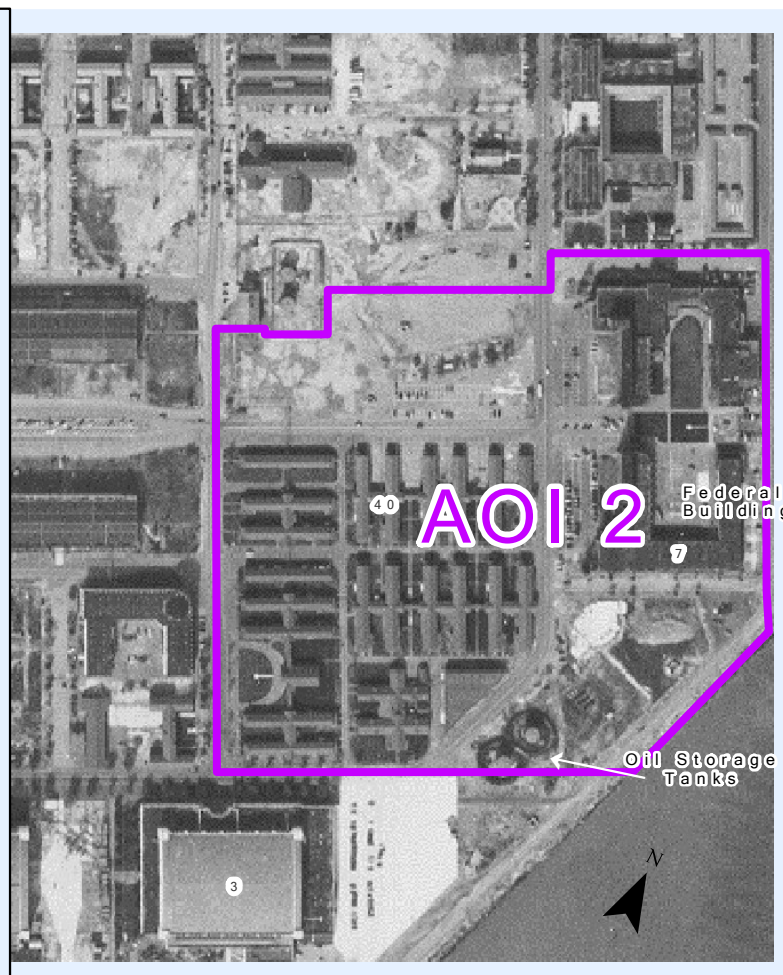
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 3

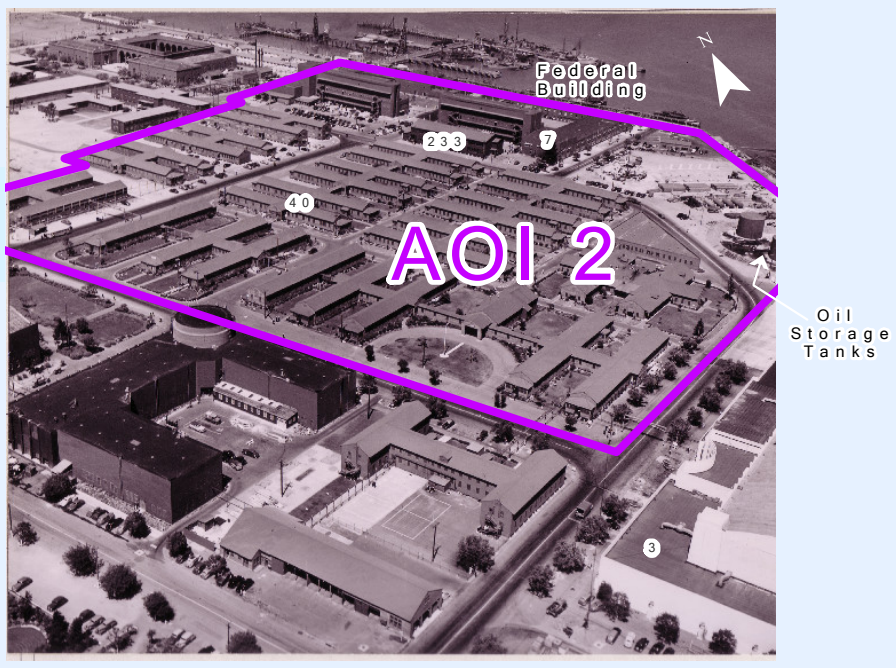
SEAPLANE LAGOON AREA OF INTEREST 1



NOTES:
-Area of interest was built out prior to commencement of significant naval operations.
-No significant construction occurred during war period with the exception of piers.
-Oil storage tanks on southeast corner of Treasure Island removed shortly after the end of WWII.

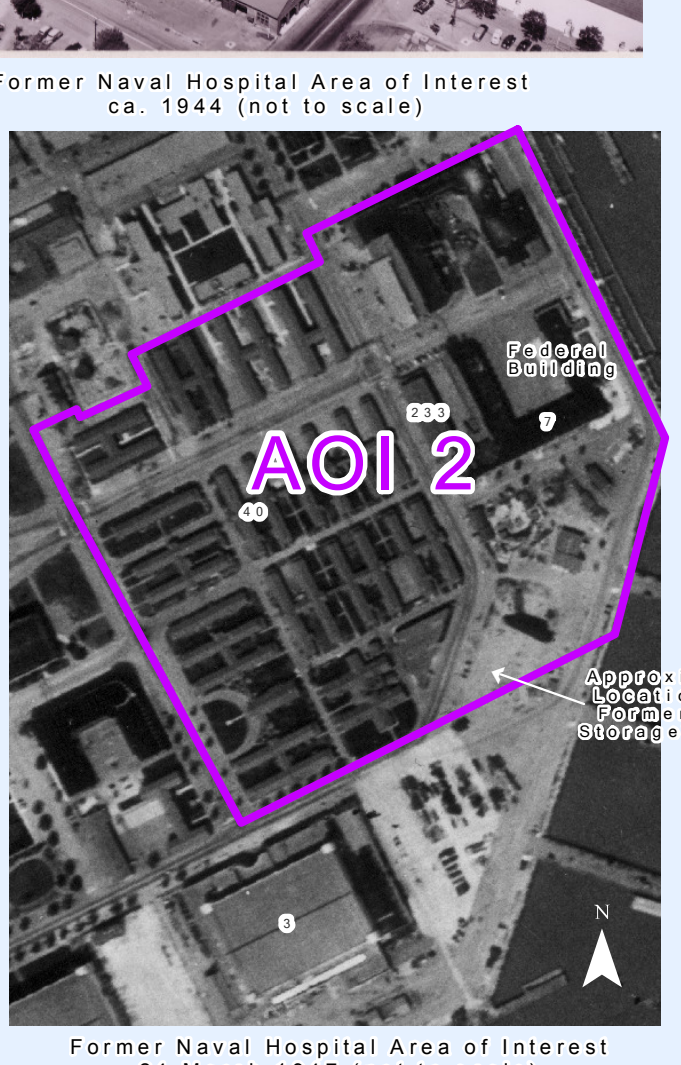


Former Naval Hospital and Surrounding Area of Interest 04 June 1942 (not to scale)



Former Naval Hospital Area of Interest ca. 1944 (not to scale)

Former Naval Hospital Area of Interest 15 August 2000 (not to scale)



Former Naval Hospital Area of Interest 24 March 1947 (not to scale)

LEGEND

- Area of Interest
- Newly Identified Radiologically Impacted Site
- Newly Identified Radiologically Impacted Sewer or Storm Lines
- 2006 HRA Radiologically Impacted Site Where Recent Surveys Have Not Found Low Level Radiological Contamination. Site Released.
- 2006 HRA Radiologically Impacted Site Where Recent Surveys Have Found Low Level Radiological Contamination or Objects
- IR Site
- Road
- Fence
- Existing Building (as of 19 June 2011)
- Demolished Building
- Former Lake of the Nations

Note: Areas are not radiologically impacted unless specifically identified.

HRA Historical Radiological Assessment
IR Installation Restoration

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Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

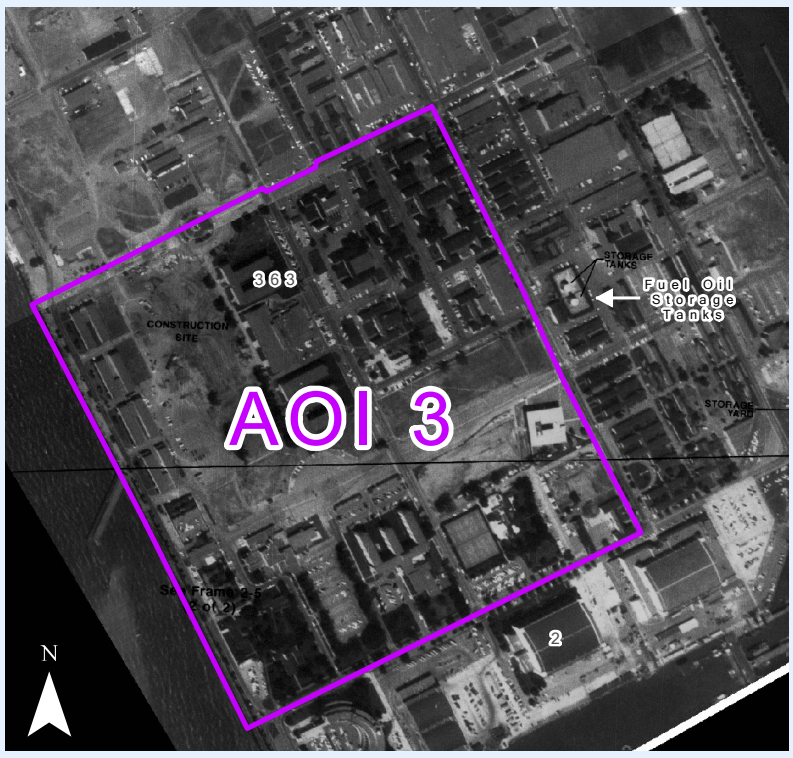
FIGURE 4

FORMER NAVAL HOSPITAL AREA OF INTEREST 2

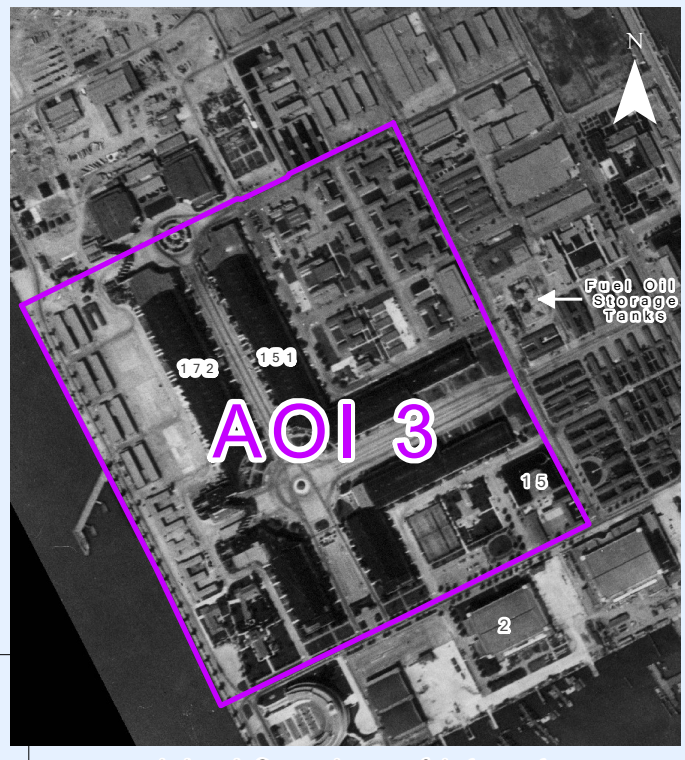
NOTES:
Area of Interest 3 has no radiologically impacted areas:
1) No evidence of radiological work has been found in this area;
2) Buildings in the area primarily served as barracks and support facilities and there is no evidence of industrial activities in this area;
3) There is no evidence of industrial lay down areas having been present in this area from review of available documents.

Island Core Area of Interest
15 August 2000 (not to scale)

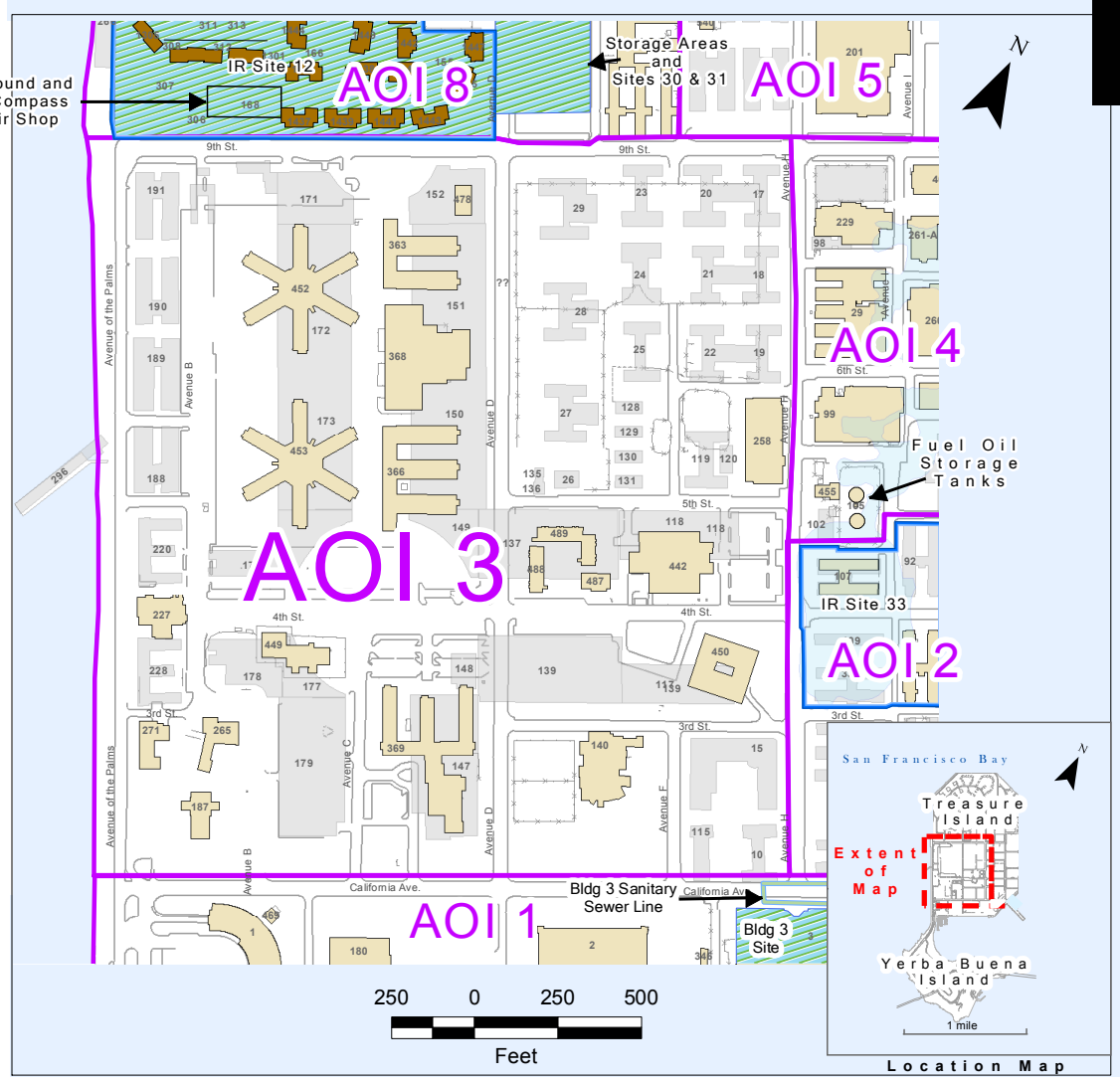
Island Core Area of Interest
19 May1969 (not to scale)

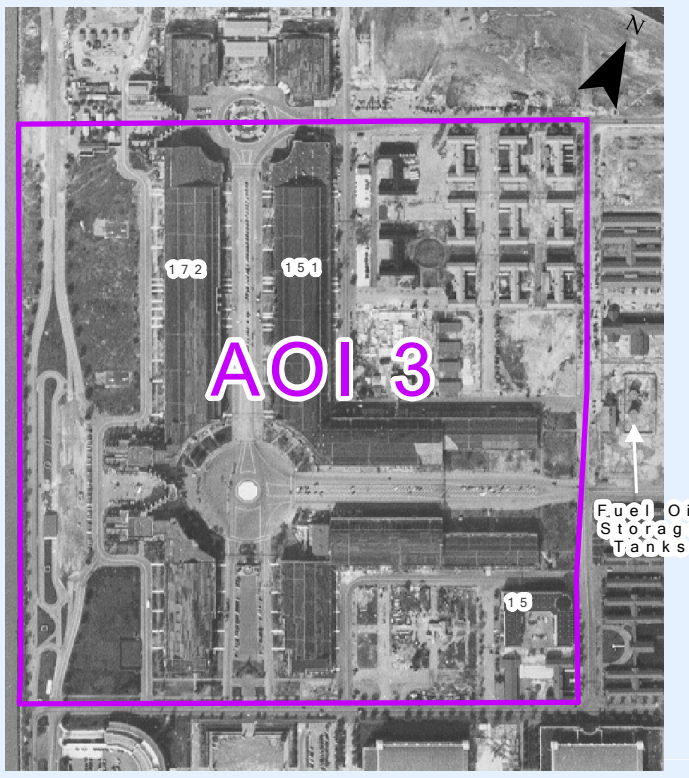


Island Core Area of Interest
18 April 1968 (not to scale)



Island Core Area of Interest
24 March 1947 (not to scale)





Island Core Area of Interest
ca. 1942 (not to scale)

LEGEND

- Area of Interest
- IR Site
- Newly Identified Radiologically Impacted Site
- Radiologically Impacted Soil Site With Non-Radiologically Impacted Building/Structure
- Newly Identified Radiologically Impacted Sewer or Storm Lines
- Former Lake of the Nations
- Existing Building (as of 19 June 2011)
- Demolished Building
- Fence
- Road

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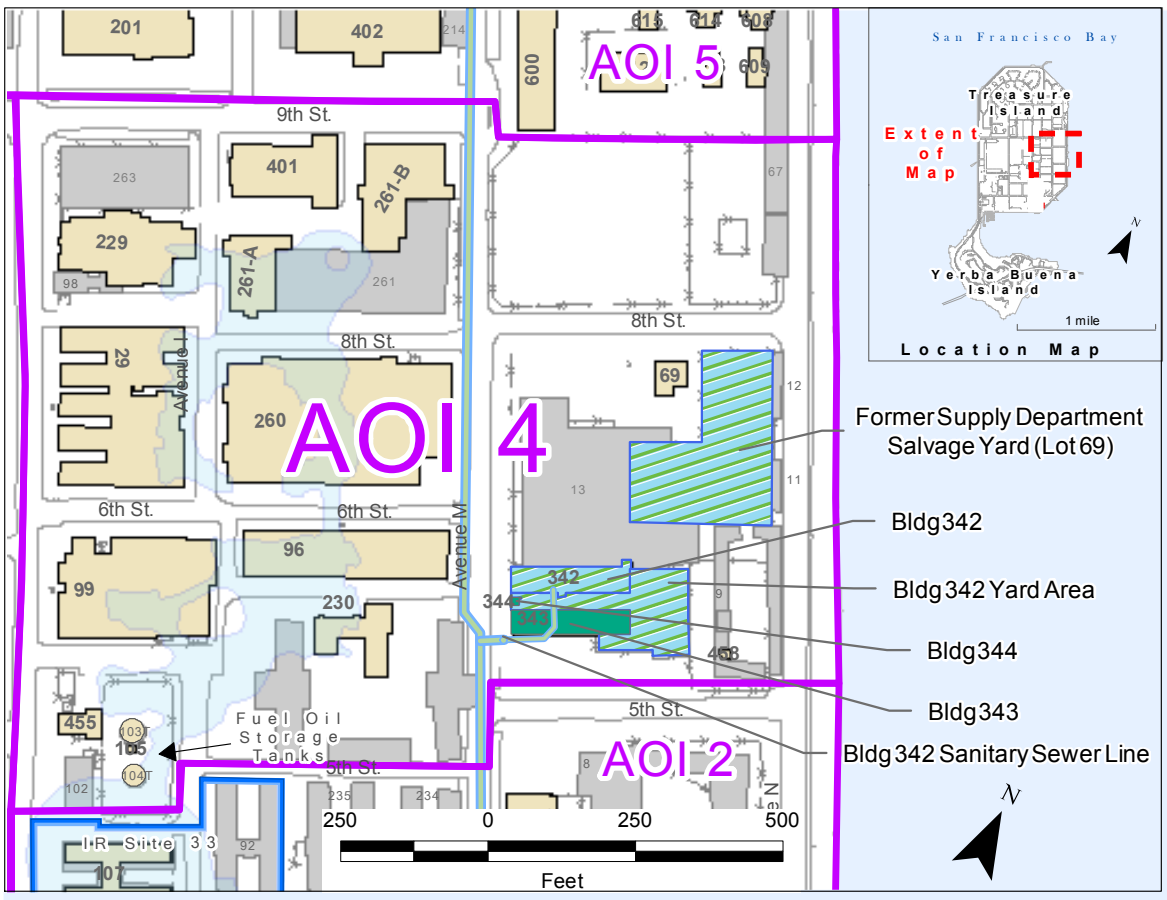
Note: Areas are not radiologically impacted unless specifically identified.

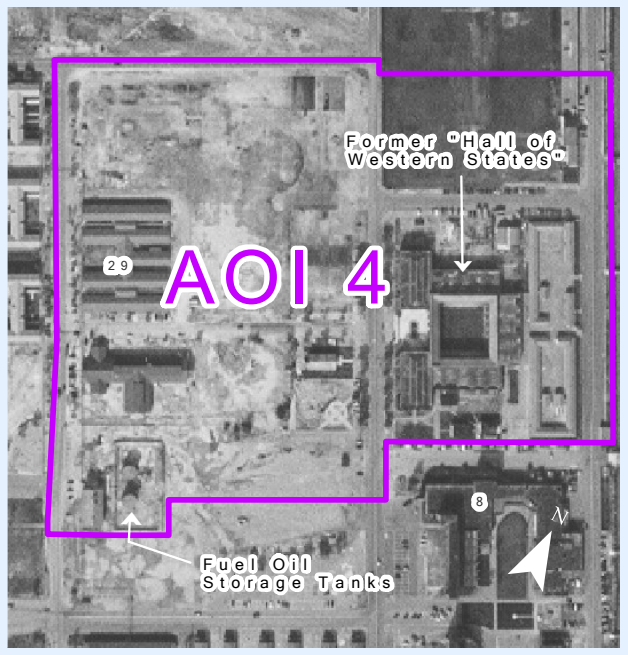
IR Installation Restoration

Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 5

ISLAND CORE AREA OF INTEREST 3



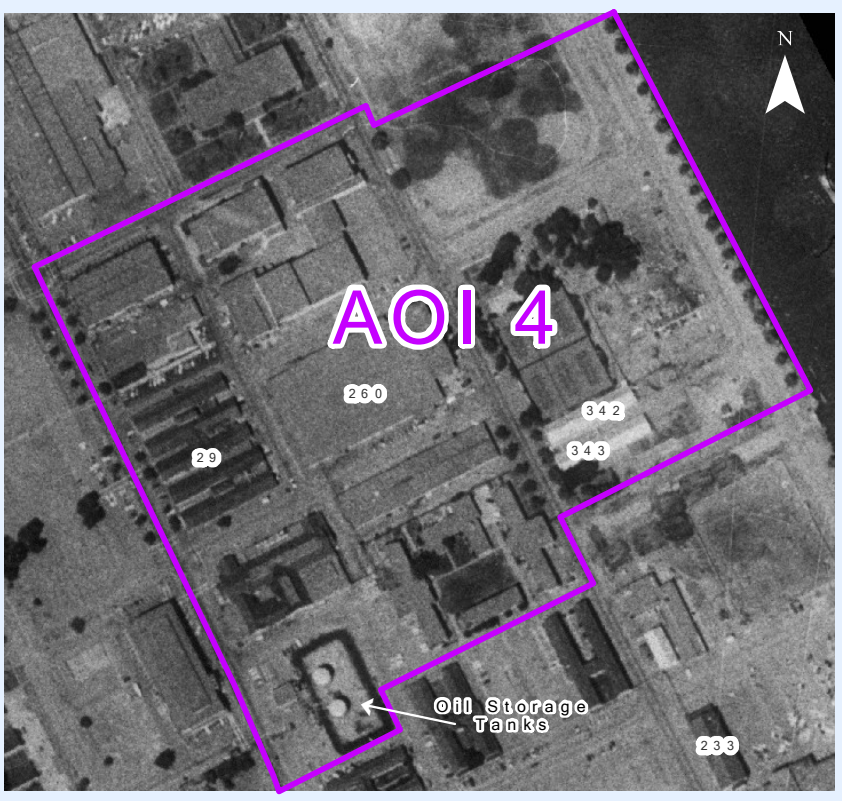


Southwestern Area of Interest
04 June 1942 (not to scale)

Southwestern Area of Interest
24 March 1947 (not to scale)

Southwestern Area of Interest
1 March 1958 (not to scale)

Southwestern Area of Interest
15 August 2000 (not to scale)



Southwestern Area of Interest
09 April 1975 (not to scale)

LEGEND

- Area of Interest
- IR Site
- Newly Identified Radiologically Impacted Site
- Newly Identified Radiologically Impacted Sewer or Storm Line
- Former Lake of the Nations
- 2006 HRA Radiologically Impacted Site Where Recent Surveys Have Not Found Low Level Radiological Contamination. Site Released.
- Existing Building (as of 19 June 2011)
- Demolished Building
- Fence
- Road

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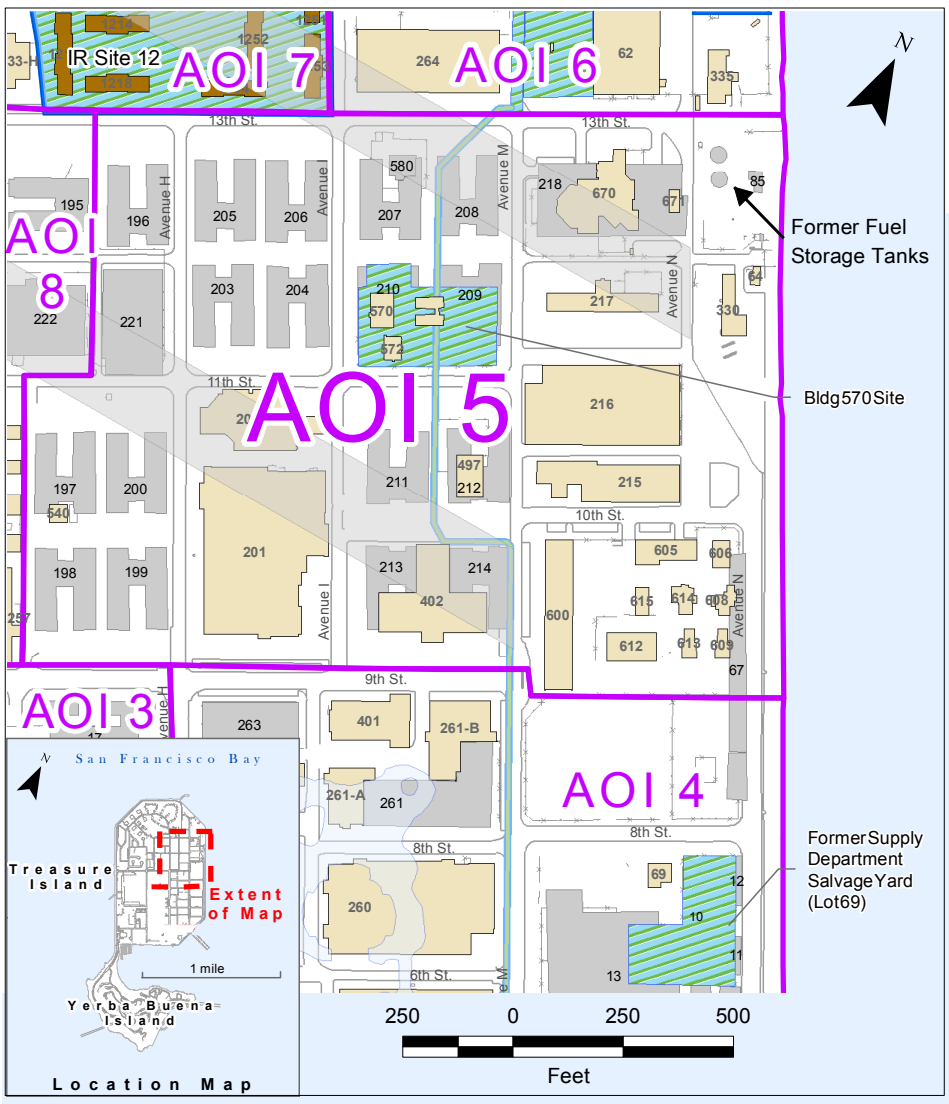
Note:
Areas are not radiologically impacted unless specifically identified.

HRA Historical Radiological Assessment
IR Installation Restoration

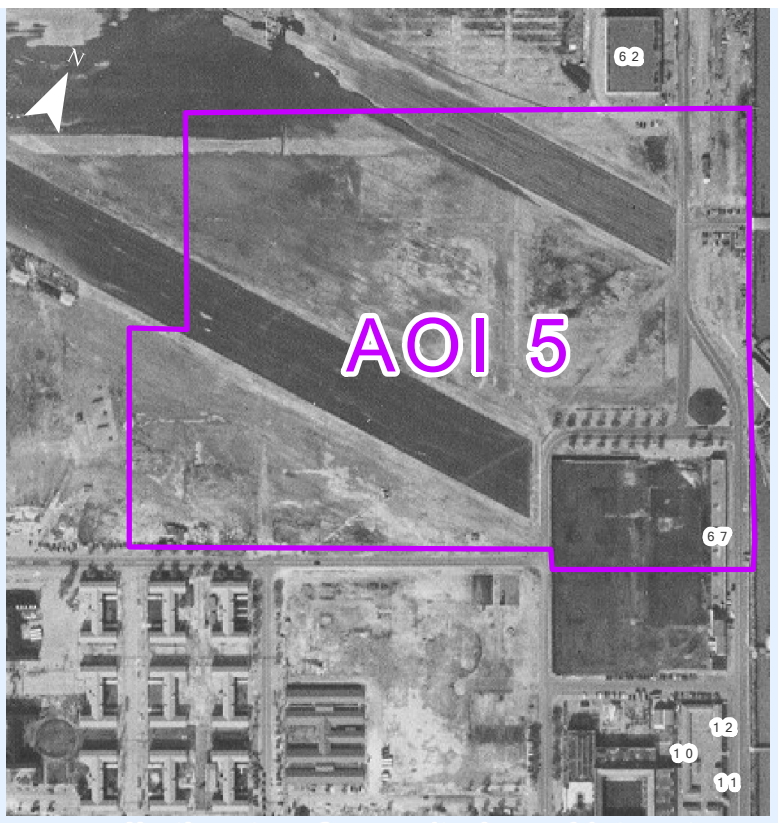
Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 6

SOUTHWESTERN AREA OF INTEREST 4



NOTES:
-Area of Interest largely undeveloped prior to commencement of significant naval operations with the exception of runway construction (later abandoned) and the piers.
-The parcel was entirely built out during war period leaving little likelihood or opportunity for disposal operations to occur.

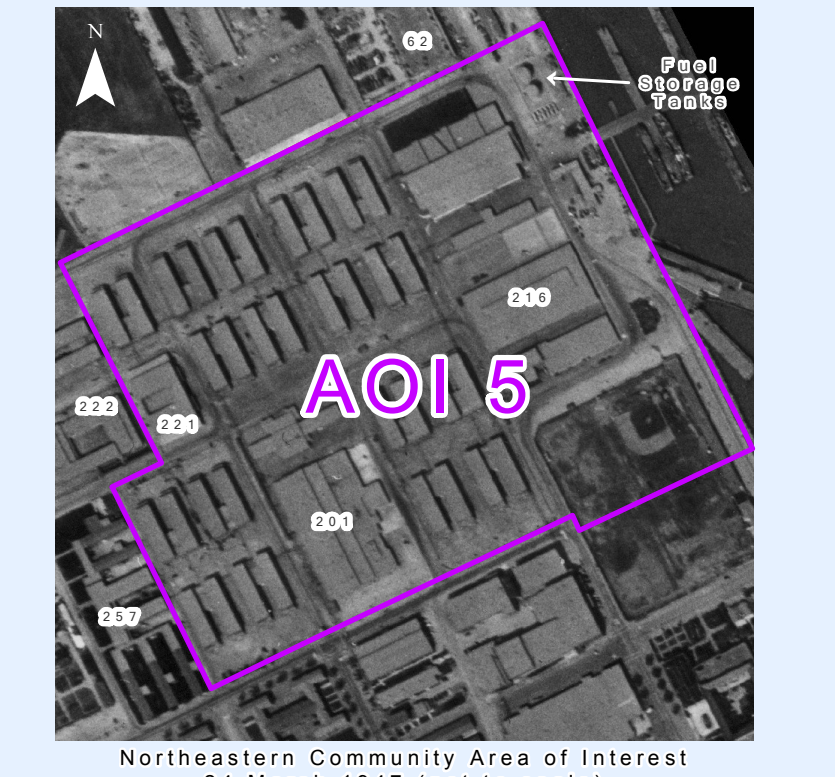


Northeastern Community Area of Interest
04 June 1942 (not to scale)

Northeastern Community Area of Interest
01 March 1958 (not to scale)

Northeastern Community Area of Interest
24 March 1947 (not to scale)

Northeastern Community Area of Interest
15 August 2000 (not to scale)



Northeastern Community Area of Interest
04 September 1975 (not to scale)

LEGEND

- Area of Interest
- IR Site
- Newly Identified Radiologically Impacted Site
- Newly Identified Radiologically Impacted Sewer or Storm Line
- Radiologically Impacted Soil Site With Non-Radiologically Impacted Building/Structure
- Existing Building (as of 19 June 2011)
- Demolished Building
- Former Lake of the Nations
- Former Runway
- Road
- Fence

Note: Areas are not radiologically impacted unless specifically identified.

IR Installation Restoration

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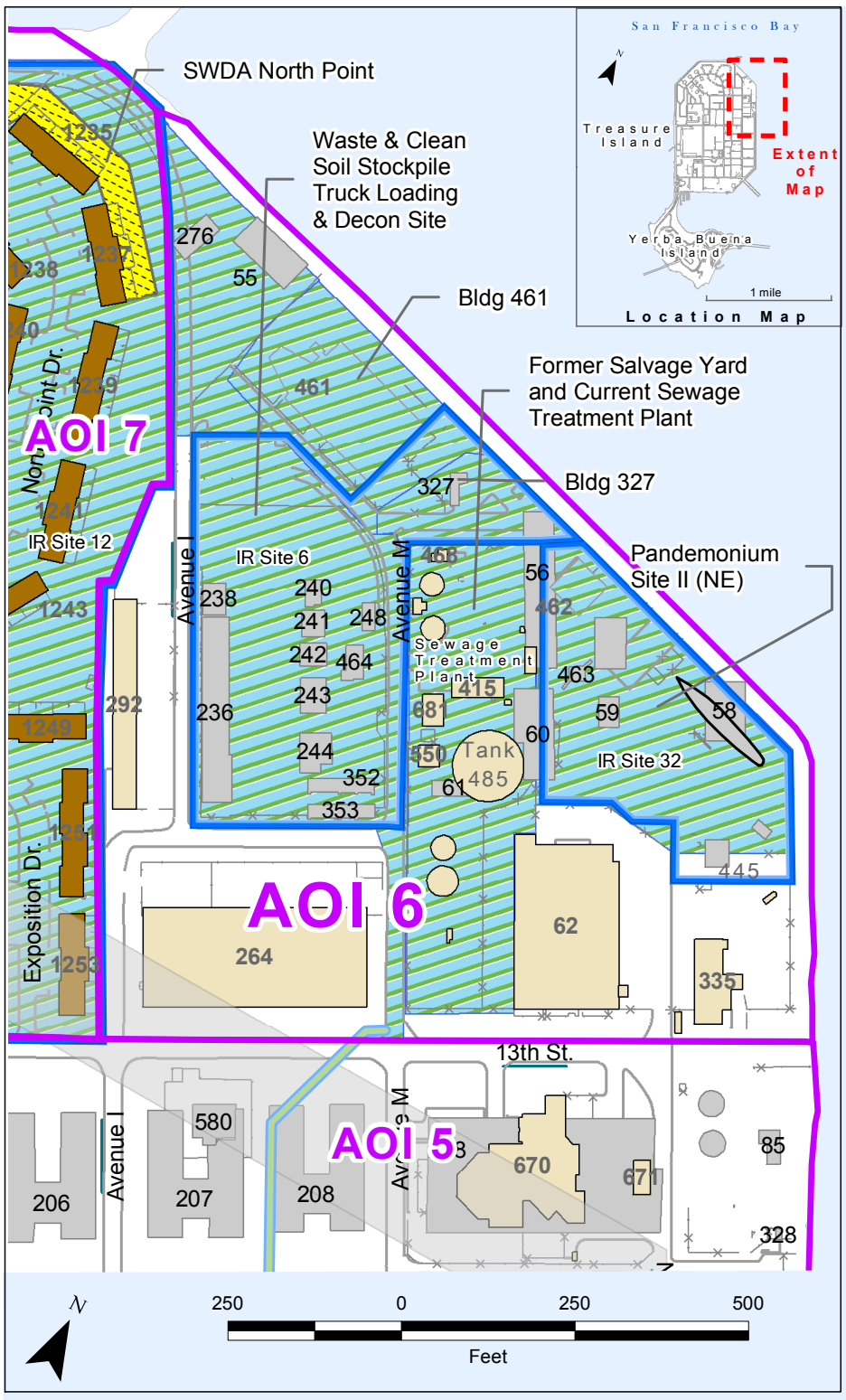
Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

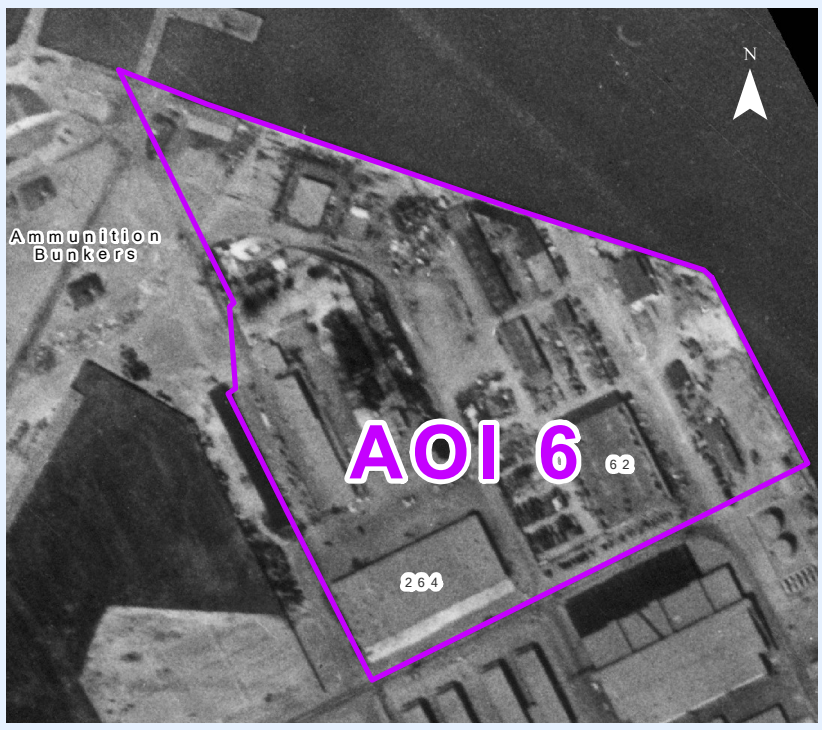
FIGURE 7

NORTHEASTERN COMMUNITY AREA OF INTEREST 5

2014-06-26 \\DISKSTATION\TriEcoProjects\NAVFAC - AECRU V\BRAC 2\Treasure Island\CTO-0003_Treasure_Island\Treasure_Is_GIS\TI_HRASTM_2012\Fig07\fig-7_TI_Dispensary_AOI-5_rev-13.mxd TriEco-Tt clynch



Sewage Treatment Area of Interest
04 June 1942 (not to scale)



Sewage Treatment Area of Interest
24 March 1947 (not to scale)

Sewage Treatment Area of Interest
15 August 2000 (not to scale)

Sewage Treatment Area of Interest
30 December 1969 (not to scale)

NOTES:
-There is evidence of lay down areas being utilized during the war in the area that is now the sewage treatment plant, suggesting this activity was associated with the Supply Department or a salvage yard. The waste treatment facility was constructed in the early 1960s.
-In 1970, the Navy's damage control school, which included radioactive decontamination training, was relocated to the northern portion of the site. Facilities included Buildings 461 and 462 and the USS Pandemonium Site II (NE), a full scale mockup training ship. The relocation was completed in September 1970. The use of these facilities ended by 20 February 1994.

LEGEND

- Area of Interest
- IR Site
- Newly Identified Radiologically Impacted Site
- Newly Identified Radiologically Impacted Sewer or Storm Line
- 2006 HRA Radiologically Impacted Site Where Recent Surveys Have Found Low Level Radiological Contamination or Objects
- Radiologically Impacted Soil Site With Non-Radiologically Impacted Building/Structure
- Existing Building (as of 19 June 2011)
- Demolished Building
- Former Runway
- Road
- Fence

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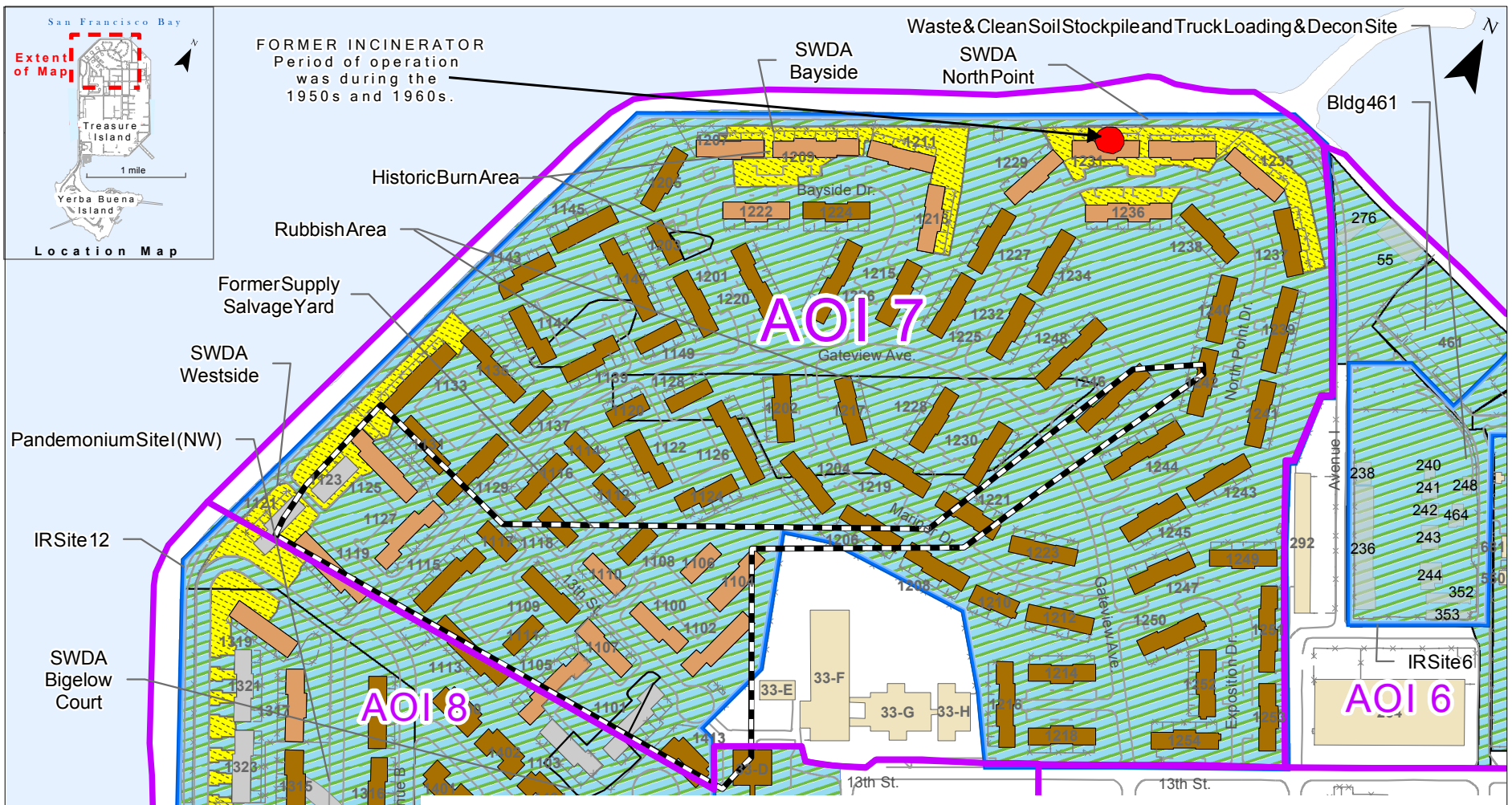
Note: Areas are not radiologically impacted unless specifically identified.

HRA Historical Radiological Assessment
IR Installation Restoration
SWDA Solid Waste Disposal Area

Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

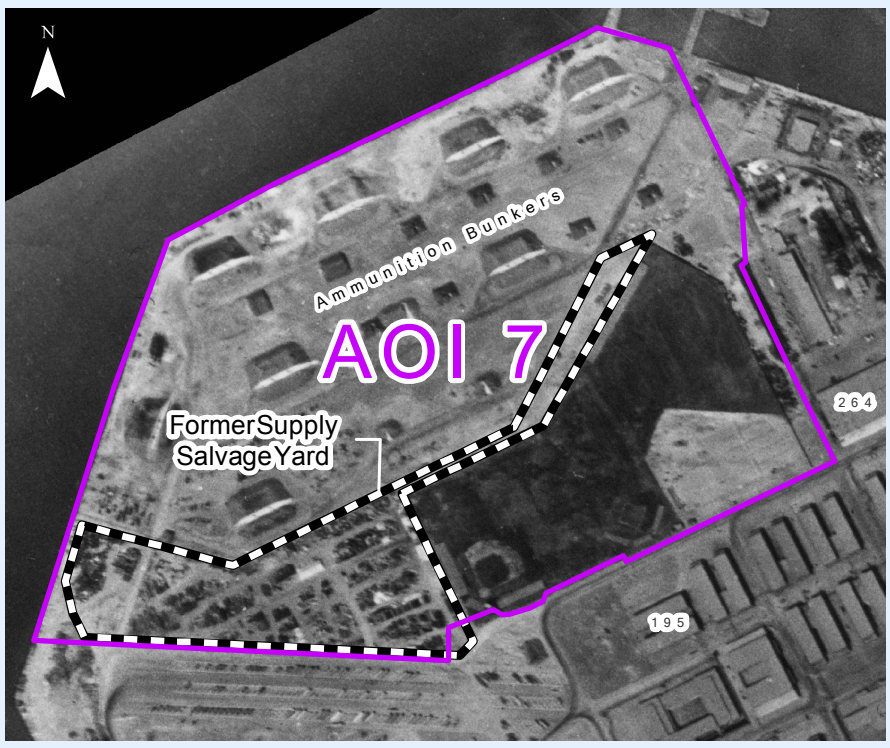
FIGURE 8

SEWAGE TREATMENT AREA OF INTEREST 6

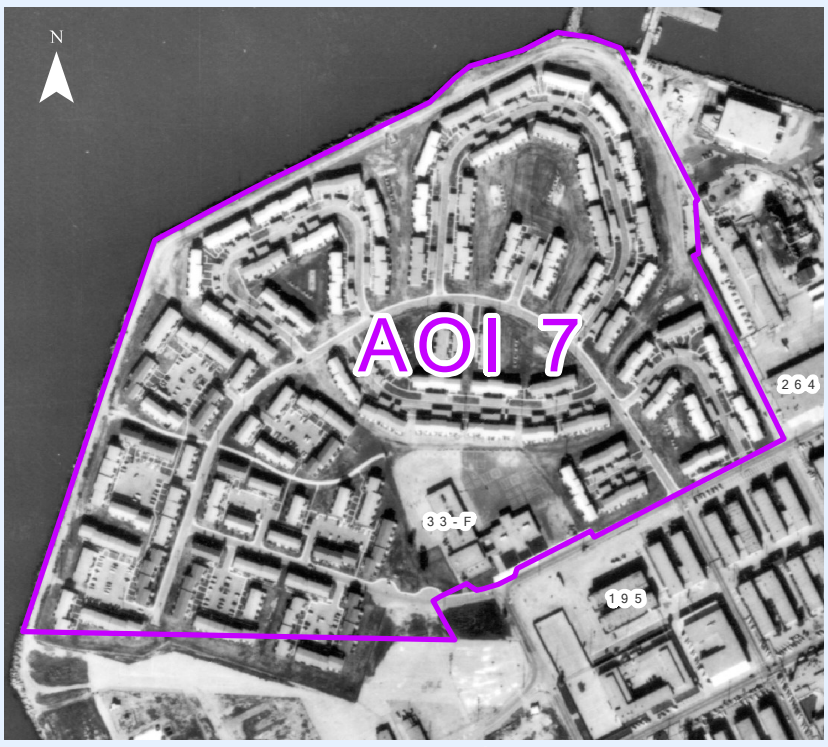


NOTES:
-The Area of Interest remained a likely spot for disposal of debris throughout WWII and into the 1960s.
-Housing was constructed in the area beginning in the mid-1960s.
-A salvage yard was operated in the southwestern portion of the site beginning sometime during WWII and into the 1960s.

Housing Area of Interest
04 June 1942 (not to scale)



Housing Area of Interest
24 March 1947 (not to scale)



Housing Area of Interest
30 December 1969 (not to scale)

Housing Area of Interest
10 April 1968 (not to scale)

LEGEND

- Area of Interest
- IR Site
- Newly Identified Radiologically Impacted Site
- 2006 HRA Radiologically Impacted Site Where Recent Surveys Have Found Low Level Radiological Contamination or Objects
- Radiologically Impacted Soil Site With Non-Radiologically Impacted Building/Structure
- Former Storage/Salvage Yard†

Buildings

- Occupied
- Unoccupied
- Demolished
- Road
- Fence

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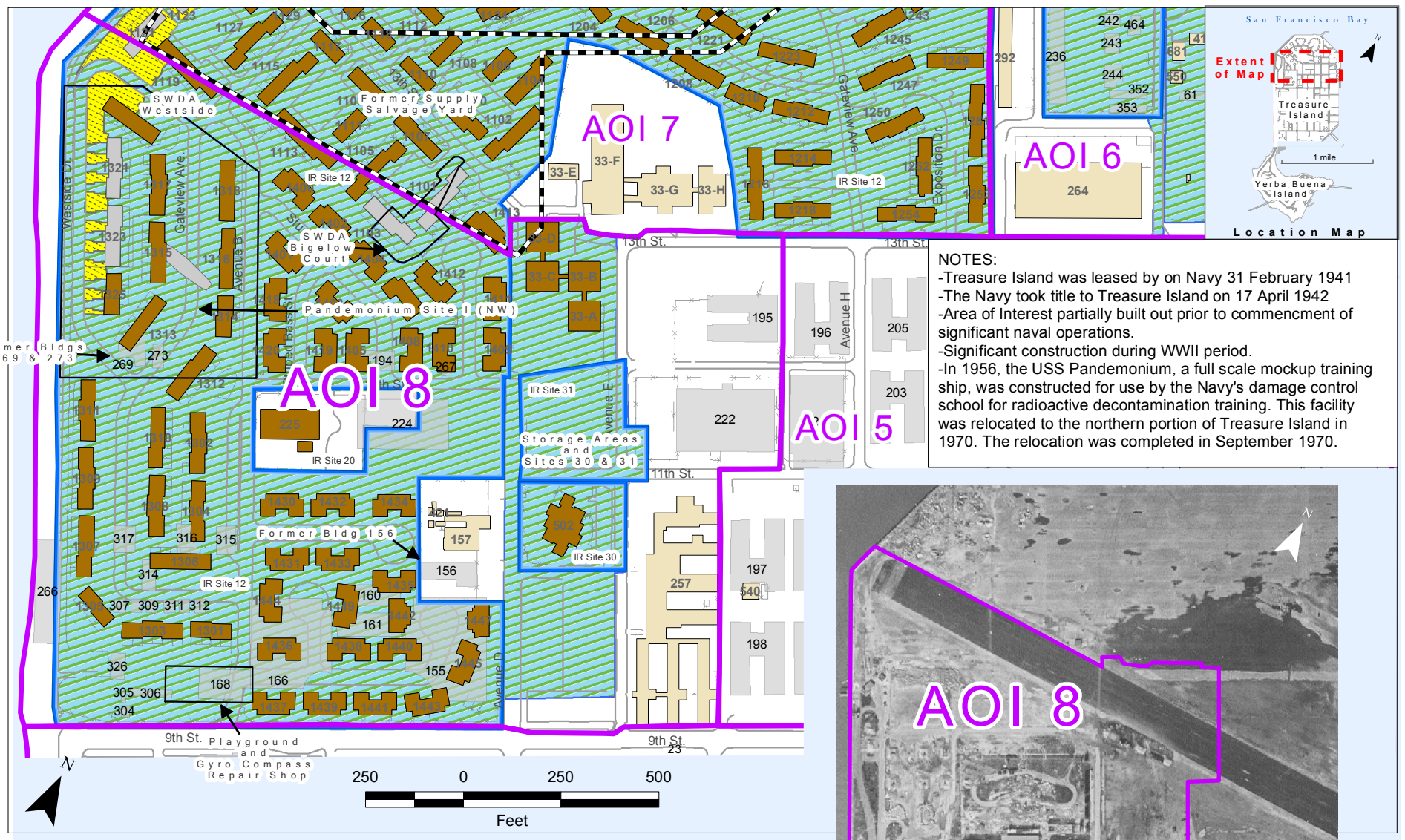
Notes:
Areas are not radiologically impacted unless specifically identified.
† Former Supply Salvage Yard from US Naval Station Treasure Island San Francisco, California General Development Map, 1962.

HRA Historical Radiological Assessment
IR Installation Restoration
SWDA Solid Waste Disposal Area

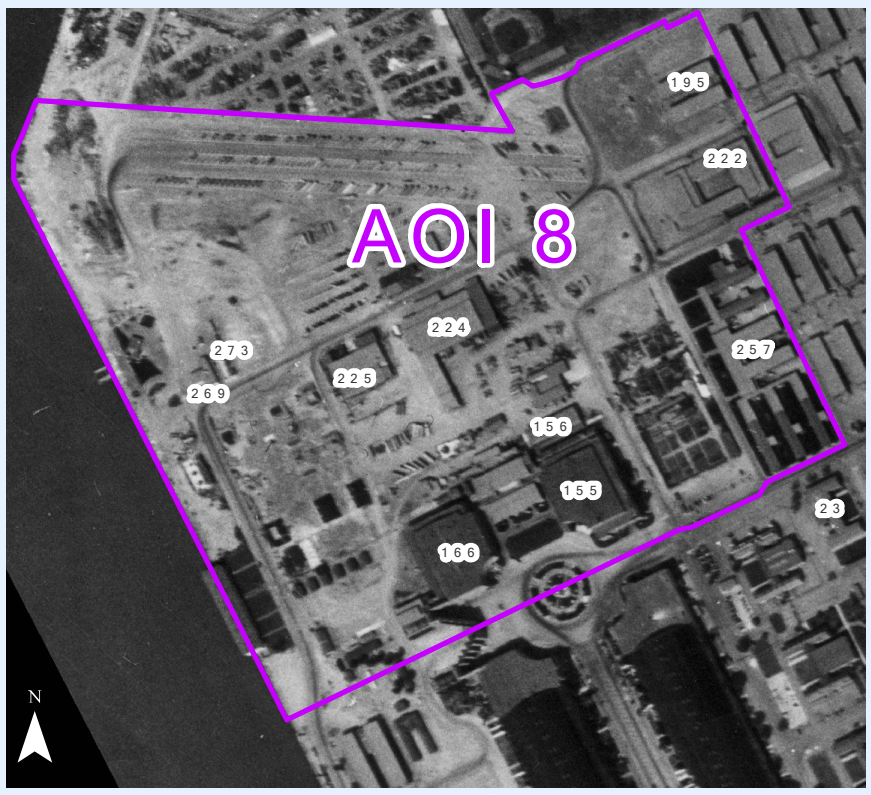
Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 9
HOUSING AREA OF INTEREST 7



NOTES:
-Treasure Island was leased by on Navy 31 February 1941
-The Navy took title to Treasure Island on 17 April 1942
-Area of Interest partially built out prior to commencment of significant naval operations.
-Significant construction during WWII period.
-In 1956, the USS Pandemonium, a full scale mockup training ship, was constructed for use by the Navy's damage control school for radioactive decontamination training. This facility was relocated to the northern portion of Treasure Island in 1970. The relocation was completed in September 1970.

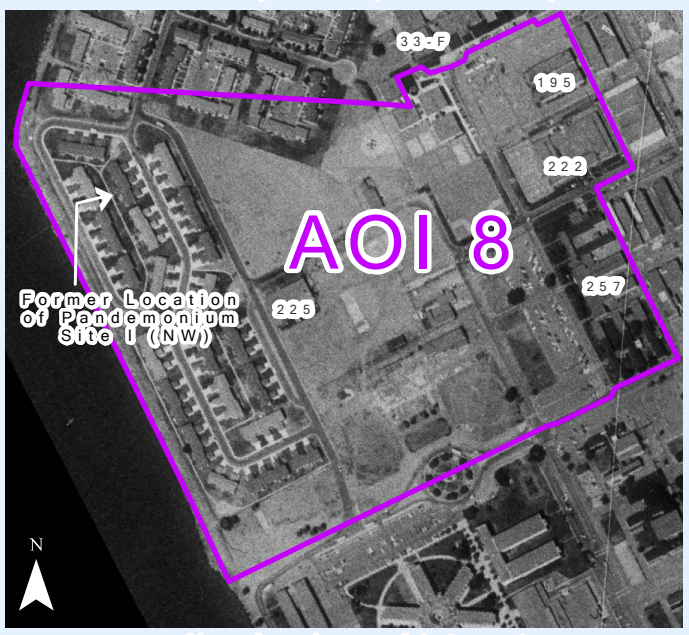
Housing Area of Interest
04 June 1942 (not to scale)



Housing Area of Interest
24 March 1947 (not to scale)

Housing Area of Interest
9 July 1963 (not to scale)

Housing Area of Interest
15 August 2000 (not to scale)



Housing Area of Interest
4 September 1975 (not to scale)

LEGEND

- Area of Interest
- IR Site
- Newly Identified Radiologically Impacted Site
- 2006 HRA Radiologically Impacted Site Where Recent Surveys Have Found Low Level Radiological Contamination or Objects
- Radiologically Impacted Soil Site With Non-Radiologically Impacted Building/Structure
- Former Storage/Salvage Yard†
- Road
- Fence
- Existing Building (as of 19 June 2011)
- Demolished Building

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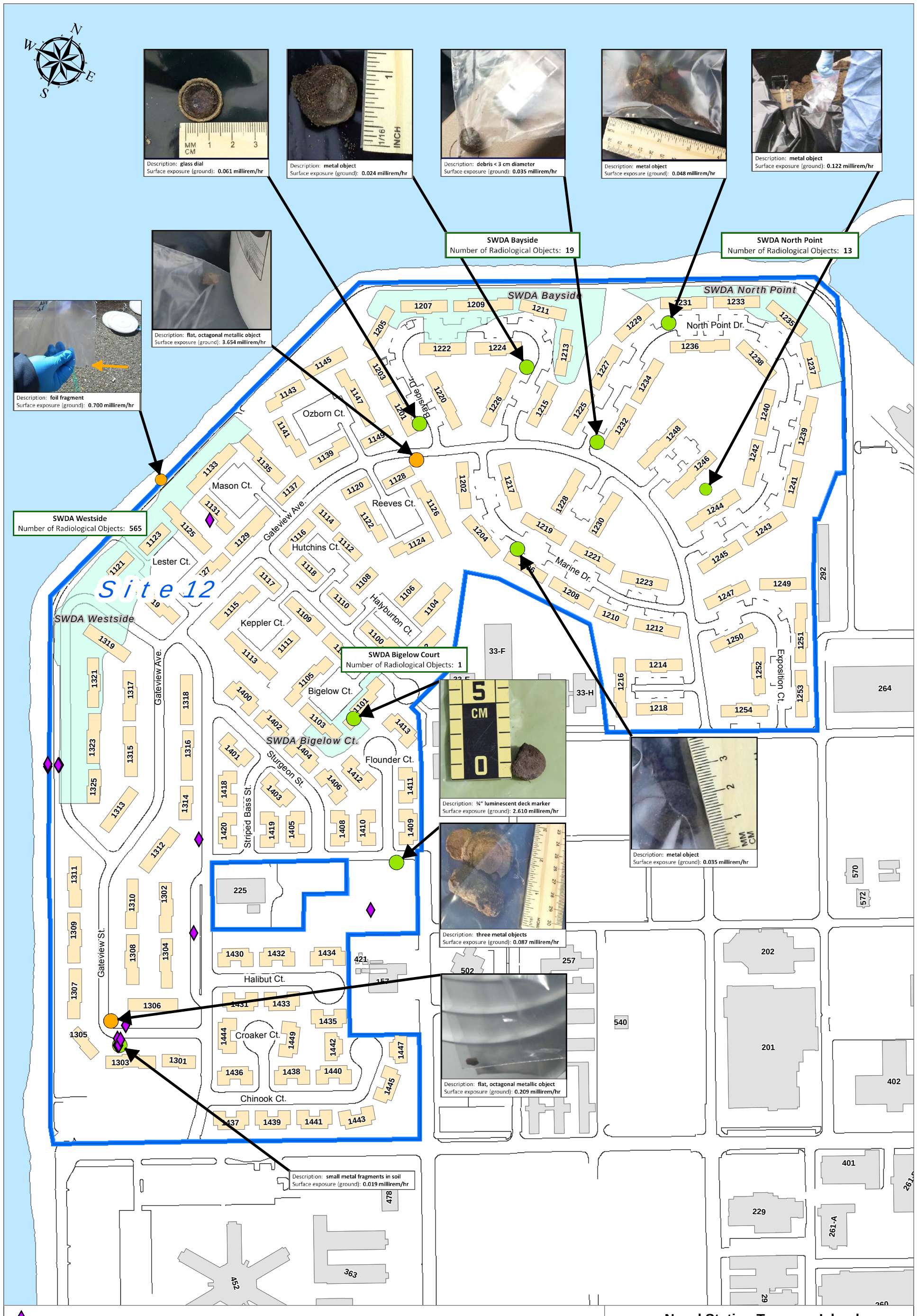
Notes:
Areas are not radiologically impacted unless specifically identified.
† Former Supply Salvage Yard from US Naval Station Treasure Island San Francisco, California General Development Map, 1962.

HRA Historical Radiological Assessment
IR Installation Restoration
SWDA Solid Waste Disposal Area

Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 10
HOUSING
AREA OF INTEREST 8



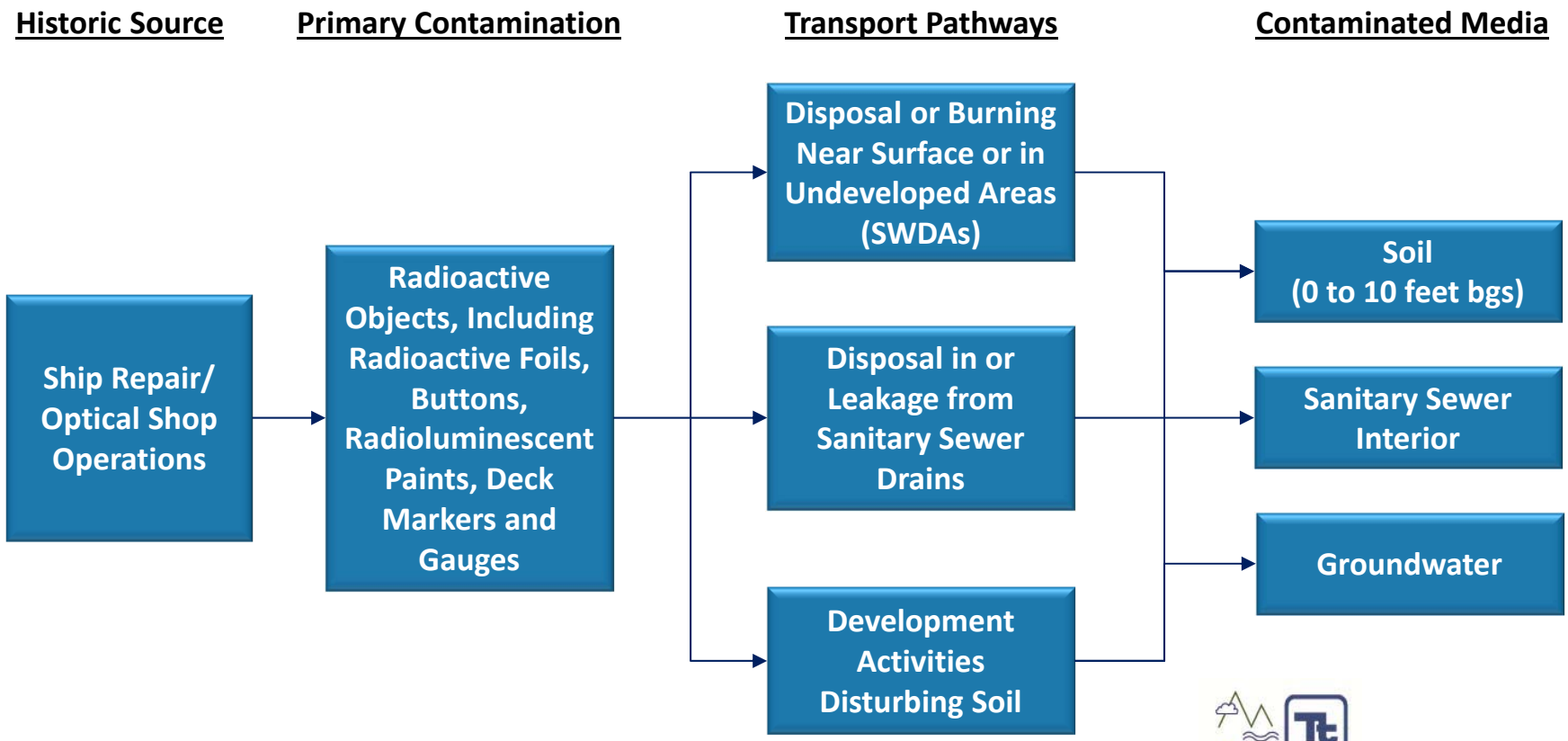
Note:
1. The surface exposure readings were measured at the ground surface.
2. Three SWDAs have been renamed as follows: SWDA Westside (previously A&B), SWDA Bayside (previously 1207/1209), SWDA North Point (previously 1231/1233).

cm Centimeter
IR Installation Restoration
millirem/hr Milliroentgens equivalent man per hour
SWDA Solid waste disposal area

Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 11

SITE 12
LOW LEVEL RADIOLOGICAL OBJECTS



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Notes:

bgs Below ground surface
SWDA Solid waste disposal area

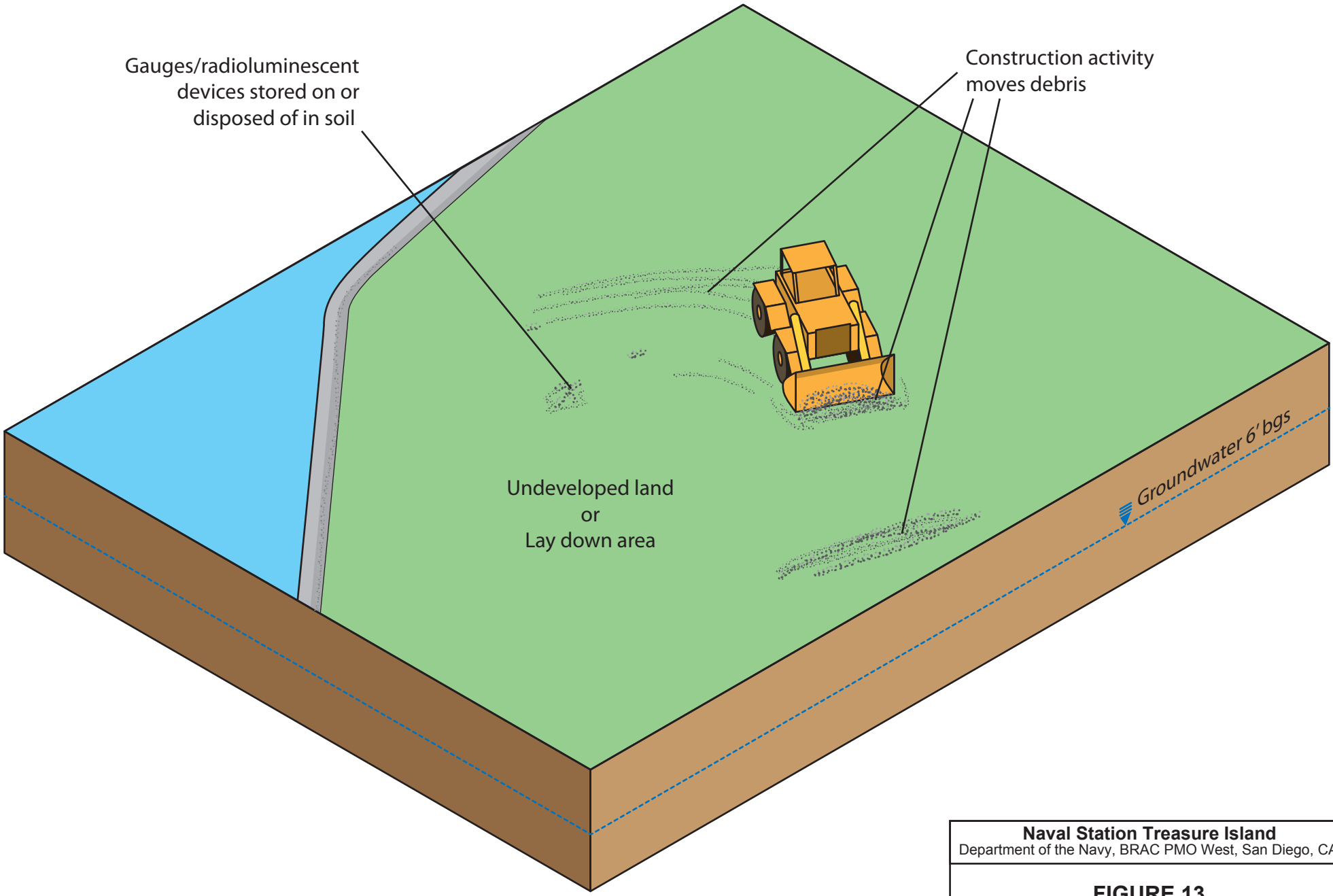
Key Assumptions:

1. Ship repair activities were limited to WWII (the Frontier Base) and for a short period afterward (the "Small Craft Facility").
2. Disposal/burial areas would not be found within active or developed areas of the base.

Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 12

REPAIR/SOLID WASTE DISPOSAL OPERATIONS – CONCEPTUAL SITE MODEL

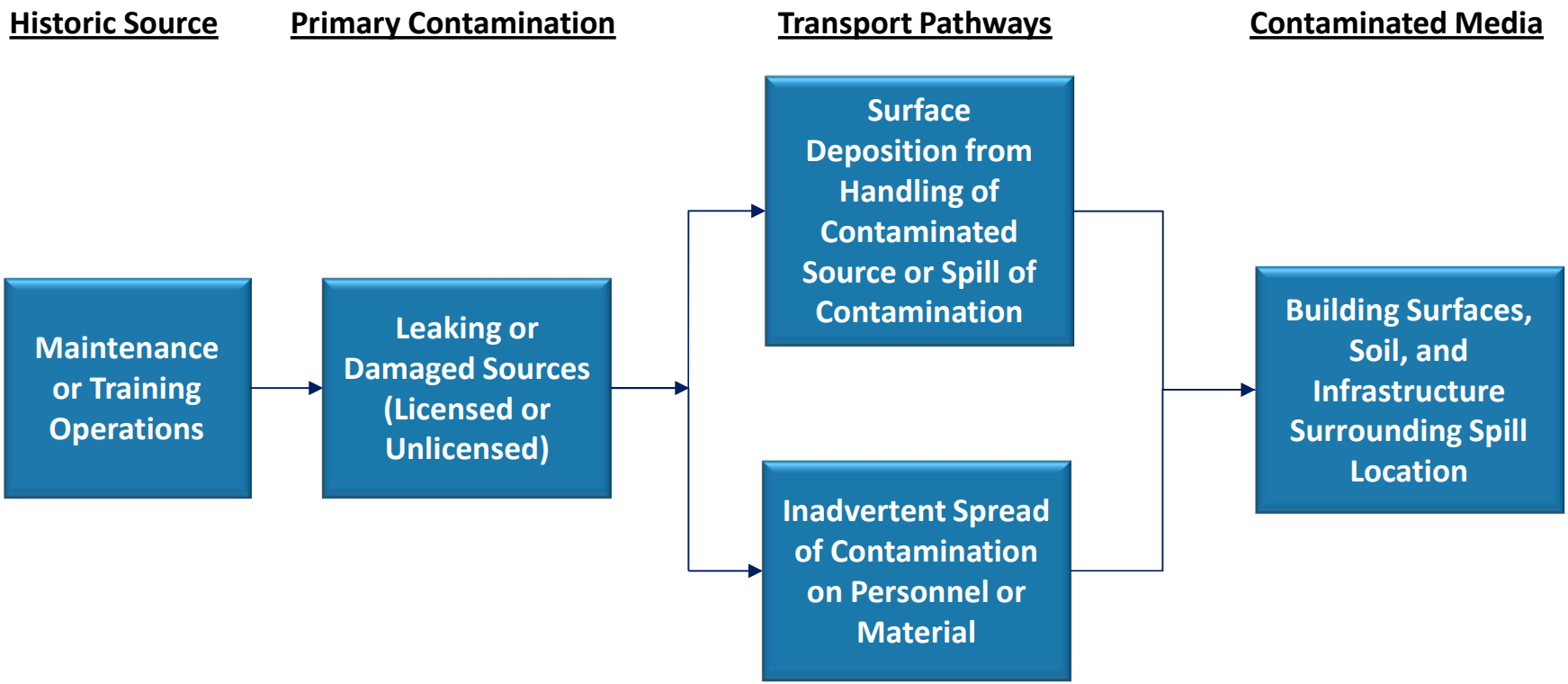


Note:
bgs Below ground surface

Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, CA

FIGURE 13

REPAIR/SOLID WASTE DISPOSAL OPERATIONS - CONCEPTUAL SITE MODEL



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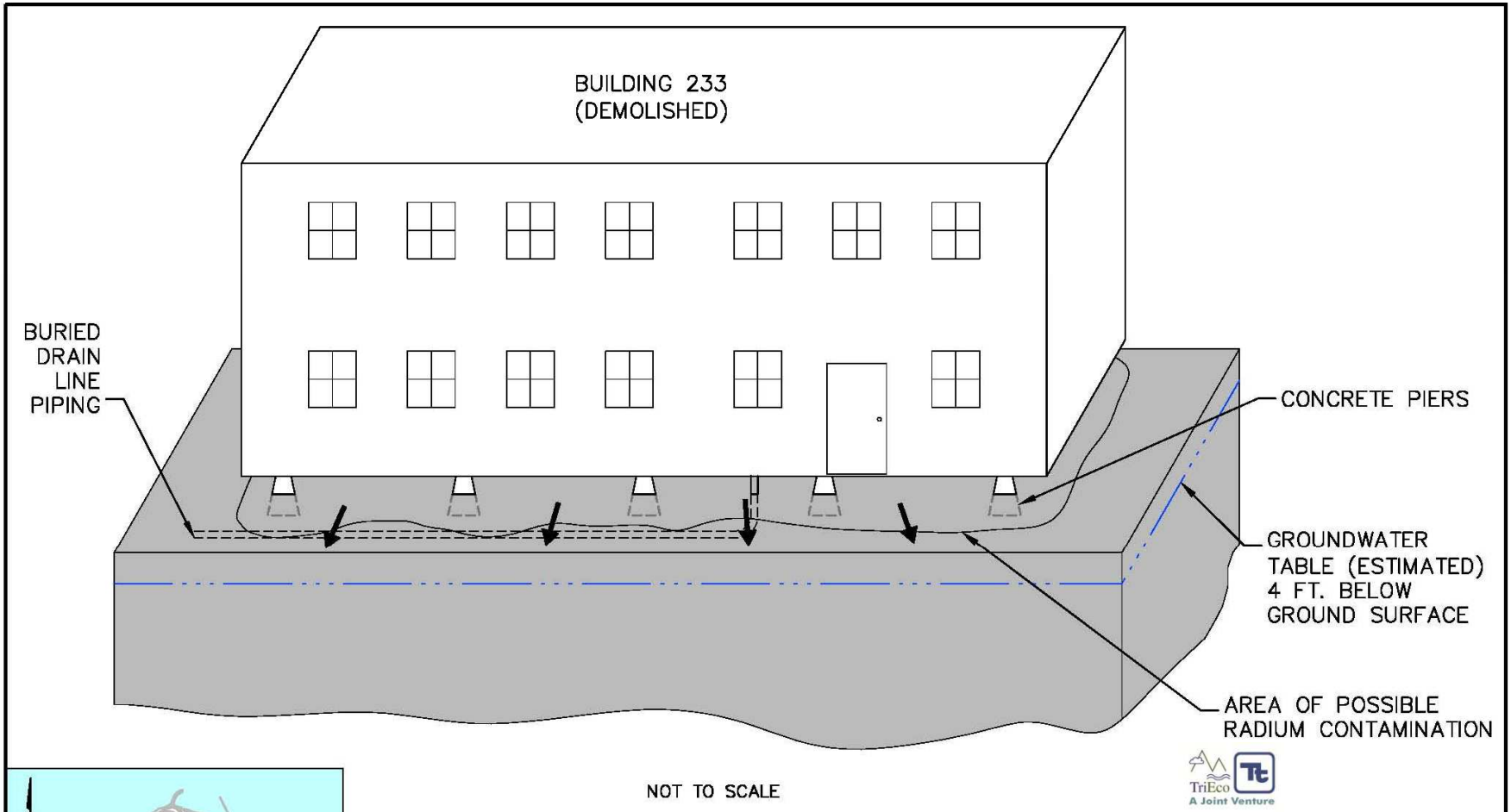
Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

Key Assumption:

1. Known actual or potential spills are confined to Building 233 and former USS *Pandemonium* locations.

FIGURE 14

INCIDENTAL RELEASES FROM TRAINING OPERATIONS – CONCEPTUAL SITE MODEL

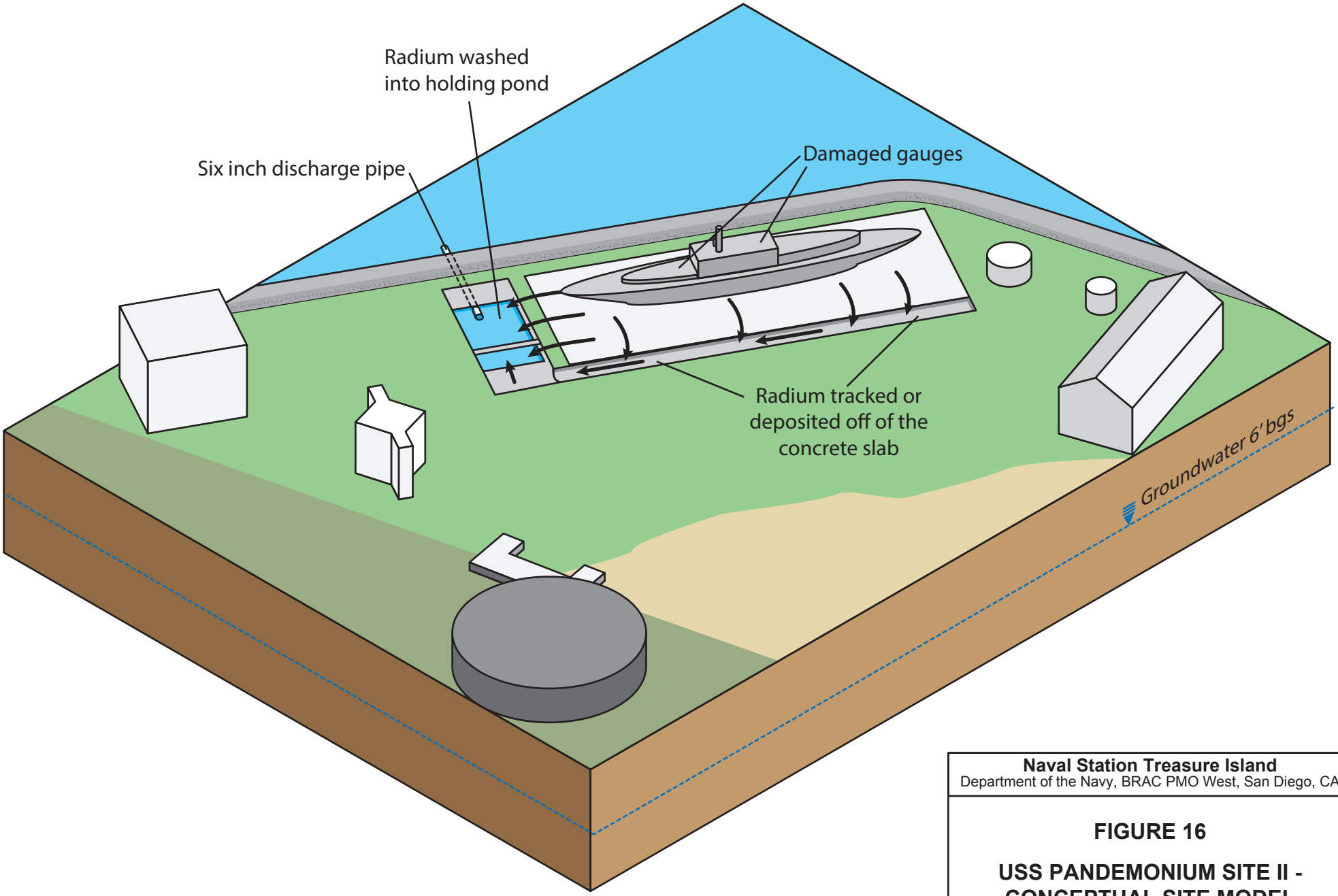


Source: Shaw Environmental, Inc. 2012. "Final Characterization, Remediation, and Final Status Survey Work Plan, Building 233 Site, Naval Station Treasure Island, San Francisco, California." January.

Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 15

BUILDING 233 – CONCEPTUAL SITE MODEL

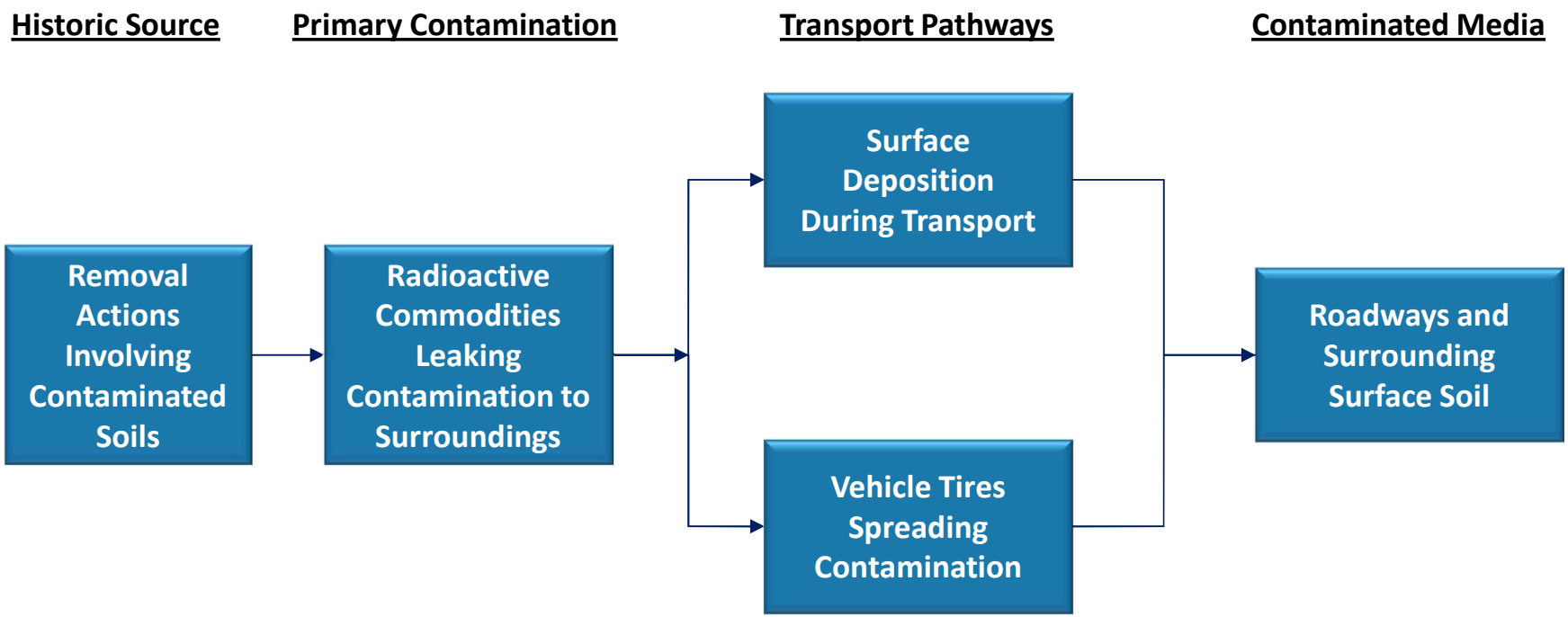


Note:
bgs Below ground surface

Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, CA

FIGURE 16

USS PANDEMONIUM SITE II - CONCEPTUAL SITE MODEL



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Note:

SWDA Soild waste disposal area

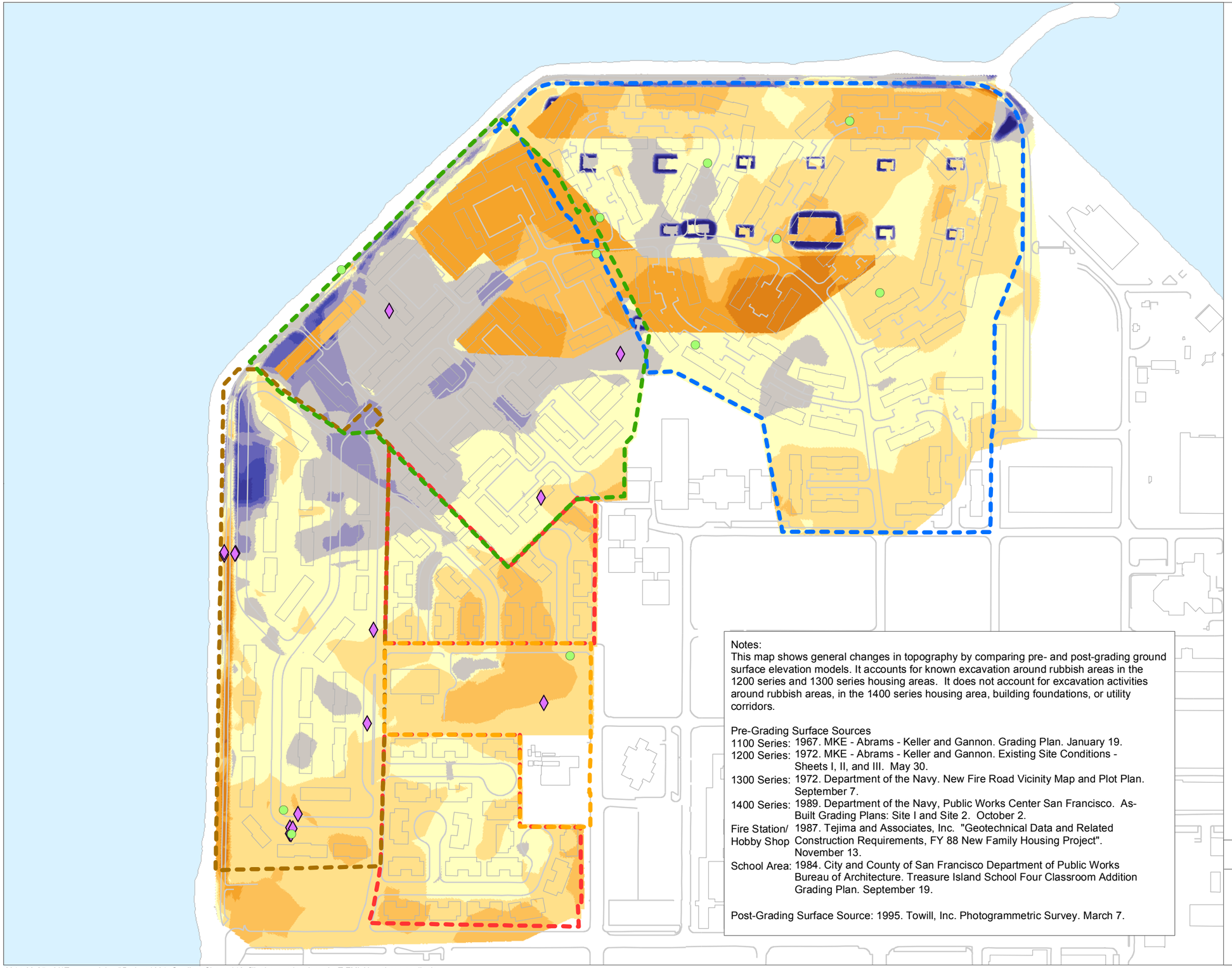
Key Assumptions:

1. Controls on transport of contaminated soil from Site 6, Site 12 SWDAs, and Site 32 were not adequate to contain contamination.
2. Impacted areas would be confined to primary truck routes.

Naval Station Treasure Island
Department of the Navy, BRAC PMO West, San Diego, California

FIGURE 17

SPILLS/CONTAMINATION RESULTING FROM HANDLING OF CONTAMINATED SOILS FROM SITE 12 SWDAs – CONCEPTUAL SITE MODEL



Note:
* Information on excavation and compaction beneath buildings is incomplete. Where available it suggests that between 2 and 2.5 feet of compacted soil was required beneath footings.

150 0 150 300
Feet

Notes:
This map shows general changes in topography by comparing pre- and post-grading ground surface elevation models. It accounts for known excavation around rubbish areas in the 1200 series and 1300 series housing areas. It does not account for excavation activities around rubbish areas, in the 1400 series housing area, building foundations, or utility corridors.

Pre-Grading Surface Sources
1100 Series: 1967. MKE - Abrams - Keller and Gannon. Grading Plan. January 19.
1200 Series: 1972. MKE - Abrams - Keller and Gannon. Existing Site Conditions - Sheets I, II, and III. May 30.
1300 Series: 1972. Department of the Navy. New Fire Road Vicinity Map and Plot Plan. September 7.
1400 Series: 1989. Department of the Navy, Public Works Center San Francisco. As-Built Grading Plans: Site I and Site 2. October 2.
Fire Station/ Hobby Shop: 1987. Tejima and Associates, Inc. "Geotechnical Data and Related Construction Requirements, FY 88 New Family Housing Project". November 13.
School Area: 1984. City and County of San Francisco Department of Public Works Bureau of Architecture. Treasure Island School Four Classroom Addition Grading Plan. September 19.

Post-Grading Surface Source: 1995. Towill, Inc. Photogrammetric Survey. March 7.

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FIGURE 18

GRADING ELEVATION CHANGE COMPARED TO EXCAVATED PRE-GRADING SURFACE

2014-06-25 V:\Treasure Island\Projects\031_Grading_Change\18_fill_above_min_alt.mxd TtEMI-AL simon.cardinale

TABLE

TABLE 1 – LOW-LEVEL RADIOLOGICAL OBJECTS RECOVERED FROM SITE 12
Historical Radiological Assessment Supplemental Technical Memorandum, NAVSTA TI, California

No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
1	TI-01	2007-08	0.028	jar	0.0031	New World Technology 3/7/2007 to 4/27/2008
2	TI-02	2007-08	0.022	jar	0.0024	New World Technology 3/7/2007 to 4/27/2008
3	TI-03	2007-08	0.044	jar	0.0049	New World Technology 3/7/2007 to 4/27/2008
4	TI-04	2007-08	0.032	jar	0.0035	New World Technology 3/7/2007 to 4/27/2008
5	TI-05	2007-08	12	jar	1.3271	New World Technology 3/7/2007 to 4/27/2008
6	TI-06	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 4/27/2008
7	TI-07	2007-08	9	foil	0.9954	New World Technology 3/7/2007 to 4/27/2008
8	TI-08	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 4/27/2008
9	TI-09	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 4/27/2008
10	TI-10	2007-08	6	foil	0.6636	New World Technology 3/7/2007 to 4/27/2008
11	TI-11	2007-08	6	foil	0.6636	New World Technology 3/7/2007 to 4/27/2008
12	TI-12	2007-08	6	foil	0.6636	New World Technology 3/7/2007 to 4/27/2008
13	TI-13	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 11/24/2008
14	TI-14	2007-08	5	foil	0.5530	New World Technology 3/7/2007 to 11/24/2008
15	TI-15	2007-08	9	foil	0.9954	New World Technology 3/7/2007 to 11/24/2008

TABLE 1 – LOW-LEVEL RADIOLOGICAL OBJECTS RECOVERED FROM SITE 12
Historical Radiological Assessment Supplemental Technical Memorandum, NAVSTA TI, California

No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
16	TI-16	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 11/24/2008
17	TI-17	2007-08	6	foil	0.6636	New World Technology 3/7/2007 to 4/27/2008
18	TI-18	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 11/24/2008
19	TI-19	2007-08	6	foil	0.6636	New World Technology 3/7/2007 to 11/24/2008
20	TI-20	2007-08	6	foil	0.6636	New World Technology 3/7/2007 to 11/24/2008
21	TI-21	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 11/24/2008
22	TI-22	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
23	TI-23	2007-08	4	foil	0.4424	New World Technology 3/7/2007 to 11/24/2008
24	TI-24	2007-08	4	foil	0.4424	New World Technology 3/7/2007 to 4/27/2008
25	TI-25	2007-08	12	foil	1.3271	New World Technology 3/7/2007 to 11/24/2008
26	TI-26	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
27	TI-27	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 11/24/2008
28	TI-28	2007-08	0.02	button	0.0022	New World Technology 3/7/2007 to 11/24/2008
29	TI-29	2007-08	0.006	foil	0.0007	New World Technology 3/7/2007 to 4/27/2008
30	TI-30	2007-08	0.02	foil	0.0022	New World Technology 3/7/2007 to 11/24/2008

TABLE 1 – LOW-LEVEL RADIOLOGICAL OBJECTS RECOVERED FROM SITE 12
Historical Radiological Assessment Supplemental Technical Memorandum, NAVSTA TI, California

No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
31	TI-31	2007-08	0.044	button	0.0049	New World Technology 3/7/2007 to 11/24/2008
32	TI-32	2007-08	0.04	button	0.0044	New World Technology 3/7/2007 to 11/24/2008
33	TI-33	2007-08	0.006	button	0.0007	New World Technology 3/7/2007 to 11/24/2008
34	TI-34	2007-08	0.022	button	0.0024	New World Technology 3/7/2007 to 11/24/2008
35	TI-35	2007-08	0.022	button	0.0024	New World Technology 3/7/2007 to 11/24/2008
36	TI-36	2007-08	0.02	button	0.0022	New World Technology 3/7/2007 to 4/27/2008
37	TI-37	2007-08	0.032	button	0.0035	New World Technology 3/7/2007 to 11/24/2008
38	TI-38	2007-08	0.03	button	0.0033	New World Technology 3/7/2007 to 11/24/2008
39	TI-39	2007-08	0.032	button	0.0035	New World Technology 3/7/2007 to 11/24/2008
40	TI-40	2007-08	0.02	clear button cover	0.0022	New World Technology 3/7/2007 to 11/24/2008
41	TI-41	2007-08	0.04	soil	0.0044	New World Technology 3/7/2007 to 4/27/2008
42	TI-43	2007-08	0.026	rusted metal	0.0029	New World Technology 3/7/2007 to 11/24/2008
43	TI-44	2007-08	0.015	metal strap with button	0.0017	New World Technology 3/7/2007 to 11/24/2008
44	TI-45	2007-08	0.03	soil	0.0033	New World Technology 3/7/2007 to 11/24/2008
45	TI-46	2007-08	0.024	piece of old deck marker?	0.0027	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
46	TI-47	2007-08	0.02	soil	0.0022	New World Technology 3/7/2007 to 11/24/2008
47	TI-48	2007-08	0.015	soil	0.0017	New World Technology 3/7/2007 to 11/24/2008
48	TI-49	2007-08	0.015	soil	0.0017	New World Technology 3/7/2007 to 4/27/2008
49	TI-50	2007-08	0.04	soil	0.0044	New World Technology 3/7/2007 to 11/24/2008
50	TI-51	2007-08	0.015	soil	0.0017	New World Technology 3/7/2007 to 11/24/2008
51	TI-52	2007-08	0.024	soil	0.0027	New World Technology 3/7/2007 to 11/24/2008
52	TI-53	2007-08	0.08	soil	0.0088	New World Technology 3/7/2007 to 11/24/2008
53	TI-54	2007-08	0.022	soil	0.0024	New World Technology 3/7/2007 to 4/27/2008
54	TI-55	2007-08	0.015	soil	0.0017	New World Technology 3/7/2007 to 11/24/2008
55	TI-56	2007-08	9	foil	0.9954	New World Technology 3/7/2007 to 11/24/2008
56	TI-57	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
57	TI-58	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
58	TI-59	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
59	TI-60	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 11/24/2008
60	TI-61	2007-08	6	foil	0.6636	New World Technology 3/7/2007 to 4/27/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
61	TI-62	2007-08	8	two 0.5 cm chunks of corrosion?	0.8848	New World Technology 3/7/2007 to 11/24/2008
62	TI-63	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
63	TI-64	2007-08	6	foil	0.6636	New World Technology 3/7/2007 to 11/24/2008
64	TI-65	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 11/24/2008
65	TI-66	2007-08	0.24	foil	0.0265	New World Technology 3/7/2007 to 4/27/2008
66	TI-67	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
67	TI-68	2007-08	6	foil	0.6636	New World Technology 3/7/2007 to 11/24/2008
68	TI-69	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
69	TI-70	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 11/24/2008
70	TI-71	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 11/24/2008
71	TI-72	2007-08	12	foil	1.3271	New World Technology 3/7/2007 to 11/24/2008
72	TI-73	2007-08	8	foil	0.8848	New World Technology 3/7/2007 to 4/27/2008
73	TI-74	2007-08	1.6	foil	0.1770	New World Technology 3/7/2007 to 11/24/2008
74	100	2007-08	58	foil	6.4145	New World Technology 3/7/2007 to 11/24/2008
75	101	2007-08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
76	102	2007-08	5	foil	0.5530	New World Technology 3/7/2007 to 11/24/2008
77	103	2007-08	0.012	soil	0.0013	New World Technology 3/7/2007 to 4/27/2008
78	104	2007-08	0.008	soil	0.0009	New World Technology 3/7/2007 to 11/24/2008
79	105	2007-08	0.006	soil	0.0007	New World Technology 3/7/2007 to 11/24/2008
80	106	2007-08	0.03	button	0.0033	New World Technology 3/7/2007 to 11/24/2008
81	107	2007-08	0.022	button	0.0024	New World Technology 3/7/2007 to 11/24/2008
82	108	2007-08	0.015	button	0.0017	New World Technology 3/7/2007 to 11/24/2008
83	109	2007-08	0.034	button	0.0038	New World Technology 3/7/2007 to 11/24/2008
84	110	2007-08	0.024	button	0.0027	New World Technology 3/7/2007 to 4/27/2008
85	111	2007-08	0.012	soil	0.0013	New World Technology 3/7/2007 to 11/24/2008
86	112	2007-08	0.04	button	0.0044	New World Technology 3/7/2007 to 11/24/2008
87	113	2007-08	0.006	soil	0.0007	New World Technology 3/7/2007 to 11/24/2008
88	114	2007-08	0.23	button	0.0254	New World Technology 3/7/2007 to 11/24/2008
89	115	2007-08	0.02	button	0.0022	New World Technology 3/7/2007 to 4/27/2008
90	401	04/28/08	6	foil	0.6636	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
91	402	04/29/08	5	foil	0.5530	New World Technology 3/7/2007 to 11/24/2008
92	403	04/29/08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
93	404	04/30/08	12	foil	1.3271	New World Technology 3/7/2007 to 11/24/2008
94	405	04/30/08	2	possible foil fragments	0.2212	New World Technology 3/7/2007 to 11/24/2008
95	501	05/01/08	15	foil	1.6589	New World Technology 3/7/2007 to 11/24/2008
96	502	05/21/08	0.04	button	0.0044	New World Technology 3/7/2007 to 4/27/2008
97	503	05/22/08	0.008	switch	0.0009	New World Technology 3/7/2007 to 11/24/2008
98	504	05/29/08	0.035	button	0.0039	New World Technology 3/7/2007 to 11/24/2008
99	601	06/02/08	0.025	button	0.0028	New World Technology 3/7/2007 to 11/24/2008
100	602	06/16/08	2	appear to be foil fragments	0.2212	New World Technology 3/7/2007 to 11/24/2008
101	603	06/19/08	0.04	button	0.0044	New World Technology 3/7/2007 to 4/27/2008
102	604	06/26/08	0.04	foil	0.0044	New World Technology 3/7/2007 to 11/24/2008
103	701	07/03/08	0.04	button	0.0044	New World Technology 3/7/2007 to 11/24/2008
104	702	07/24/08	0.008	electronic component	0.0009	New World Technology 3/7/2007 to 11/24/2008
105	703	07/24/08	0.008	metallic piece	0.0009	New World Technology 3/7/2007 to 11/24/2008

TABLE 1 – LOW-LEVEL RADIOLOGICAL OBJECTS RECOVERED FROM SITE 12
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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
106	704	07/24/08	0.025	button like	0.0028	New World Technology 3/7/2007 to 11/24/2008
107	705	07/24/08	0.02	metallic piece	0.0022	New World Technology 3/7/2007 to 11/24/2008
108	706	07/30/08	0.008	switch	0.0009	New World Technology 3/7/2007 to 4/27/2008
109	707	07/30/08	0.008	metal piece	0.0009	New World Technology 3/7/2007 to 11/24/2008
110	801	08/04/08	0.008	metal piece	0.0009	New World Technology 3/7/2007 to 11/24/2008
111	802	08/12/08	10	foil	1.1060	New World Technology 3/7/2007 to 11/24/2008
112	803	08/19/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
113	804	08/19/08	10	foil fragments	1.1060	New World Technology 3/7/2007 to 4/27/2008
114	805	08/20/08	0.4	metal fragments	0.0442	New World Technology 3/7/2007 to 11/24/2008
115	806	08/20/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
116	807	08/26/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
117	808	08/27/08	0.02	metal fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
118	809	08/28/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
119	810	08/28/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
120	901	09/02/08	0.02	metal fragments	0.0022	New World Technology 3/7/2007 to 4/27/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
121	902	09/23/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
122	903	09/23/08	0.01	switch	0.0011	New World Technology 3/7/2007 to 11/24/2008
123	904	09/23/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
124	905	09/23/08	0.04	metal fragments	0.0044	New World Technology 3/7/2007 to 11/24/2008
125	906	09/23/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 4/27/2008
126	907	09/23/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
127	908	09/23/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
128	909	09/23/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
129	910	09/23/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
130	911	09/23/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
131	912	09/23/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
132	913	09/23/08	4	foil	0.4424	New World Technology 3/7/2007 to 4/27/2008
133	914	09/24/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
134	915	09/24/08	0.014	metal fragments	0.0015	New World Technology 3/7/2007 to 11/24/2008
135	916	09/24/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
136	917	09/24/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
137	918	09/24/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 4/27/2008
138	919	09/24/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
139	920	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
140	921	09/25/08	0.04	metal fragments	0.0044	New World Technology 3/7/2007 to 11/24/2008
141	922	09/25/08	0.014	metal fragments	0.0015	New World Technology 3/7/2007 to 11/24/2008
142	923	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
143	924	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
144	925	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 4/27/2008
145	926	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
146	927	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
147	928	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
148	929	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
149	930	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 4/27/2008
150	931	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
151	932	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
152	933	09/25/08	0.02	metal fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
153	934	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
154	935	09/25/08	0.018	metal fragments	0.0020	New World Technology 3/7/2007 to 11/24/2008
155	936	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
156	937	09/25/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 4/27/2008
157	938	09/25/08	0.03	metal fragments	0.0033	New World Technology 3/7/2007 to 11/24/2008
158	939	09/29/08	20	foil	2.2119	New World Technology 3/7/2007 to 11/24/2008
159	940	09/29/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
160	941	09/29/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
161	942	09/29/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 4/27/2008
162	943	09/29/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
163	944	09/29/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
164	945	09/29/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
165	946	09/29/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
166	947	09/29/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
167	948	09/29/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
168	949	09/29/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 4/27/2008
169	950	09/29/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
170	951	09/29/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
171	952	09/30/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
172	953	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
173	954	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 4/27/2008
174	955	09/30/08	0.22	metal fragments	0.0243	New World Technology 3/7/2007 to 11/24/2008
175	956	09/30/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
176	957	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
177	958	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
178	959	09/30/08	0.014	metal fragments	0.0015	New World Technology 3/7/2007 to 11/24/2008
179	960	09/30/08	0.02	metal fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
180	961	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 4/27/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
181	962	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
182	963	09/30/08	0.014	metal fragments	0.0015	New World Technology 3/7/2007 to 11/24/2008
183	964	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
184	965	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
185	966	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 4/27/2008
186	967	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
187	968	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
188	969	09/30/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
189	970	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
190	971	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
191	972	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
192	973	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 4/27/2008
193	974	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
194	975	09/30/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
195	976	09/30/08	0.018	metal fragments	0.0020	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
196	977	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
197	978	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 4/27/2008
198	979	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
199	980	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
200	981	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
201	982	09/30/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
202	983	09/30/08	0.014	metal fragments	0.0015	New World Technology 3/7/2007 to 11/24/2008
203	984	09/30/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
204	1001	10/01/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
205	1002	10/01/08	0.08	metal fragments	0.0088	New World Technology 3/7/2007 to 11/24/2008
206	1003	10/01/08	0.03	metal fragments	0.0033	New World Technology 3/7/2007 to 11/24/2008
207	1004	10/01/08	0.05	metal fragments	0.0055	New World Technology 3/7/2007 to 11/24/2008
208	1005	10/01/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
209	1006	10/01/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
210	1007	10/01/08	0.05	metal fragments	0.0055	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
211	1008	10/01/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
212	1009	10/01/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
213	1010	10/01/08	0.08	metal fragments	0.0088	New World Technology 3/7/2007 to 11/24/2008
214	1011	10/01/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
215	1012	10/01/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
216	1013	10/01/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
217	1014	10/02/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
218	1015	10/02/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
219	1016	10/02/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
220	1017	10/02/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
221	1018	10/02/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
222	1019	10/02/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
223	1020	10/02/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
224	1021	10/02/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
225	1022	10/02/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008

TABLE 1 – LOW-LEVEL RADIOLOGICAL OBJECTS RECOVERED FROM SITE 12
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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
226	1023	10/02/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
227	1024	10/02/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
228	1025	10/02/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
229	1026	10/06/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
230	1027	10/06/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
231	1028	10/06/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
232	1029	10/06/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
233	1030	10/07/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
234	1031	10/07/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
235	1032	10/07/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
236	1033	10/07/08	2	foil	0.2212	New World Technology 3/7/2007 to 11/24/2008
237	1034	10/07/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
238	1035	10/07/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
239	1036	10/08/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
240	1037	10/08/08	0.02	metal fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
241	1038	10/08/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
242	1039	10/08/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
243	1040	10/08/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
244	1041	10/09/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
245	1042	10/09/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
246	1043	10/13/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
247	1044	10/13/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
248	1045	10/13/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
249	1046	10/13/08	0.025	metal fragments	0.0028	New World Technology 3/7/2007 to 11/24/2008
250	1047	10/13/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
251	1048	10/13/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
252	1049	10/13/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
253	1050	10/13/08	0.04	metal fragments	0.0044	New World Technology 3/7/2007 to 11/24/2008
254	1051	10/13/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
255	1052	10/14/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
256	1053	10/14/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
257	1054	10/14/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
258	1055	10/14/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
259	1056	10/14/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
260	1057	10/14/08	0.015	4" dia x 4" long cylindrical gauge	0.0017	New World Technology 3/7/2007 to 11/24/2008
261	1058	10/14/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
262	1059	10/14/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
263	1060	10/14/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
264	1061	10/14/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
265	1062	10/14/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
266	1063	10/14/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
267	1064	10/15/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
268	1065	10/15/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
269	1066	10/15/08	1.5	foil	0.1659	New World Technology 3/7/2007 to 11/24/2008
270	1067	10/15/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
271	1068	10/15/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
272	1069	10/15/08	0.5	metal fragments	0.0553	New World Technology 3/7/2007 to 11/24/2008
273	1070	10/15/08	0.02	foil fragment	0.0022	New World Technology 3/7/2007 to 11/24/2008
274	1071	10/16/08	0.006	metal fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
275	1072	10/16/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
276	1073	10/16/08	0.005	metal fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
277	1074	10/16/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
278	1075	10/16/08	0.004	metal fragments	0.0004	New World Technology 3/7/2007 to 11/24/2008
279	1076	10/16/08	0.005	metal fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
280	1077	10/16/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
281	1078	10/16/08	0.1	metal disc	0.0111	New World Technology 3/7/2007 to 11/24/2008
282	1079	10/20/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
283	1080	10/20/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
284	1081	10/20/08	0.005	metal fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
285	1082	10/20/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
286	1083	10/20/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
287	1084	10/20/08	0.005	metal fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
288	1085	10/20/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
289	1086	10/20/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
290	1087	10/21/08	0.007	metal fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
291	1088	10/21/08	0.012	metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
292	1089	10/21/08	0.007	metal fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
293	1090	10/21/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
294	1091	10/23/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
295	1092	10/23/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
296	1093	10/23/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
297	1094	10/23/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
298	1095	10/23/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
299	1096	10/23/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
300	1097	10/23/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
301	1098	10/27/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
302	1099	10/27/08	0.007	metal fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
303	10100	10/27/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
304	10101	10/27/08	0.006	metal fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
305	10102	10/27/08	0.006	metal fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
306	10103	10/27/08	0.007	metal fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
307	10104	10/27/08	0.015	metal fragments	0.0017	New World Technology 3/7/2007 to 11/24/2008
308	10105	10/27/08	0.006	metal fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
309	10106	10/28/08	0.006	metal fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
310	10107	10/28/08	0.006	metal fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
311	10108	10/28/08	0.006	metal fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
312	10109	10/28/08	0.004	metal fragments	0.0004	New World Technology 3/7/2007 to 11/24/2008
313	10110	10/28/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
314	10111	10/28/08	0.005	metal fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
315	10112	10/28/08	0.006	metal fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
316	10113	10/28/08	0.005	metal fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
317	10114	10/28/08	0.005	metal fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
318	10115	10/28/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
319	10116	10/28/08	0.005	metal fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
320	10117	10/28/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
321	10118	10/28/08	0.007	metal fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
322	10119	10/28/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
323	10120	10/29/08	2.8	Soil/Debris Fragments	0.3097	New World Technology 3/7/2007 to 11/24/2008
324	10121	10/29/08	0.014	Metal Fragments	0.0015	New World Technology 3/7/2007 to 11/24/2008
325	10122	10/29/08	0.014	Metal Fragments	0.0015	New World Technology 3/7/2007 to 11/24/2008
326	10123	10/29/08	0.03	Metal Fragments	0.0033	New World Technology 3/7/2007 to 11/24/2008
327	10124	10/29/08	2	Foil	0.2212	New World Technology 3/7/2007 to 11/24/2008
328	10125	10/29/08	0.05	Button	0.0055	New World Technology 3/7/2007 to 11/24/2008
329	10126	10/29/08	2	Foil	0.2212	New World Technology 3/7/2007 to 11/24/2008
330	10127	10/30/08	0.07	Metal Fragments	0.0077	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
331	10128	10/30/08	1.5	Foil	0.1659	New World Technology 3/7/2007 to 11/24/2008
332	10128	10/30/08	0.012	Metal Fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
333	10130	10/30/08	1	Foil Fragments	0.1106	New World Technology 3/7/2007 to 11/24/2008
334	10131	10/30/08	0.008	Metal Fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
335	10132	10/30/08	0.05	Soil	0.0055	New World Technology 3/7/2007 to 11/24/2008
336	10133	10/30/08	0.04	Soil	0.0044	New World Technology 3/7/2007 to 11/24/2008
337	10134	10/30/08	0.035	Metal Fragments	0.0039	New World Technology 3/7/2007 to 11/24/2008
338	10135	10/30/08	0.012	Metal Fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
339	1101	11/04/08	2	Foil	0.2212	New World Technology 3/7/2007 to 11/24/2008
340	1102	11/04/08	0.017	Metal Fragments	0.0019	New World Technology 3/7/2007 to 11/24/2008
341	1103	11/04/08	0.01	Metal Fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
342	1104	11/04/08	0.012	Metal Fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
343	1105	11/04/08	0.007	Metal Fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
344	1106	11/04/08	0.006	Metal Fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
345	1107	11/04/08	0.01	Metal Fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
346	1108	11/04/08	0.005	Metal Fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
347	1109	11/04/08	0.007	Metal Fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
348	1110	11/04/08	0.008	Metal Fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
349	1111	11/04/08	0.006	Metal Fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
350	1112	11/04/08	0.006	Metal Fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
351	1113	11/04/08	0.008	Metal Fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
352	1114	11/04/08	0.006	Metal Fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
353	1115	11/04/08	0.02	Metal Fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
354	1116	11/04/08	0.04	Metal Fragments	0.0044	New World Technology 3/7/2007 to 11/24/2008
355	1117	11/04/08	0.007	Metal Fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
356	1118	11/04/08	0.03	Metal Fragments	0.0033	New World Technology 3/7/2007 to 11/24/2008
357	1119	11/04/08	0.005	Metal Fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
358	1120	11/04/08	4	Foil	0.4424	New World Technology 3/7/2007 to 11/24/2008
359	1121	11/04/08	0.007	Metal Fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
360	1122	11/04/08	0.007	Metal Fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
361	1123	11/04/08	0.006	Metal Fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
362	1124	11/04/08	0.006	Metal Fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
363	1125	11/04/08	0.01	Metal Fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
364	1126	11/05/08	1.5	Foil	0.1659	New World Technology 3/7/2007 to 11/24/2008
365	1127	11/05/08	0.05	Metal Fragments	0.0055	New World Technology 3/7/2007 to 11/24/2008
366	1128	11/05/08	1.5	Foil	0.1659	New World Technology 3/7/2007 to 11/24/2008
367	1129	11/05/08	0.012	Metal Fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
368	1130	11/05/08	0.008	Metal Fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
369	1131	11/05/08	0.015	Metal Fragments	0.0017	New World Technology 3/7/2007 to 11/24/2008
370	1132	11/06/08	0.005	Metal Fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
371	1133	11/06/08	0.005	Metal Fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
372	1134	11/06/08	0.01	Metal Fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
373	1135	11/06/08	0.007	Metal Fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
374	1136	11/06/08	0.005	Metal Fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
375	1137	11/06/08	0.5	Foil Fragment	0.0553	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
376	1138	11/06/08	0.005	Metal Fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
377	1139	11/06/08	0.014	Metal Fragments	0.0015	New World Technology 3/7/2007 to 11/24/2008
378	1140	11/06/08	0.005	Metal Fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
379	1141	11/06/08	0.008	Metal Fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
380	1142	11/06/08	0.02	Button	0.0022	New World Technology 3/7/2007 to 11/24/2008
381	1143	11/06/08	0.02	Metal Fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
382	1144	11/06/08	0.007	Metal Fragments	0.0008	New World Technology 3/7/2007 to 11/24/2008
383	1145	11/06/08	0.005	Metal Fragments	0.0006	New World Technology 3/7/2007 to 11/24/2008
384	1146	11/10/08	2	Foil	0.2212	New World Technology 3/7/2007 to 11/24/2008
385	1147	11/10/08	1.5	Foil	0.1659	New World Technology 3/7/2007 to 11/24/2008
386	1148	11/10/08	0.025	Metal Fragments	0.0028	New World Technology 3/7/2007 to 11/24/2008
387	1149	11/10/08	0.008	Soil	0.0009	New World Technology 3/7/2007 to 11/24/2008
388	1150	11/10/08	0.02	Metal Fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
389	1151	11/10/08	0.008	Soil	0.0009	New World Technology 3/7/2007 to 11/24/2008
390	1152	11/10/08	0.008	Metal Fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
391	1153	11/10/08	0.025	Metal Fragments	0.0028	New World Technology 3/7/2007 to 11/24/2008
392	1154	11/10/08	2	Foil Fragments / Soil	0.2212	New World Technology 3/7/2007 to 11/24/2008
393	1155	11/10/08	0.02	Metal Fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
394	1156	11/10/08	0.006	Metal Fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
395	1157	11/10/08	0.008	Metal Fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
396	1158	11/10/08	0.02	Metal Fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
397	1159	11/10/08	2	Foil	0.2212	New World Technology 3/7/2007 to 11/24/2008
398	1160	11/10/08	0.006	Metal Fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
399	1161	11/10/08	0.015	Metal Fragments	0.0017	New World Technology 3/7/2007 to 11/24/2008
400	1162	11/11/08	0.008	Metal Fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
401	1163	11/12/08	0.01	Metal Fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
402	1164	11/13/08	0.02	Metal Fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
403	1165	11/17/08	0.005	metal object 4" dia x 6"	0.0006	New World Technology 3/7/2007 to 11/24/2008
404	1166	11/17/08	0.012	soil with metal fragments	0.0013	New World Technology 3/7/2007 to 11/24/2008
405	1167	11/17/08	0.007	small metal fragment	0.0008	New World Technology 3/7/2007 to 11/24/2008

TABLE 1 – LOW-LEVEL RADIOLOGICAL OBJECTS RECOVERED FROM SITE 12
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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
406	1168	11/17/08	0.01	small metal object	0.0011	New World Technology 3/7/2007 to 11/24/2008
407	1169	11/17/08	0.004	metal fragment	0.0004	New World Technology 3/7/2007 to 11/24/2008
408	1170	11/17/08	0.005	metal object 1 ft x 1" dia	0.0006	New World Technology 3/7/2007 to 11/24/2008
409	1171	11/17/08	0.01	metal fragment	0.0011	New World Technology 3/7/2007 to 11/24/2008
410	1172	11/17/08	0.012	metal fragment	0.0013	New World Technology 3/7/2007 to 11/24/2008
411	1173	11/17/08	0.008	rusted metal object 9" dia	0.0009	New World Technology 3/7/2007 to 11/24/2008
412	1174	11/17/08	0.01	metal fragment	0.0011	New World Technology 3/7/2007 to 11/24/2008
413	1175	11/17/08	0.005	metal fragment	0.0006	New World Technology 3/7/2007 to 11/24/2008
414	1176	11/17/08	0.012	metal fragment	0.0013	New World Technology 3/7/2007 to 11/24/2008
415	1177	11/17/08	0.015	soil with metal fragments	0.0017	New World Technology 3/7/2007 to 11/24/2008
416	1178	11/18/08	0.015	metal fragments	0.0017	New World Technology 3/7/2007 to 11/24/2008
417	1179	11/18/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
418	1180	11/18/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
419	1181	11/18/08	0.025	foil	0.0028	New World Technology 3/7/2007 to 11/24/2008
420	1182	11/18/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
421	1183	11/18/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
422	1184	11/18/08	0.03	button	0.0033	New World Technology 3/7/2007 to 11/24/2008
423	1185	11/18/08	0.025	metal fragments	0.0028	New World Technology 3/7/2007 to 11/24/2008
424	1186	11/18/08	0.03	button	0.0033	New World Technology 3/7/2007 to 11/24/2008
425	1187	11/18/08	0.008	metal fragments	0.0009	New World Technology 3/7/2007 to 11/24/2008
426	1188	11/18/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
427	1189	11/18/08	0.02	metal fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
428	1190	11/18/08	0.025	button	0.0028	New World Technology 3/7/2007 to 11/24/2008
429	1191	11/18/08	0.006	metal fragments	0.0007	New World Technology 3/7/2007 to 11/24/2008
430	1192	11/18/08	0.015	metal fragments	0.0017	New World Technology 3/7/2007 to 11/24/2008
431	1193	11/18/08	0.015	metal fragments	0.0017	New World Technology 3/7/2007 to 11/24/2008
432	1194	11/18/08	0.01	brick (concrete)	0.0011	New World Technology 3/7/2007 to 11/24/2008
433	1195	11/18/08	0.02	metal fragments	0.0022	New World Technology 3/7/2007 to 11/24/2008
434	1196	11/18/08	0.01	metal fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
435	1197	11/20/08	1.5	Foil	0.1659	New World Technology 3/7/2007 to 11/24/2008

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
436	1198	11/20/08	0.025	Glass	0.0028	New World Technology 3/7/2007 to 11/24/2008
437	1199	11/24/08	0.01	Metal Fragments	0.0011	New World Technology 3/7/2007 to 11/24/2008
438	11100	11/24/08	0.015	Soil/Metal Fragments	0.0017	New World Technology 3/7/2007 to 11/24/2008
439	09-0001	01/15/09	0.01	Metal Fragments	0.0011	Shaw 07/02/09 to Present
440	070209-1	07/02/09	0.02	Metal Fragment	0.0022	
441	070209-2	07/02/09	0.013	Sandy soil (1 tsp)	0.0014	Shaw 07/02/09 to Present
442	070609-3	07/06/09	0.01	Metal flakes & soil	0.0011	Shaw 07/02/09 to Present
443	070709-4	07/07/09	0.032	4-in dia by 8-in long rusted metal cylinder	0.0035	Shaw 07/02/09 to Present
444	070709-5	07/07/09	0.013	3-in by 2-in flat rusty metal	0.0014	Shaw 07/02/09 to Present
445	070709-6	07/07/09	0.009	1.5-in round by 3/8-in thick metallic device	0.0010	Shaw 07/02/09 to Present
446	070709-7	07/07/09	0.02	metal fragment 0.75-in by 0.5-in by 0.125-in	0.0022	Shaw 07/02/09 to Present
447	070809-8	07/08/09	0.015	3 metal fragments mixed w/soil	0.0017	Shaw 07/02/09 to Present
448	070809-9	07/08/09	0.016	Soil and Rust flakes ~ 2 tsp	0.0018	Shaw 07/02/09 to Present
449	070909-10	07/09/09	0.011	Soil ~ 2 tbsp	0.0012	Shaw 07/02/09 to Present
450	071409-11	07/14/09	0.013	3.5-in round metal	0.0014	Shaw 07/02/09 to Present
451	071409-12	07/14/09	0.014	~1 cup soil	0.0015	Shaw 07/02/09 to Present

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
452	071409-13	07/14/09	0.013	~1/4 cup soil w/metal flakes	0.0014	Shaw 07/02/09 to Present
453	071409-14	07/14/09	0.022	Metal 3/4-in long by 1/2-in thick by 1/2-in wide	0.0024	Shaw 07/02/09 to Present
454	071409-15	07/14/09	0.018	Oval metal fragment 1/2-in long by 3/8-in wide	0.0020	Shaw 07/02/09 to Present
455	071409-16	07/14/09	0.014	1/8 cup of soil	0.0015	Shaw 07/02/09 to Present
456	071409-17	07/14/09	0.016	Metal fragment 3/4-in long by 1/4-in wide	0.0018	Shaw 07/02/09 to Present
457	071409-18	07/14/09	0.016	1.5 cups soil with metal fragments	0.0018	Shaw 07/02/09 to Present
458	071509-19	07/15/09	0.015	Wire 3-in long by 1/4-in diameter	0.0017	Shaw 07/02/09 to Present
459	071509-20	07/15/09	0.016	Gauge 5-in diameter by 5-in long with wires extending from the back	0.0018	Shaw 07/02/09 to Present
460	072009-21	07/20/09	0.016	wire 2.5-in long by 0.25-in in diameter	0.0018	Shaw 07/02/09 to Present
461	072009-22	07/20/09	0.015	2-in rounded piece of metal 1/4–in wide	0.0017	Shaw 07/02/09 to Present
462	072009-23	07/20/09	0.012	1.5-in diameter, 3/8-in thick piece of metal	0.0013	Shaw 07/02/09 to Present

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
463	072009-24	07/20/09	0.012	A gauge 4-in in diameter by 3-in deep	0.0013	Shaw 07/02/09 to Present
464	072109-25	07/21/09	0.014	piece of metal 1.75-in long by 3/4-in wide	0.0015	Shaw 07/02/09 to Present
465	072109-26	07/21/09	0.024	3/4-in diameter by 1/2-in thick button	0.0027	Shaw 07/02/09 to Present
466	072109-27	07/21/09	0.013	3-in diameter by 3-in deep gauge	0.0014	Shaw 07/02/09 to Present
467	072109-28	07/21/09	0.034	piece of metal 5-in long by 3.5-in wide by 3-in deep	0.0038	Shaw 07/02/09 to Present
468	072209-29	07/22/09	0.017	4-in round by 1.5-in deep metal object	0.0019	Shaw 07/02/09 to Present
469	080309-30	08/03/09	0.016	3.5" x 2.5" x 1.5" Metal object fused with rock	0.0018	Shaw 07/02/09 to Present
470	080309-31	08/03/09	0.012	5" x 4" x 1" Metal Object	0.0013	Shaw 07/02/09 to Present
471	080309-32	08/03/09	0.012	.75" x .5" x .25" Metal Object	0.0013	Shaw 07/02/09 to Present
472	080309-33	08/03/09	0.012	3" x 1.5" x 1" Metal object	0.0013	Shaw 07/02/09 to Present
473	080309-34	08/03/09	0.013	1.5" x 1" x .5" Metal	0.0014	Shaw 07/02/09 to Present
474	080509-35	08/05/09	0.012	Fused mixture of glass, rock, and soil 6" x 4" x 2"	0.0013	Shaw 07/02/09 to Present

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No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
475	081109-36	08/11/09	0.014	Fused metal rock and glass 6" round x 3" thick	0.0015	Shaw 07/02/09 to Present
476	081109-37	08/11/09	0.019	Infused rock, metal and glass 9" long x 6" wide x 5" thick	0.0021	Shaw 07/02/09 to Present
477	081209-38	08/12/09	0.019	4 Metal fragments .75" x .25" and up to 4" x 2" x 1.5"	0.0021	Shaw 07/02/09 to Present
478	081809-39	08/18/09	1	Hexagon shaped object ~.75"	0.1106	Shaw 07/02/09 to Present
479	081809-39A	08/18/09	0.014	7" x 3.5" x 2" object	0.0015	Shaw 07/02/09 to Present
480	082009-40	08/20/09	0.036	Round metal object 1.5" round and .5" thick	0.0040	Shaw 07/02/09 to Present
481	082409-41	08/24/09	0.015	Round metal object 1.5" x 1" x .5"	0.0017	Shaw 07/02/09 to Present
482	082409-42	08/24/09	0.04	Round metal object .75" round and .5" thick	0.0044	Shaw 07/02/09 to Present
483	083109-43	08/31/09	0.017	2" x .5" pocket watch	0.0019	Shaw 07/02/09 to Present
484	083109-44	08/31/09	2	Dime size piece of black metal hexagon shaped	0.2212	Shaw 07/02/09 to Present
485	083109-45	08/31/09	0.024	An infused rock metal and wire 1.5" x 1.25" x .5"	0.0027	Shaw 07/02/09 to Present
486	083109-46	08/31/09	0.06	Round metal object 2" x .5" round	0.0066	Shaw 07/02/09 to Present

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487	090209-47	09/02/09	0.036	Metal button 1.5" x .25"	0.0040	Shaw 07/02/09 to Present
488	090209-48	09/02/09	0.032	Metal object 3" long x 2" wide x 1.5" thick	0.0035	Shaw 07/02/09 to Present
489	091509-49	09/15/09	0.018	Metal object 3" x 2" x 1.5"	0.0020	Shaw 07/02/09 to Present
490	092309-50	09/23/09	0.016	Metal object 1/2" across and 1/8" in depth	0.0018	Shaw 07/02/09 to Present
491	092909-51	09/29/09	0.018	Metal object 3/4" round and 3/8" deep	0.0020	Shaw 07/02/09 to Present
492	093009-52	09/30/09	1.4	Metal object 1/2" diameter and 1/8" deep	0.1548	Shaw 07/02/09 to Present
493	093009-53	09/30/09	0.014	Metal object 1/2" x 1/4" round	0.0015	Shaw 07/02/09 to Present
494	093009-54	09/30/09	0.022	Metal object 4" x 2.5" x 1"	0.0024	Shaw 07/02/09 to Present
495	100109-55	10/01/09	0.044	10" long tool (micrometer)	0.0049	Shaw 07/02/09 to Present
496	102209-56	10/22/09	0.014	Metal object 1" x 1/2" x 1/8"	0.0015	Shaw 07/02/09 to Present
497	102209-57	10/22/09	0.03	Metal object 3 1/2" x 1/2"	0.0033	Shaw 07/02/09 to Present
498	102609-58	10/26/09	0.024	Round metal object 3/4" by 1/4"	0.0027	Shaw 07/02/09 to Present
499	102609-59	10/26/09	0.017	Triangular metal object 1/2" x 1/4"	0.0019	Shaw 07/02/09 to Present
500	102609-60	10/26/09	0.014	Metal object 1/2" x 1/2" x 1/8"	0.0015	Shaw 07/02/09 to Present
501	110409-61	11/04/09	0.014	Wrist watch (no band) 3/4" x 1/4"	0.0015	Shaw 07/02/09 to Present

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502	110409-62	11/04/09	0.02	Metal object 2 1/2" x 1"	0.0022	Shaw 07/02/09 to Present
503	110409-63	11/04/09	0.024	Metal object 3/8" x 3/8" x 1/8"	0.0027	Shaw 07/02/09 to Present
504	110409-64	11/04/09	0.016	Metal object 4" x 1 1/2"	0.0018	Shaw 07/02/09 to Present
505	110909-65	11/09/09	0.013	Fused wire and rock 2" x 3/4" x 1/2"	0.0014	Shaw 07/02/09 to Present
506	111009-66	11/10/09	0.013	Metal object 1/2" x 1/2" x 1/4"	0.0014	Shaw 07/02/09 to Present
507	111009-67	11/10/09	0.015	Wire 3" long by 1 1/4"	0.0017	Shaw 07/02/09 to Present
508	111209-68	11/12/09	0.034	Metal object 3/4" x 1/2" x 1/4"	0.0038	Shaw 07/02/09 to Present
509	111709-69	11/17/09	0.015	Metal object 1 3/4" x 1/2"	0.0017	Shaw 07/02/09 to Present
510	112309-70	11/23/09	0.015	Fused metal and wire 4" x 2"	0.0017	Shaw 07/02/09 to Present
511	113009-71	11/30/09	0.013	Metal object 2" x 1" x 1"	0.0014	Shaw 07/02/09 to Present
512	113009-72	11/30/09	0.013	Compass 3/4" x 1/4"	0.0014	Shaw 07/02/09 to Present
513	120909-73	12/09/09	0.02	Metal object 3/4" x 1/2" x 1/2"	0.0022	Shaw 07/02/09 to Present
514	120909-74	12/09/09	0.02	Wire 3/4" x 1/4"	0.0022	Shaw 07/02/09 to Present
515	011310-75	01/13/10	0.036	Metal object 6" x 4"	0.0040	Shaw 07/02/09 to Present
516	011310-76	01/13/10	0.032	Metal object 2" x 1/2"	0.0035	Shaw 07/02/09 to Present
517	020210-77	02/02/10	0.034	Metal object 1 1/2" x 1/4"	0.0038	Shaw 07/02/09 to Present
518	020910-78	02/09/10	0.016	Metal object 1" x 1/2"	0.0018	Shaw 07/02/09 to Present
519	021010-79	02/10/10	0.015	Metal object 3" x 2 1/2" x 1/2"	0.0017	Shaw 07/02/09 to Present

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520	021010-80	02/10/10	0.018	Metal object 1" x 3/4" x 1/2"	0.0020	Shaw 07/02/09 to Present
521	021010-81	02/10/10	0.018	Metal object 1" x 3/4" x 1/2"	0.0020	Shaw 07/02/09 to Present
522	021110-82	02/11/10	0.022	Metal object 1" x 1/2"	0.0024	Shaw 07/02/09 to Present
523	021110-83	02/11/10	0.07	Metal object 2" x 1/2"	0.0077	Shaw 07/02/09 to Present
524	021510-84	02/15/10	0.06	Metal object (possible Radiolumine scent Personnel Marker) 2" x 1/4"	0.0066	Shaw 07/02/09 to Present
525	021510-85	02/15/10	0.013	Metal object (slag) 4' x 3" x 3"	0.0014	Shaw 07/02/09 to Present
526	021510-86	02/15/10	0.018	Metal object 3/4" x 1/4"	0.0020	Shaw 07/02/09 to Present
527	021810-87	02/18/10	0.019	Metal object 1/4" round	0.0021	Shaw 07/02/09 to Present
528	021810-88	02/18/10	0.014	Metal object 1/2" x 1/4" x 1/4"	0.0015	Shaw 07/02/09 to Present
529	021810-89	02/18/10	0.015	Metal object 1/2" x 1/4" x 1/4"	0.0017	Shaw 07/02/09 to Present
530	021810-90	02/18/10	0.02	Metal object 1/8" round	0.0022	Shaw 07/02/09 to Present
531	022210-91	02/22/10	0.012	Metal object 1" x 3/4" x 1/2"	0.0013	Shaw 07/02/09 to Present
532	022210-92	02/22/10	0.02	Metal object 8" x 6" x 5"	0.0022	Shaw 07/02/09 to Present
533	022210-93	02/22/10	0.017	Metal object 1/2" x 1/4" x 1/4"	0.0019	Shaw 07/02/09 to Present
534	022210-94	02/22/10	0.016	Metal object 1/2" x 1/2" x 1/4"	0.0018	Shaw 07/02/09 to Present
535	022310-95	02/23/10	0.013	Metal object 1/2" x 1/4"	0.0014	Shaw 07/02/09 to Present

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536	030410-96	03/04/10	0.015	Metal object 1/2" round with 2" wire	0.0017	Shaw 07/02/09 to Present
537	030910-97	03/09/10	0.017	Metal object 1 1/2" x 1" x 1/4"	0.0019	Shaw 07/02/09 to Present
538	030910-98	03/09/10	0.034	Metal object 2" x 2" x 1/16"	0.0038	Shaw 07/02/09 to Present
539	030910-99	03/09/10	0.016	Metal object 1/2" x 1/4" x 1/8"	0.0018	Shaw 07/02/09 to Present
540	031010-100	03/10/10	0.06	Flat metal object 1/2" round	0.0066	Shaw 07/02/09 to Present
541	031010-101	03/10/10	0.018	Metal object 1" x 1/4" x 1/4"	0.0020	Shaw 07/02/09 to Present
542	032410-102	03/24/10	0.013	Metal object 1/4" x 1/4"	0.0014	Shaw 07/02/09 to Present
543	040710-103	04/07/10	0.03	Metal object 1/2" x 1/4"	0.0033	Shaw 07/02/09 to Present
544	050810-104	05/08/10	0.018	Metal object rusted oblong 1/8 " x 1/2"	0.0020	Shaw 07/02/09 to Present
545	051910-105	05/19/10	0.02	Metal object round 1/4" think by 1/2" diameter	0.0022	Shaw 07/02/09 to Present
546	052010-106	05/20/10	0.02	Metal object 4"x4" by 1/4" thick with a 2"x1.5 " diameter object attached in center	0.0022	Shaw 07/02/09 to Present
547	052010-107	05/20/10	0.015	Metal object cylindrical 1"x3/8" diameter	0.0017	Shaw 07/02/09 to Present
548	052010-108	05/20/10	0.8	Metal object 1/4"x1/2"	0.0885	Shaw 07/02/09 to Present

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549	052010-109	05/20/10	0.034	Metal object flat round 1/8" diameter x 1/2"	0.0038	Shaw 07/02/09 to Present
550	052610-110	05/26/10	0.015	Metal object oblong 1/2" x 1/4" x 1/4" thick	0.0017	Shaw 07/02/09 to Present
551	052610-111	05/26/10	0.02	Metal object oblong 1" x 1/2" x 1/4" thick	0.0022	Shaw 07/02/09 to Present
552	052610-112	05/26/10	0.013	Metal object square 1" x 1" x 1/2" thick	0.0014	Shaw 07/02/09 to Present
553	052610-113	05/26/10	0.013	Metal object round 1/2" diameter 1/8" thick	0.0014	Shaw 07/02/09 to Present
554	052610-114	05/26/10	0.015	Metal object oblong 1/2" x 1/4" x 1/8" thick	0.0017	Shaw 07/02/09 to Present
555	070110-115	07/01/10	0.013	Watch round 3" x 1/2"	0.0014	Shaw 07/02/09 to Present
556	070610-116	07/06/10	0.012	Metal object 1" x 1/4"	0.0013	Shaw 07/02/09 to Present
557	070610-117	07/06/10	0.013	Metal object 1" x 1/8"	0.0014	Shaw 07/02/09 to Present
558	070810-118	7/8/2010	0.015	Metal object 1/8" by 1/2" by 1/2"	0.0017	Shaw 07/02/09 to Present
559	070810-119	07/08/10	0.02	Metal round object 1/4" x 1/2" thick	0.0022	Shaw 07/02/09 to Present
560	071310-120	07/13/10	0.016	3" Needle from gauge	0.0018	Shaw 07/02/09 to Present
561	071310-121	07/13/10	0.015	1" long wire in insulation	0.0017	Shaw 07/02/09 to Present
562	071410-122	07/14/10	0.034	Personnel marker 1 1/2" diameter	0.0038	Shaw 07/02/09 to Present

TABLE 1 – LOW-LEVEL RADIOLOGICAL OBJECTS RECOVERED FROM SITE 12
Historical Radiological Assessment Supplemental Technical Memorandum, NAVSTA TI, California

No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
563	071510-123	07/15/10	0.014	Metal Object 1" x 1/2"	0.0015	Shaw 07/02/09 to Present
564	071910-124	07/19/10	0.013	Piece of Metal 1/8" x 1/4"	0.0014	Shaw 07/02/09 to Present
565	072010-125	07/20/10	0.014	Metal fragment 1/2" x 1/2"	0.0015	Shaw 07/02/09 to Present
566	072110-126	07/21/10	0.014	Metal Foil 1" x 3"	0.0015	Shaw 07/02/09 to Present
567	072210-127	07/22/10	0.02	1" diameter round metal object 1/4" thick	0.0022	Shaw 07/02/09 to Present
568	072610-128	07/26/10	0.017	Metal 1/2" x 3"	0.0019	Shaw 07/02/09 to Present
569	072710-129	07/27/10	0.016	Stone & Metal 1/2" x 1/2"	0.0018	Shaw 07/02/09 to Present
570	072710-130	07/27/10	0.014	Metal object 1/4" x 1/8"	0.0015	Shaw 07/02/09 to Present
571	072710-131	07/27/10	0.017	Metal object 1/2" x 1/4"	0.0019	Shaw 07/02/09 to Present
572	072710-132	07/27/10	0.015	Metallic Fragment 1/32" x 1/64"	0.0017	Shaw 07/02/09 to Present
573	072710-133	07/27/10	0.014	1" x 1/2 thick triangle hard clay metallic	0.0015	Shaw 07/02/09 to Present
574	072710-134	07/27/10	0.024	1/2" x 3/4" triangular hard clay metallic	0.0027	Shaw 07/02/09 to Present
575	072710-135	07/27/10	0.026	Tiny metal fragment 1/8" x 1/8"	0.0029	Shaw 07/02/09 to Present
576	072710-136	07/27/10	0.016	1/4" x 1/8" x 1/8" oval metal object	0.0018	Shaw 07/02/09 to Present
577	072710-137	07/27/10	0.03	1" x 1" x 1/2" triangular hard clay metallic	0.0033	Shaw 07/02/09 to Present

TABLE 1 – LOW-LEVEL RADIOLOGICAL OBJECTS RECOVERED FROM SITE 12
Historical Radiological Assessment Supplemental Technical Memorandum, NAVSTA TI, California

No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
578	032013-138	03/20/13	1.6	flat octagonal metallic object	0.1770	Tetra Tech EC 03/20/13 to 06/03/13
579	032113-139	03/21/13	0.014	flat octagonal metallic object	0.0015	Tetra Tech EC 03/20/13 to 06/03/13
580	032013-140	05/30/13	0.014	soil	0.0015	Tetra Tech EC 03/20/13 to 06/03/13
581	032113-141	05/30/13	0.014	soil	0.0015	Tetra Tech EC 03/20/13 to 06/03/13
582	032013-142	05/30/13	0.024	soil	0.0027	Tetra Tech EC 03/20/13 to 06/03/13
583	032113-143	05/31/13	0.036	soil	0.0040	Tetra Tech EC 03/20/13 to 06/03/13
584	032013-144	05/31/13	0.015	soil	0.0017	Tetra Tech EC 03/20/13 to 06/03/13
585	032113-145	05/31/13	0.018	soil	0.0020	Tetra Tech EC 03/20/13 to 06/03/13
586	032013-146	06/03/13	0.04	foil fragment	0.0044	Tetra Tech EC 03/20/13 to 06/03/13
587	032113-147	03/21/13	0.022	UNK device	0.0024	Tetra Tech EC 03/20/13 to 06/03/13
588	012814-148	01/28/14	0.012	box of samples	0.0013	Tetra Tech EC 03/20/13 to 06/03/13
589	012814-149	01/28/14	0.4	box of samples	0.0442	Tetra Tech EC 03/20/13 to 06/03/13
590	012814-150	01/28/14	0.22	bucket of Samples	0.0243	Tetra Tech EC 03/20/13 to 06/03/13
591	012814-151	01/28/14	0.36	bag of soil from drum	0.0398	Tetra Tech EC 03/20/13 to 06/03/13
592	020514-152	02/05/14	1.2	metal object .75" hexagon	0.1327	CB&I 02/04/14 to 2/17/14
593	021114-153	02/11/14	0.018	Rock	0.0020	CB&I 02/04/14 to 2/17/14
594	021114-154	02/11/14	0.01	Metal fragment	0.0011	CB&I 02/04/14 to 2/17/14
595	021714-155	02/17/14	0.02	Gauge	0.0022	CB&I 02/04/14 to 2/17/14
596	021914-156	02/19/14	0.008	Toggle switch	0.0009	CB&I 02/19/14
597	022114-157	02/21/14	0.12	TtEC misc material	0.0133	CB&I 02/21/14

TABLE 1 – LOW-LEVEL RADIOLOGICAL OBJECTS RECOVERED FROM SITE 12
Historical Radiological Assessment Supplemental Technical Memorandum, NAVSTA TI, California

No.	LLRO ID Number	Date Recovered	Highest 30 cm (mR/h) [1]	LLRO Description	Estimated Ra-226 (mCi) RadiumThumb Rule [2]	LLRO Recovered By and Date Recovered
598	020214-158	02/20/14	0.008	metal objects	0.0009	CB&I 02/20/14
599	022414-159	02/24/14	0.01	metal debris	0.0011	CB&I 02/24/14
600	022414-160	02/24/14	0.16	knob/ Button	0.0177	CB&I 02/24/14
601	032514-161	03/25/14	0.11	2 " dial	0.0122	CB&I 03/25/14
602	Gilbane 1	10/29/13	0.028	debris < 3 cm diameter	0.0031	Gilbane 10/29/13
603	Gilbane 2	10/29/13	0.015	fragments in soil	0.0017	Gilbane 10/29/13
604	Gilbane 3	11/12/13	0.028	metal object	0.0031	Gilbane 11/12/13
605	Gilbane 4	12/02/13	0.02	metal object	0.0022	Gilbane 12/02/13
606	Gilbane 5	12/02/13	0.006	metal object	0.0007	Gilbane 12/02/13
607	Gilbane 6	12/02/13	0.03	metal object	0.0033	Gilbane 12/02/13
608	Gilbane 7	12/05/13	0.03	metal object	0.0033	Gilbane 12/05/13
609	Gilbane 8	12/09/13	0.025	metal object	0.0028	Gilbane 12/09/13
610	Gilbane 9	01/29/14	0.012	glass dial	0.0013	Gilbane 01/29/14

Note:

1. Reading shown as measured in mR/h or calculated using highest contact reading (µR/h) × 0.001.
2. Radium Thumb Rule, RSO Magazine, Volume 10, No 4, 2005 = mR/h × 929/8400.

µR/h	Microroentgen per hour
cm	Centimeter
ID	Identification
mCi	Millicurie
mR/h	Milliroentgen per hour
NA	Not available; not calculated
No.	Number
Ra-226	Radium-226
tbsp	Tablespoon
tsp	Teaspoon

APPENDIX A
GENERAL HEALTH PHYSICS INFORMATION

APPENDIX A: GENERAL HEALTH PHYSICS INFORMATION

A1.0 GENERAL

Radiation is energy in the form of electromagnetic waves or subatomic particles. It is emitted from the nucleus or electron cloud of atoms or from devices generating electromagnetic waves and particles such as X-ray machines, neutron generators, and cyclotrons. Radiation is either *ionizing* or *non-ionizing*.

Radiation that has insufficient energy to remove electrons from atoms is non-ionizing radiation. Examples of non-ionizing radiation include most visible light, infrared light, microwaves, and radio waves. Radiation that has sufficient energy to remove electrons from atoms is ionizing radiation. All radiological investigations at Naval Station Treasure Island have focused on ionizing radiation, which includes alpha, beta, and gamma radiation.

A2.0 ALPHA RADIATION

Alpha particles are charged particles containing two protons and two neutrons. Alpha particles are emitted from the nuclei of certain heavy atoms, such as uranium, when they decay. Because of its size and heavy electrical charge, +2, an alpha particle can travel only a few centimeters in air. It can be stopped or shielded by a sheet of paper. Alpha particles cannot penetrate the outer layer of skin but can cause localized damage inside the body if ingested or inhaled.

A3.0 BETA RADIATION

Beta particles are particles with the mass of an electron and a -1 electrical charge; essentially they are high-velocity electrons. Radioactive isotopes of many different elements emit beta particles. Even though moderate energy beta particles can travel as far as 10 feet through air, they easily can be stopped by a 1/3-inch-thick sheet of plastic or a 1/8-inch-thick sheet of aluminum. They are a hazard to the body's skin and the eyes because beta particles can penetrate the outer layer of skin and affect living tissue.

A4.0 GAMMA RADIATION

Gamma radiation is electromagnetic radiation with no mass or charge. Gamma rays are emitted from the nucleus of an atom during radioactive decay. Gamma radiation can penetrate most materials because it has no mass or charge. In air, higher-energy gamma radiation can travel several hundred feet. Gamma radiation can penetrate the skin and interact with the dense structures of the body. Dense materials such as lead or concrete are needed for shielding against gamma radiation.

A5.0 X-RAYS

X-rays are also electromagnetic radiation with no mass or charge. The difference between gamma radiation and X-radiation is the nature of their origin. Gamma radiation originates in the nucleus, while X-rays originate in the electron region of the atom. The penetrating properties are the same; therefore, safety concerns and shielding mechanisms are similar. X-rays are typically produced by machines, and thus are not a hazard if the machine is turned off.

A6.0 SCIENTIFIC NOTATION

Radiation measurement units are normally reported in scientific notation. Scientific notation is also known as exponential or power-of-ten notation. It is a concise method of expressing numbers from very small to very large. Basically, scientific notation is the expression of a number raised to a power of ten. For example, 3,456 can be expressed as 3.456×10^3. Scientific notation is often used in this technical memorandum when radiation units are reported.

Here is a listing of common numbers expressed in scientific notation:

$10^6 = 1{,}000{,}000$
$10^5 = 100{,}000$
$10^4 = 10{,}000$
$10^3 = 1000$
$10^2 = 100$
$10^1 = 10$
$10^0 = 1$

$10^{-1} = 0.1$ (1/10)
$10^{-2} = 0.01$ (1/100)
$10^{-3} = 0.001$ (1/1000
$10^{-4} = 0.0001$ (1/10,000)
$10^{-5} = 0.00001$ (1/100,000)
$10^{-6} = 0.000001$ (1/1,000,000)

A7.0 RADIATION UNITS

Radiation measurements are stated in units of curies, roentgens, rads, and rems. These units are defined as:

A7.1 CURIE (CI)

The curie measures radioactivity: one curie is that quantity of a radioactive material that will have 37,000,000,000 (3.7×10^{10}) transformations in 1 second. Often, radioactivity is expressed in smaller units like thousandths (10^{-3}**,** millicurie or mCi), millionths (10^{-6}**,** microcurie or μCi), billionths (10^{-9}**,** nanocurie or nCi) or trillionths (10^{-12}, picocurie or pCi) of a curie.

A7.2 ROENTGEN (R)

The roentgen is a unit used to measure exposure. It describes an amount of gamma and X-rays, and only in air. The roentgen is a measure of the ionization of the molecules in a mass of air: one roentgen is equal to depositing in dry air enough energy to cause an electrical charge of 2.58×10^4 coulombs per kilogram (kg; 1 kg = 2.2 pounds). The main advantage of this unit is

that it is easy to measure directly, but it is limited because it is only for deposition in air, and only for gamma and X-rays.

A7.3 RAD (RADIATION ABSORBED DOSE)

The rad is a unit used to measure absorbed dose. This measure relates to the amount of energy actually absorbed in some material. It is used for any type of radiation and any material. One rad is defined as the absorption of 100 ergons (ergs) per gram of material. The unit "rad" can be used for any type of radiation, but it does not describe the biological effects of different radiations.

A7.4 REM (FROM ROENTGEN EQUIVALENT MAN)

The rem is a unit used to derive a quantity called equivalent dose. This measure relates the absorbed dose in biological tissue to the biological effect. Not all radiation has the same biological effect, even for the same amount of absorbed dose. Equivalent dose is often expressed in terms of thousandths of a rem, or millirem (mrem). To determine equivalent dose in rem, absorbed dose (rad) is multiplied by a quality factor (Q) that is unique to the type of incident radiation and the material in which the energy is deposited.

APPENDIX B
INTERVIEWS

APPENDIX B: INTERVIEWS

B1.0 GENERAL

Archival research conducted during preparation of the Naval Station Treasure Island (NAVSTA TI) Historical Radiological Assessment Technical Memorandum (HRASTM) included locating and making contact with people who had specific knowledge of radiological and related operations at NAVSTA TI.

To make contact with these people, archival documents were reviewed for the names of individuals who may have such knowledge, and commercial web search engines were utilized to try to locate those individuals. Interviews with those individuals who were located and consented to provide information have been included as references to this HRASTM. In addition, informal interviews were conducted by e-mail or phone with a number of other individuals, and the substance of all of the interviews conducted follows:

B2.0 INTERVIEWS

Brian DeGraffenried

Dennis Kelly of Tetra Tech spoke with Mr. DeGraffenried by telephone on the afternoon of August 6, 2013. Mr. DeGraffenried was an enlisted sailor and designated as the Chief Photographer in the Naval History of Treasure Island published in 1946 (TI-HRASTM-2). He was on temporary assignment at the TACDEN PHOTO LAB, located on the second floor of Ships Service Building #1, from May 24, 1945, to May 10, 1946. His rate was Photographers Mate 2nd Class and he was the Petty Officer in Charge of the photo laboratory most of that time. His responsibility was photographing assignments for various purposes.

Mr. DeGraffenried did not recall seeing any rubbish or solid waste burial or burning taking place on TI. He did recall photographing the north end of TI (at the time an ammunition storage area), but had no recollection of pits or disposal areas.

Mr. DeGraffenried did not recall any berthing of Operation Crossroads Ships at NAVSTA TI and believes that if they would have been berthed, it would have been after he left (Note: this information is consistent with his time of service and the time frame for the conduct of Operation Crossroads).

Mr. DeGraffenried was asked if he ever observed or photographed the optical shop on Building 3. Mr. DeGraffenried was not aware of the presence of the optical shop and stated he had never seen it.

Mr. DeGraffenried was questioned to see if he had any recall of radioactive materials being used or stored on NAVSTA TI. Mr. Kelly explained that these materials would include the use of radioluminescent paints on dials or in deck markers. Mr. DeGraffenried explained that he was

unaware of any radioactive material use on NAVSTA TI and further explained that he was not aware of the term radioactive until later after he left NAVSTA TI. He did note that he was aware of X-ray machines being used for medical purposes on NAVSTA TI.

In response to who he worked with that may recall more information, he indicated that a potential contact would be Commander Henry McDowell, Commanding Officer of the Radar Training Facility on Treasure Island, who was living at 19 Madison Ave, Summit, NJ, when he last heard from him on March 27, 1947 (Note: that Tetra Tech attempted to locate Commander McDowell and was unable to find him) (TI-HRASTM-47).

Chuck Taylor

Mr. Kelly of Tetra Tech spoke with Mr. Taylor by telephone on the afternoon of November 21, 2013. Mr. Taylor was an enlisted sailor and served at NAVSTA TI from about 1965 to 1970. During this time, he was first assigned as an electronics "A" school (A school was basic or introductory school) instructor and later worked in the Radiation Detection, Indication, and Computation (RADIAC) repair facility in Buildings 342 and 343, and the vault in Building 344. He was also responsible for maintenance of the licensed sources and licenses used for calibrating instruments in the *Pandemonium* training. During that time, he did periodic leak checks on the sources. He recalled that when the *Pandemonium* was moved from the west side of the island to the east side, he first removed all of the sealed sources from the ship and temporarily stored them in the vault in Building 344. His recollection was that the sources were cesium-137. When he temporarily stored them in the Building 344 vault, he built a matrix with 2- by 12-lumber in the vault and filled it with soil surrounding 60-millimeter (mm) shell casings into which he placed the sealed sources.

Mr. Taylor did not recall seeing any rubbish or solid waste burial or burning taking place on TI, nor did he have any information regarding operation of the incinerator, which was operated during the 1950s at the north end of the island or in particular, what happened to the ash from the incinerator. Mr. Taylor did not recall ever hearing any information regarding the berthing of Operation Crossroads Ships.

Mr. Kelly described the octagonal radium foils that have been found in the Solid Waste Disposal Areas (SWDA) on NAVSTA TI. Mr. Taylor was familiar with the foils as he had recently dug up some of those that have been found during his current work on Navy projects at NAVSTA TI; however, he has no recollection of the foils being used in association with any operations on NAVSTA TI. Mr. Kelly asked if perhaps they had been used in association with *Pandemonium* training operations, and Mr. Taylor indicated that he had never seen any foils like those found used anywhere during his tenure on NAVSTA TI. Mr. Taylor was asked if he ever observed the optical shop on Building 3. Mr. Taylor was not aware of the presence of the optical shop and stated he had never seen it.

Mr. Taylor was asked if he ever worked in Building 233, and he indicated that he had not worked there until the recent decontamination efforts in the last few years as a Navy contractor. Mr. Taylor was asked if he recalled any radiation areas or materials ever being present in the supply

department at NAVSTA TI. He responded that he had no recollection of any such radiation areas or materials in the supply department. Mr. Taylor was questioned to see if he recalled radioactive materials used or stored on NAVSTA TI or any radiological spills anywhere on NAVSTA TI. Mr. Taylor explained that he was unaware of any radioactive material use on NAVSTA TI other than as described above. In response to who he worked with who may recall more information, he indicated that he could not recall the names of any individuals who might have additional information or individuals who worked in the Public Works Department (TI-HRASTM-48).

David Nishimura

Mr. Kelly of Tetra Tech spoke with Mr. Nishimura on several occasions by telephone in late 2013. Mr. Nishimura was the Project Civil Engineer for the Actus Sundt Joint Venture, the contractor that built the 1400 series housing on NAVSTA TI. Mr. Nishimura indicated that his primary focus on that project had been the design of the sewer systems, and he noted that he had spent limited time on site during construction. Although no formal interview was conducted, Mr. Nishimura provided the following information:

Mr. Nishimura was asked if he was aware of any evidence (geotechnical or field observations) that rubbish disposal took place on the site prior to the construction of this housing project. Mr. Nishimura responded that the actual construction phase of the project was under the direction of the project managers, project architect, and construction managers, and that he was not very involved, so his knowledge is limited. With that qualification, he did state that he was not aware of any specific rubbish disposal areas within the project boundaries. He recalled that the base was constructed of fill material and not native soil. Mr. Nishimura also stated that he was not aware of any evidence that grading and construction associated with the adjacent housing to the north and west moved soil onto the project site. Tetra Tech attempted to locate the soils engineer for the project, but found that he was deceased.

Mr. Nishimura did not specifically recall if the "Project Boundaries" shown in the as-built drawings had meaning with respect to the extent of site intrusive activities associated with grading (TI-HRASTM-44). Mr. Nishimura stated that typically all work on the turnkey military family housing projects were to be confined to the project boundaries provided by the Military. Mr. Nishimura could not recall whether or not the project boundaries were fenced during construction.

Mr. Nishimura provided the names of several individuals involved in the 1400 series housing construction, including the owner of Town and Country Inc., the project architect, and that of the construction superintendent; however, none of the individuals could be located by Tetra Tech as they were since deceased.

Breton Hanville

Mr. Kelly of Tetra Tech spoke with Mr. Hanville on June 14, 2013. Mr. Hanville was employed by the Naval Facilities Engineering Command, Engineering Field Activity West, at the time of construction of the 1400 series housing in 1987, and his proper title relative to the housing would have been "Project Leader." He fulfilled that role for the design and construction of housing projects up and down the West Coast and Alaska. He has no recollection of any specific issues related to soils engineering or grading at the 1400 series site. He believes that the proper person to contact would be the Resident Officer in Charge of Construction (ROICC) for site-specific information. Tetra Tech attempted to contact the ROICC personnel who would have been involved in the construction of the 1400 series housing, but was unable to locate them.

APPENDIX C
RESPONSES TO AGENCY COMMENTS ON THE DRAFT HISTORICAL RADIOLOGICAL ASSESSMENT SUPPLEMENTAL TECHNICAL MEMORANDUM

RESPONSES TO AGENCY COMMENTS ON THE DRAFT HISTORICAL RADIOLOGICAL ASSESSMENT – SUPPLEMENTAL TECHNICAL MEMORANDUM NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA

NOTE REGARDING THE FOLLOWING RESPONSES TO COMMENTS:

This document presents the Department of the Navy's (Navy) responses to comments that were previously submitted to the regulatory agencies for review on January 18, 2013. These responses were provided to the "Draft Historical Radiological Assessment – Supplemental Technical Memorandum (HRASTM), Naval Station Treasure Island (NAVSTA TI), San Francisco, California, dated August 6, 2012."

Following submission of these responses, a corresponding revision to the HRASTM, and several meetings with the regulatory agencies, the Navy initiated additional research to address several questions associated with the radiological history of NAVSTA TI. The Navy revised the HRASTM to include the findings of the additional research and to conform to discussions and agreements made following the submission of the following RTCs. As a result of those revisions, some of the responses that follow may no longer reflect the additional findings or changes made to the text of this "*Final Historical Radiological Assessment – Supplemental Technical Memorandum (HRASTM),"* however, these responses were included to maintain the integrity of the administrative record.

RESPONSES TO AGENCY COMMENTS ON THE DRAFT HISTORICAL RADIOLOGICAL ASSESSMENT – SUPPLEMENTAL TECHNICAL MEMORANDUM NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA

This document presents the Department of the Navy's (Navy) responses to comments from staff at the California Department of Toxic Substances Control (DTSC); the California Department of Public Health's (CDPH) Environmental Management Branch (EMB); the San Francisco Public Utilities Commission (SF PUC); AMEC Environmental & Infrastructure (AMEC), on behalf of the Treasure Island Development Authority (TIDA); NGTS, Inc. (NGTS) on behalf of TIDA and AMEC; Terraphase Engineering Inc. (Terraphase) on behalf of the Treasure Island Community Development, LLC (TICD); Dade Moeller on behalf of Arc Ecology; EPA; and the San Francisco Bay Regional Water Quality Control Board (Water Board) on the "Draft Historical Radiological Assessment – Supplemental Technical Memorandum (HRASTM), Naval Station Treasure Island (NAVSTA TI), San Francisco, California, dated August 6, 2012." The comments addressed below were received from the DTSC on October 5, 2012; CDPH EMB on October 4, 2012; SF PUC on October 2, 2012; TIDA (NGTS and AMEC) on October 3 and 5, 2012; TICD (Terraphase Engineering) on October 5, 2012; Arc Ecology (Dade Moeller) on October 5, 2012; EPA on October 10, 2012; and the Water Board on October 12, 2012.

Additional comments were received from CDPH EMB on December 11, 2012 in response to the Navy's initial responses to comments received from the above regulatory agencies in October 2012. Please note that the Navy's initial responses to October 2012 comments were thus revised to conform with the responses to December 2012 comments where appropriate.

RESPONSES TO DTSC COMMENTS (REMEDIOS SUNGA)

GENERAL COMMENTS

1. Comment: **<u>Information and Data since 2006 HRA</u>. The HRASTM should discuss and provide all information and data that have been generated and gathered to date from the radiological activities at TI since 2006. The 2006 HRA indicated that radiological contamination in the Solid Waste Disposal Areas (SWDAs) was unlikely. However, the 2007 removal actions in the SWDAs found radiological contamination and several commodities. This new information should be incorporated in the HRASTM.**

Response: The text will be updated to include a listing of commodities that have been found to-date as requested. All remedial actions with radiological analysis were considered in the HRASTM when making determinations of property classification as impacted or not impacted. As information becomes available from ongoing radiological investigation prior to finalization of the HRASTM, the HRASTM text will be updated to summarize any new information resulting from these ongoing investigations. This work includes investigations at Sites 12, 31, 33, and Building 233.

2. Comment: **<u>Final HRASTM</u>. The HRASTM should be finalized with changes in the text, figures, and tables, as needed, in response to all comments, and not just attaching the Responses to Comments to the draft as an appendix.**

Response: Navy concurs.

SPECIFIC COMMENTS

3. Comment: **<u>Section 2.2.7-AOI7: Northern Housing Area of Interest, Pages 18-24</u>. The soil removal action in 2007 at SWDAs 1207/1209 and 1231/1233 should be discussed in this section. The sampling data and a list of all commodities found at these SWDAs should also be included for reference. The discovery of radiological commodities during the 2007 removal action warranted the 2009 surveys at the Northpoint and Bayside housing areas. If wipe samples were collected during this surveys from residential buildings, the results of this sampling should also be incorporated in the HRASTM. The HRASTM should include all radiological findings from any buildings, soil/wipe samples, scans, and commodities found to date not previously provided in the 2006 HRA.**

Response: The work done within solid waste disposal areas (SWDAs) 1207/1209 and 1231/1233 is discussed in general in Sections 4.3.6 and 4.3.7. Regarding the request for additional detail, please see the response to DTSC General Comment #1.

4. Comment: **<u>Section 2.2.8-AOI8: Southern Housing Area, Pages 24 and 25</u>. The 2007 soil removal action at SWDAs A&B should be discussed in this section. The sampling data and a list of all radiological commodities found at these SWDAs should also be included for reference. The removal action findings prompted the California Department of Public Health (CDPH) to survey the areas surrounding the Radiological Controlled Area at SWDAs A&B.**

Response: The work done within SWDAs A&B is discussed in general in Section 4.3.8. Regarding the request for additional detail, please see the response to DTSC General Comment #1.

5. Comment: **<u>Section 4.1-Radiologically Impacted Sites, Pages 28-33</u>. The Bigelow Court SWDA should be included in the list of radiologically impacted sites. The reason for this is because it was classified as a SWDA in earlier investigations at Site 12 and as discussed on page 22 of the HRASTM.**

Response: Comment noted the Navy will designate this area as an impacted. Details on the basis for this recommendation will be addressed in Section 6.0. Contamination potential for subsurface will be listed as unlikely and a scoping survey will be recommended.

6. Comment: <u>Section 4.1.7-Former Storage Areas 30 and 31, Page 32</u>.

6.1 <u>First Paragraph</u>. The last sentence states that no radiological or other Installation Restoration Program (IRP) related work has been done at Site 30 or the areas north and south of the IR sites, since the 2006 HRA. Please clarify the meaning of "work" in this sentence since IR related work or activities have been completed at Site 30, i.e., Proposed Plan and Record of Decision.

Response: The last sentence of the first paragraph has been revised to eliminate the use of the word "work" as follows: "No radiological or other intrusive activities related to the Installation Restoration (IR) Program has been done at Site 30 or the areas north and south of the IR sites since the 2006 HRA."

6.2 <u>Second Paragraph</u>. The second to the last sentence states that laboratory testing confirmed the presence of non-naturally occurring Ra-226, possibly from a deteriorated metal gauge. Please clarify whether a deteriorated metal gauge or any commodity was found in the area of elevated radiological readings.

Response: Elevated radiological readings were discovered during the Phase I activities, but no commodities were observed. Laboratory analysis of soil confirmed the presence of radium (Ra)-226 at levels suggesting non-naturally occurring radionuclides (10 to 11 picocuries per gram [pCi/g]). While unconfirmed, it is possible that this elevated concentration was from a deteriorated man-made item.

7. Comment: <u>Section 4.2-Radiologically Non-Impacted Sites, Pages 33 and 34</u>. The radiological screenings at Site 33 was performed in early 2012 and the results of this survey should be discussed in the HRASTM. Site 33 is classified as not impacted based on the screening results as presented in the Radiological Characterization Report that is currently under review.

Response: Comment noted. The text of the last sentence of the second paragraph of Section 2.2.2 has been revised to read: "At the time of publication, the majority of remedial action fieldwork at the Waterline Replacement Area, Site 33 (Figure 4), has been completed including radiological surveys/samples. Although not yet documented in a final report, the preliminary data would support the conclusion that soil and asphalt

samples from the five separate excavation areas, Site 33 are free of non-naturally occurring Ra-226, cesium (Cs)-137, and strontium (Sr)-90 contamination."

8. Comment: **<u>Section 6.1.2.7-Former Storage Area and Sites 30 and 31, Pages 55-56. Site 31, Page 56</u>. The elevated radiological readings during the July 2010 soil excavation and the removal of soil with no commodities found in April 2011 should be discussed in this section. The HRASTM needs to incorporate all available data.**

Response: Section 6.1.2.7 has been updated to address the current radiological status of Site 31 by revising the language under the header "Previous Radiological Investigations" to read as follows: "The northern and southern portions of the storage area – None; Site 30 – None; Site 31 – non-time-critical removal action (NTCRA). During the Phase I removal action, elevated radioactivity suggesting the presence of non-naturally occurring Ra-226 was discovered in the sidewall of the excavation. Laboratory testing confirmed the presence of Ra-226 in concentrations exceeding the cleanup goal (Shaw 2012b). The contaminated soil was removed and no commodities were found in association with the elevated background." All work will be documented in a site-specific remedial action completion report (RACR) and final status survey (FSS) report.

9. Comment: **<u>Figure 2-Newly Identified Radiologically Impacted Areas</u>.**

9.1 <u>Radiologically Impacted Sites</u>. SWDAs A&B, 1207/1209 and 1231/1233 are shown in this figure but not identified in the Legend as radiologically impacted sites. In addition, Bigelow Court SWDA is not shown and Building 233 is not identified as impacted. Please clearly present both the new areas identified as impacted in this HRASTM as well as those identified in the 2006 HRA in different colors. The figure should denote all radiologically impacted areas identified in the 2006 HRA and the newly identified areas. The newly impacted areas should also include Bigelow Court SWDA and the paved compound at the rear of Buildings 342, 343 and 344 (see Comments #6 and 11). The figure title should also be updated accordingly.

Response: Figure 2 and all other appropriate figures (Figures 4, 6, 8, 9 and 10) have been revised to indicate those areas previously identified as impacted in the 2006 Historical Radiological Assessment (HRA), as requested. In addition, the figure title has been updated and explanatory text has been added to the end of the Section 2.3 to further discuss and introduce the results of the HRA.

In addition, as requested, The Bigelow Court SWDA and the paved compound at the rear of Buildings 342, 343 and 344 have been added as radiologically impacted sites to the HRASTM.

9.2 <u>Radiologically Impacted Site Boundaries</u>. The current SWDA boundaries exclude the buildings where sidewall samples taken beneath the buildings showed radiological contamination. The boundaries should be adjusted to conservatively include the buildings. Building 233 impacted boundaries should also be adjusted as discussed at the BCT meetings based on the detection of radiological contamination along sewer lines. The Building 233 boundary includes surrounding areas beyond the building footprint.

Response: The 2006 HRA boundaries for the SWDAs and Building 233 have been expanded in the HRASTM as recommended. See the revised boundaries in Figures 2, 4, 8, 9 and 10.

The text of the HRA has been modified as follows:

1. Add the following bullet to the end of the Executive Summary:

   - *This HRASTM expands the site boundaries for each of the Site 12 SWDAs to account for investigatory results obtained subsequent to the HRA.*

2. Revise the last sentence of paragraph 5 in Section 2.2.7 to read:

   "*Although further investigation will be performed throughout Site 12, the potential for the presence of radioactive materials in AOI 7 outside of the SWDAs is minimized because:…*"

3. Revise the last sentence of the first paragraph in Section 2.2.8 to read:

   "*The findings of this HRASTM for Area of Interest (AOI) 8 differ from the HRA in that this HRASTM expands the footprint of the existing SWDAs by 50 feet around the perimeter based on new information from investigations subsequent to the final HRA.*"

4. Insert the following new Sections 4.1.1 and 4.1.2 and renumber the follow-on sections:

   "4.1.1 Radiologically Impacted Sites Identified in the HRA

   This section addresses work that was done at sites designated as radiologically impacted at the time of the HRA. These sites include the former Building 233, Buildings 343 and 344, and SWDAs 1231/1233, 1207/1209, and A&B.

4.1.1.1 Building 233

Building 233 was the former location of the RADIAC Instrument Calibration School. In 1950, a spill of radium sulfate was reported in one of the laboratories in Building 233. Students unknowingly tracked the radiological material throughout the building before the spill was discovered. The U.S. Naval Radiological Defense Laboratory decontaminated and cleaned up the building. Although the floor was decontaminated at the time, the Navy is currently performing remedial activities and surveys to ensure the 1950 cleanup meets current standards. At the time of publication, the building and foundation have been removed surface contamination was remediated, and the existing contamination related to storm drains and sewer lines associated with the former building is being characterized.

A radiological assessment of Building 233 was done and a survey report was issued (Tetra Tech EC, Inc. 2008c). The scoping survey indicated that at least some of the building interior, exterior and piping was radiologically impacted. It was recommended that the piping be removed and fully surveyed for release during building demolition. In addition, a scoping survey of the building completed in September 2007 identified contamination under paint in interior areas and areas of elevated readings outside the building (Shaw 2012d). The demolition of the building was completed in January 2011 and at the time of this HRASTM, the Navy is conducting the characterization, remediation, and FSS for the building footprint, the sanitary/storm sewer system associated with the building and the surrounding area in accordance with MARSSIM (Revision 1 August 2000).

4.1.1.2 Buildings 343 and 344

Building 343 is one of the three buildings that comprised the RADIAC school from the 1950s to the 1970s. The closeout survey conducted by the Navy in a storeroom of Building 343 detected two alpha wipe survey points that were above release limits. Although these survey points were decontaminated, the HRA found that these had not been adequately investigated and recommended an FSS for the building. Building 344 was the location of a 1988 investigation of contamination in a waste container. The radioactive contamination was cleaned up and disposed of at a location off of NAVSTA TI. Surveys demonstrated that the areas were decontaminated to meet the Navy standards at the time. The HRA recommended an FSS for Building 344.

MARSSIM Final Status Surveys of Buildings 343 and 344 occurred in September 2007. In 2008, FSS reports were prepared for Buildings 343 and 344 (Tetra Tech EC Inc. 2008a, 2008b). The survey reports regarding Buildings 343 and 344 indicated that the survey results for both buildings had met the release criteria and the buildings could be

released for unrestricted use. DTSC and CDPH concurred that unrestricted release for Buildings 343 and 344 was appropriate (DTSC 2009).

4.1.1.3 SWDA 1231/1233, 1207/1209 (Bayside/North Point)

A NTCRA began in March 2007 at SWDAs 1231/1233, and 1207/1209 (Bayside/North Point) (Shaw 2007b). During the NTCRA, approximately 20 radiological commodities were discovered as well as incidental soil contamination. Additional remediation of SWDAs 1231/1233 and 1207/1209 will take place in order to support free release of the area.

4.1.1.4 SWDA A&B

A NTCRA began in March 2007 at SWDAs A&B (Shaw 2007b). During the NTCRA, several hundred radiological items ranging in Ra-226 content from 0.4 to 6,400 microcuries (µCi) were found. Additional remediation is necessary for SWDA A&B in order to support free release of the area.

4.1.2 Radiologically Impacted Sites Identified in this HRASTM

This section addresses work done at sites not designated as radiologically impacted at the time of the HRA, but subsequently designated as radiologically impacted in this HRASTM. These sites include Building 3, the entire sanitary sewer line from Buildings 3 and 233, the storm drain line from Building 233, the former incinerator in Site 12 and the downwind area potentially affected by aerial deposition, Building 570, both former USS Pandemonium Sites I and II, a probable former salvage yard site, a waste & clean soil stockpile/loading and decontamination site, the Bigelow Court SWDA, the asphalted area outside and east of Building 342, Building 168 (a former gyro compass repair building), and a former storage area (Sites 30 and 31)."

5. Add the following to the end of Section 6.1.1.3:

"*Intrusive investigation of SWDAs A&B, 1207/1209, and 1231/1233 has shown that radioactive debris extends beyond the footprints identified in the HRA for these SWDAs. Figures 2, 9, and 10 of this HRASTM show the expanded footprints for these impacted areas.*"

10. Comment: **<u>Appendix A-References, HRASTM-27 Lic 04-0436002 Amend</u>. This reference document states "The Radiac Instrument Maintenance Branch of Nuclear, Biological and Chemical Defense School is located near the corner of 5th Street and Avenue M on the Northeast side of Treasure Island (Fig. 1). It consists of numbered Buildings 343, 344**

and a portion of 342 and a paved compound of approximately 4,800 square feet which is enclosed by a 7' chain link fence (Figs. 2, 3, 4, and 5)… The paved compound to the rear of the buildings (Fig. 5) is used to conduct outdoor monitoring exercises using sealed sources. Whenever sources are exposed in the compound a red warning light on the inside wall of Lab #3 is activated by staff personnel and personnel are restricted from that area." Based on these statements, the paved compound should be identified in the HRASTM as potentially impacted. Please also verify whether there is documentation indicating a release of sealed sources in any of these locations. This new impacted location should be shown in Figure 2.

Response: The text of the HRASTM has been modified to address this outdoor area as radiologically impacted. The last paragraph has been rewritten as follows to improve the clarity of the HRASTM:

> "*This HRASTM identifies Building 342 and surrounding area (Figure 6) as impacted based on new information indicating the possibility that prior use of the building may have included use as a radiological counting room. The presence of a counting room suggests the possibility that samples may have been handled without encapsulation and warrants designating the building as radiologically impacted. Buildings 343 and 344 were identified as impacted in the HRA. An FSS was recommended for the storeroom in Building 343 and for Building 344. These FSS reports were completed in 2008 (Tetra Tech EC, Inc. 2008a, 2008b). The California Environmental Protection Agency's DTSC concurred with the unrestricted release of Buildings 343 and 344 on January 16, 2009 (DTSC 2009). Based on the completion of the FSS reports for Buildings 343 and 344, and DTSC acceptance of unrestricted release of these buildings, no further action is required for these buildings at the time of this HRASTM. The radioactive materials license for the Buildings 342, 343 and 344 compound also indicates that the paved area to the rear of the buildings was used to conduct outdoor monitoring exercises using sealed sources. This area has also been designated as impacted to allow for the possibility of outside spills or leaks*."

OTHER COMMENT

11. Comment: Additional comments from CDPH are provided in the enclosed memorandum. Many of these comments pertain directly to the HRASTM, and the Navy should consider them the State's comments. Several of the comments or parts of the comments are related to future work or are not germane to the HRASTM. The Navy should address these comments in future documents. The comments that do not apply directly to the HRASTM and which the Navy should address in future documents are:

- **Comment 3 - third and fourth sentences**
- **Comment 21 - second and third sentences**
- **Comments 7 and 14**
- **Comments 4, 5, 6, 8, 11, 12, 16, 18 and 23 should be addressed in the revised HRASTM if information is available. If not, they should be addressed in a future document**

Response: Comment noted. The Navy has addressed all CDPH comments, including those referenced above. The Navy recognizes that additional site history/information developed after the HRASTM is published may be presented in future documents.

RESPONSES TO CDPH EMB COMMENTS (LARRY MORGAN)

GENERAL COMMENTS

1. Comment: EMB recommends identification and listing of radionuclides of concern for all radiological impacted sites and buildings. The Department of Navy (DON) needs to identify the use of radionuclides, and where and how disposed. Please establish if there were any known radionuclide sealed sources or radiological contamination prior to DON's ownership of Treasure Island (TI), and whether your records indicate the fate and transport of such items.

Response: The HRASTM (as well as the 2006 HRA) identifies radionuclides of concern for all radiological impacted sites and buildings. Please see Section 6.1.2 and subheadings "Potential Radionuclides of Concern" for all newly impacted sites. Regarding previously identified radiologically impacted sites in the HRA, the radionuclides of concern were identified in the HRA in Section 8.3 under the subheading "Radionuclides of Concern."

With respect to identifying the use of radionuclides, and where and how disposal occurred, the research, references and conceptual site models developed in both the 2006 HRA and the HRASTM aim to answer these questions. As noted in the HRASTM, the Navy has reviewed documents from the Golden Gate International Exposition (GGIE) and has found no evidence to date of use or presence of radioactive materials during the period prior to Navy ownership of Treasure Island. While this does not preclude presence of radioluminescent materials on common items such as watches or on instruments associated with the Pan American (Pan Am) Clippers, no evidence has been found of disposal of these items. The following text has been added to the end of the 3rd paragraph in Section 2.2:

> *"The Navy has reviewed documents from the GGIE and has found no evidence to date of the use or presence of radioactive materials during the period prior to Navy ownership of Treasure Island. While this does not preclude the presence of radioluminescent materials in*

association with common items such as watches or on instruments associated with the Pan Am Clippers, no evidence has been found of disposal of these items at TI."

2. Comment: The Historical Radiological Assessment Supplemental Technical Memorandum (HRA-STM) needs to adequately address EMB current concerns regarding the higher level activity Ra-226 items found on Treasure Island (TI) in the form of radium foils and buttons, commonly referred to as commodities.

EMB stated in a Memorandum of May 17, 2012, "Understanding the presence, use and location of disposal for all these items (foils and buttons) needs to be the primary focus of the Technical Memorandum (TM) to the Historical Radiological Assessment (HRA)." The updated Conceptual Site Model, 5.2.1.1 states, "Based on the research conducted to date, the source of the radioactive foils and buttons is unclear..." Please further elaborate their use, location, and disposal. Please detail how many cubic feet of Low Level Radioactive Waste (LLRW) have been shipped from TI and its point of origin. Please detail how many radioactive waste shipments whose contents were greater than LLRW have been made from TI, their nature and point of origin.

Response: The Navy concurs that in the absence of information for a site, a better understanding of function and use of different commodities may lead to a better of understanding of which areas warrant designation as radiologically impacted. However, the weight of evidence suggests that the radium foils resulted from Navy operations and that they were probably used in association with training activities. This basis is concluded because the foils are found buried in the SWDAs. Burial in the SWDAs would have been done by the Navy in the late 1940s or early 1950s based on when the SWDA debris pits were in use. The fact that the burial would have occurred after the WWII period indicates that it is unlikely that the foils would have been from the period of the GGIE. Furthermore, the curie content of the foils seems to vary, which indicates the foils were probably used for naval training activities. The absence of additional specific knowledge does not preclude the Navy from designating impacted areas and conducting appropriate response actions based on the availability of other lines of evidence. In fact, the SWDAs had been identified without any knowledge of what type, if any, commodities were present, even though all but one of the commodities have been found within those SWDAs to-date. I addition, the Navy has performed extensive records research as part of the HRASTM in an attempt to understand as many specifics as possible regarding the types of commodities that have been found. To the extent information is available on the types of commodities that have been found to-date, this information is provided in Section 5.2.1.1 of the HRASTM. The Navy continues to

research all types of radioluminescent devices and Ra-226 sources used by the Navy. Areas of interest on TI include the TI calibration laboratory, classrooms, and USS *Pandemonium* locations due to the use of radioactive sources and devices.

No High Level Radioactive Waste (HLRW) has been shipped from NAVSTA TI. Appropriate changes have been made in response to the CDPH EMB request to summarize information related Low Level Radioactive Waste (LLRW) shipped from TI including available details on such shipments.

3. **Comment:** **DON previously excavated approximately 580 trenches presumably for characterization purposes, and collected over 1,500 soil samples; of which four soil samples were analyzed for radionuclides. EMB has not seen characterization plan(s) that included analysis of a large fraction or all of the 1,500 samples. If the previously collected samples are unavailable for analysis now, the locations where samples were collected and chemicals, debris, staining or odors were found need to be incorporated into upcoming characterization plans. Since CDPH's stated conceptual model is that these sites are potentially impacted by radionuclides, these characterization plans need to be developed soon.**

Response: The soil samples that were collected in 2003 have been subsequently disposed of and are not available for additional analysis. All previous investigative data will be considered in the process of developing upcoming characterization plans and CDPH will be provided an opportunity to comment on these plans.

4. **Comment:** **Based on a preliminary review, EMB has found DON did not provide radiological information about the extent of contamination for all radiologically impacted buildings or sites from the following:**

- **Industrial waste lines,**
- **Outfalls to the San Francisco Bay,**
- **Characterization of surface below asphalt,**
- **Removal of surface anomalies,**
- **Excavation of sewer drainage system,**
- **Plume footprint from incinerator, and**
- **Solid waste disposal areas for the entire island.**

Response: Regarding the extent of contamination at radiologically impacted buildings or the listed sites, the following Navy input is provided:

- Industrial waste lines: There are no industrial waste lines on TI.

- Outfalls to the San Francisco Bay: Outfalls to San Francisco Bay have not been designated as impacted; however, the outfalls will be designated impacted if ongoing investigations warrant such designation.
- Characterization of surface below asphalt: Characterization of soil surfaces below the asphalt cover will occur in impacted areas.
- Removal of surface anomalies: One near-surface anomaly was found and disposed of, and that anomaly is discussed in Section 2.2.7. If additional anomalies are found they will be investigated appropriately.
- Excavation of sewer drainage system: The Navy presumes this comment refers to the sewer lines undergoing remediation in association with Building 233. That work is ongoing and will be reported as additional data becomes available.
- Plume footprint from incinerator will be investigated.
- All known SWDAs for the entire island are being investigated: The Navy presumes this comment refers to the radiologically impacted SWDAs in Site 12 (Bigelow Court, 1231/1233, 1207/1209, and A&B). That work is ongoing and will be reported separately from this HRASTM.

5. Comment: **For future reference, please provide EMB with a summary table of Site 12, Solid Waste Disposal Area (SWDA) sites. The table should include the following information: all buildings, potentially impacted buildings and building sites. At a minimum, display the following information; Area of Interest (AOI), surface area m^2, total number of soil samples collected, elevated Radionuclide of Concern (ROC), total soil remediated, and backfill soil data and analysis for all buildings, building sites and sites.**

It is important for EMB to understand past and current soil movement by DON and their contractors. EMB's conceptual model views the presence of debris, odors or soil discoloration, as an indicator of potential presence of radionuclides. EMB welcomes future review of a revised and complete conceptual site model.

The revision to the HRA document does not list the sites at TI where debris, odors or soil discoloration has been observed. Please list these sites in a summary table and provide a corresponding legend. This table would guide further scoping and characterization work that EMB has indicated will be needed at TI.

Response: The summary of all radiological work performed to-date in the SWDA sites is documented in two separate reports: SWDA Bayside/North Point Post Construction Summary Report (PCSR) and the SWDA A&B PCSR.

These reports summarize all the details and information referenced in the above comment.

Historic soil movement activities within Site 12 and other impacted sites (Sites 32, 31 30, 6 and Building 233) includes material related to investigation-derived waste (IDW), remediation, and construction activities. The only other intrusive CERCLA excavation involves the current remedial action at Site 33 for which preliminary results suggest there is no man-made Ra-226 contamination. Soil movement associated with remediation activities are summarized in their respective project reports. For Site 12, this work would have included: PCB investigation at Halyburton and Bigelow Courts; the four historic removal actions conducted within Site 12 (Site 12 RI, Section 1.3.13); and, the ongoing removal actions at SWDAs A&B and Bayside/North Point. Petroleum corrective actions within Site 6 and the Toxic Substances Control Act (TSCA) action within Site 32 are also documented in their respective reports. All projects were performed per work plans that included control procedures to properly contain contaminated soil and debris. Work associated with the Building 233 remediation and SWDAs A&B and Bayside/North Point includes radiological characterization of soil. Characterized LLRW is put into sealed bins at the radiologically controlled area and disposed of in out-of-state facilities. Comprehensive records are not available to document soil movements associated with historic construction activities.

Two primary lines of evidence have been used to develop areas that are impacted and subject to further investigation. (1) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites with other non-radiological known soil contamination, and suspect contamination based on historical site models. All CERCLA sites with soil contamination are subject to ongoing or future investigation. These CERCLA sites were identified over the years following various investigations, taking into account factors including visual characteristics as well as subsurface soil analysis. (2) In addition, several areas will be investigated because of the conceptual potential for radiological contamination based on historical site models (e.g., Building 3, Lot 69, etc.).

6. Comment: In reference to soil movement on TI, EMB recommends including information gained from public interviews of current and past contract workers who worked or remediated during site operation or after site closure.

Response: Although no interviews were or will be conducted as part of the preparation of the HRASTM, the Navy has taken a number of actions to address the potential that soil movement from the Site 12 SWDAs to the soil stockpile areas may have resulted in the spread of contamination. These actions include performing surface scans of the route taken by the transport vehicle, designating the soils stockpile area for the IDW as radiologically impacted, and the commitment to conduct site-wide gamma walkover surveys of Site 12. The information appears in the last paragraph of Sections 2.2.6 and 5.2.3.3.

7. Comment: There are no Applicable or Relevant and Appropriate Requirements (ARARS) in the HRA-STM that describe radiological ARARS. Please provide radiological ARARS information in a prescribed section. See Title 17 of California Code of Regulations Section 30256, which EMB uses to determine Radiological Unrestricted Release Recommendation (RURR) for buildings and sites.

Response: Applicable or Relevant and Appropriate Requirements (ARARs) are not included in HRAs, but are evaluated per site as part of the CERCLA process.

8. Comment: Provide an assessment for the likelihood of contamination migration from surface to subsurface, sediment, soil types, ground water, airborne, and drainage systems for all impacted sites.

Response: Contaminated media and potential migration pathways are addressed in this HRASTM, as well as in the 2006 HRA. Please see "Contaminated media" and "potential migration pathways" in the HRA (Section 8.3) and the HRASTM (Section 6.1.1). Please note that consistent with DTSC's Other Comment #11, additional detail regarding investigation of impacted sites will be appropriately included in future work plans prepared pursuant to CERCLA.

9. Comment: During past discussions at Base Closure Team (BCT) meetings and Technical meetings, DON staff mentioned possible disposal of radionuclides used at Treasure Island (TI). Please provide documentation and resolution about a DON contracted report (NBy-61078) submitted in 1965, and other reports if they exist, that provide further information about "...radioactive and poisonous wastes had been buried west of the abandoned landing strip in a future construction area."

Response: The referenced report is the only known reference regarding deliberate disposal of radiological wastes at Treasure Island other than the short half-life bromine (Br)-82 isotopes that were used during training operations on the USS *Pandemonium,* which are discussed in detail in the HRA. The statement has been confirmed with the discovery of contamination at

SWDA A&B, the referenced disposal area at the end of an early runway. Other known debris disposal activities within Site 12 are supported by other lines of evidence but do not specifically indicate purposeful disposal of radiological wastes. The last paragraph of Section 2.2.8 of the HRASTM has been modified to discuss this cited report by replacing the second sentence with the following four sentences:

> "*After the 2006 HRA, radiological commodities were found in each of the SWDAs confirming the report of radiological disposal activities at Treasure Island. The referenced report is a geotechnical report that contains the statement that 'discussions with station personnel during our investigation revealed that portions of the proposed construction area have been used for the disposal of debris…and that radioactive and poisonous wastes had been buried west of the abandoned landing strip in a future construction area.' (*McCreary Koretsky Engineers 1965*). No other reports have been discovered that specifically suggest the disposition of radiological waste at Treasure Island. .*"

In addition, this report has been added to the HRASTM list of references as follows:

> *McCreary Koretsky Engineers. 1965. "Soil and Foundation Investigations for Appropriated Fund Quarters at U. S. Naval Station, Treasure Island, San Francisco, California." January 11.* ***TI-HRASTM-33.***

10. Comment: Area of Interest (AOI) boundaries should follow streets or natural landmarks. AOI boundaries currently cut through buildings making identification difficult.

Response: All AOI boundaries do follow existing streets or natural landmarks except for the boundary between AOI 7 and AOI 8. The boundary between AOI 7 and AOI 8 was established to align with the northern edge of the former runway. The runway is an important landmark that appears in aerial photographs of TI through the early 1960s, and it facilitates efforts to locate some historic site features important to this analysis, specifically a former salvage yard discussed in Section 2.2.7 and a radioactive material disposal area discussed in Section 2.2.8. As such, the existing AOI boundaries will be retained as presented in the draft HRASTM.

11. Comment: There is no general discussion about release of radiological contaminants from the outfalls to the San Francisco Bay. Please explain potential storm drain and sanitary sewer contamination.

Response: Drainage systems and the potential for impacted sites to affect them have been discussed in this HRASTM. See the sub-category "Drainage Systems" under the "Potential Migration Pathways" category in HRA Section 8.3 and in HRASTM Section 6.1.1. The final HRASTM has been modified to designate the entire sanitary sewer line from Buildings 3 and 233 (the potential sources of contamination) to the outfall as contaminated. Storm sewer evaluation within impacted sites will be considered during development of radiological survey work plans.

12. Comment: HRA-STM needs to address the potential contamination migration via sanitary sewer and storm drains. For example, Building 233 sanitary sewer system extends beyond the boundaries of Building Site 233 and its terminus is as yet unknown.

Response: The HRASTM addresses drainage systems as discussed in CDPH EMB General Comment #11 above.

SPECIFIC COMMENTS

13. Comment: <u>Page ES-1, Executive Summary, paragraph four</u>, bulleted radiological impacted areas should have included the following:

- **Site 33 Sailboard pad and drain lines,**
- **Ash Incinerator, and**
- **Roads, storm drains and ditches adjacent to roads and wash down areas used in soil transport**

Response: All radiologically impacted areas will be included in the Executive Summary.

- Site 33 has not been designated as impacted as the weight of the evidence does not support such as designation (see DTSC Comment #7 for additional discussion regarding Site 33).
- The sailboard pad has been designated impacted in the HRASTM as suggested.
- Drain lines are considered in each impacted area as discussed in Section 6 of the HRASTM.
- The former incinerator has been designated impacted as well as the prevailing downwind areas on TI.
- The roads, storm drains, ditches and transfer areas in AOI 6 have all been impacted. AOI 6 is the area most likely to be impacted by contamination resulting from transportation of soil.

14. Comment: **<u>Page 9, Section 2.2.2, AOI 2: Former Hospital Area, second paragraph</u> "The Waterline Replacement Area, Site 33, (Figure 4) is currently undergoing additional investigation ... the work will be published in a Remedial Action Completion Report after the work is done". A final status survey report of Site 33 should also be provided.**

Response: The waterline replacement area, Site 33, is not designated as an impacted site. Characterization surveys have been completed for this site and did not identify any Ra-226, Cs-137, or Sr-90 contamination above the investigation levels. As this is not an impacted site, the Navy is considering regulatory comment.

15. Comment: **<u>Page 11, Section 2.2.2, AOI 2: Former Hospital Area, paragraph three</u>, states "AOI 2 was built out by the end of WWII and because it was already developed by that time, there is little likelihood for debris to be disposed of in the AOI during that period". What is DON's rationale for this statement? What are the soil subsurface conditions? Does DON still maintain that it stored the more than 200 drums of radiological waste originating from Building 233 (Final Treasure Island Naval Station Historical Radiological Assessment, Former Naval Station Treasure Island, San Francisco, California. February 2006, page 6-21, Section 6.6.1, paragraph two, sentence five) prior to being loaded aboard USS *Independence*? Please review to see if this statement still reflects DON assessment.**

Response: The Navy began leasing property on TI in 1941 and began constructing new buildings on the site. By early 1942, the Lake of the Nations had been filled in and construction of the hospital buildings was nearing completion. Disposal of debris in the AOI during that period was unlikely because the site had been developed when the Navy began leasing the property. The only area within AOI 2 where a small amount of debris was observed in the subsurface is at Site 33 and this area was filled in almost immediately following the transition to Navy ownership.

Based on a review of documents included in the HRA and new research conducted as part of the HRASTM, no new information has been found to conflict with the statement that the drums were stored until they were loaded onto the USS *Independence* for storage pending disposal. It is most likely that the drums used for decontamination of Building 233 were stored at the work site and near Building 233 until they were filled, and then they would have been shipped off site to Hunters Point Shipyard where radiological storage areas already existed that could accommodate the drums. The radiologically impacted area surrounding Building 233 has been expanded to include the outdoor paved area, which was the most likely temporary storage area for the drums during the decontamination of Building 233.

16. Comment: **<u>Page 16, Section 2.2.6, AOI6: Sewage Treatment Area, paragraph three</u>, states "After the HRA, and unrelated to the USS *Pandemonium* Site II, a removal action was completed in 2009 at Site 32 that included the footprint of the USS *Pandemonium* Site II". It further noted soil was removed to a depth of two to twelve feet; please include the fate and transport of removed soil. The USS *Pandemonium* itself was dismantled and shipped from site. Please include a radiological assessment of the vessel at time of disassembly as well as fate and transport of remains.**

The infrastructure to wash or remove radiological contamination at both sites needs further clarification. Radiological decontamination by washing or some other means indicates that the affected pipes, containers, ditches etc. are considered contaminated. Please expand the discussion about areas or buildings that are potentially contaminated during radiological training.

Response: Approximately 790 tons of Class 1 (hazardous) soil was excavated from Site 32 and taken to the Chemical Waste Management, Inc. facility in Kettleman City, California. Approximately 12,700 tons of Class 2 (nonhazardous) soil was excavated from Site 32 and disposed of at the Altamont Landfill in Livermore, California. Although no radiological screening of the material was conducted on-site, it is appropriate to note that hazardous waste that is shipped to landfills for disposal may include screening on arrival for radiological materials using radiological portal monitors. There is no record of any waste generated at TI being rejected at a landfill. Concrete and asphalt was broken up and recycled. No liquid waste (waste water) was generated during field activities; soil excavated from below the water table was dried before being transported offsite (Shaw 2011).

As noted in Section 4.1.3 of the HRASTM, "The USS *Pandemonium* was removed from the training site and sold for scrap metal prior to the HRA." The final destination of the scrap metal from the former USS *Pandemonium* is unknown. The Navy would simulate various radiation levels at various locations on the mockup by moving sealed Cs-137 sources within the ship and the students would use monitoring instruments to locate "radioactivity" during training exercises. In addition, decontamination training exercises were conducted that involved dispersing water containing a radioactive isotope with a half-life of approximately 10 days (such as Br-82) on the surface of the mock ship and the students would decontaminate the ship. The concrete holding tanks would collect the effluent water that ran off of the concrete pad until the radioactivity had decreased to safe levels, and then the water would be drained to the San Francisco Bay. The wash-down activities ceased in 1972, but training continued using sealed sources of Cs-137 at the mock ship until 1992.

The ship was stored on land, atop a 9-inch thick concrete pad occupying much of the site. While most of the training was conducted using sealed sources within shielded wells on the mockup ship, decontamination exercises were also conducted by washing down the surface of the ship with water that had radioactive isotopes with short half-lives (10 days). The wash-down water would have presumably drained to the concrete pad and then into the concrete holding tanks via piping or grading of the concrete surface. On a 1973 sanitary sewer system map, a 6-inch pipe is shown leading to the San Francisco Bay from the concrete holding tanks (see HRA reference TI-HRA-82). A figure included in the 2011 Final Site 32 field activity report (Shaw 2011) shows several utilities near the concrete pad, including a steam line, separate storm and sanitary sewer pipelines, a fresh water pipeline (hydrant), and two steel pipelines (2- and 3-inch diameters) of unknown use. During the removal action, the 3-inch steel pipe was discovered originating from the concrete sump and running parallel to the rip rap; the piping was removed and discarded and the openings were plugged (Shaw 2011). Following the removal action, the only remaining site features that could be potentially contaminated were soils deeper than 2 feet below ground surface (bgs) (soils were excavated down to 2 feet bgs in the entire removal action footprint, though some areas were excavated up to 12 feet), the two concrete holding tanks, interior areas within Building 462, and any remaining piping associated with the tanks. All other site features that may have been contaminated during training exercises have been removed. The Navy is planning a gamma walkover survey and sampling of soil and sediment at the former USS *Pandemonium* Site II (NE) area.

17. Comment: **<u>Page 18, Section 2.2.6, AOI 6: Sewage Treatment Area, paragraph one, sentence four</u>, please clarify the period of use, and potential trips per day for the "...end loader bucket..." used to transport potential radiologically contaminated soil from Site 12 to Site 6.**

Response: The field work plan for the NTCRA activities at the Site 12 SWDAs described appropriate procedures for storing and transporting soil that was excavated during the removal action. Section 4.6.4.5 of the NTCRA Work Plan (Shaw 2007b) states that "During excavation activities, waste soil will be either directly loaded on to local haul trucks for transportation to a waste soil/debris staging area or directly loaded into end-dumps for offsite transportation and disposal. Prior to leaving the exclusion zone, local haul trucks and/or end-dumps will be decontaminated and tarped."

Although the work plan called for tarped transport of soil from Site 12 to Site 6, transport of untarped soil within end loader buckets possibly occurred for a limited period of time. Since the use of this transport method clearly was not an approved method of transport, the Navy has committed to conducting a gamma walkover survey of the roadways between Sites 12 and 6 to ensure absence of radioactive contamination

along the roadsides that could have resulted from such transport practices. It is noted that a survey conducted by the contractor at the time did not disclose any evidence of a release of radioactive material associated with this transport method.

18. Comment: **<u>Page 18, Section 2.2.7, AOI 7: Northern Housing Area of Interest, first paragraph</u> states that a radiological survey performed in North Point and Bayside Areas in 2009 provide the data and insert those data and results in the HRA-STM, perhaps as an appendix. Gamma walkover surveys will not address the subsurface contamination or the debris underneath the building and soil beneath telephone poles.**

Response: The work is not complete, data collected to-date for the ongoing NTCRA has also been presented in the draft post construction summary report (Shaw 2012c).

19. Comment: **<u>Page 20, Section 2.2.7, AOI 7: Northern Housing Area of Interest, photograph 19</u>, this is a picture of the former incinerator, provide an assessment of the conceptual site model for the ash from the incinerator that includes standard meteorological data and wind−flow information. The seasonal plume areas need to be identified, especially adjacent to the incinerator. Please identify how the ash from the incinerator was transported and deposited on the island. Please provide maps or diagrams of ash distribution. Please detail the extent of burn pits to which the ash might have been transported, including the methodology on how those pits were bounded.**

The conceptual model should include historical background, nature and extent of the contaminant release, environmental media impacted, fate and transport of radionuclides of concern in the environment, potential receptors, exposure pathways and risk assessment In this description please include the high activity foils, the buildings and debris locations, the adjacent incinerator's plume impact on this site, demographics of ash and burn debris, radiological fall out, wind flow diagrams, sanitary sewer and industrial waste lines, the crawl space below the building and the area surrounding the building.

Response: Please note that the incinerator is located within SWDA 1231/1233 and is considered an impacted area. In addition, areas located downwind of the incinerator based on prevailing winds have been impacted in this HRASTM to account for the possibility of radiological materials having been incinerated. All available information regarding the designation of the former incinerator as an impacted area, including prevailing wind analysis, will be provided in the final HRASTM.

20. Comment: **<u>Page 30, Section 4.1.3, USS *Pandemonium* Site II (NE), paragraph two</u>, states, "…the contractor did periodic radiological scans on the hands and feet of personnel and on rubber tires of heavy equipment demobilizing from the site ... No elevated radiation was detected." Health and Safety scans for remediation staff do not qualify as a characterization scan for any site. Please eliminate this statement from the HRA-STM text.**

Response: The Navy concurs that the information does not preclude the need for future work plans detailing appropriate scoping, characterization, and an FSS for the site. The statement regarding health and safety screening has been eliminated as request.

21. Comment: **<u>Page 36, Section 4.3.4, Building 233, first paragraph</u>, the text fails to mention discovery of additional radiologically impacted terra cotta pipe.**

The Final Status Survey (FSS) must demonstrate a preponderance of evidence that there are no other impacted lines associated with Building 233. The remediation of a newly discovered impacted pipe, encountered while remediating a known impacted pipe, does not meet this standard.

Response: Comment noted. As discussed in the second paragraph of the referenced section, the characterization, remediation, and FSS for the Building 233 footprint, the sanitary and storm sewer system associated with the building and the surrounding area are ongoing. The summary of the response actions will appear in future documents.

22. Comment: **<u>Page 39, Section 5.2.1.4, Human Receptors and Exposure Pathways</u>, please include Building 233, Site 6, Site 32, as bulleted items.**

Response: A bullet for Building 233 will be added to Section 5.2.2.4, which is under the conceptual site model (CSM) for incidental releases in association with training/operations.

Information regarding Site 6 is included as the Waste and Clean Soil Stockpile/Loading and Decontamination Site in Section 5.2.3.4, which is under the CSM for spills/contamination resulting from handling of contaminated soils from Site 12 SWDAs.

Information regarding Site 32 is included as USS *Pandemonium* Site II (NE) in Section 5.2.2.4, which is under the CSM for incidental release in association with training operations.

23. Comment: **<u>Page 43, Section 6.1.1.1, Building 233, paragraph one</u> states "This HRASTM did not identify any changes from the previous findings of the HRA for this building and sanitary sewer system other than the plan to conduct an FSS for the Building footprint, the sanitary sewer system associated with the building and surrounding areas." This statement fails to identify the Building 233 parking lot and additional sanitary sewer pipes adjacent to Building 233 as items to be covered in a FSS. What additional sites or building drainage systems are impacted by the contaminated pipelines?**

Response: The impacted area associated with Building 233 now includes the Class 1 Survey area, which includes the building footprint and surrounding areas that will be subject to a FSS. Utilities and associated catch basins outside of this area will be investigated as a separate area. Building 233 field work performed to-date showing this Class 1 survey area will be documented in a PCSR (Shaw in-production)

RESPONSES TO ADDITIONAL CDPH EMB COMMENTS (DATED DECEMBER 11, 2012) ON THE NAVY'S RESPONSES TO COMMENTS

GENERAL COMMENTS

1. Comment: **EMB requests that the *Draft Historical Radiological Assessment - Supplemental Technical Memorandum (DHRA-STM)* and/or a modified version of the HRA (2006) include a complete listing and investigational information, and times and locations of shipment of all commodities or fragments of commodities or items found to date on Treasure Island. These items have been referred to in documents such as the Site 12 Trench Report of 2004 and *Draft Post Construction Summary Report Installation Restoration Site 12 Solid Waste Disposal Areas 1207/1209 and 1231/1233, September 2012.* Other than Site 12 and Building Site 233, where else have remediation activities or other activities located radionuclides?**

Response: The text will be updated to include a listing of commodities as requested. As indicated in the draft responses to comments provided to CDPH EMB, the HRASTM text will be updated as information becomes available from ongoing investigations to summarize any new information resulting from ongoing investigations. Other than Site 12 and Building 233, radionuclides have only been detected at Site 31, which was discussed in the text of the draft HRASTM.

2. Comment: **Please provide a history of past soil movement during remediation activities, non-remediation activities, and storage of soil for future use or disposal on or off the TI. Include a parallel accounting of all radiological activities on Yerba Buena Island and Treasure Island.**

Response: Navy will consider past soil movement from radiologically impacted areas in future work plans for surveys of radiologically impacted sites. Yerba Buena Island (YBI) is not addressed in the HRASTM because no radiologically impacted sites have been identified on YBI (Weston 2006). CDPH EMB concurred in a December 23, 2011 memorandum that no further involvement by CDPH is required for YBI because of the lack of radionuclide impacts to YBI and the fact that control procedures were in place to properly contain radiologically contaminated soil and debris transported via trucks over YBI (CDPH EMB 2011).

3. Comment: Provide EMB with a copy of all available surface and subsurface drawings, maps, and blueprints that identify current and past locations and routes of sewer and storm lines, drains, manholes, catchments, and outfalls.

Response: The requested documents will be provided separately to CDPH EMB as requested.

4. Comment: Specify all locations of potentially contaminated surfaces or routes that have been contaminated with radionuclides and insert those findings in the HRA.

Response: All potential radiologically contaminated areas and routes have been identified in the HRASTM as radiologically impacted areas and the findings for these areas are discussed in the HRASTM. Truck routes outside of Sites 12 and 6 are not classified as radiologically impacted because known transport of contaminated materials over roadways in these other areas was conducted utilizing control procedures designed to properly contain contaminated soil and debris being transported by trucks.

5. Comment: The current conceptual site model, pages 37 to 42 of the HRA-STM needs to be revised based on the November 29, 2012 Coordination Meeting that outlined recent DON accommodation of additional sites on TI that are now considered impacted with radionuclides.

Response: The CSMs will be adjusted to account for discussion during a November 29, 2012 meeting between the Navy, DTSC, and CDPH EMB. Specifically, the CSMs will be revised to include the potential for radiological impacts from air emissions from the former incinerator, the former gyro compass shop, and the potential for releases into or from sewers (both sanitary and storm).

SPECIFIC COMMENTS RELATED TO NAVY'S RESPONSES TO DTSC COMMENTS

6. Comment: <u>DTSC Comment 8, Page 3 of 20 in responses</u>: The work plan for Site 31 indicates that a FSSR will be done for Site 31. The response to this comment indicates that work will be documented in a site specific Remedial Action Completion Report (RACR). The Navy has

committed to providing a FSSR in their work plan. Is the response saying that the FSSR will be submitted as part of the RACR? Based on a December 7, 2012 Coordination Meeting, the DON indicated that a FSSR will be supplied either through a RACR or a stand-alone FSSR.

Response: It is the Navy's intent to publish the FSS for Site 31 as a stand-alone document that is independent of the Site 31 RACR.

7. Comment: **<u>DTSC Comment 9.2, Item 2 and 4 on Page 5 of 20 in responses</u>: The responses indicate that this HRA-STM expands the footprint perimeters of the existing SWDA's by 50 feet. The HRA-STM needs to explain the basis for this adjustment, and identify information leading to selection of a 50-foot value for the expansion of the footprint for the SWDAs.**

Response: The HRASTM will include an explanation of the basis for this adjustment and identify information that was used to select the 50-foot value.

8. Comment: **<u>DTSC Comment 9.2, Item 3 on Page 5 of 20 in responses</u>: The revised last sentence of paragraph 5 in Section 2.2.7, which was revised to read in part, "...potential for the presence for radioactive materials in AOI-7 outside of the SWDAs is minimized because..." Please state the DON's basis for this conclusion.**

Response: The basis for the Navy's conclusion is stated in the six bullets that are presented in the draft HRASTM at the end of Section 2.2.7. These bullets remain valid evidence for mitigating the potential for radioactive materials outside of the SWDAs.

9. Comment: **<u>DTSC Comment 9.2, Item 5, Section 4.1.1, Radiologically Impacted Sites Identified on the HRA, on Page 5 of 20 in the responses</u>: An examination of the Draft Remedial Investigation Report for Installation Restoration Site 12, Old Bunker Area, Naval Station Treasure Island, San Francisco, June 2011, Figure 1-3, Historical Site Features, photograph dated 1968 shows a section labeled, "Historical Burn Area", which is congruent with Soil Area of Interest 1201/1203/1220. Historically, burn pits have been associated with elevated Ra^{226} levels; and EMB's conceptual site model for TI indicates the soil for Area of Interest 1201/1203/1220 should be considered potentially impacted. Please include a description of the burn areas and an explanation about the conceptual site model.**

Response: Section 2.2.7, which already discusses the burn pits, will be expanded to provide additional information including their locations. In addition, the CSM for Solid Waste Disposal Operations will be modified to include the burn pits. The Navy will consider impacting the portion of Site 12 RI Area of Interest 1201/1203/1220 associated with the "Historical Burn Area."

10. Comment: **<u>DTSC Comment 9.2, Item 5, Section 4.1.1.1, Building 233, on Page 6 of 20 in the responses</u>: Reference labeled as Shaw 2012d needs to be added to the references in the HRA-STM.**

Response: The reference list will be updated in the final HRASTM. The referenced document is the forthcoming Building 233 FSS.

11. Comment: **<u>DTSC Comment 9.2, Item 5, Section 4.1.1.5, SWDA A&B, Page 7 of 20 in the responses</u>: The response states that "… low level radiological items containing Ra-226 were found in all of the SWDAs." The term "low level radiological items" is misleading to many people, and that terms needs to be replaced with a specific range of the activities of items found. While the items found are not high level radioactive waste as defined by the Nuclear Regulatory Commission (NRC), the levels found in these areas are elevated.**

Response: The term "low level" has been eliminated and the second sentence of Section 4.1.1.3 has been revised as follows: "*During the NTCRA, radiological items ranging in Ra-226 content from 0.4 to 6,400 µCi were found in all of the SWDAs."*

12. Comment: **<u>DTSC Comment 9.2, Item Section 4.1.2, Radiologically Impacted Sites Identified in this HRA-STM as described on Page 7 of 20 in the responses</u>: It appears that the HRA-STM needs to address sanitary sewer and storm drainages from, or passing in the vicinity of, potentially impacted areas; potentially impacted buildings and any related structures. These sanitary sewer and storm drainage systems should be designated as potentially impacted in the HRA-STM including their outfalls.**

Response: The final HRASTM has been modified to designate the entire sanitary sewer line from Buildings 3 and 233 (the potential source of contamination) to the outfall as contaminated. Please note that drainage systems and the potential for radiologically impacted sites to affect those systems have been discussed in the draft HRASTM for all impacted sites. See the sub-category "Drainage Systems" under the "Potential Migration Pathways" category in Section 8.3 of the 2006 final HRA and in Section 6.1.1 of the draft HRASTM. Sections of the Building 233 sewer systems have been found to be contaminated with Ra-226. The sewer lines associated with Building 233 remain under investigation and the extent of the contamination has not been fully determined. Characterization of the sanitary system associated with the Building 3 optical repair shop will also occur as a separate project. Storm sewer evaluation within impacted sites will be considered during development of radiological survey work plans.

13. Comment: Please include areas now classified as potentially impacted due to their location relative to collection and disposal of ash directly from the incinerator, and due to the incinerator's discharge plume of smoke and ash potentially contaminated with radionuclides.

Response: The former incinerator was located within SWDA 1231/1233, which is considered an impacted area. The CSMs and potentially impacted areas will be adjusted to include the potential for radiological impacts from air emissions from the former incinerator, as well as potential impacts associated with ash disposal. (Note that no records have been located that provides any details on ash disposal from the former incinerator). All available information regarding the incinerator will be provided in the final HRASTM.

14. Comment: <u>DTSC Comment 10, on Page 8 of 20 in the responses</u>: This indicates that text of the HRA-STM has been modified to address Building 342 and the area between Buildings 342, 343, and 344. However, the response fails to indicate that the HRA-STM has been modified to address the Building 343 and 344 sanitary sewer line.

Response: Buildings 342 and 343 are serviced by sanitary sewer lines. No sanitary sewer line services Building 344. The sanitary sewer line servicing Building 342 will be designated as impacted in the final HRASTM. A FSS was conducted for Building 343 in 2008; no contamination was found and the building was provided unrestricted release by the DTSC per a memorandum from CDPH to DTSC.

SPECIFIC COMMENTS RELATED TO NAVY'S RESPONSES TO CDPH GENERAL COMMENTS

15. Comment: <u>CDPH Comment 2, page10 of 20 in the responses</u>: This response appears to indicate that the Navy has no idea where the larger level Ra-226 sources came from or where these sources could be found on Treasure Island.

Response: The prior CDPH comment focused, in part, on the potential use of radiological items on Treasure Island prior to the Navy's ownership. The Navy's response was intended to convey that the Navy has searched for and found no records of the use of radiological items prior to Navy ownership. While this does not preclude the presence of radioluminescent materials on common items such as watches or on instruments associated with the Pan Am Clippers, or the GGIE, no specific evidence has been found regarding the use or disposal of these items at TI.

The Navy does not, as indicated in the comment, know what the larger level Ra-226 sources (radium foils) were used for, or where they were used; however, the extent of the disposal locations (SWDAs) are known with a high degree of certainty and the areas containing those disposal locations has been designated as radiologically impacted. The Navy will

continue to investigate the use of the foils after the publication of the HRASTM.

16. Comment: **<u>CDPH Comment #1</u> indicates that there is no record indicating that the sources found on Treasure Island came from the Golden Gate International Exposition. Some of the sources found so far exceed levels of Ra-226 known to have been used in instruments, or as deck or bridge markers. Based on the responses to CDPH Comments 1 and 2, it appears the DON has no current information regarding the activities that could have utilized these sources and why the highest level Ra-226 sources were disposed on Treasure Island or existing location of contamination. Therefore, the basis for designation of areas impacted by these sources is knowledge of where they have been found to date. So the current conceptual model for the largest Ra-226 sources found is that their location of use and use is unknown, consequently, it is unknown where they could be disposed. Based on available information, all but one of these sources has been found within the SWDAs. Other than where they have been found to date, there is no basis to prematurely eliminate other locations on Treasure Island.**

Response: Comment noted. The HRASTM conservatively impacts the locations where both licensed and unlicensed activities could have taken place, regardless of any actual documentation specifically indicating so. In the absence of specific documentation, conceptual site models have been developed to support impacting a site.

17. Comment: **The numerous sources that came from the Building 1321 "hot spot" have apparently not been characterized and that characterization information might provide additional information useful for the site conceptual model. Please provide an estimate of the date when that information would be available.**

Response: No specific information regarding commodities found at the Building 1321 "hotspot" is available. The soil associated with the "hotspot" under the steel plate (a subarea of SWDA A) that was excavated in June 2011 was placed commingled (soil and any commodities present) into B-25 boxes. The material will be disposed of in upcoming field work activities during 2013.

18 Comment: **<u>CDPH Comment 3, on page 11 of 20, in responses</u>: The soil samples collected in 2003 from the trenching work have been disposed. As noted previously, CDPH considers any areas with debris or discoloration to be potentially impacted. The previous trenching activity in Site 12 recorded areas with observed debris or discoloration. Therefore, those areas should be identified as potentially impacted in the HRA-STM.**

Response: Although the Navy does not agree with the statement that any areas with debris or discoloration as discussed in the trenching work should be considered impacted for that reason alone, the Navy will conduct further radiological surveys within IR Site 12.

19. Comment: **<u>CDPH Comment 4, on page 11 of 20:</u>**

Bullet 2: This indicates outfalls have not been designated as impacted if ongoing investigations warrant such designation. Given that the sanitary sewer lines and storm drains from Building 233 have both been identified as impacted, an investigation of outfalls is warranted. Please include outfalls as potentially impacted.

Bullet 5: Please amend this bullet to include storm drains.

Bullet 6: The incinerator plume footprint should be shown in the HRA-STM as potentially impacted.

Response: Bullet 2: The entire upland section of the sanitary sewer lines from Building 3 (the most upstream potential contamination source) to the waterfront has been identified as impacted. As indicated in the prior response, outfalls to San Francisco Bay have not been designated as impacted; however, the outfalls will be designated impacted if ongoing investigations of sewer lines yield data that warrant such designation.

Bullet 5: As noted in the original CDPH EMB Comment #4 and its reference to "excavation of sewage drainage system," it is presumed that this additional CDPH EMB comment requests that the draft HRASTM be modified to include current radiological information for the ongoing investigation of storm drain lines at Building 233. Thus, the text of the final HRASTM will be updated to summarize the investigation and remedial actions completed at Building 233 to-date.

Bullet 6: Areas on TI within the incinerator plume footprint and the Building 461 area that is downwind of the former incinerator will be shown as radiologically impacted.

20a. Comment: **<u>CDPH Comment 5, on page 12 of 20 in responses</u>: This statement is misleading. While Site 12 was subject to extensive subsurface soil characterization as reported in Shaw 2004, the characterization was for Chemicals of Concern. Only a few samples were analyzed for radionuclides. Please amend the response to indicate the number of radiological samples taken and the utility of those samples.**

Response: The Navy agrees that the primary purpose of the Site 12 trenching investigation was for subsurface characterization and to identify areas of debris disposal, staining, and for chemicals of concern that did not include radioisotopes (except for three soil samples that were analyzed for radioisotopes at a laboratory). The trenching investigation consisted of

587 trenches approximately 2 feet wide by 5 feet long and excavated to 4 feet bgs. Removed soils and the trench walls were logged and scanned with sodium iodide detectors for gamma radiation. A total of 2,244 radiation readings were recorded and of these, only three exceeded the health and safety action levels. While this work was not conducted to the standards recommended by MARSSIM, it does provide valuable information about the potential for debris disposal within Site 12 and the relative lack of higher reading commodities within the trenched areas.

20b. Comment: **<u>CDPH Comment 5, on page 12 of 20 in responses</u>: Please list in table form the sites where debris, odor or soil discoloration was observed and add them as potentially impacted.**

Response: As indicated in the Navy's response to additional CDPH EMB Comment #20a above, detailed results and a tabular presentation of the trench log observations were previously published (Shaw 2004) and is included as a reference in Appendix A of the HRASTM.

20c. Comment: **<u>CDPH Comment 5, on page 12 of 20 in responses</u>: Figure 2 does not appear to identify those SWDA's that have been identified as radiologically impacted in the legend, nor does it show the 50-foot step-out from the existing SWDA footprint perimeters.**

Response: The 50-foot step-out boundary from the existing SWDA boundaries will be included on the figures.

21. Comment: **<u>CDPH Comment 11, on page 14 of 20 in responses</u>: This indicates that the Building 233 sewer line contamination is not expected to extend beyond the gravity portion of the sewer systems. Please explain the basis for this statement.**

Response: The HRASTM will be revised to show the entire downstream portion of the sanitary sewer line from Building 233 as radiologically impacted; therefore, the statement subject to this comment will be removed.

SPECIFIC COMMENTS RELATED TO NAVY'S RESPONSES TO CDPH SPECIFIC COMMENTS

22. Comment: **<u>CDPH Comment 15, on page 16 of 20 responses</u>: Please refine the time period and potential locations of temporary storage areas for the 200 drums of radiological waste originating from Building 233. The DON states that all drums were eventually loaded on the USS Independence for disposal.**

Response: There is no record of the temporary storage area(s) for the waste drums associated with the Building 233 spill cleanup. It is presumed that for practical reasons these drums were stored near Building 233 prior to being shipped to the USS *Independence* at Hunters Point Shipyard. The Navy

notes that, according to the HRA, the shipment of the drums to the USS *Independence* was for storage and not for disposal.

23. Comment: **<u>CDPH Comment 16, on page 16 of 20 in responses</u>: Will additional information about waste disposal from USS Pandemonium Site 2 be included in the HRA-STM? If this site is now considered potentially impacted, what actions are needed for the waste previously shipped to Altamont and Buttonwillow?**

Response: The additional information provided in the Navy's response to original CDPH EMB Comment #16 will be summarized in the final HRASTM. While the USS *Pandemonium* Site II has now been designated as radiologically impacted, the Navy notes this is a conservative designation and no evidence of actual contamination at the site exists. No action is planned regarding previous waste shipments unless results of the future investigation indicate that actual contamination existed on the site.

23b. Comment: **Note that based on the original HRA, the description of uses of Cs-137 need to be further developed so it is clear that only Cs-137 sealed sources were used, if that is indeed the case.**

Response: It is presumed that this comment refers to the USS *Pandemonium* Site II (NE). It is not the case that only Cs-137 sealed sources were used at USS *Pandemonium* Site II, as detailed in both the HRA and the HRASTM. Bagged radioluminescent gauges were used as check sources as discussed in Section 2.2.6 of the draft HRASTM. The knowledge that these types of items were used during training exercises contributed to the Navy's decision to consider the site radiologically impacted.

RESPONSES TO SF PUC COMMENTS (GEORGE BIBBINS)

GENERAL COMMENTS

1. Comment: **Document is for TI only; what is YBI status?**

Response: The CDPH EMB has concurred that areas of YBI subject to future transfer are not contaminated. (CDPH EMB 2011). Therefore, this HRASTM does not evaluate YBI. The last sentence in Section 2.1 has been replaced with the following sentence to clarify the status of YBI: "CDPH has concurred that areas on YBI subject to future property transfers are not contaminated and are therefore have not been evaluated in the HRASTM."

SPECIFIC COMMENTS

1. Comment: **<u>Figure 2</u>: Newly Identified Radiologically Impacted Areas (Map)**

- **Building 233 not colored green although sounds "previously impacted" (Section 2.2.2 and 4.3.4); maybe because already demolished, however some activities are ongoing.**

- **Site 12 SWDAs not shown as "impacted", although radiation remediation and monitoring is ongoing (Section 2.2.7 and 4.3.6).**
- **Radiological item found in AOI 7, but outside of SWDA (Sections 2.2.7, 5.2.1.3 and 4, 6.1.1.3, Figures 11 and 12). Future scans planned; precaution/warning needed for SFPUC subsurface work. Not noted on map or document; "impacted" designation appears applicable.**

Response: Areas previously identified as radiologically impacted (i.e. Building 233 and the SWDAs) were added to the figures in this HRASTM as further discussed in response to DTSC Specific Comment #9.1.

Site 12 will be subject to area specific scoping surveys as well as further general investigation to determine potential for radiological contamination outside of discrete areas. Due to the current status of Site 12 as a site still under evaluation as well as the presence of other impacted sites on TI, radiological controls are required for any intrusive work in these areas. Figure 2 will note that all areas not formally designated as impacted are considered non-impacted.

2. Comment: **<u>Sections 6.1.2.4 and 6.1.2.5</u>: What is basis for listing contamination potential as unlikely; is potential there because areas may have buried salvage materials (6.1.2.4) or site 12 SWDA soil (6.1.2.5).**

Response: The assessments provided in these sections are qualitative judgments prepared in conformance with Sections 7.3 and 7.4 of the HRA. For clarity, Section 6.1 of the HRASTM has been expanded to include a new sentence that reads: "The findings and recommendations presented in this section have been developed in conformance with Sections 7.3 and 7.4 of the HRA, which provides background and guidance on assessing media, migration pathways and recommendations (Weston 2006)."

The former Salvage Yard has been designated with a contamination potential of "unlikely" in Section 6.1.2.4 because of absence of direct evidence that radiological items or other debris was buried, and because extensive excavation would have occurred in association with construction of the sewage treatment plant.

The Waste and Clean Soil Stockpile/Loading and Decontamination Site has been designated with a contamination potential of "unlikely" in Section 6.1.2.5 because (1) the source of contamination would have been IDW from recent removal activities, (2) no direct evidence indicates that radiological items or other debris was buried in the subsurface, and (3) all work has been conducted with procedures in place and with awareness that radiological materials were being handled.

RESPONSES TO TIDA (AMEC) COMMENTS (SCOTT WARNER)

GENERAL COMMENTS

1. Comment: We believe that the introduction to the document (starting in Section 1.0) should be strengthened to better indicate the rationale for commencing with the research that lead to the HRASTM. We also request that the introduction be strengthened to better indicate how the conclusions reached by the HRASTM integrate with those reached by the 2006 HRA. Please clarify what parts of the 2006 HRA are now obsolete, and which parts are specifically supplemented by the HRASTM. Please provide an overall "roadmap" showing the integration of the information, if appropriate.

Response: The text of Section 1.1 has been replaced with the following text to address this comment:

> *"The HRASTM format and content are designed to augment the original HRA with new information obtained through additional research and the review and consideration of new data that became available through site investigations since the HRA was finalized. The new information was also used to update CSMs for radiologically impacted areas and to update the list of areas designated as impacted. The updated CSMs, historical research, and a review of activities that occurred at TI since the original HRA was published are presented in this HRASTM. Figure 2 presents all of the areas which are considered radiologically impacted and non-impacted on TI based on the results of the 2006 HRA and this HRASTM. Details regarding specific CERCLA investigations or remedial efforts after issuance of this HRASTM will be documented in project specific reports or additional technical memoranda."*

2. Comment: We also request that the definition of "impacted" and "non-impacted" sites be provided in the opening paragraph of the document. Please consider both the technical and non-technical reader in providing this definition.

Response: The following new paragraph has been added to the end of the Executive Summary and as a new second paragraph in Section 1.1.

> *"A radiologically impacted site is one that has, or at one time had, the potential for radioactive contamination, based on historical information, in excess of natural background or fallout levels. The designation as radiologically impacted does not confirm that radioactive contamination is present; only that the possibility exists and must be investigated. A non-impacted site is one not classified as impacted and with no possibility of containing residual radioactivity in excess of natural background or fallout levels.*

3. Comment: **It appears that key drivers to the reasoning for preparing the HRASTM do not appear until late in the document. For example, Section 5.2 refers to preparing Conceptual Site Models (CSM) as a major advantage of this HRASTM. We believe this to be important and this objective should be presented early in the introduction to the document. Another important item that should be presented much earlier is the information in Section 2.3 on the summary of the 2006 HRA (which currently appears on Page 26 of the HRASTM).**

Response: See new text inserted in accordance with response to TIDA (AMEC) General Comment #1

4. Comment: **While a full listing of references is provided in the accompanying Compact Disc (CD) of information, could a table be provided that better indicates what documents in the Reference CD was used to support the various bullets of information provided on Pages 1 and 2 of Section 1.2.**

Response: Citations to the references that support the findings have been added to Section 1.2. Please note that not all findings are supported by such references. Some findings are based on maps or figures included in the text or the results of ongoing activities as described in the text.

5. Comment: **Please define, or consider, replacing the word "significant" within the document, unless this term is being used for specific quantification of a value (such as "statistically significant"). For example, what does "significant" ship repair refer to (in Section 1.2, Page 2) compared to what "insignificant" ship repair activities might refer to.**

Response: In general, the term "significant" has either been replaced with the word "major" or the term has been deleted. The word "significant" has been retained at a few locations where appropriate.

6. Comment: **The final section of the HRASTM (6.2) indicates that all areas subject to the prior HRA and this HRASTM are suitable for transfer with respect to impacts on human health and the environment. However, the HRASTM indicates substantial differences from the HRA, and questions remain regarding the potential for discrete sources or localized contamination, unknown piping, former facilities that could have been impacted where deconstruction material may have found its way to other parts of TI. We suggest that this section provide an area by area summary table to better evaluate the potential issues, including uncertainties that will affect the transferability of areas on the island.**

Response: As stated in the existing text, all areas of NAVSTA TI subject to the prior HRA and this HRASTM are suitable for transfer with respect to potential impacts on human health and the environment from exposure to radiological contamination, provided they have not been designated as radiologically impacted in either of these documents. The designations—developed based on a very conservative evaluation of TI—include areas where the hypothetical discrete source would most likely be present. Although the significant contamination is typically sought during any environmental investigation, the HRASTM conservatively has considered even where de minimus concentrations of radionuclides would most likely be present. This includes select lengths of sewer systems.

The text of Section 6.2 has been revised to add a new second paragraph as follows in response to this comment: "No further action is necessary to address the potential for radiological contamination at areas within TI that are subject to this HRASTM, and are not designated radiologically impacted as shown in Figure 2. In areas that are not impacted, no evidence has been found to warrant further investigation of those areas." Similar language has also been added to the front of the document, at the end of the Executive Summary.

RESPONSES TO TIDA (NGTS) COMMENTS (BOB BURNS)

GENERAL COMMENTS

1. Comment: Please clarify how the STM is to be reconciled/integrated with the original HRA or how the two documents are going to be applied to provide consistent guidance for performing radiological investigations on TI. Be as explicit as possible regarding parts of the HRA that may be obsolete, and those parts/conclusions where the STM is more of a compliment or supplement to the HRA.

Response: Although the HRASTM is intended to supplement the 2006 HRA, the HRASTM was developed so that it is a stand-alone document that can be referenced for an accurate radiological status of sites at the time of publication. Although the primary purpose of the HRASTM was to evaluate areas not impacted in the 2006 document, the HRASTM does provide extra detail regarding sites discussed in the prior HRA. Section 6.0 of the HRASTM does discuss the conclusions of the original HRA that have been modified as a result of new information and research during development of the HRASTM. Section 6.0 also presents conclusions regarding new sites identified as impacted in this HRASTM.

2. Comment: The definition of radiologically impacted and the other information provided in Section 2.3 should be moved to or otherwise restated in the introductory sections of the STM. The conclusion that no imminent threat or substantial risk to human or environmental health

was identified should receive particular emphasis. We request that the definitions of "impacted" and "non-impacted" be introduced at the very start of the document and repeated in practical locations thereafter.

Response: See response to TIDA (AMEC) General Comments #1 and #2.

3. Comment: As discussed under Section 3.2 and elsewhere, there is a potential for anomalous or otherwise unknown discrete sources or associated, localized contamination to be discovered at TI in areas outside the currently known SWDAs. This should be addressed in the Executive Summary, the Conceptual Site Model (Section 5), and the Findings and Recommendations (Section 6).

Response: The following language has been added to the end of the second paragraph of Section 1.1 in response to this comment:

> "*Additional radiological investigation will be conducted within Site 12, in addition to specific impacted areas (i.e. SWDAs) within Site 12."*

See the response to TIDA (AMEC) General Comment #6 for changes made to Section 6.2.

SPECIFIC COMMENTS

1. Comment: <u>Section 1.1</u>: Please acknowledge and summarize some of the concerns with the original HRA expressed by CDPH in April 2011. Presently no information is provided as to what prompted the STM to be developed.

Response: As requested, additional text has been added to summarize CDPH concerns that led to the development of the HRASTM. The second and third sentences have been rewritten as follows in response to this comment: "The format and content are designed to be responsive to concerns expressed by the CDPH and to augment the original HRA with new information obtained through additional research and the review and consideration of new data that became available through site investigations since the HRA was finalized. The new information was used to update CSMs for radiologically impacted areas as was requested by the CDPH and to update the list of areas designated as impacted."

2. Comment: <u>Section 1.3</u>: Is there a word missing in the first sentence of this section?

Response: The first sentence has been revised to insert the word "presented" in the following sentence: "A detailed review of the facility background was done using the information acquired through the file research and is *presented* in Section 2.0."

3. Comment: **<u>Page 10</u>: Photos 6 and 7 appear to have inconsistent orientation. Please correct or clarify if so.**

Response: Photo 7 has been rotated 90 degrees counterclockwise to provide consistent orientation as requested.

4. Comment: **<u>Section 2.2.2, first paragraph at the top of page 11</u>: Elaborate on the findings from the radiological investigations at the Building 233 site with respect to the discovery of undocumented piping and the fact the (known) sewer line and the surrounding soil were found to be contaminated. Undocumented utility lines or inaccurate location information should be considered in work planning.**

Response: At time of publication, remediation is essentially complete within the Class 1 survey area at Building 233. This field work will be documented in a PCSR (Shaw in production). Additional field work will be performed in 2013 to conduct the FSS to support free release of the Building 233 Class 1 area. The Navy concurs that undocumented utility lines or inaccurate location information should be considered in work planning. Characterization of all sewer lines within the Building 233 footprint is part of the ongoing fieldwork for that site, which is essentially complete. Evaluation of sewer lines outside of the Class 1 survey area for the Building 233 footprint will be addressed in subsequent investigations.

5. Comment: **<u>Section 2.2.6, bottom of page 16</u>: What was the fate of the soil removed from Site 32 to remediate chemical contamination? Are additional actions warranted for that material now that that area has been deemed radiologically impacted?**

Response: Please see the response to CDPH EMB Specific Comment #16.

6. Comment: **<u>Section 2.2.6 re: the further investigations related to the elevated gross gamma measurements discussed on page 18</u>: How will the findings from these additional investigations be incorporated in the HRA/STM once they are completed?**

Response: The sites identified as radiologically impacted in the 2006 HRA, as well as in this HRASTM, are considered to be the entire set of radiologically impacted sites on NAVSTA TI. Findings from future investigation/site characterization will be documented in follow-on documents such as completion reports, and survey reports or additional technical memoranda

7. Comment: **<u>Section 2.2.7</u>: While the results from the gamma walkover surveys performed outside the SWDAs in Site 12 are a good indication there is no widespread radiological contamination, caution should be applied in how those results are interpreted with respect to discrete**

commodities given that one has already been found. It may be an overreach to say the potential for radioactive material outside the SWDAs is minimized.

Response: Comment noted. In order to supplement the CSMs and characterization performed to-date that have identified the discrete impacted areas within Site 12, further radiological surveys will be performed within Site 12 in addition to surveys of specifically identified impacted areas.

8. Comment: <u>Section 2.2.7, page 22, second bullet</u>: What was the fate of the soil excavated from the Halyburton and Bigelow Court areas in Site 12?

Response: All soil excavated as part of the removal action was disposed of off-site at appropriate landfills per the State reviewed (Cal/EPA) work plan.

9. Comment: <u>Section 2.2.7, page 24, first bullet</u>: Elaborate on the source of the elevated dose rate readings that prompted expansion of the RCA.

Response: The CDPH reported Ra-226 as the source of the elevated radiation readings (CDPH RHB 2011). Further information regarding the source of the elevated readings that prompted expansion of the radiologically controlled area (RCA) has yet to be determined. The sources of elevated readings will be addressed as part of the Phase II NTCRA work at the SWDA A&B. The Navy presumes that the sources of the elevated readings will be additional commodities or contamination similar to that already found within SWDA A&B or related to asphaltic debris. Such commodities have included deck markers, buttons, metal debris, and foils.

10. Comment: <u>Section 4.0</u>: What is meant by work done "outside" the impacted and non-impacted areas? Shouldn't all areas be one or the other?

Response: All areas are designated as either impacted or non- impacted. Figure 2 shows the classification of property on Treasure Island. A "radiologically impacted site" has, or had at one time, the potential for radioactive contamination above natural background or fallout levels based on historical information. Conversely, a site designated as "non-impacted" has hosted radiological operations but currently poses no reasonable possibility for the presence of radioactive contamination.

11. Comment: <u>Section 4.1</u>: Augment the title to make it clear only the newly-identified radiologically impacted sites are addressed.

Response: Subsequent to the publication of the draft HRASTM pursuant to the response to DTSC Specific Comment #9.2, this section has been rewritten. The section now addresses all radiologically impacted sites and the initial text reads as follows: "This section addresses work done at sites designated as radiologically impacted. This includes sites designated as

radiologically impacted at the time of the HRA, and sites that have been designated as radiologically impacted as part of the HRASTM evaluation efforts."

12. Comment: **<u>Section 4.2 et seq.</u>: The STM cites the fact that no "intrusive IRP work" has been done at a number of sites since the original HRA as a basis for deeming those areas as non-impacted rather than a re-evaluation of those areas vis-à-vis the new information and additional degree of conservatism applied in the STM. This results in an inconsistency with respect to the former pier areas, for instance, where the finding that significant ship repair activities took place on TI would call into question the non-impacted designation given these areas in the HRA. It is recognized those pier areas are long gone, but the associated shoreline areas could still be considered radiologically impacted. There could also be questions about the fate of the materials from the pier demolition actions. The STM should be clear that the non-impacted designations given in Section 4.2 et seq. are based on the original HRA and do not represent a reevaluation of those areas.**

Response: The non-impacted areas were reevaluated as part of the HRASTM and no new evidence has been found to suggest that the shoreline areas should be considered radiologically impacted. Please note that, contrary to the citation in the comment, this section neither implies nor states that "the fact that no 'intrusive IRP work' has been done at a number of sites since the original HRA as a basis for deeming those areas as non-impacted…"

13. Comment: **<u>Section 4.3.2</u>: Recommend including a statement about any public health risk (or lack thereof) associated with the Site 12 recreational area.**

Response: The CDPH has separately requested that the Navy designate the Site 12 recreation area as radiologically impacted (CDPH 2012a). As a result of the recommendation and further evaluation of historical data and references, a portion of the recreation area will be classified as impacted. The subject text in Section 4.3.2 was deleted and moved to Section 4.1, which discusses impacted sites. Section 4.1.10 now reads as follows: "In July 2011, the CDPH RHB performed surveys (CDPH RHB 2011b) of the 9th Street recreational area on NAVSTA TI (see Figure 10). Based on the elevated readings that were noted during the survey, the CDPH RHB recommended the recreational area be designated as radiologically impacted. On March 22, 2012, the CDPH modified their recommendations for this area to provide the conclusion that they did not believe that that there is an external radiation exposure hazard from the recreational area elevated readings and to include characterization to identify the isotopes present and additional actions if found necessary (CDPH 2012a). The CDPH recommended the recreational area not be used as a basis for site

wide background radiation levels due to elevated radiation readings (CDPH 2012a). Subsequent investigation by the Navy included additional soil sampling and the results are suggestive of background naturally occurring isotopes. Based on recent analysis of existing characterization data, additional samples and analysis is required to definitively state whether the detected isotopes are naturally occurring. This sampling is anticipated in conjunction with future survey work plans that will be required because a portion of the area has been designated as impacted in conformance with the CDPH RHB recommendation."

Changes have also been made to the Executive Summary and Sections 2.2.8 and 6.1.2.10 to designate the recreation field as a radiologically impacted site.

14. Comment: **Section 4.3.4: Same comment as for Section 2.2.2 with respect to the additional utility lines discovered at the Building 233 site.**

Response: Please see response to TIDA (NGTS) Specific Comment #4.

15. Comment: **Section 5.0: None of the CSMs appear to address anomalous discrete commodities such as those identified in Site 31 and elsewhere. Given this was one of the drivers for creating the STM in the first place the CSMs ought to address the potential for such sources/types of contaminants.**

Response: Please see response to TIDA (NGTS) General Comment #3.

16. Comment: **Section 5.0: The CSMs focus on specific buildings and areas rather than types of activities. As with any historical site assessment, the STM/HRA should serve as a general guidance document for all radiological investigations at TI.**

Response: The CSMs included in this HRASTM were developed to more fully recognize and conform to the known releases on TI. For instance, the CSM for Repair/Solid Waste Disposal Operations addresses the possibility of disposal of radioactive commodities and contamination resulting from repair/recycling activities in general, but also takes into account some site-specific information such as known disturbances by grading activities during construction of housing within the SWDAs in Site 12. Previous known activities causing contamination such as training or documented disposal have been re-affirmed by the HRASTM. Several new sites however, e.g. lot 69, have been added to the list of impacted sites due to the addition of repair/recycling efforts as potentially impacting sites. Additionally, the HRASTM takes into account all radiological investigations at TI, i.e. those at Site 12, 31, 33 and Building 233.

17. Comment: **<u>Section 5.2.1 and Figure 11</u>: It does not seem appropriate to limit disposal (inadvertent or otherwise) of commodities to known salvage yards. Also, suggest revising the transport pathway to read "near-surface disposal."**

Response: Figure 11 was revised to read "Near Surface Disposal" as suggested.

18. Comment: **<u>Section 5.2.1 and Figure 11</u>: Except for the mention of "sanitary sewers" in Section 5.2.1.2, the CSM does not appear to address known or unknown plumbing or drainage systems in or downstream of the area of concern, or potential contamination migration from such systems (either directly or from leakage).**

Response: The CSM in Figure 11 was revised to include disposal in and leakage from sanitary sewer systems as suggested. Figures 11, 12, 13, and 15 have also been modified to show the contaminant migration pathway from surface soil into storm drains.

19. Comment: **<u>Section 5.2.1</u>: With respect to Building 3 and other facilities where similar work was performed, was there reasonable potential for ship repair activities to have involved any surface-contaminated materials or internally-contaminated components such as those that could have originated from vessels involving in nuclear weapons testing operations in the Pacific Proving Grounds? Presently the CSM does not address potential airborne or liquid contamination pathways from routine repair/refurbishment operations (cutting, grinding, shot blasting, cleaning, rinsing, etc.). We recognize that significant time has elapsed (relative to fission and activation product half-lives) since weapons testing activities in the Pacific ceased, but longer-lived fission products could still remain, in addition to potential actinides. We view this as unlikely, but it is a question that could be raised.**

Response: There is no evidence of repair work at NAVSTA TI on contaminated ships subjected to nuclear weapons testing. The HRA provides a detailed discussion of ships subjected to nuclear weapons testing during OPERATION CROSSROADS and their history at NAVSTA TI. As discussed in the HRA, four ships were brought to NAVSTA TI for berthing following decontamination at other locations. The ships were berthed at NAVSTA TI while awaiting final radiological clearance for redeployment to the fleet. The HRA notes that all four ships subsequently received final clearances, and the HRA concludes that "there is no likelihood of contamination due to berthing of OPERATION CROSSROADS ships." Research for this HRASTM found no additional information that would alter the conclusion of the 2006 HRA.

20. Comment: **<u>Sections 5.2.1.4, 5.2.2.4, and 5.2.3.4</u>: Consider augmenting the categories of potentially-exposed individuals (workers, residents, etc.) with types of activities that could result in them becoming exposed.**

Response: The following text will be added to the end of Sections 5.2.1.4, 5.2.2.4, and 5.2.3.4: "Human receptors may be exposed to radiological contamination in three basic ways: ingestion of, dermal contact with, and inhalation of media (soil, water, air) that is impacted by radioactive contamination."

21. Comment: **<u>Section 5.2.3</u>: The CSM does not address stormwater runoff, wind dispersal, etc. as contamination transport mechanisms for the contaminated soil removed from Site 12. Has this material always been containerized? Also, there is no mention of wash water or other potential contamination transport mechanisms associated with rinsing or cleaning of vehicles used to transport contaminated soil.**

Response: Soil removed from Site 12 has historically been placed into containers for ultimate transport to various disposal facilities. Methods for containerizing soil including direct loading at the site, transport via end loader, and direct loading to sealed container have been employed at Site 12. Due to the concerns about transporting contaminated soil within Site 12, CDPH performed their survey of the roadways. Furthermore, the Navy will conduct additional evaluation of the roadways and open areas to address the potential for surface contamination. Although all material has not always been containerized, all environmental soil remediation efforts have been conducted following work plan procedures to control contaminated soil. This would include decontamination of equipment and vehicles, as well as proper control and disposition of decontamination media. Additionally, sewers will be evaluated as necessary within Site 12. See response to TIDA (NGTS) Specific Comment #18 for additional background.

22. Comment: **<u>Section 6.1.1.1</u>: Same comment as for Sections 2.2.2 and 4.3.4 with respect to the additional utility lines discovered at the Building 233 site.**

Response: Please see response to TIDA (NGTS) Specific Comment #4.

23. Comment: **<u>Section 6.1.1.1</u>, second sentence at the top of page 43 reading "… at least some of the building piping is radiologically impacted." Suggest changing "impacted" to contaminated.**

Response: Section 6.1.1.1 was revised as recommended in the comment.

24. Comment: **<u>Section 6.1.2.1</u>: If such areas still exist, consider expanding the scope of the scoping survey for Building 3 to include areas where dusts or liquids could have accumulated during ship repair activities (e.g., behind wall panels, in/on overhead structures or fixtures, in air handling components, blower motor interiors, intake/exhaust points, floor drains, etc.). Ensure that the characterization methods used would be sensitive to legacy fission products or actinides in addition to Ra-226 or Th-232.**

Response: The "Structures" category under "Contaminated Media" is designated as "Low" to account for the need to consider the building structure itself as potentially contaminated. Designs of future surveys required because of designation of Building 3 as impacted will be considered at the time those survey work plans are prepared. The surveys will also consider CDPH's scans conducted in September 2012 (CDPH RHB 2012b, 2012c), which did not identify any radiation above background levels. Regarding legacy fission products or actinides, these have not been added to the "Potential Radionuclides of Concern." See response to TIDA (NGTS) Specific Comment #19 for additional background.

25. Comment: **<u>Section 6.1.2.1</u>: If there's a high potential for contaminated plumbing/piping associated with the optical shop or other activities, it seems inconsistent to then say there's no potential for contaminated subsurface soil or sediment.**

Response: The "Contaminated Media" sub-section of Section 6.1.2.1 has been revised to re-designate the contamination potential for subsurface soil from "None" to "Low" and the contamination potential for sediment from "None" to "High (sediment within the sanitary sewer piping)."

RESPONSES TO TICD (TERRAPHASE) COMMENTS (BILL CARSON AND WENDY BELLAH)

GENERAL COMMENT

1. Comment: **The document is meant to be a living document, however two known radiological issues are not discussed in the document and it seems pertinent to discuss them in this draft rather than releasing another draft almost immediately upon finalization of this version. The specific issues are:**

- **Radiological detections found beneath the sewer lines for Building 233.**
- **Potential impacts to utilities for Building 3.**

Response: Details regarding the additional characterization of utilities outside of the Building 233 footprint will be discussed in the final HRASTM. The potential for impacts on utilities at Building 3 is considered to be

associated with the sanitary sewer system. The existing text captures that potential by identifying the contamination and indicating a high probability that drainage systems could provide migration pathways. The results of the Navy's future characterization of Building 3 and associated sanitary sewer will be summarized in a corresponding report, i.e., FSS.

SPECIFIC COMMENT

1. Comment: **<u>Section 1.2, Bulleted list at top of Page 2</u>: Should the SWDA NTCRA and Building 233 activities be added to this list? If not, why were these activities/results not reviewed?**

Response: The SWDA NTCRA and Building 233 activities were reviewed along with all other field activities at TI. The referenced list was intended to serve as a general indication of records that were reviewed, not as a detailed list of such. The last bullet has been rewritten to be more descriptive as follows: "Field activity logs, work plans and other materials associated with intrusive environmental remediation work."

2. Comment: **<u>Section 1.2, First bullet at the bottom of Page 2</u>: Please change the sentence in the middle of the text to read: "While it is unclear precisely when these ship repair activities ceased, they were significantly reduced immediately following WWII."**

Response: The word "war" has been changed to read "WWII" as suggested.

3. Comment: **<u>Section 2.2.1, Fourth paragraph</u>: How do we know there are not other utility lines for Building 3?**

Response: The referenced paragraph discusses the former optical repair shop, which is the specific area of interest regarding presence of drain lines. Only one sanitary sewer line is shown on plans for areas leading to the former optical repair shop, and this same line appears on utility drawings. Physical evidence within Building 3 confirms presence of the drain lines that would have served the optical shop. Based on numerous historical plans, there is one main gravity sanitary sewer line that has historically serviced Building 3 and it will be investigated as part of the Building 3 radiological scoping survey.

4. Comment: **<u>Section 2.2.2, Last paragraph</u>: This section discusses B233. Should the utility lines for B233 also be discussed in this section?**

Response: The utility line is discussed in this section to the extent that this section notes the impacted status of Building 233 area and sewer lines.

5. Comment: **<u>Section 2.2.6, Last paragraph</u>: This section discusses AOI 6. However, the end of this paragraph discusses the further investigation activities that are required in Site 12 which is in AOI 7. It may help a reader if this discussion is moved to the next section where activities in AOI 7 are discussed.**

Response: The relevant text has been moved to Section 2.2.7 as suggested.

6. Comment: **<u>Section 2.2.7, Page 22, Second bullet</u>: Please clarify if the excavations conducted in the former storage yard were backfilled to grade or if they were left at an elevation below grade.**

Response: According to the post-construction report (IT 2002a), the excavations were not backfilled to grade. The bullet in Section 2.2.7 will be revised to add the following sentence as the third to last sentence: "The excavation was not backfilled completely to the final grade because additional removal is necessary in the area near Building 1100."

7. Comment: **<u>Section 2.2.7, Photo 23</u>: Additional explanation for the shading shown on the photograph is needed. What areas are considered radiologically impacted and what are not?**

Response: The text and photo have been updated to identify the Bigelow Court SWDA areas in Photo 23 as radiologically impacted.

8. Comment: **<u>Section 6.2</u>: This section states that the FOST areas are suitable for transfer, except for those areas identified in the HRA and the HRASTM as radiologically impacted. However, this HRASTM does not discuss the impacts to the B233 utilities and the potential impacts to the Building 3 utilities. Please clarify how these areas are/will be delineated and the appropriateness of the transfer of these areas under the FOST.**

Response: Figure 2 has been revised to show the previously impacted Building 233 and the impacted sewer and storm lines. The current Figure 2 shows the impacted sanitary sewer line associated with Building 3. The sanitary sewer lines for both sites are shown as impacted along with downstream portions of the sewer lines.

RESPONSES TO ARC ECOLOGY (DADE MOELLER) COMMENTS (STEPHEN BUMP)

GENERAL RECOMMENDATION

1. Comment: **One of the drivers for the updated HRA was the intrusive investigation that has happened since the original HRA was written in 2006. As additional intrusive investigation is undertaken, radiological**

screening should be conducted on removed material to ensure that additional undiscovered impacted areas are not present.

Response: The Navy will conduct radiological screening during intrusive investigation of all radiologically impacted sites until completion of a FSS at those sites. All work will proceed in accordance with plans accepted by the state, and will be documented in site-specific reports. In general, areas not designated as radiologically impacted do not warrant further investigation or screening; however, the Navy has agreed to conduct additional radiological surveys of Site 12.

GENERAL COMMENT

1. Comment: There is very little information presented regarding selection of reference areas for the final status surveys. These areas need to be selected carefully due to the history of Treasure Island. For example, when Building 343 was surveyed, Building 342 was used the reference area. Building 342 is now listed as impacted which could call into question the results of the final status survey of Building 343. Reference areas for outdoor areas need to be of similar soil types and must be on Treasure Island. It should be noted if any imported fill material has been placed in the reference area (an example being when the Lake of the Nations was backfilled following the exposition). Such areas should not be used as they will not be representative of the soil present on the remainder of Treasure Island. Care must be taken that the reference area is sufficiently distant from other outdoor impacted areas as to minimize the potential for cross contamination. Reference Areas for buildings should be buildings of similar construction and buildings constructed during the same time frame as the building of interest.

Response: The process of selecting reference areas for any radiological investigation will be included as part of the related work plans. Summary of site selection and characterization is included in subsequent summary reports. The comment regarding use of Building 342 as a reference area is noted. Should future surveys detect contamination in Building 342, the survey results for Building 343 will be evaluated relative to the new data. However, this is an unlikely scenario because no anomalous or unexpected readings were noted during the reference area measurements in Building 342.

SPECIFIC COMMENTS

1. Comment: <u>Section 6.1.1.2, Building 343</u>: Building 342 was used as the reference area for the Final Status Survey (FSS) of Building 343. As part of that FSS it was assumed the Building 342 had no radiological history. The

HRASTM has now reclassified Building 342 as impacted. The FSS for Building 343 should be re-evaluated in light of this reclassification.

Response: See response to ARC Ecology General Comment #1.

3. Comment: **<u>Gamma Walkover Surveys</u>: The purpose of Gamma Walkover Surveys needs to be clearly defined. Once the purpose is defined, the sensitivity and limitations also need to be defined. For example, as they are currently being performed, they are adequate to detect hot spot anomalies that are near the surface as noted in several references in the HRASTM. They are not adequate to detect soil contamination that may be near, but above natural background levels. In addition, if the instrumentation used is calibrated to Cesium-137, as is common, the instrument's response to Radium-226 is approximately a factor of two lower which needs to be accounted for in the calculations (see Table 6-7 of MARSSIM, a higher MDC means a lower response). Calibrating the field instrumentation to Ra-226 would eliminate some of this uncertainty. It would not eliminate the inability of a walkover survey to detect soil contamination. In areas where soil contamination is suspected, a sampling protocol should be established that can clearly define whether there is in fact contamination present above natural background levels. As noted earlier, selection of a reference area with which to compare these samples is a key aspect of this sampling protocol.**

Response: The purpose of the gamma walkover survey is to further investigate the surface areas within Site 12 including roadways, in response to a 2011 CDPH scan of Site 12 roadways. The level of detail discussed in the comment, including reference areas, will be addressed in the preparation of the survey work plan. Although there were elevated readings within the Site 12 roadways, it is expected that this is due to naturally occurring isotopes within the roadway aggregate. Roadway shoulders as well as open spaces between houses not previously scanned by the Navy will also be scanned as a conservative effort to ensure lack of human health risk from unknown shallow subsurface radiological contamination.

3. Comment: **<u>Impacted Area Surveys</u>: At least two of the impacted areas, USS Pandemonium Site NW and the former Salvage Yard, have had significant construction added on top of the impacted area. Additional supporting documentation is needed to justify only scoping surveys and Gamma Walkover Surveys of these areas given their operational history. This is also supported by the addition of Building 570 and its laydown area where contaminated soil samples from the Solid Waste Disposal Areas on Site 12 were stored and analyzed. The proximity of these SWDAs to the USS Pandemonium Site NE should be evaluated for impact.**

Response: The respective first sentences of the "Recommended Actions" in Sections 6.1.2.3 and 6.1.2.6 have been revised to read as follows: "Complete a scoping survey of the subsurface soil and former holding tanks, structures, and ground surface in the USS *Pandemonium* Site I (NW) area and a gamma walkover survey of the roadways and areas not previously subject to gamma walkover surveys." To address the comment regarding proximity to the SWDAs, the "Former Uses" subsection in Section 6.1.2.6 has been revised to add the following new last sentence: "In addition, this site is located adjacent to and contiguous with SWDA A&B discussed in Section 6.1.1.3."

SUMMARY

1. Comment: The HRASTM follows the MARSSIM HRA process and appears to be a thorough and conservative update to the original HRA. The conclusions reached and the recommended actions for each of the impacted areas are reasonable, except as noted, based on the radiological history and the operations conducted in the facilities. The isotopes of interest are reasonable based on the operations of the Treasure Island Shipyard. The HRASTM is a good first step in the MARSSIM process and identifies those areas needing additional radiological investigation. It does not draw any conclusions about their impact on the environment or the public, only that there is a potential impact that needs to be investigated.

Response: Comment noted.

RESPONSE TO EPA COMMENT (DAVID STENSBY)

GENERAL COMMENT

1. Comment: EPA has reviewed the Subject Document. EPA agrees with the State that the document should include and discuss all the additional information California DTSC and DPH have requested. EPA fully concurs with the California DTSC and DPH comments. We do not have any additional comments or questions on the "Draft Historical Radiological Assessment Supplemental Technical Memorandum".

Response: Comment noted. Please see responses to DTSC and CDPH EMB comments.

RESPONSES TO WATER BOARD COMMENTS (MYRIAM ZECH)

SPECIFIC COMMENTS

1. Comment: Please add a glossary to the beginning of the document. Words like "impacted" or "contaminated" are defined in the 2006 HRA, but not

in the HRASTM. Interested parties reviewing the HRASTM may not necessarily consult the 2006 HRA.

Response: A glossary has been added as requested.

2. Comment: The Executive Summary could benefit from a small section explaining the difference between alpha and beta particles, and why we're interested in Radium-226, Thorium-232 and Cesium-137.

Response: The fourth paragraph of the Executive Summary has be rewritten as follows to comply with the suggested changes: "As a result of the research performed and discussed elsewhere in this HRASTM, activities involving the use of the radioisotopes Ra-226, Cs-137, and thorium (Th)-232 resulted in the designation of new radiologically impacted areas. Ra-226 is associated with use in radioluminescent paints, Cs-137 with use in sealed sources, and Th-232 in optical coatings and glass. Discussion regarding nuclear health physics, including alpha and beta particles, will be reserved for discussion in other forums and not in the HRASTM because of the complex and expansive nature of the topic.

3. Comment: Please add a final paragraph to the Executive Summary, describing what work remains to be done to ensure that all sites are radiologically safe.

Response: A new paragraph has been added to the end of the Executive Summary as follows: "Sites that have been designated as radiologically impacted in the prior HRA or in this HRASTM will be addressed following the recommended action protocols outlined in Section 7.4 of the 2006 HRA (Weston 2006)."

4. Comment: Please include a table indicating:

a) radiation levels found in the soil, in pCi/g;
b) release criteria;
c) background concentrations.

Response: This type of information is site-specific and will be documented in corresponding work plans, after-action summary reports, and the final status .

5. Comment: Please include a table or a chart indicating dates by which investigations or reports are to be completed, including:

a) the scoping surveys that remain to be done;
b) the report explaining the elevated readings at the 9th Street recreational area;
c) the work currently being done on Building 233.

Response: Closeouts of radiologically impacted sites (including those sites identified in the draft HRASTM), as well as anticipated deliverables and time frames, have been integrated into the NAVSTA TI Site Management Plan. Living schedules for further characterization and remediation will be developed with the BCT. A separate technical memorandum will be developed to focus on the 9th street recreational area. The text has updated to summarize the current status of the Building 233 and associated sewer investigations.

6. Comment: Please indicate how elevated count rates (in cpm) relate to pCi/g (p. 26, second paragraph).

Response: The elevated count rates in units of counts per minute (cpm) are the results of radiological gamma scanning with a sodium iodide detector, whereas the Ra-226 concentrations expressed in pCi/g are the results of radiological analyses of soil samples. The relationship between the count rate acquired during gamma scanning and the Ra-226 concentration derived from the analytical results is qualitative. Areas of elevated count rate are used to bias soil sample locations.

7. Comment: The 2006 HRA says that "The Cs-137 sealed sources were leak tested and were demonstrated to be intact." However, on p. 26, the HRASTM designates the USS *Pandemonium* Site I (NW) area as a "radiologically impacted area based on a more conservative interpretation of existing information [about Cs-137] in the HRA." Can you please explain what the more conservative interpretation is, and explain which sites are affected?

Response: The ninth sentence of the fifth paragraph of Section 2.2.8 has been replaced with the following to be consistent with Section 4 of the HRASTM and to clarify the basis for the changed designation: "This HRASTM designates the USS *Pandemonium* Site I (NW) area as a radiologically impacted area based on a more conservative estimate that the documented use of unlicensed instrument check sources could have resulted in a spread of contamination."

8. Comment: Since materials stored at the former storage yard before the construction of housing are not known (p.22), please include Halyburton Court and Bigelow Court on the "impacted" list on p. 44.

Response: Bigelow Court has been designated as impacted (See response to DTSC Specific Comments #9 for Bigelow Court discussion). Halyburton Court has not been impacted as there is no evidence that the area was used as a solid waste disposal area.

9. Comment: On p. 61, please explain more clearly that the purpose of a FOST is to document that the property is environmentally suitable for transfer. Please add a note to say that Buildings 343 and 344 were released for closure because, although impacted, 2007 surveys have shown that they are not contaminated.

Response: Section 6.2 of the HRASTM was revised to read as follows:

"The purpose of a Finding of Suitability to Transfer is to identify property that is environmentally suitable for transfer and to identify any specific notices, restrictions or covenants that are required. All areas of NAVSTA TI subject to the prior HRA and this HRASTM are suitable for transfer with respect to potential impacts on human health and the environment from exposure to radiological contamination, provided: (1) they have not been designated as radiologically impacted in either of these documents, and (2) they are clear of other CERCLA issues preventing transfer. Only Buildings 343 and 344 have reached regulatory closure for radiological concerns as they have been released for unrestricted use (DTSC 2009). Therefore, these "radiologically impacted" buildings are suitable for transfer. No radiological related notices, restriction or covenants are required for the FOST areas.

No further action is necessary to address the potential for radiological contamination at areas within TI that were subject to the HRA or this HRASTM, and are (1) not designated as radiologically impacted, or (2) designated as non-impacted. The conservative evaluation of TI as a whole serves to identify areas not only where significant contamination could be, but even where there are anomalous discrete sources of localized contamination from unlicensed activities. In areas that are not impacted, the probability of contamination posing an unacceptable human health risk is minimal and no evidence has been found to warrant further investigation of the areas."

10. Comment: Typo on p. 37, second paragraph: "impacted areas based <u>on</u> the detection of Ra-226."

Response: The text was revised as suggested.

RESPONSE TO REGULATORY AGENCY COMMENTS ON THE INTERNAL FINAL HISTORICAL RADIOLOGICAL ASSESSMENT-SUPPLEMENTAL TECHNICAL MEMORANDUM AND RESPONSES TO AGENCY COMMENTS ON THE DRAFT HISTORICAL RADIOLOGICAL ASSESSMENT-SUPPLEMENTAL TECHNICAL MEMORANDUM, NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA

This document presents the responses to comments from staff from the Department of Toxic Substances Control (DTSC) on the redline version of the "Internal Final Historical Radiological Assessment – Supplemental Technical Memorandum [HRASTM], Naval Station Treasure Island, San Francisco, California," and the Responses to Agency Comments on the Draft HRASTM, dated February 14, 2013. The comments addressed below were received from DTSC on March 4, 2013.

RESPONSES TO DTSC COMMENTS

GENERAL COMMENTS

1. Comment: New impacted areas/Utility lines and area south of Building 233. The area surrounded by the utility lines south of Building 233 and the utility lines beyond the impacted boundaries of Buildings 3, 233 and 342 as highlighted on Figure 2 is not listed in the bullet list in the Executive Summary. These lines are labeled as Bldg 3 Sanitary Sewer Line, Bldg 233 Storm Line, and Bldg 342 Sanitary Sewer Line on Figure 2. This area and utility lines should be collectively classified as one new impacted area separate from the buildings.

Response: Please see response to Specific Comment #1.

2. Comment: Boundaries of new impacted areas. Please verify the boundaries of the new impacted areas for the larger rubbish area and the yard behind Building 342. The boundaries shown in Figure 2 and the AOI specific figures are inconsistent with the photos.

Response: The boundaries have been revised for consistency.

3. Comment: No Further Action (NFA) on non-impacted areas. The NFA statements in the Executive Summary and FOST section are confusing. It sounds like that NFA is recommended for the whole of TI which is the subject of the HRASTM. Please revise these statements.

Response: These sections have been revised as a result of the comment.

SPECIFIC COMMENTS

1. **Comment:** **<u>Executive Summary, Page ES-2, 8th Bullet</u>. Please add the sewer and storm lines in the bullet list of new impacted areas. Figure 2 shows utility lines from Buildings 3, 233 and 342 to the storm outfall and the WWTP. These lines outside of the buildings and the area surrounding the lines south of Building 233 should be collectively classified as an impacted area separate from the buildings.**

   Response: Potential migration pathways are evaluated in Section 6.1 for radiologically impacted areas. This includes the storm and sanitary utility lines servicing Buildings 3, 233 and 342 and the portions shown on the Figures 2 through 9.

2. **Comment:** **<u>Executive Summary, Page ES-3, 1st Paragraph</u>. Should this definition of an impacted site be moved before the list of newly identified impacted areas?**

   Response: The text defining an impacted site has been moved as suggested.

3. **Comment:** **<u>Executive Summary, Page ES-3, Last Paragraph</u>. The statement is confusing. The whole of TI is the subject of the HRASTM. Please revise this statement.**

   Response: The statement has been revised to read as follows: "*No further action is necessary to address the potential for radiological contamination at TI that are not designated radiologically impacted. No evidence has been found to warrant further radiological investigation of areas that are not impacted.*"

4. **Comment:** **<u>Section 1.1, Purpose, Page 1, 2nd Paragraph</u>. Please delete. This is a duplicate of a paragraph in the Executive Summary.**

   Response: The Executive Summary is intended to be stand alone and may contain duplicate text of the document if specific wording and descriptions are desired.

5. **Comment:** **<u>Section 2.2.2, AO1 2: Former Hospital Area, Page 12, Top Paragraph,</u>. Please add the sentence "Therefore, IR Site 33 was classified as not impacted in this HRASTM."**

   Response: The text was revised as suggested.

6. **Comment:** **<u>Section 2.2.2, AO1 2: Former Hospital Area, Page 13, Top Paragraph</u>. Item #12 of the Action Items from the 11/29/2103 conference call requires including the cleanup document for Building 233 in Appendix A. Has this been included in Appendix A?**

Response: The following reference has been added to Appendix A as requested.

Shaw. 2014. "*Final Radiological Remedial Action Report and Final Status Survey Plan, Building 233 Site, Former Naval Station Treasure Island, San Francisco, California*." January. TI-HRASTM-49.

7. Comment: Section 2.2.2, AO1 2: Former Hospital Area, Page 13, Top Paragraph. Insert "be": "A report will "be" issued…

Response: The text was revised as suggested.

8. Comment: Section 2.2.4, AO1 4: Southwestern Community Area, Page 16, 2nd Paragraph. Please insert "and CDPH": (DTSC "and CDPH" 2009)

Response: The referenced letter for DTSC 2009 included the CDPH letter as an attachment, thus no change was made to the citation. Rather, the sixth sentence of the last paragraph of Section 2.2.4 was revised to the following: "The California Environmental Protection Agency's DTSC concurred with the unrestricted release of Buildings 343 and 344 on January 16, 2009, and the CDPH concurred with unrestricted use on November 12, 2008 (DTSC 2009)."

9. Comment: Section 2.2.5, AO1 5: Northeastern Community Area, Page 18, 1st Paragraph. Missing word. Insert "of": "…mobilization "of" two gamma..."

Response: This comment is no longer relevant due to other text revisions.

10. Comment: Section 2.2.6, AO1 6: Sewage Treatment Area, Page 18. Please discuss the four identified impacted areas in AOI 6 in bullet form for clarity.

Response: The section has been modified as requested.

11. Comment: Section 2.2.6, AO1 6: Sewage Treatment Area, Page 18, First Paragraph. Please name the two Pandemonium sites consistently in the text and figures. Figure 2 shows "NE" and no "II".

Response: Figure 2 and text has been modified accordingly.

12. Comment: Section 2.2.6, AO1 6: Sewage Treatment Area, Page 19, 3rd Paragraph. *"Radiological sampling was not part of this action, although radiological portals were not set off at target landfills."* Please clarify this statement.

Response: The subject sentence and section has been rewritten to read as follows: "*Radiological sampling was not part of this action, although some screening occurred when excavated soil was delivered to landfills. Landfills typically screen incoming truckloads of soil for radioactivity with sensitive portal monitors and will refuse loads if the delivery causes the portal monitor to sound an alarm. There are no reports that radiological portal monitors had sounded an alarm when the landfills accepted the waste from the removal action at Site 32.*"

13. Comment: **<u>Section 2.2.6, AO1 6: Sewage Treatment Area, Page 21, 1st Paragraph</u>. *"Additionally, bins filled in Site 12 had to be emptied at Site 6 and resurveyed. Elevated readings outside of the bins had prevented their transport over public roads."* Please clarify these statements. How were the bins transported from Site 12 to Site 6. What roads were used?**

Response: The sentence was revised for clarity to read as follows: "*Additionally, bins containing radioactively contaminated soil that were filled in Site 12 were emptied at Site 6 and resurveyed (Shaw 2013a, 2013b).*" Truck routes are shown in the work plans for the solid waste disposal areas (SWDAs); but no changes to the text has been made because all of Site 12 has been radiologically impacted thus making the specific roads used for transport of the bins little importance.

14. Comment: **<u>Section 2.2.7, AO1 7: Northern Housing Area of Interest, Page 24, 1st Paragraph</u>. Please delete this statement *"Although further investigation will be done throughout Site 12"* or clarify based on the 2/25/2103 conference call.**

Response: The statement has been clarified to read as follows: "*Although further investigation will be done throughout Site 12, various lines of evidence exist to suggest the movement of low-level radiological objects (LLROs) outside of SWDAs by grading was limited within Area of Interest 7 as follows…*"

15. Comment: **<u>Section 2.2.7, AO1 7: Northern Housing Area of Interest, Page 28, 1st Paragraph</u>. Please explain the how the boundary of the larger rubbish area was determined. This boundary is not consistent with the approximate limits of the rubbish disposal area in Photo 24 below.**

Response: The following has been added to the caption of the photo: "*(Note: The lower rubbish disposal area is only partially shown)*" The rubbish disposal areas are based on the report by McCreary, Koretsky Engineers 1965.

16. Comment: **<u>Section 2.2.7, AO1 7: Northern Housing Area of Interest, Page 28, Last Paragraph</u>. Please revise this new paragraph based on the team's 2/25/2013 conference call.**

Response: The last paragraph has been deleted due to the decision to radiologically impact all of Site 12.

17. Comment: **<u>Section 2.2.8, AO1 8: Southern Housing Area, Page 29, 1st Paragraph, 4th Sentence</u>. Please clarify that although a larger portion of Bigelow Court is within AOI 8, Bigelow Court was classified as impacted under AOI 7.**

Response: The first paragraph of Section 2.2.8 was revised to include the following text as the fourth sentence: "*In addition, this HRASTM provides additional detail regarding AOI 8 including an approximately 175,000-square-foot former storage yard overlapping Bigelow Court (portions of Bigelow Court are also located in AOI 7).*"

Section 2.2.7 was also revised to read, in part: "*Based on a 1945 aerial photograph, Site 12 also contains portions of an approximately 175,000-square-foot former storage yard overlapping Halyburton Court and Bigelow Court (TriEco-Tt 2012) (portions of Bigelow Court are also found in AOI 8).*"

18. Comment: **<u>Section 2.2.8, AO1 8: Southern Housing Area, Page 29, 1st Paragraph, 4th Sentence</u>. Please label the Pandemonium Site I (NW) on Figure 9, and make the name consistent on Figure 2.**

Response: Figures 2 and 9 have been revised as requested.

19. Comment: **<u>Section 2.2.8, AO1 8: Southern Housing Area, Page 29, 1st Paragraph, 4th Sentence</u>. Please discuss this "new information" suggesting that a 50-foot buffer is appropriate to extend the SWDA impacted areas.**

Response: The language regarding the "new information" and the 50 foot buffer has been removed and the entire footprint of Site 12 has now been designated as radiologically impacted.

20. Comment: **<u>Section 2.2.8, AO1 8: Southern Housing Area, Page 31, 2nd Paragraph, 2nd Sentence</u>. Please identify the specific SWDAs where commodities were found since Bigelow Court was also identified as a SWDA in the Site 12 RI report.**

Response: The second sentence of the 7th paragraph was revised to read as follows: "*After the 2006 HRA, LLROs were found in each of the SWDAs, with the exception of the Bigelow Court debris disposal area, confirming the report of radiological disposal at TI.*"

21. Comment: **<u>Section 4.1.1.3, SWDAs 1231/1233 and 1207/1209 (Bayside/North Point), and Section 4.1.1.4, SWDA A&B), Page 35</u>. Please clarify that all commodities have been removed from the SWDAs to the storage area at TI, and not all commodities have been removed from TI based on the Dec 2012 RAB meeting presentation. The remaining commodities that are still stored at TI should be discussed.**

Response: The following new 5th sentence has been added to Section 4.1.1.3: "*LLROs are retained on TI until sufficient quantities have been collected and shipment logistics have been arranged.*"

22. Comment: **<u>Section 4.1.2, Radiologically Impacted Sites Identified in this HRASTM, Page 36</u>. Please include the utility lines from Buildings 3, 233 and 342 to the storm outfall and the WWTP in the list of impacted sites as shown on Figure 2.**

Response: Please see response to Specific Comment 1.

23. Comment: **<u>Section 4.1.2.8, Building 342, Photo 30: Site 31 Excavation Areas, Page 41</u>. This yard area limit is not consistent with the area in Figures 2 and 6. Please reconcile the impacted yard area.**

Response: Figures 2 and 6 of have been revised to match the yard area as shown in the photo.

24. Comment: **<u>Section 4.3, Other Significant Radiologically-Related Work, Page 46</u>. Please discuss the following work in this section: (1) Navy radiological surveys and soil sampling as part of the background concentration determination; and (2) CDPH RHB surveys in 2012 requested by the City.**

Response: Additional text has been added to Section 4.3 to address requested surveys.

25. Comment: **<u>Section 4.3.1, Site 12 Trenching, Page 47</u>. This is inconsistent with the introductory sentence under Section 4.3 that states this section presents other significant radiological surveys done AFTER the final HRA.**

Response: The first two sentences of Section 4.3.2 have been revised to clarify the timing of the trenching work: "*The Navy did trenching and sampling throughout Site 12. These trenching investigations began concurrently with the HRA, but the analysis was not completed until after the final HRA was published.*"

26. Comment: **<u>Section 6.1.1.1, Building 233, 2nd Paragraph, Last Sentence, Page 55</u>. Please clearly identify the sewer systems downstream of Building 233. Figure 2 shows lines from Buildings 3, 233 and 342 to the outfall and the WWTP downstream and upstream of Building 233. These lines outside of the buildings should be classified as an impacted area separate from the buildings.**

Response: Please see response to Specific Comment #1.

27. Comment: **<u>Section 6.1.1.3, Site 12, Site Description, Last Sentence, Page 56</u>. Please clarify that the commodities were found only at the four SWDAs A, B, 1207/1209, and 1231/1233, and not throughout Site 12.**

Response: Based on findings subsequent to this comment, the suggested clarification was not made.

28. Comment: **<u>Section 6.1.1.3, Site 12, Recommended Actions, Last Sentence, Page 57</u>. Please revise this statement per the team's 2/25/2013 conference call.**

Response: Based on decisions subsequent to this comment, the entire Site 12 area has been designated as radiologically impacted. The "Recommended Actions" subsection in Section 6.1.1.3 has been revised accordingly.

29. Comment: **<u>Section 6.1.2, Radiologically Impacted Sites Identified in this HRASTM, Page 57</u>. These utility lines outside of the buildings and the area surrounding the lines south of Building 233 should be collectively classified as an impacted area separate from the buildings.**

Response: Please see response to Specific Comment #1

30. Comment: **<u>Section 6.1.2,7, Former Storage Area and Sites 30 and 31, Site 31, Last Sentence, Page 69</u>. Please revised this statement since completion report and FSS report for Site 31 has not been submitted to the regulatory agencies for review.**

Response: The following text has been added to the end of the Site 31 discussion: "*At the time of this HRASTM, the Navy has finished the soil remediation at Site 31 and the site has been restored and radiologically downposted. The remedial action completion report is being prepared.*"

31. Comment: **<u>Section 6.1.2,7, Former Storage Area and Sites 30 and 31, Previous Radiological Investigations, Page 70</u>. Please clarify that the contamination was found within Site 31 and only small volume of soil is impacted.**

Response: The second sentence has been revised to read as follows: "*During the Phase I removal action, a small volume of soil with elevated radioactivity suggesting the presence of non-naturally occurring Ra-226 was discovered in the sidewall of the Site 31 excavation.*"

32. Comment: <u>Section 6.2, Findings of Suitability to Transfer (FOST) Areas, Last Paragraph, Page 82</u>. Please rewrite for clarity.

Response: The last paragraph of Section 6.2 has been rewritten to read as follows: "*No further action is necessary to address the potential for radiological contamination at areas in TI that are (1) not designated as radiologically impacted, or (2) designated as non-impacted in both the HRA and this HRASTM. The probability that contamination would pose an unacceptable human health risk is minimal and no evidence has been found to warrant further investigation of those areas in areas that are not designated as radiologically impacted or are designated as non-impacted.*"

33. Comment: <u>Figure 2</u>. Please label the utility lines outside of the buildings and the area surrounded by the lines collectively as one impacted area.

Response: See response to Specific Comment #1

34. Comment: <u>Figure 2</u>. Please show Site 24 boundary.

Response: Figure 2 has been updated to show the Site 24 boundary as requested.

35. Comment: <u>Figure 4</u>. The area surrounded the utility lines is shaded as impacted in Figure 2.

Response: Figures 2 and 4 have been updated to show the same impacts for utility lines.

36. Comment: <u>Figure 8</u>. Please make label consistent with the text as "Pandemonium Site II (NE)."

Response: The label has been changed as requested.

37. Comment: <u>Figure 8</u>. Please show and label Building 327. This building is shown and labeled in the first draft HRASTM.

Response: Building 327 has been shown and labeled as requested.

38. Comment: <u>Figure 9</u>. Please identify buildings that are not occupied in a different color and noted in the legend.

Response: Unoccupied buildings in Figure 9 and 10 have been noted in a different color as requested.

39. Comment: <u>Figure 10</u>. Please label the SWDA, Pandemonium Site I (NW) and the playground that were classified as impacted.

Response: The polygons that define these areas have been added to the figure and labeled accordingly as requested.

APPENDIX D
HISTORICAL RADIOLOGICAL ASSESSMENT SUPPLEMENTAL TECHNICAL MEMORANDUM REFERENCES

(Provided on DVD)

Final

Treasure Island Naval Station Historical Radiological Assessment

FORMER NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA

February 2006

Prepared for:
Base Realignment and Closure
Program Management Office West
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LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

µCi	microcurie
µCi/cc	microcurie per cubic centimeter
µg	microgram
µrem/h	microrem per hour
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
Am-241	americium-241
ARG	Auxiliary Internal Combustion Engine Repair Ship
ATF	Amphibious Tug Fleet
Ba-140	barium-140
Bay	San Francisco Bay
BCT	BRAC Cleanup Team
bgs	below ground surface
BEQ	bachelor enlisted quarters
BOQ	bachelor officers quarters
BPMOW	BRAC Program Management Office West
Br-82	bromine-82
BRAC	Base Realignment and Closure
BUMED	Navy Bureau of Medicine and Surgery
BUSHIPS	Navy Bureau of Ships
C-14	carbon-14
CAB	Citizens Advisory Board
CAE	Committee on Atomic Energy
Cd-109	cadmium-109
CDHS	California Department of Health Services
cm^3	cubic centimeter
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS	CERCLA Information System
Ci	curie
CFR	Code of Federal Regulations
CNO	Chief of Naval Operations
CPO	Chief Petty Officer
Co-60	cobalt-60
COM	Commissioned Officers Mess
Cs-137	cesium-137
CSO	Caretaker Site Office
CWSF	Commander Western Sea Frontier

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

DEA	Drug Enforcement Administration
D.C.T.C.	Damage Control Training Center
DERP	Defense Environmental Restoration Program
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
dpm	disintegration per minute
dpm/100 cm^2	disintegration per minute per 100 square centimeters
DRMO	Defense Reutilization and Marketing Office
DTSC	Department of Toxic Substances Control
EFA WEST	Engineering Field Activity West, Naval Facilities Engineering Command
EPA	U.S. Environmental Protection Agency
ERDA	U.S. Energy Research and Development Administration
FFA	Federal Facility Agreement
FFSRA	Federal Facility Site Remediation Agreement
FS	feasibility study
FSS	final status survey
FTC	Fleet Training Center
G-RAM	general radioactive material
H-3	tritium
HLA	Harding Lawson Associates
HP	Hunters Point
HPNSY	Hunters Point Naval Shipyard
HPS	Hunters Point Shipyard
HRA	Historical Radiological Assessment
HRS	Hazard Ranking System
IAS	Initial Assessment Study
IR	Installation Restoration
K-40	potassium-40
K-42	potassium-42
kg	kilogram
kV	kilovolt
LLD	lower limit of detection
LST	Amphibious Tank Landing Ship
MARAD	Maritime Administration
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mCi	millicurie
MDA	minimum detectable activity

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

MeV	megaelectron volt
MI	Mare Island
MINS	Mare Island Naval Shipyard
MINSY	Mare Island Naval Shipyard
MOU	memorandum of understanding
mR/h	milliroentgen per hour
mrem	millirem
mrem/h	millirem per hour (also expressed as mR/h)
msl	mean sea level
MSTS	Military Sea Transport Service
MWR	Morale, Welfare and Recreation
N/A	not applicable
Na-24	sodium-24
NACIP	Naval Assessment and Control of Installation Pollutants
NaI	sodium iodide
NARA	National Archives and Records Administration
NARM	naturally occurring accelerator-produced radioactive material
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	U.S. Department of the Navy
NAVSEA	Naval Sea Systems Command
NAVSEADET RASO	Naval Sea Systems Command Detachment, Radiological Affairs Support Office (also expressed as RASO)
NC	non-commissioned
NCDC	National Climatic Data Center
nCi	nanocurie
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDT	non-destructive test(ing)
NDTC	Navy Training Devices Command
NEESA	Naval Energy and Environmental Support Activity
NEX	Navy Exchange
NNPP	Naval Nuclear Propulsion Program
NORM	naturally occurring radioactive material
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
NRDL	Naval Radiological Defense Laboratory
NRMP	Navy Radioactive Material Permit
NRSC	Navy Radiation Safety Committee

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

NTTC	Navy Technical Training Center
NUREG	Nuclear Regulatory Guide
OP	operational
PA	Preliminary Assessment
pCi/g	picocurie per gram
pCi/L	picocurie per liter
Pm-147	promethium-147
PP	proposed plan
PRG	preliminary remediation goal
Pu-Be	plutonium-beryllium
Pu-239	plutonium-239
PUC	Public Utility Commission
Ra-226	radium-226
RAB	Restoration Advisory Board
RADLAB	radiation laboratory
RADIAC	radiation detection, indication, and computation instrument
RAS	Radar Automatic System
RASO	Radiological Affairs Support Office
RASP	Radiological Affairs Support Program
RI	remedial investigation
Rn-222	radon-222
ROD	Record of Decision
RPTD	reported
RSO	radiation safety officer
RWQCB	Regional Water Quality Control Board
SAP	Security Assistance Program
SARA	Superfund Amendments and Reauthorization Act of 1986
SD	San Diego
SF	San Francisco
SFBNSY	San Francisco Bay Naval Shipyard
SFFD	San Francisco Fire Department
SFNS	San Francisco Naval Shipyard
SI	site inspection
Sr-90	strontium-90
SUPSHIP	Supervisor of Shipbuilding, Conversion, and Repair
SWDIV	Southwest Division, Naval Facilities Engineering Command
Th-232	thorium-232
TI	Treasure Island

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

TIDA	Treasure Island Development Authority
U-233	uranium-233
U-235	uranium-235
U-236	uranium-236
U-238	uranium-238
USC	United States Code
USCG	United States Coast Guard
USMC	United States Marine Corps
USN	United States Navy
USS	United States Ship
YBI	Yerba Buena Island
Y-90	yttrium-90

GLOSSARY

AEC—Atomic Energy Commission. Federal agency created in 1946 to manage the development, use, and control of nuclear energy for military and civilian applications. Succeeded by the Energy Research and Development Administration (now part of the U.S. Department of Energy) and the U.S. Nuclear Regulatory Commission.

Aggregate—A clustered mass of individual soil products varied in shape and size (such as soils, sand, and rock).

Air—Atmosphere that becomes a migration pathway for resuspension and disposal of radioactive contamination and contaminated media.

Alpha particle—A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. Alpha particles can be stopped by a thin sheet of paper.

Aquifer—A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Background radiation—Naturally occurring radiation from cosmic or terrestrial sources.

Beta particle—A charged particle emitted from a nucleus during radioactive decay with a mass equal to 1/1837 that of a proton. Negatively charged beta particles are electrons, and positively charged particles are positrons. Beta particles can be stopped by a thin sheet of plastic.

Base Closure and Realignment Act of 1990—The Defense Base Closure and Realignment Act of 1990, as amended (Public Law 101-510), was enacted by the U.S. Congress to provide a fair process that will result in timely closure and realignment of military installations in the United States. Navy uses the BRAC Program to comply with this Act.

Base Realignment and Closure (BRAC) Program—A formal Navy program managed by the Naval Facilities Engineering Command that was created in 1993 to dispose of excess Navy and Marine Corps properties, designated for closure or realignment by the U.S. Congress, by transfer to the local communities for reuse and economic revitalization.

BUMED—Navy Bureau of Medicine and Surgery. BUMED is responsible for the Navy's Radiation Health Program.

BUSHIPS—A former Navy bureau that was responsible for ships.

Byproduct Material—Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material;

CERCLA—Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Legislation that established the federal Superfund for response to uncontrolled releases of hazardous substances to the environment.

CERCLIS—Comprehensive Environmental Response, Compensation, and Liability Act Information System. U.S. Environmental Protection Agency's computerized inventory and tracking system for potential hazardous waste sites.

Characterization Survey—Site assessments generally taken after radioactive contamination has been confirmed in an impacted site by a scoping survey. The survey determines the extent of contamination and identifies and defines the extent of radionuclides of concern. These surveys include in-depth surveys, sampling, monitoring, and analysis necessary to develop, analyze, and select appropriate cleanup techniques.

Check Source—A radioactive source that is used to check the response of radiation detection instruments. In many cases, the check source is attached to the instrument.

Class 1 area (based on MARSSIM)—An area that is projected to require a Class 1 final status survey.

Class 2 area (based on MARSSIM)—An area that is projected to require a Class 2 final status survey.

Class 3 area (based on MARSSIM)—An area that is projected to require a Class 3 final status survey.

Class 1 survey—A type of final status survey that applies to areas with the highest potential for contamination, and meet the following criteria: (1) impacted; (2) potential for delivering a dose above the release criterion; (3) potential for small areas of elevated activity; and (4) insufficient evidence to support reclassification as Class 2 or Class 3.

Class 2 survey—A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

Class 3 survey—A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

Contaminated media—Materials at an impacted site that contain, or are suspected of containing, radioactive contamination or to which radioactive contamination may have migrated.

Contaminated media assessment—A rating of the potential contamination media or migration at an impacted site.

Contamination potential—The possibility for residual radioactive contamination at an impacted site that has been determined through a professional evaluation of historical information, previous survey results, and site reconnaissance.

Curie—Abbreviated Ci. A unit of measure of the amount of radioactivity equal to 3.7×10^{10} disintegrations per second or 2.22×10^{12} disintegrations per minute (dpm).

Decontamination—The reduction or removal of radioactive material from a structure, object, or person. Accomplished by treating the surface to remove or decrease the contamination or by letting the material decrease as a result of radioactive decay.

Direct measurement—Measurement of alpha, beta, or gamma radiation. Data can be displayed as a digital rate, timed count, or integrated dose count.

Dose—The amount of energy absorbed by a person exposed to radiation.

Drainage system—Sanitary drains, facility storm drains, or septic systems and leach fields. This category can include bay sediments where drainage to the bay occurs.

Emergency action—Immediate remediation or containment is required because the levels of radioactive contamination or radiation exposure are such that there is a high potential for significant exposure or release of radioactive materials to the public or the environment.

EPA—U.S. Environmental Protection Agency. The lead federal regulatory agency under CERCLA for cleanup of hazardous waste sites on the National Priorities List (NPL).

FFA—Federal Facility Agreement. An agreement among the EPA, state, and site lead agency (for example, the Navy) detailing the extent and schedule of remedial actions.

Final Status Survey:—Also stated as FSS. Measurements and sampling performed to describe the radiological conditions of a site, following completion of decontamination activities (if any) in preparation for release. The survey verifies that an impacted site complies with applicable release criteria by taking the appropriate measurements and sampling that will define the radiological condition of a site.

Free release—A recommendation made after historical documentation and previous and current investigations and surveys indicate all applicable release criteria have been met and the site is ready for review by Navy and regulatory agencies for future non-radiological use.

Gamma radiation—High-energy, short-wave length electromagnetic radiation emitted from the nucleus of an atom. Gamma radiation frequently accompanies the emission of alpha and beta particles and always accompanies fission. Gamma rays are stopped by shielding with heavy materials such as lead.

G-RAM— All general radioactive materials that are not associated with the Naval Nuclear Propulsion Program (NNPP).

Groundwater—Waters contained in subsurface materials and aquifers.

Half-life—Time required for a population of atoms of a given radionuclide to decrease through radioactive decay to exactly one-half of the original number of atoms. No operation, either

chemical or physical, can change the decay rate of a radioactive substance. Half-lives range from much less than 1 microsecond to more than 1 billion years. The longer the half-life, the more stable the nuclide. After one half-life, half of the original atoms will remain; after two half-lives, one fourth (or 1/2 of 1/2) will remain; and so on.

Hazardous material—Material that possess properties of radioactivity, chemical toxicity, or other potential nuisance to cause human illness or injury.

Hazardous substance—Any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive.

High—Contamination assessment indicating that evidence of contamination in the media or migration pathway has been identified.

HRA—Historical Radiological Assessment. A detailed investigation to collect historical radiological information and data derived from environmental monitoring for a particular site and its surroundings where radioactive materials were used. The HRA is comparable to the Historical Site Assessment as defined in MARSSIM.

HSA—Historical Site Assessment. MARSSIM terminology for an historical radiological assessment. See HRA above.

Impacted area—An area that has or historically had a potential for G-RAM contamination based on the site operating history or known contamination detected during previous radiation surveys. Impacted sites include sites where radioactive materials were used or stored; sites where known spills, discharges, or other instances involving radioactive materials have occurred; or sites where radioactive materials might have been disposed of or buried. Impacted sites are ranked as Class 1, 2, or 3 based on MARSSIM guidelines.

Investigation level—A radionuclide-specific level based on the release criterion that, if exceeded, triggers some response such as further investigation or remediation.

Known-Continued Access Contamination Potential—Low levels of contamination exist, but the contamination is contained in system, fixed on building surfaces, or is in generally inaccessible areas.

Known-Restricted Access Contamination Potential—Radioactive contamination is known to exist at levels that could be hazardous without protective clothing, respiratory protection, or radiation monitoring.

Likely Contamination Potential—Residual radioactive contamination is expected but has not been confirmed.

Low—Assessment of contaminated media or migration pathway indicating that the contamination potential is remote.

Media—Types of materials at an impacted site that may contain or are suspected of containing radioactive contamination or to which radioactive contamination may migrate.

Micro—Abbreviated μ. A prefix denoting one-millionth (10^{-6}).

Migration pathway—Media or transport mechanisms that allow radioactive contamination to spread in the immediate vicinity of the contaminated media.

Milli—Abbreviated m. A prefix denoting one-thousandth (10^{-3}).

Moderate—Assessment of contamination media or migration pathway that indicates the potential for contamination exists but has not been fully assessed.

Neutron Activation—The process of producing radioactivity in a stable isotope by bombarding the isotope with neutrons. Following the capture of a neutron by a stable isotope, the resulting product nucleus is a radioisotope that later decays to a stable state and can be detected. The energy level of the emitted gamma rays is characteristic of the specific element.

None—Assessment of contaminated media or migration pathway that indicates evidence of contamination has not been found or known contamination has been removed and surveys indicate that the media or migration pathway meets release criteria.

NNPP—Naval Nuclear Propulsion Program. A joint Navy and U.S. Department of Energy program to design, build, operate, maintain, and oversee operation of Naval nuclear-powered ships and associated support facilities.

Non-impacted area—An area having no reasonable possibility of residual G-RAM contamination resulting from site operations based on historical documents. Includes residential or other buildings that have or had no sealed radioactive sources other than smoke detectors or exit signs.

No Contamination Potential (None)—Radioactive contamination has been fully assessed and removed, if necessary, and the site has been free released by the Navy and the regulatory agencies.

NPL—National Priorities List. Under the Superfund program, a list of sites of releases and potential releases of hazardous substances, pollutants, and contaminants that appear to pose the greatest threat to public health, welfare, and the environment.

NRC—U.S. Nuclear Regulatory Commission. An organization of the federal government that oversees and authorizes the use of byproduct, source, and special nuclear materials.

NRDL—Naval Radiological Defense Laboratory. A Navy command based at HPS from 1948 until 1969. The mission of NRDL was the study of nuclear weapons effects and the development of countermeasures to the atomic weapon and decontamination methods for ships from OPERATION CROSSROADS.

NRMP—Navy Radioactive Materials Permit. Site-specific or broad-scope Navy license for the use of specified radioactive materials under specified conditions. These permits are issued by the Navy Radiation Safety Committee (NRSC) under the authority of the Master Materials License granted to the Navy by the NRC.

NRSC—Navy Radiation Safety Committee. Navy organization providing administrative control of all NRC-licensed radioactive material used by the Navy and U.S. Marine Corps.

Nuclide—Any known isotope, either stable or unstable, of any element. A single element can have isotopes, but when referring to isotopes of more than one element, the proper term is nuclide.

NUREG—Nuclear Regulatory Commission's implementation guidance document.

Pico—Abbreviated p. A prefix denoting one-trillionth (10^{-12}).

RADIAC—Radiation Detection, Indication, and Computation instruments used to measure radiation emission rate or exposure.

Radiography—The process of examining a person, animal, object, or structure below the surface without injury or incursion using a radioactive source or a machine source of ionizing radiation.

Radioisotope—An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. These elements have the same number of protons but different numbers of neutrons in their nuclei. Approximately 3,700 natural and artificial radioisotopes have been identified.

Radioluminescence—Luminescence produced by the bombardment of radiant energy such as x-rays, radioactive waves, or alpha particles on a material such as phosphors.

Radioluminescent device—An item containing radioluminescent paint that allows the device to be seen in the dark. These devices were commonly used by the Navy and possibly contained radium-226, strontium-90, tritium, or promethium-147.

Radioluminescent paint—A paint containing a radioisotope that interacts with a phosphor to produce radioluminescence. The paint was commonly applied to devices that needed to be seen in areas without natural or artificial lighting.

Radionuclide—An unstable nuclide or isotope. See radioisotope.

RASO—The Naval Sea Systems Command Detachment, Radiological Affairs Support Office, located in Yorktown, Virginia. RASO provides technical support to the Navy for management and control of G-RAM.

Release criterion—A regulatory limit established to set a limit for decontamination of residual radioactive contamination. The term may be expressed as a quantification of radioactivity, dose, or exposure risk.

Roentgen—A unit of exposure for x-rays or gamma rays.

Scoping Survey—A survey to identify radionuclide contaminants, relative radionuclide ratios and general levels, and extent of contamination. These surveys usually include minimal surface scans, sampling, and dose rate assessments.

Source—A small device containing radioactive material. The device may be used in research and industrial processes and may be sealed or unsealed. Sealed sources are often part of specialized industrial devices that measure quantities such as the moisture content of soil or the density or thickness of materials (radiography or NDT). Sources are usually enclosed in a housing that prevents the escape of the radioactive materials. Often referred to as "radioactive sources" or "sealed sources."

Source Material—(1) Uranium or thorium, or any combination thereof, in any physical or chemical form or (2) ores which contain by weight one-twentieth of one percent (0.05%) or more of: (i) Uranium, (ii) thorium or (iii) any combination thereof. Source material does not include special nuclear material.

Special Nuclear Material—(1) plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the U.S Nuclear Regulatory Commission, pursuant to the provisions of section 51 of the Atomic Energy Act, determines to be special nuclear material, but does not include source material; or (1) any material artificially enriched by any of the foregoing but does not include source material

Spectroscopy—Physics that deals with the theory and interpretation of interactions of matter and radiation. Often used in the analysis of samples for quantification or qualification of radioactive content.

Structure—A man-made surface(s) above the surface or contained within subsurface media.

Subsurface soil and media—Solid materials and media found below the surface soils.

Surface soil—The top layer of soil (6 inches below ground surface), fill, gravel, waste piles, concrete, or asphalt that is available for direct exposure, growing plants, resuspension of particles for inhalation, and mixing from human disturbances.

Surface water—Waters found in streams, rivers, lakes, and oceans as well as coastal tidal waters.

Swipe sample—Type of sample collected to measure removable contamination on surfaces by alpha and beta particles.

Tolerance level—Levels used for ship and materials clearance and radiation exposure before and after ship decontamination. Term was used during the early years, mainly concerned with OPERATION CROSSROADS ships and work on those ships.

Undifferentiated Sedimentary Deposits—Sediments consisting of varying types of sands, clays, soils, and rocks which are either structurally indistinguishable or can not divided into finer age divisions.

Unknown Contamination Potential—Residual radioactive contamination potentially exists but no clear indication of possible contamination levels or contaminants has been established.

Unlikely Contamination Potential—Residual radioactive contamination is not expected but investigation is warranted.

Weatherboard—A length of timber boarding (usually elm, now pine) fixed horizontally or vertically to the exterior of a structure.

Wetland—A type of sensitive environment sufficiently inundated or saturated by surface water or groundwater to support vegetation adapted for life under saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

1.0 EXECUTIVE SUMMARY

This document is a Historical Radiological Assessment (HRA) that provides a comprehensive history of radiological operations by the U.S. Department of the Navy (Navy) and Navy contractors at Naval Station Treasure Island (NAVSTA TI). The HRA has been prepared pursuant to the Navy's Installation Restoration (IR) Program, which encompasses the Navy's Base Realignment and Closure (BRAC) Program, and in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA). The format and content follow the guidelines for a Historical Site Assessment established in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM.)

The primary purpose of the HRA is to designate sites as impacted or non-impacted. An impacted site is one that has, or at one time had, the potential for radioactive contamination, based on historical information, in excess of natural background or fallout levels. In many instances, designation as impacted does not confirm that radioactive contamination is present; only that the possibility exists and must be investigated.

A non-impacted site is one, based on historical documentation or results of previous radiological survey information, where there is no reasonable possibility for residual radioactive contamination. If new historical information becomes available or contamination is found at a non-impacted site, the site would be redesignated as "impacted."

To designate sites as impacted or non-impacted, the HRA defines the extent of past radiological operations, assesses the likelihood of potential contamination and potential contamination migration pathways, and recommends future actions. Historical radiological operations examined at NAVSTA TI included:

- Training personnel on the calibration, maintenance, and operation of radiation monitoring instruments.
- Training personnel on radiological monitoring, and decontamination of ships and airplanes.

- Berthing of OPERATION CROSSROADS ships prior to those ships being given final radiological clearance.

The HRA assessed 542 historical and current sites (e.g., buildings, structures, and open areas) at NAVSTA TI. Eighteen sites were identified as requiring further review. Of those 18 sites, 13 were ultimately designated as non-impacted and are discussed further in this HRA to document the "non-impacted" designation. Five sites are designated as "impacted" and are recommended for further investigative actions. The impacted sites include:

- Two buildings, Building 233 and Building 344 were the locations of a documented 1950 spill of radioactive material (Building 233) and a 1988 investigation of contamination in a waste container (Building 344). In each case, the radioactive contamination was cleaned up and disposed of off the naval station. Surveys are available to demonstrate that the areas were decontaminated to meet the Navy standards at the time. A characterization survey is recommended for Building 233. A final status survey is recommended for Building 344.
- Building 343 is one of the three buildings of the radiation detection, indication, and computation instrument (RADIAC) school during the 1950s, 1960s, and 1970s. The closeout survey by the Navy in a storeroom detected two alpha wipe survey points that were above release limits and although decontaminated, they were not adequately investigated. Therefore a final status survey of the storeroom is recommended.
- Four solid waste disposal areas located within IR Site 12 although unlikely could contain radioluminescent devices. However, The disposal of such devices at NAVSTA TI is unlikely because NAVSTA TI's mission was training and not the maintenance and repair of ships, during which such devices were removed and disposed in base landfills. Therefore, precautionary radiation surveys are recommended during remedial or removal actions at these areas.
- Scoping surveys are recommended for Building 233 internal sink drains and drain traps and the first sanitary sewer drain manhole downstream of the building to determine if wash water containing radioactive material was introduced to the building drainage system during the initial personnel decontamination in Building 233.

Potentially contaminated media include surface soils (Building 233 and solid waste disposal areas within IR Site 12), subsurface soil and media (IR Site 12), structures (Buildings 233, 343, and 344), and sanitary sewer drainage systems (Building 233).

Section 6.0 provides the history of radiological operations at NAVSTA TI. Section 8.0 provides specific details for each potentially impacted site, including site description, former uses, current uses, radionuclides of concern, previous radiological investigations, assessment of potential

contamination, identification of potential contaminated media and potential migration pathways, recommendations for future actions, and site maps. No impacted site is recommended for emergency action. No sites are identified with known contamination that requires restricted access, although Building 233 is to be surveyed to confirm the building does not contain residual radium contamination from the 1950 spill cleanup activities.

Overall the review of previous radiological activities, cleanup actions, and release surveys has not identified any imminent threat or substantial risk to human health or the environment of NAVSTA TI or the local community.

2.0 INTRODUCTION

This document, entitled *Historical Radiological Assessment, Use of General Radioactive Materials, 1947-2003, Naval Station Treasure Island,* presents a comprehensive history of radiological operations using radioactive materials that were conducted by the Navy and Navy contractors at the NAVSTA TI. The Navy closed NAVSTA TI in 1997. Early estimates indicated TI included approximately 397 acres. Later surveys revised that figure to approximately 403 acres. An additional 122 acres on Yerba Buena Island (YBI) are part of the Naval Station (**TI-HRA-1**).

2.1 SCOPE

TI and YBI are located approximately midway between San Francisco and Oakland. Over the years, NAVSTA TI has also been known as Treasure Island Naval Air Station and San Francisco Navy Technical Training Center (NTTC) (**TI-HRA-2**). For purposes of this document, NAVSTA TI refers to the Naval Station and TI or YBI refer to the discrete islands that makeup NAVSTA TI.

This document describes the history of operations involving general radioactive material (G-RAM), which is defined as any radioactive material used by the Navy or Navy contractors not associated with the Naval Nuclear Propulsion Program (NNPP). The distinction is necessary because NNPP radioactive material and G-RAM are managed by different Navy offices and have different historical controls and practices. Some other Navy installations operated under both programs. There is no indication that NAVSTA TI was associated with NNPP.

2.2 HRA PURPOSE

The Navy uses HRAs to document the extent of past radiological operations at a specific site and the residual effects these operations may have had on the site. HRAs meet the protocol for a Preliminary Assessment (PA), as defined by the Environmental Protection Agency's (EPA) CERCLA guidance and can be used to support removal actions within the CERCLA process.

The HRA also meets the definition of a Historical Site Assessment as defined by the MARSSIM **(TI-HRA-3)**.

Historical G-RAM operations conducted at NAVSTA TI included:

- Calibration laboratory operations for ensuring radiological survey instrument accuracy.
- Training of personnel to calibrate, maintain, and use radiological survey instruments.
- Training of personnel to perform radiation surveys and to decontaminate navy vessels and aircraft.
- Providing berthing for some OPERATIONS CROSSROADS vessels prior to issuance of final radiological clearance.

In addition to documenting the radiological history of a site, the Navy uses an HRA as a tool to assess, if any, the residual effect radiological operations may have had on buildings, structures, and open land areas. Assessments for the potential presence of radioactive materials result in designation of buildings, structures, and open areas as "non-impacted" or "impacted" sites. Non-impacted sites are considered to have no reasonable potential for residual radioactive contamination. A designation of impacted means the history of the site indicates that radioactive materials may have been used, stored, or disposed at that location. At these sites, further investigation may be required to verify that the building or area is not contaminated, that there is no potential for residual radioactive contamination at levels exceeding natural background and current state and federal release standards. If further investigation and remediation of impacted sites are necessary, documentation of the activities will be presented in separate reports.

2.3 REGULATORY BACKGROUND

The information in this HRA is being presented pursuant to the Navy's IR Program, which encompasses the Navy's BRAC Program. These programs function in accordance with CERCLA and SARA as directed by Executive Order 12316 of 20 August 1981, which required the U.S. Department of Defense (DoD) to comply with CERCLA.

The Navy instituted the Naval Assessment and Control of Installation Pollutants (NACIP) Program in the mid-1980s as a method of complying with CERCLA. The first step in the NACIP Program was to conduct an Initial Assessment Study (IAS) to assess potential contamination by hazardous materials, including radioactivity. The NAVSTA TI IAS was completed in 1988 **(TI-HRA-4)**. NAVSTA TI was not placed on the EPA's National Priority List (NPL).

In 1993, the U.S. Congress called for the closure and release of NAVSTA TI for reuse under the Base Closure and Realignment Act of 1988. A Federal Facility Site Remediation Agreement (FFSRA) signed on September 29, 1992, by the Navy and the California Environmental Protection Agency (Cal EPA), established cleanup actions and timeframes for NAVSTA TI **(TI HRA-5)**. On July 31, 1990, a Memorandum of Understanding (MOU) was finalized between the California Department of Health Services (CDHS) and Cal EPA Water Resources Control Board, and Regional Water Quality Control Boards which specifies each agency's responsibilities in hazardous waste site cleanup.

The DoD has the authority to undertake CERCLA actions under Title 42 of the *United States Code* (USC), Section 9604; Title 10 of the USC, Section 2705; and Federal Executive Order 12580. Under the authority of CERCLA, DoD has undertaken the assessment of radioactive materials at NAVSTA TI by conforming to the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Title 40 of the *Code of Federal Regulations* (CFR), Part 300. Because CERCLA defines radionuclides as hazardous substances, radionuclides are included in the CERCLA process to investigate, characterize, and remediate contamination. Appendix B of Title 40 of the CFR, Part 302.4 lists the specific radionuclides defined as CERCLA hazardous substances. All of the radionuclides previously used at NAVSTA TI are included on this list (**TI-HRA-6**).

The MARSSIM is a consensus document of the EPA, DoD, the U.S. Department of Energy (DOE), and the U.S. Nuclear Regulatory Commission (NRC). MARSSIM provides detailed guidance for investigation of radiologically impacted sites. Developed to be consistent with CERCLA, MARSSIM uses a single-phase approach (Survey and Site Investigation Process) to address radioactive contamination issues versus CERCLA's multi-phased approach. MARSSIM is not designed to replace or conflict with existing CERCLA or RCRA guidance, it is designed to

provide supplemental guidance for specific applications of the CERCLA Remedial or Removal Process or the RCRA Corrective Action Process. Once the presence of radioactive material has been identified and remediated at impacted sites, MARSSIM recommends a Final Status Survey (FSS) for radiological release of a site for unrestricted use to fulfill the CERCLA closure and post-closure process. Section 8.0 provides the current status of each impacted site with the appropriate recommendation to comply with MARSSIM.

2.4 REPORT ORGANIZATION

This HRA is organized to present the history of radiological operations at NAVSTA TI from the beginning of documented Navy radiological activities in 1947 through 2003, by providing the following information:

- Potential, likely, or known sources of G-RAM.
- Potential, likely, or known areas of G-RAM use.
- History of G-RAM operations, investigations, remediations, and surveys.
- Classification of an area as impacted or non-impacted by radiological operations.
- Identification of potentially contaminated media.
- Assessments of the likelihood of contamination migration.
- Assessment of risk to human health and the environment.
- Information useful to radiological scoping and characterization surveys.
- Recommendations for future radiological investigations and remediation processes.

The basic organization of the report is listed below. Individual tables and appendices are not included here, but are listed in the Table of Contents. Figures are presented after their first mention in the text of the HRA, tables are presented after their respective sections, and appendices are presented after Section 10.0. Section 10.0 lists the reference documents used to prepare this HRA. The actual documents are provided separately on a compact disc.

3.0 SITE IDENTIFICATION AND DESCRIPTION

NAVSTA TI is located on two islands in San Francisco Bay approximately midway between the City of San Francisco and the City of Oakland (Figure 3.1). TI is a man-made island of approximately 403 acres. YBI is a natural island of approximately 170 acres connected to TI via a man-made causeway (Figure 3.2). This section details the geological and physical site characteristics and the current and historical information for NAVSTA TI and immediately adjacent areas.

Figure 3.1 San Francisco Bay Area (TI-HRA-7)

Figure 3.2 Treasure Island and Yerba Buena Island (TI-HRA-8)

3.1 SITE DESCRIPTION

NAVSTA TI consists of approximately 945 acres, of which approximately 454 acres surrounding TI and on the northern side of YBI are submerged below the Bay. The dry land property includes all of TI (approximately 403 acres) and a portion of YBI north of the San Francisco-Oakland Bay Bridge (approximately 88 acres) (**TI-HRA-9**). Access to TI and YBI is via the east-bound (lower deck) of the bridge from San Francisco, and via the west-bound (upper deck) of the bridge from Oakland.

For purposes of CERCLA, the Naval Station is identified as:

Treasure Island Naval Station (NAVSTA TI)
San Francisco, California
EPA Region IX
CERCLA Information System (CERCLIS) Identification No. CA7170023330 (**TI-HRA-10**)

The Army Corps of Engineers constructed TI in 1936 to be the site of the 1939 Golden Gate International Exposition. The construction project, which required approximately 19 months, included the creation of a perimeter seawall using 287,000 tons of rock. The seawall was then filled with almost 30 million cubic yards of sand and gravel dredged from San Francisco Bay. The seawall was originally 13 feet above sea level. After filling the cavity, the fill material was desalinized by pumping in millions of gallons of fresh water and extracting the diluted saltwater. A six-foot layer of topsoil was used to surface the entire island. After completion of construction of TI in August 1937, the next eighteen months were devoted to constructing the exposition buildings and preparing the site for the exposition to open in February 1939 (**TI-HRA-11**).

3.2 GEOLOGICAL SETTING

The Bay was dry land during the ice ages when sea level dropped more than 300 feet as water accumulated in the great continental glaciers. The Sacramento River picked up several tributaries as it flowed through the coastal lowland, and then through the last mountain ridge in a deep canyon that is now the Golden Gate Strait. Coastal lowlands filled with water as sea level rose at

the end of the last ice age. The Bay assumed its present form about 10,000 years ago, when sea level returned to its present stand.

Since the rising sea level flooded the Golden Gate Strait and converted the lower part of the river valley into what is now known as San Francisco Bay, the Sacramento and San Joaquin Rivers have been filling the Bay with sediment. This is because early mining operations in the Sierra Nevada started billions of cubic yards of sediment moving down the rivers. More than a billion cubic yards of that sediment has now reached the Bay. It is estimated about 8 million cubic yards of sediment wash into the Bay every year. Recognizing the sand and gravel dredged from the bay and used to fill the island came from the gold bearing Sierra Nevada Mountains, the island was named "Treasure Island" (**TI-HRA-12**).

The Bay is about 55 miles long from north to south and 3 to 12 miles wide, an area of about 435 square miles. At its deepest part, the Bay is about 350 feet deep, but more than 80 percent is less than 12 feet deep. The Bay is made up of brackish water that is about 2.8 percent dissolved salts, 15 percent less than normal seawater, which flows in and out with the tides. An average cycle of rising and ebbing tide moves enough water through the Golden Gate Strait to flood about 1.25 million acres to a depth of 1 foot. Incoming currents reach speeds as great as 4 miles per hour; outgoing flow is much slower (**TI-HRA-13**).

3.3 GEOLOGY

TI is a manmade island, measuring approximately 403 acres and consisting primarily of sand sediments dredged from San Francisco Bay and placed within a retaining wall of rock and sand dikes. Dredging and construction of the island, as directed by the U.S. Army Corps of Engineers, began in 1936 and was completed in 1937. The island was constructed on the Yerba Buena Shoals, a sand spit that extended north and northwest of naturally occurring YBI.

Subsurface materials at TI can be divided into the following four geologic units, listed from youngest (shallowest) to oldest (deepest):

- Fill and Shoal Sands (dredged sand fill and Yerba Buena shoal sands).
- Younger Bay Mud.

- Older Bay Mud.
- Franciscan Assemblage.

Dredged sediments used for construction of TI consisted primarily of fine- to coarse-grained sand with lesser amounts of silt, clay, and gravel. The dredged sand included some shell fragments and clay nodules. The clay nodules were derived from clay beds within the sediment, excavated by dredging, and rounded as they passed through the delivery pipeline. Thin beds of clay occasionally developed as finer materials in the dredged sand fill settled out during dredging operations. Of the more than 29,360,000 cubic yards of material dredged from a variety of locations in San Francisco Bay, approximately 21 million cubic yards was retained behind the sea wall of TI. The remainder of the dredged material was lost during construction as a result of tidal current erosion and flotation of fine-grained material.

Underlying the Yerba Buena Shoal sands are Younger Bay Mud sediments of marine origin that consist of soft to stiff, olive gray silty clay and clay with interbedded sand and silt layers in some areas. Younger Bay Mud sediments range in thickness from approximately 10 to 120 feet; these sediments are thinnest on the eastern portion of the island and thicken toward the northwestern portion of the island (**TI-HRA-14**), (**TI-HRA-15**).

Underlying the Younger Bay Mud sediments are the Older Bay Mud sediments, which consist of stiff to very stiff, sandy, silty, and peaty clays that extend to the Franciscan bedrock. The Older Bay Mud sediments, which range in thickness from approximately 20 to 170 feet, are thinnest on the southern portion of the island and thicken toward the northern portion of the island (**TI-HRA-14**), (**TI-HRA-15**).

Underlying the Older Bay Mud sediments is bedrock of the Franciscan Assemblage, which consists of interbedded shales and sandstone. Based on logs for borings on the northwestern portion of TI that penetrated bedrock, the estimated depth to the Franciscan Assemblage ranges from 150 to 320 feet below ground surface, depths are shallowest on the southern portion of the island and deepest toward the northern portion of the island (**TI-HRA-14**), (**TI-HRA-15**).

YBI is a natural island that has been mapped by Blake and others (1974) to consist of four geologic units: landslide debris, artificial fill, sand of the Colma Formation, and sandstone and

shale bedrock of the Franciscan assemblage. The most recent geologic unit at YBI is the landslide debris which results from the clayey silty sand that has moved downslope. An area of significant landslide debris is located on the north side of the Island although smaller areas of landsliding are found at other locations. The next unit, artificial fill, has been placed along the eastern shoreline of the Island. The Colma Formation, a fine to medium grained sand with minor amounts of interbedded sandy silt, clay, and gravel, is exposed over approximately 70 percent of the island. It unconformably overlies the bedrock below and is variable in thickness, extending from a few inches to several feet. It blankets the ravines and slopes and in places even forms relatively flat benches. Underlying these deposits is the Franciscan Assemblage which is the oldest geologic unit on the island consisting of resistant sandstone and shale. It tends to be highly variable in compositions and structure in the San Francisco Bay region; however, surficially at YBI it appears very consistent in structure and composition. The Franciscan units exposed on YBI generally dip to the northeast and have a northwest to south east trend (**TI-HRA-4**).

The major active faults in the TI vicinity are all part of the San Andreas fault system. Figure 3.3 shows the location of active fault systems surrounding the area. TI lies between two major faults: the San Andreas fault, 9 miles to the west, and the Hayward fault, 3 miles to the east. Both of these fault systems are considered active and likely to experience a major event (Richter of magnitude 6.7 or greater) within the next 200 years. Other significant faults include the Calaveras fault approximately 50 miles to the southeast, the San Gregorio-Seal Cove fault 24 miles to the west, the Rodgers Creek fault approximately 40 miles to the north, and the Maacama fault approximately 100 miles to the north. There are several lesser-known faults within approximately 60 miles (**TI-HRA-4**).

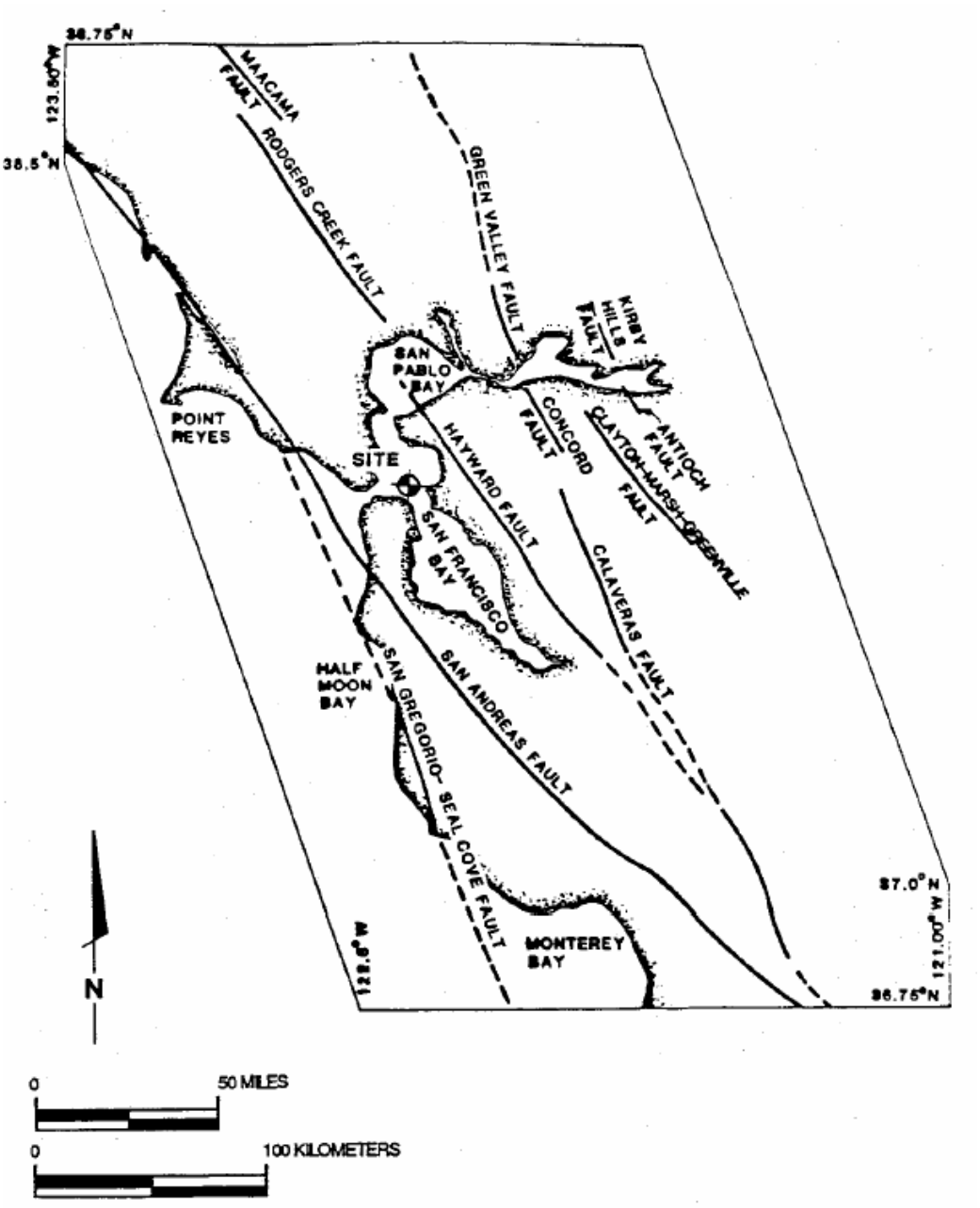

Figure 3.3 Major Earthquake Fault Systems Surrounding TI (TI-HRA-4)

During the Loma Prieta Earthquake on 17 October 1989, some lateral spreading and liquefaction were experienced on TI. (**See Figure 3.4**)

Figure 3.4 Liquefaction on Treasure Island after Loma Prieta Earthquake (TI-HRA-16)

3.4 HYDROLOGY

3.4.1 Groundwater

TI and YBI are surrounded by the waters of the San Francisco Bay. Any surface drainage off the two islands flows into the Bay.

Ground water at TI is generally present at depths of 2.5 to 6 feet below ground surface (bgs). Subsurface water at TI has no beneficial use and is not used.

The primary source of drinking water, industrial water, and landscape irrigation, at both TI and YBI, is the water provided by the San Francisco Water Department. This water is piped in from San Francisco across the Bay Bridge. A secondary source of water is from the East Bay Municipal Utility District piped in from Emeryville across the Bay Bridge (**TI-HRA-4**).

3.4.2 Climate and Meteorology

In general, the climate of the area is marine and characterized by very little change in temperature. The average annual precipitation is about 25 to 30 inches. Most precipitation falls between October and April. Localized showers are infrequent and storms are moderate in

duration and intensity. The average annual air temperature is 56 to 58 degrees F., and the average frost-free period is 300 to 330 days. The relative humidity in winter is about 80 to 90 percent at night and 60 to 70 percent in the afternoon. It is less in spring, but increases at night in summer. Humidity is lowest in fall. It ranges from 50 percent during the day to 70 percent at night. Frequent morning and evening fog occurs during the summer. Throughout the year the wind direction for the area is predominately from the west-northwest. The average wind speed ranges from 8 miles per hour to 14 miles per hour and annually averages 11 miles per hour. (**TI-HRA-17**). The strongest winds are usually associated with winter storms. Winds from the north and east are sometimes accompanied by cold temperatures in winter and spring. Westerly winds in summer are generated by the cool marine air flowing to the warmer interior. These winds are strongest early in summer, mainly late in the afternoon and in the evening (**TI-HRA-4**).

3.5 ADJACENT POPULATION

The 2000 Census reported 33,871,648 people in California, with almost 9 million residing in counties at least partially within a 50-mile radius of NAVSTA TI. The metropolitan areas of San Francisco, Alameda, and Santa Clara Counties contain most of this population. The distribution of this population is shown in Table 3-1 (**TI-HRA-18**). The population in cities within a 10-mile radius of NAVSTA TI is shown in Table 3-2.

Current approximate population on TI and YBI is 3,500 (**TI-HRA-19**).

3.6 PAST, CURRENT AND FUTURE NAVSTA TI USAGE

As early as 1968, the Navy has leased some NAVSTA TI buildings to private tenants and Navy-related entities for various uses. For example, the Bureau of Alcohol, Tobacco, and Firearms operated a laboratory in Building 233 beginning in about 1976; the California Conservation Corps leased Building 109 for their operations; and the San Francisco Unified School District operated a school on NAVSTA TI. Many non-navy and even non-military tenants occupied space on NAVSTA TI including the American Red Cross, the Environmental Protection Agency, the National Maritime Union Job Corps, and the Treasure Island Yacht Club. Table 3-3 summarizes the identified buildings, structures, and open areas currently and formerly located on

TI, their former and current uses, and current tenants. There is no indication that any of the buildings on Yerba Buena Island were utilized in support of the radiological activities of the various training schools on NAVSTA TI. A pier on Yerba Buena Island was used for a few days to provide accommodation berthing for an OPERATION CROSSROADS ship after it was decontaminated at Hunters Point Shipyard but before the ship was given final radiological clearance. Therefore Tables 3-3 and 3-4 list TI only buildings. Many of the buildings had multiple uses over the life of the naval station. Table 3-4 shows the chronological history of use of NAVSTA TI buildings and locations.

Several alternative scenarios are under review for development of the former Naval Station. All scenarios include some combination of residential, open space, publicly oriented, and institutional and community uses. Figure 3.5 shows one proposed future reuse of NAVSTA TI (**TI-HRA-20**).

There are no known current uses of licensed or unlicensed radioactive materials on Treasure Island.

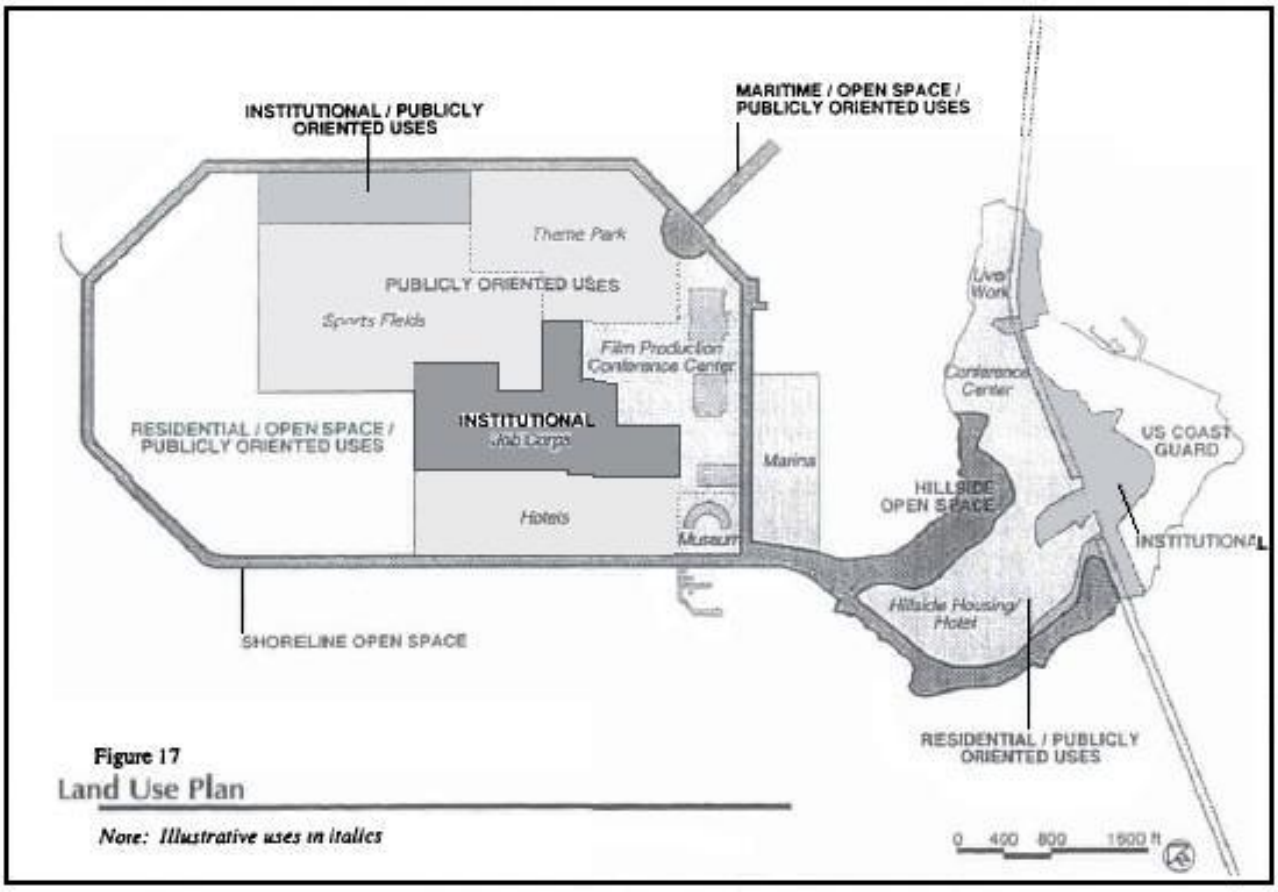

Figure 3.5 Land Use Plan (TI-HRA-21)

3.7 ENVIRONMENTALLY SENSITIVE AREAS

Terrestrial and aquatic ecosystems occur on or near TI and YBI. Wetland ecosystems are present throughout the Bay Area, but are not located on or near TI or YBI. However, both islands are highly influenced by the surrounding marine habitat of San Francisco Bay. Additionally, a wetlands area has been proposed as part of the future redevelopment plan for one or more locations on TI and YBI.

TI is intensively developed, maintained and landscaped with trees, shrubs, and lawns, landscaping and maintained areas. The vegetation consists of grasses, shrubs, herbaceous perennials, and trees: most of which have been cultivated in landscaped areas as the island was developed. Some of the more dominant species include perennial ryegrass, Kentucky bluegrass, Star acacia, bottle brush, boxwood, oleander, English ivy, ice plant, blue gum, Monterey pine, coast live oak, bishop pine, sycamore, and white fir (**TI-HRA-4**).

YBI is a rugged, steeply sloping heavily wooded island which contrasts greatly with the flat urban industrial character of the man-made TI. The majority of the island is undeveloped. However, there are approximately 55 acres of developed urban terrestrial habitat consisting mostly of residential housing areas on the northern side of the island. Vegetation in these areas is similar to the cultivated landscaping described for TI. The majority of YBI consists of undeveloped land. The undeveloped areas consist of grasslands, woodlands, and brushlands. Some of the typical species include brome, California oatgrass, blue gum, coyote bush, coastal sage, poison oak, California buckeye, and blackberry.

Wildlife known and expected to occur on TI and YBI consist mostly of species adapted to urban environments and landscape plantings. Terrestrial habitat of TI is of poor quality for wildlife species because the island is predominately covered with urbanized areas (**TI-HRA-4**). Buildings, pavement, lawns, and other landscaped sections provide poor quality habitat because of the large proportion of the island that is sealed beneath buildings, streets, and parking lots. As described below, the vegetated parts of TI are made up of lawns and landscaped areas. Birds typically associated with urban or residential environments and adapted to human disturbance are found on TI and YBI. These include house finch, stellar jay, English sparrow, Savannah sparrow,

and robin. Large areas of shrubs interspersed with grasslands and extensive eucalyptus woodlands occur on YBI. These areas provide cover for birds such as quail, woodpecker, horned lark, cedar waxwing, and white-breasted nuthatch. The shoreline areas of YBI are used by terns and pelicans for foraging and by herring gulls for roosting. The mammals of both TI and YBI consist primarily of California ground squirrel and pocket mice. A small group of harbor seals uses the southwest shoreline of YBI (**TI-HRA-4**).

Several Federal and California threatened and endangered species have been observed at or near NAVSTA TI. In particular, the following species have been observed: chinook salmon, steelhead trout, coho salmon, American peregrine falcon, peregrine falcon, California brown pelican, California clapper rail, California least tern, western snowy plover, southern sea otter, and stellar sea lion. All of the above species are listed as endangered or threatened by the federal government or by the State of California or both (**TI-HRA-22**).

Treasure Island Elementary School located at 13th and E Streets on Treasure Island is operated by the San Francisco Unified School District and in 2004 served approximately 450 students in grades K through 8 (**TI-HRA-23**).. The reported 2005 enrollment is about 350 students with 130 living on TI and the other 220 students bussed in from various locations in San Francisco (**TI-HRA-24**). No other elementary schools are within a one-mile radius of TI or YBI. There is a daycare center just across the street from the Treasure Island Elementary School. The Kidango Treasure Island Center serves ages from birth to Kindergarten entry with a capacity of 100 children (**TI-HRA-25**).

SECTION 3

TABLES

Table 3-1

Population Of Counties "All" or "Partially" within a 50-Mile Radius of Naval Station Treasure Island

COUNTY	1990 POPULATION	2000 POPULATION
Alameda	1.279,182	1.443,741
Contra Costa	803,732	948,816
Marin	230,096	247,289
Napa	110,765	124,279
Sacramento	1.041,219	1,223,499
San Francisco	723,759	776,733
San Joaquin	480,628	563,598
San Mateo	649,623	707,161
Santa Clara	1.497,577	1.682,585
Santa Cruz	229,734	255,602
Solano	340,421	394,542
Sonoma	388,222	458,614
Yolo	141,092	168,660

Source – (**TI-HRA-18**)

Table 3-2

Population of Cities within
a 10-Mile Radius of Naval Station Treasure Island
(Greater Than 10,000 Population)

CITY	1990 POPULATION	2000 POPULATION
Alameda	76,459	72259
Albany	16,327	16,444
Berkeley	102,724	102,743
Daly City	92,311	103,621
El Cerrito	22,869	23,171
Hercules	16,829	19,488
Larkspur	11,070	12,014
Mill Valley	13,038	13,600
Oakland	372,242	399,484
Orinda	16,642	17,599
Piedmont	10,602	10,952
Pinole	17,460	19,039
Richmond	87,425	99,216
San Francisco	723,959	776,733
San Pablo	25,158	30,215
San Rafael	48,404	56,063
South San Francisco	54,312	60,552

Source – (**TI-HRA-18**)

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
1	China Clipper terminal, Navy Headquarters offices, museum, SWDIV offices	Police station, TIDA office, John Stewart Co. rental agency office, BRAC Caretaker offices
2	Aviation exhibits, airplane hanger, Reserve center, general use	Leased to City of San Francisco
3	Palace of Fine and Liberal arts, Port Control Office, Ship repair shops, training and equipment repair	Leased to City of San Francisco
4-6	Diesel oil and gasoline storage tanks (8 total)	Scheduled to be demolished
7	Federal Building, various navy schools, Naval Reserve Center	Closed
8	Exposition building, Federal Building, General mess, Administration and training	Demolished
9	Exposition building, Coast Guard barracks, Administrative offices	Demolished
10	Exposition building, Barracks	Demolished
11	Exposition building, Galley and mess, Barracks, Administrative offices	Demolished
12	Exposition building, Administrative offices	Demolished
12A	Derrick house, Port Operations Office, Ships pilot office, storage	In place
12B	Shed for building 12A	In place
12C	Shed for building 12A	Demolished
13	Exposition building, Main barracks	Demolished
14	Heating plant	Demolished
15	Exposition building, Dispensary	Demolished
16	Barracks (Schools Command)	Demolished
17	Barracks (Schools Command)	Demolished
18	Barracks (Schools Command)	Demolished
19	Barracks (Schools Command)	Demolished
20	General Barracks	Demolished
21	General Barracks	Demolished
22	General Barracks	Demolished
23	Barracks (Schools Command)	Demolished
24	Barracks (Schools Command)	Demolished
25	Barracks (Schools Command)	Demolished
26	Heating plant #2	Demolished
27	Radio Material School, Classrooms (Schools Command)	Demolished
28	Radio Material School, Administration (Schools Command)	Demolished
29	Mess hall, Radio Material School, Administration building	Layup
30	Surgical Operations, Barracks, Administration	Demolished
31	Surgical Ward, Barracks, Storage	Demolished

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
32	Surgical Ward, Barracks, Administration, Storage	Demolished
33	Isolation Ward, Administration	Demolished
34	Subsistence, Commissary	Layup
35	Medical (Eye, Ear Nose, and Throat), Barracks	Demolished
36	General Medical Ward, Barracks	Demolished
37	General Medical Ward, Barracks, Storage	Demolished
38	Urological Ward, Barracks, Classrooms (Schools Command)	Demolished
39	Urological Ward, Barracks	Demolished
40	Isolation Ward, Barracks and supply	Layup
41	Small Arms building, Forge and Foundry, Paint shop, Port Operations	Layup
42	Inert Ammunition Storage, Storage	Demolished
43	High Explosives Magazine, Inert Ammunition Storage, Storage	Demolished
44	High Explosives Magazine, Inert Ammunition Storage, Storage	Demolished
45	High Explosives Magazine, Inert Ammunition Storage, Storage	Demolished
46	High Explosives Magazine, Inert Ammunition Storage, Storage	Demolished
47	High Explosives Magazine, Inert Ammunition Storage, Storage	Demolished
48	High Explosives Magazine	Demolished
49	High Explosives Magazine, Inert Ammunition Storage, Storage	Demolished
50	Inert Ammunition Storage	Demolished
51	Y-Gun Storage, Inert Ammunition Storage, Storage	Demolished
52	Fuse and Detonator Magazine	Demolished
53	Fuse and Detonator Magazine, Inert Ammunition Storage, Storage	Demolished
54	Ammunition Magazine	Demolished
55	Inert Ammunition Storage, Storage	Demolished
56	Storage	Demolished
57	Storage	Demolished
58	Incinerator and Refuse Building, Paint Shop	Demolished
59	Office, Work Improvement Program	Demolished
60	Machine shop, Shop, Storage	Demolished
61	Carpenters Shop, Paint Spray Shop, Storage	Demolished
62	Exposition Warehouse, First Lieutenant's Warehouse, Naval Reserve, Training Center	Layup
63	Signal Tower at Pier 21	Demolished
64	Dock Master's Office, Fuel Detail Office	Layup
65	Slip Shed, Shelter and Rifle Range	Demolished

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
66	Number not used	NA
67	Bleachers and Gear Locker, Storage, Recreation	Demolished
68	Athletic Fields, Shops, Recreation	Demolished
69	Engineers and Shipfitters shop, Hobby shop, garage, storage, public toilets	Layup
70	Gear locker and storage	In place
71	Scrub House, Launderette	Demolished
72	Sterilizer building, Storage, Paper Disintegrator	Demolished
73	Storage and Dock Master's Office	Demolished
74	Office	Demolished
75	Signal Tower	Demolished
76	Dock Crew's Quarters, Wharf Builders Shop	Demolished
77	DC Generator House	Demolished
78	Garbage House	Demolished
79	Gun Shed, Training	Demolished
80	Damage Control School, Training	Demolished
81	Gasoline Station, Fireboat Storage, Storage	Demolished
82	Gasoline Station	Demolished
83	Gasoline Storage and Lubrication Station, Road Striping Detail, Paint Shop Annex, Garage, film Exchange	Demolished
84	Unknown (may have been small office)	Demolished
85	Diesel Oil Clarifier and Pump Station	Demolished
86	Unknown (may have been small office)	Demolished
87	Incinerator	Demolished
88	Storage or Repair	Demolished
89	Hospital storehouse, Communications storage, Office and storage	Demolished
90	Garbage house	Demolished
91	Toilets and self-serve laundry	Layup
92	General Medical Ward, Barracks and Classrooms, Fire Department Inspection Division	Layup
93	Waiting station, Weather shelter	Demolished
94	Number not used	N A
95	Number not used	NA
96	Storage, Reserve training, Printing plant	CSO
97	Number not used	NA
98	Storage	Demolished

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
99	Laundry, Cobbler shop, Tailor, Dry cleaners, Meat Processing facility, Government Printing shop	Undergoing remediation
100	Gun Loading trainer, Portable Office	Demolished
101	Oil pump house	Demolished
102	Heating plant	Demolished
103	Fuel Oil Tank	Cleaned and Abandoned
104	Fuel Oil Tank	Cleaned and Abandoned
105	Oil Pump House	Layup
106	Water Softener Building	Demolished
107	CPO Barracks and Offices, Police station	Layup
108	Waiting station	Demolished
109	Pharmacy and Reception, Barracks	Demolished
110	Linen, bag and miscellaneous storage, Rod and Gun Locker	Demolished
111	Fire House, Fire Station, Port Operations Storage	Layup
112	Derrick House, Port Operations Main Office, Ship's Pilot Office, port Control Storage. Note: Original Building 112 was subdivided and renumbered to Buildings 12A, 12B and 12C	Layup
113	Lumber shed, Port Operations storage	Demolished
114	Storage, Reserve Training shops	Leased to City
115	Garage and shop, Storage, Officer's Wives Mess Storage, Wives Club	Demolished
116	Garage, Storage	Demolished
117	Exposition Building – Palace N, Barracks	Demolished
118	Exposition Building – Palace K-1, Barracks	Demolished
119	Barracks	Demolished
120	Storage, Office	Demolished
121	Electric Shop, Classrooms	Demolished
122	Greenhouse	Demolished
123	Office, Storage and Tool Shed (Nursery)	Demolished
124	Bus Stop Shelter	Demolished
125	Garage, Storage	Demolished
126	Storage, Paint Locker	Demolished
127	Radio Materiel School, Laboratory	Demolished
128	Scrub house, Storage	Leased to City

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
129	Scrub house, Jeep Garage, Storage	Layup
130	Scrub house, Storage	Layup
131	Scrub house, Medical/Dental Storage	Layup
132	Storage	Demolished
133	Fuel Oil Tank	Demolished
134	Fuel Oil Tank	Demolished
135	Garbage house, Launderette, Sunday School	Transferred to Department of Labor
136	Storage, Garbage house, Storage	Demolished
137	Exposition Building Palace - K, Subsistence	Demolished
138	Number not used	NA
139	Exposition Building – Palace – C 2, Gymnasium	Demolished
140	Basalt House, Officer's Mess, Conference Center	Leased to City
141	Explosives office, Carpenter Shop and storage	Layup
142	Oil Storage Building, Paint Locker	Demolished
143	Gasoline pump house, Hazardous Material Locker	Vacant
144	Gasoline storage, Salt Water Pumping Station	Demolished
145	Underground Gasoline Storage Tank	Demolished
146	Control and dispatch, Security, Main Gate	Layup
147	Exposition Building (Home and Garden), Aquacade, Barracks	Demolished
148	Exposition Building (Aquacade), Swimming Pool	Demolished
149	Exposition Building (Hall of Science), Bakery	Demolished
150	Exposition Building (Hall of Science), Barracks	Demolished
151	Exposition Building (Vacationland), Barracks, Paint Locker	Demolished
152	Exposition Building (Vacationland), Ship services	Demolished
153	Garbage house	Demolished
154	Storage	Demolished
155	Exposition Building (Ford Motor Company Building), School	Demolished
156	Gun Shed, Classrooms	Demolished
157	Fire House, Fire Station	In use by SFFD
158	Air Compressor Building, Storage	Demolished
159	Plotting Room, Storage	Demolished
160	Ship Mockup, Classrooms	Demolished
161	Ship Mockup, Classrooms	Demolished
162	Acetylene Generator, Storage	Demolished
163	Diving Tank and Building, Classrooms	Demolished

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
164	Night Lookout Training Building, Storage, School, Community Center	Demolished
165	Storage, Navy Exchange Auto Accessory Sales	Demolished
166	Exposition Building (General Motors Building), School	Demolished
167	Number not used	NA
168	Exposition Building (General Motors Building), Gyro Compass Shop	Demolished
169	Storage	Demolished
170	Exposition Building (Hall of Science), Theatre Office	Demolished
171	Exposition Building (Hall of Science), Theatre	Demolished
172	Exposition Building (Hall of Science), Barracks	Demolished
173	Exposition Building (Electricity and Communications), Barracks	Demolished
174	Exposition Building (Electricity and Communications), Offices	Demolished
175	Exposition Building (Electricity and Communication), Offices	Demolished
176	Tower of the Sun, Band Stand	Demolished
177	Exposition Building (Mines, Metals, and Machinery Exhibit), Reception	Demolished
178	Exposition Building (Mines, Metals, and Machinery Exhibit), Offices, Training Building	Demolished
179	Exposition Building (Mines, Metals, and Machinery Exhibit), Barracks	Demolished
180	Hanger, PWC Transportation Shop	Leased to City
181	PAN AM Gasoline Storage Tanks	Demolished
182	PAN AM Gasoline Pump House	Demolished
183	Office, Traffic Control Office, Yacht Club MWR	Leased to City
184	Sentry house and Bus Stop	Part of Building 146
185	Waiting station	Demolished
186	Waiting station	Demolished
187	Chapel	Leased to City
188	Barracks, Administration	Demolished
189	Barracks, Administration and Barracks	Demolished
190	Barracks, Storage, Dependent Public School	Demolished
191	Barracks, Dependent Public School	Demolished
192	Magnet Channel Range, Degaussing Range, Radar Bomb Scoring Unit	Demolished
193	Magnet Channel Range Garage, Radar Bomb Scoring Unit	Demolished
194	Transportation Building	Demolished
195	Brig Overflow	Demolished
196	Barracks, Public School	Demolished
197	Barracks, Electronics Materiel School	Demolished

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
198	Barracks, Electronics Materiel School	Demolished
199	Barracks, Electronics Materiel School	Demolished
200	Barracks, Electronics Materiel School	Demolished
201	Subsistence, Galley and Mess Hall, Retail Store, MWR tickets and warehouse	Layup
202	Ships Service, Stores and Cafeteria, Retail Store and restaurant, Credit union, Laundromat, NEX Storage, Credit Union ATM	Layup
203	Barracks	Demolished
204	Barracks	Demolished
205	Barracks	Demolished
206	Barracks	Demolished
207	Barracks	Demolished
208	Barracks	Demolished
209	Barracks	Demolished
210	Barracks	Demolished
211	Barracks	Demolished
212	Barracks	Demolished
213	Barracks	Demolished
214	Barracks	Demolished
215	Administration, Storage, Hobby shop, Chapel, Special Services	Layup
216	Assembly shed, Bus pool storage, Draft shed, Recreational Vehicle storage	In use by PUC
217	Bachelor Officers' Quarters, Storage, Post Office, NTTC Training, Cable TV	Leased to City
218	Storehouse, Administration	Demolished
219	Transformer and Storage	Demolished
220	Shop, Classrooms	Demolished
221	Administration, Office and Storage	Demolished
222	Brigade Guard House, Correctional facility	Demolished
223	Paint Shop, Bus Washing Shed	Demolished
224	Garage and Checking Station	Demolished
225	Gun Shed, Storage, Auto Hobby Shop Storage	In use by Department of Public Works
226	Bachelor Officers' Quarters	Demolished
227	Officer's Subsistence Building, Fog Watch Club	Leased to TIDA

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
228	Bachelor Officers Quarters	Demolished
229	Chief Petty Officer's Club, teen or Youth Center, Pizza restaurant	Leased to City
230	WAVES Subsistence Building, Storage, Shop (Mobile ordnance Technical Unit)	Layup
231	Wave Officers' Quarters, Religious Education building	Demolished
232	Wave Barracks (enlisted)	Demolished
233	Classrooms and Administration, RADIAC Calibration training, ATF Laboratory, California National Guard	Layup
234	Nurses Quarters, CPO Quarters	Demolished
235	Ward, Blood Bank and Laboratory, Waves Barracks, Jewish Chaplain	Demolished
236	Administration, Classrooms DCTC	Demolished
237	Oil Storage tank	Demolished
238	Shop and Boiler house, Repair Shop	Demolished
239	Oil Separating Pit and Suction Pump	Demolished
240	Forecastle Mock Up	Demolished
241	Boiler Room Mock Up	Demolished
242	Engine Room Mock Up	Demolished
243	Flight Deck Mock Up	Demolished
244	Diving Tank and OBA Storage and Repair	Demolished
245	Oil Separating Pit	Demolished
246	Smothering Pit	Demolished
247	Oil Storage	Demolished
248	Pump house	Demolished
249	Gasoline Storage	Demolished
250	Suction tank	Demolished
251	Foam tank	Demolished
252	Training tank	Demolished
253	Christmas Tree Training tank	Demolished
254	Christmas Tree Training tank	Demolished
255	Tank (Open)	Demolished
256	Gasoline tank	Demolished
257	Skeet range (prior to construction), dispensary and ward, Family services, Red Cross, Youth Center, Child Care Center	Layup
258	Administration, US Post Office, Bank, Officers' Wives Club and Thrift Shop, Drug Testing Facility	Layup

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
259	Gun Mount, Classrooms	Demolished
260	Supply offices, Warehouse, Servmart	CSO
261	Gym, Pool and Bowling Alley	vacant
262	Theatre	Demolished
263	Welfare Building, Recreation, EM Club and Library	Demolished
264	Refrigerated Storehouse, shops	In use by PUC
265	Hostess House, MWR Offices, Library	Leased to City
266	Sonar School building	
267	Transportation storage, Barracks, Training building, Teen Club	Demolished
268	Gun Loading Shed, Classrooms	Demolished
269	Chemical Warfare Office	Demolished
270	Paint and Oil Storage	Demolished
271	Officer's Recreation Building, Community Facility	Leased to City
272	Electrical and Mechanical Storage, Air Compressor Station	Demolished
273	Decontamination Building, Classrooms	Demolished
274	Dynamometer Shop, Fallout Shelter	Demolished
275	Waves Barracks, Navy Band Barracks	Demolished
276	Office, Film Exchange, Storage	Demolished
277	Ammunition Magazine, Storage	Demolished
278	Ammunition Magazine, Storage	Demolished
279	Ammunition Magazine, Small Craft, Storage	Demolished
280	Ammunition Magazine, Medical Storage	Demolished
281	Ammunition Magazine, Film Storage, Storage	Demolished
282	Ammunition Magazine, Storage	Demolished
283	Ammunition Magazine, Storage	Demolished
284	Ammunition Magazine, Electronic Storage, Storage	Demolished
285	Ammunition Magazine, Storage	Demolished
286	Ammunition Magazine, Tear Gas Storage, Storage	Demolished
287	Ammunition Magazine, Film Storage, Storage	Demolished
288	Gas Chamber (Training)	Demolished
289	Storage, Shop, Paint Storage	Layup
290	Port Operations Storage	Layup
291	Gun Mount	Demolished
292	Pest Control shop	In use by Department of Public Works
293	Shed (NTTC training, damage control)	Layup

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
294	Gear Locker	Demolished
295	Generator building, Training Unit Mock Up	Demolished
296	Water Taxi Pier Shelter and Office	Demolished
297	Transformer house, Storage	Demolished
298	Marina loading shed	Leased to City
299	Loading shed	Demolished
300	Army Barracks, Office, storage	Demolished
301	Subsistence, Storage	Demolished
302	Subsistence, Storage	Demolished
303	Subsistence, Storage	Demolished
304	Toilets	Demolished
305	Toilets	Demolished
306	Supply Office, Storage	Demolished
307	Barracks, Storage	Demolished
308	Barracks, Storage	Demolished
309	Barracks, Shops, Film Exchange	Demolished
310	Barracks, Shops, Film Exchange	Demolished
311	Barracks, Shops, Film Exchange, Storage	Demolished
312	Barracks, Shops, Film Exchange, Storage	Demolished
313	POW Subsistence Storage, Storage	Demolished
314	Gun Mount	Demolished
315	School	Demolished
316	School	Demolished
317	School	Demolished
318	Service Station, Gun Mount, Classrooms	Demolished
319	School (mock-up)	Demolished
320	School (mock-up)	Demolished
321	School (mock-up)	Demolished
322	Gun Mount	Demolished
323	Gun Trainer, Classrooms	Demolished
324	Assembly Shed	Demolished
325	Battery shop and Storage, Pest Control shop	Layup
326	Gun shed	Demolished
327	Salvage building	Demolished
328	Tranformer house	

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
329	Storehouse, Office and Storehouse	Demolished
330	Lucky Bag, Navy Exchange Gas Station, Grounds Maintenance Shop	Layup
331	Greenhouse	Demolished
332	POW Brig, Storage	Demolished
333	Recreation Building	Demolished
334	Paint Locker	Demolished
335	Lucky Bag, Paint Shop, Grounds Maintenance	In use as landscaping shop
336	Linoleum Shop, Storage	Demolished
337	Masons Locker, Storage	Demolished
338	Duty Barracks	Demolished
339	Duty Barracks	Demolished
340	Dock Master's Office	Demolished
341	USS Buttercup (Damage Control Trainer)	Layup
342	RADIAC Instruction	Layup
343	RADIAC Instruction	Layup
344	Radium Vault	Layup
345	Incinerator	Demolished
346	Radio Transmitting Station, Offices	Leased to City
347	Gun Mount	Layup
348	Issue Room, Classroom (Chemical Warfare)	Demolished
349	Field Work shop, Classroom (Chemical Warfare)	Demolished
350	Repair shop, Classroom (Chemical Warfare)	Demolished
351	Repair shop, Classroom (Chemical Warfare)	Demolished
352	NTTC Training	Demolished
353	NTTC Training	Demolished
354	Riggers shed, Storage	Demolished
355	Port Operations Storage, Sandblast shed	Demolished
356	Steam Clean and Car Wash	Demolished
357	Bus Wash	Demolished
358	Resistor Bank building, Storage	Leased to City
359	Mobile Decontamination, Classrooms	Demolished
360	Boat house – Pier 24	Demolished
361	Hot water tank building	Layup
362	Port Operations storage shed	Layup
363	Civilian Barracks, Maritime Cooking School	Transferred to Department of Labor

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
364	Barracks	Transferred to Department of Labor
365	Barracks and Offices	Transferred to Department of Labor
366	Barracks and Offices	Transferred to Department of Labor
367	Transient Personnel Unit Administration, Personnel Support Detachment, Barracks	Transferred to Department of Labor
368	Enlisted Men's Dining Hall	Transferred to Department of Labor
369	BOQ, Officers Club	Transferred to Department of Labor
370	Gasoline filling station	Demolished
371	USS Pandemonium (mock-up trainer)	Demolished
372	Training Facility- Antenna Tower	Demolished
373	Training Facility- Antenna Tower	Demolished
374	Sump house	In place
375	Training Facility- Antenna Tower	Demolished
376	Training Facility- Antenna Tower	Demolished
377	Sump house	In place
378	Sump house	In place
379	Paint and Hazmat Locker	Layup
380	Sump house	In place
381	MWR Baseball Field Storage	Layup
382	Sump house	In place
383	Radio tower	In place
384	Garage, Training Tanks, Naval Reserve Storage	Leased to City
385	Skeet Range building	Layup
386	Storage	Demolished
387	Storage	Demolished
388	Storage	Demolished
389	Storage	Demolished
390	Sump house	In place
391	Number not used	NA
392	Number not used	NA
393	Sump house	In place
394	Sump house	In place
395	Sump house	In place
396	Sump house	In place
397	Tennis Courts	NA

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
398	Tennis Courts	NA
399	Training facility- Antenna Tower	Demolished
400	Training facility- Antenna Tower	Demolished
401	Theatre	Layup
402	Gymnasium	Leased to City
403	Incinerator	Demolished
404	Incinerator	Demolished
405	Flag Pole (Building 1)	Demolished
406	Number not used	NA
407	Athletic field	Demolished
408	Number not used	NA
409	Number not used	NA
410	Mechanical Equipment	Demolished
411	Number not used	NA
412	Storage	Demolished
413	Storage	Layup
414	Transformer house	Demolished
415	Wastewater Treatment Facility	Waste Treatment system
416	Wastewater Treatment Facility- Digester tank	Waste Treatment system
417	Wastewater Treatment Facility-Sedimentation tank	Waste Treatment system
418	Airship Field, Athletic Fields	Demolished
419	Number not used	NA
420	Number not used	NA
421	Storage (Fire Department)	In place
422	Number not used	NA
423	Number not used	NA
424	Switchgear house	Demolished
425	Switchgear house	Demolished
426	Switchgear house	Demolished
427	Switchgear house	Demolished
428	Switchgear house	Demolished
429	Switchgear house	Demolished
430	Number not used	NA
431	Number not used	NA
432	Number not used	NA

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
433	Number not used	NA
434	Number not used	NA
435	Number not used	NA
436	Number not used	NA
437	Police Station (located on Clay Street in San Francisco)	Demolished
438	Number not used	NA
439	Number not used	NA
440	Sump house	In place
441	Sump house	Demolished
442	Medical- Dental Clinic	Transferred to Department of Labor
443	Sump house	In place
444	Sump house	In place
445	Storage and Vehicle Maintenance Shop	Layup
446	Storage	Demolished
447	Weather shelter	Demolished
448	Storage	Layup
449	Administration and storage, Reserve Training Center	CSO
450	12ND Headquarters, Offices	Layup
451	Number not used	NA
452	BEQ	Layup
453	BEQ	Layup
454	Storage, Storage for Armory	Layup
455	Boiler plant	Layup
456	Gasoline storage tanks	Demolished
457	Storage shed	Demolished
458	Pyrotechnics Storage, Paint Storage	Layup
459	Skeet range	Layup
460	Microwave tower	Demolished
461	Damage Control School Classrooms, NTTC Headquarters, Fire Training	Leased to City
462	Decontamination Building, Fire Training	Leased to City
463	Gas Chamber	Leased to City
464	Smoke Elimination structure	Demolished
465	Trickling Filter	Waste Treatment system
466	Secondary Sedimentation	Waste Treatment system
467	Digester #2	Waste Treatment system

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
468	Sludge Dewatering Structure	Waste Treatment system
469	No Break Generator Building	Layup
470	Saluting Battery Gun Mount	Removed
471	Smoke Elimination Facility Control Building	Demolished
472	Flag pole	Demolished
473	Flag pole	Demolished
474	Flag pole	In place
475	Flag pole	In place
476	West Guard tower	Demolished
477	East Guard tower	Demolished
478	Basketball court	Transferred to Department of Labor
479	Basketball courts (16)	Demolished
480	Public toilets	Layup
481	Incinerator	Layup
482	Antenna tower	Demolished
483	Refreshment stand	Layup
484	Dewater tower	Demolished
485	Little League field	Layup
486	Barge shelter	Demolished
487	CPO Barracks and Administration	Transferred to Department of Labor
488	CPO Barracks	Transferred to Department of Labor
489	CPO Barracks	Transferred to Department of Labor
490	Number not used	NA
491	Separating pit	Demolished
492	Recreation grounds	In place
493	Stormwater pump	In place
494	Number not used	NA
495	Sentry booth	Demolished
496	Harbormaster Office and Boathouse	Leased to City
497	Fitness Center	Leased to City
498	Wind Generator tower on Building 260	Demolished
499	Number not used	NA
500	Number not used	NA
501	Armory	Layup
502	Child Care Center	Layup

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
503	Number not used	NA
504	Number not used	NA
505	Training mockup (Does not appear on any map)	NA
506	Training mockup (Does not appear on any map)	NA
507	Number not used	NA
508	Training mockup (Does not appear on any map)	NA
509	Training mockup (Does not appear on any map)	NA
510-519	Number not used	NA
520	Steam heat building	Layup
521-529	Number not used	NA
530	Pier steam plant	Layup
531-539	Number not used	NA
540	Steam heat building	Layup
541-549	Number not used	NA
550	Steam heat building	Layup
551-564	Number not used	NA
565	Battle Simulator Trainer	Demolished
566-569	Number not used	NA
570	Operational Trainer Facility	CSO
571	Collimation tower	Removed
572	RAS Operations tower	Layup
573	Collimation tower	Removed
574	Electrical substation	Unknown
575-579	Number not used	NA
580	NTTC Elevator Trainer	Removed
581-599	Number not used	NA
600	Administration/Academic Building for Fire Fighting School	Leased to City
601-604	Number not used	NA
605	P-250 Pump Trainer Firefighting	Leased to City
606	Advanced Shipboard Firefighting	Leased to City
607	OBA locker	Leased to City
608	General Shipboard Firefighting	Leased to City
609	General Shipboard Firefighting	Leased to City
610	Equalization tank (Firefighting)	Leased to City
611	Equalization tank (Firefighting)	Leased to City

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
612	Aviation Firefighting	Leased to City
613	General Shipboard Firefighting	Leased to City
614	General Shipboard Firefighting	Leased to City
615	Utility building	Leased to City
616	Aviation tower	Leased to City
617	P-250 tower (Firefighting)	Leased to City
618	Propane farm	Leased to City
619-669	Number not used	NA
670	Brig	Leased to City
671	Brig carpenter shop	Leased to City
672-679	Number not used	NA
680	Sewage processing	Unknown
681	Industrial Waste Treatment	Waste treatment facility
682	Number not used	NA
683	Number not used	NA
684	Number not used	NA
685	Number not used	NA
686	Number not used	NA
687	Number not used	NA
688	Number not used	NA
689	Number not used	NA
690	Electronic Sign	Demolished and replaced with a non-electric sign
691-1099	Number not used	NA
1100-1449	Married Enlisted Men's Quarters. (These buildings are complexes of 240 units each over several areas of Treasure Island. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200, 1255 through 1300, 1320, 1322, 1324, 1326 through 1399, 1407, 1414 through 1417, 1421 through 1429, 1446, and 1448 were not used,)	
Pier 1	Fueling Pier, General purpose pier	Original Pier 1 (Fueling Pier) demolished NLT 1961
Pier 2	Small boat berthing	Marina
Pier 3	Pier and floats	Demolished
Pier 4	Pier and floats	Demolished
Pier 5	Marine railway	Demolished
Pier 6	Pier and floats	Demolished

Table 3-3 Current and Former Sites at Treasure Island by Building Number

Building/Site No.	Former Uses	Current Status
Pier 7	Pier and floats	Demolished
Pier 8	Pier and floats	Demolished
Pier 9	Marine railway	Demolished
Pier 9A	Marine railway – 50 Ton	Demolished
Pier 10	Fuel pier	Demolished
Pier 11	Ship's Berthing and Floating Dry Dock pier, Ship's Berthing Pier	
Pier 12	Repair pier, Small Boat pier	Small Craft Pier
Pier 13	Maintenance pier	Demolished
Pier 14	Maintenance pier	Demolished
Pier 15	Maintenance pier	Demolished
Pier 16	Maintenance pier	Demolished
Pier 17	South pier	Demolished
Pier 18	Short pier	Demolished
Pier 19	Repair pier, Marine Railway	Demolished
Pier 20	Ferry slip (Oakland Landing)	Demolished
Pier 21	North pier, Berthing pier, Fuel pier	
Pier 22	Ammunition pier	Demolished
Pier 23	Small boat landing, Recreational, fishing pier	Fishing Pier
Pier 24	Small Boat pier	Demolished
Pier (Unnumbered)	Recreational marina	
Shed (Unnumbered)	Bottled gas storage	

Source – (**TI-HRA-11**)

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
Table 3-4 summarizes the uses of the buildings at NAVSTA TI from 1939 (International Exposition) through 1994. The information is taken from the referenced documents. Most of the references are maps of the U.S. Naval Station showing conditions on particular dates. Many buildings were demolished during the life of the naval station. After being identified as demolished once, the following year blocks are greyed out. Not all buildings are listed on each of the maps referenced. These are identified as Not Listed.								
1	China Clipper Terminal,	Administration Building	Com. Western Sea Frontier	Administration	Administration	Admin CWSF	Admin Com 12	Naval Station, Treasure Island
2	Aviation exhibits, airplane hanger	Hangar	Navy and MC Training Center	Naval and Marine Res Training Ctr	Naval and Marine Res. Training Ctr.	USNR and Mar Trng. Center	USNR and Mar Trng. Center	General Use (Movie set)
3	Palace of Fine and Liberal arts.	Ship Repair Shops	Public Works	Public Works Shop	Public Works Shop	Public Works	Public Works	Training School, equipment repair
4-6	Not listed	Diesel oil Storage, Gasoline Storage	Diesel oil Storage, Gasoline Storage	Diesel oil Storage, Gasoline Storage	Diesel oil Storage, Gasoline Storage	Diesel oil Storage, Gasoline Storage	Diesel oil Storage, Gasoline Storage	Diesel oil Storage, Gasoline Storage
7	Federal Building south half.	Schools	Director of Training	Admin and Training	Administration	NIS, CCPO,	NIS, CCPO, Navy Rel.	Director of Training Facilities
8	Exposition building.	Galley and Recreation	Gen Mess CPO	Admin and Training	Demolished			
9	Exposition building	Barracks	Office	Administration	Demolished			

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
10	Exposition building,	Barracks	Barracks	Barracks	Demolished			
11	Exposition building,	Barracks	Offices	Galley	Demolished			
12	Exposition building,	Office	Offices	Barracks	Demolished			
12A 12B, 12C	Original Bldg 112 was subdivided and renumbered 12A,B,C. Date unknown.							Port Control Storage
13	Exposition building,	Barracks	Demolished					
14	Not listed	Heating Plant	Heating Plant No. 1	Heating Plant No. 1	Demolished			
15	Exposition building,	Dispensary	Demolished					
16	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Barracks	Barracks (Vacant)	Barracks (Vacant)	Demolished

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
17	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Barracks	Demolished		
18	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Barracks	Demolished		
19	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Barracks	Demolished		
20	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Demolished			
21	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Demolished			
22	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Demolished			
23	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Barracks and Post Office	Demolished		
24	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Administration	Admin and Post Office	Admin	Demolished
25	Not listed	Barracks (Hospital Corps)	Barracks	Barracks	Barracks	Not Listed	Not Listed	Demolished
26	Not listed	Heating Plant	Heating Plant No. 2	Heating Plant No. 2	Heating Plant No. 2	Not Listed	Not Listed	Demolished

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
27	Not listed	Radio Material School A	Classrooms	Classrooms	Classrooms	Classrooms	Classrooms	Demolished
28	Not listed	Radio Material School B	Classrooms	Classrooms	Administration	Administration	Administration	Demolished
29	Not listed	Radio Material School D	Classrooms	Classrooms	Administration	Administration and Instruction	Administration Schools Com.	Admin.
30	Not listed	Surgical Operation	Barracks	Storage	Administration	Administration	Administration	Demolished
31	Not listed	Surgical Ward	Barracks	Storage	Housing Office, 12 ND Band Barracks	12 ND Band, Storage	12 ND Band Pers. Center	Demolished
32	Not listed	Surgical Ward	Barracks	Administration	Administration , Band Practice	Admin and Storage	Admin and Storage	Demolished
33	Not listed	Admin. & Sick Officers	Adm Offices	Administration	Administration	Barracks (Women)	Barracks (Women)	Demolished
34	Not listed	Subsistence	Commissary Store	Commissary Store	Commissary	Commissary	Commissary	Commissary
35	Not Listed	Eye, Ear, Nose, and Throat	Barracks	Barracks	Storage	Storage	Storage	Demolished
36	Not Listed	General Medical Ward	Barracks	Barracks	Demolished			

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
37	Not Listed	General medical Ward	Barracks	Barracks	Storage	Demolished		
38	Not Listed	Urological Ward	Barracks	Classrooms	Classrooms	Demolished		
39	Not Listed	Urological Ward	Barracks	Barracks	Demolished			
40	Not Listed	Isolation Ward	Barracks	Barracks	Classrooms	Classrooms	Classrooms	Barracks and Supply
41	Not Listed	Forge and Foundry Building	Forge and Foundry	Paint Shop	Paint Shop	Paint Shop	Paint Shop	Port Ops
42	Not Listed	Small Arms	Storage	Storage	Storage	Demolished		
43	Not Listed	Inert Ammunition Storage	Storage	Storage	Not Listed	Demolished		
44	Not Listed	Inert Ammunition Storage	Storage	Storage	Not Listed	Demolished		
45	Not Listed	Inert Ammunition Storage	Storage	Storage	Not Listed	Demolished		
46	Not Listed	Inert Ammunition Storage	Storage	Storage	Not Listed	Demolished		
47	Not Listed	Inert Ammunition Storage	Storage	Storage	Not Listed	Demolished		

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
48	Not Listed	Demolished	Demolished	Demolished				
49	Not Listed	Inert Ammunition Storage	Storage	Storage	Not Listed	Demolished		
50	Not Listed	Inert Ammunition Storage	Storage	Storage	Not Listed	Demolished		
51	Not Listed	Inert Ammunition Storage	Storage	Storage	Not Listed	Demolished		
52	Not Listed	Not listed	Storage	Storage	Not Listed	Demolished		
53	Not Listed	Inert Ammunition Storage	Storage	Storage	Not Listed	Demolished		
54	Not Listed	Demolished	Demolished	Demolished				
55	Not Listed	Inert Ammunition Storage	Storage	Storage	Vacant	Demolished		
56	Not Listed	Shop and storage	Storage	Storage	Not Listed	Demolished		
57	Not Listed	Shop and storage	Storage	Storage	Storage	Demolished		
58	Not Listed	Incinerator and Refuse Building	Paint shop	Storage	Demolished			
59	Not Listed	Office	Office	Office	Demolished			
60	Machine shop	Shop	Storage	Storage	Demolished			

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
61	Not Listed	Carpenter Shop	Carpenter Shop	Storage	Demolished			
62	Exposition Warehouse	Warehouse and shop	West Coast Training Aid	Training	Training Aids Center	Naval Edu. and Trng Support Det.	Reserves and CB Mobile Battalion	Reserves and CB Mobile Battalion
63	Not Listed	Signal Tower	Signal Tower	Signal Tower	Signal Tower	Signal Tower	Signal Tower	Signal Tower
64	Not Listed	Dock Master's Office	Fuel Detailing Office	Fuel Receiving Office	Fuel Detailing Office	Fuel Detailing Office	Fuel Detailing Office	Fuel Detailing Office
65	Not Listed	Shelter and Rifle Range	Rifle Range and Storage	Surveyed	Demolished			
66	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*
67	Bleachers and Gear Locker	Bleachers and Gear locker	Storage	Recreation	Bleachers and Storage	Bleachers	Not Listed	Demolished
68	Athletic Fields	Shops	Shop and Grounds Office	Recreation	Demolished			
69	Not Listed	Engineers and Shipfitters Shops	Garage	Hobby Shop Garage	Storage	Storage, Public Toilets	Storage, Public Toilets	Storage, Public Toilets
70	Not Listed	Gear Locker	Gear Locker	Fire Station Gear Locker	Gear locker	Storage	Storage	Storage
71	Not Listed	Scrub House	Scrub House	Laundryette	Laundryette (secured)	Demolished		
72	Not Listed	Sterilizer Building	Sterilizer Bldg	Sterilizer Bldg	Disintegrator Building	Disintegrator	Storage	Demolished

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

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73	Not Listed	Storage and Dock Master's Office	Storage	Administration	Demolished			
74	Not Listed	Office	Office	Administration	Demolished			
75	Not Listed	Signal Tower	Signal Tower	Signal Tower	Demolished			
76	Not Listed	Dock Crew Quarters	Dock Crews Qtrs	Wharf Builders Shop	Demolished			
77	Not Listed	D.C. Generator House	Aux Power House P-10	Generator House	Demolished			
78	Not Listed	Garbage House	Garbage House	Garbage Storage	Demolished			
79	Not Listed	Gun Shed	Gun Shed	Training	Demolished			
80	Not Listed	Damage Control School	Instruction Bldg	Training	Demolished			
81	Not Listed	Gasoline Station	Fireboat Storage	Storage	Demolished			
82	Not Listed	Gasoline Station	Gas Station	Gasoline Service Sta.	Demolished			
83	Not Listed	Lubrication Station	Road Striping Detail	Paint Shop Annex	Film Exchange	Film Exchange	Film Exchange	Demolished
84	Not Listed	Demolished						

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
85	Not Listed	Diesel Oil Clarifier and Pump Station	Diesel Oil Clarifier	Diesel Oil Clarifier	Diesel Oil Clarifier	Diesel Oil Pumping Station	Diesel Oil Pumping Station	Diesel Oil Pumping Station
86	Not Listed	Demolished						
87	Not Listed	Incinerator	Incinerator	Incinerator	Demolished			
88	Not Listed	Storage	Demolished					
89	Not Listed	Storehouse	Storehouse	Storage	Storage and Acct. Office	Office and Storage	Office and Storage	Demolished
90	Not Listed	Garbage house	Garbage House	Garbage Storage	Garbage house	Garbage House	Not Listed	Demolished
91	Not Listed	Toilets	Toilets	Toilets	Toilets	Toilets	Toilets	Toilets and self-serve laundry
92	Not Listed	General Medical Ward No.13	Barracks	Barracks	Classrooms	Classrooms	Classrooms	Fire Dept. Insp. Division
93	Not Listed	Waiting Station	Waiting Station	Waiting Station	Waiting Station	Waiting Station	Waiting Station	Weather Shelter
94	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*
95	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*
96	Not Listed	Storage	Storage	Storage	Storage, NPPSO	Storage, NPPSO	Storage, NPPSO	Printing Plant
97	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*
98	Not Listed	Storage	Storage	Not Listed	Demolished			

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
99	Not Listed	Laundry	Laundry, tailor, cobbler shop	Laundry	Laundry and Dry Cleaning	Cobbler Shop, Dry Cleaning	Cobbler Shop, Dry Cleaning	Disaster preparation storage
100	Not Listed	Gun Loading Trainer	Office – Portable	Office – Portable	Demolished			
101	Not Listed	Oil pump House	Oil pump House	Oil Pumping Station	Not Listed	Demolished		
102	Not Listed	Heating Plant No. 3	Heating Plant No. 3	Heating Plant No. 3	Heating Plant No. 3	Demolished		
103	Not Listed	Fuel Oil Tank	Fuel Oil Tank	Fuel Oil Storage	Fuel Oil Tank (Standby)	Fuel Oil Tank (Standby)	Fuel Oil Tank (Standby)	Fuel Oil Tank (Standby)
104	Not Listed	Fuel Oil Tank	Fuel Oil Tank	Fuel Oil Storage	Fuel Oil Tank (Standby)	Fuel Oil Tank (Standby)	Fuel Oil Tank (Standby)	Fuel Oil Tank (Standby)
105	Not Listed	Oil pump House	Oil pump House	Oil pumping station	Oil Pumphouse	Oil Pumphouse	Oil Pumphouse	Oil Pumphouse
106	Not Listed	Water Softener Building	Demolished					
107	Not Listed	C.P.O. Barracks	C.P.O. Barracks	C.P.O. Barracks	Admin. Office and Barracks	Admin. Office and Barracks	Adm. Off. And Barracks	Police Station
108	Not Listed	Waiting Station	Waiting Station	Waiting Station	Waiting Station	Waiting Station	Waiting Station	Demolished
109	Not Listed	Overflow Pharmacy and Reception	Barracks	Barracks	Barracks	Barracks	Barracks	Demolished

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
110	Not Listed	Linen, Bag and Misc. Storage	Storage	Storage	Storage (Vacant)	Rod and Gun Locker	Rod and Gun Locker	Demolished
111	Fire House No. 1	Fire Station No. 1	Fire Station No. 1	Fire Station No. 1	Fire Station No. 2	Fire Station No. 2	Fire Station No. 2	Port Ops Storage
112	Not Listed	Derrick house	Derrick house	Crane Machinery	Derrick House	Derrick House	Derrick House	Port Control Storage
113	Not Listed	Lumber Shed	Lumber Shed	Lumber Storage	Lumber Shed	Lumber Shed	Lumber Shed	Port Ops Storage
114	Not Listed	Storage	Storage	Storage	Storage	Storage	Storage	vacant
115	Not Listed	Garage & Shop	Wine Mess	Storage	Wine Mess and COM Mgrs Qtrs	Wine Mess, Wives Club - EM	Wine Mess, Wives Club - EM	Demolished
116	Not Listed	Storage	Storage locker	Storage	Demolished			
117	Exposition Building – Palace N	Barracks N	Demolished					
118	Exposition Building – Palace K-1	Barracks K-1	Demolished					
119	Not Listed	Barracks (Marine)	Barracks	Barracks	Barracks and Office	Not Listed	Not Listed	Demolished
120	Not Listed	Storage	Office	Office	Storage	Demolished		
121	Not Listed	Electric Shop	Classrooms	Classrooms	Demolished			
122	Not Listed	Greenhouse	Greenhouse	Greenhouse	Demolished			
123	Not Listed	Office and Storage (Nursery)	Office and Tool Shed	Office and Tool Shed	Demolished			

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
124	Not Listed	Waiting Station	Waiting Station	Waiting Station	Waiting station	Waiting station	Waiting station	Demolished
125	Not Listed	Garage	Garage	Garage	Storage	Storage	Storage	Demolished
126	Not Listed	Storage	Paint Locker	Paint Locker	Demolished			
127	Not Listed	Radio Materiel School C	Laboratory	Classrooms	Laboratory	Laboratory	Laboratory	Demolished
128	Not Listed	Scrub House	Storage	Storage	Storage	Storage	Storage	Storage
129	Not Listed	Scrub House	Jeep Garage	Garage	Storage	Storage	Storage	Storage
130	Not Listed	Scrub House	Scrubhouse	Storage	Storage	Storage	Storage	Storage
131	Not Listed	Scrub House	Scrubhouse	Storage	Drill Team	Elect. Hobby	Radio Station	Medical-Dental Storage
132	Not Listed	Storage	Storage	Storage	Storage	Demolished		
133	Not Listed	Fuel Oil Tank	Fuel Oil Tank	Fuel Oil Storage	Fuel Oil Tank	Demolished		
134	Not Listed	Fuel Oil Tank	Fuel Oil Tank	Fuel oil Storage	Fuel Oil Tank	Demolished		
135	Not Listed	Garbage House	Garbage House	Storage	Launderette	Launderette	Launderette	Sunday School
136	Not Listed	Garbage House	Garbage House	Storage	Demolished			
137	Exposition Building Palace - K,	Subsistence K	Demolished					
138	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
139	Exposition Building – Palace – C 2	Gymnasium	Demolished					
140	Not Listed	Officers Mess	Officers Club	Comm. Officers Mess (Open)	COM (Open)	COM (Open)	COM (Open)	Nimitz Conference Center
141	Not Listed	Explosives Office	Carpenter Shop	Carpenter Shop and Storage	Storage	Storage	Storage	Vacant
142	Not Listed	Oil Storage Building	Paint Locker	Paint Locker	Paint locker	Demolished		
143	Not Listed	Gasoline Pump House	Carpenter Shop	Gasoline Pumping Station	Storage	Storage	Storage	vacant
144	Not Listed	Gasoline Storage	Salt Water pump House	Salt Water pumping Station	Not Listed	Demolished		
145	Not Listed	Gasoline Storage Tank	Gasoline Tank	Not Listed	Demolished			
146	Not Listed	Control and Dispatch	Office	Storage	Security Office Vehicle Gate	Security Office Vehicle Gate	Security Office Vehicle Gate	Main gate
147	Exposition Building (Home and Garden), Aquacade,	Barracks C-1	Demolished					

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
148	Exposition Building (Aquacade),	Swimming Pool	Swimming Pool	Swimming Pool (Secured)	Demolished			
149	Exposition Building (Hall of Science),	Bakery	Demolished					
150	Exposition Building (Hall of Science),	Barracks J	Demolished					
151	Exposition Building (Vacationland) ,	Barracks I	Demolished					
152	Exposition Building (Vacationland) ,	Ship Services	Demolished					
153	Not Listed	Garbage House	Demolished					
154	Not Listed	Storage	Demolished					
155	Exposition Building (Ford Motor Company Building)	Palace H School	Demolished					
156	Not Listed	Gun Shed	Gun Shed	Classrooms	Classroom	Classroom	Classroom (vacant)	Demolished

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
157	Not Listed	Fire House # 2	Fire House # 2	Fire House No. 2	Fire House No. 1	Fire House No. 1	Fire House No. 1	Fire Station #1
158	Not Listed	Air Compressor Building	Air Compressor Building	Storage	Demolished			
159	Not Listed	Plotting Room	Plotting Room	Classrooms	Classrooms	Classrooms (Vacant)	Classrooms (Vacant)	Demolished
160	Not Listed	Shop No. 2	Ship Mockup #2	Classrooms	Classrooms	Classrooms (Vacant)	Classrooms (Vacant)	Demolished
161	Not Listed	Shop No. 1	Ship Mockup #1	Classrooms	Classrooms	Classrooms (Vacant)	Classrooms (Vacant)	Demolished
162	Not Listed	Acetylene Generator B	Acetylene Generator B	Storage	Storage	Storage	Storage	Demolished
163	Not Listed	Diving Tank Building	Diving Tank Building	Classrooms	Demolished			
164	Not Listed	Night lookout Training Building	Night lookout Training Building	Storage	Classrooms	Community Facility	Community Facility	Demolished
165	Not Listed	Storage	Storage	Storage	Auto Accessory Sales	Auto Accessory Sales	Not Listed	Demolished
166	Exposition Building (General Motors Building), School	Palace G School	Demolished					

TABLE 3-4
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BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
167	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*	*Number not used*
168	Exposition Building (General Motors Building), Gyro Compass Shop	Gyro Compass Shop	Demolished					
169	Storage	Storage	Demolished					
170	Exposition Building (Hall of Science), Theatre Office	Theatre Office	Demolished					
171	Exposition Building (Hall of Science), Theatre	Theatre	Demolished					
172	Exposition Building (Hall of Science), Barracks	Barracks F	Demolished					

TABLE 3-4
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BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
173	Exposition Building Palace E	Barracks E	Demolished					
174	Exposition Building Palace E	Offices	Demolished					
175	Exposition Building Palace E	Offices	Demolished					
176	Tower of the Sun	Band Stand	Band Stand	Band Stand	Demolished			
177	Exposition Building Palace D	Reception	Demolished					
178	Exposition Building Palace D	Offices	Demolished					
179	Exposition Building Palace D	Barracks	Demolished					
180		Hangar	Garage & Shops	Garage and Shops	12 ND Transportation Ctr.	Transportation	Transportation	PWC Transportation Shop
181		Gasoline Storage Tanks	Gasoline Tanks	Gasoline Storage	Demolished			
182		Gasoline Pump House	Gasoline Pump House	Gasoline Pumping Station	Demolished			

TABLE 3-4
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BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
183		Office	Office	Administration	Traffic Control office	Storage	Storage	Yacht club MWR
184		Sentry House	Vehicle Gate Guard	Sentry Booth	Waiting Station	Waiting Station	Waiting Station	Bus Stop
185		Waiting Station	Demolished					
186		Waiting Station	Waiting Station	Waiting Station	Demolished			
187		Chapel	Chapel	Chapel	Chapel	Chapel	Chapel	Chapel
188		Barracks	Barracks	Barracks	Admin & Barracks	Administration	Administration Vacant	Demolished
189		Barracks	Barracks	Barracks	Admin & Office	Not Listed	Not Listed	Demolished
190		Barracks	Storage	Barracks	Public School	Public School	Public School	Demolished
191		Barracks	Barracks-Storage	Barracks	Public School	Public School	Public School	Demolished
192		Degaussing Range	Degaussing Range	Radar Bomb Scoring Unit	Storage	Demolished		
193		Garage	Garage	Radar Bomb Scoring Unit	Storage	Demolished		
194		Transportation Building	Garage & office	Administration	Classrooms	Demolished		
195		Barracks	Barracks	Barracks	Brig Retraining and Barracks	Brig Retraining and Barracks	Brig Retraining and Barracks	Brig Overflow
196		Barracks	Barracks	Barracks	Barracks	Public School	Public School	Demolished

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
197		Barracks	Electronics Materiel School	Classrooms	Classrooms	Classrooms	Classrooms	Demolished
198		Barracks	Electronics Materiel School	Classrooms	Classrooms	Classrooms	Classrooms	Demolished
199		Barracks	Electronics Materiel School	Classrooms	Classrooms	Classrooms	Classrooms	Demolished
200		Barracks	Electronics Materiel School	Classrooms	Classrooms	Classrooms	Classrooms	Demolished
201		Subsistence	Galley	Galley and Mess Hall	Retail Store-warehouse	Retail Store warehouse	Retail Store warehouse	MWR warehouse
202		Ships Service	Store and Cafeteria	Retail Store and restaurant	Navy Exchange Cafeteria	Navy Exchange Cafeteria	Navy Exchange Cafeteria	NEX storage
203		Barracks	Barracks	Barracks	Barracks	Barracks (Vacant)	Barracks (Vacant)	Demolished
204		Barracks	Barracks	Barracks	Barracks	Barracks (Vacant)	Barracks (Vacant)	Demolished
205		Barracks	Barracks	Barracks	Barracks	Barracks (Vacant)	Barracks (Vacant)	Demolished
206		Barracks	Barracks	Barracks	Barracks	Barracks (Vacant)	Barracks (Vacant)	Demolished
207		Barracks	Barracks	Barracks	Barracks	Barracks (Vacant)	Barracks (Vacant)	Demolished
208		Barracks	Barracks	Barracks	Barracks	Barracks (Vacant)	Barracks (Vacant)	Demolished

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NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
209		Barracks	Barracks	Barracks	Barracks	Vacant	Barracks (Vacant)	Demolished
210		Barracks	Barracks	Barracks	Barracks	Not Listed	Demolished	Demolished
211		Barracks	Barracks	Barracks	Barracks	Demolished		
212		Barracks	Barracks	Barracks	Barracks (CPO)	Vacant (CPO)	Barracks (CPO) Vac	Demolished
213		Barracks	Barracks	Not Listed	Demolished			
214		Barracks	Barracks	Not Listed	Demolished			
215		Administration	Shops	Administration and Training	Chapel, Hobby Shop, TV Shop office	Chapel, Hobby Shop, TV Shop office	Chapel, Hobby Shop, TV Shop office	Vacant
216		Assembly Shed	Draft Shed	Administration and Training	Assembly Shed (Vacant)	Storage Shed, Rec. Veh.	Storage Shed, Rec. Veh.	Vehicle Storage
217		Bachelor Officers Qtrs.	Separation	Post Office	Station Locator Office, Red Cross	Pers. Office, Fam Service Ctr., Red Cross	Pers. Office, Fam Service Ctr., Red Cross	Cable TV
218		Storehouse	Administration	Administration	Admin. Office	Admin Off. Proj. Team	Admin Off. Proj. Team	Demolished
219	Transformer and Storage	Transformer and Storage	Demolished					
220		Shop	Classroom	Classrooms	Demolished			
221		Administration	Office-Storage	Administration and Storage	Office and Storage	Office and Storage	Office and Storage	Demolished
222		Brigade Guard House	Brig	Brig	Brig	Confinement Facility	Confinement Facility	Demolished

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223		Paint Shop	Bus Washer	Bus Washing Shed	Demolished			
224		Garage & Checking Station	Trans. Repair Facilities	Garage	Demolished			
225		Gun Shed	Gun Shed Storage	Storage	Hobby Shop Garage	Hobby Shop Garage	Hobby Shop Garage	Hobby shop garage
226		Bachelor Officer Qtrs	Bachelor Officers Qtrs	Bachelor Officers Qtrs	Demolished			
227		Subsistence Bldg. (Officers)	Cafeteria	Comm. Officers Mess (Closed)	1st and 2nd PO mess (open)	1st and 2nd PO mess (open)	1st and 2nd PO mess (open)	Fog Watch Club
228		Bachelor Officer Qtrs	Bachelor Officers Qtrs	Bachelor Officers Qtrs	Demolished			
229		C.P.O. Club	CPO Club	CPO Mess	CPO Club	CPO Club	CPO Club	Pizza Restaurant
230		Subsistence (Waves)	Waves Subsistence	Waves Galley and Mess	Shop	Shop	Shop	Mobile Ord. Tech. unit
231		Wave Officers Qtrs	Barracks Waves CPO	Barracks Waves	Barracks Waves	Barracks Waves	Barracks Waves	Demolished
232		Wave Barracks (Enlisted)	Wave Barracks	Barracks Waves	Barracks Waves	Barracks Waves	Barracks Waves	Demolished
233		Instruction Building	Admin. DCS Radiological School	Administration	Classroom, Administration, D.C.T.C.	Classrooms Admin., UNREP	Classrooms Admin., UNREP	Calif. Nat'l Guard

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234		Nurses Qtrs	CPO Qtrs	Barracks	Classrooms and Barracks	Classrooms	Classrooms	Demolished
235		Ward, Blood Bank and Lab.	Rec. Sta. Chapel	Barracks	Demolished			
236		Administration	Classrooms	Classrooms	Classrooms, D.C.T.C.	Classrooms, D.C.T.C.	Classrooms, D.C.T.C.	Demolished
237		Oil Storage	Oil Storage Tank	Oil Storage	Oil Storage Tank	Oil Storage Tank	Oil Storage Tank	Demolished
238		Shops and Boiler House	Shops and Boiler House	Repair Shop	Shop and Boiler House	Shop and Boiler House	Shop and Boiler House	Demolished
239		Suction Pump	Suction Pump	Pump House	Oil Separating pit	Oil Separating pit	Oil Separating pit	Demolished
240		Forecastle	Forecastle	Training Unit Mockup	Forecastle, Mock-up	Forecastle, Mock-up	Forecastle, Mock-up	Demolished
241		Boiler Room	Boiler Room	Training Unit Mockup	Boiler Room, Mock-up	Boiler Room, Mock-up	Boiler Room, Mock-up	Demolished
242		Engine Room	Engine Room	Training Unit Mockup	Engine Room, Mock-up	Engine Room, Mock-up	Engine Room, Mock-up	Demolished
243		Flight Deck	Flight Deck	Training Unit Mockup	Flight Deck, Mock-up	Flight Deck, Mock-up	Flight Deck, Mock-up	Demolished
244		Diving Tank	Diving Tank	Training Unit Mockup	OBA Storage and Repair	OBA Storage and Repair	OBA Storage and Repair	Demolished
245		Oil Separator	Oil Separator	Training Unit Mockup	Oil Separating Pit	Oil Separating Pit	Oil Separating Pit	Demolished

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246		Smothering Pit	Smothering Pit	Training Unit Mockup	Smothering pit	Smothering pit	Smothering pit	Demolished
247		Oil Storage	Oil Storage	Fuel Oil Storage	Oil Storage	Oil Storage	Oil Storage	Demolished
248		Pump House	Pump House	Pumping Station	Pump House	Pump House	Pump House	Pump House
249		Gasoline Storage	Gasoline Storage	Gasoline Storage	Gasoline Storage	Gasoline Storage	Gasoline Storage	Demolished
250		Suction Tank	Sump Tank	Sump	Suction Tank	Suction Tank	Suction Tank	Demolished
251		Foam Tank	Foam Tank	Foam Storage	Foam Tank	Foam Tank	Foam Tank	Demolished
252		Tank	Tank (Open)	Training	Training Tank (Open)	Training Tank (Open)	Training Tank (Open)	Demolished
253		Xmas Tree	Xmas Tree	Training	Training Tank	Training Tank	Training Tank	Demolished
254		Xmas Tree	Xmas Tree	Training	Training Tank	Training Tank	Training Tank	Demolished
255		Tank	Tank (Open)	Training	Tank (Open)	Tank (Open)	Tank (Open)	Demolished
256		Gasoline Storage	Gasoline Tank	Gasoline Storage	Gasoline Tank	Gasoline Tank	Gasoline Tank	Demolished
257		Dispensary and Ward	Dispensary	Infirmary	Dispensary	Dispensary, Dental and Nursery	Dispensary, Dental and Nursery	Child Care Center
258		Administration	Post Office, Bank	Administration	U.S Post Office, Bank, and CU	U.S Post Office, Bank, and CU	U.S Post Office, Bank, and CU	U.S. Post Office
259		Gun Mount	Gun Mount	Classrooms	Demolished			
260		Storehouse and Office	Storehouse and Office	Storage	Offices, Storehouse	Offices, Storehouse	Offices, Storehouse	Servmart

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261		Gym Pool and Bowling	Gym Pool and Bowling	Gymnasium	Swimming Pool, Bowling Alley	Swimming Pool, Bowling Alley	Swimming Pool, Bowling Alley	Gym, Pool, Bowling
262		Theatre	Theatre #3	Theatre	Demolished			
263		Welfare Building	Welfare Building	Recreation	Spec. Ser. Off., EM Club, Library	Offices, Library, EM Club	Offices, Library, EM Club	Demolished
264		Refrigerated Storehouse	Refrigerated Storehouse	Storage, Provision	Refrigerated Storehouse	Refrigerated Storehouse	Refrigerated Storehouse	PWC shops
265		Hostess House	Admin. Bldg	Administration	Admin Bldg	Admin Bldg	Admin Bldg	Library
266		Sonar School Building	Sonar School Bldg	Classrooms	Demolished			
267		Trans. Storage	Trans Pool 12th ND	Barracks	Teen Club	Teen Club	Teen club	Demolished
268		Gun Loading Shed	Gun Loading Shed	Classrooms	Classrooms	Classrooms (Vac)	Classrooms (Vac)	Demolished
269		Office Chem. Warfare	Office Chem. Warfare	Administration	Instr D.C.T.C.	Not Listed	Not Listed	Demolished
270		Paint and Oil Storage	Paint and Oil Storage	Storage	Storage	Not Listed	Demolished	Demolished
271		Officers Rec. Bldg.	Officers Rec. Bldg.	Recreation	COM (Open) Annex	COM (Open) Annex	COM (Open) Annex	Community Facility
272		Elec. And Mech. Service	Sub Stn and Compressor	Air Compressor Station	Sub Sta.	Sub Sta., Storage	Sub Sta., Storage	Demolished

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273		Decontaminati on Bldg	Decontaminati on Bldg	Classroom	Decontaminati on Bldg	Not Listed	Not Listed	Demolished
274		Dynamometer Shop	Dynamometer Shop	Not Listed	Demolished			
275		Waves Barracks (Enlisted)	Waves Barracks (Enlisted)	Barracks, Waves	Barracks	Instruction	Instruction	Demolished
276		Office	Film Exchange	Storage	Insp. Office	Not Listed	Not Listed	Demolished
277		Magazine Ammunition	Storage	Storage	Not Listed	Demolished		
278		Magazine Ammunition	Storage	Storage	Not Listed	Demolished		
279		Magazine Ammunition	Small Craft-Ship Group	Storage	Not Listed	Demolished		
280		Magazine Ammunition	Storage-Medical	Storage	Not Listed	Demolished		
281		Magazine Ammunition	Film storage	Storage	Not Listed	Demolished		
282		Magazine Ammunition	Storage	Storage	Not Listed	Demolished		
283		Magazine Ammunition	Storage	Storage	Not Listed	Demolished		
284		Magazine Ammunition	Electronic Storage	Storage	Not Listed	Demolished		
285		Magazine Ammunition	Storage	Storage	Not Listed	Demolished		
286		Magazine Ammunition	Tear Gas Storage	Storage	Not Listed	Demolished		

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287		Magazine Ammunition	Film Storage	Storage	Not Listed	Demolished		
288		Gas Chamber	Gas Chamber	Training	Storage	Demolished		
289		Storage	Shop	Storage	Storage	Storage	Storage	Paint Storage
290		Storage	Storage	Storage	Storage	Storage	Storage	Port Ops Storage
291		Gun Mount	Gun Mount	Gun Mount	Demolished			
292		Storage Shed	Storage Shed	Storage	Storage Shed	Storage Shed	Storage Shed	Storage Shed
293		Shed	Mechanical School	Shop	Instructions	Instructions	Instructions	Shed (NTTC)
294		Gear Locker	Gear Locker	Storage	Not Listed	Demolished		
295		Generator Building	Generator Building	Training Unit Mockup	Not Listed	Demolished		
296		Shelters Office	Water Taxi Pier	Administration	Office (Vacant)	Demolished		
297		Transformer House	Transformer House	Storage	Storage	Storage	Storage	Demolished
298		Loading Shed	Waiting Station	Waiting Station	Waiting station	Waiting station	Waiting Station	MWR Boat House
299		Loading Shed	Waiting Station	Demolished				
300		Office	Storage	Storage	Demolished			
301		Subsistence	Storage	Not Listed	Demolished			
302		Subsistence	Storage	Not Listed	Demolished			
303		Subsistence	Storage	Not Listed	Demolished			
304		Toilets	Toilets	Not Listed	Demolished			
305		Toilets	Toilets	Not Listed	Demolished			

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306		Supply Office	Storage	Not Listed	Demolished			
307		Barracks Army	Storage	Not Listed	Demolished			
308		Barracks Army	Storage	Not Listed	Demolished			
309		Barracks Army	Shops-Film Exch.	Not Listed	Demolished			
310		Barracks Army	Shops-Film Exch.	Not Listed	Demolished			
311		Barracks Army	Shops-Film Exch.	Storage	Demolished			
312		Barracks Army	Shops-Film Exch.	Storage	Demolished			
313		POW Subsistence Storage	Storage	Not Listed	Demolished			
314		Gun Mount	Gun Mount	Not Listed	Demolished			
315		School	Demolished					
316		School	Demolished					
317		School	Demolished					
318	Service Station	Gun Mount	Gun Mount	Classrooms	Ham Radio Station	Vacant	Vacant	Demolished
319		School	Demolished					
320		School	Demolished					
321		School	Demolished					
322		Gun Mount	Demolished					
323		Gun Trainer	Gun Trainer	Classrooms	Demolished			

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324		Assembly Shed	Demolished					
325		Shop	Shop & Storage	Shop and Storage	Shop Pest Control	Shop Pest Control	Shop Pest Control	Pest Control Shop
326		Gun Shed	Gun Shed	Classrooms	Not Listed	Demolished		
327		Salvage Building	Salvage Building	Not Listed	Demolished			
328		Transformer House	Transformer House	Transformer house	Transformer House	Transformer House	Transformer House	Transformer House
329		Storehouse	Office-Storehouse	Administration	Demolished			
330		Store	Ship Ser. Gas Station	Gasoline Service Station	Navy Exc. Gas Station	Navy Exc. Gas Station	Navy Exc. Gas Station	Grounds Maintenance Shop
331		Greenhouse	Greenhouse	Greenhouse	Demolished			
332		POW Brig	Storage	Storage	Not Listed	Demolished		
333		Recreation Building	Demolished					
334		Paint Locker	Demolished					
335		Store	Bus Paint Shop	Paint Shop	Shops, Can Washing	Shops, Can Washing	Shops, Can Washing	Paint Shop
336		Linoleum Shop	Linoleum Shop	Storage	Demolished			
337		Masons Locker	Masons Locker	Storage	Demolished			

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338		Duty Barracks	Duty Barracks	Not Listed	Demolished			
339		Duty Barracks	Duty Barracks	Not Listed	Demolished			
340		Dock Masters Office	Dock Masters Office	Not Listed	Demolished			
341			Buttercup	Training unit Mockup	Instruction, USS Buttercup	Instruction, USS Buttercup	Instruction, USS Buttercup	Instruction, USS Buttercup
342				Classrooms	Instruction, RADIAC	Instruction UNREP	Instruction UNREP	Instruction UNREP
343				Classrooms	Instruction, RADIAC	Instruction	Instruction	Instruction
344				Storage	Radium vault	Radium Vault	Radium Vault	Radium Vault
345				Incinerator	Demolished			
346				Classroom	Radio Trans. Sta	Radio Trans. Sta	Radio Trans. Sta	Offices
347				Training Unit Mockup	Gun Mount	Gun Mount	Gun Mount	Gun Mount
348				Issue Room	Instruction	Instruction	Demolished	
349				Field Work Shop	Instruction	Instruction	Demolished	
350				Repair Shop	Instruction	Demolished		
351				Repair Shop	Demolished			
352				Classrooms	Instruction	Instruction	Instruction	Demolished
353				Classrooms	Instruction	Instruction	Instruction	Demolished

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354				Storage	Storage, COM (Open)	Inst. (Fire Dept.)	Inst. (Fire Dept.)	Demolished
355				Riggers Shed	Sand Blasting Shed	Sand Blasting Shed	Sand Blasting Shed	Sand Blast Shed
356					Steam Clean and Car Wash	Not Listed	Demolished	Demolished
357					Bus Wash	Bus Wash	Bus Wash	Demolished
358					Resistor Bank Building	Resistor Bank Building	Resistor Bank Building	Storage
359					Classrooms	Classrooms	Demolished	
360					Boat House – Pier 2	Boat House – Pier 2	Boat House – Pier 2	Demolished
361					Hot Water Tank Building	Hot Water Tank Building	Hot Water Tank Building	Hot Water Tank Building
362					Storage Shed	Storage Shed	Storage Shed	Storage Shed
363					Barracks	Barracks	Barracks	Cooking School
364					Barracks	Barracks	Barracks	Barracks
365					Barracks	Barracks	Barracks	Barracks
366					Barracks	Barracks	Barracks	Barracks
367					Barracks	Barracks	Barracks	Barracks
368					Subsistence bldg	Subsistence bldg	Subsistence bldg	EM Dining Hall

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369					Bachelor Officers Qtrs and Subsistence	Bachelor Officers Qtrs and Subsistence	Bachelor Officers Qtrs and Subsistence	Officers Club
370					Gasoline Filling Station	Gasoline Filling Station	Gasoline Filling Station	Gasoline filling Station
371					USS Pandemonium (mock-up trainer)	USS Pandemonium (mock-up trainer)	USS Pandemonium (mock-up trainer)	USS Pandemonium (mock-up trainer)
372					Training Facility-Antenna Tower	Training Facility-Antenna Tower	Training Facility-Antenna Tower	Demolished
373					Training Facility-Antenna Tower	Training Facility-Antenna Tower	Training Facility-Antenna Tower	Demolished
374					Sump House No.12	Sump House No.12	Sump House No.12	
375					Training Facility-Antenna Tower	Training Facility-Antenna Tower	Training Facility-Antenna Tower	Demolished
376					Training Facility-Antenna Tower	Training Facility-Antenna Tower	Training Facility-Antenna Tower	Demolished

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377					Sump House No. 17	Sump House No. 17	Sump House No. 17	Sump House
378					Sump House No. 9	Sump House No. 9	Sump House No. 9	Sump House No. 9
379					Paint Locker	Paint Locker	Paint Locker	Paint Locker
380					Sump House No. 11	Sump House No. 11	Sump House No. 11	Sump House No. 11
381					Paint Locker	Paint Locker	Paint Locker	Storage
382					Sump House No. 21	Sump House No. 21	Sump House No. 21	Sump House No. 21
383					Radio Tower	Radio tower	Radio tower	Radio tower
384					Garage, Training Tanks	Garage, Training Tanks	Garage, Training Tanks	Garage, Training Tanks
385					Storage	Storage	Storage	Skeet Range Bldg.
386					Storage	Not Listed	Demolished	Demolished
387					Demolished			
388					Demolished			
389					Demolished			
390					Sump House No. 7	Sump House No. 7	Sump House No. 7	Sump House No. 7
391					*Number not used*	*Number not used*	*Number not used*	*Number not used*
392					*Number not used*	*Number not used*	*Number not used*	*Number not used*
393					Sump House No. 16	Sump House No. 16	Sump House No. 16	Sump House No. 16

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394					Sump House No. 5	Sump House No. 5	Sump House No. 5	Sump House No. 5
395					Sump House No. 4	Sump House No. 4	Sump House No. 4	Sump House No. 4
396					Sump House No. 6	Sump House No. 6	Sump House No. 6	Sump House No. 6
397					Tennis Courts (6)	Tennis Courts (6)	Tennis Courts (6)	Tennis Courts (6)
398					Tennis Courts	Tennis Courts	Tennis Courts	Tennis Courts
399					Training Facility-Antenna Tower	Training Facility-Antenna Tower	Training Facility-Antenna Tower	Demolished
400					Training Facility-Antenna Tower	Training Facility-Antenna Tower	Training Facility-Antenna Tower	Demolished
401					Theatre	Theatre	Theatre	Theatre
402					Gymnasium	Gymnasium	Gymnasium	Gymnasium
403					Demolished			
404					Demolished			
405					Flag Pole (Building 1)	Flag Pole (Building 1)	Flag Pole (Building 1)	Flag Pole
406					*Number not used*	*Number not used*	*Number not used*	*Number not used*
407					Athletic Field	Athletic Field	Athletic Field	Athletic Field

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408					*Number not used*	*Number not used*	*Number not used*	*Number not used*
409					*Number not used*	*Number not used*	*Number not used*	*Number not used*
410					Mechanical Equipment Bldg	Demolished		
411					*Number not used*	*Number not used*	*Number not used*	*Number not used*
412					Storage	Storage	Storage	Demolished
413					Storage	Storage	Storage	Storage
414					Transformer House	Transformer House	Transformer House	Demolished
415					Operation Bldg	Operation Bldg	Operation Bldg	Waste Water treatment
416					Digester Tank	Digester Tank	Digester Tank	Digester tank
417					Sedimentation Tank	Sedimentation Tank	Sedimentation Tank	Sedimentation Tank
418					Demolished			
419					*Number not used*	*Number not used*	*Number not used*	*Number not used*
420					*Number not used*	*Number not used*	*Number not used*	*Number not used*
421					Storage	Storage (Fire Dept.)	Storage (Fire Dept)	Storage (Fire Dept)
422					*Number not used*	*Number not used*	*Number not used*	*Number not used*

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
423					Hose Storage Shed	Not Listed	Not Listed	Not Listed
424					Switchgear House	Switchgear House	Switchgear House	Switchgear House
425					Switchgear House	Switchgear House	Switchgear House	Switchgear House
426					Switchgear House	Demolished		
427					Switchgear House	Demolished		
428					Switchgear House	Demolished		
429					Switchgear House	Demolished		
430					*Number not used*	*Number not used*	*Number not used*	*Number not used*
431					*Number not used*	*Number not used*	*Number not used*	*Number not used*
432					*Number not used*	*Number not used*	*Number not used*	*Number not used*
433					*Number not used*	*Number not used*	*Number not used*	*Number not used*
434					*Number not used*	*Number not used*	*Number not used*	*Number not used*
435					*Number not used*	*Number not used*	*Number not used*	*Number not used*
436					*Number not used*	*Number not used*	*Number not used*	*Number not used*

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
437					Police Station (located on Clay Street in San Francisco)	Police Station (located on Clay Street in San Francisco)	Police Station (located on Clay Street in San Francisco)	Demolished
438					*Number not used*	*Number not used*	*Number not used*	*Number not used*
439					*Number not used*	*Number not used*	*Number not used*	*Number not used*
440					Sump House No. 3	Sump House No. 3	Sump House No. 3	Sump House No. 3
441					Sump House No. 19	Demolished		
442					Not Listed	Not Listed	Not Listed	Medical-Dental Clinic
443					Sump House No.8	Sump House No.8	Sump House No.8	Sump House No.8
444					Sump House No. 10	Sump House No. 10	Sump House No. 10	Sump House No. 10
445					Storage and Salvage Bldg	Storage	Storage	Storage
446					Storage	Storage	Storage	Demolished
447					Bus Stop Shelter	Bus Stop Shelter	Bus Stop Shelter	Weather Shelter
448					Truck Service Facilities	Truck Service Facilities	Truck Service Facilities	Storage

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
449					Administration and storage,	Administration and storage,	Administration and storage,	Reserve Training Center
450					Administration	Administration	Administration	MWR
451						*Number not used*	*Number not used*	*Number not used*
452						Barracks	Barracks	BEQ
453						Barracks	Barracks	BEQ
454						Storage	Storage	Storage
455						Heating Plant	Heating Plant	Boiler Plant
456						Gasoline Storage Tanks-Moved from YBI to TI in 1968	Gasoline Storage Tanks	Gasoline Storage Tanks
457						Storage Shed	Storage Shed	Demolished
458	Pyrotechnics Storage	Not Listed	Not Listed	Not Listed	Not Listed	Pyrotechnics Storage, Paint Storage	Pyrotechnics Storage, Paint Storage	Pyrotechnics Storage, Paint Storage
459						Skeet Range	Skeet Range	Skeet Range
460						Microwave Tower	Microwave Tower	Microwave Tower

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
461						Damage Control School Classrooms, NTTC Headquarters, FTC	Damage Control School Classrooms, NTTC Headquarters, FTC	Damage Control School Classrooms, NTTC Headquarters, FTC
462						Decontaminati on Building, FTC	Decontaminati on Building, FTC	Decontaminati on Building, FTC
463						Gas Chamber	Gas Chamber	Gas Chamber
464						Smoke Elimination Structure	Smoke Elimination Structure	Demolished
465						Trickling Filter	Trickling Filter	Trickling Filter
466						Secondary Sedimentation	Secondary Sedimentation	Secondary Sedimentation
467						Digester #2	Digester #2	Digester #2
468						Sludge Dewatering Structure	Sludge Dewatering Structure	Sludge Dewatering Structure
469						No Break Generator Building	No Break Generator Building	No Break Generator Building

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
470						Saluting Battery Gun Mount	Saluting Battery Gun Mount	Saluting Battery Gun Mount
471						Smoke Elimination Facility Control Building	Smoke Elimination Facility Control Building	Demolished
472						Flag Pole	Flag Pole	Flag Pole
473						Flag Pole	Flag Pole	Flag Pole
474						Flag Pole	Flag Pole	Flag Pole
475						Flag Pole	Flag Pole	Flag Pole
476						West Guard Tower	West Guard Tower	Demolished
477						East Guard Tower	East Guard Tower	Demolished
478						Basketball Court	Basketball Court	Basketball Court
479						Basketball Courts (16)	Basketball Courts (16)	Demolished
480						Public Toilets	Public Toilets	Public toilets
481						Incinerator	Incinerator	Incinerator
482							Antenna Tower	Antenna Tower
483							Refreshment Stand	Refreshment Stand
484							Dewater Tower	Demolished

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
485							Little League Field	Little League Field
486							Barge Shelter	Demolished
487							CPO Barracks and Administration	CPO Barracks and Administration
488							CPO Barracks	CPO Barracks
489							CPO Barracks	CPO Barracks
490							*Number not used*	*Number not used*
491							Separating Pit	Demolished
492							Recreation Grounds	Recreation Grounds
493							Storm water pump	Storm water pump
494							*Number not used*	*Number not used*
495							Sentry Booth	Demolished
496							Harbormaster Office and Boathouse	Harbormaster Office and Boathouse
497							Fitness Center	Fitness Center

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
498							Wind Generator Tower on Building 260	Demolished
499							*Number not used*	*Number not used*
500							*Number not used*	*Number not used*
501							Armory	Armory
502							Child Care Center	Child Care Center
503							*Number not used*	*Number not used*
504							*Number not used*	*Number not used*
505							Training Mockup (Does not appear on any map)	Training Mockup (Does not appear on any map)
506							Training Mockup (Does not appear on any map)	Training Mockup (Does not appear on any map)
507							*Number not used*	*Number not used*

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
508							Training Mockup (Does not appear on any map)	Training Mockup (Does not appear on any map)
509							Training Mockup (Does not appear on any map)	Training Mockup (Does not appear on any map)
510-519							*Number not used*	*Number not used*
520							Steam Heat Building	Steam Heat Building
521-529							*Number not used*	*Number not used*
530							Pier Steam Plant	Pier Steam Plant
531-539							*Number not used*	*Number not used*
540							Steam Heat Building	Steam Heat Building
541-549							*Number not used*	*Number not used*
550							Steam Heat Building	Steam Heat Building
551-564							*Number not used*	*Number not used*

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
565							Battle Simulator Trainer	Demolished
566-569							*Number not used*	*Number not used*
570							Operational Trainer Facility	Operational Trainer Facility
571							Collimation Tower	Collimation Tower
572							RAS Operations Tower	RAS Operations Tower
573							Collimation tower	Collimation tower
574							Electrical Substation	Electrical Substation
575-579							*Number not used*	*Number not used*
580							NTTC Elevator Trainer	NTTC Elevator Trainer
581-599							*Number not used*	*Number not used*
600							Administration /Academic Building for Fire Fighting School	Administration /Academic Building for Fire Fighting School

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
601-604							*Number not used*	*Number not used*
605							P-250 Pump Trainer Firefighting	P-250 Pump Trainer Firefighting
606							Advanced Shipboard Firefighting	Advanced Shipboard Firefighting
607							OBA Locker	OBA Locker
608							General Shipboard Firefighting	General Shipboard Firefighting
609							General Shipboard Firefighting	General Shipboard Firefighting
610							Equalization Tank (Firefighting)	Equalization Tank (Firefighting)
611							Equalization Tank (Firefighting)	Equalization Tank (Firefighting)
612							Aviation Firefighting	Aviation Firefighting
613							General Shipboard Firefighting	General Shipboard Firefighting

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
614							General Shipboard Firefighting	General Shipboard Firefighting
615							Utility Building	Utility Building
616							Aviation Tower	Aviation Tower
617							P-250 Tower (Firefighting)	P-250 Tower (Firefighting)
618							Propane Farm	Propane Farm
619-669							*Number not used*	*Number not used*
670							Brig	Brig
671							Brig Carpenter Shop	Brig Carpenter Shop
672-679							*Number not used*	*Number not used*
680							Sewage Processing	Sewage Processing
681							Not Listed	Not Listed
682							Not Listed	Not Listed
683							Not Listed	Not Listed
684							Not Listed	Not Listed
685							Not Listed	Not Listed
686							Not Listed	Not Listed

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
687							Not Listed	Not Listed
688							Not Listed	Not Listed
689							Not Listed	Not Listed
690							Electronic Sign	Electronic Sign
691-1099							*Number not used*	*Number not used*
1100-1449								See Table 3-3
Pier 1	Unknown	Fueling Pier	Fueling Pier	Fueling pier	Demolished approximately 1961	Not Listed	Fueling Pier, General purpose Pier. Built 1986	General Purpose Pier
Pier 2	Small boat berthing	Small boat	Small boat	Small Boat Pier	Small Boat Pier	Small Boat Pier	Small boat berthing.	Small boat berthing
Pier 3	Pier and Floats	Pier and Floats	Pier and Floats	Pier	Demolished			
Pier 4	Pier and Floats	Pier and Floats	Pier and Floats	Pier	Demolished			
Pier 5	Marine Railway	Marine Railway	Marine Railway	Marine Railway	Demolished			
Pier 6	Pier and Floats	Pier and Floats	Pier and Floats	Pier	Demolished			

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
Pier 7	Pier and Floats	Pier and Floats	Pier and Floats	Pier	Demolished			
Pier 8	Pier and Floats	Pier and Floats	Pier and Floats	Pier	Demolished			
Pier 9	Marine Railway	Marine Railway	Marine Railway	Marine Railway	Demolished			
Pier 9A	Marine Railway – 50 Ton	Marine Railway – 50 Ton	Marine Railway – 50 Ton	Marine Railway	Marine Railway	Demolished		
Pier 10	Fuel Pier	Fuel Pier	Fuel Pier	Pier	Demolished			
Pier 11	Ship's Berthing and Floating Dry Dock Pier, Ship's Berthing Pier	Floating Dry dock Pier	Floating Dry dock Pier	Pier	Ship's Berthing Pier	Ship's Berthing Pier	Ship's Berthing Pier	Ship's bething pier
Pier 12	Repair Pier, Small Boat Pier	Repair Pier, Small Boat Pier	Repair Pier, Small Boat Pier	Pier	Small boat Pier	Small boat Pier	Small boat Pier	Small boat pier
Pier 13	Maintenance Pier	Maintenance Pier	Maintenance Pier	Pier	Pier	Pier	Pier	Demolished
Pier 14	Maintenance Pier	Maintenance Pier	Maintenance Pier	Pier	Pier	Pier	Pier	Demolished
Pier 15	Maintenance Pier	Maintenance Pier	Maintenance Pier	Pier	Pier	Pier	Pier	Demolished
Pier 16	Maintenance Pier	Maintenance Pier	Maintenance Pier	Pier	Pier	Pier	Pier	Demolished
Pier 17	South Pier	South Pier	South Pier	Pier	Pier	Pier	Pier	Demolished
Pier 18	Short Pier	Demolished						

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
Pier 19	Repair Pier, Marine Railway	Repair Pier, Marine Railway	Repair Pier	Marine Railway (Surveyed)	Demolished			
Pier 20	Ferry Slip (Oakland Landing)	Ferry Slip (Oakland Landing)	Ferry Slip	Ferry slip	Ferry slip	Ferry slip	Ferry slip	Demolished
Pier 21	North pier, Berthing Pier, Fuel Pier	North pier, Berthing Pier, Fuel Pier	North pier	Pier	Fuel Pier	Fuel Pier	Fuel Pier	Damaged
Pier 22	Ammunition Pier	Ammunition Pier	Ammunition Pier	Pier	Pier	Pier	Pier	Demolished
Pier 23	Small boat landing, Recreational, fishing pier	Small boat landing, Recreational, fishing pier	Small boat landing	Pier	Small boat landing	Small boat landing	Small boat landing	Fishing pier
Pier 24	Small Boat Pier	Small Boat Pier	Small Boat Pier	Small Boat Pier	Small Boat Pier	Small Boat Pier	Small Boat Pier	Demolished
Pier (Unnumbered)						Recreational Marina	Recreational Marina	Marina
Shed (Unnumbered)						Bottled gas storage	Bottled gas storage	Bottled Gas Storage
YBI Pier 1	Receiving Ship Pier	Pier 1	Pier	Pier	USCG Pier	USCG Pier	USCG Pier	USCG Pier
YBI Pier 2	Long Wharf	Pier 2	Pier	Pier	Demolished			
YBI Pier 3	Fueling Pier	Fueling Pier	Pier	Pier	Not Listed	Demolished		

TABLE 3-4
NAVSTA TI
BUILDING USE CHRONOLOGY

Building/Site No.	1939 (TI-HRA-11)	June 1945 (TI-HRA-26)	July 1949 (TI-HRA-27)	June 1952 (TI-HRA-28)	August 1968 (TI-HRA-29)	December 1971 (TI-HRA-30)	June 1973 (TI-HRA-31)	December 1994 (TI-HRA-11)
YBI Pier 4	Not Listed	Pier 4	Pier	Pier	Demolished			
Army Pier (YBI)	Torpedo (Mine) loading Pier	Not Listed	Not Listed	Not Listed	Demolished			

4.0 HRA METHODOLOGY

An HRA is a tool used by the Navy to provide a comprehensive review and assessment of the impact of radiological operations at Navy or U.S. Marine Corps installations. This section describes the processes used by the Navy to prepare an HRA.

4.1 HRA OVERVIEW

Documentation of operations involving radioactive materials conducted at a Navy or Marine Corps installation, regulatory controls of these operations, and closeout surveys following the operations are vital to the future uses of current and former Navy and Marine Corps property. The Navy uses an HRA to document historical radiological operations at an installation and to recommend future actions. This gives Navy management a critical tool needed to properly control, investigate, and/or release property.

This HRA generally follows the guidelines in MARSSIM for preparation of a Historical Site Assessment and provides information in a format similar to the PA protocol used by the EPA within the CERCLA process **(TI-HRA-3).**

An HRA provides historical documentation of radiological operations for a specified period. Since NAVSTA TI is closed and being prepared for transfer as the result of the BRAC Program, this HRA documents identified radiological operations of the Naval Station as a Navy facility up to the time of closure and subsequent radiological surveys and investigations through 2003, with two exceptions (Building 233 and IR Site 12 solid waste disposal areas).

Building 233 is currently being surveyed for residual radioactivity from a radium spill in 1950. The spill was cleaned up to the standards of the time, but the building is being surveyed again to ensure it is acceptable to today's standards. Results of this survey will be reported in a separate document.

Past subsurface investigations performed at IR Site 12 indicate several small areas on the northwestern and northern perimeter of the site contained buried solid waste. Investigation trenches installed in these areas typically identified soil mixed with metal, glass, and wood

rubbish. Naval Sea Systems Command Detachment, Radiological Affairs Support Office (NAVSEADET RASO) initially determined the likelihood of radioactive material being present at Site 12 was very low, however as a conservative precaution recommended radiological surveys be performed in the solid waste disposal trench areas of Site 12 (**TI-HRA-32**). Soil samples have been collected from various trenches in the IR Site 12 area. Over 2000 gamma radiation readings have been recorded in the trenches and around the soil piles created by the trenching. Evaluation of analyses is pending at this writing and will be documented in the Site 12 Remedial Investigation report.

4.2 PURPOSE

The purpose of the NAVSTA TI HRA is to document radiological operations involving G-RAM. This includes the following radiological operations:

- Training of personnel on the calibration, maintenance, and operation of radiation monitoring instruments.
- Training of personnel on radiological monitoring, and decontamination of ships and airplanes.
- Berthing of OPERATION CROSSROADS ships prior to those ships being given final radiological clearance (the actual decontamination procedures were not performed at TI).

In general, this HRA provides the following information about these radiological operations:

- History of buildings, structures, and outdoor areas potentially impacted by radiological operations.
- Potential, likely, or known sources of radioactive material and radioactive contamination.
- Previous investigation results.
- Contamination migration assessments.
- Recommended future actions.

4.3 MARSSIM GUIDELINES

This section describes MARSSIM guidance and how it applies to the NAVSTA TI HRA.

4.3.1 Historical Site Assessment

Preparation of this HRA is the first step in following MARSSIM guidelines for evaluating the effects of past radiological operations. This is followed by scoping surveys and, if necessary, site characterization and remedial actions. The final action to demonstrate regulatory compliance for free release of the property is the final status survey (FSS). The FSS report is the final clearance document for a property that is presented to regulators and the public.

Per MARSSIM guidance, this HRA will:

- Identify potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information.
- Identify sites that need further action, as opposed to those posing no risk to human health or the environment from radiological operations.
- Identification of potentially contaminated media.
- Provide an assessment for the likelihood of contamination migration.
- Provide information useful to Scoping and Characterization Surveys.
- Provide initial classification of the area or survey unit as 'impacted' or 'non-impacted'.

4.3.2 Historical Research

MARSSIM recommends that historical information be collected by:

- Reviewing site evaluations; federal, state, and local investigations; and emergency actions.
- Reviewing existing radiological data in licenses, site permits, authorizations, and operating records.
- Interviewing previous employees or personnel with knowledge of radiological operations at the site.
- Performing site reconnaissance by reviewing maps and blueprints and conducting a physical inspection of facilities.
- Using professional judgment.

4.3.3 Non-Impacted and Impacted Sites

After review of the information obtained during historical research, MARSSIM recommends assigning a general preliminary area classification of "non-impacted" or "impacted" to all areas at the site.

Non-impacted areas are those with no history of radiological operations or those that have no reasonable potential for residual contamination such as residential or administrative buildings. Areas with only standard safety devices that contain generally licensed radioactive material, and commercially available, exempt quantity radioactive items such as smoke detectors or exit signs, are classified as non-impacted if the site has no other radiological history. Non-impacted areas are not considered for radiological investigation because there is no reasonable potential for radioactive material to be present. Should information become available that identifies radiological operations associated with a non-impacted area, the area is reclassified as impacted. Discovery of minimal radioactivity attributable to natural background radiation or fallout from weapons testing is not, in itself, cause for designation of an area as impacted. Areas containing machines that produced ionizing radiation (such as x-ray machines) are not classified as impacted based solely on the use of the machines.

Impacted areas are generally those with a history of radiological materials being used, stored, and/or disposed and therefore having the potential for residual radioactive contamination. Examples include locations where leaks or spills are known to have occurred, former burial or disposal sites, areas where radioactive decontamination was performed, or radium paint facilities. Although an impacted site may be remediated and released as free from residual contamination, the site is not generally reclassified as non-impacted.

4.3.4 Potentially Contaminated Media

Once an area is properly classified, the next process involves the identification of potentially contaminated media within the area. While MARSSIM focuses on surface soils and building surfaces, it also provides preliminary guidance on other media types, including:

Surface Media - A term used to describe the top layer of soil, fill, gravel, waste piles, concrete, or asphalt that is available for direct exposure, growing plants, resuspension of particles for inhalation, and mixing from human disturbances.

Subsurface Media - A term used to describe solid materials below the surface medium.

Sediment - Material that settles to the bottom of a liquid or is deposited by water.

Surface Water - A term used to describe waters from rain run-off, streams, rivers, lakes, coastal tidal waters, and oceans.

Groundwater - A term used to describe the waters contained in subsurface materials and aquifers.

Air - A term used to describe a pathway for resuspension and dispersal of contaminated media in the atmosphere.

Structures - A term used to describe man-made surfaces that are above or below the ground surface, such as buildings and drydocks.

4.4 PREPARATION OF THE NAVSTA TI HRA

This section discusses the approach and rationale of the HRA, document reviews, field investigations, and interviews, site designation, radionuclide identification, and evaluation of previous investigations conducted specifically to prepare the NAVSTA TI HRA.

4.4.1 NAVSTA TI HRA Approach and Rationale

To prepare the NAVSTA TI HRA, all available historical and current radiological and non-radiological information was evaluated. The research was conducted during the period of September 2004 through May 2005. This research became the basis for designating sites as non-impacted or impacted and will subsequently be used by the Navy and other Federal, state, and local regulatory agencies to determine future actions for the sites.

Obtaining and evaluating information during preparation of the HRA included:

- Archival research.
- Site assessments and reconnaissance.
- Personal interviews by e-mail and by phone.
- Site designation and classification.

- Identification of radionuclides of concern.

These activities are discussed in Sections 4.4.2 through 4.4.6.

4.4.2 Archival Research

Navy operations at NAVSTA TI were discontinued in 1997. Since the majority of the personnel working on NAVSTA TI were active duty military, and since military personnel are routinely transferred to new duty stations, archival research was the primary method used to prepare this HRA. Every effort was made to find as many records as possible concerning radiological operations at NAVSTA TI. Both government and private archives were reviewed.

A listing of all archival documents and sources used as references in this HRA are detailed in the listings in Section 10.0. Electronic copies of documents used as references are provided on this compact disc as Appendix B. The numbering of the references is not consecutive because they correspond directly to the database of historical information compiled during research for the HRA.

4.4.2.1 Archive Locations

Table 4-1 lists archives where information on NAVSTA TI was found. Many hundreds of pertinent documents varying in length from 1 to 900 pages and more than 200 maps and drawings were reviewed. Research at three of the archive locations was performed at the archive. The regional National Archives and Records Administration (NARA) facility at San Bruno, California was visited four times between September 2004 and April 2005. The NAVSEADET RASO records were investigated in October 2004 and again in April 2005. The Naval Historical Center at the Washington Navy Yard in Washington D.C. was visited in October 2004. In addition, the available maps, drawings, and records in storage in Building 1 on NAVSTA TI were investigated during eight visits between September 2004 and May 2005.

4.4.2.2 Archive Information

Archival information was reviewed to identify potential G-RAM sources, areas of use, radiological controls, regulatory procedures, and releases of radioactive materials at NAVSA TI.

Reviews of historical records identified two main, separate, but connected categories of radiological operations, and one brief connection to the OPERATIONS CROSSROADS nuclear weapons tests.

Radiological Safety Training, 1947-1993 - In December of 1946, the Bureau of Naval Personnel directed the Damage Control School at Treasure Island to set up a course of instruction in Radiological Safety to furnish naval officers with the specialized training necessary to evaluate and combat atomic weapon damage. The first course in Radiological Safety convened at 0800 on March 17, 1947 in Building 7 (**TI-HRA-33**). A radiological history of radiation safety training is presented in Section 6.3.

Calibration, Maintenance, and Operation of Radiation Detection Instruments, 1947-1993 After initially establishing the Radiological Safety class, the Damage Control Training Center also began Radiological Defense classes including laboratory exercises in the calibration of radiation detection instruments (ion chambers). A radiological history of the calibration, maintenance and operation of radiation detection instruments is provided in Section 6.2.

Convenience berthing for ships from OPERATION CROSSROADS, in 1946 - Following the two nuclear weapons detonations of the OPERATIONS CROSSROADS test series, many of the target ships and support ships returned to the continental United States for decontamination and clearance from radiological restrictions. In the San Francisco Bay area returning ships were surveyed and decontaminated at Hunters Point Shipyard (HPS) and at Mare Island Shipyard. A radiological history of the ships known to have berthed at NAVSTA TI is provided in Section 6.4.

4.4.3 Site Assessments and Reconnaissance

4.4.3.1 Historical Assessments

One base-wide assessment has been performed on NAVSTA TI to identify and assess sites posing a potential threat to human health or the environment due to contamination from past hazardous material operations including radioactive materials. This assessment (**TI-HRA-4**) addresses the entire Naval Station. Other radiological remediations or release surveys have been performed to address specific areas or buildings on Treasure Island. The surveys included scans,

direct measurements, air and soil sample analysis, and swipe sample analysis. These methods were used to evaluate the radionuclides of concern and associated release limits at the time of the survey.

Assessments were performed solely by the Navy. No records have been found to indicate that federal, state, or local regulatory agencies have performed any assessments on NAVSTA TI. Section 6.6 includes a synopsis of each known radiological assessment, including investigation techniques and findings, from 1950 through 2003. Section 5.0 discusses the types of radioactive materials used at NAVSTA TI. A generic description of pathways these materials could have taken to impact human health and the environment is detailed in Section 7.0. A comprehensive site-specific summary of this information is provided for each impacted site in Section 8.0.

4.4.3.2 Current Assessments

Two radiological assessments are currently in progress. A survey of building 233 is in progress to determine if there is residual radium present from a spill in 1950. Future assessment activities in the solid waste disposal areas of IR Site 12 in the northern part of Treasure Island will also include screening for radioactive materials as a potential contaminant of concern. The scope of these assessments is addressed in Section 6.0, and the results, when available, will be published in separate reports.

4.4.3.3 HRA Site Reconnaissance

As a supplement to archival research, on-site visual inspections of areas with a history of radiological operations were conducted. Through these site visits, current facilities were compared with previous radiological assessments, historical documentation, and maps. The history for each impacted site, with descriptions of the current condition of the site, is provided in Section 8.0. An example of the value of the site visit is the case of Building 7. This building is one of the original buildings constructed for the 1939 International Exposition. The Radiation Safety School was initially located on the fourth floor of Building 7 (**TI-HRA-34**). On-site inspection of Building 7 in 2004 reveals that the building has only two levels. No fourth floor exists. Additional research of records eventually revealed that the west wing of Building 7 was a

four-story wing (**TI-HRA-35**) which was destroyed by fire and demolished in 1957 (**TI-HRA-36**).

4.4.4 Interviews

One aspect of the research and investigation is the personal interview. During research into radiological operations at some other closed or closing military bases, personal interviews provided useful information beyond that available in archives. Such was not the case for NAVSTA TI. Newspaper advertisements were placed in the major circulation Bay Area newspapers including the San Francisco Examiner, the San Francisco Chronicle, the San Jose Mercury News, and the Oakland Tribune and run for two consecutive Sundays. The ads requested anyone with knowledge of radiological operations on NAVSTA TI to call in to a 1-800 phone number. The text of the advertisement is in Appendix A. The ads were run on November 14 and November 21, 2004. One individual who actually was stationed on NAVSTA TI responded to the ad. However, she had no knowledge of the radiological operations on the Naval Station.

In addition to the newspaper advertisements, a fact sheet discussing the HRA process was published and sent to more than 1,100 people on the NAVSTA TI mailing list. The fact sheet also solicited input from the public but no responses were received (**TI-HRA-37**)

Based upon the historical research, some additional individuals were identified who could provide information about the radiological operations on NAVSTA TI based on their personal involvement. Telephone and/or e-mail interviews were conducted and information derived from those interviews was recorded.

Appendix A provides details of the interviews that were conducted by NAVSEADET RASO in 2003. 2004, and 2005.

4.4.5 Site Designation

Each building, structure, and open space at NAVSTA TI has been designated as either radiologically non-impacted or impacted based on information derived from the archive reviews,

site reconnaissance, and personal interviews. Impacted areas have been assessed as to the possibility and extent of residual contamination and recommendations of actions to evaluate the extent of potential residual radioactive contamination or radiologically free release of the property are provided. If a site has been previously radiologically free-released by the Navy and California regulators to current standards, no further action is recommended. Recommendations for each impacted site are provided in Section 8.0.

4.4.6 Radionuclide Identification

To properly assess a site, the HRA must determine any radionuclide that was used, who used it, and where it was used at NAVSTA TI. Table 4-2 lists radionuclides that were used at NAVSTA TI. This list was compiled from several documents that identified uses of the individual isotopes. The reference for each isotope is listed in Table 4-2. Most of the sources were used as check sources or calibration sources for radiation survey instruments. The Cs-137 and Br-82 were used to simulate radioactive fallout. Br-80, K-42, and Na-24 were byproducts of the neutron activation of Br-82 and thus were present with the Br-82 used to simulate radioactive fallout.

Any radionuclide that could have decayed through 10 half-lives since its time of use at NAVSTA TI is no longer considered a radionuclide of concern. Table 4-3 lists the radionuclides that may potentially still be a concern at NAVSTA TI today. Radionuclides used only as instrument check sources are not likely to leak. If they were to leak they would not go undetected for very long because of longstanding requirements to conduct periodic leak tests. No reports of leaking check sources were found in any of the documents reviewed for this HRA. The assessments in Section 8.0 of non-impacted sites (i.e. sites that only used sealed sources or were only associated with radionuclides that have decayed through 10 or more half-lives) will therefore conclude that no further action is required. The short-lived isotopes used on NAVSTA TI to simulate radioactive fallout (Br-80, Br-82, K-42, Na-24) had such short half-lives and low initial quantities, that all traces were gone within three months of the last use in 1972.

4.5 HRA BOUNDARIES

4.5.1 Physical Boundaries

It is not the intent or purpose of this HRA to assess the radiological status of sites outside of NAVSTA TI, rather it addresses radiological operations within the physical boundaries of the Naval Station as described in Section 3.0. Review of the history of operations on NAVSTA TI had not indicated that there were any instances of NAVSTA TI routine radiological operations performed off station. The report of the Building 233 spill notes that some students lived off station and states that the Director of the Department of Public Health, San Francisco was notified and concurred in the procedures used in locating, monitoring, and decontaminating residences in the San Francisco area. Further, one student resided at the Presidio of San Francisco. The Commanding Officer of the Presidio gave permission to the monitoring and decontamination of the student's quarters. Two separate newspaper accounts of the spill and the follow-up surveys in the San Francisco area reported that "traces of radium" "were tracked into homes widely scattered throughout the bay area" "but nowhere was radioactivity found exceeding that of luminous dials on a wrist watch" (**TI-HRA-38**). No specific locations were identified in the newspaper accounts or in the reports made by the navy. Therefore this HRA only addresses the radiological operations within the physical boundaries of the NAVSTA TI. A map of NAVSTA TI areas covered by the HRA is provided in Figure 4.1.

4.5.2 Temporal Boundaries

The Navy leased the NAVSTA TI property in 1941 and started operating as a Navy facility. The Navy took title to NAVSTA TI in April 1942. The first known use of radioactive materials on NAVSTA TI was in 1947. For purposes of this HRA, the temporal HRA boundaries are 1941 through June 2003. The current investigations of Building 233 and Site 12 are briefly discussed in this report; however, final reports of these investigations will be provided in separate site-specific reports.

NAVAL STATION TREASURE ISLAND

LEGEND
- IMPACTED SITE
- NON–IMPACTED SITE
- SWDA — SOLID WASTE DISPOSAL AREA

USS PANDEMONIUM NE SITE

FORMER LOCATION OF PIER 21

BLDG 342

BLDG 343

BLDG 344

FORMER LOCATION OF BLDG 7 WEST WING

BLDG 233

PIER 1

BLDG 462

BLDG 461

FORMER LOCATION OF PIER 13

SWDA 1231/1233

SWDA 1207/1209

IR SITE 12 LOCATION

SWDA A & B

BLDG 3

FORMER LOCATION OF BLDG 228

USS PANDEMONIUM NW SITE

FORMER LOCATION OF BLDG 273

FORMER LOCATION OF BLDG 226

400 0 400 800 1200
SCALE IN FEET

FIGURE 4–1A

WESTON SOLUTIONS

750 Dump Road
Mare Island
Vallejo, California

HISTORICAL RADIOLOGICAL ASSESSMENT SITES,
TREASURE ISLAND NAVAL STATION
SAN FRANCISCO, CALIFORNIA

YERBA BUENA ISLAND

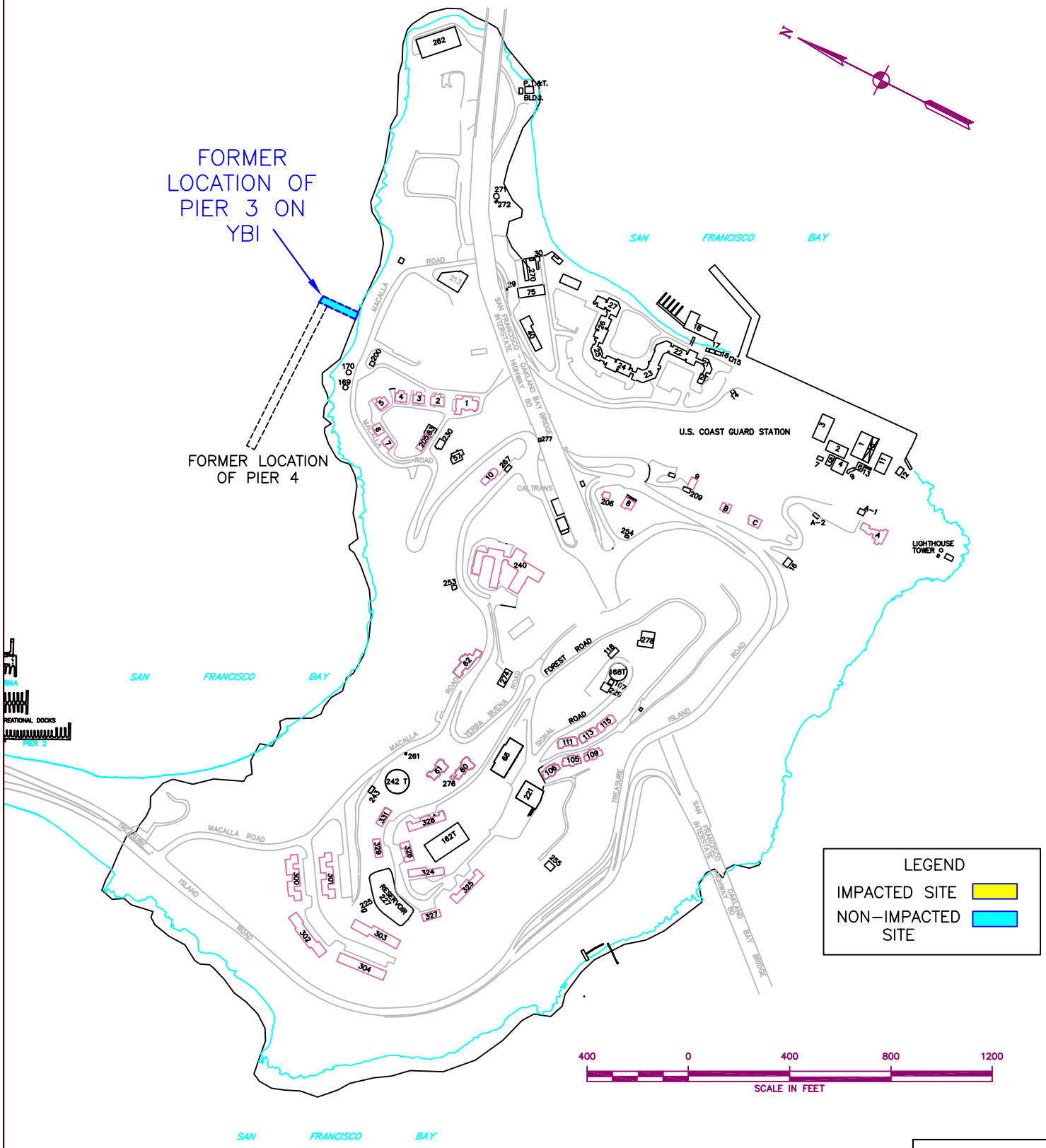

FIGURE 4-1B

WESTON SOLUTIONS	750 Dump Road Mare Island Vallejo, California	HISTORICAL RADIOLOGICAL ASSESSMENT SITES, TREASURE ISLAND NAVAL STATION SAN FRANCISCO, CALIFORNIA

SECTION 4

TABLES

Table 4-1

Archive Locations

ARCHIVE FACILITY	LOCATION
National Archives and Records Administration (NARA)	San Bruno, California
Department of Energy/Bechtel Reading Room	Las Vegas, Nevada
Naval Historical Center	Washington D.C.
Naval Sea Systems Command Detachment Radiological Affairs Support Office (RASO)	Yorktown, Virginia
Tetra Tech EM Inc. Electronic Library	San Francisco, California
San Francisco Public Library	San Francisco, California

TABLE 4-2

Radionuclides used at NAVSTA TI

Radionuclide	Half-life	Radiation	Uses	Ref.
Am-241 (americium)	432 years	alpha, gamma	Instrument Calibration	**TI-HRA-40**
Ba-133 (barium)	10.5 years	gamma	Instrument Calibration	**TI[HRA-41 TI-HRA-40**
Ba-137m (barium)	2.55 minutes	beta, gamma	check source	**TI-HRA-42**
Be-7 (beryllium)	53.44 days	gamma	Instrument Calibration	**TI-HRA-40**
Br-80 (bromine)	17.4 minutes	beta, gamma	Decontamination Training	**TI-HRA-43**
Br-82	35.3 hours	beta, gamma	Decontamination Training	**TI-HRA-43**
C-14 (carbon)	5,730 years	beta	check source	**TI-HRA-40**
Cd-109 (cadmium)	464 days	gamma	Instrument Calibration	**TI-HRA-40**
Co-60 (cobalt)	5.27 years	beta, gamma	Instrument Calibration	**TI-HRA-44 TI-HRA-45 TI-HRA-41**
Cs-137 (cesium)	30.17 years	beta,	Decontamination Training	**TI-HRA-46 TI-HRA-45**
H-3 (tritium)	12.28 years	beta	Instrument Calibration	**TI-HRA-40**
In-113m (indium)	1.66 hours	gamma	Instrument Calibration	**TI-HRA-42**

K-42 (potassium)	12.36 hours	beta, gamma	Decontamination Training	**TI-HRA-43**
Kr-85 (krypton)	10.72 years	beta, gamma	check source	**TI-HRA-40**
Na-22 (sodium)	2.60 years	beta, gamma	check source	**TI-HRA-40**
Na-24	15 hours	beta, gamma	Decontamination Training	**TI-HRA-43**
Pu-239 (plutonium)	24,131 years	alpha, gamma	Instrument Calibration	**TI-HRA-45**
Ra-226 (radium)	1,600 years	alpha, beta, gamma	Instrument Calibration,	**TI-HRA-47**
Sn-113 (tin)	115.1 days	gamma	check source	**TI-HRA-42**
Sr-90 (strontium)	28.6 years	beta	Instrument Calibration	**TI-HRA-41**
Tc-99 (technetium)	213,000 years	beta, gamma	check source	**TI-HRA-41**
Th-232 (thorium)	1.4 E+4 million years	alpha, gamma	check source	**TI-HRA-40**
Y-90 (yttrium)	64.1 hours	beta	Instrument Calibration	**TI-HRA-41**

Table 4-3

Radionuclides of Concern at NAVSTA TI

RADIONUCLIDES	HALF-LIFE	RADIATION	USES
Am-241 (americium)	**432 years**	**alpha, gamma**	**Instrument calibration**
Ba-133 (barium)	**10.5 years**	**gamma**	**Instrument calibration**
C-14 (carbon)	**5,730 years**	**beta**	**Check source**
Cd-109 (cadmium)	**464 days**	**gamma**	**Instrument calibration**
Co-60 (cobalt)	**5.27 years**	**beta, gamma**	**Instrument calibration**
Cs-137 (cesium)	**30.17 years**	**beta**	**Decontamination training**
H-3 (tritium)	**12.28 years**	**beta**	**Instrument calibration**
Kr-85 (krypton)	**10.72 years**	**beta, gamma**	**Check source**
Na-22 (sodium)	**2.60 years**	**beta, gamma**	**Check source**
Pu-239 (plutonium)	**24,131 years**	**alpha, gamma**	**Instrument calibration**
Ra-226 (radium)	**1,600 years**	**alpha, beta, gamma**	**Instrument calibration**
Sr-90 (strontium)	**28.6 years**	**beta**	**Instrument calibration**
Tc-99 (technetium)	**213,000 years**	**beta, gamma**	**Check source**
Th-232 (thorium)	**1.4 x 104 years**	**alpha, gamma**	**Check source**

5.0 REGULATORY INVOLVEMENT

This section provides an overview of regulatory agencies involved with the oversight of radioactive materials and their use at NAVSTA TI. Included is the regulatory authority and requirements for the HRA, as well as the involvement of regulatory agencies at NAVSTA TI.

5.1 FEDERAL REGULATORY AGENCIES

5.1.1 Atomic Energy Commission (AEC)

The Atomic Energy Act (AEA) of 1 August 1946 established the AEC to develop and manage the atomic energy program following WW II. A civilian government agency, the AEC assumed responsibility for control of radioactive material and its uses from the military's Manhattan Project, the group that developed the atomic bomb during WW II. The AEC's mission included the production and control of fissionable material, accident prevention, research, and peaceful uses of the atom, including the commercial generation of electricity. While the AEC had control of atomic energy production and nuclear materials, facilities using the materials remained under government control. The act provided for a five-member commission, the General Advisory Committee, as well as a Military Liaison Committee within the National Military Establishment, which worked with the AEC on military applications of atomic energy.

In 1953, the DoD established the Committee on Atomic Energy (CAE) to provide assistance and guidance for research and development activities within DoD. The main fields of interest for the CAE were atomic research and its effect on national security and research and development of atomic energy for military use. During this time, the AEC and DoD also formalized the "Agreement for the Development, Production and Standardization of Atomic Weapons" that established regulations to prevent conflicts of responsibility between the military and the AEC **(TI-HRA-48)**.

The AEC controlled uses of radioactive materials by issuing "authorizations" or "permits" until 1954, when the AEA was modified. This modification amended AEC controls and established the licensing program, which allowed for partnerships with private facilities to produce

fissionable materials. An additional amendment in 1964 permitted private ownership of nuclear fuels, aiding the growing nuclear power industry.

The AEC was dissolved when the Energy Reorganization Act of 1974 established two new federal agencies to administer and regulate atomic energy activities: the U.S. Energy Research and Development Administration (ERDA) and the NRC. The NRC assumed responsibilities for regulation of the byproduct, source, and special nuclear material previously controlled by the AEC. Military applications of radioactive material remained under the control of ERDA, which was renamed the DOE in 1977.

5.1.2 AEC Licensing Controls

With the establishment of AEC licensing controls in 1954, procurement and use of radioactive materials became more stringently controlled. Users were required to submit lengthy "license applications," with different license types required for byproduct, source, or special nuclear material. AEC required license applications to include:

- Quantity of each radionuclide to be possessed at any one time.
- Purposes for which the licensed material was used.
- Location where radioactive materials were used.
- Qualifications of a Radiation Safety Officer.
- Demonstration that facilities were adequate to safely control materials and protect human health.
- Administrative and managerial controls.
- Monitoring procedures and instrumentation.
- Material receipt and accountability procedures.
- An occupational radiation safety program for workers.
- Standard operating and emergency procedures.
- Radioactive waste disposal procedures.

5.2 NAVY RADIOACTIVE MATERIALS CONTROLS

5.2.1 General Controls

The first formal document controlling use of radioactive material by the Navy was Safety Series No. 9 of 1942 for Ra-226 **(TI-HRA-49)**. However, the Navy did not establish a formal radiological controls program for all types of radioactive material until 1946, shortly after the end of WW II. These controls were the predecessors of the more stringent radiological controls programs the Navy has in effect today. The first Radiological Safety Manual for general applications of radioactive material was issued in 1947 by the Chief of Naval Operations (CNO) **(TI-HRA-50)**. This manual was based on knowledge gained from the bombing of Hiroshima and Nagasaki and OPERATION CROSSROADS testing of the atomic bomb. As experience with and knowledge of the effects of radiation on ships and naval personnel grew, the Navy worked to establish more protective requirements that met or exceeded federal regulations.

In the late 1940s and early 1950s, the Bureau of Medicine and Surgery (BUMED) and the Bureau of Ships (BUSHIPS) worked closely with the radiation laboratory (RADLAB) and the Naval Radiological Defense Laboratory (NRDL) at HPS to develop controls for use of radioactive material throughout the Navy. Simply due to their close proximity to HPS, the instructors and students at the Damage Control School at NAVSTA TI benefited from the radiological knowledge being developed at NRDL. BUMED established and incorporated safety tolerances into regulations, determined physiological effects and developed treatment methods, and approved specifications for instruments to cover medical uses and exposure to radioactive materials. BUMED continues to oversee the radiation health protection program in the Navy and Marine Corps today.

BUSHIPS developed and procured instruments to detect radioactivity, equipment to protect personnel onboard ships, and methods and equipment for decontaminating ships. Eventually, the Navy reorganized, and these responsibilities were assigned to the Naval Sea Systems Command (NAVSEA). Today, NAVSEA remains responsible for the safety and control of ionizing radiation, including radioactive material, by the Navy and Marine Corps and provides oversight and regulatory guidance to the NNPP, Nuclear Weapons Radiological Controls Program, and G-RAM Program (known as the Radiological Affairs Support Program [RASP]).

5.2.2 AEC Licensing of Navy Headquarters Commands

In some instances, the Navy's headquarters commands applied to the AEC for authority to use licensed radioactive material. The AEC licenses were issued to a single headquarters command even though the material might only be used by an individual field command or ship. In some instances, the licenses authorized use of a radioactive commodity by multiple commands. Two such licenses that directly involved NAVSTA TI are listed below.

AEC Source Material License No. SMB-473 was issued to the Naval Electronics Systems Command on January 23, 1969. The license states "for use within the Naval Establishment as instrument check sources" (**TI-HRA-51**). The check sources were uranium and thorium. Amendment No. 1 to this license changed the uranium to depleted uranium in January of 1974. There is no indication that NAVSTA TI used depleted uranium sources.

U.S. NRC Materials License No. 08-00038-12 was issued to the Naval Electronics Systems Command. The original issue date is not known but Amendment No. 35 issued on January 31, 1979, authorized use of C-14, Cs-137, Kr-85, Sr-90, and Tc-99. Amendment No. 36 issued January 23, 1980 added Am-241. The license states "Licensed material may be used throughout the Unites States" (**TI-HRA-52**).

5.3 REGULATORY INVOLVEMENT AT NAVSTA TI AND AEC LICENSES

NAVSTA TI was subject to the AEC licensing requirements for radioactive materials that began in 1954, with additional oversight provided by BUMED and BUSHIPS. The State of California became an Agreement State with the AEC on September 1, 1962, and established the California Agreement State Licensing Program managed by the CDHS. As a Federal entity, NAVSTA TI remained under the AEC licensing program. However, it should be noted that use of radioactive material by Navy contractors or NAVSTA TI lessees could have fallen under auspices of the CDHS licensing program. No records have been found that indicate uses of radioactive materials by contractors or lessees. The AEC licenses for NAVSTA TI are discussed below.

The AEC issued two separate licenses for possession and use of radioactive material on NAVSTA TI. These licenses are summarized below and detailed in Table 5-1.

AEC Byproduct Material License 04-04346-01 was initially issued on January 30, 1959 to the Restricted Weapons Defense Division, Treasure Island. The license authorized the use of radioactive materials for simulation of a fallout radiation field on a training ship for indoctrination of monitors and decontamination teams. The license was terminated on February 8, 1982. The uses of radioactive material covered by this license were transferred to license 04-04346-02 on the same day.

AEC Byproduct Material License 04-04346-02 was initially issued to the RADIAC Instrument Maintenance School, Treasure Island on June 22, 1959. The license authorized the use of radioactive materials for calibration of RADIAC instruments and training of personnel in the use of radiation detection instruments. On February 8, 1982, Amendment No. 29 to license 04-04346-02 added authorization to use radioactive materials for simulation of fallout radiation for indoctrination and training of personnel. On April 1, 1987 license 04-04346-02 was officially converted to Navy Radioactive Materials Permit (NRMP) 04-62639-C1NP. The NRMP was terminated by Amendment No. 6 on February 24, 1994.

5.4 NON-LICENSED ACTIVITIES AT NAVSTA TI INVOLVING RADIOACTIVE MATERIAL

In addition to the radioactive materials licensed by the AEC, small quantities of radioactive material, below levels requiring licensing by the AEC, were probably also used in commodity items throughout the Naval Station, such as smoke detectors, deck markers, check sources for radiation survey instruments, and radioluminescent dials and gauges. Since one of the schools operated on NAVSTA TI was the Electronics School, many items of electronic equipment such as radar and radios and test equipment were in use. Use of non-AEC licensed materials sources of ionizing radiation used by the NAVSTA TI are described below.

Naturally Occurring Radioactive Material (NORM) and other radioactive materials not requiring licensing by the AEC were probably used throughout the Naval Station in various commodity items. Some examples include smoke detectors containing (americium-241 [Am-241] after 1970), exit signs (tritium [H-3]) after 1970), sound-powered telephone jacks (Ra-226), deck markers (Ra-226 and strontium-90 [Sr-90]), electron tubes (many different radionuclides), radio

receivers and transmitters containing radium dials, knobs and switches (Ra-226), thoriated welding rods (thorium-232 [Th-232]), divers' watches (Ra-226, H-3, and promethium [Pm-147]), and wristwatches and compasses (Ra-226, H-3, and Pm-147). Formalized controls for these items were not found, which is common because these controls were not typically warranted during the operational time of NAVSTA TI. (Formal controls were established in NAVSUPINST 5101.6 series starting in about 1964 under AEC licenses.)

Controlled disposal of radioactive commodity items began in the late 1960s when the Navy instituted a program to control devices containing Ra-226 that included removal of radium devices from ships and replacement with non-radium substitutes **(TI-HRA-53)**. Gradually, the Navy expanded the control program to include all commodity items containing radioactive material. Prior to the implementation of the control programs, NAVSTA TI likely disposed of these items as normal trash. Disposal of these items in commercial landfills was common practice by private industry as well. Although NAVSTA TI did not operate a solid waste landfill, several localized areas of solid waste disposal have been identified in the area around the former bunkers at the north end of Treasure Island. The area now known as IR Site 12, is a potential location for disposal of such radioactive commodities. This area was used until about 1965. Aerial photographic analysis performed by the U.S.EPA appears to confirm that waste disposal stopped at about that time (**TI-HRA-54**). Most of the licensed commodities had controlled disposal procedures and were not introduced into the Navy until 1964 or later. It is unlikely that these commodities exist in the solid waste disposal areas.

5.5 FEDERAL REGULATORY AUTHORITY AND OVERSIGHT AT NAVSTA TI

The following sections discuss the current regulatory agencies that oversee NAVSTA TI. Each organization has distinct responsibilities. By agreement, federal agencies do not share jurisdiction over a site.

5.5.1 NRC

The NRC is the federal regulatory authority for use of source, special nuclear and byproduct material as defined in Title 10 of the CFR. Currently the Navy holds a NRC Master Materials License to cover use of NRC-licensed radioactive material by the Navy and Marine Corps.

One of the two AEC licenses specifically issued to NAVSTA TI, **04-04346-01** was terminated and the functions transferred to License No. **04-04346-02.** The other license, License No. **04-04346-02,** was converted to a Navy Radioactive Material Permit. Therefore, the NRC did not review license termination documentation for either license.

5.5.2 EPA

The EPA is a federal agency that was established in 1970 to protect human health and to safeguard the natural environment (air, water, and land). The EPA is divided into 10 geographic regions; NAVSTA TI falls under the jurisdiction of EPA Region IX. Each regional office is responsible for execution of EPA's programs within that region. EPA works closely with other Federal agencies and state and local governments to enforce environmental regulations. While EPA sets environmental regulations, often the responsibilities for oversight activities are delegated to state offices. For NAVSTA TI, the EPA oversees the radiological release of outdoor structures and open areas but defaults release of buildings to the CDHS. The EPA is a member of both the BRAC Cleanup Team (BCT) and the Restoration Advisory Board (RAB). EPA regulatory programs at NAVSTA TI are discussed below.

5.5.2.1 CERCLA

CERCLA (commonly known as Superfund) was enacted by Congress in 1980 and allows the EPA to:

- Establish prohibitions and requirements for closed and abandoned hazardous waste sites.
- Hold the persons responsible for releases of hazardous waste at a site liable for cleanup of the site.
- Establish a trust fund to provide for cleanup when a responsible party cannot be identified.

The act authorizes two kinds of response actions:

Short-Term Removals, which are prompt responses to address releases or threatened releases.

Long-Term Remedial Responses, which are permanent actions taken to significantly reduce the danger of a release or threat of release of hazardous substances that are serious but not immediately life threatening.

CERCLA also enabled the revision of the NCP to provide guidance and procedures to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. This revision also established the NPL.

5.5.2.2 SARA

SARA amended CERCLA in 1986 and made significant changes to the program. These changes provided new enforcement authorities, including:

- Stressing the importance of permanent remedies and innovative technologies.
- Considering other environmental laws and regulations.
- Increasing state involvement.
- Increasing the focus on human health problems.
- Encouraging greater citizen participation in the decision-making process.

SARA also required EPA to revise the Hazard Ranking System (HRS) to ensure accurate assessment of sites placed on the NPL. As noted earlier, NAVSTA TI is not listed on the NPL.

5.5.3 NPL

CERCLA requires that the statutory criteria of the HRS be used to establish a list of national priorities of known or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States. The NPL is the result of this requirement. A tool used in the CERCLA process upon completion of the HRS, the NPL is an appendix of the NCP. Identification of a site for the NPL provides notification to the public that the EPA has determined that the site warrants further investigation to assess risks to human health and the environment and serves as notice to responsible parties that EPA may be seeking remedial action. Inclusion of a site on the NPL is not a judgment of the activities of the property owner

nor does it require action or assign liability. The NPL primarily serves to identify a location where remedial actions appear to be warranted. NAVSTA TI is not listed on the NPL.

5.5.3.1 Major Steps in the CERCLA Process

The CERCLA process has been divided into the following series of steps:

- **PA -** A screening process to determine if further study is necessary.
- **SI -** An on-site investigation to determine if there has been a release or a potential for a release and to determine any associated threats.
- **RI -** A process generally taken by the responsible agency to determine the nature and extent of the problem associated with the release.
- **Removal Actions -** An expedited action taken to remove a more immediate environmental threat or health hazard.
- **FS -** Action taken by the lead agency to develop and evaluate options for remedial actions.
- **Proposed Plan (PP) -** Presentation of the nature and extent of contamination, alternatives evaluated, and preferred approach to remediation.
- **Record of Decision (ROD) -** A public document that describes the selected cleanup action.
- **Remedial Design -** Technical analysis of the site remedy with detailed plans for implementation.
- **Remedial Action -** Actual implementation of the cleanup.

5.6 DEPARTMENT OF THE NAVY

Because this HRA deals with G-RAM, the Navy's regulatory involvement is addressed below.

5.6.1 NRSC

The NRC has granted the CNO a Master Materials License, which allows the Navy to administer and manage the use of licensed radioactive materials by the Navy and Marine Corps. To manage that license authority, the Navy established the Naval Radiation Safety Committee (NRSC) chaired by CNO N45 **(TI-HRA-55)**. The NRSC is supported by two technical support centers: the Navy Environmental Health Center, which manages medical uses of radioactive materials, and the NAVSEA Detachment, Radiological Affairs Support Office (NAVSEADET RASO),

which manages industrial and operational uses. RASO is the Navy office providing support for radiological issues at NAVSTA TI.

5.6.2 RASP

The CNO delegated responsibility for the safe uses of radioactive materials and machines that produce ionizing radiation to the NAVSEA. To implement the responsibilities for G-RAM, NAVSEA established the RASP **(TI-HRA-56)**. RASO provides technical support to NAVSEA for administration and management of the RASP. While this is the current organization since 1984, the RASP and RASO were established in 1972. RASO made technical assistance visits approximately every 3 years since 1974 (**TI-HRA-57, TI-HRA-58, TI-HRA-42, TI-HRA-59**). During these visits, radiological operations including procedures and leak test records were routinely reviewed.

5.6.3 IR Program

The Navy established the IR Program to implement the requirements of the Defense Environmental Restoration Program (DERP) and CERCLA. The purpose of the IR Program is to identify, investigate, and clean up or control releases of hazardous substances and to reduce the risk to human health and the environment from past waste disposal operations and hazardous materials spills on Navy and Marine Corps property in a cost-effective manner. The IR Program is managed by the Naval Facilities Engineering Command (NAVFAC). RASO provides technical expertise to NAVFAC for G-RAM issues associated with IR sites.

The IR Program manages Navy property closed under the BRAC Program. The specific manager for NAVSTA TI is the BRAC Program Management Office West (BPMOW), which works with the EPA, as well as state and local agencies and the public, to ensure all actions taken at NAVSTA TI comply with CERCLA. The BPMOW uses a BRAC Cleanup Team (BCT) that comprises representatives from all regulatory agencies and BPMOW to review ongoing and proposed actions at NAVSTA TI on a monthly basis. Additionally, representatives from regulatory agencies, the local community, special interest groups, and the Navy comprise a restoration advisory board (RAB). The RAB meetings are held bi-monthly to exchange information on environmental cleanup issues. The meetings are open to the public.

5.7 STATE OF CALIFORNIA

The State of California works with EPA and SWDIV to ensure all aspects of CERCLA are implemented at NAVSTA TI. The primary state agencies involved with NAVSTA TI are detailed below.

5.7.1 CDHS

CDHS is the recognized authority on public health and a technical leader in scientific investigation. This department also implements the California Agreement State Radioactive Material Licensing Program. CDHS concurrence is required for release of all property being transferred from federal ownership to state, local or private ownership.

5.7.2 DTSC

As a department of the California Environmental Protection Agency, the Department of Toxic Substances Control's (DTSC) mission is to protect Californians from exposure to hazardous wastes. DTSC is a member of the BCT and RAB and plays an integral role in overseeing the cleanup actions at NAVSTA TI.

5.7.3 RWQCB

The Regional Water Quality Control Board (RWQCB) is a regional office of the California State Water Resources Control Board. The RWQCB develops and enforces water quality objectives and protects the beneficial uses of the state's waters. The RWQCB oversees the Petroleum Program and groundwater issues at NAVSTA TI and is a member of the RAB.

5.8 CITY AND COUNTY OF SAN FRANCISCO

The City and County of San Francisco takes an active role in the ongoing development and reuse of NAVSTA TI. San Francisco is the prospective transferee of NAVSTA TI from the Navy.

5.9 LOCAL COMMUNITY

The local community provides input on NAVSTA TI's environmental cleanup activities via the Treasure Island Development Authority (TIDA), the Citizens Advisory Board (CAB) of the

TIDA and the RAB. The Navy maintains a NAVSTA TI mailing list of over 1100 names including residents of TI and YBI, business on TI, elected officials, community groups, media contacts and surrounding community members.

5.10 CURRENT CONTRACTORS

While the Navy has an NRC Master Materials License that would cover the residual radioactive material at the site, it is Navy policy that the contractor actually performing the work must maintain independent license authority.

All contractors performing radiological work at NAVSTA TI prepare site work plans delineating proposed work efforts and safety measures. These work plans are reviewed by RASO and the appropriate regulatory agencies prior to initiation of work efforts. RASO also provides oversight during the work process and reviews all subsequent reports.

Contractors performing radiological work at NAVSTA TI involving licensable quantities of radioactive material must have an NRC or a California Agreement State license for remediation, packaging, and transportation of any resultant waste.

SECTION 5

TABLES

Table 5-1

Atomic Energy Commission Licenses Issued To NAVSTA TI

LICENSE NO./ AMENDMENT	ISSUED TO	DATE	AUTHORIZED ISOTOPES	COMMENTS
4-4346-1 Initial Issue	Restricted Weapons Defense Division	1/30/59	Cs-137 7.8 curies total. 12 sources of 0.65 curies each	For simulation of a fallout radiation field on a training ship.
4-4346-1 Amend. #1	Restricted Weapons Defense Division	12/15/60	No change in isotopes or quantities	
4-4346-1 Amend. #2	Restricted Weapons Defense Division	7/5/61	No change in isotopes or quantities	
4-4346-1 Amend. #3	Restricted Weapons Defense Division	1/4/62	No change in isotopes or quantities	
4-4346-1 Amend. #4	Restricted Weapons Defense Division	6/3/64	No change in isotopes or quantities	
4-4346-1 Amend. #5	Restricted Weapons Defense Division	11/19/64	A. Cs-137 7.8 curies total. 12 Sources of 0.65 curies each B. Br-82 4 curies C. Br-80 240 millicuries D. K-42 180 millicuries E. Na-24 66 millicuries	B through E added for use in Model 11F3A radiological training device for use in radiation monitoring, decontamination and contamination control training exercises. B through E are all short-lived isotopes.
04-04346-01 Amend. #6	NBC Defense Department	5/20/66	A. Cs-137 7.1 curies total 11 Sources of 0.65 curies each B. Br-82 4 curies C. Br-80 240 millicuries D. K-42 180 millicuries	Deleted one Cs-137 source

Table 5-1

Atomic Energy Commission Licenses Issued To NAVSTA TI

LICENSE NO./ AMENDMENT	ISSUED TO	DATE	AUTHORIZED ISOTOPES	COMMENTS
			E. Na-24 66 millicuries	
04-04346-01 Amend. #7	NBC Defense Department	1/5/67	No change in isotopes or quantities	
04-04346-01 Amend. #8	NBC Defense Department	9/6/68	No change in isotopes or quantities	
04-04346-01 Amend. #9	NBC Defense School Division	2/27/69	Cs-137 7.1 Curies Total. 11 Sources of 0.65 Curies each.	Short-lived isotopes deleted during transfer of training ship.
04-04346-01 Amend. #10	NBC Defense School Division	6/24/69	No change in isotopes or quantities	
04-04346-01 Amend. #11	NBC Defense School Division	5/22/70	A. Cs-137 7.1 curies total 11 Sources of 0.65 curies each B. Br-82 4 curies C. Br-80 240 millicuries D. K-42 180 millicuries E. Na-24 66 millicuries	Short-lived isotopes added again after transfer of training ship
04-04346-01 Amend. #12	NBC Defense School Division	6/4/70	No change in isotopes or quantities	
04-04346-01 Amend. #13	NBC Defense School Division	3/18/71	No change in isotopes or quantities	
04-04346-01 Amend. #14	NBC Defense School Division	5/20/72	Cs-137 7.1 curies total. 11 Sources of 0.65 curies each	Use of short-lived isotopes terminated
04-04346-01 Amend. #15	NBC Defense School Division	9/20/73	No change in isotopes or quantities	
04-04346-01 Amend. #16	NBC Defense School Division	9/11/74	No change in isotopes or quantities	

Table 5-1

Atomic Energy Commission Licenses Issued To NAVSTA TI

LICENSE NO./ AMENDMENT	ISSUED TO	DATE	AUTHORIZED ISOTOPES	COMMENTS
04-04346-01 Amend. #17	NBC Defense School Division	10/1/75	No change in isotopes or quantities	
04-04346-01 Amend. #18	Naval Technical Training Center	5/18/78	No change in isotopes or quantities	
04-04346-01 Amend. #19	Naval Technical Training Center	9/22/78	Cs-137 11 sources not to exceed 0.54 curies each	Curie content reduced
04-04346-01 Amend. #20	Naval Technical Training Center	6/14/79	No change in isotopes or quantities	
04-04346-01 Amend. #21	Naval Technical Training Center	2/8/82	None	License terminated concurrent with Amendment # 29 to License 04-04346-02
4-4346-2 Initial Issue	RADIAC Instrument Maintenance School	6/22/59	A. Co-60 500 millicuries total. No source to exceed 100 millicuries. 22 sources B. Cs-137 120 curies C. Co-60 2025 millicuries total in 9 sources	Authorized use is for calibration of RADIAC instruments and training of personnel in the use of radiation detection instruments.
4-4346-2 Amend. #1	RADIAC Maintenance Branch	11/21/60	A. Co-60 160 millicuries total. 4 sources B. Co-60 521 millicuries total. 7 sources C. Co-60 2254 millicuries total. 10 sources D. Cs-137 120 curies	A total of 10 Co-60 sources deleted
4-4346-2 Amend. #2	RADIAC Maintenance Branch	5/22/61	No change in isotopes or quantities	
4-4346-2 Amend. #3	RADIAC Maintenance Branch	4/19/62	No change in isotopes or quantities	
4-4346-2 Amend. #4	RADIAC Maintenance Branch	5/2/63	No change in isotopes or quantities	

Table 5-1

Atomic Energy Commission Licenses Issued To NAVSTA TI

LICENSE NO./ AMENDMENT	ISSUED TO	DATE	AUTHORIZED ISOTOPES	COMMENTS
4-4346-2 Amend. #5	RADIAC Maintenance Branch	10/28/63	No change in isotopes or quantities	
4-4346-2 Amend. #6	RADIAC Maintenance Branch	4/14/64	No change in isotopes or quantities	
4-4346-2 Amend. #7	RADIAC Maintenance Branch	11/19/64	No change in isotopes or quantities	
4-4346-2 Amend. #8	RADIAC Maintenance Branch	7/30/65	A. Co-60 436.11 millicuries total. 8 sources B. Co-60 1446.68 millicuries total. 3 sources C. Cs-137 100 curies	A total of 10 Co-60 sources deleted Authorized use for A and B is calibration of instruments and training of personnel. Authorized use for C is use in Model AN/UDM-1A RADIAC Calibrator.
4-4346-2 Amend. #9	RADIAC Maintenance Branch	1/13/66	No change in isotopes or quantities	
4-4346-2 Amend. #10	RADIAC Instrument Maintenance Division	6/17/66	No change in isotopes or quantities	
4-4346-2 Amend. #11	RADIAC Instrument Maintenance Division	1/5/67	No change in isotopes or quantities	
4-4346-2 Amend. #12	RADIAC Instrument Maintenance Division	5/4/67	No change in isotopes or quantities	
04-04346-02 Amend. # 13	RADIAC Instrument	7/10/67	A. Co-60 340.47 millicuries total. 7 sources	One Co-60 source deleted

Table 5-1

Atomic Energy Commission Licenses Issued To NAVSTA TI

LICENSE NO./ AMENDMENT	ISSUED TO	DATE	AUTHORIZED ISOTOPES	COMMENTS
	Maintenance Division		B. Co-60 894.27 millicuries total. 3 sources C. Cs-137 100 curies	
04-04346-02 Amend. # 14				Amendment not found
04-04346-02 Amend. # 15	RADIAC Instrument Maintenance Division	2/7/68	A. Co-60 340.47 millicuries total. 7 sources. B. Co-60 894.27 millicuries total. 3 sources C. Cs-137 100 curies D. Cs-137 30 curies	D added for use in Model TS-1216(B)/UD RADIAC Calibrator
04-04346-02 Amend. # 16	RADIAC Instrument Maintenance Division	10/7/68	No change in isotopes or quantities	
04-04346-02 Amend. # 17	RADIAC Instrument Maintenance Division	10/15/69	No change in isotopes or quantities	
04-04346-02 Amend. # 18	RADIAC Instrument Maintenance Division	6/4/70	No change in isotopes or quantities	
04-04346-02 Amend. # 19	RADIAC Instrument Maintenance Division	3/18/71	No change in isotopes or quantities	
04-04346-02 Amend. # 20	RADIAC Instrument Maintenance Division	6/5/72	A. Co-60 180.375 millicuries total. 7 sources. B. Co-60 551.34 millicuries total. 3 sources C. Cs-137 87 curies	Isotope curie contents reduced due to decay.

Table 5-1

Atomic Energy Commission Licenses Issued To NAVSTA TI

LICENSE NO./ AMENDMENT	ISSUED TO	DATE	AUTHORIZED ISOTOPES	COMMENTS
			D. Cs-137 27 curies	
04-04346-02 Amend. # 21	RADIAC Instrument Maintenance Division		No change in isotopes or quantities	Date of issue not legible
04-04346-02 Amend. # 22	RADIAC Instrument Maintenance Division	9/11/74	No change in isotopes or quantities	
04-04346-02 Amend. # 23	RADIAC Instrument Maintenance Division	9/30/75	No change in isotopes or quantities	
04-04346-02 Amend. # 24	Naval Technical Training Center	6/9/77	A. Co-60 92.1 millicuries total. 7 sources. B. Co-60 241.2 millicuries total. 3 sources C. Cs-137 76.9 curies D. Cs-137 24 curies	Isotope curie content reduced due to decay
04-04346-02 Amend. # 25	Naval Technical Training Center	5/26/78	A. Cs-137 76.9 curies B. Cs-137 24 curies	Deleted previous Items A and B (ten Co-60 sources). Renamed previous Items C and D to be Items A and B.
04-04346-02 Amend. # 26	Naval Technical Training Center	1/31/80	No change in isotopes or quantities	
04-04346-02 Amend. # 27	Naval Technical Training Center	7/8/81	A. Cs-137 77 curies B. Cs-137 24 curies	
04-04346-02 Amend. # 28	Naval Technical Training Center	11/2/81	No change in isotopes or quantities	
04-04346-02 Amend. # 29	Naval Technical Training Center	2/8/82	A. Cs-137 77 curies B. Cs-137 24 curies C. Cs-137 not to exceed 400 millicuries	In conjunction with termination of License 04-04346-01, item C added to this license. Quantity of sources not

Table 5-1

Atomic Energy Commission Licenses Issued To NAVSTA TI

LICENSE NO./ AMENDMENT	ISSUED TO	DATE	AUTHORIZED ISOTOPES	COMMENTS
			per source	listed. Item C for use in simulation of fallout radiation for indoctrination and training of personnel.
04-04346-02 Amend. # 30	Naval Technical Training Center	10/29/82	No change in isotopes or quantities	
04-04346-02 Amend. # 31	Naval Technical Training Center	2/9/84	No change in isotopes or quantities	
04-04346-02 Amend. # 32	Naval Technical Training Center	1/8/86	A. Cs-137 69 curies B. Cs-137 22 curies	Previous Item C (Sources for fallout training) deleted. .
04-04346-02 Amend. # 34	Naval Technical Training Center	8/20/86	A. Cs-137 69 curies B. Cs-137 22 curies	Last license issued directly to NAVSTA TI by AEC/NRC. This license converted to Navy Radioactive Material Permit 04-62639 C1NP on 4/1/87.
NRMP 04-62639-C1NP Amend. # 0	Naval Technical Training Center	5/3/89	A. Cs-137 63 curies B. Cs-137 22 curies C. Am-241/Be-7 100 millicuries	Converted from NRC license. Item C added.
NRMP 04-62639-C1NP Amend. # 1	Naval Technical Training Center	6/6/90	No change in isotopes or quantities	
NRMP 04-62639-C1NP Amend. # 2	Naval Technical Training Center	8/16/90	No change in isotopes or quantities	
NRMP 04-62639-C1NP Amend. # 3	Naval Technical Training Center	11/9/90	No change in isotopes or quantities	
NRMP 04-62639-C1NP Amend. # 4	Naval Technical Training Center	7/28/92	No change in isotopes or quantities	
NRMP 04-62639-C1NP Amend. # 5	Naval Technical Training Center	7/7/93	No change in isotopes or quantities	
NRMP 04-62639-C1NP Amend. # 6	Naval Technical Training Center	2/2/94	None	NRMP terminated.

6.0 HISTORY

This section presents a historical overview of NAVSTA TI as it relates to the use of radioactive materials. There are many details augmented in Section 8.0. Two separate, but closely related, operational areas accounted for the major uses of radioactive materials on NAVSTA TI. These two areas are:

- Uses of radioactive sources to train naval personnel on the calibration and operation of radiation monitoring instruments.
- Uses of radioactive sources to train naval personnel on monitoring and decontamination of ships and airplanes.

A third possible, albeit very minor, source of radioactive materials is the berthing of OPERATION CROSSROADS ships at NAVSTA TI. Although no ship decontamination operations were known to have occurred at NAVSTA TI some OPERATION CROSSROADS ships which were decontaminated at HPS were temporarily berthed at NAVSTA TI prior to those ships receiving final radiological clearance.

The first documented uses of radioactive materials on NAVSTA TI began in 1947. Radiological studies, surveys, and characterizations conducted on Treasure Island since radiological activities began are summarized in this section. Survey and remedial actions after June 2003, in Building 233 and at IR Site 12, are not included. These will be documented in separate reports.

6.1 TREASURE ISLAND

Construction of TI was begun in February of 1936. The island was built by creating a rock seawall on the Yerba Buena shoals on the north side of YBI. After the seawall was built up, almost 30 million cubic yards of sand and gravel fill were deposited into the cavity made by the seawall.

Figure 6.1 Construction of Treasure Island 1937
(TI-HRA-60)

While TI was being completed, construction began on two large hangers and the Terminal and Administration building. These three buildings were intended to be permanent structures and were to be employed as airport facilities after completion of the International Exposition. On February 18, 1939, the Golden Gate International Exposition opened on TI on-time.

Figure 6.2 Golden Gate International Exposition on Treasure Island 1939
(TI-HRA-61)

The exposition closed in September 1940. Earlier plans had been to convert TI into an international airport following the closure of the exposition. A master plan for construction of the Treasure Island Airport prepared by the U.S. Public Roads Administration and approved by the 12th Naval District Acting Public Works Officer on July 2, 1941 shows two crossing runways and three future runways taking up almost all available space on the island.

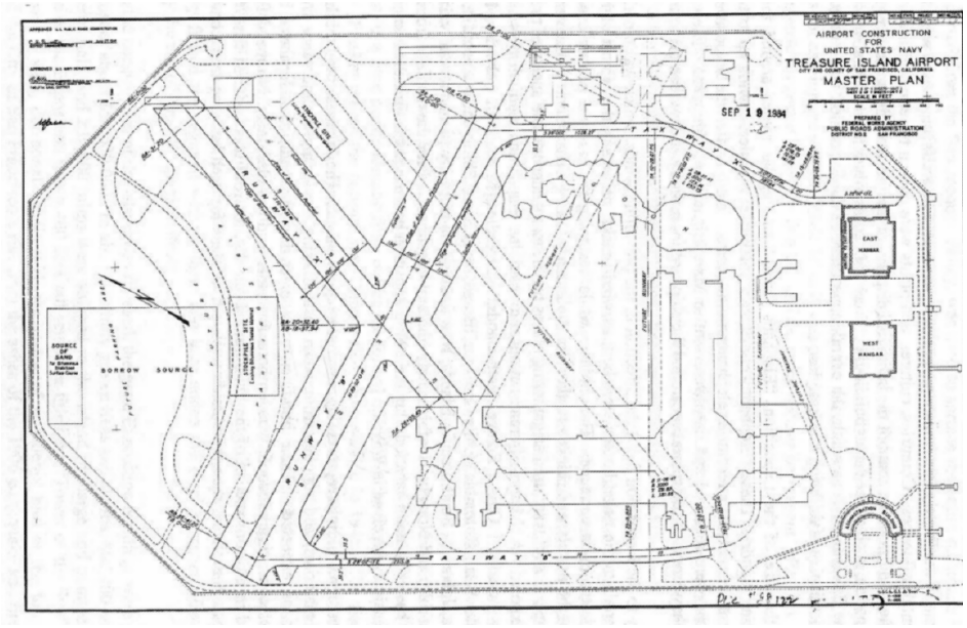

Figure 6.3 Treasure Island Airport Master Plan (TI-HRA-62)

During the same time frame, the Navy was actively attempting to obtain Treasure Island for a naval base. In mid-1940 Admiral Greenslade attempted to get the Navy Department to agree to lease TI from the City of San Francisco. His efforts were denied at that time. However, it was becoming clear to the City of San Francisco that the proposed airport at TI would soon be too small. The city agreed to lease TI to the Navy in exchange for assistance in obtaining land south of San Francisco for use as an international airport. Treasure Island was leased to the Navy in February 1941. After the attack on Pearl Harbor in December 1941, the Navy accelerated use of TI. In April 1942, the Navy took title to TI and YBI. Many of the structures built for the International Exposition were converted to Navy uses. By mid 1942 the runways previously built in anticipation of conversion to an airport were partially overtaken by new buildings in support of the ever increasing mission of the Naval Training and Distribution Center.

Figure 6.4 Treasure Island 1942 (TI-HRA-63)

By June 1942, there were 20 separate divisions operating under three main command groups all assigned to the Naval Training and Distribution Center. Throughout the war, the emphasis on training of Navy enlisted and officer personnel grew rapidly. The first technical school on TI was the Radio Materiel School which opened in 1941. Training was conducted on skills such as Fire Control, Gunner's Mate, Electric Hydraulics, Gyro Compass, Rangefinder Operations, Advanced Welding, and Underwater Cutting and Welding. At the end of World War II, the entire military downsized. Even so, The Commander-in-Chief directed a Damage Control Training Center be established at TI for the purpose of training the post-war Navy. The length of instruction was changed from 3 weeks to 6 weeks. The school was ordered to be moved from Cogswell Polytechnical College in San Francisco to a suitable location on TI. In January 1946, the Damage Control School was established in Building 7 on TI. In March of 1946 the U.S. Naval School (Damage Control) took over the functions performed by the Chemical Warfare School. In April of 1946, the U.S. Naval School (Damage Control) assumed all functions of the Fire Fighting School. The October 1946 authorized complement of instructors and staff for the Damage Control School was 17 officers and 31 enlisted personnel.

In July of 1946, the United States conducted two atmospheric nuclear weapon tests in the Bikini Atoll. These tests were known as OPERATION CROSSROADS. Many of the support ships involved in those tests were brought back to the continental United States for radiological survey, decontamination and eventual release from radiological control restrictions. In the San Francisco Bay area, these ships were processed at Hunters Point Shipyard (HPS) and at Mare Island Naval Shipyard (MINS). There is no evidence any decontamination work was performed at Treasure Island. There is documentation that some of the ships were berthed at Treasure Island following decontamination at HPS. This will be discussed in Section 6-4.

Of more significance relative to TI, was the recognition of the need to prepare for the potential of atomic warfare. Command History for the period 1 October 1946 to 10 December 1946 reported that a letter was received from the Bureau of Naval Personnel that directed setting up a course in Radiological Safety to furnish naval officers with the specialized training necessary to evaluate and combat atomic weapon damage. In January of 1947 the fourth floor of the Damage Control School, Building #7, was converted into a suitable location for the Radiological Safety School. The facility consisted of three lecture rooms, a laboratory suitable for demonstrating practical exercises, a meter repair and stowage room, and a room for storing a radioactive source needed for the practical exercises (**TI-HRA-64**).

6.2 RADIOLOGICAL SAFETY SCHOOL

On March 17, 1947, the first class in Radiological Safety convened at 0800 with 39 students in attendance. An officer assigned to the U. S. Public Health Service also attended the first course as an observer and evaluator (**TI-HRA-33**). To support this additional training, the Bureau of Naval Personnel increased the authorized complement of instructors and staff by five officers and five enlisted personnel. Some technical support for the training was provided by NRDL, which had been set up at HPS. The NRDL radiation safety officer (RSO) was assigned additional duty to deliver lectures to naval personnel attending the Radiation Safety School at TI. Students from the radiation Safety School were given initial radiation safety physical examinations at NRDL. Additional technical support was provided by technical advisors from nearby University of California at Berkeley. After completion of a second Radiation Safety class in Building 7, the new Commanding Officer moved the Radiation Safety School next door to Building 233. Larger

quarters were required to accommodate the increased student population anticipated for future training classes. The third class in Radiation Safety convened in Building 233 on June 30, 1947. Prior to that class, the U.S. Naval School (Damage Control) was renamed the U.S. Naval Damage Control Training Center.

Training in radiation monitoring, safety, etc continued to grow. In 1948, the mission statement of the Damage Control Training Center included instruction in Fire Fighting, Chemical Warfare and associated subjects, Radiological Safety, defensive Atomic Defense for officers, and damage control for prospective commanding officers and prospective executive officers.

In January 1950, during a training session in which students were to learn to calibrate radiation survey instruments, a spill of radium occurred in the first floor laboratory of Building 233 (**TI-HRA-47**). A capsule containing approximately 40 milligrams of radium was inadvertently dropped and became damaged. Foot traffic in the laboratory resulted in tracking the radium sulfate powder throughout the building before the spill was detected. The dry powdery nature of the radium sulfate also resulted in spreading the contamination to many of the students and school staff in attendance. The first indications a spill had occurred were erratic readings from the survey instruments being used by the students. Initial investigations by the students and the instructors concluded the cause of the erratic readings was a leak of radon gas from one of the capsules. This conclusion was supported by the fact a similar leak had occurred a year earlier (**TI-HRA-47**).

All personnel in the laboratory were sent to a classroom for monitoring. Several students were found to be contaminated. Initial personnel decontamination with an abrasive soap and scrubbers was successful for some, but not all of the students. The liquids generated by the initial personnel decontamination efforts were probably washed down the drain. After several attempts at decontamination were unsuccessful, the remaining contaminated personnel were sent home with instructions to carefully continue the decontamination. In the meantime, investigation in the laboratory revealed a damaged radium capsule and deposits of radium on the floor of the laboratory. The building was closed and all personnel attending classes (approximately 150) were sent home. The following day, personnel from the classes were brought back for additional monitoring. The initial Damage Control Training Center report states that “a decontamination

center was established at the Chemical Warfare School" (**TI-HRA-47**) on the day after the spill. The Chemical Warfare School was housed in buildings 269 and 273. Building 269 was the office for the Chemical Warfare School. Building 273 is specifically identified as a decontamination building. These buildings are approximately one half mile from Building 233. There are no details of the decontamination performed at the Chemical Warfare School. Since the decontamination building (273) was in place and used for training in chemical decontamination, it is very likely the building was properly prepared for radioactive contamination including provisions to prevent contamination of building surfaces and provisions for collection of decontamination liquids. Both Buildings 269 and 273 have been demolished to make way for new housing.

On the day following the spill, a team from NRDL arrived and commenced monitoring staff and students present in Building 233 on the day of the spill. On the second day following the spill, five still contaminated individuals were decontaminated. Personnel decontamination was initially accomplished using abrasive soap, hand scrubbers and deck scrubbers. Citric acid solution was also used. During the follow-up decontamination performed by NRDL personnel, a special decontamination solution of trisodium citrate, Triton X-100 (a detergent), and Hyamine 1622 (a disinfectant) was used (**TI-HRA-65**).

Monitoring and decontamination teams were formed and started monitoring of homes and quarters of staff and students on and off NAVSTA TI. Monitoring of personnel continued for 7 days. Contamination of students and personal effects are documented but not contamination levels in specific locations. It is known that both Bachelor Officers Quarters were monitored (**TI-HRA-47**). (The 1949 map of NAVSTA TI lists Buildings 226 and 228 as the Bachelor Officers Quarters (**TI-HRA-27**). Other quarters on NAVSTA TI may have been monitored as well, but there are no specific records to indicate monitoring took place. All monitoring of student and staff homes and quarters was completed with no reports of residual contamination. On the third day following the spill, NRDL entered Building 233 to assess conditions, locate the spill, and vacuumed up about one quarter of the spilled radium.

It became apparent that a large personnel change and monitoring station would be required for the handling of the working parties necessary to clean the building. Consequently, "an

unoccupied building across the street from the contaminated building was prepared for this purpose" (**TI-HRA-66**). The identification of the building used for the monitoring and decontaminating station is not clear. The NRDL report includes a detailed diagram of the decontamination station. A detailed examination in 2005 of each nearby existing building as well as review of building floor plans indicate that none of the existing buildings could have accommodated the decontamination station.

Monitoring and decontamination of Building 233 proceeded. This work was accomplished by personnel wearing protective clothing and self-contained breathing apparatus. Air analyses were performed throughout the cleanup. Radon concentration exceeded the maximum allowable levels for two weeks after the spill. Radium samples exceeded the maximum allowable for more than a month (**TI-HRA-65**). Several methods of decontamination were utilized. By the end of March 1950, the contamination had been cleaned up to the extent that a request was submitted to the BUMED to grant operational clearance for Building 233. The Chief of the BUMED concurred with the request for operational clearance and authorized the Commandant, Twelfth Naval District to grant operational clearance which was granted on May 1, 1950. More than three months later, a request for final clearance was submitted by the Commanding Officer of the Damage Control Training Center. The request reported all surfaces had been further decontaminated or if unable to be decontaminated, it was removed and disposed. Air samples and smear samples were all less than the AEC limits identified in the NRDL report (**TI-HRA-66**). These limits were:

> For airborne long-lived alpha activity ─ 0.33 d/m/ft3 (disintegrations per minute per cubic foot of air volume)
>
> For smear (wipe sample) alpha activity ─ 2000 d/m/150 cm2 (disintegrations per minute per 150 square centimeters of surface area)

Finally, the interior of Building 233 was completely painted. The Chief of the BUMED granted final clearance for Building 233 on September 11, 1950, almost nine months after the spill of radium took place (**TI-HRA-67**).

No further records of Building 233 during its use for instrument calibration training have been found. Buildings, 342, 343, and 344 were built in 1951 for the Naval Technical Training Center. Buildings 342, 343 and 344 were used for RADIAC Instruction and for storage of the radium and other portable sources. The 1952 listing of buildings on TI contained in the map of U.S. Naval Station, Treasure Island identifies Buildings 342 and 343 as classrooms assigned to U S Naval Schools Command and Building 344 as a storage building assigned to U S Naval Schools Command (**TI-HRA-28**). It would appear the ever-expanding classes and student population required the Damage Control Training Center to move to larger facilities. Note that the Damage Control Training Center was renamed the Damage Control School under the U.S. Naval Schools Command in April of 1952. At that time, courses offered by the Damage Control School included Atomic Defense, Atomic, Biological, Chemical Defense, and RADIAC Instrument Maintenance among others. Students included personnel from all branches of the military services, as well as officers from several foreign countries. The Damage Control Schools were reorganized in 1955 and again in 1956. In the 1956 reorganization, the Biological/Chemical Warfare School, which had been part of the Atomic Defense School, was established as a separate school. The six separate schools then under the Damage Control School were: Damage Control Primary School, Fire Fighters School, RADIAC Maintenance School, Atomic Defense School, Damage Control Class 'A' School, and the Biological Warfare/Chemical Warfare School.

In January 1958, the first class for Medical Officers was convened for the study of defense against Atomic, Biological and Chemical Warfare. This class was intended to be offered twice a year for Medical Officers from all services. The third and fourth courses (January and May 1959) are described as courses for Senior Medical Officers. The courses were four weeks in duration and covered the medical aspect of modern warfare.

In April 1959, the RADIAC Instrument Maintenance School of the Naval Schools Command applied for a Byproduct Material License from the Atomic Energy Commission. License No. 4-4346-2 was issued June 22, 1959 and authorized possession and use of 22 Co-60 sources totaling no more than 500 millicuries with no individual source greater than 100 millicuries; one cesium-137 source of 120 curies; and nine Co-60 sources totaling 2025 millicuries. The possession and use of these sources was authorized for "Calibration of RADIAC instruments and training of

personnel in the use of radiation detection instruments". Over the years, the isotopes and quantities authorized by License No. 4-4346-2 changed as the needs of the school changed. License No. 4-4346-2 remained continuously in effect until April 1, 1987 at which time it was converted to a Navy Radioactive Material Permit. A tabular history of License No. 4-4346-2 is presented in Table 5-1. Buildings 342 and 343 were used as classrooms, calibration rooms, laboratories, offices, and equipment issue rooms. Instruction on RADIAC calibration and maintenance, and RADIAC instrument use were presented in these two buildings and in the fenced off compound in-between the two buildings. Building 344 was the source storage vault for portable sources. By 1972, Building 342 was only used for storage space, a workshop, and a counting room. One of the three laboratories in Building 342 had been turned over to the Underway Replenishment School, and another was no longer being used. Radioactive material use in Building 342 was discontinued in 1972. Building 342 was being turned over to other schools for use. In 1982, the Byproduct Material License was modified to remove Building 342 from the authorized locations list. In January 1986, the license was again modified to remove Building 344 from the authorized locations list (**TI-HRA-68**). Building 344 was still in use as a storage location for radioactive sources as confirmed by the 1986 Technical Assistance visit by RASO (**TI-HRA-59**). The 1986 modification removing Building 344 from the license was a mistake. The initial issue of the Navy Radioactive Materials Permit (which superseded the Byproduct material License) in 1989 again included Building 344 as an authorized location (**TI-HRA-69**).

During a routine survey of the Building 344 vault in March 1988, two waste containers were found to be contaminated. An investigation revealed the source of the contamination was a cesium/barium mini-generator kit. Small vials labeled as "Cesium 137/Barium 137," and "Tin 113/Indium 113" were found inside the kit. Contamination levels inside the kit were higher than in the waste containers leading to the conclusion the source of the contamination in the waste containers was liquid from the mini-generator kit. Swipe surveys were taken in the area where the kit was located and swipe surveys of the shelves and floor of the vault gave no readings above background. The mini-generator kit and the contaminated waste were secured. Arrangements for off-site disposal of the contaminated waste were made via the Navy Supply Center, Oakland (**TI-HRA-70**).

In April of 1990, the NTTC submitted a request to remove Building 344 from the NRMP. Amendment No. 3 to the NRMP removed Building 344 from the authorized locations in November of 1990 (**TI-HRA-71**). In August of 1991 the Commanding Officer of the NTTC reported that although the NRMP had been amended to remove Building 344, documentation of close-out surveys of Building 344 had not been performed and in fact contaminated material was stored in Building 344 until July of 1991 (**TI-HRA-72)**. Closeout surveys of Building 344 were performed later in 1991 and were reported to RASO in June of 1992 along with a new request to amend the NRMP (**TI-HRA-73**). A follow-up letter in July of 1993 corrected some calculations concerning MDA. The corrections did not affect the results of the previously completed surveys. (**TI-HRA-74**).

6.3 DECONTAMINATION TRAINING

One of the recommendations from the investigation of the 1950 radium spill in Building 233 was to replace the radium capsules with Co-60 sources. Even before the decontamination of Building 233 was complete, action was initiated to replace the radium sources. In February 1951 six Co-60 sources were transferred to the Damage Control School on Treasure Island from NRDL. Four of the six sources were sent to the Damage Control Center and two were sent to the Electronics School.

The first documented training on ship decontamination procedures was in 1952. It is not clear that the training at that time included use of mockups or even used radioactive sources. Since four Co-60 sources were shipped to the Damage Control Training Center at NAVSTA TI in 1951 (**TI-HRA-44**), it is probable that these sources were utilized in the decontamination training. It is clear that some formal training was provided in April of 1952. Crewmen from the Military Sea Transportation Service (MSTS) ship General E T Collins, were sent to Treasure Island for Damage Control School including training on Nuclear Decontamination procedures. They were subsequently returned to their ship and participated in OPERATION IVY nuclear weapons testing at Eniwetok in 1952 (**TI-HRA-75**). During the 1950s, there were more than 60 nuclear tests just in the Marshall Islands. Personnel trained at the Naval Schools Command on Treasure Island participated in many of these tests. For example, planning for the OPERATION HARDTACK series of 33 nuclear tests in 1958 called for a monitors training program to be

conducted at the Naval Schools Command, Treasure Island. The 'standard' two week atomic defense course given by the Naval Schools Command was to be augmented by two weeks of additional training given by experienced radiation and contamination control personnel (**TI-HRA-76**).

In July of 1956, a training ship, the USS Pandemonium, was 'launched'. The USS Pandemonium was built from materials of salvage and scrap companies. It was a full-scale, above the water-line, mockup of a 173 foot patrol craft and was located on the northwest part of Treasure Island, Figure 6-5. A complete water washdown system was donated by the Damage Control Section of the Bureau of Ships. The USS Pandemonium was 'commissioned' in February 1957 and was described as "one of the most realistic training aids to be found in the Atomic, Biological, and Chemical Defense School". One design feature of the USS Pandemonium was the ability to simulate various radiation levels at various locations on the mockup. Wells containing sealed cesium-137 sources were installed at eleven locations on the ship. Using cables from a central position, an instructor was able to withdraw one or more sources from their shielded wells so the students using monitoring instruments could locate 'radioactivity' during a training exercise.

As noted earlier, the Atomic Energy Commission began issuing licenses for possession and use of radioactive materials in 1954. In 1958, the Restricted Weapons Defense Division of the U.S. Naval Schools Command applied for an AEC license to support training on the USS Pandemonium. A Byproduct Material License No. 4-4346-1 was issued by the Atomic Energy Commission to the Restricted Weapons Defense Division on January 30, 1959. The license authorized possession and use of 12 sealed cesium-137 sources for 'simulation of a fallout radiation field on a training ship for indoctrinating monitors and decontamination teams'.

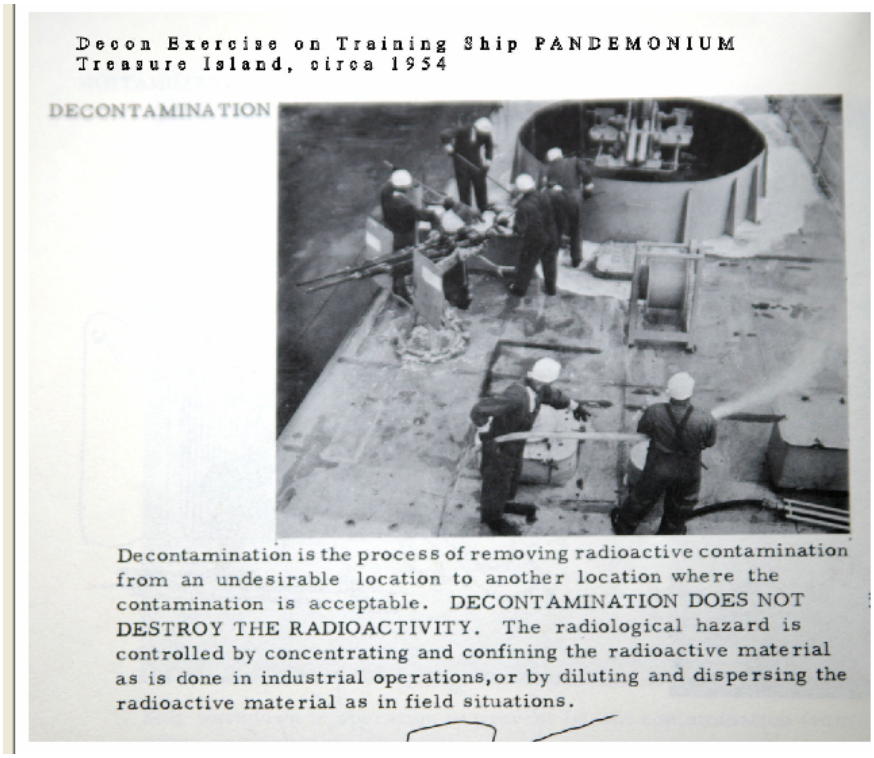

Figure 6.5 Decontamination Training on USS Pandemonium.

Note the date. The USS Pandemonium was not constructed until 1956, therefore the date is in error and is probably 1957 or 1958. Photograph courtesy of R. Sulit. (**TI-HRA-77**)

A plan view of the layout of the USS Pandemonium training ship showing the location of the installed cesium-137 sources is contained in Figure 6.6.

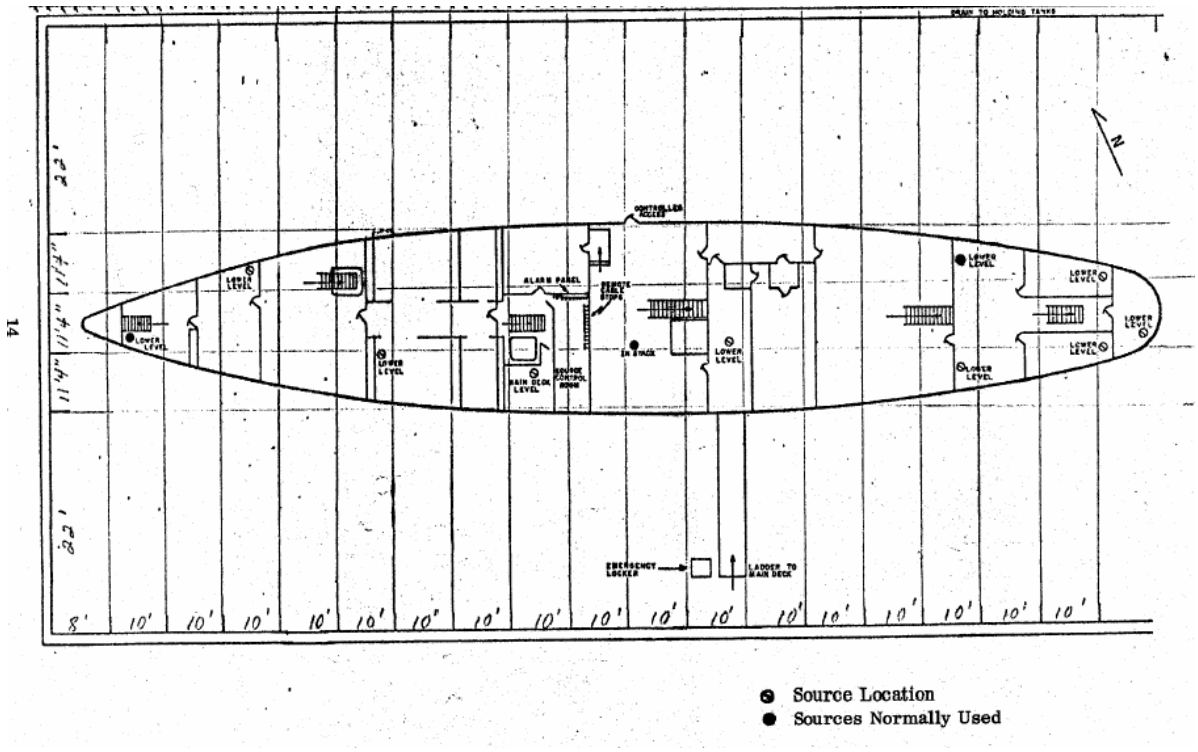

Figure 6.6 Plan View of USS Pandemonium (TI-HRA-45)

Training in contamination detection and subsequent decontamination became more sophisticated with the introduction of short-lived isotopes (a short-lived isotope is one with such a short half-life that it decays to a negligible quantity in a matter of hours or perhaps days). During the actual training of personnel for the OPERATION HARDTACK series of nuclear tests, short-lived isotopes were used to contaminate the exterior decks of the Pandemonium (**TI-HRA-78**). The advantages of using the short-lived isotopes are: the contamination could be spread over a surface rather than appear as a point source thus better simulating a real contamination situation, trainees could experience detecting the contamination with survey instruments, trainees could witness first-hand the affect that decontamination techniques had on the contaminated areas. Decontamination involved spraying and scrubbing the surfaces of the mockup with water and detergent to wash away the radioactive contamination. No documented information exists, however, the contaminated liquid thus created was probably allowed to soak into the ground where the short-lived isotopes decayed away. This conclusion is based on the reports of testing of a radiological spreader device discussed below. Trainees and instructors agreed the use of the short-lived isotopes was more realistic than when fixed sources were used. A recommendation was made to develop a device for spreading the short-lived isotopes. The Bureau of Naval

Personnel approved the recommendation and authorized the Naval Training Devices Command (NDTC) to develop a prototype for testing.

The prototype device for spreading radioactivity on the mockup was tested jointly by the US Naval Schools Command, Treasure Island and the NRDL. Six tests over a period from November 1962 through February 1963 were conducted under actual training conditions to determine if the device was useful and could be used safely. One of the tests involved contaminating a jet aircraft. The other tests were conducted on the USS Pandemonium. The tests of the Radiological Trainer Device concluded the device was a valuable tool and should be incorporated into the training program at TI as well as other locations with the proper facilities to control the use of radioactive sources (**TI-HRA-78**). The report of testing states "drainage from the area was from an old sewer system that is isolated from the sanitary sewers and leads directly to San Francisco Bay." During the tests, all inlets to the drain were blocked off to prevent discharge into the bay. The effluent from the washdown operations was allowed to soak into the soil. The report goes on to recommend installation of holding tanks to collect the effluent until it decays. The Bureau of Personnel issued approval for incorporating use of the trainer into the course curriculum. A technical briefing and demonstration of the trainer was presented to interested representatives from all military services in September 1963 (**TI-HRA-79**). In December of 1963, the Naval Schools Command, Treasure Island submitted a formal request for an amendment to the AEC license covering the USS Pandemonium. The request notes that control of contaminated run-off is maintained by allowing the run-off to flow into two holding tanks each with a capacity of 6,000 gallons. The run-off, once it had decayed to a safe level of radiation is drained into the bay by means of a 6-inch pipe (**TI-HRA-80**). On November 19, 1964, the AEC issued an amendment to Byproduct Material License No. 04-04346-01, adding authorization for possession and use of short-lived isotopes bromine-82, bromine-80, potassium-42, and sodium-24 (**TI-HRA-43**). The principal isotope was bromine-82 with a half-life of 35.3 hours. The remaining three isotopes all have half-lives less than the bromine-82 and are incidental to the generation of that isotope by reactor irradiation. In 1966, an amendment was issued to the license which reduced the total quantity of cesium-137 allowed to eleven sealed sources of 0.65 curies each (**TI-HRA-43**).

The USS Pandemonium remained in use until July 1969. However, a new damage control school complex was being constructed on the Northeast end of Treasure Island. The new complex consisted of Building 461, Building 462, and the fenced-in area at the northeast end of the island containing the foundation for the USS Pandemonium and the below grade collection tanks. The USS Pandemonium was to be moved to the new complex, Figure 6-7. In anticipation of that move, a request was submitted to amend the Byproduct Material License to delete the possession and use of the short-lived isotopes. Amendment No. 9 to the license was approved on February 27, 1969. In May of 1969, a request was submitted to the AEC to again modify the license to accomplish the move of the USS Pandemonium. Amendment No. 10 to the license approved the modification request which included temporarily storing the cesium-137 sealed sources in Building 344 until the transfer of the training ship to the new damage control school complex was complete. The new complex consisting of Buildings 461, 462, and the exercise area (containing the USS Pandemonium and two below-grade concrete holding tanks) was accepted in March of 1970. Refurbishment of the USS Pandemonium, Figure 6-7 and reinstallation of the sources was completed in September of 1970. Amendment No. 11 to the license again authorized the possession and use of the same short-lived isotopes previously authorized by Amendment No. 5, as well as the fixed cesium-137 sources. The Naval Schools Command Instruction governing radioactive sources specified collecting the runoff water from the decontamination exercises in the holding tanks until the bromine-82 had decayed to below the allowable levels for discharge ($< 3 \times 10^{-4}$ microcuries per milliliter) (**TI-HRA-81**). A 1973 drawing of the Sanitary Sewer System shows a single 6-inch pipe leading from the holding tanks to the bay (**TI-HRA-82**). In May of 1972, the Naval Schools Command submitted a request to the AEC to delete the authorization for use of the short-lived isotopes in the Radiological Trainer. The request was approved later the same month at which time the simulation of radiation fallout contamination reverted to use of the fixed cesium-137 sources installed in the USS Pandemonium. License No. 04-04346-01 remained in effect and unchanged except for identification of responsible personnel, until February 1982. At that time, by Amendment No. 21, License No. 04-04346-01 was terminated. This did not mean that use of the USS Pandemonium was ended. A concurrent amendment (No. 29) on the same February date was approved for License No. 04-04346-02 adding the authorization for possession and use of cesium-137 sources for simulation of fallout training. Thus, the authorization for possession and use of cesium sources for the USS

Pandemonium remained continuously in effect. License No 04-04346-02 was renewed for the last time by Amendment No. 32 on January 8, 1986. The main change affected by Amendment No. 32 was deletion of authorization for the Cs-137 sources used in the USS Pandemonium. The following year, the Byproduct Material License was superseded by Navy Radioactive Material Permit 04-62639-C1NP. At that time, the Radiological Affairs Support Office took over the detailed management of the radioactive material licensing for the Navy. The initial issue of the NRMP authorized a Cs-137 source of approximately 63 curies, a Cs-137 source of approximately 20 curies, and an americium-241/beryllium-7 neutron source. These same sources were authorized in each amendment of the NRMP until the permit termination on February 24, 1994. The radioactive sources were transferred to the Service School Command in Orlando, Florida (**TI-HRA-83**). Throughout the history of the USS Pandemonium, no mention was ever made to indicate a problem with the use or control of the Cs-137 sources. Some of the survey instruments utilized during decontamination training contained installed instrument check sources. All sources were required to be leak checked every six months. In 1980, the Radiological Affairs Support Office of the Naval Nuclear Power Unit analyzed leak tests performed by NTTC on eleven Cs-137 sources used on the USS Pandemonium. The leak test results were all at or below the minimum detectable activity of 8.19×10^{-6} microcuries. Also tested at the same time were three other devices containing Cs-137 sources, a TS-1216 calibrator, a TS-1189 calibrator, and a UDM-1 calibrator. These three sources were also well below the NRC limit for indication of a leaking source (**TI-HRA-84**). In addition to the specific leak tests just discussed, there were no reports of leaking check sources submitted. Thus there is no evidence to indicate a loss of control of radioactivity at either of the USS Pandemonium sites or at the buildings (461 and 462) associated with the final USS Pandemonium site. The short-lived isotopes used with the radioactive spreader device had a half-life of less than 36 hours, were last used in 1972 and are no longer present.

Figure 6.7 USS Pandemonium after move to Northeast corner of Treasure Island Approximately 1970. (TI-HRA-85)

6.4 BERTHING OF OPERATION CROSSROADS SHIPS

At least four OPERATIONS CROSSROADS ships were berthed at NAVSTA TI after being decontaminated at HPS and before they were given final clearance. Three of the ships were berthed at NAVSTA TI before being given operational clearance, but after having been monitored. A Navy Port Director report listed three OPERATION CROSROADS ships present at NAVSTA TI on December 2, 1946. The USS CEBU, ARG-6, an internal combustion engine repair ship, was berthed at Pier 21 on TI. The LST-388, a tank landing ship, was berthed at Pier 13 on TI. The LST-861, a tank landing ship, was berthed at the short dock on YBI (**TI-HRA-86**). The USS ACHOMAWI, ATF-148, a fleet ocean tug, departed HPS for TI on December 9, 1946, the actual berthing location is not listed (**TI-HRA-87**). Final radiological clearance was granted

to each of the four ships by December 21, 1946 (**TI-HRA-88**). The three identified piers used for OPERATIONS CROSSROADS ships have all been demolished. All four ships were monitored before arriving at NAVSTA TI, and all four ships subsequently received final clearances. There is no likelihood of contamination due to the berthing of OPERATION CROSSROADS ships. As noted in Section 6.0, there is no documentation that any OPERATIONS CROSSROADS ships were decontaminated while berthed at NAVSTA TI.

6.5 OTHER BUILDINGS AND LOCATIONS

One additional building and two sites on NAVSTA TI had a potential for exposure to radioactive materials. There is no documentation to indicate that a spill occurred or a spread of contamination or a loss of control of radioactive material took place. The building and sites are listed here for completeness.

Building 3 provided administrative office space for the Damage Control School Hull Technician "A" School in the 1980s. RADIACS with check sources were maintained in that area (**TI-HRA-89**). There were no reports of leaking check sources.

What is now known as IR Site 12 on the northern end of NAVSTA TI was once a disposal area for trash and debris. The US EPA aerial photographic analysis of historical photographs of the area conclude that trash and debris were disposed of at that site between 1946 and 1963, most notably in the four solid waste disposal areas (**TI-HRA 54**). However, although general waste disposal sites on military facilities have been frequently been used for disposal of unlicensed radioactive materials such as radioluminescent devices, this practice was more common at naval facilities where ships and planes were maintained and repaired. This was particularly true at repair facilities that had radium dial painting operations. NAVSTA TI's mission has always been training, not repair, which greatly reduces the possibility of finding radioluminescent devices in NAVSTA TI disposal areas. In a letter to the Navy, the California Integrated Waste Management Board recommended conducting surveys of the site (**TI-HRA-90**). Gamma monitoring outside of the known solid waste disposal areas was conducted during 2003 as part of the Site 12 Housing Area Sitewide Investigation (**TI-HRA-91**). Approximately 580 test pits were excavated to a depth of 4 feet. Radiation monitoring of the removed soil and the test pits detected only natural radioactivity. Evaluation of analyses will be documented in a separate

report. This recent sampling and analysis plan for chemicals possibly disposed of over the years in IR Site 12 shows the boundaries of IR Site 12 as well as the locations within IR Site 12 known to be areas of solid waste disposal (**TI-HRA-91**). See Figure 6.8.

Figure 6.8 Installation Restoration Site 12 (TI-HRA-91)

The sanitary drain system connected to Building 233 may have been exposed to radioactive materials during the initial survey and cleanup associated with the radium spill. The students participating in the exercise were initially taken upstairs for survey and decontamination of hands and shoes. The building was a classroom and laboratory facility and was likely not set up to collect contaminated liquids generated from washing and scrubbing of hands and shoes.

6.6 HISTORICAL INVESTIGATIONS AND SURVEYS

Some radiological investigations and surveys have been conducted on NAVSTA TI and some are in progress.

6.6.1 Building 233 Radium Spill

The first known radiological investigation of a spill of radioactive material on NAVSTA TI took place in January 1950 following the spill of approximately 40 milligrams of radium in Building 233. The investigation of the magnitude and extent of this spill involved monitoring of alpha airborne activity and radon activity inside Building 233. In addition, alpha wipe surveys and beta-gamma direct radiation survey measurements were performed. Since many of the occupants of Building 233 left the building before the extent of the spill was fully identified, radioactive contamination was carried by personnel (on shoes, clothing etc) to personal automobiles and personal residences. Direct measurements and wipe surveys of alpha radioactivity revealed various levels of contamination in automobiles, on furniture, and on clothing (**TI-HRA-65**).

Numerous innovative decontamination techniques were utilized to control and contain and eventually remove the radium contamination. Some of the techniques were as simple as using damp wipes and hot tri-sodium phosphate cleaning solutions. Other methods included use of high efficiency filtered vacuum cleaners, paint removal, wire brushing, flame decontamination (burning off the surface layer of concrete and wood), and material disposal. Some items such as small portable furniture, rubber floor mats, linoleum flooring, etc. were simply packaged as radioactive waste and disposed (**TI-HRA-66**). More than 200 barrels of radioactive waste were generated and were stored aboard the USS Independence at Hunters Point Shipyard. The drums were weighted with concrete and were sunk at sea at a depth of more than 100 fathoms (**TI-HRA-105**).

6.6.2 Building 344 Investigation

In March of 1988, a scheduled routine beta-gamma wipe survey of the waste containers inside the storage vault revealed low levels of loose contamination on the inside of the waste containers. Only wipe surveys were feasible in this location because the numerous sources maintained in the vault made direct radiation surveys not possible. After the wipes were removed

from the vault and counted, revealing the low levels of contamination, an investigation quickly identified the source to be the mini-generator kit located on a shelf near the waste containers. Surveys of the shelf containing the mini-generator kit, all other shelves in the vault and of the floor of the vault were all negative. No spread of radioactivity was found outside of the mini-generator kit and the waste containers.

Cleanup of the low levels of contamination simply involved packaging and off-site disposal of the mini-generator kit and the waste containers. Arrangements for off-site disposal were made by NSC Oakland (**TI-HRA-70**).

6.6.3 Closeout Survey of Building 344

The closeout survey of Building 344 was conducted in 1991. Alpha, beta, and gamma wipes were collected and analyzed by NTTC. Following review of the initial survey data, the NTTC submitted a summary of the Building 344 survey data to RASO along with a request for amendment of the NRMP to remove Building 344 from the authorized storage locations (**TI-HRA-73**). Further review by RASO resulted in an additional report from the NTTC to RASO to clarify calculation of minimum detectable activity (MDA) for alpha activity (**TI-HRA-74**). The Radiological Affairs Support Office reviewed the Building 344 survey data and recommended approval of termination of the NRMP by letter in 1994 (**TI-HRA-92**). The actual change to the NRMP, Amendment No. 3, was issued in November 1990 (**TI-HRA-71**). This amendment removed Building 344 from the NRMP leaving only building 343 as an authorized location for possession of radioactive materials.

6.6.4 Closeout Survey of Building 343

Closeout surveys of Building 343, the last authorized location for possession of licensed radioactive material, were conducted in June 1993. The Naval Technical Training Center submitted a request to the Radiological Affairs Support Office for termination of the NRMP No. 04-62639-C1NP (**TI-HRA-83**). The request, an 86 page document, contained documentation of the disposal of all sources, wipe surveys of all sources and source containers, and wipe surveys of the rooms in building 343. This document included the leak tests of the sealed and plated calibration sources and AN/UDM-7 alpha calibrators that were stored in Building 343. All leak tests were less than the MDA of the counting system used by NTTC. RASO analyses of 172

wipes taken in a portion of Building 343 was reported in July 1993 (**TI-HRA-94**). RASO reported all beta wipes were equal to or less than the lower limit of detection (LLD) for beta of 88 disintegrations per minute (dpm), and all, but six, alpha wipes were equal to or less than the LLD for alpha of 2.5 dpm. Two of the six alpha wipes above the LLD were also above release limits. They were located on a counter top in the storeroom. Of the remaining four wipes above the LLD (but well below release limits), two were in shelves in the storeroom, one was on the floor in the restroom, and one was in a drawer in the Chemical, Biological, Radiological Defense Laboratory. Follow-up wipes were taken by the Naval Technical Training Center to resolve the six alpha wipes (**TI-HRA-95**). The Naval Technical Training Center reported that the areas were decontaminated using commercial decontamination spray foam. RASO analyses of the six areas resurveyed by NTTC determined that all six were less than the LLD for both alpha and beta (**TI-HRA-96**). There were no direct surveys taken and the wipes were not analyzed for gamma isotopes. An additional 95 wipes were forwarded to RASO for alpha, beta, and gamma analyses of the remainder of Building 343 in July 1993 (**TI-HRA-97**). RASO reported all beta wipes were equal to or less than the LLD for beta of 92 dpm, and all, but two, of the alpha wipes were less than or equal to the LLD for alpha of 2.1 dpm. The two alpha wipes above the LLD were well below the release limits. All wipes were counted as a group for gamma in a High Purity Ge (Germanium) detector for 50,000 seconds. No gamma other than natural background was detected (**TI-HRA-98**).

Amendment No. 6 terminated the Navy Radioactive Material Permit (**TI-HRA-93**). Documentation had been provided that stated all surveys were complete and all radioactive material properly disposed.

6.6.5 Investigation of Installation Restoration Site 12 Solid Waste Disposal Areas

Gamma monitoring outside of known solid waste disposal areas was conducted in 2003. Approximately 580 test pits were excavated to a depth of 4 feet. Radiation monitoring of the removed soil and the test pits detected only natural radioactivity. Evaluation of the analyses will be documented in a separate report.

7.0 ASSESSMENT OF IMPACTED SITES

This section describes the methods and definitions used in Section 8.0 to categorize and assess the likelihood of residual contamination at impacted sites, the contaminated media involved, the potential for migration of contamination, and the recommended actions for each impacted site. Evaluations and definitions are based on guidance provided in MARSSIM.

Impacted sites were assessed based on the site's operational history and whether G-RAM was used, stored, or potentially disposed of at the site. Previous site surveys, studies, and investigations, when available, were also used to confirm or expand on the historical information.

The historical radiological surveys and investigations at NAVSTA TI were conducted prior to the publication of MARSSIM in December 1996; therefore, the terminology used in this section will not necessarily apply to historical (pre-MARSSIM) documents. However, the radiological investigations that are currently being conducted on NAVSTA TI are being conducted following MARSSIM guidelines.

7.1 IMPACTED SITES

An impacted site is one that has a potential for radioactive contamination based on historical information or is known to contain radioactive contamination. Areas immediately adjacent to the primary impacted site may be included in this designation. Impacted sites include:

- Sites where radioactive materials were used or stored.
- Sites where known spills, discharges, or other unusual occurrences involving radioactive materials have occurred, or may have occurred, that could have resulted in the release or spread of contamination.
- Sites where radioactive materials might have been disposed of or buried.

7.2 NON-IMPACTED SITES

A non-impacted site is one with no reasonable possibility for residual radioactive contamination. Examples of areas that would be non-impacted, rather than impacted, include buildings or sites

where only sealed sources were used and there were no reports of source leakage, where only survey instruments containing check sources were used or stored, or where only short-lived radionuclides were used. Non-impacted areas do not receive any level of survey coverage.

7.3 IMPACTED SITE ASSESSMENTS

Assessments for each impacted site are provided in Section 8.0. These are based on the historical information and site surveys conducted prior to June 30, 2003. The assessments cover both media and migration pathways. These assessments may change in the future as the result of the implementation of recommended actions or location of additional historical information. The system used to assess the potential radiological contamination at an impacted site is detailed below.

7.3.1 Contamination Potential

The potential for residual radioactive contamination at each impacted site has been determined through a professional evaluation of historical information, previous survey results, and site reconnaissance. As recommended actions are completed in the future, these assessments will change. Contamination potentials are categorized as:

- **Known-Restricted Access -** Radioactive contamination is known to exist at levels that could require protective clothing, respiratory protection, radiation monitoring, and site access controls.
- **Known-Continued Access -** Low levels of contamination exist, but the contamination is contained in a system, fixed on building surfaces, or is in generally inaccessible areas.
- **Likely -** Residual radioactive contamination is expected but has not been confirmed.
- **Unlikely -** Residual radioactive contamination is not expected but investigation is warranted.
- **Unknown -** Residual radioactive contamination potentially exists but no clear indication of possible contamination levels or contaminants has been established.
- **None -** Radioactive contamination has been fully assessed and removed, if necessary, and the site has been free-released by the Navy and regulators. The site remains classified as impacted but no further action is required.

7.3.2 Contaminated Media

Section 8.0 also categorizes and assesses different types of media at each impacted site that contain, or are suspected of containing, radioactive contamination. Previous survey data, historical information, and professional judgment were used to confirm the presence of contamination or determine contamination potential. Generic terms, as defined in MARSSIM, are used to categorize the types of material that would contain the contamination. For example, if a building contains radioactive contamination in concrete floor materials, the medium would be defined as "structures." To ensure that all potential media contamination has been evaluated, Section 8.0 includes an assessment for all media categories for each impacted site. The definitions for the types of media that could be contaminated are provided below.

- **Surface Soil -** The top layer of soil (to 6 inches bgs), fill, gravel, waste piles, concrete, or asphalt that is available for direct exposure, growing plants, resuspension of particles for inhalation, and mixing from human disturbances. This definition includes surface sediment in underwater areas.
- **Subsurface Soil -** Solid materials and media found below the surface soils.
- **Sediment -** Material that settles to the bottom of a liquid or is deposited by water.
- **Surface Water -** Waters found in streams, rivers, lakes, and oceans as well as coastal tidal waters.
- **Groundwater -** Waters contained in subsurface materials and aquifers.
- **Air** Atmosphere that becomes a migration pathway for resuspension and dispersal of radioactive contamination and contaminated media.
- **Structures -** A man-made surface(s) above the surface or contained within subsurface media.
- **Drainage Systems -** Sanitary drains, facility storm drains, or septic systems and leach fields and sediments contained therein. This category can include Bay sediments where drainage to the Bay occurs.

7.3.3 Contaminated Media Assessment

Section 8.0 provides an assessment of each contaminated media category at each impacted site. These ratings are determined during the evaluation of each media type. The ratings may change if additional historical information becomes available or further information is developed during the performance of surveys at the site. Ratings are defined below.

- **High -** Evidence of contamination in the media or migration pathway has been identified.
- **Moderate -** The potential for contamination in the media or migration pathway exists, although the extent has not been fully assessed.
- **Low -** The potential for contamination in the type of media or migration pathway is remote.
- **None -** Evidence of contamination in the specific media or migration pathway has not been found, or known contamination has been removed, and surveys indicate that the media or migration pathway meet today's release criteria.

7.3.4 Potential Migration Pathways

Migration pathways are the media or transport mechanisms that allow contamination to spread in the immediate vicinity of the contaminated media or off site. The assessment of each impacted site in Section 8.0 provides an evaluation of the potential migration of radioactive contamination. The type of potential or confirmed contaminated media and the radionuclides of concern were used to assess the potential migration pathways.

7.4 RECOMMENDED ACTIONS

A recommended action for each impacted site is also provided in Section 8.0. The recommendation is the result of the investigations conducted to determine radionuclides of concern, contamination potential, contaminated media, and potential migration pathways for exposure. The categories of recommended actions are defined below.

- **Emergency Action -** Immediate remediation or containment is required because the levels of radioactive contamination or radiation exposure are such that there is a high potential for significant exposure or release of radioactive materials to the public or the environment.
- **Scoping Survey -** Historical documentation indicates that radioactive materials may be present at an impacted site that has not had an initial evaluation previously performed, and a survey is required to determine if contamination exists. The intent of these surveys is to identify radionuclide contaminants, relative radionuclide ratios, and general levels and extent of contamination. These surveys usually include minimal surface scans, sampling, and dose rate assessments.

- **Characterization Survey -** Radioactive contamination has been confirmed within an impacted site by a scoping survey, and action must be taken to determine the extent of the contamination and to identify and define the extent of the radionuclides of concern. These surveys include facility or site in-depth surveys, sampling, monitoring, and analysis to provide the basis for acquiring necessary technical information to develop, analyze, and select appropriate cleanup techniques.
- **Remediation -** Radioactive contamination has been fully characterized within an impacted site, and remedial or removal action is necessary to comply with site-specific release criteria. Remedial action support surveys are performed while remediation is being conducted to guide the cleanup activities.
- **Final Status Survey -** Historical documentation and previous investigations or remediations indicate that radioactive contamination has been removed from an impacted site, and a survey needs to be conducted in accordance with MARRSIM guidelines to verify that an impacted site complies with applicable site release criteria. This survey includes the appropriate measurements and sampling that will define the radiological condition of a site in preparation for release. The surveys follow completion of decontamination or remediation activities, if any were performed, but can also be conducted to confirm that past radiological activities at an impacted site did not result in residual contamination.
- **Free Release -** Historical documentation and previous investigations and surveys indicate that all applicable release criteria have been met, and the site documentation is ready for review by the Navy and applicable regulators for future non-radiological usage. This may include confirmatory surveys by Navy or regulatory personnel to verify the results reported in the release documentation.
- **No Further Action -** An impacted site has been shown by the Navy and applicable regulatory agencies to meet release criteria.

7.5 IMPACTED SITE EXAMPLE

A building, formerly used as a research laboratory, is identified as impacted. Ra-226 contamination levels, slightly above the background level have been measured on interior building surfaces during a scoping survey.

Contamination Potential—Known-Continued Access. The contamination has been confirmed, but there are no indications of hazardous levels.

Potentially Contaminated Media

Surface Soil-Low - There is a slight likelihood that contamination from the building could be in the surface soils immediately surrounding the building.

Subsurface Soil-Low **-** There is a very slight likelihood that contamination from the surface soils could be in subsurface soils. Depending on the information available at the time of rating and professional evaluation of the information, this potential could be identified as "*None*."

Sediment-None **-** There is not sediment associated with the building.

Surface Water –None **-** There is no surface water near the laboratory.

Groundwater-None **-** As the contamination is in the interior of the building, there is no potential for groundwater contamination.

Air- None **-** Contamination found in the building surfaces is insufficient to cause concern for airborne contamination. This rating is based on the type and level of radioactivity identified and if it were fixed or loose surface contamination.

Structures-High **-** Contamination has been identified in the building.

Drainage System-High **-** With surface contamination on the building interior surfaces, there is a significant potential that the drainage systems (primarily sanitary) would be contaminated, as most laboratory rooms contain sink drains.

Migration Pathways for Exposure to the Public or Environment

Surface Soil-Low **-** The potential contamination in the surface soils would present a low probability for exposure to the public or off-site environment, as there is no probable transport mechanism to cause detectable levels of contamination to spread to off-site locations.

Subsurface Soil-None **-** There is limited means of initially contaminating subsurface soils; therefore, an exposure to the public or off-site environment is not likely.

Surface Water-None **-** The information on potentially contaminated media already established that there were no surface waters in the vicinity of the building. Contamination in the interior of a building would require transport of the contamination

to surface waters by a secondary method such as runoff to a storm drain system, which is not likely to occur.

Air- None - Low levels of interior building surface contamination would require transport of a significant portion of the contamination outside the confines of the building, and then a secondary mechanism to carry the contamination off site.

Structures-Low to Moderate - Migration of the contamination in the building is likely. However, the potential for contamination to migrate to the public would be dependent on the access and security controls for the building.

Drainage Systems-Low - With contamination on interior building surfaces, the building drainage sanitary system may be contaminated. Low levels in drainage systems would be diluted by flow of non-contaminated liquids from other sources. The exposure potential from this contamination is minimal.

Recommended Actions - Characterization Survey.

8.0 FINDINGS AND RECOMMENDATIONS

This HRA assessed 542 historical and current sites on NAVSTA TI (buildings, structures, and open areas). Eighteen sites were identified as requiring further review and are assessed in this section. Five sites are designated as impacted by historic radiological operations. Thirteen buildings, structures, and open areas at NAVSTA TI are designated as non-impacted.

8.1 IMPACTED VERSUS NON-IMPACTED SITES

The scope of radiological operations at NAVSTA TI has been assessed to determine whether these operations had a direct or indirect effect on buildings, structures, or open areas. These evaluations were based on guidance provided in MARSSIM to define all sites as either "impacted" or "non-impacted" by radiological operations. Impacted sites are those where radiological operations occurred, including the use, handling, packaging, or disposal of radioactive materials where the potential for residual radioactive contamination above background exists.

A summary of the former and current uses of impacted sites is provided in Table 8-1.

Non-impacted sites are those where radiological operations occurred and there is no reasonable possibility for residual radioactive contamination.

A summary of the former and current uses of the non-impacted sites is provided in table 8-2.

8.2 SITE ASSESSMENTS

This section provides complete descriptions for each potentially impacted site, including the former and current uses, radionuclides of concern, and previous radiological investigations of the site and designates the site as impacted or non-impacted. This section also categorizes and defines the likelihood of residual contamination at impacted sites, the contaminated media involved, the potential for migration of G-RAM, and the recommended actions for each impacted site using the categories described in Section 7.0. Five sites are classified as impacted.

Thirteen sites are classified as non-impacted based upon the information developed during the investigation.

8.3 SUMMARY OF INDIVIDUAL SITE ASSESSMENTS AND RECOMMENDATIONS

Details of each of the impacted sites are provided in Sections 8.3.1.1 through 8.3.1.5 and in Table 8-1.

Details of the non-impacted sites are provided in Sections 8.3.2.1 through 8.3.2.13 and in Table 8-2.

8.3.1 IMPACTED SITES

Each of the impacted sites is discussed in the following paragraphs.

8.3.1.1 Building 233

Figure 8.3-1 Building 233

Site Description - Building 233 is a two-story raised wood structure built on pillars in 1944. It was used as the Radiation Safety School beginning in 1947. The 18,790 ft^2 building has classrooms, offices, and laboratories. The radium spill in this building took place in the first floor laboratory in January 1950. Radium contamination from a capsule containing radium sulfate was spread throughout the majority of the building before the spill was discovered. The building was secured and the scheduled classes were suspended and reassigned. Students directly involved in the spill were sent to a second floor classroom for monitoring and to the washroom for decontamination of hands and shoes. Decontamination of hands and shoes was performed using water, an abrasive detergent, and scrubbers. The liquid generated by the decontamination was probably washed down the drain. Decontamination of the building required removal of floor coverings and portable furniture and destructive procedures to completely decontaminate wooden and cement floors. Monitoring inside the building revealed high levels of airborne radon and airborne alpha contamination for weeks after the spill. Only five of the rooms in the building were not contaminated. These rooms had been closed at the time of the spill. It was nine months after the spill before decontamination of the building was completed and it was released for use again.

Former Uses - Radiation Safety School. Classrooms and Administration, RADIAC Calibration training, ATF Laboratory, California National Guard.

Current Uses - None, unoccupied.

Radionuclides of Concern - Ra-226

Previous Radiological Investigations - Extensive surveys of entire building following radium spill. Final Navy clearance granted in September 1950

Contamination Potential - Likely

Contaminated Media

Surface Soil - Low

Subsurface Soil - None

Sediment - None

Surface Water - None

Groundwater - None

Air - None

Structures - Low

Drainage Systems - Low

Potential Migration Pathways

Surface Soil - Low

Subsurface Soil - None

Sediment - None

Surface Water - None

Groundwater - None

Air - None

Structures - None

Drainage Systems - Low

Recommended Actions - Characterization surveys of both floors and the crawl space under the building. Scoping surveys of the sanitary drains. See also Section 8.3.1.5

Figure 8.3-2 Building 233 Location

8.3.1.2 Building 343

Figure 8.3-3 Building 343

Site Description - Metal one story building built on a concrete foundation. The building was completed in 1951 and covers approximately 8000 ft^2 similar to Building 342. During peak use of this building, it contained a radiological detection instrument issue and storage room, instrument repair shop, three classrooms, staff offices and lounges, washrooms, and the UDM-1A (gamma calibrator using a large Cs-137 source) laboratory.

Former Uses - Naval Technical Training Center RADIAC instruction. Calibration range, instrument issue facility, instrument repair shop.

Current Uses - None, unoccupied.

Potential Radionuclides of Concern - Ra-226.

Previous Radiological Investigations - In 1993, Navy closeout surveys of building were performed in advance of terminating NRMP. The NTTC submitted a request to the Radiological Affairs Support Office for termination of the NRMP No. 04-62639-C1NP (**TI-HRA-83**). The request, an 86 page document, documented the disposal of all sources, wipe surveys of all

sources and source containers, and wipe surveys of the rooms in building 343. RASO analysis of 172 wipes taken in a portion of Building 343 was reported in July 1993 (**TI-HRA-94**). RASO reported all beta wipes were equal to or less than the lower limit of detection (LLD) for beta of 88 disintegrations per minute (dpm), and that all, but six, alpha wipes were equal to or less than the LLD for alpha of 2.5 dpm. Of the six alpha wipes greater than the LLD, two in a storeroom on a counter were above release limits. Follow-up wipes were taken by the NTTC to resolve the six alpha wipes (**TI-HRA-95**). The NTTC reported that the areas were decontaminated using commercial decontamination spray foam. Although the two above release limits locations were decontaminated, direct surveys of the areas were not performed and gamma analysis of the above limits wipes was not performed. An additional 95 wipes for the remainder of the building were forwarded to RASO for alpha, beta, and gamma analyses in July 1993 (**TI-HRA-97**). The documentation demonstrated that all surveys had been satisfactorily completed and proper disposal of all sources.

Contamination Potential - Unlikely.

Contaminated Media

Surface Soil - None

Subsurface Soil - None

Sediment - None

Surface Water - None

Groundwater - None

Air - None

Structures - Low

Drainage Systems - None

Potential Migration Pathways

Surface Soil - None

Subsurface Soil - None

Sediment - None

Surface Water - None

Groundwater - None

Air - None

Structures - None

Drainage Systems - None

Recommended Actions - Final Status Survey in the storeroom. Navy's 1993 leak tests demonstrated the building is free of radioactivity except for the instrument storeroom.

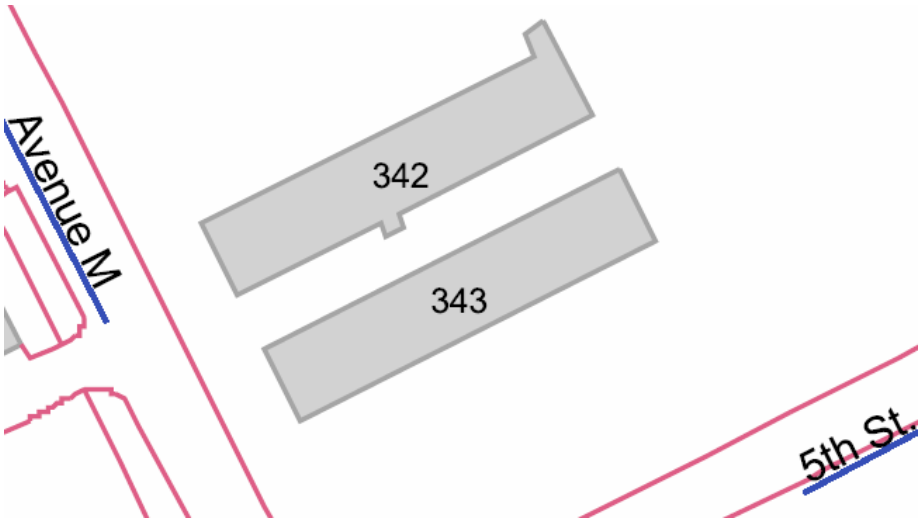

Figure 8.3-4 Building 343 Location

8.3.1.3 Building 344

Figure 8.3-5 Building 344

Site Description - Building 344 is a small 244 ft^2 concrete building approximately 15 feet by 17 feet. This concrete vault was built in 1951 in conjunction with Buildings 342 and 343. The walls and ceiling are 14-inch thick reinforced concrete to provide radiation shielding for the sources stored within. The floor is set approximately five feet below grade. There is a one-half inch thick steel door. Access to the door is from inside the fenced compound containing the three buildings.

Former Uses - Storage location for all portable sources maintained by RADIAC facility when the sources were not in use.

Current Uses - None, unoccupied.

Potential Radionuclides of Concern - Cs-137.

Previous Radiological Investigations - During a routine wipe survey of the Building 344 vault in March 1988, the insides of two waste containers were found to be contaminated. An investigation revealed the source of the contamination was a cesium/barium mini-generator kit. Small vials labeled as "Cesium 137/Barium 137," and "Tin 113/Indium 113" were found inside the kit. Contamination levels inside the kit were higher than in the waste containers leading to the conclusion the source of the contamination in the waste containers was liquid from the mini-generator kit. Surveys of the area where the kit was located and of the floor and shelves in the vault revealed no other contamination. Cleanup was accomplished by off-site disposal of the waste containers and the mini-generator kit as radioactive waste (**TI-HRA-70**). In 1990, NTTC submitted a request to remove Building 344 from the NRMP. The request was approved and the NRMP was amended (**TI-HRA-71**). In August of 1991 NTTC reported that although the NRMP had been amended to remove Building 344, documentation of close-out surveys of Building 344 had not been performed and in fact contaminated material was stored in Building 344 until July of 1991 (**TI-HRA-72)**. Closeout surveys of Building 344 were performed later in 1991and were reported to RASO in June of 1992 along with a new request to amend the NRMP (**TI-HRA-73**). The Radiological Affairs Support Office reviewed the Building 344 survey data and recommended approval of a termination amendment by letter in 1994 (**TI-HRA-92**).

Contamination Potential - Unlikely.

Contaminated Media

Surface Soil - None

Subsurface Soil - None

Sediment -None

Surface Water - None

Groundwater - None

Air - None

Structures - Low

Drainage Systems - None

Potential Migration Pathways

Surface Soil - None

Subsurface Soil - None

Sediment - None

Surface Water - None

Groundwater - None

Air - None

Structures - Low

Drainage Systems - None

Recommended Actions - Final status survey. The Navy closeout surveys by swipe surveys demonstrated the building was free of residual radioactivity. However, contamination had been discovered in the waste containers in the building. A final status survey is warranted to permit release of the building.

Figure 8.3-6 Building 344 Location

8.3.1.4 INSTALLATION RESTORATION SITE 12

Figure 8.3-7 Installation Restoration Site 12 (TI-HRA-91)

Site Description - What is now known as Installation Restoration 12 on the northern end of NAVSTA TI was once a disposal area for trash and debris. Four discrete solid waste disposal areas have been identified. Parts of Site 12 were used for storage of ammunition in bunkers and also for the disposal and incineration of refuse. Later, portions of the site were used for material storage. Beginning in the 1960s, the area was developed for military housing. It is believed that over the course of development of the northern portion of the island for residential use, some of the debris and ash has been incorporated into fill material or otherwise scattered as a result of site grading operations (**TI-HRA-91**). General waste disposal took place around and in-between bunkers. Waste disposal operations continued until approximately 1963.

Former Uses - Ammunition bunkers surrounded by cell-type disposal units and general debris areas. Burn pit and incinerator were also used in the area.

Current Uses - Multi-family housing area.

Potential Radionuclides of Concern - Ra-226

Previous Radiological Investigations - None for the known solid waste disposal areas.

Contamination Potential - Unlikely.

Contaminated Media

Surface Soil - None

Subsurface Soil - None

Sediment - None

Surface Water - None

Groundwater - None

Air - None

Structures - None

Drainage Systems - None

Potential Migration Pathways

Surface Soil - None

Subsurface Soil - None

Sediment - None

Surface Water - None

Groundwater - None

Air - None

Structures - None

Drainage Systems - None

Recommended Actions - Perform radiation monitoring during soil excavation of the known solid waste disposal areas.

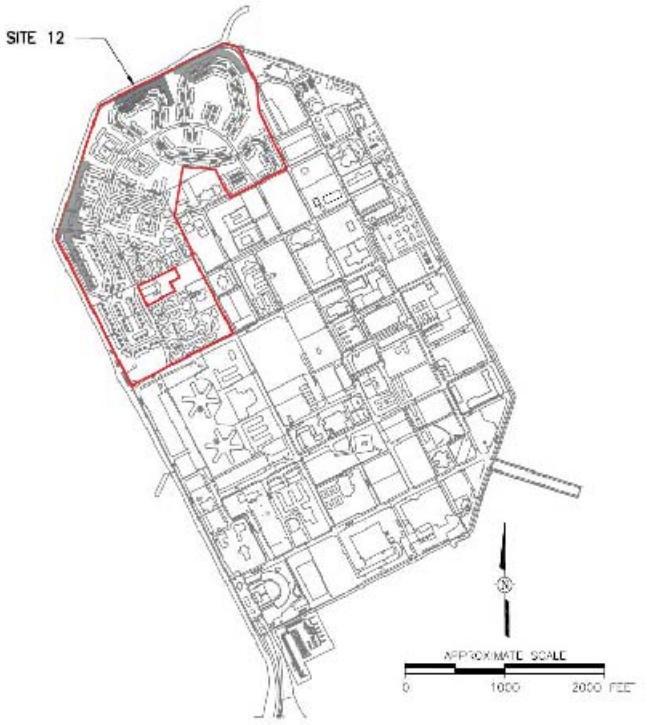

Figure 8.3-8 Installation Restoration Site 12 Location

8.3.1.5 Building 233 Sewer Drain

Site Description - Sanitary drains from sinks and washbasins and lavoratories may have carried radioactive contamination. Building 233 is a building where contamination is known to have been present. The initial personnel decontamination efforts in Building 233 following the spill in January 1950 were performed using abrasive soap, water, and scrubbers. The liquid generated from that decontamination was probably washed down the drain. Since radium is a heavy element, it can accumulate in low points and low flow areas. (Drawings of Building 233 downstream sanitary drains not included.)

Former Uses - Sanitary sewer lines .

Current Uses - Sanitary sewer lines.

Potential Radionuclides of Concern - Ra-226

Previous Radiological Investigations - None identified.

Contamination Potential - Unlikely.

Contaminated Media

Surface Soil - None

Subsurface Soil - None

Sediment - None

Surface Water - None

Groundwater - None

Air - None

Structures - None

Drainage Systems - None

Sanitary Sewer Lines - Low

Potential Migration Pathways

Surface Soil - None

Subsurface Soil - None

Sediment - None

Surface Water - None

Groundwater - None

Air - None

Structures - None

Drainage Systems - None

Sanitary Sewer Lines - Low

Recommended Actions - Scoping Survey from upstairs drain points internal to Building 233. Sample first sanitary sewer manhole downstream from Building 233.

8.3.2 NON-IMPACTED SITES

Each of the non-impacted sites is discussed in the following paragraphs.

8.3.2.1 Building 342

Figure 8.3-9 Building 342

Site Description - Metal one story building built on a concrete foundation. The building was completed in 1951. As originally configured, this building of approximately 8000 ft^2 contained three laboratories of equal size. The floor plan of the building as used for instrument calibration and instruction in 1965 is shown below. Laboratories 2 and 3 were used to conduct training exercises and instrument calibrations with sources in fixed locations. The radiation beams from the sealed sources were controlled in specific directions. Periodic leak tests of all sealed sources were required by operational procedures. The use of the building was gradually reduced, and the last use of radioactive sources was in 1972. No reports of leakage were made.

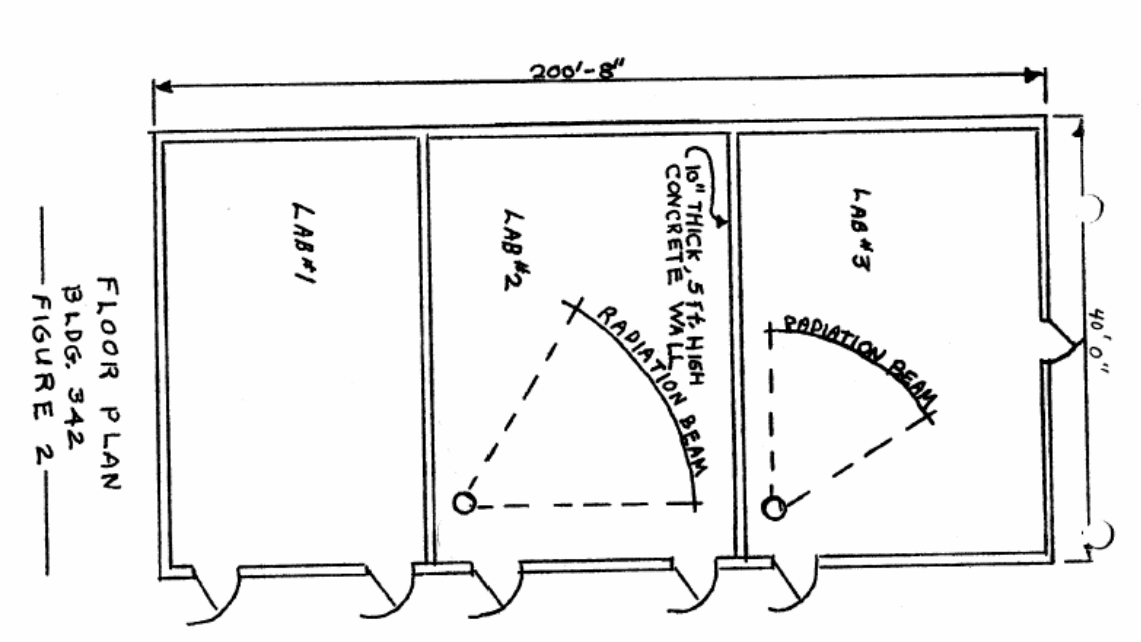

Figure 8.3-10 Building 342 Floor Plan – 1965 (TI-HRA-99)

Former Uses - RADIAC instruction and RADIAC calibration.

Current Uses - None, unoccupied.

Potential Radionuclides of Concern - None

Designated - Non-impacted. Only sealed sources were utilized in this building. There is no history of source leakage.

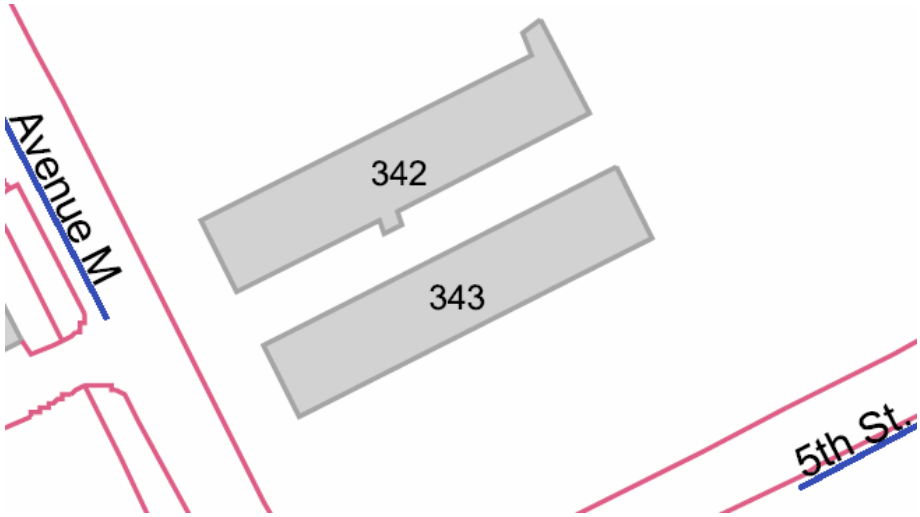

Figure 8.3-11 Building 342 Location

8.3.2.2 Building 3

Figure 8.3-12 Building 3

Site Description - Building 3 is one of the original buildings constructed on Treasure Island for the 1939 Exposition. It is a large general warehouse building with both arched and flat roofs. The building covers an area of approximately 145,000 square feet.

Former Uses - Palace of Fine and Liberal Arts, Port Control Office, Ships Repair Shops, Training School, Equipment Repair. Damage Control HT "A" school administration and offices maintained radiation survey instruments with check sources. There were no reports of leaking check sources.

Current Uses – Commercial film studio.

Radionuclides of Concern - None.

Designated - Non-impacted. Only instrument check sources were stored in this building. There were no reports of check source leakage.

Figure 8.3-13 Building 3 Location

8.3.2.3 Building 7

Figure 8.3-14 Former Location of Building 7 West Wing

Site Description - Building 7 was constructed in 1938 and is one of the original buildings constructed on Treasure Island for the 1939 Golden Gate International Exposition. It was originally a "U" shaped structure of approximately 68,000 ft^2. The east wing and the south wing were two-story structures and the west wing (destroyed by fire in September 1956) was a four-story structure. The footprint of the west wing is now a parking lot.

Former Uses - Federal Building South Half, various military schools, Radiation Safety School (fourth floor of west wing), and Director of Training. Radioactive source(s) were kept in a fourth floor storeroom when not in use for training conducted by the Radiation Safety School.

Current Uses - East and south wings vacant, west wing demolished.

Potential Radionuclides of Concern - None

Designated - Non-impacted. Only sealed sources were stored in storeroom on the fourth floor of the west wing (demolished in 1956). There were no reports of source leakage.

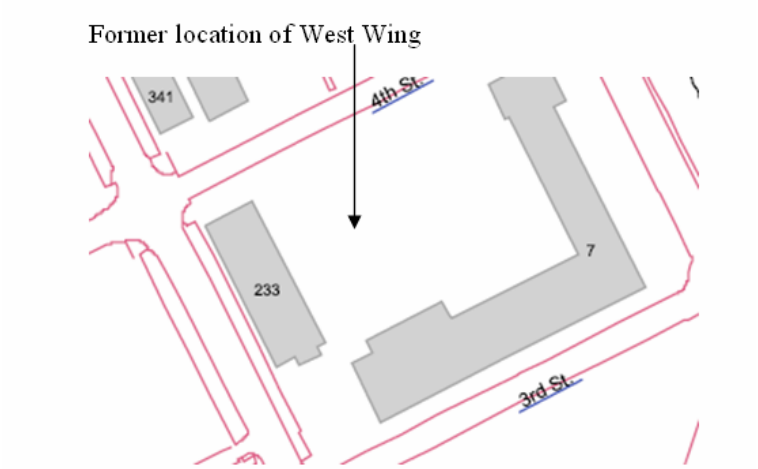

Figure 8.3-15 Building 7 Location

8.3.2.4 Building 461

Figure 8.3-16 Building 461

Site Description - Building 461 was constructed in 1970 and is part of the new Damage Control School complex that included Buildings 462 and 463 and the training ship mockup, USS Pandemonium, after it was moved from the northwest corner of NAVSTA TI.

Former Uses - Damage Control School classrooms. NTTC headquarters, Fire Training. RADIAC instruments with attached check sources were maintained in the building for use during decontamination exercises on USS Pandemonium (**TI-HRA-40**). There were no reports of leaking check sources.

Current Uses - None. Vacant

Potential Radionuclides of Concern - None

Designated - Non-impacted. Only instrument check sources were used in this building. There were no reports of check source leakage.

Figure 8.3-17 Building 461 Location

8.3.2.5 Building 462

Figure 8.3-18 Building 462

Site Description - Building 462 was constructed in 1970 and is part of the new Damage Control School complex that included Buildings 461 and 463 and the training ship mockup, USS Pandemonium, after it was moved from the northwest corner of NAVSTA TI. Building 462 is inside the compound containing the USS Pandemonium and the below-grade collection tanks for run-off water. Building 462 was the normal entrance to the compound and to the USS Pandemonium. RADIAC instruments with attached check sources were maintained in the building for use during decontamination exercises on USS Pandemonium (**TI-HRA-40**). There were no reports of leaking check sources.

Former Uses - Damage Control School tear gas decontamination building. Fire Training.

Current Uses - None, unoccupied.

Potential Radionuclides of Concern - None

Designated - Non-impacted. Only instrument check sources were used in this building. There were no reports of check source leakage.

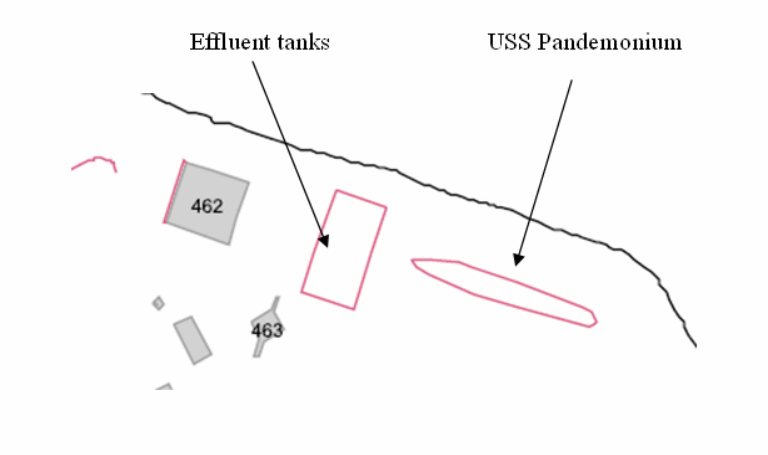

Figure 8.3-19 Building 462 Location

8.3.2.6 USS Pandemonium Training Site Northwest Corner

Figure 8.3-20 USS Pandemonium Training Site Northwest Corner—1969 (TI-HRA-100)

Site Description - The USS Pandemonium training ship was 'launched' in 1956. The training ship was 'commissioned' for use in February 1957 and remained in service in the northwest corner until July 1969. The fenced off training area was approximately 400 feet by 600 feet and was gravel surfaced. The area enclosed eight buildings, two obsolete aircraft, the USS Pandemonium mockup and a paved road. During testing of the radioactive spreader device for short-lived isotopes, the radioactive water was allowed to soak into the soil. Later, radioactive water from the decontamination training was collected in two sub-grade concrete tanks and stored until the short-lived isotopes had decayed. When the radioactivity was within allowable limits, the water was discharged to the bay via a six-inch pipe. The USS Pandemonium was moved to the Northeast corner of NAVSTA TI in 1969. The area has since been converted into multiple family military housing units.

Former Uses - Nuclear, Biological, and Chemical Warfare School. Decontamination training area. Decontamination training initially used only Cs-137 sealed sources to simulate radioactive fallout. In 1963 a radioactive material license was granted by the AEC to also utilize short-lived liquid radioisotopes (Br-82, Br-80, Na-24, and K-42) to more realistically simulate radioactive fallout. Survey instruments containing radioactive check sources were used during the training

exercises. The Cs-137 sealed sources were leak tested and were demonstrated to be intact. The check sources were required to be leak tested on a periodic basis. No reports of leakage were issued. The short-lived isotopes were last used at this location in 1969, have decayed away and are no longer present.

Current Uses - Multi-family housing area.

Potential Radionuclides of Concern - None

Designated - Non-impacted. Sealed Cs-137 sources were used for fallout simulation. Leak test of the Cs-137 sources confirmed there was no leakage. The short-lived liquid isotopes decayed away within three months of last use (1969). There were no reports of instrument check source leakage.

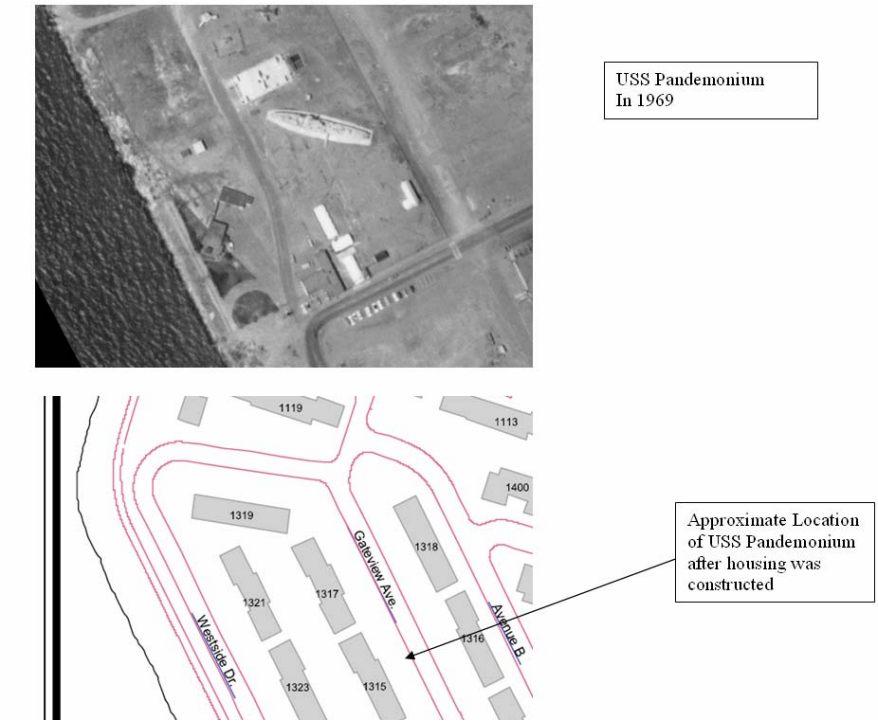

Figure 8.3-21 Former USS Pandemonium Location on Northwest Corner.

8.3.2.7 USS Pandemonium Training Site Northeast Corner

Figure 8.3-22 USS Pandemonium Training Site Northeast Corner

Site Description - The USS Pandemonium training ship was moved to the northeast corner of NAVSTA TI in 1969 where it remained until it was demolished in 1996. The training ship was part of the new Damage Control School complex that included Buildings 461, 462, and 463. Access to the area was by the tear gas decontamination building (462). An eight foot high fence separated the training area from the rest of the island. Although the mock-up remained until 1996, the use of the mockup was ended in 1992. While in use, the training ship was used to simulate radioactive fallout using the short-lived isotopes discussed earlier and also using the fixed location Cs-137 sources. Two below grade concrete holding tanks were used to collect the washdown water when decontamination of short-lived isotopes was conducted. The washdown water was released to the bay via a 6-inch pipe after it had decayed away.

Former Uses - Damage Control School decontamination training area. (After July 1969) Although the mock-up remained until 1996, the use of the mockup was ended in 1992.

Decontamination training used Cs-137 sealed sources to simulate radioactive fallout and also utilized short-lived liquid radioisotopes (Br-82, Br-80, Na-24, and K-42) to more realistically simulate radioactive fallout. Survey instruments containing radioactive check sources were used during the training exercises. The Cs-137 sealed sources were leak tested and were demonstrated to be intact. The check sources were required to be leak tested on a periodic basis. No reports of leakage were issued. The short-lived isotopes were last used at this location in 1972, have decayed away and are no longer present.

Current Uses - None

Potential Radionuclides of Concern - None

Designated - Non-impacted. Sealed Cs-137 sources were used for fallout simulation. Leak test of the Cs-137 sources confirmed there was no leakage. The short-lived liquid isotopes decayed away within three months of last use (1972). There were no reports of instrument check source leakage.

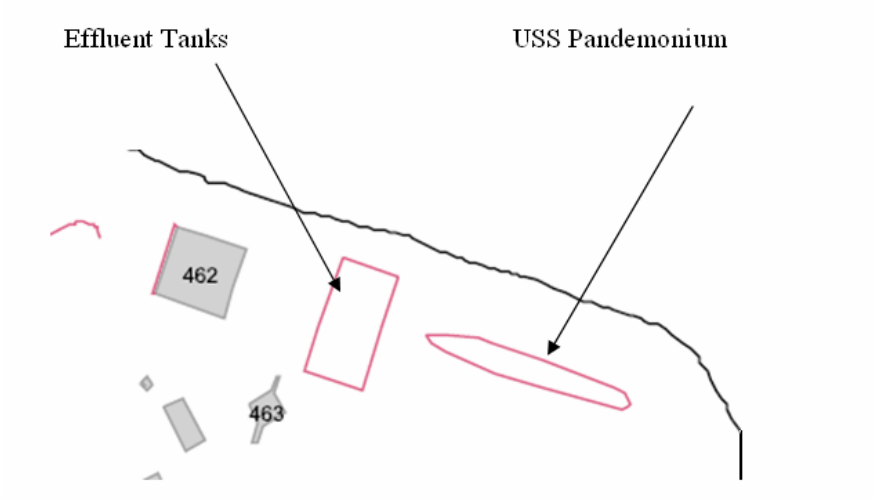

Figure 8.3-23 USS Pandemonium Site Plan on Northeast Corner.

8.3.2.8 Building 273

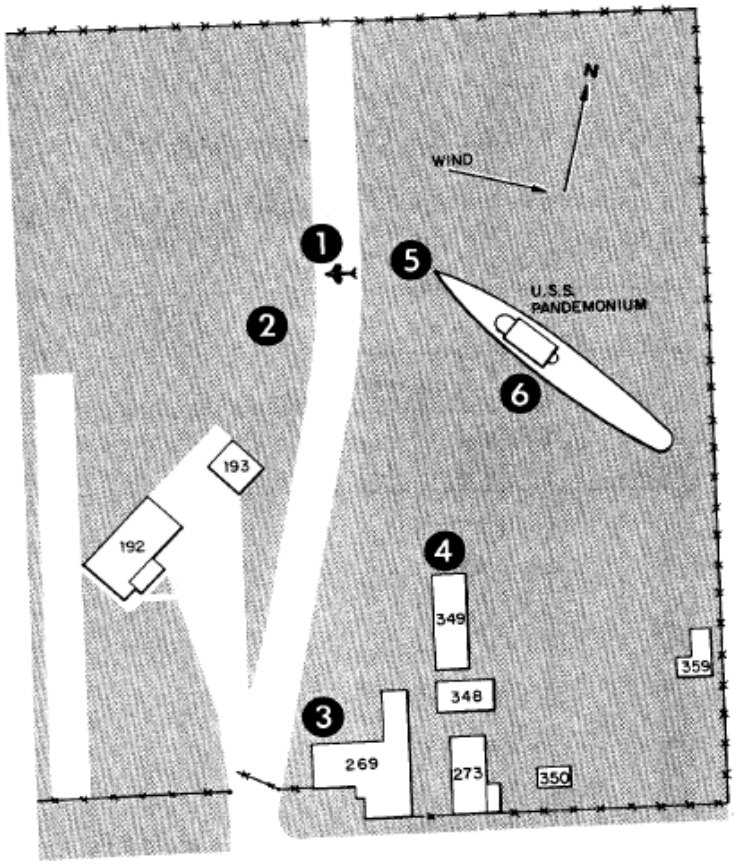

Figure 8.3-24 Building 273 in the USS Pandemonium Training Area – Northwest (TI-HRA-78)

Site Description - Building 273 is a small, single-story building (Quonset Hut type) on a concrete foundation with concrete and wood superstructure, and a corrugated iron roof. Building 273 was built in 1944 and covers approximately 1,100 ft^2 It is identified on maps and Public Works Data as the Chemical Warfare School Decontamination Building. Building 273 was located inside the fenced compound on the northwest side of TI. As the designated Chemical Warfare School decontamination building, Building 273 was likely always set up to

accommodate decontamination operations including collection of decontamination materials and prevention of spread of contamination.

Former Uses - Chemical Warfare School Decontamination building. Was very likely used as the personnel decontamination center during the 1950 Building 233 Radium spill cleanup activities.

Current Uses - Building demolished approximately 1977. Currently multi-family housing area.

Potential Radionuclides of Concern - None

Designated - Non-impacted. If used as a personnel decontamination center, the building would have been prepared to contain any contamination without spread. Building has been demolished.

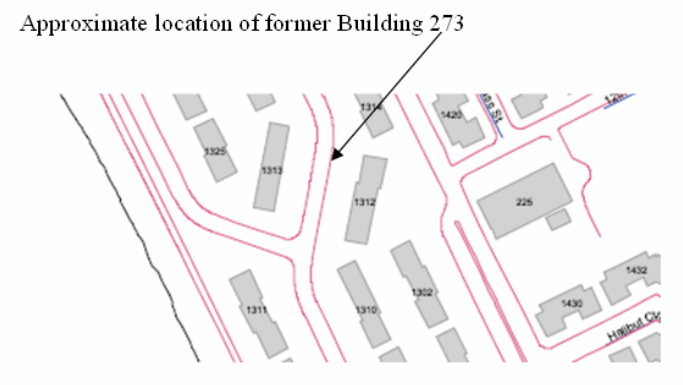

Figure 8.3-25 Former Building 273 Location Map

8.3.2.9 Pier 21

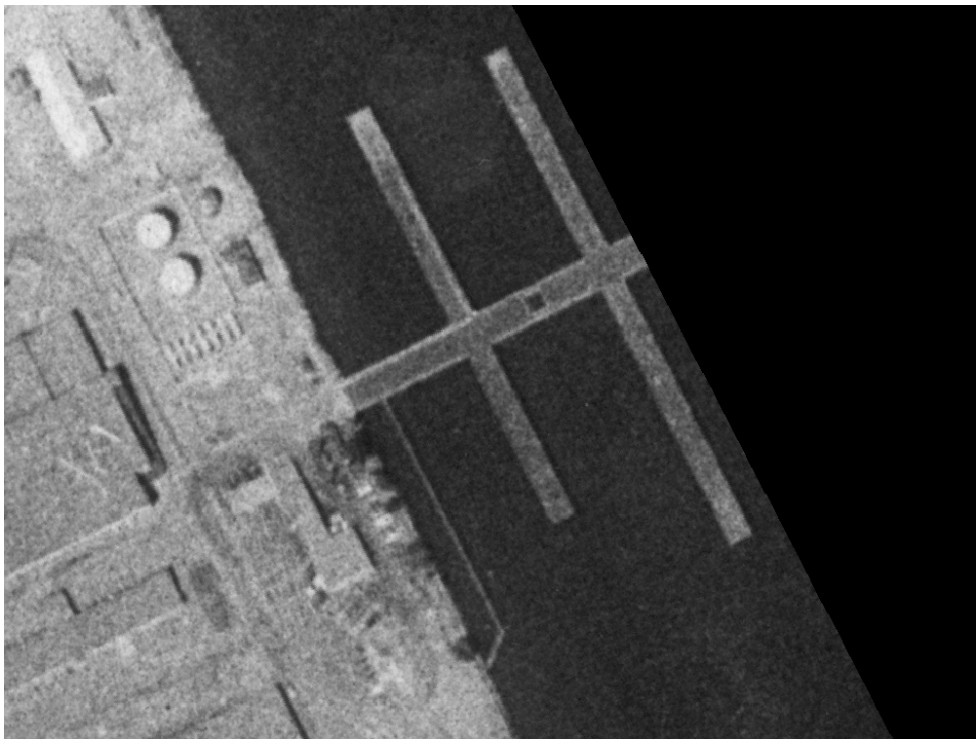

Figure 8.3-26 Pier 21 Area 1975 Photograph (TI-HRA-101)

Site Description - Previous location of multiple-finger piers on northeast side of Treasure Island. Pier 21 was built in approximately 1942. The pier had a 500 foot main stem, a 404 foot finger and 2-248 foot fingers on the north side of the main stem. It was intended to provide sufficient docking space for the destroyers and minesweepers based at TI. By 1945 additional fingers had been added to the south side of the main stem. Some fingers were demolished by the time the above photograph was taken in 1975. The pier was demolished after 1995.

Former Uses - General ship's berthing, fuel pier. Briefly provided a pier for USS CEBU (ARG-6) in December 1946.

Current Uses - None. Pier demolished approximately 1995.

Potential Radionuclides of Concern - None

Designated - Non-impacted. The only OPERATION CROSSROADS ship berthed at pier 21 had been decontaminated before arrival at the pier.

8.3.2.10 Pier 13 Area

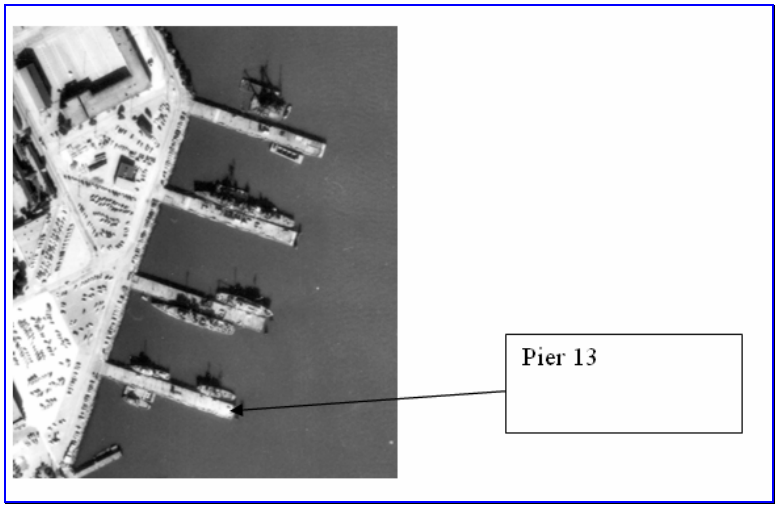

Figure 8.3-27 Pier 13 Area 1969 Photograph (TI-HRA-100)

Site Description - One of four piers formerly located on the southeast end of Treasure Island. Adjacent to Building 3. Pier 13 was built in 1938 and was demolished in 1991.

Former Uses - Maintenance pier. Briefly provided berthing for the tank landing ship LST-388 in December 1946.

Current Uses - None. Pier demolished approximately 1991.

Potential Radionuclides of Concern - None

Designated - Non-impacted. The only OPERATION CROSSROADS ship berthed at pier 13 had been decontaminated before arrival at the pier.

8.3.2.11 YBI Short Pier Area

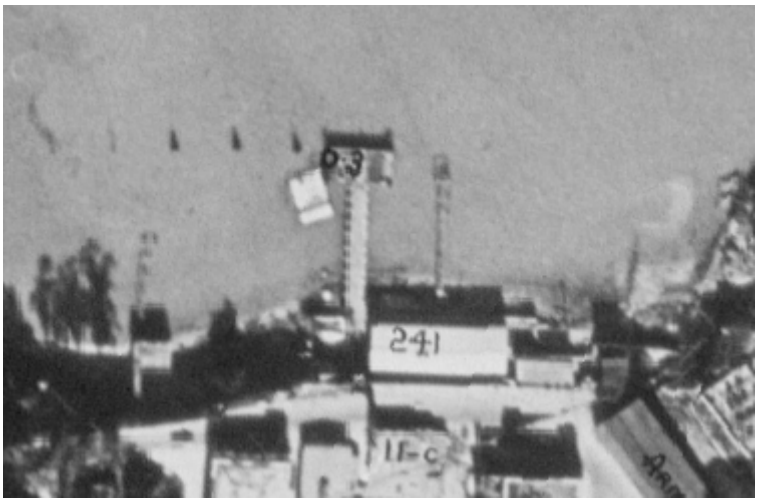

Figure 8.3-28 YBI Short Pier Area 1945 Photograph (TI-HRA-102)

Site Description - A fueling pier on the north side of YBI. This pier was built in 1938 and was demolished approximately 1991.

Former Uses - Maintenance pier. Briefly provided berthing for the tank landing ship LST-388 in December 1946.

Current Uses - None. Pier demolished approximately 1991.

Potential Radionuclides of Concern - None

Designated - Non-impacted. The only OPERATION CROSSROADS ship berthed at the YBI Short Pier had been decontaminated before arrival at the pier.

8.3.2.12 Building 226

Figure 8.3-29 Building 226 – 1945 Photograph (TI-HRA-102)

Site Description - Building 226 was one of two identified Bachelor Officer's Quarters. It was a multi-story "E" shaped structure constructed approximately 1944. Building 226 was part of a three building group including Buildings 226, 227 (the officers dining hall), and Building 228 (an identical Bachelor Officer's Quarters). Building 226 was demolished by 1966.

Former Uses - Building 226 was an officers quarters from the time of construction in 1944 until it was demolished by 1966. During the investigtion and follow-up surveys after the spill in building 233 the Bachelor Officers Quarters were both monitored (**TI-HRA-47**)

Current Uses - None. Building demolished approximately 1966.

Potential Radionuclides of Concern - None

Previous Radiological Investigations - Monitoring of Bachelor Officers Quarters took place during the week following the Building 233 spill. All monitoring and decontamination was completed within a week of the spill.

Designated - Non-impacted. The building was monitored and decontaminated as necessary within a week of the initial spill. There were no reports of residual contamination. The building has since been demolished.

8.3.2.13 Building 228

Figure 8.3-30 Building 228 – 1945 Photograph (TI-HRA-102)

Site Description - Building 228 was one of two identified Bachelor Officer's Quarters. It was a multi-story "E" shaped structure constructed approximately 1944. Building 228 was part of a three building group including Buildings 228, 227 (the officers dining hall), and Building 226 (an identical Bachelor Officer's Quarters). Building 228 was demolished by 1968.

Former Uses - Building 228 was an officers quarters from the time of construction in 1944 until it was demolished by 1968. During the investigtion and follow-up surveys after the spill in building 233 the Bachelor Officers Quarters were both monitored (**TI-HRA-47**)

Current Uses - None. Building demolished approximately 1968.

Potential Radionuclides of Concern - None

Previous Radiological Investigations - Monitoring of Bachelor Officers Quarters took place during the week following the Building 233 spill. All monitoring and decontamination was completed within a week of the spill.

Designated - Non-impacted. The building was monitored and decontaminated as necessary within a week of the initial spill. There were no reports of residual contamination. The building has since been demolished.

SECTION 8

TABLES

Table 8-1

Impacted Sites at NAVSTA TI
Current Uses

BUILDING/SITE NO.	FORMER USE	CURRENT USE
Building 233	Classrooms; Radiation Safety School; ATF Laboratory; California National Guard	None, unoccupied.
Building 343	Naval Technical Training Center RADIAC instruction	None, unoccupied.
Building 344	Naval Technical Training Center Radium and RADIAC Vault	None, unoccupied.
IR Site 12	Ammunition bunkers; general landfill and waste disposal	Housing area.
Sanitary Sewer Drains associated with Building 233	Sanitary sewer drains	Sanitary sewer drains.

Table 8-2

Non-Impacted Sites at NAVSTA TI
Current Uses

BUILDING/SITE NO.	FORMER USE	CURRENT USE
Building 3	Palace of Fine and Liberal Arts; Port Control Office; Ship Repair Shops; Training School, Equipment repair	Leased to City. Building is occupied.
Building 7 West Wing	Federal Building South Half; various military schools; Director of Training Facilities	West Wing demolished by fire in 1956. Building unoccupied.
Building 273	Chemical Warfare Decontamination Building; Classrooms	None. Building demolished
Building 342	Naval Technical Training Center RADIAC instruction	None, unoccupied.
Building 461	Damage Control School classrooms; NTTC headquarters	None, unoccupied.
Building 462	Damage Control School decontamination building	None, unoccupied.
Pier 13	Maintenance pier	None. Pier demolished.
Pier 21	Berthing pier; fuel pier	None. Pier demolished.
YBI Short Pier	Fueling pier	None. Pier demolished.
USS Pandemonium site NW Corner	Radiation decontamination Training area	Housing area.
USS Pandemonium site NE Corner	Damage Control School training, Firefighting school; radiation decontamination training	None. The USS Pandemonium has been dismantled and removed.
Building 226	Bachelor Officers Quarters	None. Building demolished
Building 228	Bachelor Officers Quarters	None. Building demolished

9.0 CONCLUSIONS

9.1 HISTORICAL RESEARCH

Treasure Island was constructed in 1937 for the Golden Gate International Exposition. The Navy leased Treasure Island from the City of San Francisco in 1941 and acquired title to Treasure Island in 1942. During World War II, Treasure Island grew from a small base to a busy fully operational military facility processing as many as 13,000 men per day. The original buildings constructed for the exposition were for the most part demolished and replaced with barracks and training facilities during the war years. The first specifically identified use of G-RAM on NAVSTA Treasure Island took place during the Radiation Safety training course in Building 7 in 1947. Over the years following, G-RAM was used in support of training on calibration and maintenance of radiation survey instruments, and in support of training on survey, detection, and decontamination of radioactive fallout.

9.2 IMPACTED SITE ASSESSMENTS

The preparation of the HRA was an extended process that involved review of hundreds of records from federal and private record repositories. Some electronic mail and telephonic contact with persons with knowledge of radiological operations at NAVSTA TI were also utilized. The information extracted from this process identified a total of 542 NAVSTA TI historic and current sites, including buildings, structures, defined open areas, and ship's berths. Of these, 18 sites were selected for further review, and five sites have been designated as "impacted". This indicates the site has a potential for radioactive contamination based on historic information or is known to contain radioactive contamination. These impacted sites include:

- One building with a documented spill (Building 233).
- One building with an investigation of loose contamination in a waste container (Building 344).
- One building that was part of the RADIAC Instrument School (Building 343).

- Four former solid waste disposal areas located within Installation Restoration Site 12.
- Sanitary Sewer Drain System associated with Building 233.

The potential for residual contamination at the five impacted sites was assessed using the following categories: Known-Restricted Access, Known-Continued Access, Likely, Unlikely, Unknown, and None. The assessment of potential contamination at the 5 impacted sites is summarized as follows:

0 - Known, Restricted Access

0 - Known, Continued Access

1 - Likely

4 - Unlikely

0 - Unknown

0 - None

The categories high, moderate, low, and none were used to assess potentially contaminated media for each impacted site. The highest level of potentially contaminated media at each of the 5 impacted sites is presented below.

High - 0 sites

Moderate - 0 sites

Low - 4 sites

None - 1 site

The categories of high, moderate, low, and none were also used to assess potential migration pathways for any radioactive contamination at each impacted site. The highest level of migration pathways assessed at each of the 5 impacted sites is presented below:

High - 0 sites

Moderate - 0 sites

Low - 3 sites

None - 2 sites

The categories of Emergency Action, Scoping survey, Characterization Survey, Remediation, Final Status Survey, Free Release, and No Further Action were used to recommend future actions at each of the impacted sites. The recommended actions for each of the 5 impacted sites are presented below:

Emergency Action - 0 sites

Scoping Survey - 1 site

Characterization Survey - 1 site

Remediation - 0 sites

Final Status Survey - 2 sites

Free Release pending review of Characterization or Final Status Survey Report - 0 sites

No Further Action - 0 sites

9.3 OVERALL CONCLUSIONS

Using the above criteria, the HRA concludes that:

- The potential for residual radioactive contamination exists and needs to be addressed at 5 of the impacted sites.
- The potential for residual radioactive contamination is currently being addressed at 2 of the 5 impacted sites (Building 233 and IR Site 12). The need for additional action at these sites is pending completion of the assessments.
- Thirteen sites are designated as non-impacted sites.

- To date, no historical information about radiological operations or previous radiological investigations at any of the impacted sites presents a level of concern that would require any Emergency Action.
- To date, high-level contamination has not been found at the site nor is the potential considered a possibility by the HRA.
- To date, 0 impacted sites require restricted access due to known levels of undisturbed radioactive contamination.
- To date, no evidence for potential airborne contamination has been found.
- To date, potential pathways for contamination migration remain within the impacted site areas. No pathway has been identified for contamination to migrate off the NAVSTA TI site.

The overall conclusion of the HRA is, even though there is potential residual radioactive contamination at 5 impacted sites, the contamination, if any, is expected to be at low levels within the confines of each site on NAVSTA TI. Recommendations have been made to assess the identified areas of potential residual radioactive contamination and address its removal. The review of previous radiological activities, cleanup actions, and release surveys has not identified any imminent threat or substantial risk to human health or the environment of NAVSTA TI or the local community.

10.0 REFERENCES

File Name:	Title:
TI-HRA-1	1952-9-1 Property Record Card US Naval Station Treasure Island
TI-HRA-2	2005-3-28 Department of Toxic Substances Control website for Naval Station Treasure Island
TI-HRA-3	Multi-Agency Radiation Survey and Site Inspection Manual
TI-HRA-4	1988-4-1 Preliminary Assessment/Site inspection of Naval Station Treasure Island, Ca
TI-HRA-5	1992-9-29 Federal Facility Site Remediation Agreement for Treasure Island Naval Station
TI-HRA-6	2005-3-24 40CFR Part 302 Designation, Reportable Quantities and Notification
TI-HRA-7	no date website http:// ludb.clui.org/ex/i/CA3119 Map of Treasure Island,
TI-HRA-8	no date aerial photograph of TI and YBI showing the connecting causeway
TI-HRA-9	2004-9-14 Website "www.navfac,navy.mil/brc/cf-bin/dispmap/activity.cfm" Naval Station Treasure Island at San Francisco, Ca
TI-HRA-10	2004-10-26 Website "www.epa.gov/fedfac/ff/treasure.htm" Federal Facilities Restoration and Reuse- Treasure Island Naval Station
TI-HRA-11	1996-3-1 Historical Study of Yerba Buena Island Treasure Island and their Buildings
TI-HRA-12	1966-4-1 Historical View Yerba Buena and Treasure Island
TI-HRA-13	2004-8-31 Final Historical Radiological Assessment, Volume II, History of the Use of General Radioactive Materials, 1939-2003, Hunters Point Shipyard (excerpt from Section 3)
TI-HRA-14	1990-8-31 Results of Field Exploration and Laboratory Testing Program
TI-HRA-15	2005 3 Final Remedial Investigation Report for Installation Restoration Sites 09 and 10
TI-HRA-16	1989 Liquefaction during Loma Prieta earthquake in 1989 website www.unh.edu/nges/images/photos
TI-HRA-17	1998 -11-1 Climatic Wind Data for the United States, San Francisco airport, Summary of data from 1930 to 1996
TI-HRA-18	2003 Website "www.dof.ca.gov/HTML/DEMOGRAP/histtext.htm" California State Department of Finance, Demographic Research Unit
TI-HRA-19	2000-4-3 Website "www.baycrossings.com/Archives/2001/03_April/treasure_islands_seeks_ferry_funds.htm
TI-HRA-20	2003-6 Final Environmental Impact Statement (EIS) For the Disposal and Reuse of Naval Station Treasure island, San Francisco , Cal
TI-HRA-21	1996-7 Draft NSTI Reuse Plan
TI-HRA-22	2005-3-10 Supplemental Environmental Baseline Survey Revised Draft Final
TI-HRA-23	2004-5-6 Website "http://orb.sfusd.edu/profile/prfl-852.htm" S.F.U.S.D. School Profiles 2003-04 (Fall 2003), Treasure Island Elementary School
TI-HRA-24	2005-5-23 Budget Squeeze Threatens school, the island's treasure SEIUCA article about TI Elementary School
TI-HRA-25	2004 website "www.kidango.org"
TI-HRA-26	1945-6 Map of U.S. Naval Training Station (Treasure Island) showing conditions on June 1945
TI-HRA-27	1949-7-1 Map of U.S. Naval Station Treasure Island and Yerba Buena Island San Francisco, Cal Showing conditions on July 1, 1949
TI-HRA-28	1952-6-30 Map of U.S. Naval Station Treasure Island as of 30 June 1952
TI-HRA-29	1968-8-1 Map of U.S Naval Station Treasure and Yerba Buena Islands as of August 1, 1968
TI-HRA-30	1971-12-1 Map of U.S. Naval Station showing conditions on December 1, 1971

File Name:	Title:
TI-HRA-31	1973-6-1 Map of U.S. Naval Station Treasure and Yerba Buena Island showing conditions as of June 1, 1973
TI-HRA-32	2001-7-19 RADIOLOGICAL ASSESSMENT REGARDING FORMER NAVAL STATION, TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA
TI-HRA-33	1947-4-7 Report on opening of Radiological Safety School, Treasure Island
TI-HRA-34	1959-8 U.S Naval School, Damage Control, Command History, 1945 -1959
TI-HRA-35	1944-1-4 PWC Drawings 85524 dated 1-4-1944 Federal Building Additions and Alterations
TI-HRA-36	1957-8-29 PWC Drawing 85531 dated 8/29/1957 titled Demolition of West Wing and Rehabilitation of Building 7
TI-HRA-37	2004-11-18 Former Naval Station Treasure Island Historical Radiological Assessment Fact Sheet #1
TI-HRA-38	1950-1-26 Geiger Counter Sleuths Go After Spilled Radium
TI-HRA-39	Not Used
TI-HRA-40	1989-6-30 Monthly Survey and Inventory Report of Radioactive Sources
TI-HRA-41	1982-10-28 Radiological Affairs Technical Assistance Visit
TI-HRA-42	1980-3-21 RASO Report of Technical Assistance Visit to Naval Technical Training Center, Treasure Island
TI-HRA-43	1960-12-15 By Product Material License 4-4346-1 Amendments 1 through 21
TI-HRA-44	1951-2-15 Radioactive Training Materials, shipment of
TI-HRA-45	1973-3-14 NAVSCOLCOM Instruction 5100.5C, Radioactive sources; safety and operating regulations
TI-HRA-46	2003-12-11 Record of phone interview with CDR James Winstanley (USNR) by William Morris (RASO)
TI-HRA-47	1950-1-30 Contamination of Building 233, U.S. Naval Damage Control Training Center, U.S. Naval Station, Treasure Island, California; report of
TI-HRA-48	1953-3-21 An Agreement between AEC and DOD for the Development, Production and Standardization of Atomic Weapons
TI-HRA-49	1942-1-31 General Safety Rules Section No. 9, Safe Handling of Radioactive Luminous Compounds
TI-HRA-50	1947-12-8 Radiological Safety Manual 1947
TI-HRA-51	1969-1-23 Source Material License No. SMB-473
TI-HRA-52	1979-1-31 NRC Materials License No. 08-00038-12 Amend 35 and 36
TI-HRA-53	1966 7-1 Radioluminescent Materials; hazards of
TI-HRA-54	1995-6 Aerial Photographic Analysis of Naval Station Treasure Island
TI-HRA-55	1985-12-10 Navy Radiation Safety Committee
TI-HRA-56	1988 4-1 Radiological Affairs Support Program
TI-HRA-57	1974-7-3 RASO Report of Technical Assistance Visit to Naval Schools Command Treasure Island of 15 April 1974
TI-HRA-58	1977-11-1 RASO Report of Technical Assistance Visit to Naval Technical Training Center, Treasure Island
TI-HRA-59	1986-5-15 RASO Report of Technical Assistance Visit to Naval Technical Training Center, Treasure Island
TI-HRA-60	1947-9-18 Photographs and Negatives Relating to Harbor Projects 1913-1938
TI-HRA-61	1939 Photograph of the site of the Golden Gate International Exposition before opening in 1939
TI-HRA-62	1941-6-27 TREASURE ISLAND AIRPORT MASTER PLAN PWC drawing 88122
TI-HRA-63	1942 Photograph of Treasure Island looking to the south- 1942

File Name:	Title:
TI-HRA-64	1946-12-10 U.S. Naval School (Damage Control) Command History
TI-HRA-65	1950-10-10 Hazard Evaluation and Control Following a Spill of 40 milligrams of Radium
TI-HRA-66	1950-8-9 Decontamination of Building 233, U.S. Naval Station, Treasure Island, California
TI-HRA-67	1950-9-11 Final radiological clearance; granting of
TI-HRA-68	1959-6-22 By-Product material License 04-4346-2 Initial Issue and Amendments
TI-HRA-69	1989-5-5 NAVY RADIOACTIVE MATERIAL PERMIT No. 04-62639-C1NP
TI-HRA-70	1988-3-21 Monthly Survey and Inventory Report of Radioactive Sources
TI-HRA-71	1990-11-9 Navy Radioactive Materials Permit 04-62639-C1NP Amendment #3
TI-HRA-72	1991-8-12 SUMMARY OF CLOSEOUT SURVEY ICO BUILDING 344 FOR NAVY RADIOACTIVE MATERIAL PERMIT NO. 04-62639-C1NP
TI-HRA-73	1992-6-15 Summary of Closeout Survey ICO Building 344 for NAVTECHTRACEN Treasure Island Navy Radioactive Material Permit (NRMP) No. 04-62639-C1NP
TI-HRA-74	1993-7-12 Correction for Closeout Survey ICO Building 344 for NAVTECHTRACEN Treasure Island Navy Radioactive Material Permit (NRMP) No. 04-62639-C1NP
TI-HRA-75	1998-9-23 US Atomic Veterans, John R. (Jack) Hensley, e-mail about participation in Operation Ivy
TI-HRA-76	1957-4-16 Operation Hardtack Radiological Safety Support
TI-HRA-77	2005-2-14 e-mail from Bob Sulit with pictures from Principles of Radiation and Contamination Control
TI-HRA-78	1963-6-26 Evaluation Tests of Radiological Trainer, Device X11F3, at USNAVSCOLCOM Treasure Island
TI-HRA-79	1963-12-31 Command History 1 Jan 1963 - 31 Dec 1963, US Naval Schools Command, Treasure Island, San Francisco, California, 94130
TI-HRA-80	1963-12-19 Byproduct Material license 4-4346-1; application for renewal of and amendment to
TI-HRA-81	1970-4-13 NAVSCOLCOM INSTRUCTION 5100.B Radioactive sources; safety and operating regulations
TI-HRA-82	1973-6 PWC Plan 79831 Drawing TI Sanitary Sewer System
TI-HRA-83	1993-8-25 Termination of Navy Radioactive Materials Permit (NRMP) No. 04-62639-C1NP
TI-HRA-84	1980-3-26 Report of Radioactive Source Leak Test
TI-HRA-85	1970 USS Pandemonium (371)
TI-HRA-86	1946-12-2 Crossroads Ships present in or expected arrivals in San Francisco Bay Area requiring radiological clearance
TI-HRA-87	1948 CROSSROADS ships known to have returned to San Francisco following OPERATION CROSSROADS
TI-HRA-88	2004-8-31 Selected Pages of Table 6-2 of HPS HRA
TI-HRA-89	2003-11-20 e-mail interview Capt. David Farrand
TI-HRA-90	2001-5-9 Radiological Screening at Site 12, Naval Station Treasure Island, California
TI-HRA-91	2003-7-28 Final Sampling and Analysis Plan Site 12
TI-HRA-92	1994-2-11 Naval Technical Training Center, Treasure Island navy Radioactive materials Permit No. 04-62639-C1NP
TI-HRA-93	1994-2-24 Navy Radioactive Materials Permit 04-62639-C1NP Amendment #6
TI-HRA-94	1993-7-27 Wipe Analysis
TI-HRA-95	1993 8-2 Follow-up Swipes for Closeout of Radiac Maintenance School, Treasure Island
TI-HRA-96	1993-8-18 Wipe analysis
TI-HRA-97	1993-7-23 Request for Alpha/Beta/Gamma counting service for Radiac Maintenance School Swipes

File Name:	Title:
TI-HRA-98	1993-8-2 Wipe Analysis
TI-HRA-99	1965-5-19 Application for renewal of license 4-4364-2 of May 19, 1965
TI-HRA-100	1969-12-30 Aerial Photograph-1969
TI-HRA-101	1975 Aerial Photograph -1975
TI-HRA-102	1945 Aerial Photograph 1945
TI-HRA-103	2003-12-11 e-mail interview LaMarr Beuchler
TI-HRA-104	2003-11-7 e-mail interview James Spahn
TI-HRA-105	1953-8 Hazard Evaluation and Control after a Spill of 40 mg of Radium
TI-HRA-106	1990-6-6 Navy Radioactive Materials Permit 04-62639-C1NP Amendment #1
TI-HRA-107	1990-8-16 Navy Radioactive Materials Permit 04-62639-C1NP Amendment #2
TI-HRA-108	1992-7-28 Navy Radioactive Materials Permit 04-62639-C1NP Amendment #4
TI-HRA-109	1993-7-7 Navy Radioactive Materials Permit 04-62639-C1NP Amendment #5

APPENDIX A

INTERVIEWS

A1. GENERAL

Archival research conducted during preparation of the NAVSTA TI Historical Radiological Assessment (HRA) was intended to be augmented by contacts with people who had specific knowledge of radiological operations at NAVSTA TI.

To make contact with these people, the Navy posted a newspaper advertisement looking for personnel with knowledge of radiological operations at NAVSTA TI. The Navy advertised in newspapers surrounding the Bay Area in hopes of reaching former military or civilian employees. The following advertisement was published in the *San Francisco Chronicle*, *San Francisco Examiner*, *San Francisco Independent*, the *San Jose Mercury News*, the *Oakland Tribune*, the *Alameda Times Star* and several smaller papers affiliated with the *Oakland Tribune* and the *Alameda Times Star*.

NAVAL STATION TREASURE ISLAND

SEEKING INFORMATION

FOR HISTORICAL RADIOLOGICAL ASSESSMENT

The Department of the Navy (Navy) is presently seeking to interview current and former Navy personnel, civilian employees, and contractors regarding radiological operations at the former Naval Station Treasure Island (NAVSTA TI), San Francisco, California. The Base Realignment and Closure Program Management Office West is working with the Naval Facilities engineering Command, Southwest Division and the Navy's Radiological Affairs Support Office in the preparation of the Historical Radiological Assessment (HRA) for NAVSTA TI. The HRA will document the historical radiological operations of the Naval Station including former uses of radioactive materials and locations where radioactive materials were used or stored. Radiological operations at NAVSTA TI may have been conducted by any of the following employers or their contractors: Naval Station Treasure Island, Naval Schools Command, or Naval Radiological Defense Laboratory.

Face-to-face interviews as well as telephonic or e-mail interviews can be arranged. Information resulting from interviews will be used for preparation of the HRA. The Navy is interested in obtaining open and honest oral histories. The Navy is not interested in pursuing adverse action against interviewees based on information supplied during the interviews. **If you are a current or former member of the Navy, former civilian employee, or contractor and have information about past radiological operations at NAVSTA TI, please contact Robert O'Brien, Weston Solutions, Inc., at e-mail address robert.obrien@westonsolutions.com or call 1-800-538-9815.**

Only one response was forthcoming from the newspaper advertisements. A woman who worked in personnel in Building 367 was stationed on Treasure Island from 1980 to 1983. She did not remember the name of her military unit. She did not have any knowledge of the use or presence of radioactive materials.

The Navy Radiological Affairs Support Office (NAVSEADET RASO) provided some additional e-mail and telephone interviews conducted in late 2003. The substance of those interviews follows:

A.2 INTERVIEWS

LaMarr Buechler

Lt. Buechler was stationed at the Damage Control School from 1967 to 1971. He was the Radiation Safety Officer listed on the AEC radioactive material license. He recalls that during his tour of duty, the mockup training ship was moved (from the northwest corner) to make room for planned housing. The training ship was installed on a new site with a cement pad for the ship and retention tanks for the effluents that came from the pad. The ship mockup was used to train damage control personnel in survey and decontamination procedures.

He recalls that this was accomplished by dispersing a solution of Br-82 on the deck or by raising and lowering sealed sources stored in lead pigs within the ship.

He stated that a capsule containing a Bromine compound was taken to Vallecitos Nuclear Center in Pleasanton, California to be irradiated. Upon return to Treasure Island, the capsule was crushed and mixed in a container of about 5 gallons of water. The radioactive solution was spread at several locations on the surface of the training ship to simulate fallout. The trainees would then conduct surveys and perform decontamination using conventional shipboard methods. The students wore protective clothing during the training exercise.

The effluent from the decontamination operation was collected in the retention tank(s) and held until it met the criteria for disposal into the bay.

He recalls that during his tour of duty, the San Francisco Bay pollution regulations became more restrictive and the Damage Control School terminated the use of the Br-82 liquid dispersal. He

believes that the Br-82 dispersal was only used once or twice during his tour. The sealed sources (Cs-137) were in use when he was transferred in 1971 (**TI-HRA-103**).

Captain David E. Farrand

At the time of the interview, Captain Farrand was Head, Radiological Controls and Health Branch, Office of Chief of Naval Operations. In 1982 to 1984, then Lt Farrand was the Radiation Safety Officer for the Naval Technical Training Center (NTTC) on NAVSTA TI. He was asked if the damage control mockup in Building 341 (USS Buttercup) might have been used for radiation training. (Note: The USS Buttercup was a mockup of a portion of a ship used to simulate flooding emergencies due to broken pipes or a hull breach). Captain Farrand stated that he had no knowledge of sources used in the Buttercup. He believes that sources would not have been used because the Buttercup was a wet trainer with water being sprayed around to simulate the flooding casualty.

Captain Farrand stated that the USS Pandemonium was the training mockup used for NBC training. All but one of the USS Pandemonium sources were disposed before he arrived in February of 1982. The one remaining source was stored in the RADIAC building (at that time Building 343) and was to be used for NBC training. He further stated that shortly thereafter, the NBC training course was revised and eliminated the need for the source.

Captain Farrand recalled that the only buildings beside the USS Pandemonium and the RADIAC buildings that had sources were Building 3 (HT "A" School), NTTC headquarters and maybe Building 323 (next to the Buttercup Building 341). They were only small check sources of exempt quantity used for instrument response demonstrations (**TI-HRA-89**). (Note: Building 323 is listed as a classroom that was demolished in 1961, and is not next to the Buttercup. The building next to Buttercup is Building 293.) Building 233 is across the street from the Buttercup building.

James Spahn

Lt. James Spahn reported to Treasure Island in October 1961 and was there until 1963. He recalls working with Ed Leahy and Al Baietti both of NRDL on licensing of the radioactive spreader device used to disperse the radioactive liquid Br-82 solution. He was unable to provide any additional details (**TI-HRA-104**).

Commander James Winstanley (USNR)

(Telephone interview between Cdr. Winstanley and William Morris)

Then Lt. Winstanley was the Radiation Safety Officer in 1979 for both the NBC School license and the RADIAC School license. He discussed how the sources were used in the Pandemonium mockup to simulate fallout levels. He stated that only one source was really used during his tour of duty. The use of short-lived isotopes had been discontinued long before his arrival at Treasure Island. He stated that he transferred eleven sources to the California Department of Health Services (**TI-HRA-46**). (Note: The sources in question are Cs-137 sources received in 1959. He actually transferred ten sources to the DHS. The remaining source was transferred to the RADIAC School.)

APPENDIX B

REFERENCES

(Note: This appendix is provided on compact disc only)

APPENDIX C

Final Response to Comments on the

Naval Station Treasure Island

Draft Historical Radiological Assessment (HRA)

Dated January 2006

Final
Response to Comments on the
Naval Station Treasure Island Draft Historical Radiological Assessment (HRA)
Dated January 2006

The following agencies and organizations have commented to the Treasure Island Naval Station draft Historical Radiological Assessment. The responses to those comments are provided herein:

1. California Department of Health Services (DHS) comments dated September 23, 2005.
2. California Environmental Protection Agency (Cal EPA) Department of Toxic Substances Control (DTSC) comments dated September 26, 2005.
3. ChemRisk (for Treasure Island Development Authority [TIDA]) comments dated September 22, 2005.
4. Naval Station Treasure Island (NAVSTA TI) Restoration Advisory Board (RAB) member Ms. Dale Smith comments dated September 27, 2005.

Response to California DHS Comments of September 23, 2005, to the Naval Station Treasure Island Draft Historical Radiological Assessment dated August 2005

General Comments:

1. Comment: **Current DHS staff are not very familiar with this site, so DHS is relying on this document to help us focus on the radiological issues.**

Response: Comment acknowledged.

2. Comment: **DHS has noted that only 5 of the 18 sites designated as impacted are selected for further investigation. The other 13 sites should be either reclassified as nonimpacted based on justifications, including historical information or receive a MARRSIM final status survey. Examples are shown in the Specific Comments below.**

Response: Navy agrees. The 13 sites that require no further action will be reclassified as non-impacted.

3. Comment: **The impacted areas that have been designated as having "no potential for contamination, so no further action is needed" will need at least a Class 3 final status survey or reclassification to non-impacted.**

Response: Navy agrees. See response to comment # 2.

4. Comment: **Because the spills that occurred also involved spreading the contamination to unknown locations and housing, there should also be surveys of soil around the buildings that may have been involved.**

Response: Navy does not agree with DHS' comment for the following reasons. With the exception of Building 233, neither the location of buildings nor the levels of contamination in the buildings that were associated with the radium incident in Building 233 are known with any certainty. Therefore, any soil samples, other than from around Building 233, would be purely speculative. The Navy will conduct soil sampling around Building 233.

The HRA also documents a spill that occurred inside the vault in Building 344. Conservatively, this was called a spill, but was limited to contamination inside a Union Carbide Cesium/Barium Nucleonics kit.

The kit contained an NRC exempt licensed quantity of Cs-137. Two waste containers were also stored in the vault that had low levels of contamination inside, but nowhere on the outside. This is not a spill. Based on these facts, it is evident there is no need to do soil sampling around Building 344. Furthermore, the Navy apologizes if the HRA is misleading. Section 6.6.2 will be revised and a better description (descriptor) of the extent of contamination in the vault at Building 344 will be provided. That descriptor will not be "a spill."

5. Comment: **DHS will be reviewing and evaluating buildings and land designated to be transferred out of federal ownership. DHS will assess the site using dose models rather than using EPA's risk analysis. If a site cannot be approved for unrestricted use, the regulatory branch, Radiological Health Branch, of DHS would determine if the site could be released for restricted use and determine if a license is required.**

Response: Comment acknowledged. The Navy has no intent of releasing any site on Treasure Island for restricted use.

Specific Comments:

1. Comment: **Page 1-2: Buildings 233 and 344 would most likely need Class 1 final status surveys, because they were previously remediated.**

Response: The purpose of the HRA is to determine which areas are impacted, i.e., will require further investigation/surveys. Areas are normally classified based on results of scoping and characterization surveys that are not available at this time. Classification of areas will be addressed in the survey plans for the buildings.

2. Comment: **Page 1-2: All of Building 343 should have final status surveys. The storeroom should receive a Class 1 survey, and the other rooms should receive Class 2 or 3 final status surveys and may need to be reclassified to Class 1, if contamination is detected.**

Response: Navy does not agree with DHS' comment. The Navy considers, based on historical information and wipe test results, the storeroom is the only impacted area in Building 343 requiring further investigation. During the closeout of Building 343, the Navy took 267 wipes in the building and on miscellaneous pieces of equipment. Navy personnel wiped in every room in the building. Only two wipes exceed the release criteria of 20 dpm / 100 cm^2 (removable). The wipes that exceeded the release criteria were of a counter top in the storeroom. All other wipe results

were significantly below, less than half the release criteria. Additionally, the Navy wiped every radioactive source that was stored in the building before its removal. None of these wipes had results exceeding background radiation levels. The Navy will conduct a final status survey of the storeroom and the floor of the room outside the storeroom. The Navy is only recommending this area for final status surveys since there are no documented results of fixed and scan surveys of the storeroom. Should the survey of the storeroom or the floor of the adjacent room detect any radioactivity above background levels, additional surveys will be conducted.

Furthermore, Navy will not provide a survey classification for impacted areas identified by the HRA. Survey classification is part of the final status survey plan for each impacted area or survey unit (also see the response to specific comment # 1 above).

3. Comment: **Page 4-4: If an area is only being considered impacted because sealed sources were stored or used at the location and there is no history of leaking sources, then DHS would not consider these locations impacted or to require a survey.**

Response: Such areas will be designated as non-impacted.

4. Comment: **Page 5-11: For clarification of DHS' role, DHS does not defer to EPA for the release of property, either buildings or land. If the property is to be transferred out of federal ownership, then the Navy will need the property to be released by DHS.**

Response: The last sentence of Section 5.7.1 will be changed to read, "CDHS concurrence is required for release of all property being transferred from federal ownership to state, local or private ownership."

Response to Cal EPA DTSC Comments of September 26, 2005, to the Naval Station Treasure Island Draft Historical Radiological Assessment dated August 2005

General Comment:

1. Comment: **All of the areas/sites where debris disposal has occurred at NSTI should be addressed in the same manner that was recommended for Site 12, which is to perform radiation monitoring during soil excavation activities. And if removal activities for known debris disposal areas are not planned, then additional characterization work for radiation may be necessary prior to completing the Remedial Investigation process (this may apply at Sites 30, 31, and 33).**

Response: There is no evidence that radioactive material was deposited in any debris disposal area on NAVSTA TI. NAVSTA TI's primary activities were training and not that of a shipyard or industrial maintenance facility that removed or repaired radioluminescent devices and disposed of them and associated waste in landfills. There is no supporting evidence to indicate NAVSTA TI disposed of any radioluminescent devices or generated associated waste. All known radiological material used for training and radiological waste from the two spills at NAVSTA TI has been transferred or disposed off the naval station.

The US EPA photographic analysis indicates that historical solid waste storage and disposal activities were confined to areas within Site 12. Since both historical documentation and actual trenching data, to date, support that radiological material was not disposed at NAVSTA TI, the Navy believes there is no need at this time to conduct additional radiological surveys at Sites 30, 31, and 33. Further discussion to support this conclusion is provided below:

An extensive historical radiological information search was performed to support the Historical Radiological Assessment (HRA). There is no documentation to suggest that radioactive materials were disposed in the solid waste disposal areas at Installation Restoration (IR) Site 12 (Site 12) or anywhere else on Naval Station Treasure Island (NAVSTA TI). The recommendation in the HRA to perform radiation monitoring during soil excavation activities was the result of an earlier recommendation from the California Environmental Protection Agency (Cal EPA) Integrated Waste Management Board (IWMB). The IWMB letter dated May 9, 2001, recommended precautionary field screening for radioactive material at the IR Site 12 solid waste disposal areas. The IWMB letter noted that "there is no direct evidence suggesting that radioactive

material was disposed of in the Site 12 disposal pits," but recommended surveying them based on their experiences in finding low-level radioactive material associated with municipal solid waste burn dumps. The U.S. Department of the Navy's (Navy) Radiological Affairs Support Office (RASO), in response on July 19, 2001, agreed and recommended radiological surveys of these disposal areas.

Since the IWMB recommendation to screen the solid waste disposal areas at Site 12 for radiological material, 580 test trenches have been excavated throughout Site 12 to a depth of 4 feet below ground surface (bgs). The trenches were installed on a 60-foot triangular grid spacing covering 80 percent of Site 12, a 93-acre site. The Navy made the decision to conduct radiological surveying of the trench sidewalls and soil spoil with sensitive gamma scintillation detectors while collecting soil analytical data for the IR Site 12 remedial investigation for chemical and solid waste contaminated soil. No evidence of radioactive material disposal, either physical or measured, was identified (Shaw, 2004). Since the solid waste disposal areas (A&B, 1207/1209, and 1231/1233) at Site 12 were not included in the trenching activities and had been investigated prior to the IWMB recommendation, they have not yet been screened for radiological material. Although it is highly unlikely any radiological material would be found in the solid waste disposal areas given the extensive document search and the results of the trenching surveys, the HRA recommended future screening of the solid waste disposal areas to fulfill the 2001 IWMB recommendation.

The U.S. Environmental Protection Agency (EPA) reviewed aerial photographs from 1931 to 1975 to determine where disposal areas were located at NAVSTA TI (EPA, 1995). Although the Site 12 area has been reportedly used for trash disposal from about 1946 to 1963, according to the 1995 photographic analysis performed by the EPA, there is no evidence that similar activities, in the form of significant debris stockpiling and disposal pits, have taken place on any other areas of NAVSTA TI.

Trench logs for excavations at Site 30 and 31 indicate that the majority of the solid waste in the soil matrix are typical of demolition/construction debris and are commonly found in soils at construction sites with a history of previous land use and redevelopment. The solid waste observed at Site 31 included burned wood/ash, black or rusty soil, concrete, asphalt, and lumber with minor amounts of metal and clay pipes, small pieces of lumber and brick, and soil and wood with hydrocarbon odors. Burned wood/ash was observed in 10 trenches with individual 2 foot layers having concentration ranging from 10-100 % in soil, black rusty soil was observed in four trenches with individual 2 foot layers having concentration ranging from 10-20 % in soil, asphalt was observed in three trenches with individual 2 foot layers having

concentration ranging from 10-20 % in soil, concrete was observed in three trenches with individual 2 foot layers having concentration ranging from 10-20 % in soil, and lumber was observed in one trench at 0-2 feet below ground surface (bgs) having a concentration of 30% in soil. Soil from Site 30, 31, and 33 excavated during previous removal actions or remedial investigations were disposed of off the naval station at a Class I or Class II landfill. Two of the landfills used for disposal of excavated soil from TI, Allied Waste's Forward Landfill and Chemical Waste Management's Kettleman Landfill, were equipped to screen each truckload of soil for radioactive contamination before entering the landfill. The amount of soil screened for radioactivity from each site where soil excavation was performed is presented in Table 1. Excavated soil not passing the radioactive screening procedure would not be received by the landfills. There were not any detections of radioactivity from the excavated soil at TI.

Table I. NAVSTA TI Excavated Soil Screened for Radioactivity at the Landfill (2003 to present)

Site/Activity	Location Description	Quantity in Tons	Disposal Location
Site 6	Fire Fighting School located to the east of Site 12 In Parcels T108 and T112	6	Forward
Site 12	Housing Area location of Former Storage Bunker on the northern portion of TI, soil removed during 580 sampling trenches	1,100	Forward
Site 24	Dry Cleaning Facility located on the southeastern portion of TI	2 73	Forward Chem Waste
Site 30/31	Former South Storage Yard north of 11th Street and the Daycare Center soil excavated from these trenches included burnt debris and construction material.	184	Forward
Site 33 Parcels T005/T006, T065/T069, T066/T117, T098, T107, T111, T112, and T115	Soils excavated from trenches during the EBS Data Gaps Investigation were collected and stockpiled at Site 6 prior to disposal. Many of the trenches in Site 33 (Water Line Replacement Areas) exhibited burnt debris and construction material.	334	Forward
Petroleum Sites 14/22	New Fuel Farm /Navy Exchange Service Station located on the northeastern portion of TI	13,827 254	Forward Chem Waste
Petroleum Site D1B	Soil excavated during a pipeline investigation near 3rd Street	5,194	Forward
Petroleum Site F2A/F2b	Soil excavated during a pipeline investigation near 5th Street	21,983	Forward

The HRA for Treasure Island identifies two known releases of radioactive material during the Navy operation of the naval station. Waste from both releases was disposed of off site. The 1950 spill of radium in Building 233 resulted in a large cleanup operation.

Decontamination and follow-up surveys required almost 9 months. More than 200 barrels of radioactive waste were generated and were stored aboard the USS Independence at Hunters Point Shipyard (HPS) prior to being disposed at sea in water deeper than 100 fathoms. In 1988, a release was detected in Building 344 (radiological material storage vault). The release was limited to contamination inside a Union Carbide Cesium/Barium Nucleonics kit. . The waste created during the cleanup of this release was disposed at a Nuclear Regulatory Commission (NRC) licensed disposal facility outside of the San Francisco Bay area.

The Navy understands that if future screening of the solid waste disposal areas in IR Site 12 detects non naturally occurring radioactivity greater than background levels, additional surveys, screening, or sampling will be evaluated not only in the IR Site 12 but in other known debris disposal areas such as Sites 30, 31, and 33.

Response to ChemRisk (for TIDA) Comments of September 22, 2005, to the Naval Station Treasure Island Draft Historical Radiological Assessment dated August 2005

Comments and Questions:

1. **Comment:** **Section 4.4.3.1 mentions a base-wide assessment that was performed to identify and assess sites potentially posing health threats from radioactive materials. Based on the citation in Section 10.0 References, this assessment was done around 1988. Very little is said about this assessment. Did it yield any data relevant to the assessment of potential contamination around Building 233, Building 273, or the USS Pandemonium sites?**

   Response: The 1988 base-wide Preliminary Assessment/Site Inspection (PA/SI) did not yield any data relevant to assessment of potential contamination around Buildings 233 or 273 (Dames and Moore, 1988). Records of the 1950 Building 233 spill and Building 273 associated decontamination operations were not available to Naval Station personnel during the 1988 base-wide PA/SI. The 1988 base-wide PA/SI identifies the USS Pandemonium radiation training area as IR Site 2 (the original location of the USS Pandemonium) and states "because the half-life of the radioactive material used (bromine-82) was on the order of 24-36 hours any remaining radiation level is expected to be below significant levels." Residual radioactivity did not exist more than three months after the last operation with bromine-82 at USS Pandemonium (~1972). The 1988 base-wide PA/SI concluded no further investigation of the site was required.

2. **Comment:** **Regarding the Cs-137 sources used at the USS Pandemonium sites, there is said to be evidence that the sources were periodically leak tested and demonstrated to be intact. While it is said in Section 8.3.10 that "no reports of leakage were issued" for the Cs-137 sources, is there evidence that no such reports were issued, or is it simply a case that no reports of leakage were located during the document review done to support preparation of this draft HRA?**

   Response: The answer to both questions in the comment is yes. As noted in Section 6.3, there was a specific analysis of the leak tests (performed by NSTI) of the eleven Cs-137 sources used in the USS Pandemonium. The analysis of the leak tests was performed in February 1980. An official record of this test was in the files at NAVSEA DET RASO. No leakage was detected. Shortly thereafter, the Cs-137 sources, while still listed on the NRC License were no longer in use in the USS Pandemonium, and

were kept in the vault, Building 344. The historical review included the command administrative file of the AEC/NRC license, complete copies of the AEC/NRC license files, supplied by the NRC, that include inspection reports and would include reports of leaking sources had any been filed, and copies of the NTTC, Treasure Island files (at NAVSEA DET RASO) of AEC/NRC licenses, and Naval Radioactive Material Permit covering the period from 1974 to 1994. No reports of leaking sources were found.

3. **Comment:** **It is said that radiological surveys were conducted following each training exercise. Were these radiological surveys limited in scope to areas of the ship mockup itself, or did they also include the underlying pad or nearby soil or gravel?**

Response: Although the radiological surveys conducted following the training exercise did not include the underlying pad or nearby soil or gravel, the surveys were comprehensive and not limited in scope to the ship mockup. Radiological surveys were performed in accordance with NAVSCOLCOM INSTRUCTION 5100.5B dated 4/13/1970, which required:

- Radiation surveys to be performed to identify and post Radiation Areas and High Radiation Areas.
- Daily survey of the Radiological Trainer Device after each use until the short-lived isotopes had decayed.
- Air sampling to be performed during each phase of the training exercise that utilized the short-lived isotopes.
- Sampling of the wash water (collected in the holding tanks) to determine when it had decayed to allow unrestricted discharge to the bay.
- Monitoring of all personnel and equipment exiting the area following an exercise.
- Monthly surveys of the exercise area.

4. **Comment:** **Figure 8.3.12.1 includes an arrow that indicates that Building 273 was located to the east of Building 1312. Another map I was provided, "Figure 1 Map of HRA 'Impacted Areas' Treasure Island" indicates that Building 273 was between Buildings 1312 and 1313. Has the former location of Building 273 been determined with any certainty?**

Response: Former Building 273 was located approximately between the present Buildings 1312 and 1313. The arrow in Figure 8.3.12.1 will be changed to show the former location of Building 273 between Buildings 1312 and 1313. The 1945 and 1952 maps and photographs of Building 273 place

it about 250 feet from the edge of the island. The 1996 map of TI shows Building 1312 about 400 feet from the edge of the island.

5. Comment: **It is stated in Section 8.3.12 that Building 273 was "very likely" used as a center for personnel decontamination activities during cleanup after the 1950 radium spill in Building 233, and that Building 273 was "probably always set up to accommodate decontamination operations including collection of decontamination materials and prevention of spread of contamination." Given the lack of knowledge about how decontamination fluids were actually handled, it is surprising that no further actions are recommended, even though it is said that no radiological investigations have been performed for this site. While the 2003 gamma monitoring of randomly selected locations outside of documented solid waste disposal areas within IR Site 12 appears to have included some excavations within the general area of former Building 273, results of those analyses have not been made available.**

Response: As is noted in Section 6.2, the function of Building 273 was a decontamination building for the Chemical Warfare School. It was specifically identified as the 'decontamination building' as early as 1945 and continued in that role at least through 1950. The specific building utilized for decontamination during the initial recovery from the 1950 spill in Building 233 is not identified in the documents available. However, since Building 273 was known as the decontamination building, the conclusion is reached that it was employed during the Building 233 spill recovery. The initial incident report states after the 1st day of the spill, NRDL personnel conducted the spill recovery and utilized the Chemical Warfare School for monitoring and decontaminating students. Decontamination and radiological control procedures used by NRDL personnel are described in NRDL reports. NRDL personnel established standard contamination control procedures prior to student arrival and monitored the students carefully at the decontamination center (a building number is never specified). NRDL personnel decontaminated five students, the only operation involving fluid handling. Building 273 and the Chemical Warfare Office (Building 269) have since been demolished and replaced with housing. At least twelve trenches were excavated in the immediate vicinity of the demolished buildings (location of current Buildings 1312 and 1313. Gamma monitoring of the spoils removed from the trenches and of the trenches themselves did not show any significant difference between trenches in these areas and trenches in other areas in IR Site 12, i.e., background. See response to ChemRisk comment # 6 below for further discussion of the monitoring. Thus, there is no indication of a release of radioactivity in the vicinity of Buildings 273.

6. Comment: **Given the apparent importance of results of the 2003 gamma monitoring of randomly selected locations outside of documented solid waste disposal areas within IR Site 12 to the HRA, its results and the report of their evaluation ("to be documented in a separate report") should be made available before the HRA is finalized so that the reasonability of arguments and conclusions presented in the Draft HRA can be evaluated.**

Response: A draft technical memorandum titled "Treasure Island Site 12 Radiological Field Screening" dated March 1, 2004, and presented to the Base Realignment and Closure (BRAC) Cleanup Team (BCT) members at the April 2004 BCT meeting, has been finalized and entered into the administrative record as of November 2, 2005 (Shaw, 2005). In summary, the Technical Memorandum provides the following information: Investigation of 580 test trenches in IR Site 12 used a Ludlum survey meter with a sodium iodide scintillation detector and included four gamma radiation readings at each trench location. The trenches were monitored (scanned) first in a 2-foot deep trench and then in the lower half of the trench after it was excavated to 4-feet deep. The removed material (spoils) from each trench was also monitored (scanned) in two steps, first the spoils removed from the 2-foot deep trench and second the spoils removed from the bottom half of the trench. A total of 2,244 gamma radiation readings were recorded. The readings were initially compared to a surface background value of 6,500 counts per minute (cpm). The background was established in a location known to be radiologically non-impacted. An action level of twice background was used to evaluate the gamma readings. Only three gamma readings exceeded the twice-surface background criteria. Each of the three greater than twice background readings was taken at the 2 to 4 foot depth in a trench and would not have exceed a background reading at that depth if one had been taken. In general, soil surrounding a detector in a trench produces a higher reading than when the detector is above ground. The spoils removed from the trenches did not have elevated gamma readings. Soil samples were taken from each of the three above twice background locations and analyzed for gamma emitting isotopes. None of the samples indicated elevated levels of radioactivity. Varying levels of natural radioactivity were measured that were not significantly different than a background sample obtained from a rock quarry.

An independent assessment of the trench and spoils gamma readings was performed by Tetra Tech EM Inc. In this assessment, each set of data (trench readings at two depths and spoils readings at the two depths) was analyzed separately. A mean and standard deviation were calculated for each data set and the gamma readings were compared to a criterion of the mean plus 3 standard deviations of that set. Readings that exceed the criterion identify locations, which are different than the average trench reading. Tetra Tech EM Inc findings are summarized below:

- The gamma readings from all trenches at the 0 to 2 foot level had two trenches that exceeded the criterion.
- The gamma readings from all trenches at the 2 to 4 foot level had five trenches that exceeded the criterion.
- The gamma readings of the first two feet of spoils removed from all trenches had four trenches that exceeded the criterion.
- The gamma readings of the last two feet of spoils removed from all trenches had five trenches that exceeded the criterion.

Only two of the locations had more than one reading exceeding the criterion. Description of the debris in the trenches and the description of the soil removed do not indicate a pattern or a correlation between any of the data. Shaw evaluation of all the data concludes that there is no data indicating the presence of radioactive contamination above ambient or that would warrant further characterization.

The Navy has reviewed the data and concludes the readings are variation of background concentrations. The debris descriptions do show a percentage of gravel, asphalt, macadam, and rock in most of the trenches that exceed the criterion. These materials can contain higher concentrations of natural radioactive materials than the soil in other trenches. No change is necessary to the HRA.

7. Comment: **The 2003 gamma monitoring of 580 excavations at randomly selected locations outside of documented solid waste disposal areas within IR Site 12 appears, based on information given, to be a reasonable step towards characterization of associated areas. Given the indication that wastes were spread across wide areas during subsequent grading and construction, have any walk-over or drive-over gamma surveys been conducted to ensure that radiation sources or areas of contamination are not missed?**

Response: Since there is no documentation to suggest that radioactive materials were disposed in the solid waste disposal areas at IR Site 12 or anywhere else on NAVSTA TI, no walk-over or drive-over gamma surveys were conducted at IR Site 12. See response to DTSC's comment # 1.

8. Comment: **It is appropriate that plans call for radiation monitoring during soil excavation of the known solid waste disposal areas within IR Site 12. Evaluation of whether such monitoring is satisfactory cannot be done based on the information contained in the Draft HRA, but must be based on review of the specific monitoring plan for those activities.**

Response: The Navy agrees with the comment.

9. Comment: **It is stated in Section 6.5 that trash and debris were "most notably" disposed of in four solid waste disposal areas within IR Site 12. How will other identified or potential waste disposal areas outside of IR Site 12 be evaluated for potential health hazard (such as Sites 31 and 33)? What is the justification for considering these other waste disposal areas as not impacted? The Navy apparently does not intend to remove debris from a waste disposal area beneath 11th Street in Site 31, and this debris could be a long-term liability for TIDA. We request justification for why the Navy has no concerns about potential disposal of radioactive material at this location.**

Response: NAVSTA TI's primary activities were training and not that of a shipyard or industrial maintenance facility that removed or repaired radioluminescent devices and disposed of the devices and associated waste in landfills. There is no supporting evidence to indicate NAVSTA TI disposed of any radioluminescent devices or generated associated waste. All known radiological material used for training and radiological waste from the two spills at NAVSTA TI was transferred or disposed off the naval station. The US EPA photographic analysis indicates that historical solid waste storage and disposal activities were confined to areas within Site 12. Since both historical documentation and actual trenching data, to date, support that radiological material was not disposed at NAVSTA TI, the Navy believes there is no need at this time to conduct additional radiological surveys at Sites 30, 31, and 33. Further discussion to support this conclusion is provided in the response to DTSC's comment # 1.

10. Comment: **With the surveys that have been conducted in the past and the planned or ongoing "Characterization Survey" and "Scoping Survey" of floors, sanitary drains, and crawl spaces, the assessments of Building 233 appear to satisfactory address radiological conditions after the 1950 radium dispersal incident.**

Response: The Navy appreciates the comment.

11. Comment: **With the surveys that have been conducted in the past and the planned or ongoing "Final status survey," the assessments of Buildings 343 and 344 appear to satisfactory address radiological conditions after isolated contamination was identified and cleaned up in 1980s and 1990s.**

Response: The Navy agrees.

12. Comment: **Throughout the draft report, there are several figures that are impossible to read (such as Figure 8.3.4.1). A better effort should be made to obtain clear images and present them in appropriate sizes so that the contained information is useful to the reader. Additionally, the figures provided in the report do not show the location of impacted areas relative to the entire island. The report needs an overview figure of Treasure Island that shows the location of all impacted areas, such as "Figure 1" that was distributed at the June 2005 BCT meeting.**

Response: A larger than single page base-wide map will be inserted in the HRA. The map will show the location of all of the identified impacted and potentially impacted sites.

13. Comment: **Throughout the draft report, there are acronyms and abbreviations used that are not included in the List of Abbreviations, Acronyms, and Symbols and are not defined when first used.**

Response: The report will be reviewed for this problem.

14. Comment: **Section 4.4.3.3 states that on-site visual inspections were conducted. The report should document who conducted these inspections, when were they conducted, and how they were documented.**

Response: The author of the report, Robert O'Brien, visited Treasure Island multiple times during research in preparation for drafting the document. The observations are made as a result of those visits..

15. Comment: **In Table 5-1, it is unclear what the letters in the comments refer to (e.g., "B through E added for use in Model 11F3A…" Please provide explanation. There does not appear to be a complete accounting of the deletion of all sources. For example, for license 4-4346-2, Amendment #1 documents 21 cobalt sources while the next amendment listed (#8) only documents 11 cobalt sources. Please provide a complete accounting for the removal of sources.**

Response: Amendment #5 of NRC license 04-4346-1 added authorization for use of the short-lived isotopes used in the Model 11F3A radiological trainer. The format of the license utilizes the letters B through E to identify the added isotopes. Table 5-1 will be expanded to include all amendments to both NRC licenses and the NRMP.

16. Comment: **Regarding the decontamination of Building 233 following the radium spill, the text indicates that some materials were disposed of (p. 6-8 refers to disposal of surfaces that could not be decontaminated and p. 6-21 refers to furniture, rubber floor mats, linoleum flooring). Please document where these materials were disposed of.**

Response: More than 200 barrels of radioactive waste were generated and were stored aboard the USS Independence at Hunters Point Shipyard. The drums were weighted with concrete and sunk at sea at a depth of more than 100 fathoms. This information will be added to the Final HRA.

17. Comment: **On page 7-6, the text states that there is no probable mechanism for transport of surface soil. Wind is a very probable transport mechanism for surface soil.**

Response: The text cited is an example of how the assessment is performed. In this case the contaminant is slightly above background levels of Ra-226 on interior building surfaces. The assessment that there is no probable transport mechanism to cause detectable levels of contamination off-site is correct.

18. Comment: **On page 8-14, (regarding Building 3), the text indicates that structures have a "low" potential to be a migration pathway. The reason for this designation is unclear given that the building itself was no potential to have contaminated media.**

Response: The designation was in error. The potential migration pathways for Structures will be changed to "None".

Response to RAB member (Ms. Dale Smith) Comments of September 27, 2005, to the Naval Station Treasure Island Draft Historical Radiological Assessment dated August 2005

General Comment:

1. **Comment:** **It would be helpful if there were a base wide map with the individual sites highlighted, so the reader could get a sense of the general location of each. This would be especially true for the USS Pandemonium, which had not been discussed at RAB meetings. The maps provided of each site show a very small portion of the island and don't provide context.**

   Response: A larger than single page base-wide map will be inserted in the HRA. The map will show the location of all of the identified impacted and potentially impacted sites.

Specific comments:

1. **Comment:** **3-12 The species cedar warring is not recognized as a bird species. Does the author mean cedar waxwing?**

   Response: Cedar waxwing is correct. The reference in Section 3 will be revised to read 'cedar waxwing'.

2. **Comment:** **8-2 The connection between radon and radium is not understood. Does the release of airborne radon have anything to do with atomic decay or is this a function of ground disturbance? If it is the result of ground disturbance, why is this the only mention of it in any document including this one?**

   Response: Radium is a radionuclide formed by the decay of uranium and thorium which are present at very low levels in virtually all rock, soil, water, and plants. Most radium (radium-226) originates from the decay of uranium-238. Radium decays to form the radioactive gas, radon, which is chemically a non-reactive gas. Radon decays into other radioactive isotopes.

   The radium in the source capsule continuously decayed to radon such that a significant amount of radon was present in the source capsule and was released when the capsule was crushed. The radium continued to decay to radon. The release of radon from the capsule and the continued production of radon created hazardous radioactivity levels in the building air until the radium was removed from the building.

3. Comment: If direct surveys of the areas were not performed and gamma analysis of the above limits wipes was not performed, how can the survey be considered complete?

Response: The Navy decision to conduct additional surveys in Building 343 and 344 is based on the fact that no direct radiation surveys of the storeroom were performed.

REFERENCES:

Dames and Moore, 1988. Preliminary Assessment/Site Inspection of Naval Station Treasure Island, CA, NEESA Document 13-092, April 1988.

Shaw, 2005. Treasure Island Site 12 Radiological Field Screening Technical Memorandum, November 2, 2005.

PROPERTY RECORD CARD (*For Property Class 1 Only*)
NAV. S. AND A. FORM 264

(7)

ACTIVITY NAME AND LOCATION 6029-700 U. S. Naval Station, Treasure Island, S. F., Calif.

ACCOUNTING NO. 60028 DATE OF CARD September 1952

DESCRIPTION: (*Must be complete and accurate*)

Total Acreage (Fee Ownership)
Navy Land
Treasure Island 402.88 Acres
Yerba Buena Island 122.28 Acres
Total 525.16 Acres

Type of Ownership
Fee 525.16 Acres
Permit
Government Agency
Total 525.16 Acres

Reserved for Bureau Use

CARD NUMBER 1-00003

TYPE OF PROPERTY

EXPENSE GROUP

TOTAL COST $1,312,905.00

YEAR ACQUIRED

REFERENCE Adj.Acq.for Acq.of additional property, replaces card 1-00002

Remarks: Acquisition Data-
Treasure Island Title to 380 acres, more or less. (But determined to be 402.88 ~~acres by Navy Survey~~) known as Treasure Island, acquired from the City of San Francisco in the State of California, via condemnation proceedings judgment on declaration of taking by Secretary of the Navy, dated 11 April 1942, was filed in the District Court of the United States for Southern Division of the Northern District of California 17 April 1942. Title acquired in fee simple by United States this date, subject to final judgment filed in the said District Court 13 April 1945, as the result of stipulations covering waiver to compensation contained in Agreement between Navy Department and City of San Francisco, dated 15 March 1941.

(Further description of property: Acquisition and disposition remarks)

Yerba Buena Island acquired by Executive Order 12 October 1866. 107.37 acres transferred to Navy Department by Executive Order 1899. 2.697 acres transferred to Navy Department by Acting Secretary War Department letter dated 19 August 1938. 7.028 acres transferred by War Department to Navy Department by Public Law 027 of 79th Congress, 23 April 1948. 2.0 acres reclaimed by construction of causeway to Treasure Island. 1.19 acres transferred to Navy Department by U.S. Coast Guard 30 Sept 1949. 2.072 acres (sites of Army tank house, mine wharf, storehouse and quarters) transferred to Navy Dept. from the Department of the Army and accepted by Com 12 Secret letter, serial 00120 dated 19 February 1952 to U. S. Army Engineers, Box 3050 Rincon Annex, San Francisco, California. Restricted letter from District Public Works Officer, 12th Naval District file DE212-ck/sa NS1 (13230) serial 1507 dtd 20 Feb 1952 to Commanding Officer, U. S. Naval Station, Treasure Island states "The Commandant has accepted custody and accountability of the remainder of Department of the Army property on Yerba Buena Island as of 18 February 1952."

Total Navy Owned property, Y.B.I.	122.28 acres
Property owned by Treasury Dept and occupied by Coast Guard YBI	25.32 acres
Total acreage YBI	147.60 acres

Cost Date -

Since no record exists of the original cost, if any, of Yerba Buena Island and also, due to the fact that Treasure Island was not acquired as the result of the payment of any direct cost for the land, the cost shown is an estimate based on approximate value of $2,500 per acre, for Navy owned property.

2005-3-28 Department of Toxic Substances Control website for Treasure Island

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DTSC: Site Cleanup

Site Cleanup - Site Mitigation and Brownfields Reuse Program Database

All public inquiries regarding data should be directed to the Site Mitigation and Brownfields Reuse Program Database (CalSites) Helpdesk at (916) 323-3400.

Profile Report --

Site Map

ID:38370044 - Naval Station Treasure Island

529 ACRES; BETWN SAN FRANCISCO & OAKLAND
SAN FRANCISCO CA 94130

County: SAN FRANCISCO **Branch:** OMF-NORTHERN CALIF **DTSC Region:** 2

Status: 01/01/1991 - ANNUAL WORKPLAN - ACTIVE SITE
Lead: DEPT OF TOXIC SUBSTANCES CONTROL
Type: CLOSED MILITARY BASE
NPL: NOT LISTED
Project Manager: David Rist - (510) 540-3763 Email: DRIST@dtsc.ca.gov
SIC: 37 - MANU - TRANSPORTATION EQUIPMENT
Assembly District: 13 **Senate District:** 03

Site History

Treasure Island (TI) Naval Station is located on a 404 acre man-m ade island that is anchored to a natural rock island (Yerba Buena) in the San Francisco Bay. TI was built in the 1930s for the Wor ld Trade Exhibit. Military use of the island started in the 1940 s. TI provided administrative and support facilities for process ing Pacific-bound naval personnel, and for the admin- istrative o perations of other Navy, Marine Reserves, and non- military Feder al activities. In April 1988, a Preliminary Assessment/Site Ins pection (PA/SI) Report of the facility was prepared by Dames & Mo ore for the Naval Energy and Environmental Support Activity (NEES A). Based on information from historical records; aerial photos; agency contacts; field inspection; and personnel interviews, a t otal of 20 areas were identified with potential contamination and for additional site investigation. These areas identified inclu ded: a medical clinic; a former foundry; a boiler plant; an old b unker; stormwater outfalls; a refuse transfer area; a car hobby s hop; an oil recovery waste facility; a seaplane maintenance shop; an exchange service station; a hydraulic training school; a pain ting shop; two storage shed areas; a landfill; and fire training fuel tank releases. Further site investigation is being conducted to confirm the presence of suspected contaminants at the site. Potential conta- minants include: low level radioactive waste, p olychlorinated biphenyls (PCBs), pesticides, paints, waste oil an d fuel, sol- vents, asbestos, acids, and heavy metals. Potential pathways of migration of contaminants is via surface run-off and groundwater migration. San Francisco Bay is probably the discha rge point for both surface and groundwater migration of contamina nts. Potential receptors at TI would include small animals, bird species, and aquatic species that inhabit the Bay. Contaminants could be introduced to the food chain by small animals and birds. *** OPERABLE UNIT/SITE DESCRIPTION *** Ste 01 Medical Clini c; COC: Silver Ste 03 PCB Equipment Storage Area; COC: Polychlor inated Biphen- yls Ste 05 Old Boiler Plant; COCs: Petroleum/Vola tile Organic Com- pounds Ste 07 Pesticide Storage; COCs: Pestici des/Metals Ste 08 Army Point Sludge Disposal Area; COCs: Pestici des/Metals Ste 09 Foundry; COCs: Petroleum/Metals Ste 10 Bus Pa inting Shop; COCs: Metals Ste 11 Yerba Buena Island Landfill; CO Cs: Petroleum/Metals Ste 21 Vessel Waste Oil Recovery; COCs: Vol atile Organic Com- pounds Ste 24 Dry Cleaning Facility/5th Stree t Fuel Lines; COCs: Volatile Organic Compounds/Petroleum Site 28 West Side On/Off Ramps; COCs: Metals Site 29 East Side On/Off Ram ps; COCs: Metals Site 12 OU Site Ste 12 Old Bunker Area/Former S torage Yard; COCs: Metals/Poly- chlorinated Biphenyls/Polyaromati c Hydrocarbons/Petroleum Offshore OU Sites Ste 13 Storm Water Ou tfalls; COCs: Petroleum/Metals Site 27 Clipper Cove Skeet Range; COCs: Lead/Polyaromatic Hydro- carbons Corrective Action Plan Sit es Ste 04 Hydraulic Training School; COCs: Petroleum Ste 06 Fir e Training Area; COCs: Petroleum Ste 14 New Fuel Farm; COCs: Pet roleum Ste 15 Old Fuel Farm; COCs: Petroleum Ste 17 Tanks 103/1 04; COCs: Petroleum Ste 19 Refuse Transfer Area; COCs: Petroleum Ste 20 Auto Hobby Shop; COCs: Petroleum Ste 22 Navy Exchange s ervice Station; COCs: Petroleum Ste 25 Seaplane Maintenance; COC s: Petroleum *** Commitment Descriptions *** 03/03/92 - PPP - Public Participation Plan - Final PPP as agreed to by DTSC and N avy. 09/29/92 - FFA - Change to FFSRA - Federal Facility Site Rem edi- ation Agreement. 03/15/95 - 402AC - Represents 402 acres (dr y land area of Trea- sure Island) - should be changed to 404 acre s. 03/15/92 - TINS (Treasure Island Naval Shipyard) Base Wide Env i- ronmental Baseline Survey 04/30/95 - FOSL for

Parcel B-2. B-2 is a former hangar that will be used for special events and movie production. Size: Approxi- mately 10 acres.****

Comments

07/25/1991 Naval station containing industrial landfill and bay fill areas. Soils are contaminated with petroleum hydrocarbons and heavy metals.

12/30/2001 PEA - IR1&3 -- Completion of sites 1 and 3 Preliminary Endangerment Assessment documentation.

Potential/Confirmed Hazardous Waste

Description

ASBESTOS CONTAINING WASTE
PAINT SLUDGE
PESTICIDES & WASTES ASSOC W/ PESTICIDE PRODUCTION
PHOTOCHEMICALS/PHOTOPROCESSING WASTE
UNSPECIFIED ACID SOLUTION
UNSPECIFIED OIL CONTAINING WASTE
UNSPECIFIED SOLVENT MIXTURES

Identification Information

RWQCB Region: SAN FRANCISCO BAY
File Name:

Associated IDs

Code	Description	Value
PCODE	BEP DATABASE PCODE	P23048

Names Used For This Site

TREASURE ISLAND NAVSTA
SAN FRANCISCO NTTC
SF NAVY TECHNICAL TRAINING CENTER
Naval Station Treasure Island

Addresses Used For This Site

529 ACRES; BETWN SAN FRANCISCO & OAKLAND	SAN FRANCISCO	CA	94130
TREASURE ISLAND	SAN FRANCISCO	CA	94130

Special Characteristics

Program	Program Name
BRAC3	BASE REALIGNMENT & CLOSURE, 3RD ROUND

DSMOA DEFENSE MEMORANDUM OF AGREEMENT

Access: No data available at this time.

Groundwater Contamination: Groundwater Contamination Suspected - 5 source(s)

Operational Methods

LANDFILL

Commitment Information

Code	Desc.	Due Date	Revised	Completed	Activity
PPP		03/03/1992		03/03/1992	PUBLIC PARTICIPATION PLAN
ORDER	FFA			09/29/1992	I/SE, IORSE, FFA, FFSRA, VCA, EA
CERFA	402AC	03/15/1995		03/15/1995	COMMUNITY ENVIRONMENTAL RESPONSE FACILITATION ACT
BWEBS	TINS	03/15/1995		03/15/1995	BASEWIDE ENVIRONMENTAL BASELINE SURVEY
FOSL	B-2	04/30/1995		04/30/1995	FINDING OF SUITABILITY TO LEASE
BWEBS	T005	05/03/1995		05/03/1995	BASEWIDE ENVIRONMENTAL BASELINE SURVEY
FOSL	T005	08/03/1995		08/03/1995	FINDING OF SUITABILITY TO LEASE
BWEBS	Site	08/10/1995		08/10/1995	BASEWIDE ENVIRONMENTAL BASELINE SURVEY
FOSL	E.S.	11/17/1995		11/17/1995	FINDING OF SUITABILITY TO LEASE
BWEBS	T077	05/10/1996		05/10/1996	BASEWIDE ENVIRONMENTAL BASELINE SURVEY
BWEBS	T007	05/31/1996		05/31/1996	BASEWIDE ENVIRONMENTAL BASELINE SURVEY
FOSL	T007	06/20/1996		06/20/1996	FINDING OF SUITABILITY TO LEASE
FOSL	T077	07/10/1996		07/10/1996	FINDING OF SUITABILITY TO LEASE
FOSL	T064	08/12/1996		08/12/1996	FINDING OF SUITABILITY TO LEASE
BWEBS	T064	08/12/1996		08/12/1996	BASEWIDE ENVIRONMENTAL BASELINE SURVEY
FOSL	NIMTZ	12/19/1996		12/19/1996	FINDING OF SUITABILITY TO LEASE
BWEBS	NIMIT	12/19/1996		12/19/1996	BASEWIDE ENVIRONMENTAL BASELINE SURVEY
FOSL	PTA	12/27/1996		12/27/1996	FINDING OF SUITABILITY TO LEASE
BWEBS	PTA	12/27/1996		12/27/1996	BASEWIDE ENVIRONMENTAL BASELINE SURVEY
FOSL	ZONE1	05/16/1997		05/16/1997	FINDING OF SUITABILITY TO LEASE
FOSL	1400H	05/23/1997		05/23/1997	FINDING OF SUITABILITY TO LEASE

FOSL	ZONE2	07/16/1997		07/16/1997	FINDING OF SUITABILITY TO LEASE
FOSL	ZONE2	08/30/1997		08/30/1997	FINDING OF SUITABILITY TO LEASE
FOSL	ZONE1	08/30/1997		08/30/1997	FINDING OF SUITABILITY TO LEASE
FOSL	ZONE3	08/30/1997		08/30/1997	FINDING OF SUITABILITY TO LEASE
FOSL	ZONE4	09/30/1997		09/30/1997	FINDING OF SUITABILITY TO LEASE
RAW	ST12L	06/11/1999		06/11/1999	REMOVAL ACTION WORKPLAN
PEA	IR1&3	12/30/2001		12/30/2001	PRELIMINARY ENDANGERMENT ASSESSMENT
FOST		11/14/2006			FINDING OF SUITABILITY TO TRANSFER
FOST		11/18/2006			FINDING OF SUITABILITY TO TRANSFER
RAP	Sites	02/15/2007			REMEDIAL ACTION PLAN / RECORD OF DECISION
RIFS	Site	03/12/2007			REMEDIAL INVESTIGATION / FEASIBILITY STUDY
RIFS	Site	06/04/2007			REMEDIAL INVESTIGATION / FEASIBILITY STUDY
RIFS	Site	06/17/2007			REMEDIAL INVESTIGATION / FEASIBILITY STUDY
FRA	Site	09/01/2007			FINAL REMEDIAL ACTION
FOSET		11/22/2007			FINDING OF SUITABILITY FOR EARLY TRANSFER
RIFS	Site	12/02/2007			REMEDIAL INVESTIGATION / FEASIBILITY STUDY
RIFS	Site	12/25/2007			REMEDIAL INVESTIGATION / FEASIBILITY STUDY
RIFS	Site	12/26/2007			REMEDIAL INVESTIGATION / FEASIBILITY STUDY
RAP	Site	01/28/2008			REMEDIAL ACTION PLAN / RECORD OF DECISION
RIFS	Site	04/12/2008			REMEDIAL INVESTIGATION / FEASIBILITY STUDY
RAP	Site	06/03/2008			REMEDIAL ACTION PLAN / RECORD OF DECISION
RAP	11289	10/24/2009	06/30/2008		REMEDIAL ACTION PLAN / RECORD OF DECISION
RAP	Site	07/27/2008			REMEDIAL ACTION PLAN / RECORD OF DECISION
RIFS	Sites	09/02/2008			REMEDIAL INVESTIGATION / FEASIBILITY STUDY
CERT	ONSHR	06/30/2009			CERTIFICATION
CERT	OFFSH	06/30/2009			CERTIFICATION
RAW	Site	01/26/2010			REMOVAL ACTION WORKPLAN
RIFS	Site	01/26/2010			REMEDIAL INVESTIGATION / FEASIBILITY STUDY
CEQA	ONSHR	04/30/2010			CEQA INCLUDING NEGATIVE DECS
RAW	Site	07/30/2010			REMOVAL ACTION WORKPLAN
CEQA	STE12	09/30/2010			CEQA INCLUDING NEGATIVE DECS

CERT	STE12	12/31/2010	CERTIFICATION
RAP	Site	01/26/2013	REMEDIAL ACTION PLAN / RECORD OF DECISION

Cal/EPA | Air Resources Board | California Integrated Waste Management Board | Department of Pesticide Regulation
Office of Environmental Health Hazard Assessment | State Water Resources Control Board

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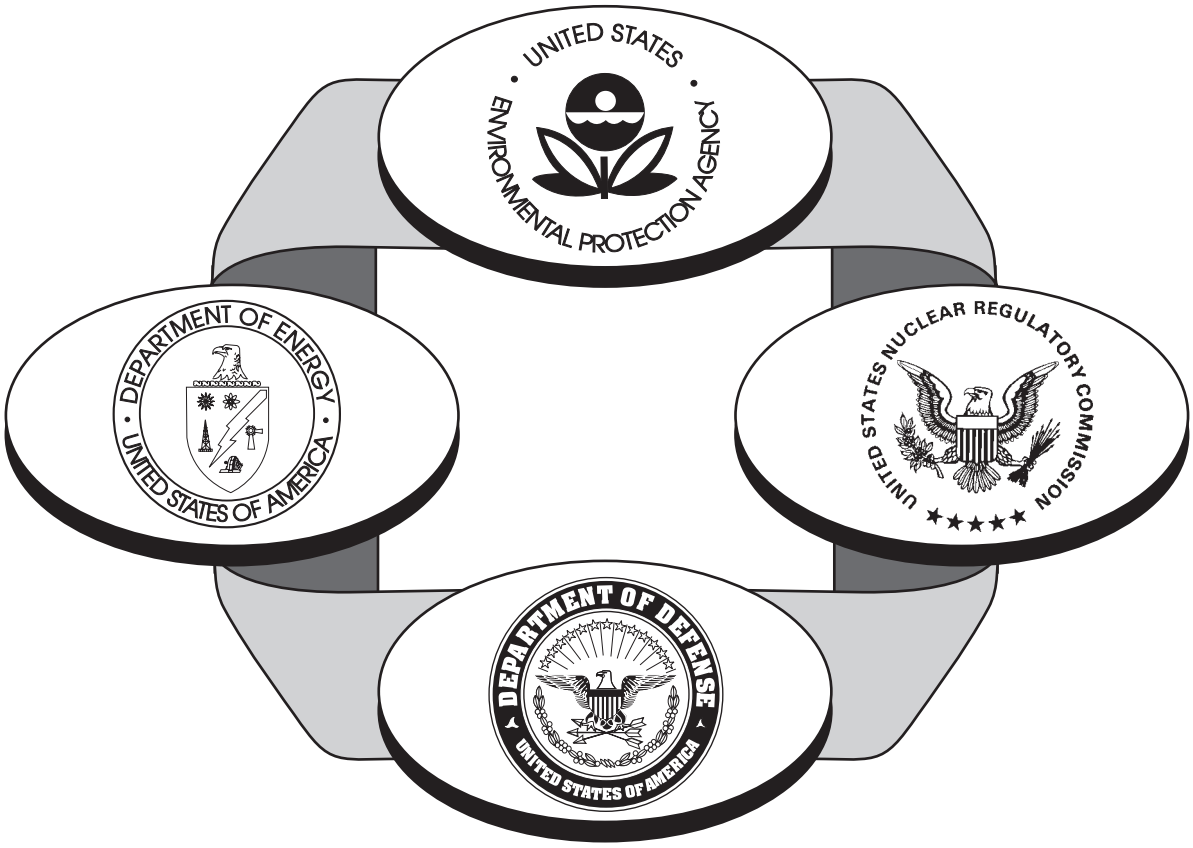
MULTI-AGENCY RADIATION SURVEY AND SITE INVESTIGATION MANUAL (MARSSIM)



Revision 1

August 2000

NUREG-1575, Rev. 1
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DOE/EH-0624, Rev. 1

MULTI-AGENCY RADIATION SURVEY AND SITE INVESTIGATION MANUAL (MARSSIM)

AUGUST 2000
REVISION 1

ABSTRACT

The MARSSIM provides information on planning, conducting, evaluating, and documenting building surface and surface soil final status radiological surveys for demonstrating compliance with dose or risk-based regulations or standards. The MARSSIM is a multi-agency consensus document that was developed collaboratively by four Federal agencies having authority and control over radioactive materials: Department of Defense (DOD), Department of Energy (DOE), Environmental Protection Agency (EPA), and Nuclear Regulatory Commission (NRC). The MARSSIM's objective is to describe a consistent approach for planning, performing, and assessing building surface and surface soil final status surveys to meet established dose or risk-based release criteria, while at the same time encouraging an effective use of resources.

DISCLAIMER

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ABBREVIATIONS

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AFI	Air Force Instructions
ALARA	as low as reasonably achievable
AMC	Army Material Command
ANSI	American National Standards Institute
AR	Army Regulations
ARA	Army Radiation Authorization
ASTM	American Society of Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
CAA	Clean Air Act
Capt.	Captain (Air Force)
CAPT	Captain (Navy)
CDR	Commander
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CHP	Certified Health Physicist
CPM	counts per minute
DCF	dose conversion factor
DCGL	derived concentration guideline level
$DCGL_{EMC}$	DCGL for small areas of elevated activity, used with the EMC
$DCGL_{W}$	DCGL for average concentrations over a wide area, used with statistical tests
DEFT	Decision Error Feasibility Trials
DLC	Data Life Cycle
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DQA	Data Quality Assessment
DQO	Data Quality Objectives
EERF	Eastern Environmental Radiation Facility
Ehf	human factors efficiency
EMC	elevated measurement comparison
EML	Environmental Measurements Laboratory
EMMI	Environmental Monitoring Methods Index
EPA	Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center
ERAMS	Environmental Radiation Ambient Monitoring System

ABBREVIATIONS

FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FRDS	Federal Reporting Data System
FSP	Field Sampling Plan
FWPCA	Federal Water Pollution Control Act
FUSRAP	Formerly Utilized Sites Remedial Action Program
GEMS	Geographical Exposure Modeling System
GM	Geiger-Mueller
GPS	global positioning system
GRIDS	Geographic Resources Information Data System
GWSI	Ground Water Site Inventory
H_0	null hypothesis
H_a	alternative hypothesis
HSA	Historical Site Assessment
HSWA	Hazardous and Solid Waste Amendments
ISI	Information System Inventory
L_C	critical level
L_D	detection limit
LBGR	lower bound of the gray region
LCDR	Lieutenant Commander
LLRWPA	Low Level Radioactive Waste Policy Act as Amended
LT	Lieutenant
MARLAP	Multi-Agency Radiation Laboratory Analytical Protocols (Manual)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCA	multichannel analyzer
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MED	Manhattan Engineering District
NARM	naturally occurring or accelerator produced radioactive material
NCAPS	National Corrective Action Prioritization System
NCRP	National Council on Radiation Protection and Measurements
NCP	National Contingency Plan
NIST	National Institute of Standards and Technology
NORM	naturally occurring radioactive material
NPDC	National Planning Data Corporation

ABBREVIATIONS

NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
NWWA	National Water Well Association
ODES	Ocean Data Evaluation System
ORNL	Oak Ridge National Laboratory
ORISE	Oak Ridge Institute for Science and Education
PERALS	photon electron rejecting alpha liquid scintillator
PIC	pressurized ionization chamber
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QMP	Quality Management Plan
RASP	Radiological Affairs Support Program
RAGS/HHEM	Risk Assessment Guidance for Superfund/Human Health Evaluation Manual
RC	release criterion
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RODS	Records of Decision System
RSSI	Radiation Survey and Site Investigation
SARA	Superfund Amendments and Reauthorization Act
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
SFMP	Surplus Facilities Management Program
SOP	Standard Operating Procedures
STORET	Storage and Retrieval of U.S. Waterways Parametric Data
TEDE	total effective dose equivalent
TLD	thermoluminescence dosimeter
TRU	transuranic
TSCA	Toxic Substances Control Act

ABBREVIATIONS

UMTRCA	Uranium Mill Tailings Radiation Control Act
USGS	United States Geological Survey
USPHS	United States Public Health Service
USRADS	Ultrasonic Ranging and Data System
WATSTORE	National Water Data Storage and Retrieval System
WL	working level
WRS	Wilcoxon rank sum
WSR	Wilcoxon signed ranks
WT	Wilcoxon test

CONVERSION FACTORS

To Convert From	To	Multiply By	To Convert From	To	Multiply By
acre	hectare	0.405	meter (m)	inch	39.4
	sq. meter (m^2)	4,050		mile	0.000621
	sq. feet (ft^2)	43,600	sq. meter (m^2)	acre	0.000247
becquerel (Bq)	curie (Ci)	$2.7x10^{-11}$		hectare	0.0001
	dps	1		sq. feet (ft^2)	10.8
	pCi	27		sq. mile	$3.86x10^{-7}$
Bq/kg	pCi/g	0.027	m^3	liter	1,000
Bq/m^2	dpm/100 cm^2	0.60	mrem	mSv	0.01
Bq/m^3	Bq/L	0.001	mrem/y	mSv/y	0.01
	pCi/L	0.027	mSv	mrem	100
centimeter (cm)	inch	0.394	mSv/y	mrem/y	100
Ci	Bq	$3.70x10^{10}$	ounce (oz)	liter (L)	0.0296
	pCi	$1x10^{12}$	pCi	Bq	0.037
				dpm	2.22
dps	dpm	60	pCi/g	Bq/kg	37
	pCi	27	pCi/L	Bq/m^3	37
dpm	dps	0.0167	rad	Gy	0.01
	pCi	0.451	rem	mrem	1,000
gray (Gy)	rad	100		mSv	10
hectare	acre	2.47		Sv	0.01
liter (L)	cm^3	1000	seivert (Sv)	mrem	100,000
	m^3	0.001		mSv	1,000
	ounce (fluid)	33.8		rem	100

ERRATA AND ADDENDA

In response to comments received on the December 1997 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), minor modifications were made to individual pages. Modifications to the manual that correct errors are listed as errata, while modifications made to clarify guidance or provide additional information are referred to as addenda. The pages affected by these modifications are listed here and have the date of the modification in the footer. A complete list of comments and resolutions is available on the MARSSIM web site at:

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Ref-3, Ref-4, Ref-8, L-1, L-2, L-3, L-4, L-5, L-6, L-7

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2-4, 3-12, 4-11, GL-11

ROADMAP

Introduction to MARSSIM

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) provides detailed guidance for planning, implementing, and evaluating environmental and facility radiological surveys conducted to demonstrate compliance with a dose- or risk-based regulation. The MARSSIM guidance focuses on the demonstration of compliance during the final status survey following scoping, characterization, and any necessary remedial actions.

The process of planning the survey, implementing the survey plan, and assessing the survey results prior to making a decision is called the Data Life Cycle. MARSSIM Chapter 2 and Appendix D provide detailed guidance on developing appropriate survey designs using the Data Quality Objectives (DQO) Process to ensure that the survey results are of sufficient quality and quantity to support the final decision. The survey design process is described in MARSSIM Chapters 3, 4, and 5. Guidance on selecting appropriate measurement methods (*i.e.*, scan surveys, direct measurements, samples) and measurement systems (*i.e.*, detectors, instruments, analytical methods) is provided in MARSSIM Chapters 6 and 7 and Appendix H. Data Quality Assessment (DQA) is the process of assessing the survey results, determining that the quality of the data satisfies the objectives of the survey, and interpreting the survey results as they apply to the decision being made. The DQA process is described in MARSSIM Chapter 2 and Appendix E and is applied in MARSSIM Chapter 8. Quality Assurance and Quality Control (QA/QC) procedures are developed and recorded in survey planning documents, such as a Quality Assurance Project Plan (QAPP) which is described in MARSSIM Chapter 9.

MARSSIM does not provide guidance for translating the release criterion into derived concentration guideline levels (DCGLs). MARSSIM discusses contamination of surface soil and building surfaces in detail. If other media (*e.g.*, ground water, surface water, subsurface soil, equipment, vicinity properties) are potentially contaminated at the time of the final status survey, modifications to the MARSSIM survey design guidance and examples may be required.

The Goal of the Roadmap

The goal of the roadmap is to present a summary of the major steps in the design, implementation, and assessment of a final status survey and to identify where guidance on these steps is located in MARSSIM. A brief description of each step is included in the roadmap along with references to the sections of MARSSIM that provide more detailed guidance.

This roadmap provides the user with basic guidance from MARSSIM combined with "rules of thumb" (indicated by ☞) for performing compliance demonstration surveys. The roadmap is not designed to be a stand-alone document, but to be used as a quick reference to MARSSIM for

users already familiar with the process of planning and performing surveys. Roadmap users will also find flow charts summarizing the major steps in the Radiation Survey and Site Investigation Process, combined with references to sections in MARSSIM where detailed guidance may be found. In addition, the roadmap serves as an overview and example for applying MARSSIM guidance at sites with radioactive contamination of surface soil and building surfaces. The roadmap assumes a working knowledge of MARSSIM terminology. If such knowledge is lacking, the user may refer to Section 2.2 of MARSSIM for definitions of key terms. In addition, a complete set of definitions is provided in the Glossary.

Data Life Cycle

Compliance demonstration is simply a decision as to whether or not a survey unit meets the release criterion. For most sites, this decision is supported by statistical tests based on the results of one or more surveys. The initial assumption used in MARSSIM is that each survey unit is contaminated above the release criterion until proven otherwise. The surveys are designed to provide the information needed to reject this initial assumption. MARSSIM recommends using the Data Life Cycle as a framework for planning, implementing, and evaluating survey results prior to making a decision. Figure 1 summarizes the major activities associated with each phase of the Data Life Cycle.

Planning Stage

The survey design is developed and documented using the Data Quality Objectives (DQO) Process (Section 2.3.1, Appendix D). The DQOs for the project are established and preliminary surveys (*e.g.*, scoping, characterization) are performed to provide information necessary to design the final status survey for compliance demonstration. The DQOs for the project are re-evaluated for each of the preliminary surveys. The preliminary surveys may provide information for purposes other than compliance demonstration that are not discussed in MARSSIM. For example, a characterization survey may provide information to support evaluation of remedial alternatives. In addition, any of the preliminary surveys may be designed to demonstrate compliance with the release criterion as one of the survey objectives. These alternate survey designs are developed based on site-specific considerations (Section 2.6). The planning phase of the Data Life Cycle produces a final status survey design that is used for demonstrating compliance with the release criterion. This design is recorded in planning documents, such as a Quality Assurance Project Plan (QAPP) described in Section 9.2.

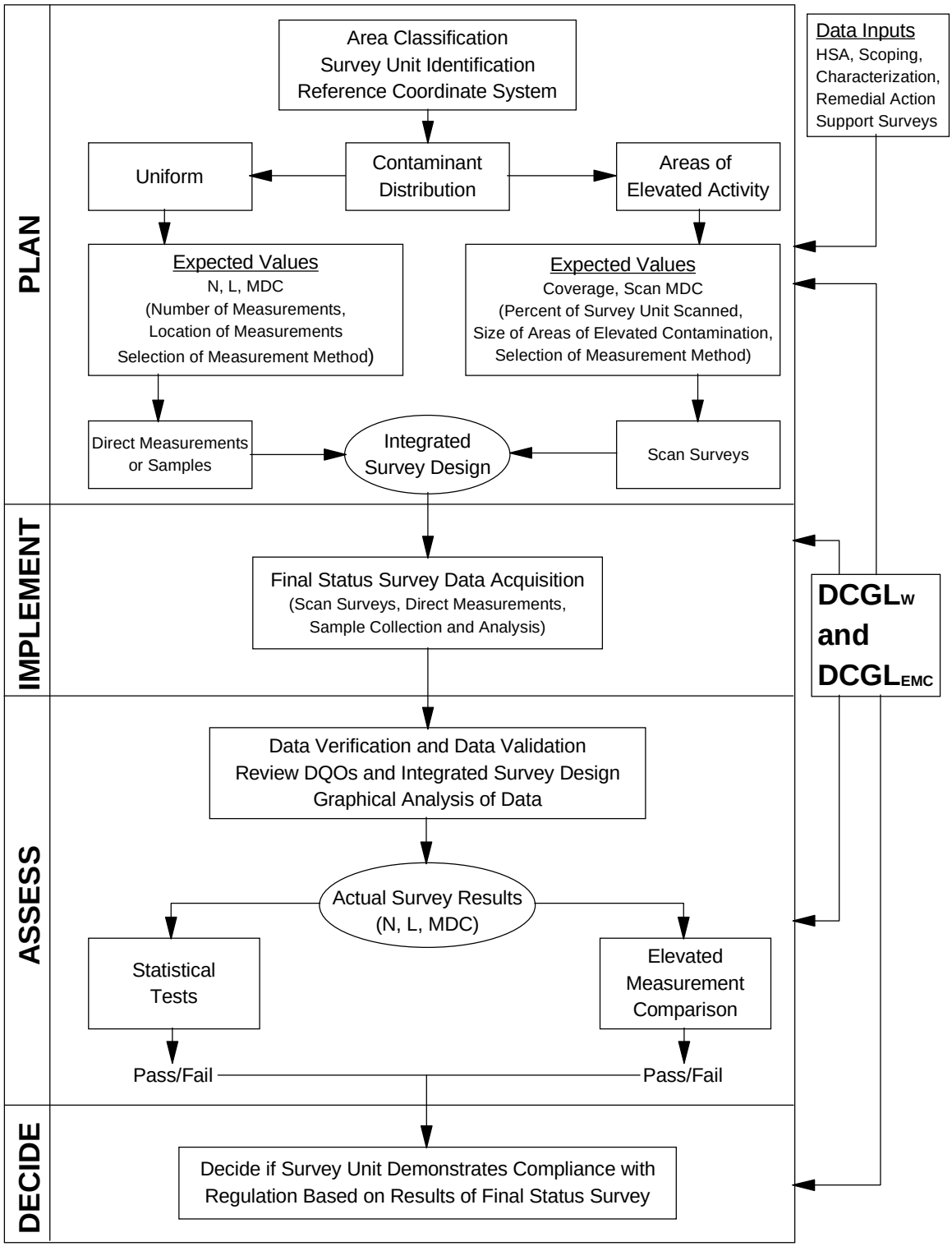

Figure 1 The Data Life Cycle Applied to a Final Status Survey

A minimum amount of information is needed from the preliminary surveys to develop an effective final status survey design. This includes

- Sufficient information to justify classification and specification of boundaries for survey units (the default is Class 1 which results in the highest level of survey effort)
- An estimate of the variability of the contaminant concentration in the survey unit (σ_s) and the reference area (σ_r) if necessary

After the preliminary surveys are completed, the final status survey design can be developed. Figure 2 presents the major steps in the development of a survey design that integrates scanning surveys with direct measurements and sampling. Most of the steps are easy to understand and references to appropriate sections of MARSSIM are included in the flowchart. Several of these steps are important enough to justify additional discussion in this guide. These steps are

- Classify Areas by Contamination Potential
- Group/Separate Areas into Survey Units
- Determine Number of Data Points
- Select Instrumentation
- Develop an Integrated Survey Design

Classify Areas by Contamination Potential (Section 4.4)

Classification is a critical step in survey design because it determines the level of survey effort based on the potential for contamination. Overestimating the potential for contamination results in an unnecessary increase in the level of survey effort. Underestimating the potential for contamination greatly increases the probability of failing to demonstrate compliance based on the survey results. There are two key decisions made when classifying areas: 1) is the average activity in the area likely to exceed the $DCGL_W$, and 2) is the contamination present in small areas of elevated activity or is the contamination distributed relatively homogeneously across the area. Each of these decisions is considered separately when designing the survey and then combined into an integrated survey design. Class 1 areas, prior to remediation, are impacted areas with concentrations of residual radioactivity that exceed the $DCGL_W$. Class 2 areas are impacted areas where concentrations of residual activity that exceed the $DCGL_W$ are not expected. Class 3 areas are impacted areas that have a low probability of containing areas with residual radioactivity. The information obtained from the preliminary surveys is crucial for classifying areas (see Figure 2.4).

☞ Area classification considers both the level of contamination relative to the $DCGL_W$ and the distribution of the contamination. The contamination may be uniformly distributed or present as small areas of elevated activity.

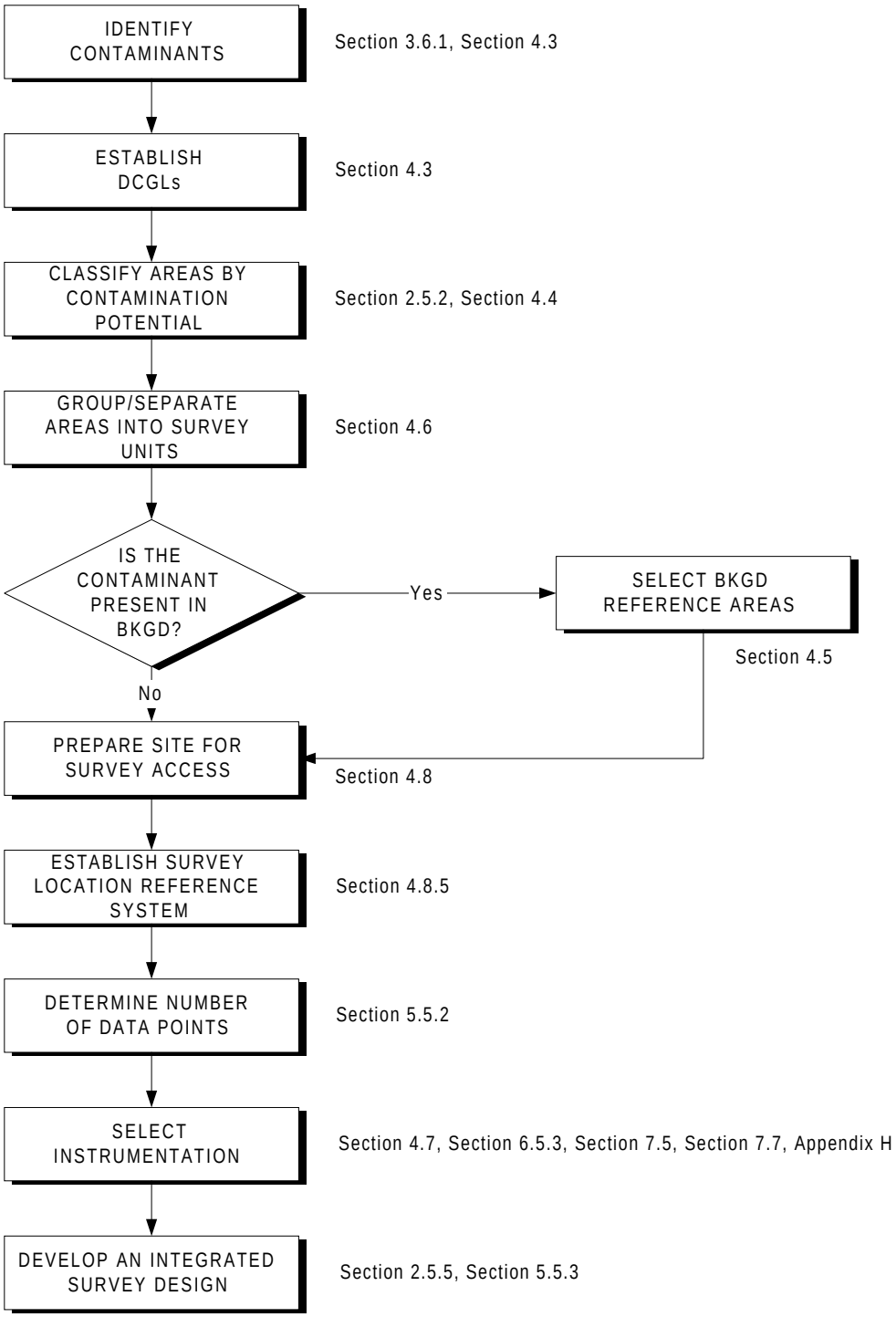

Figure 2 Flow Diagram for Designing a Final Status Survey

Group/Separate Areas into Survey Units (Section 4.6)

Survey units are limited in size based on classification, exposure pathway modeling assumptions, and site-specific conditions. Table 1 provides suggested survey unit areas based on area classification. The rationale for selecting a larger survey unit area should be developed using the DQO Process and fully documented.

Table 1 Suggested Survey Unit Areas

Classification	Suggested Area
Class 1	
Structures	up to 100 m^2
Land Areas	up to 2,000 m^2
Class 2	
Structures	100 to 1,000 m^2
Land Areas	2,000 to 10,000 m^2
Class 3	
Structures	no limit
Land Areas	no limit

☞ Survey unit areas should be consistent with exposure pathway modeling assumptions used to develop DCGLs.

Determine Number of Data Points (Section 5.5.2)

The number of data points is determined based on the selection of a statistical test, which in turn is based on whether or not the contaminant is present in background. Figure 3 presents a flow chart for determining the number of data points.

The first step in determining the number of data points is to specify the acceptable decision error rates, α and β. Decision error rates are site-specific and selected using the DQO Process. Changes in the values of α and β may result from successive iterations of the DQO Process.

☞ Values for α and β are site-specific and selected using the DQO Process.

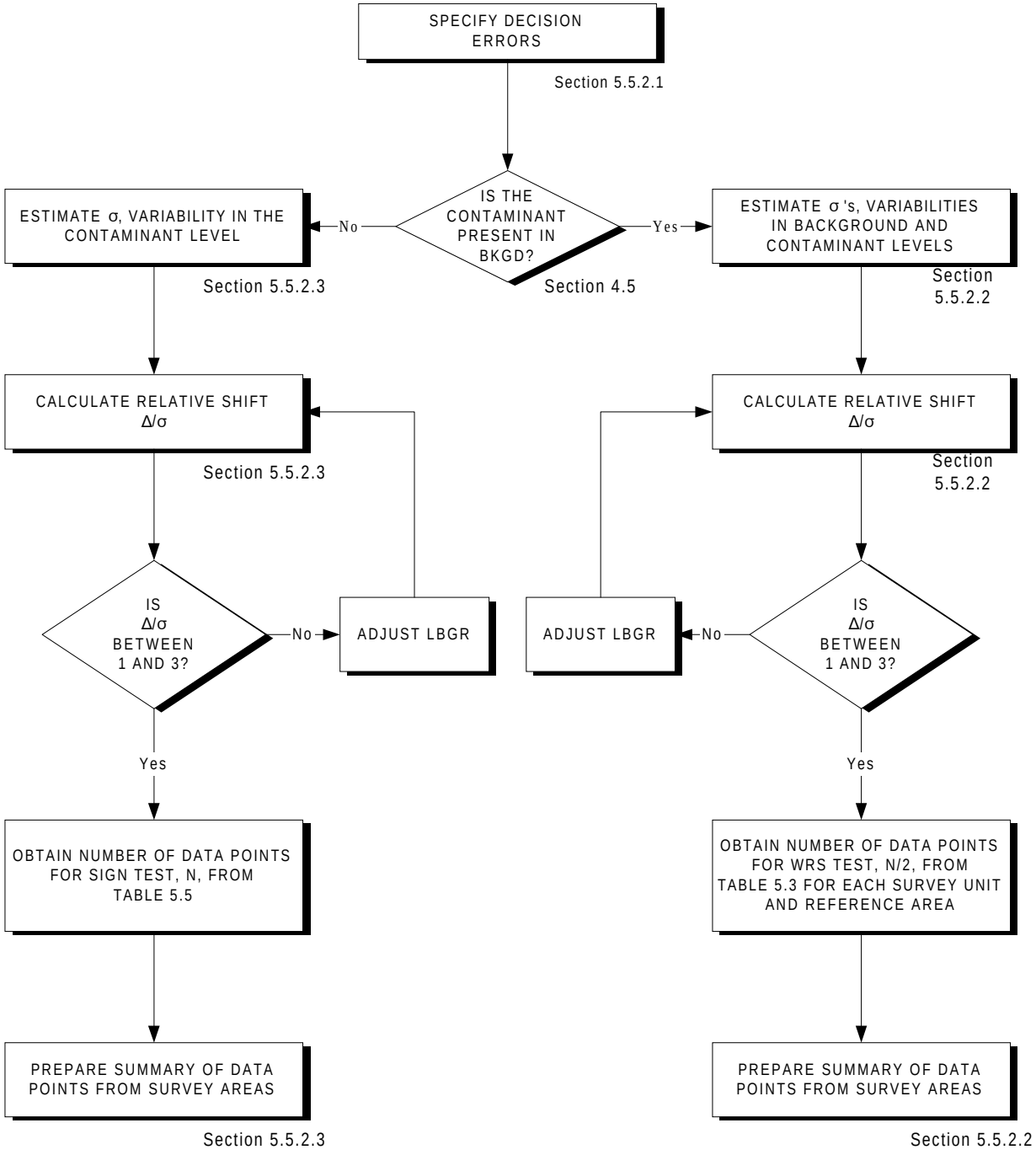

Figure 3 Flow Diagram for Determining the Number of Data Points

The next step, after determining whether or not the contaminant is present in background, is to estimate the variability of the contaminant concentration, σ. The standard deviation of the contaminant concentration determined from the preliminary survey results should provide an appropriate estimate of σ. If the contaminant is present in background, the variability in the survey unit (σ_s) and the variability in the reference area (σ_r) should both be estimated. The larger of the two values should be selected for determining the number of data points. Underestimating σ can underestimate the number of measurements needed to demonstrate compliance with the regulation, which increases the probability the survey unit will fail the statistical test. Overestimating σ can result in collecting more data than is necessary to demonstrate compliance.

☞	It is better to overestimate values of σ_s and σ_r.

☞	When σ_s and σ_r are different, select the larger of the two values.

The third step is to calculate the relative shift, Δ/σ. The variability of the contaminant concentration, σ, was determined in the previous step. The shift, Δ, is equal to the width of the gray region. The upper bound of the gray region is defined as the $DCGL_W$. The lower bound of the gray region (LBGR) is a site-specific parameter, adjusted to provide a value for Δ/σ between one and three. Δ/σ can be adjusted using the following steps:

- Initially select LBGR to equal one half the $DCGL_W$. This means $\Delta = (DCGL_W - LBGR)$ also equals one half the $DCGL_W$. Calculate Δ/σ.
- If Δ/σ is between one and three, obtain the appropriate number of data points from Table 5.3 or Table 5.5.
- If Δ/σ is less than one, select a lower value for LBGR. Continue to select lower values for LBGR until Δ/σ is greater than or equal to one, or until LBGR equals zero.
- If Δ/σ is greater than three, select a higher value for LBGR. Continue to select higher values for LBGR until Δ/σ is less than or equal to three.

Alternatively, Δ/σ can be adjusted by solving the following equation and calculating Δ/σ:

$$LBGR = DCGL_W - \sigma$$

If LBGR is less than zero, Δ/σ can be calculated as $DCGL_W/\sigma$.

☞	Adjust the LBGR to provide a value for Δ/σ between one and three.

The final step in determining the number of data points is to obtain the appropriate value from Table 5.3 or Table 5.5. Table 5.3 provides the number of data points for each survey unit and each reference area when the contaminant is present in background (N/2). Table 5.5 provides the number of data points for each survey unit when the contaminant is not present in background (N).

Select Instrumentation (Section 4.7, Section 6.5.3, Section 7.5, Section 7.7, Appendix H)

Instrumentation or measurement techniques should be selected based on detection sensitivity to provide technically defensible results that meet the objectives of the survey. Because of the uncertainty associated with interpreting scanning results, the detection sensitivity of the selected instruments should be as far below the DCGL as possible. For direct measurements and sample analyses, minimum detectable concentrations (MDCs) less than 10% of the DCGL are preferable while MDCs up to 50% of the DCGL are acceptable.

☞	Estimates of the MDC that minimize potential decision errors should be used for planning surveys.

Develop an Integrated Survey Design (Section 5.5.3)

The integrated survey design combines scanning surveys with direct measurements and sampling. The level of survey effort is determined by the potential for contamination as indicated by the survey unit classification. This is illustrated in Figure 4. Class 3 survey units receive judgmental scanning and randomly located measurements. Class 2 survey units receive scanning over a portion of the survey unit based on the potential for contamination combined with direct measurements and sampling performed on a systematic grid. Class 1 survey units receive scanning over 100% of the survey unit combined with direct measurements and sampling performed on a systematic grid. The grid spacing is adjusted to account for the scan MDC (Section 5.5.2.4).

Table 2 provides a summary of the recommended survey coverage for structures and land areas. Modifications to the example survey designs may be required to account for other contaminated media (*e.g.*, ground water, subsurface soil).

Implementation Phase

The objectives outlined in the QAPP are incorporated into Standard Operating Procedures (SOPs). The final status survey design is carried out in accordance with the SOPs and the QAPP resulting in the generation of raw data. Chapter 6, Chapter 7, and Appendix H provide information on measurement techniques.

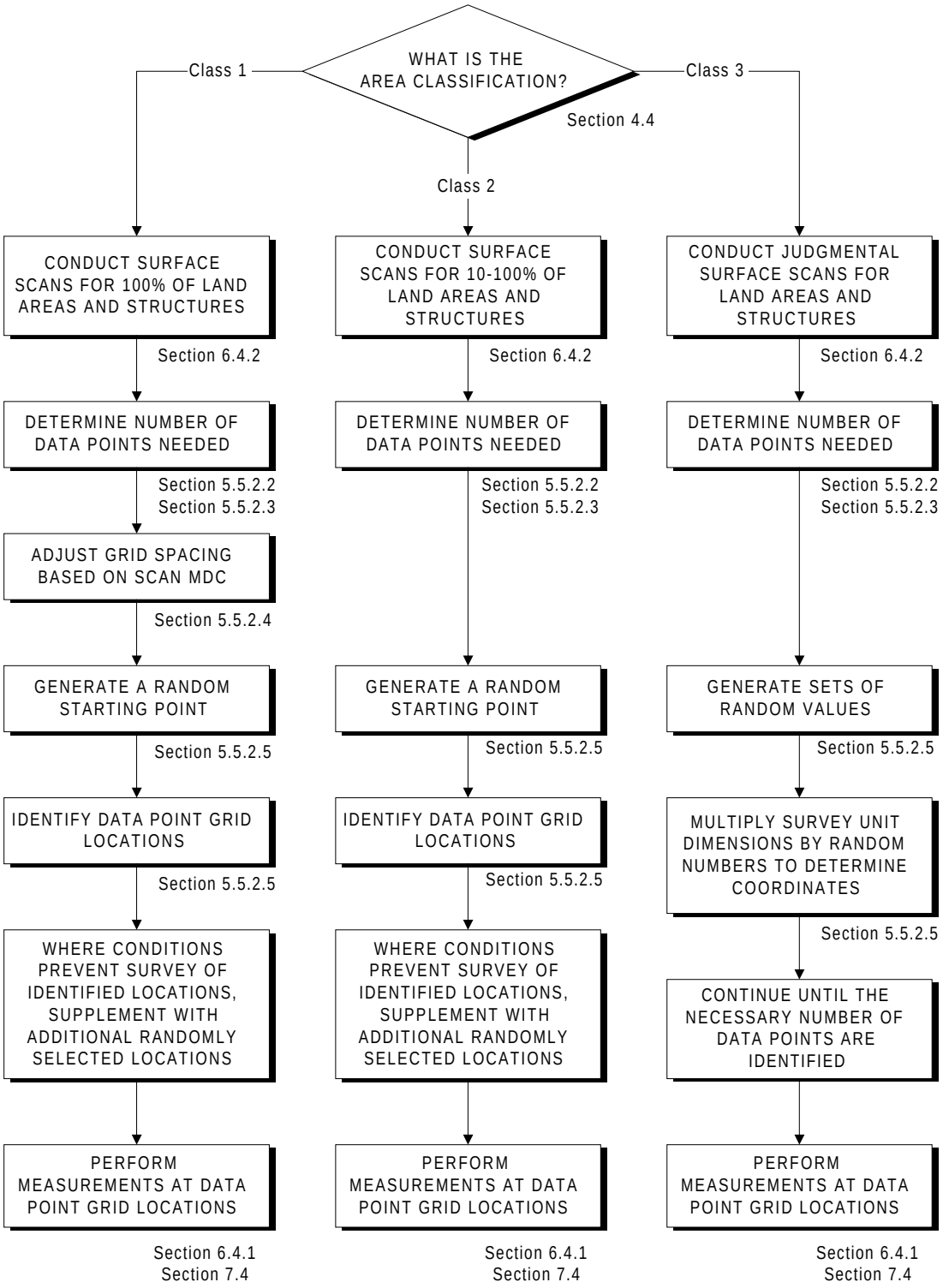

Figure 4 Flow Diagram for Developing an Integrated Survey Design

Table 2 Recommended Survey Coverage for Structures and Land Areas

Area Classification	Structures		Land Areas	
	Surface Scans	Surface Activity Measurements	Surface Scans	Surface Soil Measurements
Class 1	100%	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3); additional direct measurements and samples may be necessary for small areas of elevated activity (Section 5.5.2.4)	100%	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3); additional direct measurements and samples may be necessary for small areas of elevated activity (Section 5.5.2.4)
Class 2	10 to 100% (10 to 50% for upper walls and ceilings) Systematic and Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)	10 to 100% Systematic and Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)
Class 3	Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)	Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)

Assessment Phase

The assessment phase of the Data Life Cycle includes verification and validation of the survey results combined with an assessment of the quantity and quality of the data. As previously stated, both the average level of contamination in the survey unit and the distribution of the contamination within the survey unit are considered during area classification. For this reason, the assessment phase includes a graphical review of the data to provide a visual representation of the radionuclide distribution, an appropriate statistical test to demonstrate compliance for the average concentration of a uniformly distributed radionuclide, and the elevated measurement comparison (EMC) to demonstrate compliance for small areas of elevated activity.

The survey data are verified to ensure that SOPs specified in the survey design were followed and that the measurement systems were performed in accordance with the criteria specified in the QAPP (Section 9.3.1). The data are validated to ensure that the results support the objectives of the survey, as documented in the QAPP, or permit a determination that these objectives should

be modified (Section 9.3.2). The Data Quality Assessment (DQA) process is then applied using the verified and validated data to determine if the quality of the data satisfies the data user's needs. DQA is described in Appendix E and is applied in Chapter 8.

The first step in DQA is to review the DQOs and survey design to ensure that they are still applicable. For example, if the data suggest that a survey unit is misclassified, the DQOs and survey design would be modified for the new classification.

The next step is to conduct a preliminary data review to learn about the structure of the data and to identify patterns, relationships, or potential anomalies. This review should include calculating basic statistical quantities (*i.e.*, mean, standard deviation, median) and graphically presenting the data using at least a histogram and a posting plot. The results of the preliminary data review are also used to verify the assumptions of the tests. Some of the assumptions and possible methods for assessing them are summarized in Table 3. Information on diagnostic tests is provided in Section 8.2 and Appendix I.

Table 3 Methods for Checking the Assumptions of Statistical Tests

Assumption	Diagnostic
Spatial Independence	Posting Plot (Figure 8.1)
Symmetry	Histogram (Figure 8.2) Quantile Plot (Figure I.2)
Data Variance	Sample Standard Deviation (Section 8.2)
Power is Adequate	Retrospective Power Chart (Sign Test, Figure I.5) (WRS Test, Figure I.6)

The final step in interpreting the data is to draw conclusions from the data. Table 4 summarizes the statistical tests recommended in MARSSIM. Section 8.3 provides guidance on performing the Sign test when the contaminant is not present in background. Section 8.4 provides guidance on performing the Wilcoxon Rank Sum (WRS) test when the contaminant is present in background.

Table 4 Summary of Statistical Tests

Radionuclide not in background and radionuclide-specific measurements made:

Survey Result	Conclusion
All measurements less than $DCGL_W$	Survey unit meets release criterion
Average greater than $DCGL_W$	Survey unit does not meet release criterion
Any measurement greater than $DCGL_W$ and the average less than $DCGL_W$	Conduct Sign test and elevated measurement comparison

Radionuclide in background or radionuclide non-specific (gross) measurements made:

Survey Result	Conclusion
Difference between maximum survey unit measurement and minimum reference area measurements is less than $DCGL_W$	Survey unit meets release criterion
Difference of survey unit average and reference area average is greater than $DCGL_W$	Survey unit does not meet release criterion
Difference between any survey unit measurement and any reference area measurement greater than $DCGL_W$ and the difference of survey unit average and reference area average is less than $DCGL_W$	Conduct WRS test and elevated measurement comparison

Table 5 provides examples of final status survey investigation levels for each survey unit classification and type of measurement. For a Class 1 survey unit, measurements above the $DCGL_W$ are not necessarily unexpected. However, a measurement above the $DCGL_W$ at one of the discrete measurement locations might be considered unusual if it were much higher than all of the other discrete measurements. Thus, any discrete measurement that is above both the $DCGL_W$ and the statistical-based parameter for the measurements should be investigated further. Any measurement, either at a discrete location or from a scan, that is above the $DCGL_{EMC}$ should be flagged for further investigation.

In Class 2 or Class 3 areas, neither measurements above the $DCGL_W$ nor areas of elevated activity are expected. Any measurement at a discrete location exceeding the $DCGL_W$ in these areas should be flagged for further investigation. Because the survey design for Class 2 and Class 3 survey units is not driven by the EMC, the scanning MDC might exceed the $DCGL_W$. In this case, any indication of residual radioactivity during the scan would warrant further investigation.

Table 5 Summary of Investigation Levels

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement Result When:
Class 1	> $DCGL_{EMC}$ or > $DCGL_W$ and > a statistical-based parameter value	> $DCGL_{EMC}$
Class 2	> $DCGL_W$	> $DCGL_W$ or > MDC
Class 3	> fraction of $DCGL_W$	> $DCGL_W$ or > MDC

Because there is a low expectation for residual radioactivity in a Class 3 area, it may be prudent to investigate any measurement exceeding even a fraction of the $DCGL_W$. The level one chooses here depends on the site, the radionuclides of concern, and the measurement and scanning methods chosen. This level should be set using the DQO Process during the survey design phase of the Data Life Cycle. In some cases, the user may also decide to follow this procedure for Class 2 and even Class 1 survey units.

Both the measurements at discrete locations and the scans are subject to the EMC. The result of the EMC does not in itself lead to a conclusion as to whether the survey unit meets or exceeds the release criterion, but is a flag or trigger for further investigation. The investigation may involve taking further measurements in order to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion.[1] The investigation should also provide adequate assurance that there are no other undiscovered areas of elevated residual radioactivity in the survey unit that might result in a dose exceeding the release criterion. This could lead to a re-classification of all or part of a survey unit—that is, unless the results of the investigation indicate that reclassification is not necessary.

Decision Making Phase

A decision is made, in coordination with the responsible regulatory agency, based on the conclusions drawn from the assessment phase. The results of the EMC are used to demonstrate compliance with the dose- or risk-based regulation for small areas of elevated activity, while the nonparametric statistical tests are used to demonstrate that the average radionuclide concentration in the survey unit complies with the release criterion. The objective is to make technically defensible decisions with a specified level of confidence.

[1] Rather than, or in addition to, taking further measurements, the investigation may involve assessing the adequacy of the exposure pathway model used to obtain the DCGLs and area factors, and the consistency of the results obtained with the Historical Site Assessment and the scoping, characterization, and remedial action support surveys.

The EMC consists of comparing each measurement from the survey unit with the investigation levels in Table 5. The EMC is performed for measurements obtained from the systematic or random sample locations as well as locations flagged by scanning surveys. Any measurement from the survey unit that is equal to or greater than the investigation level indicates an area of relatively higher concentration and is investigated, regardless of the outcome of the nonparametric statistical tests.

☞ Any measurement from the survey unit that is equal to or greater than the investigation level indicates an area of relatively higher concentration and is investigated, regardless of the outcome of the nonparametric statistical tests.

The result of the Sign test or the WRS test is the decision to reject or not to reject the null hypothesis that the survey unit is contaminated above the $DCGL_W$. Provided that the results of any investigations triggered by the EMC have been resolved, a rejection of the null hypothesis leads to the decision that the survey unit meets the release criterion. If necessary, the amount of residual radioactivity in the survey unit can be estimated so that dose or risk calculations can be made. In most cases, the average concentration is the best estimate for the amount of residual radioactivity.

Summary

The roadmap presents a summary of the planning, implementation, assessment, and decision making phases for a final status survey and identifies where guidance on these phases is located in MARSSIM. Each step in the process is described briefly along with references to the sections of MARSSIM to which the user may refer for more detailed guidance. Flow charts are provided to summarize the major steps in the Radiation Survey and Site Investigation Process, again citing appropriate sections of MARSSIM. In addition to providing the user with basic guidance from MARSSIM, the roadmap also includes “rules of thumb” for performing compliance demonstration surveys.

1 INTRODUCTION

1.1 Purpose and Scope of MARSSIM

Radioactive materials have been produced, processed, used, and stored at thousands of sites throughout the United States. Many of these sites—ranging in size from Federal weapons-production facilities covering hundreds of square kilometers to the nuclear medicine departments of small hospitals—were at one time or are now radioactively contaminated.

The owners and managers of a number of sites would like to determine if these sites are contaminated, clean them up if contaminated, and release them for restricted use or for unrestricted public use. The Environmental Protection Agency (EPA), the Nuclear Regulatory Commission (NRC), and the Department of Energy (DOE) are responsible for the release of sites following cleanup. These responsibilities apply to facilities under the control of Federal agencies, such as the DOE and Department of Defense (DOD), and to sites licensed by the NRC and its Agreement States. Some States have responsibilities for similar sites under their control.

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) provides a nationally consistent consensus approach to conducting radiation surveys and investigations at potentially contaminated sites. This approach should be both scientifically rigorous and flexible enough to be applied to a diversity of site cleanup conditions. MARSSIM's title includes the term "survey" because it provides information on planning and conducting surveys, and includes the term "site investigation" because the process outlined in the manual allows one to begin by investigating any site (*i.e.*, by gathering data or information) that may involve radioactive contamination.

The decommissioning that follows remediation will normally require a demonstration to the responsible Federal or State agency that the cleanup effort was successful and that the release criterion (a specific regulatory limit) was met. In MARSSIM, this demonstration is given the name "final status survey." This manual assists site personnel or others in performing or assessing such a demonstration. (Generally, MARSSIM may serve to guide or monitor remediation efforts whether or not a release criterion is applied.)

As illustrated in Figure 1.1, the demonstration of compliance with respect to conducting surveys is comprised of three interrelated parts:

I. Translate: Translating the cleanup/release criterion (*e.g.*, mSv/y, mrem/y, specific risk) into a corresponding derived contaminant concentration level (*e.g.*, Bq/kg or pCi/g in soil) through the use of environmental pathway modeling.

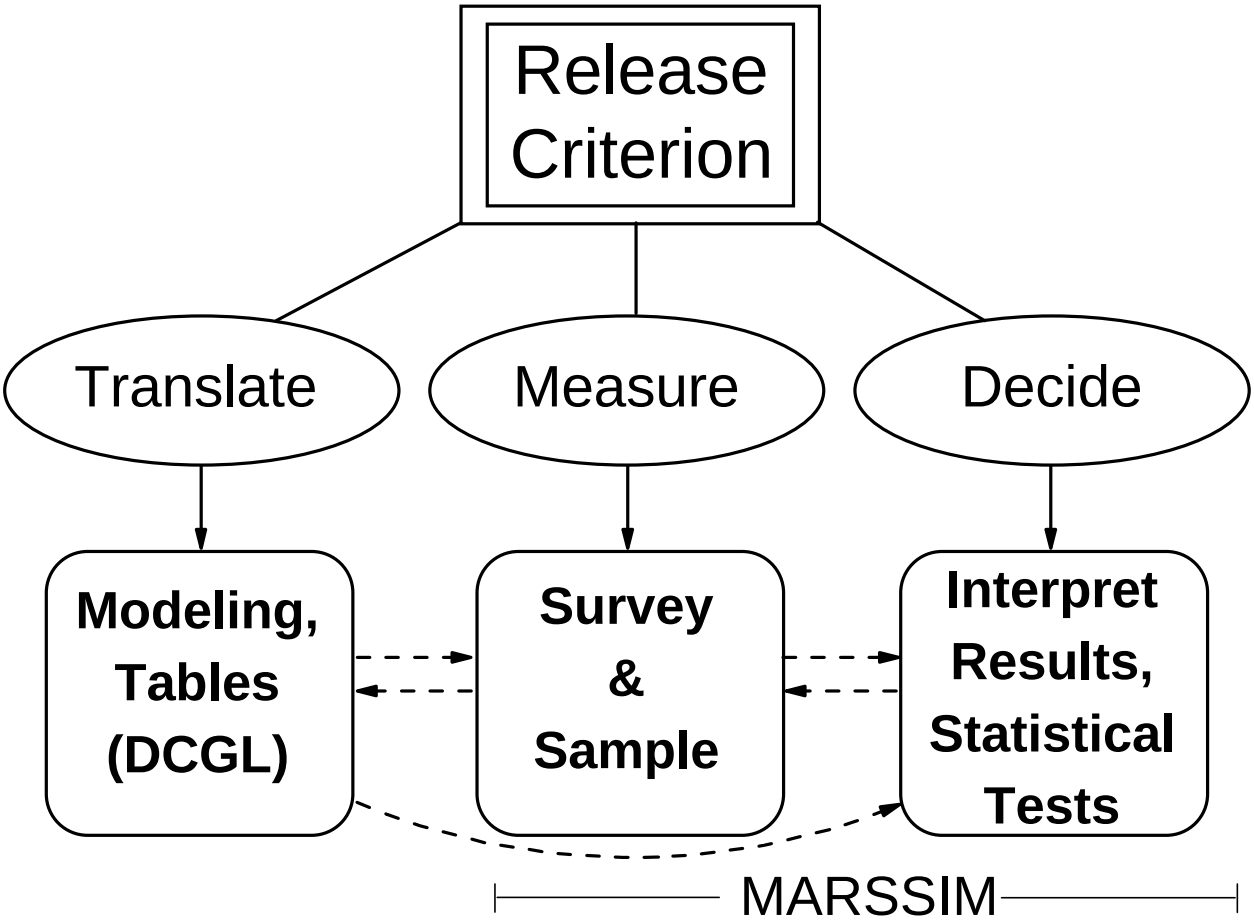

Figure 1.1 Compliance Demonstration

II. Measure: Acquiring scientifically sound and defensible site-specific data on the levels and distribution of residual contamination, as well as levels and distribution of radionuclides present as background, by employing suitable field and/or laboratory measurement techniques.[1]

III. Decide: Determining that the data obtained from sampling does support the assertion that the site meets the release criterion, within an acceptable degree of uncertainty, through application of a statistically based decision rule.

[1] Measurements include field and laboratory analyses, however, MARSSIM leaves detailed discussions of laboratory sample analyses to another manual (*i.e.*, a companion document, the Multi-Agency Radiation Laboratory Analytical Protocols (MARLAP) manual that is currently under development).

MARSSIM presents comprehensive guidance—specifically for II and III above—for contaminated soil and buildings. This guidance describes a performance-based approach for demonstrating compliance with a dose- or risk-based regulation. This approach includes processes that identify data quality needs and may reveal limitations that enter into conducting a survey. The data quality needs stated as Data Quality Objectives (DQOs) include performance measures and goals in relation to a specific intended use of the data (EPA 1997a).

DQOs must be developed on a site-specific basis. However, because of the large variability in the types of radiation sites, it is impossible to provide criteria that apply to every situation. As an example, MARSSIM presents a method for planning, implementing, assessing, and making decisions about regulatory compliance at sites with radioactive contaminants in surface soil and on building surfaces. In particular, MARSSIM describes generally acceptable approaches for:

- planning and designing scoping, characterization, remediation-support, and final status surveys for sites with surface soil and building surface contamination
- Historical Site Assessment (HSA)
- QA/QC in data acquisition and analysis
- conducting surveys
- field and laboratory methods and instrumentation, and interfacing with radiation laboratories
- statistical hypothesis testing, and the interpretation of statistical data
- documentation

Thus, MARSSIM provides standardized and consistent approaches for planning, conducting, evaluating, and documenting environmental radiological surveys, with a specific focus on the final status surveys that are carried out to demonstrate compliance with cleanup regulations. These approaches may not meet the DQOs at every site, so other methods may be used to meet site-specific DQOs, as long as an equivalent level of performance can be demonstrated.

Table 1.1, at the end of Chapter 1, summarizes the scope of MARSSIM. Several issues related to releasing sites are beyond the scope of MARSSIM. These include translation of dose or risk standards into radionuclide specific concentrations, or demonstrating compliance with ground water or surface water regulations. MARSSIM can be applied to surveys performed at vicinity properties—those not under government or licensee control—but the decision to apply the MARSSIM at vicinity properties is outside the scope of MARSSIM. Other contaminated media (*e.g.*, sub-surface soil, building materials, ground water) and the release of contaminated components and equipment are also not addressed by MARSSIM. With MARSSIM's main focus on final status surveys, this manual continues a process of following remediation activities that are intended to remove below-surface contaminants. Therefore, some of the reasons for limiting the scope of the guidance to contaminated surface soils and building surfaces include: 1) contamination is limited to these media for many sites following remediation, 2) since many

sites have surface soil and building surface contamination as the leading source of contamination, existing computer models used for calculating the concentrations based on dose or risk generally consider only surface soils or building surfaces as a source term, and 3) MARSSIM was written in support of cleanup rulemaking efforts for which supporting data are mostly limited to contaminated surface soil and building surfaces.

MARSSIM also recognizes that there may be other factors, such as cost or stakeholder concerns, that have an impact on designing surveys. Guidance on how to address these specific concerns is outside the scope of MARSSIM. Unique site-specific cases may arise that require a modified approach beyond what is presently described in MARSSIM. This includes examples such as: 1) the release of sites contaminated with naturally occurring radionuclides in which the concentrations corresponding to the release criteria are close to the variability of the background and 2) sites where a reference background cannot be established. However, the process of planning, implementing, assessing, and making decisions about a site described in MARSSIM is applicable to all sites, even if the examples in this manual do not meet a site's specific objectives.

Of MARSSIM's many topics, the Data Quality Objective (DQO) approach to data acquisition and analysis and the Data Quality Assessment (DQA) for determining that data meet stated objectives are two elements that are a consistent theme throughout the manual. The DQO Process and DQA approach, described in Chapter 2, present a method for building common sense and the scientific method into all aspects of designing and conducting surveys, and making best use of the obtainable information. This becomes a formal framework for systematizing the planning of data acquisition surveys so that the data sought yield the kind of information actually needed for making important decisions—such as whether or not to release a particular site following remediation.

1.2 Structure of the Manual

MARSSIM begins with the overview of the Radiation Survey and Site Investigation Process in Chapter 2—Figures 2.4 through 2.8 are flowcharts that summarize the steps and decisions taken in the process. Chapter 3 provides instructions for performing an Historical Site Assessment (HSA)—a detailed investigation to collect existing information on the site or facility and to develop a conceptual site model. The results of the HSA are used to plan surveys, perform measurements, and collect additional information at the site. Chapter 4 covers issues that arise in all types of surveys. Detailed information on performing specific types of surveys is included in Chapter 5. Guidance on selecting the appropriate instruments and measurement techniques for each type of measurement is in Chapters 6 and 7. Chapter 6 discusses direct measurements and scanning surveys, and Chapter 7 discusses sampling and sample preparation for laboratory measurements. The interpretation of survey results is described in Chapter 8. Chapter 9 provides guidance on data management, quality assurance (QA), and quality control (QC). Information on specific subjects related to radiation site investigation can be found in the appendices.

MARSSIM contains several appendices to provide additional guidance on specific topics. Appendix A presents an example of how to apply the MARSSIM guidance to a specific site. Appendix B describes a simplified procedure for compliance demonstration that may be applicable at certain types of sites. Appendix C summarizes the regulations and requirements associated with radiation surveys and site investigations for each of the agencies involved in the development of MARSSIM. Detailed guidance on the DQO Process is in Appendix D, and Appendix E has guidance on DQA. Appendix F describes the relationships among MARSSIM, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Resource Conservation and Recovery Act (RCRA). Sources of information used during site assessment are listed in Appendix G. Appendix H describes field survey and laboratory analysis equipment that may be used for radiation surveys and site investigations. Appendix I offers tables of statistical data and supporting information for interpreting survey results described in Chapter 8. The derivation of the alpha scanning detection limit calculations used in Chapter 6 is described in Appendix J. Comparison tables for QA documents are in Appendix K. Appendix L lists the regional radiation program managers for each of the agencies participating in the development of MARSSIM. Appendix M lists publications that serve as resources describing sampling methods. Information on data validation is provided in Appendix N.

MARSSIM is presented in a modular format, with each module containing guidance on conducting specific aspects of, or activities related to, the survey process. Followed in order, each module leads to the generation and implementation of a complete survey plan. Although this approach may involve some overlap and redundancy in information, it also allows many users to concentrate only on those portions of the manual that apply to their own particular needs or responsibilities. The procedures within each module are listed in order of performance and options are provided to guide a user past portions of the manual that may not be specifically applicable to the user's area of interest. Where appropriate, checklists condense and summarize major points in the process. The checklists may be used to verify that every suggested step is followed or to flag a condition in which specific documentation should explain why a step was not needed.

Also included in the manual is a section titled Roadmap. The roadmap is designed to be used with MARSSIM as a quick reference for users already familiar with the process of planning and performing radiation surveys. The roadmap gives the user basic guidance, rules of thumb, and references to sections in the manual containing detailed guidance.

MARSSIM, which is based on a graded approach, also contains a simplified procedure (see Appendix B) that many users of radioactive materials may—with the approval of the responsible regulatory agency—be able to employ to demonstrate compliance with the release criterion. Sites that may qualify for simplified release procedures are those in which the radioactive materials used were 1) of relatively short half-life (*e.g.*, $t_{1/2} \leq 120$ days) and have since decayed to insignificant quantities, 2) kept only in small enough quantities so as to be exempted or not

requiring a specific license from a regulatory authority, 3) used or stored only in the form of non-leaking sealed sources, or 4) combinations of the above.

1.3 Use of the Manual

Potential users of this manual are Federal, State, and local government agencies having authority for control of radioactive environmental contamination; their contractors; and other parties, such as organizations with licensed authority to possess and use radioactive materials. The manual is intended for a technical audience having knowledge of radiation health physics and an understanding of statistics as well as experience with the practical applications of radiation protection. An understanding of instrumentation and methodologies and expertise in planning, approving, and implementing surveys of environmental levels of radioactive material is assumed. This manual has been written so that individuals responsible for planning, approving, and implementing radiological surveys will be able to understand and apply the guidance provided here. Certain situations and sites may require consultation with more experienced personnel.

MARSSIM provides guidance for conducting radiation surveys and site investigations. MARSSIM uses the word "should" as a recommendation, that ought not be interpreted as a requirement. The reader need not expect that every recommendation in this manual will be taken literally and applied at every site. Rather, it is expected that the survey planning documentation will address how the guidance will be applied on a site-specific basis.

As previously stated, MARSSIM supports implementation of dose- or risk-based regulations. The translation of the regulatory dose limit to a corresponding concentration level is not addressed in MARSSIM, so the guidance in this manual is applicable to a broad range of regulations, including risk- or concentration-based regulations. The terms dose and dose-based regulation are used throughout the manual, but these terms are not intended to limit the use of the manual.

Note that Federal or State agencies that can approve a demonstration of compliance may support requirements that differ from what is presented in this version of MARSSIM . *It is essential*, therefore, *that the persons carrying out the surveys*, whether they are conducting surveys in accordance with the simplified approach of Appendix B or the full MARSSIM process, *remain in close communication with the proper Federal or State authorities throughout the compliance demonstration process*.

1.4 Missions of the Federal Agencies Producing MARSSIM

MARSSIM is the product of a multi-agency workgroup with representatives from EPA, NRC, DOE, and DOD. This section briefly describes the missions of the participating agencies. Regulations and requirements governing site investigations for each of the agencies associated with radiation surveys and site investigations are presented in Appendix C.

1.4.1 Environmental Protection Agency

The mission of the U.S. Environmental Protection Agency (EPA) is to improve and preserve the quality of the environment, on both national and global levels. The EPA's scope of responsibility includes implementing and enforcing environmental laws, setting guidelines, monitoring pollution, performing research, and promoting pollution prevention. EPA Headquarters maintains overall planning, coordination, and control of EPA programs, and EPA's ten regional offices are responsible for executing EPA's programs within the boundaries of each region. EPA also coordinates with, and supports research and development of, pollution control activities carried out by State and local governments.

1.4.2 Nuclear Regulatory Commission

The mission of the U.S. Nuclear Regulatory Commission (NRC) is to ensure adequate protection of public health and safety, the common defense and security, and the environment in the use of certain radioactive materials in the United States. The NRC's scope of responsibility includes regulation of commercial nuclear power reactors; non-power research, test, and training reactors; fuel cycle facilities; medical, academic, and industrial uses of nuclear materials; and the transport, storage, and disposal of nuclear materials and waste. The Energy Reorganization Act of 1974 and the Atomic Energy Act of 1954, as amended, provide the foundation for regulation of the Nation's commercial use of radioactive materials.

1.4.3 Department of Energy

The mission of the Department of Energy (DOE) is to develop and implement a coordinated national energy policy to ensure the availability of adequate energy supplies and to develop new energy sources for domestic and commercial use. In addition, DOE is responsible for the development, construction and testing of nuclear weapons for the U.S. Military. DOE is also responsible for managing the low- and high-level radioactive wastes generated by past nuclear weapons and research programs and for constructing and maintaining a repository for civilian radioactive wastes generated by the commercial nuclear reactors. DOE has the lead in decontaminating facilities and sites previously used in atomic energy programs.

1.4.4 Department of Defense

The global mission of the Department of Defense (DOD) is to provide for the defense of the United States. In doing this, DOD is committed to protecting the environment. Each military service has specific regulations addressing the use of radioactive sources and the development of occupational health programs and radiation protection programs. The documents describing these regulations are used as guidance in developing environmental radiological surveys within DOD and are discussed in Appendix C.

Table 1.1 Scope of MARSSIM

Within Scope of MARSSIM		Beyond Scope of MARSSIM	
Guidance	MARSSIM provides technical guidance on conducting radiation surveys and site investigations.	*Regulation*	MARSSIM does not set new regulations or non-technical issues (*e.g.*, legal or policy) for site cleanup. Release criterion will be provided rather than calculated using MARSSIM.
Tool Box	MARSSIM can be thought of as an extensive tool box with many components—some within the text of MARSSIM, others by reference.	*Tool Box*	Many topics are beyond the scope of MARSSIM, for example: -a public participation program -packaging and transportation of wastes for disposal -decontamination and stabilization techniques -training
Measurement	The guidance given in MARSSIM is performance-based and directed towards acquiring site-specific data.	*Procedure*	The approaches suggested in MARSSIM vary depending on the various site data needs—there are no set procedures for sample collection, measurement techniques, storage and disposal established in MARSSIM.
Modeling	The interface between environmental pathway modeling and MARSSIM is an important survey design consideration addressed in MARSSIM.	*Modeling*	Environmental pathway modeling and ecological endpoints in modeling are beyond the scope of MARSSIM.

Table 1.1 Scope of MARSSIM (continued)

Within Scope of MARSSIM		Beyond Scope of MARSSIM	
Soil and Buildings	The two main media of interest in MARSSIM are contaminated surface soil and building surfaces.	*Other Media*	MARSSIM does not cover other media, including construction materials, equipment, subsurface soil, surface or subsurface water, biota, air, sewers, sediments or volumetric contamination.
Final Status Survey	The focus of MARSSIM is on the final status survey as this is the deciding factor in judging if the site meets the release criterion.	*Materials or Equipment*	MARSSIM does not recommend the use of any specific materials or equipment—there is too much variability in the types of radiation sites—this information will be in other documents.
Radiation	MARSSIM only considers radiation-derived hazards.	*Chemicals*	MARSSIM does not deal with any hazards posed by chemical contamination.
Remediation Method	MARSSIM assists users in determining when sites are ready for a final status survey and provides guidance on how to determine if remediation was successful.	*Remediation Method*	MARSSIM does not discuss selection and evaluation of remedial alternatives, public involvement, legal considerations, policy decisions related to planning
DQO Process	MARSSIM presents a systemized approach for designing surveys to collect data needed for making decisions such as whether or not to release a site.	*DQO Process*	MARSSIM does not provide prescriptive or default values of DQOs.
DQA	MARSSIM provides a set of statistical tests for evaluating data and lists alternate tests that may be applicable at specific sites.	*DQA*	MARSSIM does not prescribe a statistical test for use at all sites.

2 OVERVIEW OF THE RADIATION SURVEY AND SITE INVESTIGATION PROCESS

2.1 Introduction

This chapter provides a brief overview of the Radiation Survey and Site Investigation (RSSI) Process, several important aspects of this Process, and its underlying principles. The concepts introduced here are discussed in detail throughout the manual.

The purpose of MARSSIM is to provide a standardized approach to demonstrating compliance with a dose- or risk-based regulation. Since most of the manual is based on general technical and statistical concepts, much of the guidance can still be applied to other types of regulations or standards. The purpose of this chapter is to provide the overview information required to understand the rest of this manual.

Section 2.2 introduces and defines key terms used throughout the manual. Some of these terms may be familiar to the MARSSIM user, while others are new terms developed specifically for this manual.

Section 2.3 describes the flow of information used to decide whether or not a site or facility complies with a regulation. The section describes the framework that is used to demonstrate compliance with a regulation, and is the basis for all guidance presented in this manual. The decision-making process is broken down into four phases: 1) planning, 2) implementation, 3) assessment, and 4) decision making.

Section 2.4 introduces the Radiation Survey and Site Investigation Process, which can be used for compliance demonstration at many sites. The section describes a series of surveys that combine to form the core of this process. Each survey has specified goals and objectives to support a final decision on whether or not a site or facility complies with the appropriate regulations. Flow diagrams showing how the different surveys support the overall process are provided, along with descriptions of the information provided by each type of survey.

Section 2.5 presents major considerations that relate to the decision-making and survey-design processes. This section, as well as the examples discussed in detail throughout the manual, focuses on residual radioactive contamination in surface soils and on building surfaces. Recommended survey designs for demonstrating compliance are presented along with the rationale for selecting these designs.

Section 2.6 recognizes that the methods presented in MARSSIM may not represent the optimal survey design at all sites. Some alternate methods for applying the Radiation Survey and Site Investigation process are discussed. Different methods for demonstrating compliance that are technically defensible may be developed with the approval of the responsible regulatory agency.

MARSSIM provides an approach that is technically defensible and flexible enough to be applied to a variety of site-specific conditions. Applying this guidance to a dose- or risk-based regulation provides a consistent approach to protecting human health and the environment. The manual's performance-based approach to decision making provides the flexibility needed to address compliance demonstration at individual sites.

2.2 Understanding Key MARSSIM Terminology

The first step in understanding the Radiation Survey and Site Investigation (RSSI) Process is accomplished by understanding the scope of this manual, the terminology, and the concepts set forth. Some of the terms used in MARSSIM were developed for the purposes of this manual, while other commonly used terms are also adopted for use in MARSSIM. This section explains some of the terms roughly in the order of their presentation in the manual.

The process described in MARSSIM begins with the premise that a release criterion has already been provided in terms of a measurement quantity. The methods presented in MARSSIM are generally applicable and are not dependent on the value of the release criterion.

A *release criterion* is a regulatory limit expressed in terms of dose (mSv/y or mrem/y) or risk (cancer incidence or cancer mortality). The terms release limit or cleanup standard are also used to describe this term. A release criterion is typically based on the total effective dose equivalent (TEDE), the committed effective dose equivalent (CEDE), risk of cancer incidence (morbidity), or risk of cancer death (mortality) and generally cannot be measured directly. *Exposure pathway modeling* is used to calculate a radionuclide-specific predicted concentration or surface area concentration of specific nuclides that could result in a dose (TEDE or CEDE) or specific risk equal to the release criterion. In this manual, such a concentration is termed the *derived concentration guideline level (DCGL)*. Exposure pathway modeling is an analysis of various exposure pathways and scenarios used to convert dose or risk into concentration. In many cases DCGLs can be obtained from responsible regulatory agency guidance based on default modeling input parameters, while other users may elect to take into account site-specific parameters to determine DCGLs. In general, the units for the DCGL are the same as the units for measurements performed to demonstrate compliance (*e.g.*, Bq/kg or pCi/g, Bq/m^2 or dpm/100 cm^2). This allows direct comparisons between the survey results and the DCGL. A discussion of the uncertainty associated with using DCGLs to demonstrate compliance is included in Appendix D, Section D.6.

An *investigation level* is a radionuclide-specific level based on the release criterion that, if exceeded, triggers some response such as further investigation or remediation. An investigation level may be used early in decommissioning to identify areas requiring further investigation, and may also be used as a screening tool during compliance demonstration to identify potential problem areas. A DCGL is an example of a specific investigation level.

While the derivation of DCGLs is outside the scope of MARSSIM, it is important to understand the assumptions that underlie this derivation. The derivation assumptions must be consistent with those used for planning a compliance demonstration survey. One of the most important assumptions used for converting a dose or risk limit into a media-specific concentration is the modeled area of contamination. Other considerations include sample depth, composition, modeling parameters, and exposure scenarios. MARSSIM defines two potential DCGLs based on the area of contamination.

- If the residual radioactivity is evenly distributed over a large area, MARSSIM looks at the average activity over the entire area. The $DCGL_W$[1] (the DCGL used for the statistical tests, see Section 2.5.1.2) is derived based on an average concentration over a large area.

- If the residual radioactivity appears as small areas of elevated activity[2] within a larger area, typically smaller than the area between measurement locations, MARSSIM considers the results of individual measurements. The $DCGL_{EMC}$ (the DCGL used for the elevated measurement comparison (EMC), see Section 2.5.3 and Section 2.5.4) is derived separately for these small areas and generally from different exposure assumptions than those used for larger areas.

A *site* is any installation, facility, or discrete, physically separate parcel of land, or any building or structure or portion thereof, that is being considered for survey and investigation.

Area is a very general term that refers to any portion of a site, up to and including the entire site.

Decommissioning is the process of safely removing a site from service, reducing residual radioactivity through remediation to a level that permits release of the property, and termination of the license or other authorization for site operation. Although only part of the process, the term decommissioning is used in this sense for the Radiation Survey and Site Investigation (RSSI) Process, and is used this way throughout MARSSIM.

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[1] The "W" in $DCGL_W$ stands for Wilcoxon Rank Sum test, which is the statistical test recommended in MARSSIM for demonstrating compliance when the contaminant is present in background. The Sign test recommended for demonstrating compliance when the contaminant is not present in background also uses the $DCGL_W$.

[2] A small area of elevated activity, or maximum point estimate of contamination, might also be referred to as a "hot spot." This term has been purposefully omitted from MARSSIM because the term often has different meanings based on operational or local program concerns. As a result, there may be problems associated with defining the term and reeducating MARSSIM users in the proper use of the term. Because these implications are inconsistent with MARSSIM concepts, the term is not used.

A *survey unit* is a physical area consisting of structure or land areas of specified size and shape for which a separate decision will be made as to whether or not that area exceeds the release criterion. This decision is made as a result of the *final status survey*—the survey in the RSSI Process used to demonstrate compliance with the regulation or standard. The size and shape of the survey unit are based on factors, such as the potential for contamination, the expected distribution of contamination, and any physical boundaries (*e.g.*, buildings, fences, soil type, surface water body) at the site.

For MARSSIM, *measurement* is used interchangeably to mean: 1) the act of using a detector to determine the level or quantity of radioactivity on a surface or in a sample of material removed from a media being evaluated, or 2) the quantity obtained by the act of measuring. *Direct measurements* are obtained by placing a detector near the media being surveyed and inferring the radioactivity level directly from the detector response. *Scanning* is a measurement technique performed by moving a portable radiation detector at a constant speed above a surface to semi-quantitatively detect areas of elevated activity. *Sampling* is the process of collecting a portion of an environmental medium as being representative of the locally remaining medium. The collected portion, or aliquot, of the medium is then analyzed to identify the contaminant and determine the concentration. The word sample may also refer to a set of individual measurements drawn from a population whose properties are studied to gain information about the entire population. This second definition of sample is primarily used for statistical discussions.

To make the best use of resources for decommissioning, MARSSIM places greater survey efforts on areas that have, or had, the highest potential for contamination. This is referred to as a *graded approach*. The final status survey uses statistical tests to support decision making. These statistical tests are performed using survey data from areas with common characteristics, such as contamination potential, which are distinguishable from other areas with different characteristics. *Classification* is the process by which an area or survey unit is described according to radiological characteristics. The significance of survey unit classification is that this process determines the final status survey design and the procedures used to develop this design. Preliminary area classifications, made earlier in the MARSSIM Process, are useful for planning subsequent surveys.

Areas that have no reasonable potential for residual contamination are classified as *non-impacted areas*. These areas have no radiological impact from site operations and are typically identified early in decommissioning. Areas with reasonable potential for residual contamination are classified as *impacted areas*.

Impacted areas are further divided into one of three classifications:

- *Class 1 Areas*: Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiation surveys) above the $DCGL_W$. Examples of Class 1 areas include: 1) site areas previously subjected to remedial actions[3], 2) locations where leaks or spills are known to have occurred, 3) former burial or disposal sites, 4) waste storage sites, and 5) areas with contaminants in discrete solid pieces of material and high specific activity.

- *Class 2 Areas*: Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$. To justify changing the classification from Class 1 to Class 2, there should be measurement data that provides a high degree of confidence that no individual measurement would exceed the $DCGL_W$. Other justifications for reclassifying an area as Class 2 may be appropriate, based on site-specific considerations. Examples of areas that might be classified as Class 2 for the final status survey include: 1) locations where radioactive materials were present in an unsealed form, 2) potentially contaminated transport routes, 3) areas downwind from stack release points, 4) upper walls and ceilings of buildings or rooms subjected to airborne radioactivity, 5) areas handling low concentrations of radioactive materials, and 6) areas on the perimeter of former contamination control areas.

- *Class 3 Areas*: Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$, based on site operating history and previous radiation surveys. Examples of areas that might be classified as Class 3 include buffer zones around Class 1 or Class 2 areas, and areas with very low potential for residual contamination but insufficient information to justify a non-impacted classification.

Class 1 areas have the greatest potential for contamination and therefore receive the highest degree of survey effort for the final status survey using a graded approach, followed by Class 2, and then by Class 3. Non-impacted areas do not receive any level of survey coverage because they have no potential for residual contamination. Non-impacted areas are determined on a site-specific basis. Examples of areas that would be non-impacted rather than impacted usually include residential or other buildings that have or had nothing more than smoke detectors or exit signs with sealed radioactive sources.

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[3] Remediated areas are identified as Class 1 areas because the remediation process often results in less than 100% removal of the contamination, even though the goal of remediation is to comply with regulatory standards and protect human health and the environment. The contamination that remains on the site after remediation is often associated with relatively small areas with elevated levels of residual radioactivity. This results in a non-uniform distribution of the radionuclide and a Class 1 classification. If an area is expected to have no potential to exceed the $DCGL_W$ and was remediated to demonstrate the residual radioactivity is as low as reasonably achievable (ALARA), the remediated area might be classified as Class 2 for the final status survey.

If the radionuclide of potential concern is present in background, or if the measurement system used to determine concentration in the survey unit is not radionuclide-specific, background measurements are compared to the survey unit measurements to determine the level of residual radioactivity. The *background reference area* is a geographical area from which representative reference measurements are performed for comparison with measurements performed in specific survey units. The background reference area is defined as an area that has similar physical, chemical, radiological, and biological characteristics as the survey unit(s) being investigated but has not been contaminated by site activities (*i.e.*, non-impacted).

The process of planning the survey, implementing the survey plan, and assessing the survey results prior to making a decision is called the *Data Life Cycle*. Survey planning uses the *Data Quality Objectives (DQO) Process* to ensure that the survey results are of sufficient quality and quantity to support the final decision. *Quality Assurance and Quality Control (QA/QC)* procedures are performed during implementation of the survey plan to collect information necessary to evaluate the survey results. *Data Quality Assessment* (DQA) is the process of assessing the survey results, determining that the quality of the data satisfies the objectives of the survey, and interpreting the survey results as they apply to the decision being made.

A systematic process and structure for quality should be established to provide confidence in the quality and quantity of data collected to support decision making. The data used in decision making should be supported by a planning document that records how quality assurance and quality control are applied to obtain type and quality of results that are needed and expected. There are several terms used to describe a variety of planning documents, some of which document only a small part of the survey design process. MARRSIM uses the term *Quality Assurance Project Plan* (QAPP) to describe a single document that incorporates all of the elements of the survey design. This term is consistent with consensus guidance ANSI/ASQC E4-1994 (ASQC 1995) and EPA guidance (EPA 1994c; EPA 1997a), and is recommended to promote consistency. The use of the term QAPP in MARSSIM does not exclude the use of other terms (*e.g.*, Decommissioning Plan, Sampling and Analysis Plan, Field Sampling Plan) to describe survey documentation provided the information included in the documentation supports the objectives of the survey.

2.3 Making Decisions Based on Survey Results

Compliance demonstration is simply a decision as to whether or not a survey unit meets the release criterion. For most sites this decision is based on the results of one or more surveys. When survey results are used to support a decision, the decision maker[4] needs to ensure that the

[4] The term decision maker is used throughout this section to describe the person, team, board, or committee responsible for the final decision regarding disposition of the survey unit.

data will support that decision with satisfactory confidence. Usually a decision maker will make a correct decision after evaluating the data. However, since uncertainty in the survey results is unavoidable, the possibility of errors in decisions supported by survey results is unavoidable. For this reason, positive actions must be taken to manage the uncertainty in the survey results so that sound, defensible decisions may be made. These actions include proper survey planning to control known causes of uncertainty, proper application of quality control (QC) procedures during implementation of the survey plan to detect and control significant sources of error , and careful analysis of uncertainty before the data are used to support decision making. These actions describe the flow of data throughout each type of survey, and are combined in the Data Life Cycle as shown in Figure 2.1.

There are four phases of the Data Life Cycle:

- *Planning Phase*. The survey design is developed and documented using the Data Quality Objectives (DQO) Process. Quality assurance and quality control (QA/QC) procedures are developed and documented in the Quality Assurance Project Plan (QAPP). The QAPP is the principal product of the planning process which incorporates the DQOs as it integrates all technical and quality aspects for the life cycle of the project, including planning, implementation, and assessment. The QAPP documents planning results for survey operations and provides a specific format for obtaining the type and quality of data needed for decision making. The QAPP elements are presented in an order corresponding to the Data Life Cycle by grouping them into two types of elements: 1) project management; and 2) collection and evaluation of environmental data (ASQC 1995). The DQO process is described in Appendix D, and applied in Chapters 3, 4, and 5 of this manual. Development of the QAPP is described in Section 9.2 and applied throughout decommissioning.

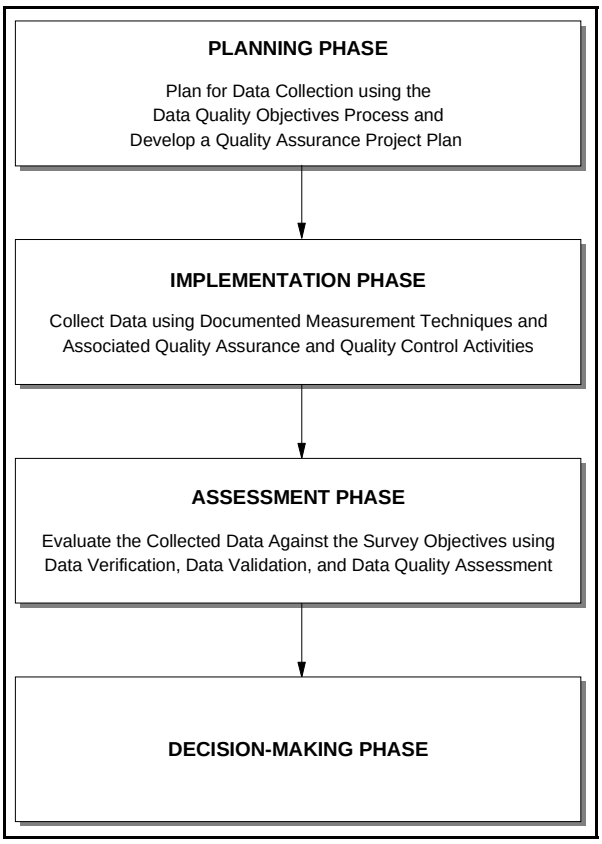


Figure 2.1 The Data Life Cycle

- *Implementation Phase*. The survey design is carried out in accordance with the SOPs and QAPP, resulting in the generation of raw data. Chapter 6, Chapter 7, and Appendix H provide information on the selection of data collection techniques. The QA and QC measurements, discussed in Chapter 6 and Chapter 7, also generate data and other important information that will be used during the Assessment Phase.

- *Assessment Phase*. The data generated during the Implementation Phase are first verified to ensure that the SOPs specified in the QAPP were actually followed and that the measurement systems performed in accordance with the criteria specified in the QAPP. Then the data are validated to ensure that the results of data collection activities support the objectives of the survey as documented in the QAPP, or permit a determination that these objectives should be modified. The data quality assessment (DQA) process is then applied using the validated data to determine if the quality of the data satisfies the data user's needs. Data verification and validation are described in Section 9.3. The DQA process is described in Appendix E and is applied in Chapter 8.

- *Decision-Making Phase*. A decision is made, in coordination with the responsible regulatory agency, based on the conclusions drawn from the assessment process. The ultimate objective is to make technically defensible decisions with a specified level of confidence (Chapter 8).

2.3.1 Planning Effective Surveys—Planning Phase

The first step in designing effective surveys is planning. The DQO Process is a series of planning steps based on the scientific method for establishing criteria for data quality and developing survey designs (ASQC 1995, EPA 1994a, EPA 1987b, EPA 1987c). Planning radiation surveys using the DQO Process improves the survey effectiveness and efficiency, and thereby the defensibility of decisions. This minimizes expenditures related to data collection by eliminating unnecessary, duplicative, or overly precise data. Using the DQO Process ensures that the type, quantity, and quality of environmental data used in decision making will be appropriate for the intended application. MARSSIM supports the use of the DQO Process to design surveys for input to both evaluation techniques (elevated measurement comparison and the statistical test). The DQO Process provides systematic procedures for defining the criteria that the survey design should satisfy, including what type of measurements to perform, when and where to perform measurements, the level of decision errors for the survey, and how many measurements to perform.

The level of effort associated with planning a survey is based on the complexity of the survey. Large, complicated sites generally receive a significant amount of effort during the planning phase, while smaller sites may not require as much planning. This graded approach defines data quality requirements according to the type of survey being designed, the risk of making a

decision error based on the data collected, and the consequences of making such an error. This approach provides a more effective survey design combined with a basis for judging the usability of the data collected.

DQOs are qualitative and quantitative statements derived from the outputs of the DQO Process that:

- clarify the study objective
- define the most appropriate type of data to collect
- determine the most appropriate conditions for collecting the data
- specify limits on decision errors which will be used as the basis for establishing the quantity and quality of data needed to support the decision

The DQO Process consists of seven steps, as shown in Figure 2.2. Each step is discussed in detail in Appendix D. While all of the outputs of the DQO Process are important for designing efficient surveys, there are some that are referred to throughout the manual. These DQOs are mentioned briefly here, and are discussed in detail throughout MARSSIM and in Appendix D.

The minimum information (outputs) required from the DQO Process to proceed with the methods described in MARSSIM are:

- classify and specify boundaries of survey units: this can be accomplished at any time, but must be finalized during final status survey planning (Section 4.4, Section 4.6)
- state the null hypothesis (H_0): the residual radioactivity in the survey unit exceeds the release criterion (Section 2.5, Appendix D, Section D.6)
- specify a gray region where the consequences of decision errors are relatively minor: the upper bound of the gray region is defined as the $DCGL_W$, and the lower bound of the gray region (LBGR) is a site-specific variable generally initially selected to equal one half the $DCGL_W$ and adjusted to provide an acceptable value for the relative shift (Section 5.5.2.2, Section 5.5.2.3, Appendix D, Section D.6)
- define Type I and Type II decision errors and assign probability limits for the occurrence of these errors: the probability of making a Type I decision error (α) or a Type II decision error (β) are site-specific variables (Section 5.5.2.2, Section 5.5.2.3, Appendix D, Section D.6)
- estimate the standard deviation of the measurements in the survey unit: the standard deviation (σ) is a site-specific variable, typically estimated from preliminary survey data (Section 5.5.2.2, Section 5.5.2.3)
- specify the relative shift: the shift (Δ) is equal to the width of the gray region ($DCGL_W$ - LBGR), and the relative shift is defined as Δ/σ, which is generally designed to have a value between one and three (Section 5.5.2.2, Section 5.5.2.3)

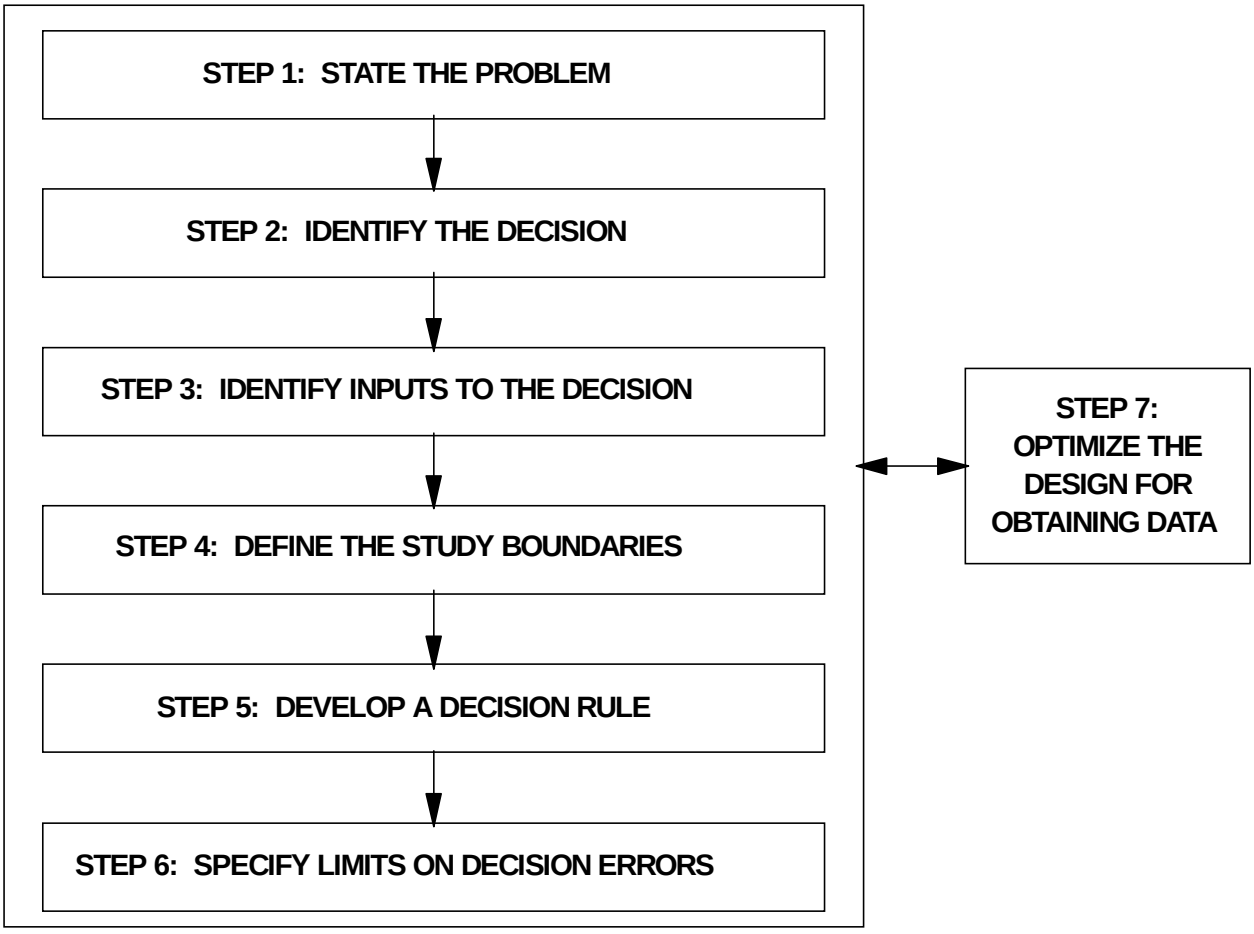


Figure 2.2 The Data Quality Objectives Process

- specify the detection limit for all measurement techniques (scanning, direct measurement, and sample analysis) specified in the QAPP: the minimum detectable concentration (MDC) is unique for each measurement system (Section 6.7)
- calculate the estimated number of measurements (N) and specify the measurement locations required to demonstrate compliance: the number of measurements depends on the relative shift (Δ/σ), Type I and Type II decision error rates (α and β), the potential for small areas of elevated activity, and the selection and classification of survey units (Section 5.5.2.2, Section 5.5.2.3)
- specify the documentation requirements for the survey, including survey planning documentation: documentation supporting the decision on whether or not the site complies with the release criterion is determined on a site-specific basis (Appendix N, Section N.2)

In addition to DQOs, values for the Data Quality Indicators (DQIs) should also be established and recorded during the planning stage. Where DQOs include performance measures and goals in relation to a specific intended use of the data, DQIs quantify the amount of error in the data collection process and the analytical measurement system regardless of how the data may be used (EPA 1997a). Precision, bias, accuracy, representativeness, comparability, and completeness are the DQIs recommended for quantifying the amount of error for survey data. These DQIs are discussed in detail in Appendix N, Section N.6.

2.3.2 Estimating the Uncertainty in Survey Results—Implementation Phase

To encourage flexibility and the use of optimal measurement techniques for a specific site, MARSSIM does not provide detailed guidance on specific techniques. Instead, MARSSIM encourages the decision maker to evaluate available techniques based on the survey objectives. Guidance on evaluating these objectives, such as detection limit, is provided.

QC programs can both lower the chances of making an incorrect decision and help the data user understand the level of uncertainty that surrounds the decision (EPA 1997a). As discussed previously, QC data are collected and analyzed during implementation to provide an estimate of the uncertainty associated with the survey results. QC measurements (scans, direct measurements, and samples) are technical activities performed to measure the attributes and performance of the survey. During any survey, a certain number of measurements should be taken for QC purposes.

2.3.3 Interpreting Survey Results—Assessment Phase

Assessment of environmental data is used to evaluate whether the data meet the objectives of the survey and whether the data are sufficient to determine compliance with the DCGL (EPA 1992a, EPA 1992b, EPA 1996a). The assessment phase of the Data Life Cycle consists of three phases: data verification, data validation, and Data Quality Assessment (DQA).

Data verification is used to ensure that the requirements stated in the planning documents are implemented as prescribed (see Section 9.3). Data validation is used to ensure that the results of the data collection activities support the objectives of the survey as documented in the QAPP, or permit a determination that these objectives should be modified (see Section 9.3 and Appendix N). Data quality assessment (DQA) is the scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support their intended use (EPA 1996a). DQA helps complete the Data Life Cycle by providing the assessment needed to determine that the planning objectives are achieved (see Section 8.2). Figure 2.3 illustrates where data verification, data validation, and DQA fit into the Assessment Phase of the Data Life Cycle.

There are five steps in the DQA Process:

- Review the DQOs and Survey Design
- Conduct a Preliminary Data Review
- Select the Statistical Test
- Verify the Assumptions of the Statistical Test
- Draw Conclusions from the Data

The strength of DQA is its design that progresses in a logical and efficient manner to promote an understanding of how well the data meet the intended use. The Assessment Phase is described in more detail in Appendix E. Section 2.6 discusses the flexibility of the Data Life Cycle and describes the use of survey designs other than those described later in MARSSIM.

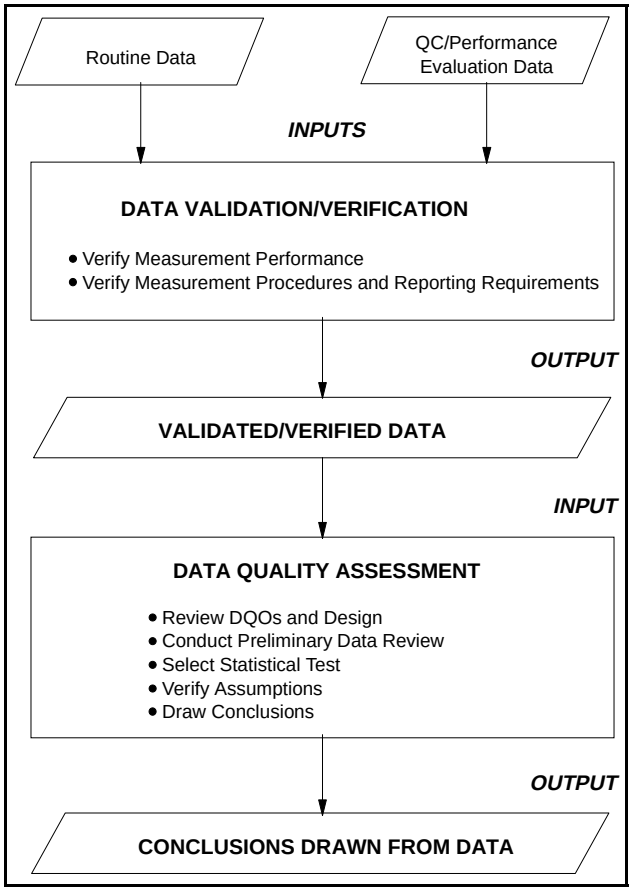


Figure 2.3 The Assessment Phase of the Data Life Cycle (EPA 1996a)

2.3.4 Uncertainty in Survey Results

Uncertainty in survey results arises primarily from two sources: survey design errors and measurement errors. Survey design errors occur when the survey design is unable to capture the complete extent of variability that exists for the radionuclide distribution in a survey unit. Since it is impossible in every situation to measure the residual radioactivity at every point in space and time, the survey results will be incomplete to some degree. It is also impossible to know with complete certainty the residual radioactivity at locations that were not measured, so the incomplete survey results give rise to uncertainty. The greater the natural or inherent variation in residual radioactivity, the greater the uncertainty associated with a decision based on the survey results. The unanswered question is: "How well do the survey results represent the true level of residual radioactivity in the survey unit?"

Measurement errors create uncertainty by masking the true level of residual radioactivity and may be classified as random or systematic errors. Random errors affect the precision of the measurement system, and show up as variations among repeated measurements. Systematic errors show up as measurements that are biased to give results that are consistently higher or lower than the true value. Measurement uncertainty is discussed in Section 6.8.

MARSSIM uses the Data Life Cycle to control and estimate the uncertainty in the survey results on which decisions are made. Adequate planning should minimize known sources of uncertainty. QC data collected during implementation of the survey plan provide an estimate of the uncertainty. Statistical hypothesis testing during the assessment phase provides a level of confidence for the final decision. There are several levels of decisions included within each survey type. Some decisions are quantitative, based on the numerical results of measurements performed during the survey. Other decisions are qualitative based on the available evidence and best professional judgment. The Data Life Cycle can and should be applied consistently to both types of decisions.

2.3.5 Reporting Survey Results

The process of reporting survey results is an important consideration in planning the survey. Again, the level of effort for reporting should be based on the complexity of the survey. A simple survey with relatively few results may specify a single report, while a more complicated survey may specify several reports to meet the objectives of the survey. Reporting requirements for individual surveys should be developed during planning and clearly documented in the QAPP. These requirements should be developed with cooperation from the people performing the analyses (*e.g.*, the analytical laboratory should be consulted on reporting results for samples). The Health Physics Society has developed several suggestions for reporting survey results (EPA 1980c). These suggestions include:

- Report the actual result of the analysis. Do not report data as "less than the detection limit." Even negative results and results with large uncertainties can be used in the statistical tests to demonstrate compliance. Results reported only as "<MDC" cannot be fully used and, for example, complicate even such simple analyses as calculating an average. While the nonparametric tests described in Section 8.3 and Section 8.4 can accommodate as much as 40% of the results as non-detects, it is better to report the actual results and avoid the possibility of exceeding this limit.

- Report results using the correct units and the correct number of significant digits. The choice of reporting results using SI units (*e.g.*, Bq/kg, Bq/m^2) or conventional units (*e.g.*, pCi/g, dpm/100 cm^2) is made on a site-specific basis. Generally, MARSSIM recommends that all results be reported in the same units as the DCGLs. Sometimes the results may be more convenient to work with as counts directly from the detector. In these cases the user should decide what the appropriate units are for a specific survey based on the survey objectives. The user should also report the correct number of significant digits as described in EPA 1980c.

- Report the measurement uncertainty for every analytical result or series of results, such as for a measurement system. This uncertainty, while not directly used for demonstrating compliance with the release criterion, is used for survey planning and data assessment throughout the Radiation Survey and Site Investigation Process. In addition, the uncertainty is used for evaluating the performance of measurement systems using QC measurement results (as described in Section 6.2 for scans and direct measurements, and in Section 7.2 for laboratory analysis of samples). The uncertainty is also used for comparing individual measurements to the action level, which is especially important in the early stages of decommissioning (scoping, characterization, and remedial action support surveys described in Section 2.4) when decisions are made based on a limited number of measurements. Section 6.8 discusses methods for calculating the measurement uncertainty.

- Report the minimum detectable concentration (MDC) for the measurement system as well as the method used to calculate the MDC. The MDC is an *a priori* estimate of the capability for detecting an activity concentration with a specific measurement system (EPA 1980c). As such, this estimate is valuable for planning and designing radiation surveys. Optimistic estimates of the MDC (calculated using ideal conditions that may not apply to actual measurements) overestimate the ability of a technique to detect residual radioactivity, especially when scanning for alpha or low-energy beta radiations. This can invalidate survey results, especially for scanning surveys. Using a more realistic MDC, as described in Section 6.7, during scoping and characterization surveys helps in the proper classification of survey units for final status surveys and minimizes the possibility of designing and performing subsequent surveys because of errors in classification. Estimates of the MDC that minimize potential decision errors should be used for planning surveys.

Reporting requirements for individual surveys should be developed during planning and clearly documented in the QAPP.

2.4 Radiation Survey and Site Investigation Process

The Data Life Cycle discussed in Section 2.3 is the basis for the performance-based guidance in MARSSIM. As a framework for collecting the information required for demonstrating compliance identified using the DQO Process, MARSSIM recommends using a series of surveys. The Radiation Survey and Site Investigation (RSSI) Process is an example of a series of surveys designed to demonstrate compliance with a dose- or risk-based regulation for sites with radioactive contamination.

There are six principal steps in the RSSI Process:

- Site Identification
- Historical Site Assessment
- Scoping Survey
- Characterization Survey
- Remedial Action Support Survey
- Final Status Survey

Table 2.1 provides a simplified overview of the principal steps in the RSSI process and how the Data Life Cycle can be used in an iterative fashion within the process. Each of these steps is briefly described in the Sections 2.4.1 through 2.4.6, and described in more detail in Chapter 3 and Chapter 5. In addition, there is a brief description of regulatory agency confirmation and verification (see Section 2.4.7). Because MARSSIM focuses on demonstrating compliance with a release criterion, specifically through the use of a final status survey, these surveys have additional objectives that are not fully discussed in MARSSIM (*e.g.*, health and safety of workers, supporting selection of values for exposure pathway model parameters).

Figure 2.4 illustrates the Radiation Survey and Site Investigation Process in terms of area classification, and lists the major decision to be made for each type of survey. The flowchart demonstrates one method for quickly estimating the survey unit classification early in the MARSSIM Process based on limited information. While this figure shows the relationship between area classification and survey unit classification along with the major decision points that determine classification, this illustration is not designed to comprehensively consider every possibility that may occur at individual survey units. As such, it is a useful tool for visualizing the classification process, but there are site-specific characteristics that may cause variation from this scheme.

The flowchart, illustrated in Figures 2.5 through 2.8, presents the principal steps and decisions in the site investigation process and shows the relationship of the survey types to the overall assessment process. As shown in these figures, there are several sequential steps in the site investigation process and each step builds on information provided by its predecessor. Properly applying each sequential step in the RSSI Process should provide a high degree of assurance that the release criterion has not been exceeded.

Table 2.1 The Data Life Cycle used to Support the Radiation Survey and Site Investigation Process

RSSI Process	Data Life Cycle		MARSSIM Guidance
Site Identification			Provides information on identifying potential radiation sites (Section 3.3)
Historical Site Assessment	Historical Site Assessment Data Life Cycle	Plan Implement Assess Decide	Provides information on collecting and assessing existing site data (Sections 3.4 through 3.9) and potential sources of information (Appendix G)
Scoping Survey	Scoping Data Life Cycle	Plan Implement Assess Decide	Discusses the purpose and general approach for performing scoping surveys, especially as sources of information when planning final status surveys (Section 5.2)
Characterization Survey	Characterization Data Life Cycle	Plan Implement Assess Decide	Discusses the purpose and general approach for performing characterization surveys, especially as sources of information when planning final status surveys (Section 5.3)
Remedial Action Support Survey	Remedial Action Data Life Cycle	Plan Implement Assess Decide	Discusses the purpose and general approach for performing remedial action support surveys, especially as sources of information when planning final status surveys (Section 5.4)
Final Status Survey	Final Status Data Life Cycle	Plan Implement Assess Decide	Provides detailed guidance for planning final status surveys (Chapter 4 and Section 5.5), selecting measurement techniques (Chapter 6, Chapter 7, and Appendix H), and assessing the data collected during final status surveys (Chapter 8 and Chapter 9)

2.4.1 Site Identification

The identification of known, likely, or potential sites is generally easily accomplished, and is typically performed before beginning decommissioning. Any facility preparing to terminate an NRC or agreement state license would be identified as a site. Formerly terminated NRC licenses may also become sites for the EPA Superfund Program. Portions of military bases or DOE facilities may be identified as sites based on records of authorization to possess or handle radioactive materials. In addition, information obtained during the performance of survey activities may identify additional potential radiation sites related to the site being investigated. Information on site identification is provided in Section 3.3.

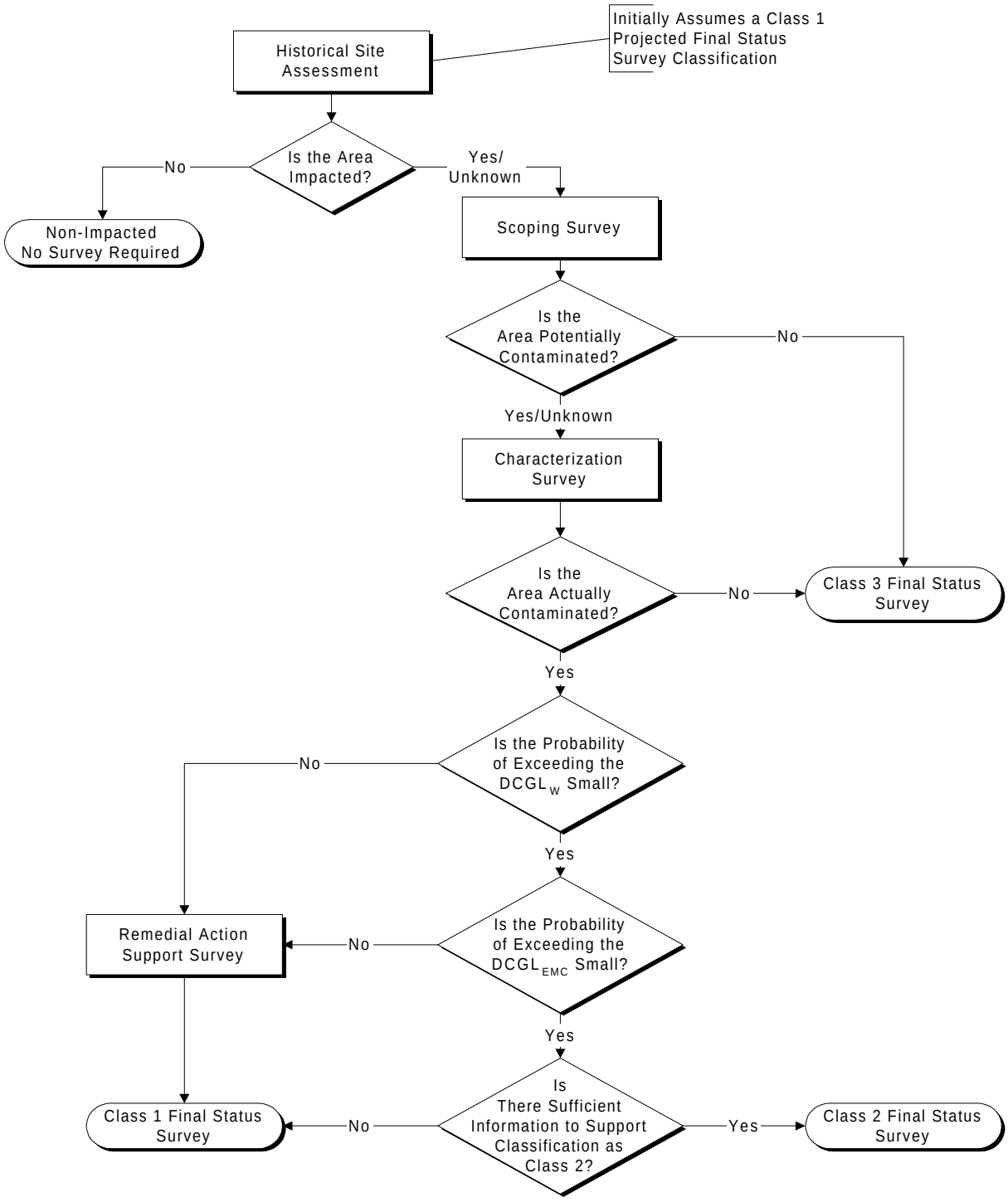


Figure 2.4 The Radiation Survey and Site Investigation Process in Terms of Area Classification

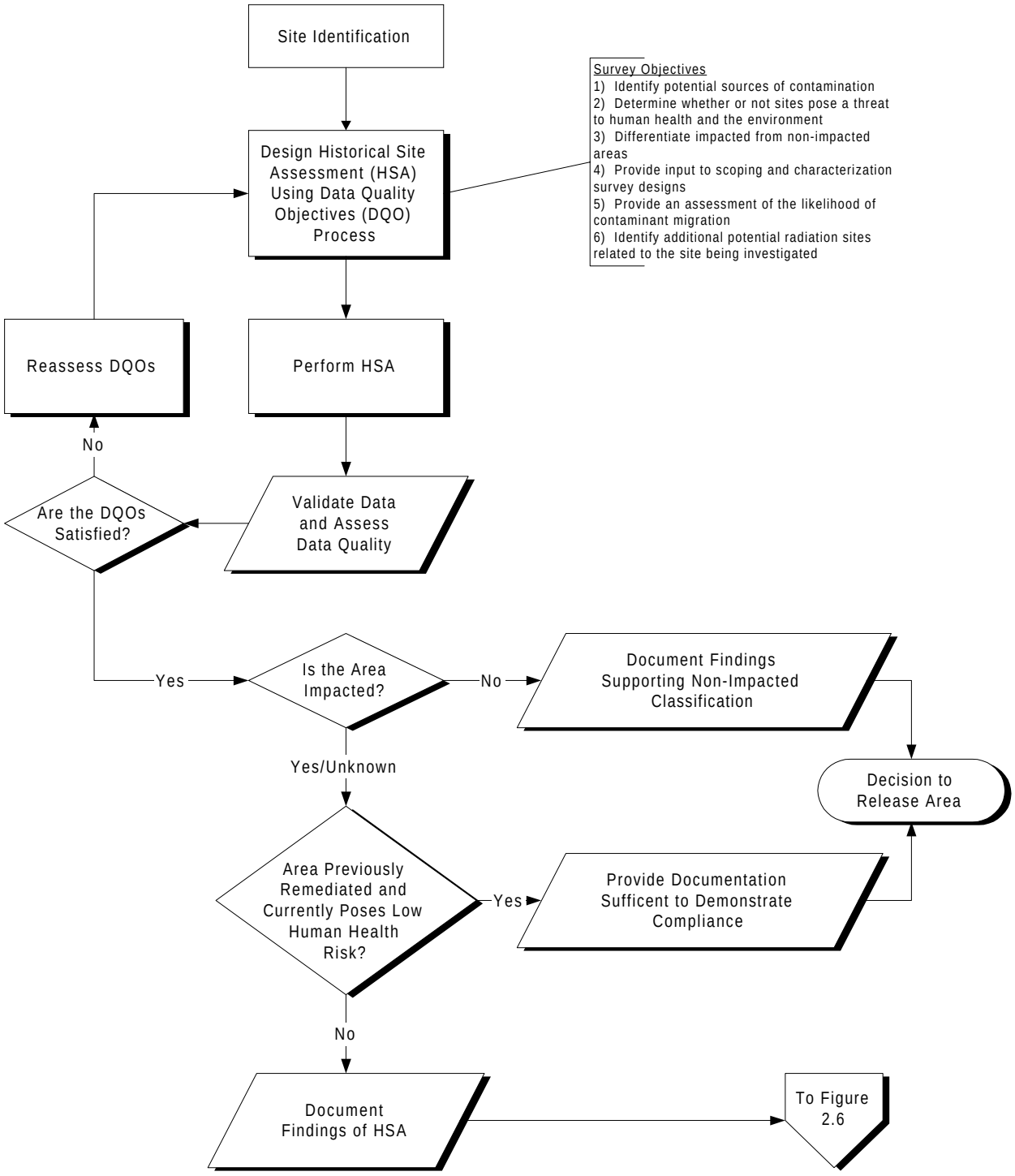


Figure 2.5 The Historical Site Assessment Portion of the Radiation Survey and Site Investigation Process

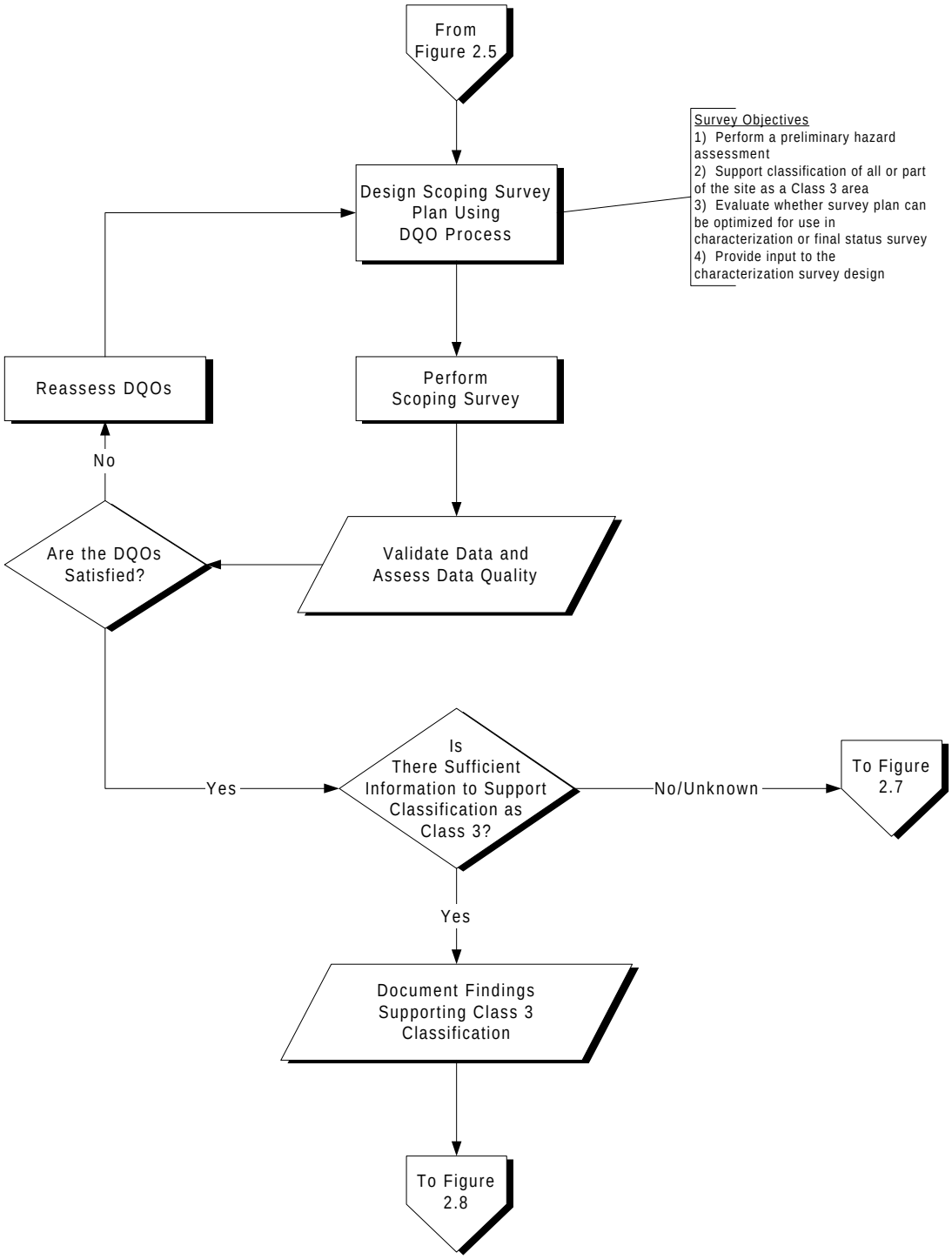
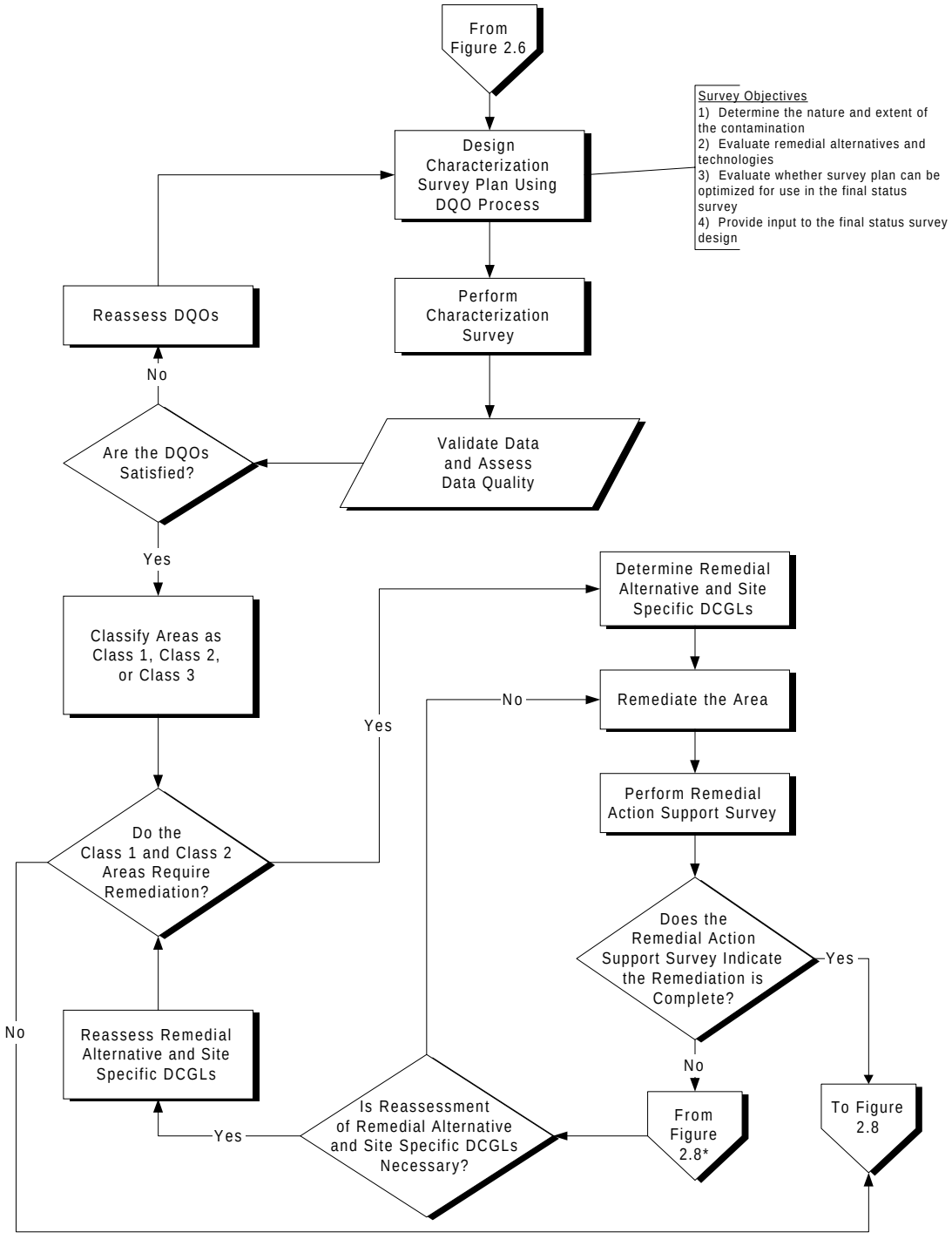
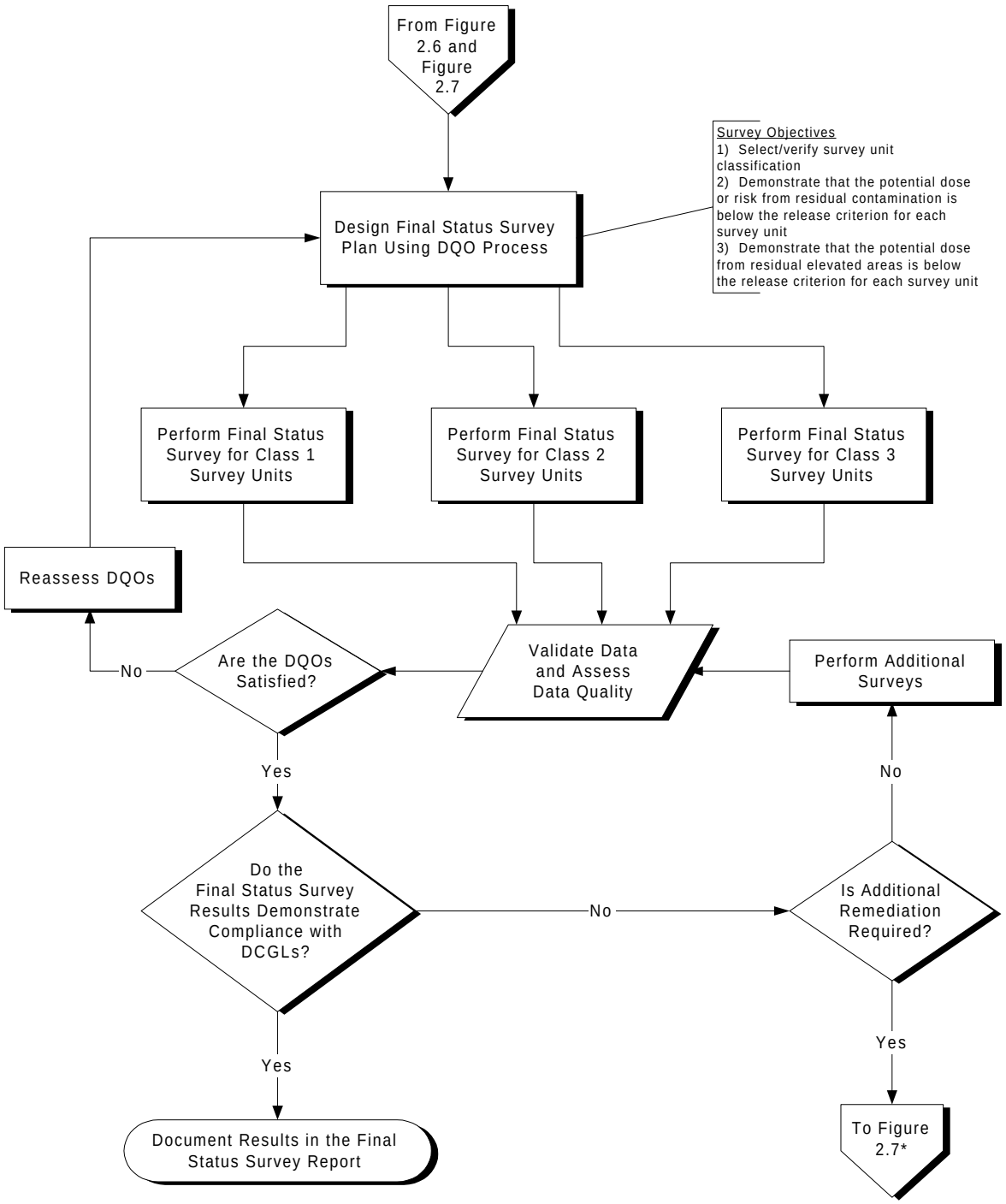


Figure 2.6 The Scoping Survey Portion of the Radiation Survey and Site Investigation Process



* The point where survey units that fail to demonstrate compliance in the final status survey in Figure 2.8 re-enter the process

Figure 2.7 The Characterization and Remedial Action Support Survey Portion of the Radiation Survey and Site Investigation Process



* Connects with the Remedial Action Support Survey portion of the process in Figure 2.7

Figure 2.8 The Final Status Survey Portion of the Radiation Survey and Site Investigation Process

2.4.2 Historical Site Assessment

The primary purpose of the Historical Site Assessment (HSA) is to collect existing information concerning the site and its surroundings.

The primary objectives of the HSA are to:

- identify potential sources of contamination
- determine whether or not sites pose a threat to human health and the environment
- differentiate impacted from non-impacted areas
- provide input to scoping and characterization survey designs
- provide an assessment of the likelihood of contaminant migration
- identify additional potential radiation sites related to the site being investigated

The HSA typically consists of three phases: identification of a candidate site, preliminary investigation of the facility or site, and site visits or inspections. The HSA is followed by an evaluation of the site based on information collected during the HSA.

2.4.3 Scoping Survey

If the data collected during the HSA indicate an area is impacted, a scoping survey could be performed. Scoping surveys provide site-specific information based on limited measurements.

The primary objectives of a scoping survey are to:

- perform a preliminary hazard assessment
- support classification of all or part of the site as a Class 3 area
- evaluate whether the survey plan can be optimized for use in the characterization or final status surveys
- provide data to complete the site prioritization scoring process (CERCLA and RCRA sites only)
- provide input to the characterization survey design if necessary

Scoping surveys are conducted after the HSA is completed and consist of judgment measurements based on the HSA data. If the results of the HSA indicate that an area is Class 3 and no contamination is found, the area may be classified as Class 3 and a Class 3 final status survey is performed. If the scoping survey locates contamination, the area may be considered as Class 1 (or Class 2) for the final status survey and a characterization survey is typically performed. Sufficient information should be collected to identify situations that require immediate radiological attention. For sites where the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements are applicable, the scoping survey

should collect sufficient data to complete the Hazard Ranking System (HRS) scoring process. For sites where the Resource Conservation and Recovery Act (RCRA) requirements are applicable, the scoping survey should collect sufficient data to complete the National Corrective Action Prioritization System (NCAPS) scoring process. Sites that meet the National Contingency Plan (NCP) criteria for a removal should be referred to the Superfund removal program (EPA 1988c). A comparison of MARSSIM guidance to CERCLA and RCRA requirements is provided in Appendix F.

2.4.4 Characterization Survey

If an area could be classified as Class 1 or Class 2 for the final status survey, based on the HSA and scoping survey results, a characterization survey is warranted. The characterization survey is planned based on the HSA and scoping survey results. This type of survey is a detailed radiological environmental characterization of the area.

The primary objectives of a characterization survey are to:

- determine the nature and extent of the contamination
- collect data to support evaluation of remedial alternatives and technologies
- evaluate whether the survey plan can be optimized for use in the final status survey
- support Remedial Investigation/Feasibility Study requirements (CERCLA sites only) or Facility Investigation/Corrective Measures Study requirements (RCRA sites only)
- provide input to the final status survey design

The characterization survey is the most comprehensive of all the survey types and generates the most data. This includes preparing a reference grid, systematic as well as judgment measurements, and surveys of different media (*e.g.*, surface soils, interior and exterior surfaces of buildings). The decision as to which media will be surveyed is a site-specific decision addressed throughout the Radiation Survey and Site Investigation Process.

2.4.5 Remedial Action Support Survey

If an area is adequately characterized and is contaminated above the derived concentration guideline levels (DCGLs), a decontamination plan should be prepared. A remedial action support survey is performed while remediation is being conducted, and guides the cleanup in a real-time mode.

Remedial action support surveys are conducted to:

- support remediation activities
- determine when a site or survey unit is ready for the final status survey

- provide updated estimates of site-specific parameters used for planning the final status survey

This manual does not provide guidance on the routine operational surveys used to support remediation activities. The determination that a survey unit is ready for a final status survey following remediation is an important step in the RSSI Process. In addition, remedial activities result in changes to the distribution of contamination within the survey unit. For most survey units, the site-specific parameters used during final status survey planning (*e.g.*, variability in the radionuclide concentration, probability of small areas of elevated activity) will need to be re-established following remediation. Obtaining updated values for these critical parameters should be considered when planning a remedial action support survey.

2.4.6 Final Status Survey

The final status survey is used to demonstrate compliance with regulations. This type of survey is the major focus of this manual.

The primary objectives of the final status survey are to:

- select/verify survey unit classification
- demonstrate that the potential dose or risk from residual contamination is below the release criterion for each survey unit
- demonstrate that the potential dose or risk from small areas of elevated activity is below the release criterion for each survey unit

The final status survey provides data to demonstrate that all radiological parameters satisfy the established guideline values and conditions.

Although the final status survey is discussed as if it were an activity performed at a single stage of the site investigation process, this does not have to be the case. Data from other surveys conducted during the Radiation Survey and Site Investigation Process—such as scoping, characterization, and remedial action support surveys—can provide valuable information for planning a final status survey provided they are of sufficient quality.

Professional judgment and biased sampling are important for locating contamination and characterizing the extent of contamination at a site. However, the MARSSIM focus is on planning the final status survey which utilizes a more systematic approach to sampling. Systematic sampling is based on rules that endeavor to achieve the representativeness in sampling consistent with the application of statistical tests.

2.4.7 Regulatory Agency Confirmation and Verification

The regulatory agency responsible for the site often confirms whether the site is acceptable for release. This confirmation may be accomplished by the agency or an impartial party. Although some actual measurements may be performed, much of the work required for confirmation and verification will involve evaluation and review of documentation and data from survey activities. The evaluation may include site visits to observe survey and measurement procedures or split-sample analyses by the regulatory agency's laboratory. Therefore, accounting for confirmation and verification activities during the planning stages is important to each type of survey. In some cases, post-remedial sampling and analysis may be performed by an impartial party. The review of survey results should include verifying that the data quality objectives are met, reviewing the analytical data used to demonstrate compliance, and verifying that the statistical test results support the decision to release the site. Confirmation and verification are generally ongoing processes throughout the Radiation Survey and Site Investigation (RSSI) Process.

2.5 Demonstrating Compliance With a Dose- or Risk-Based Regulation

MARSSIM presents a process for demonstrating compliance with a dose- or risk-based regulation. The RSSI Process provides flexibility in planning and performing surveys based on site-specific considerations. A dose- or risk-based regulation usually allows one to take into account radionuclide and site-specific differences.

The final status survey is designed to demonstrate compliance with the release criterion. The earlier surveys in the RSSI Process are performed to support decisions and assumptions used in the design of the final status survey. These preliminary surveys (*e.g.*, scoping, characterization) may have other objectives in addition to compliance demonstration that need to be considered during survey planning that are not fully discussed in this manual. For this reason MARSSIM focuses on final status survey design. To allow maximum flexibility in the survey design, MARSSIM provides guidance on designing a survey using the RSSI Process. This allows users with few resources available for planning to develop an acceptable survey design. The rationale for the development of the guidance in MARSSIM is presented in the following sections. Users with available planning resources are encouraged to investigate alternate survey designs for site-specific applications using the information provided in Section 2.6.

2.5.1 The Decision to Use Statistical Tests

The objective of compliance demonstration is to provide some level of confidence that the release criterion is not exceeded. As previously stated, 100% confidence in a decision cannot be proven because the data always contain some uncertainty. The use of statistical methods is necessary to provide a quantitative estimate of the probability that the release criterion is not

exceeded at a particular site. Statistical methods provide for specifying (controlling) the probability of making decision errors and for extrapolating from a set of measurements to the entire site in a scientifically valid fashion (EPA 1994b).

Clearly stating the null hypothesis is necessary before a statistical test can be performed. The null hypothesis recommended for use in MARSSIM is: "The residual radioactivity in the survey unit exceeds the release criterion." This statement directly addresses the issue of compliance demonstration for the regulator and places the burden of proof for demonstrating compliance on the site owner or responsible party. The statistical tests are only applied at sites that were subjected to an Historical Site Assessment (HSA). At this point, the results of the HSA have been reviewed and the site is determined to be impacted based on existing data and professional judgment as described in Chapter 3. An impacted site, by definition, is expected to contain areas of contamination, so this statement of the null hypothesis is reasonable for these sites.

The information needed to perform a statistical test is determined by the assumptions used to develop the test. MARSSIM recommends the use of nonparametric statistical tests because these tests use fewer assumptions, and consequently require less information to verify these assumptions. The tests described in MARSSIM (see Chapter 8) are relatively easy to understand and implement compared to other statistical tests.

Site conditions can also affect the selection of statistical tests. The distribution of contamination is of particular concern at sites with residual radioactivity. Is the contamination distributed uniformly, or is it located in small areas of elevated activity? Is the residual radioactivity present as surface, volumetric, or subsurface contamination? To demonstrate the use of the RSSI Process at radiation sites, MARSSIM addresses only surface soil and building surfaces for the final status survey to demonstrate compliance. This represents a situation that is expected to commonly occur at sites with radioactive contamination, and allows the survey design to take into account the ability to directly measure surface radioactivity using scanning techniques. Other contaminated media may be identified during the HSA or preliminary surveys (*i.e.*, scoping, characterization, remedial action support). If other contaminated media (*e.g.*, subsurface contamination, volumetric contamination of building materials) are identified, methodologies for demonstrating compliance other than those described in this manual may need to be developed or evaluated. Situations where scanning techniques may not be effective (*e.g.*, volumetric or subsurface contamination) are discussed in existing guidance (EPA 1989a, EPA 1994b, EPA 1994d).

2.5.1.1 Small Areas of Elevated Activity

While the development of DCGLs is outside the scope of MARSSIM, this manual assumes that DCGLs will be developed using exposure pathway models which in turn assume a relatively uniform distribution of contamination. While this represents an ideal situation, small areas of elevated activity are a concern at many sites.

MARSSIM addresses the concern for small areas of elevated activity by using a simple comparison to an investigation level as an alternative to statistical methods. Using the elevated measurement comparison (EMC) represents a conservative approach, in that every measurement needs to be below the action level. The investigation level for this comparison is called the $DCGL_{EMC}$, which is the $DCGL_W$ modified to account for the smaller area. This area factor correction (discussed in Section 5.5.2.4) is considered to be a defensible modification because the exposure assumptions (*e.g.*, exposure time and duration) are the same as those used to develop the $DCGL_W$. In the case of multiple areas of elevated activity in a survey unit, a posting plot (discussed in Section 8.2.2.2) or similar representation of the distribution of activity in the survey unit can be used to determine any pattern in the location of these areas.

If elevated levels of residual radioactivity are found in an isolated area, in addition to residual radioactivity distributed relatively uniformly across the survey unit, the unity rule (Section 4.3.3) can be used to ensure that the total dose or risk meets the release criterion. If there is more than one of these areas, a separate term should be included in the calculation for each area of elevated activity. As an alternative to the unity rule, the dose or risk due to the actual residual radioactivity distribution can be calculated if there is an appropriate exposure pathway model available. Note that these considerations generally only apply to Class 1 survey units, since areas of elevated activity should not be present in Class 2 or Class 3 survey units.

2.5.1.2 Relatively Uniform Distribution of Contamination

As discussed previously, the development of a DCGL starts with the assumption of a relatively uniform distribution of contamination. Some variability in the measurements is expected. This is primarily due to a random spatial distribution of contamination and uncertainties in the measurement process. The arithmetic mean of the measurements taken from such a distribution would represent the parameter of interest for demonstrating compliance.

Whether or not the radionuclide of concern is present in background determines the form of the statistical test. The Wilcoxon Rank Sum (WRS) test is recommended for comparisons of survey unit radionuclide concentrations with background. When the radionuclide of concern is not present in background, the Sign test is recommended. Instructions on performing these tests are provided in Section 8.3 and Section 8.4.

The WRS and Sign tests are designed to determine whether or not the level of residual activity uniformly distributed throughout the survey unit exceeds the $DCGL_W$. Since these methods are based on ranks, the results are generally expressed in terms of the median. When the underlying measurement distribution is symmetric, the mean is equal to the median. When the underlying distribution is not symmetric, these tests are still true tests of the median but only approximate tests of the mean. However, numerous studies show that this is a fairly good approximation (Hardin and Gilbert, 1993). The assumption of symmetry is less restrictive than that of normality because the normal distribution is itself symmetric. If, however, the measurement distribution is skewed to the right, the average will generally be greater than the median. In severe cases, the average may exceed the $DCGL_W$ while the median does not. For this reason, MARSSIM recommends comparing the arithmetic mean of the survey unit data to the $DCGL_W$ as a first step in the interpretation of the data (see Section 8.2.2.1).

The WRS test is a two-sample test that compares the distribution of a set of measurements in a survey unit to that of a set of measurements in a reference area. The test is performed by first adding the value of the $DCGL_W$ to each measurement in the reference area. The combined set of survey unit data and adjusted reference area data are listed, or ranked, in increasing numerical order. If the ranks of the adjusted reference site measurements are significantly higher than the ranks of the survey unit measurements, the survey unit demonstrates compliance with the release criterion.

The Sign test is a one-sample test that compares the distribution of a set of measurements in a survey unit to a fixed value, namely the $DCGL_W$. First, the value for each measurement in the survey unit is subtracted from the $DCGL_W$. The resulting distribution is tested to determine if the center of the distribution is greater than zero. If the adjusted distribution is significantly greater than zero, the survey unit demonstrates compliance with the release criterion.

Guidance on performing the statistical tests and presenting graphical representations of the data is provided in Chapter 8 and Appendix I.

2.5.2 Classification

Classifying a survey unit is crucial to the survey design because this step determines the level of survey effort based on the potential for contamination. Areas are initially classified as impacted or non-impacted based on the results of the HSA. Non-impacted areas have no reasonable potential for residual contamination and require no further evidence to demonstrate compliance with the release criterion. When planning the final status survey, impacted areas may be further divided into survey units. If a survey unit is classified incorrectly, the potential for making decision errors increases. For this reason, all impacted areas are initially assumed to be Class 1. Class 1 areas require the highest level of survey effort because they are known to have contaminant concentrations above the $DCGL_W$, or the contaminant concentrations are unknown.

Information indicating the potential or known contaminant concentration is less than the $DCGL_W$ can be used to support re-classification of an area or survey unit as Class 2 or Class 3.

There is a certain amount of information necessary to demonstrate compliance with the release criterion. The amount of this information that is available and the level of confidence in this information is reflected in the area classification. The initial assumption for affected areas is that none of the necessary information is available. This results in a default Class 1 classification. This corresponds with the statement of the null hypothesis that the survey unit is contaminated, and represents the most efficient case for the regulator. For this reason, the recommendations for a Class 1 final status survey represent the minimal amount of information necessary to demonstrate compliance.

Not all of the information available for an area will have been collected for purposes of compliance demonstration. For example, data are collected during characterization surveys to determine the extent, and not necessarily the amount, of contamination. This does not mean that the data do not meet the objectives of compliance demonstration, but may mean that statistical tests would be of little or no value because the data have not been collected using appropriate protocols or design. Rather than discard potentially valuable information, MARSSIM allows for a qualitative assessment of existing data (Chapter 3). Non-impacted areas represent areas where all of the information necessary to demonstrate compliance is available from existing sources. For these areas, no statistical tests are considered necessary. A classification as Class 2 or Class 3 indicates that some information on describing the potential for contamination is available for that survey unit. The data collection recommendations are modified to account for the information already available, and the statistical tests are performed on the data collected during the final status survey.

As previously stated, the conservative assumption that an area receive a classification of Class 1 is only applied to impacted sites. The HSA (described in Chapter 3) is used to provide an initial classification for the site of impacted or non-impacted based on existing data and professional judgment.

2.5.3 Design Considerations for Small Areas of Elevated Activity

Scanning surveys are typically used to identify small areas of elevated activity. The size of the area of elevated activity that the survey is designed to detect affects the $DCGL_{EMC}$, which in turn determines the ability of a scanning technique to detect these areas. Larger areas have a lower $DCGL_{EMC}$ and are more difficult to detect than smaller areas.

The percentage of the survey unit to be covered by scans is also an important consideration. 100% coverage means that the entire surface area of the survey unit has been covered by the field of view of the scanning instrument. 100% scanning coverage provides a high level of confidence

that all areas of elevated activity have been identified. If the available information concerning the survey unit provides information demonstrating that areas of elevated activity may not be present, the survey unit may be classified as Class 2 or Class 3. Because there is already some level of confidence that areas of elevated activity are not present, 100% coverage may not be necessary to demonstrate compliance. The scanning survey coverage may be adjusted based on the level of confidence supplied by the existing data. If there is evidence providing a high level of confidence that areas of elevated activity are not present, 10% scanning coverage may meet the objectives of the survey. If the existing information provides a lower level of confidence, the scanning coverage may be adjusted between 10 and 100% based on the level of confidence and the objectives of the survey. A general recommendation is to always err to minimize the decision error. In general, scanning the entire survey unit is less expensive than finding areas of elevated activity later in the survey process. Finding such areas will lead to performing additional surveys due to survey unit misclassification.

Another consideration for scanning surveys is the selection of scanning locations. This is not an issue when 100% of the survey unit is scanned. Whenever less than 100% of the survey unit is scanned, a decision must be made on what areas are scanned. The general recommendation is that when large amounts of the survey unit are scanned (*e.g.*, >50%), the scans should be systematically performed along transects of the survey unit. When smaller amounts of the survey unit are scanned, selecting areas based on professional judgment may be more appropriate and efficient for locating areas of elevated activity (*e.g.*, drains, ducts, piping, ditches). A combination of 100% scanning in portions of the survey unit selected based on professional judgement and less coverage (*e.g.*, 20-50%) for all remaining areas may result in an efficient scanning survey design for some survey units.

2.5.4 Design Considerations for Relatively Uniform Distributions of Contamination

The survey design for areas with relatively uniform distributions of contamination is primarily controlled by classification and the requirements of the statistical test. Again, the recommendations provided for Class 1 survey units are designed to minimize the decision error. Recommendations for Class 2 or Class 3 surveys may be appropriate based on the existing information and the level of confidence associated with this information.

The first consideration is the identification of survey units. The identification of survey units may be accomplished early (*e.g.*, scoping) or late (*e.g.*, final status) in the survey process, but must be accomplished prior to performing a final status survey. Early identification of survey units can help in planning and performing surveys throughout the RSSI Process. Late identification of survey units can prevent misconceptions and problems associated with reclassification of areas based on results of subsequent surveys. The area of an individual survey unit is determined based on the area classification and modeling assumptions used to develop the $DCGL_W$. Identification of survey units is discussed in Section 4.6.

Another consideration is the estimated number of measurements to demonstrate compliance using the statistical tests. Section 5.5.2 describes the calculations used to estimate the number of measurements. These calculations use information that is usually available from planning or from preliminary surveys (*i.e.*, scoping, characterization, remedial action support).

The information needed to perform these calculations is: 1) acceptable values for the probabilities of making Type I (α) or Type II (β) decision errors, 2) the estimates of the measurement variability in the survey unit (σ_s) and the reference area (σ_r) if necessary, and 3) the shift (Δ).

MARSSIM recommends that site-specific values be determined for each of these parameters. To assist the user in selecting site-specific values for decision error rates and Δ, MARSSIM recommends that an initial value be selected and adjusted to develop a survey design that is appropriate for a specific site. An arbitrary initial value of one half the $DCGL_W$ is selected for the lower bound of the gray region. This value is adjusted to provide a relative shift (Δ/σ) value between one and three as described in Section 5.5.2. For decision error rates a value that minimizes the risk of making a decision error is recommended for the initial calculations. The number of measurements can be recalculated using different decision error rates until an optimum survey design is obtained. A prospective power curve (see Appendix D, Section D.6 and Appendix I, Section I.9) that considers the effects of these parameters can be very helpful in designing a survey and considering alternative values for these parameters, and is highly recommended.

To ensure that the desired power is achieved with the statistical test and to account for uncertainties in the estimated values of the measurement variabilities, MARSSIM recommends that the estimated number of measurements calculated using the formulas in Section 5.5.2.2 and 5.5.2.3 be increased by 20%. Insufficient numbers of measurements may result in failure to achieve the DQO for power and result in increased Type II decision errors, where survey units below the release criterion fail to demonstrate compliance.

Once survey units are identified and the number of measurements is determined, measurement locations should be selected. The statistical tests assume that the measurements are taken from random locations within the survey unit. A random survey design is used for Class 3 survey units, and a random starting point for the systematic grid is used for Class 2 and Class 1 survey units.

2.5.5 Developing an Integrated Survey Design

To account for assumptions used to develop the $DCGL_W$ and the realistic possibility of small areas of elevated activity, an integrated survey design should be developed to include all of the design considerations. An integrated survey design combines a scanning survey for areas of

elevated activity with random measurements for relatively uniform distributions of contamination. Table 2.2 presents the recommended conditions for demonstrating compliance for a final status survey based on classification.

Table 2.2 Recommended Conditions for Demonstrating Compliance Based on Survey Unit Classification for a Final Status Survey

Survey Unit Classification		Statistical Test	Elevated Measurement Comparison	Sampling and/or Direct Measurements	Scanning
Impacted	Class 1	Yes	Yes	Systematic	100% Coverage
	Class 2	Yes	Yes	Systematic	10-100% Systematic
	Class 3	Yes	Yes	Random	Judgmental
Non-Impacted		No	No	No	None

Random measurement patterns are used for Class 3 survey units to ensure that the measurements are independent and meet the requirements of the statistical tests. Systematic grids are used for Class 2 survey units because there is an increased probability of small areas of elevated activity. The use of a systematic grid allows the decision maker to draw conclusions about the size of any potential areas of elevated activity based on the area between measurement locations, while the random starting point of the grid provides an unbiased method for determining measurement locations for the statistical tests. Class 1 survey units have the highest potential for small areas of elevated activity, so the areas between measurement locations are adjusted to ensure that these areas can be identified by the scanning survey if the area of elevated activity is not detected by the direct measurements or samples.

The objectives of the scanning surveys are different. Scanning is used to identify locations within the survey unit that exceed the investigation level. These locations are marked and receive additional investigations to determine the concentration, area, and extent of the contamination.

For Class 1 areas, scanning surveys are designed to detect small areas of elevated activity that are not detected by the measurements using the systematic grids. For this reason, the measurement locations and the number of measurements may need to be adjusted based on the sensitivity of the scanning technique (see Section 5.5.2.4). This is also the reason for recommending 100% coverage for the scanning survey.

Scanning surveys in Class 2 areas are also performed primarily to find areas of elevated activity not detected by the measurements using the systematic pattern. However, the measurement

locations are not adjusted based on sensitivity of the scanning technique, and scanning is only performed in portions of the survey unit. The level of scanning effort should be proportional to the potential for finding areas of elevated activity: in Class 2 survey units that have residual radioactivity close to the release criterion a larger portion of the survey unit would be scanned, but for survey units that are closer to background scanning a smaller portion of the survey unit may be appropriate. Class 2 survey units have a lower probability for areas of elevated activity than Class 1 survey units, but some portions of the survey unit may have a higher potential than others. Judgmental scanning surveys would focus on the portions of the survey unit with the highest probability for areas of elevated activity. If the entire survey unit has an equal probability for areas of elevated activity, or the judgmental scans don't cover at least 10% of the area, systematic scans along transects of the survey unit or scanning surveys of randomly selected grid blocks are performed.

Class 3 areas have the lowest potential for areas of elevated activity. For this reason, MARSSIM recommends that scanning surveys be performed in areas of highest potential (*e.g.*, corners, ditches, drains) based on professional judgment. This provides a qualitative level of confidence that no areas of elevated activity were missed by the random measurements or that there were no errors made in the classification of the area.

Note that the DCGL itself is not free of error. The assumptions made in any model used to develop DCGLs for a site should be examined carefully. The results of this examination should determine if the use of site-specific parameters result in large changes in the DCGLs, or whether a site-specific model should be developed to obtain DCGLs more relevant to the exposure conditions at the site. Appendix D, Section D.6 provides additional information about the uncertainty associated with the DCGL and other considerations for developing an integrated survey design using the DQO Process.

2.6 Flexibility in Applying MARSSIM Guidance

Section 2.5 describes an example that applies the performance-based guidance presented in Section 2.3 and Section 2.4 to design a survey for a site with specific characteristics (*i.e.*, surface soil and building surface contamination). Obviously this design cannot be uniformly applied at every site with radioactive contamination, so flexibility has been provided in the form of performance-based guidance. This guidance encourages the user to develop a site-specific survey design to account for site-specific characteristics. It is expected that most users will adopt the portions of the MARSSIM guidance that apply to their site. In addition, changes to the overall survey design that account for site-specific differences would be presented as part of the survey plan. The plan should also demonstrate that the extrapolation from measurements performed at specific locations to the entire site or survey unit is performed in a technically defensible manner.

Where Section 2.5 describes the development of a generic survey design that will be applicable at most radiation sites, this section describes the flexibility available within the MARSSIM for designing a site-specific survey design. Alternate methods for accomplishing the demonstration of compliance are briefly described and references for obtaining additional information on these alternate methods are provided.

2.6.1 Alternate Statistical Methods

MARSSIM encourages the use of statistics to provide a quantitative estimate of the probability that the release criterion is not exceeded at a site. While it is unlikely that any site will be able to demonstrate compliance with a dose- or risk-based regulation without at least considering the use of statistics, MARSSIM recognizes that the use of statistical tests may not always provide the most effective method for demonstrating compliance. For example, MARSSIM recommends a simple comparison to an investigation level to evaluate the presence of small areas of elevated activity in place of complicated statistical tests. At some sites a simple comparison of each measurement result to the $DCGL_W$, to demonstrate that all the measurement results are below the release criterion, may be more effective than statistical tests for the overall demonstration of compliance with the regulation provided an adequate number of measurements are performed.

MARSSIM recommends the use of nonparametric statistical tests for evaluating environmental data. There are two reasons for this recommendation: 1) environmental data is usually not normally distributed, and 2) there are often a significant number of qualitative survey results (*e.g.*, less than MDC). Either one of these conditions means that parametric statistical tests may not be appropriate. If one can demonstrate that the data are normally distributed and that there are a sufficient number of results to support a decision concerning the survey unit, parametric tests will generally provide higher power (or require fewer measurements to support a decision concerning the survey unit). The tests to demonstrate that the data are normally distributed generally require more measurements than the nonparametric tests. EPA provides guidance on selecting and performing statistical tests to demonstrate that data are normally distributed (EPA 1996a). Guidance is also available for performing parametric statistical tests (NRC 1992, EPA 1989a, EPA 1994b, EPA 1996a).

There are a wide variety of statistical tests designed for use in specific situations. These tests may be preferable to the generic statistical tests recommended in MARSSIM when the underlying assumptions for these tests can be verified. Table 2.3 lists several examples of statistical tests that may be considered for use at individual sites or survey units. A brief description of the tests and references for obtaining additional information on these tests are also listed in the table. Applying these tests may require consultation with a statistician.

Table 2.3 Examples of Alternate Statistical Tests

Alternate Tests	Probability Model Assumed	Type of Test	Reference	Advantages	Disadvantages
Alternate 1-Sample Tests (no reference area measurements)					
Student's t Test	Normal	Parametric test for H_o: Mean < L	*Guidance for Data Quality Assessment*, EPA QA/G-9, p. 3.2-2.	Appropriate if data appears to be normally distributed and symmetric.	Relies on a non-robust estimator for μ and σ. Sensitive to outliers and departures from normality.
t Test Applied To Logarithms	Lognormal	Parametric test for H_o: Median < L	*Guidance for Data Quality Assessment*, EPA QA/G-9, p. 3.2-2	This is a well- known and easy-to-apply test. Useful for a quick summary of the situation if the data is skewed to right.	Relies on a non-robust estimator for σ. Sensitive to outliers and departures from lognormality.
Minimum Variance Unbiased Estimator For Lognormal Mean	Lognormal	Parametric estimates for mean and variance of lognormal distribution	Gilbert, *Statistical Methods for Environmental Pollution Monitoring*, p. 164, 1987.	A good parametric test to use if the data is lognormal.	Inappropriate if the data is not lognormal.
Chen Test	Skewed to right, including Lognormal	Parametric test for H_o: Mean > 0	*Journal of the American Statistical Association (90)*, p.767, 1995.	A good parametric test to use if the data is lognormal.	Applicable only for testing H_o: "survey unit is clean." Survey unit must be significantly greater than 0 to fail. Inappropriate if the data is not skewed to the right.

Table 2.3 (continued)

Alternative Tests	Probability Model Assumed	Type of Test	Reference	Advantages	Disadvantages
Alternate 1-Samples Tests (no reference area measurements)					
Bayesian Approaches	Varies, but a family of probability distributions must be selected.	Parametric test for H_o: Mean < L	DeGroot, *Optimal Statistical Decisions*, p. 157, 1970.	Permits use of subjective "expert judgment" in interpretation of data.	Decisions based on expert judgment may be difficult to explain and defend.
Bootstrap	No restriction	Nonparametric. Uses resampling methods to estimate sampling variance.	Hall, *Annals of Statistics (22)*, p. 2011-2030, 1994.	Avoids assumptions concerning the type of distribution.	Computer intensive analysis required. Accuracy of the results can be difficult to assess.
Lognormal Confidence Intervals Using Bootstrap	Lognormal	Uses resampling methods to estimate one-sided confidence interval for lognormal mean.	Angus, *The Statistician (43)*, p. 395, 1994.	Nonparametric method applied within a parametric lognormal model.	Computer intensive analysis required. Accuracy of the results can be difficult to assess.

Table 2.3 (continued)

Alternative Tests	Probability Model Assumed	Type of Test	Reference	Advantages	Disadvantages
Alternate 2-Sample Tests (reference area measurements are required)					
Student's t Test	Symmetric, normal	Parametric test for difference in means H_o: $\mu_x < \mu_y$	*Guidance for Data Quality Assessment*, EPA QA/G-9, p. 3.3-2	Easy to apply. Performance for non-normal data is acceptable.	Relies on a non-robust estimator for σ, therefore test results are sensitive to outliers.
Mann-Whitney Test	No restrictions	Nonparametric test difference in location H_o: $\mu_x < \mu_y$	Hollander and Wolfe, *Nonparametric Statistical Methods*, p. 71, 1973.	Equivalent to the WRS test, but used less often. Similar to resampling, because test is based on set of all possible differences between the two data sets.	Assumes that the only difference between the test and reference areas is a shift in location.
Kolmogorov-Smirnov	No restrictions	Nonparametric test for any difference between the 2 distributions	Hollander and Wolfe, *Nonparametric Statistical Methods*, p. 219, 1973.	A robust test for equality of two sample distributions against all alternatives.	May reject because variance is high, although mean is in compliance.
Bayesian Approaches	Varies, but a family of probability distributions must be selected	Parametric tests for difference in means or difference in variance.	Box and Tiao, *Bayesian Inference in Statistical Analysis*, Chapter 2, 1973.	Permits use of "expert judgment" in the interpretation of data.	Decisions based on expert judgement may be difficult to explain and defend.

Table 2.3 (continued)

Alternative Tests	Probability Model Assumed	Type of Test	Reference	Advantages	Disadvantages
Alternate 2-Sample Tests (reference area measurements are required)					
2-Sample Quantile Test	No restrictions	Nonparametric test for difference in shape and location.	EPA, *Methods for Evaluating the Attainment of Cleanup Standards, Vol. 3*, p. 7.1, 1992.	Will detect if survey unit distribution exceeds reference distribution in the upper quantiles.	Applicable only for testing H_o: "survey unit is clean." Survey unit must be significantly greater than 0 to fail.
Simultaneous WRS and Quantile Test	No restrictions	Nonparametric test for difference in shape and location.	EPA, *Methods for Evaluating the Attainment of Cleanup Standards, Vol. 3*, p. 7.17, 1992.	Additional level of protection provided by using two tests. Has advantages of both tests.	Cannot be combined with the WRS test that uses H_o: "survey unit is not clean." Should only be combined with WRS test for H_o: "survey unit is clean."
Bootstrap and Other Resampling Methods	No restrictions	Nonparametric. Uses resampling methods to estimate sampling variance.	Hall, *Annals of Statistics (22)*, p. 2011, 1994.	Avoids assumptions concerning the type of distribution. Generates informative resampling distributions for graphing.	Computer intensive analysis required.
Alternate to Statistical Tests					
Decision Theory	No restrictions	Incorporates loss function in the decision theory approach.	DOE, *Statistical and Cost-Benefit Enhancements to the DQO Process for Characterization Decisions*, 1996.	Combines elements of cost-benefit analysis and risk assessment into the planning process.	Limited experience in applying the method to compliance demonstration and decommissioning. Computer intensive analysis required.

2.6.2 Alternate Null Hypothesis

The selection of the null hypothesis in MARSSIM is designed to be protective of human health and the environment as well as consistent with current methods used for demonstrating compliance with regulations. MARSSIM also acknowledges that site-specific conditions (*e.g.*, high variability in background, lack of measurement techniques with appropriate detection sensitivity) may preclude the use of the null hypothesis that the survey unit is assumed to be contaminated. Similarly, a different null hypothesis and methodology could be used for different survey units (*e.g.*, Class 3 survey units). NUREG 1505 (NRC 1997b) provides guidance on determining when background variability might be an issue, designing surveys based on the null hypothesis that the survey unit concentration is indistinguishable from the concentration in the reference area, and performing statistical tests to demonstrate that the survey unit is indistinguishable from background.

2.6.3 Integrating MARSSIM with Other Survey Designs

2.6.3.1 Accelerated Cleanup Models

There are a number of approaches designed to expedite site cleanups. These approaches can save time and resources by reducing sampling, preventing duplication of effort, and reducing inactive time periods between steps in a cleanup process. Although Section 2.4 describes the RSSI Process recommended in MARSSIM as one with six principal steps, MARSSIM is not intented to be a serial process that would slow site cleanups. Rather, MARSSIM supports existing programs and encourages approaches to expedite site cleanups. Part of the significant emphasis on planning in MARSSIM is meant to promote saving time and resources.

There are many examples of accelerated cleanup approaches. The Superfund Accelerated Cleanup Model (SACM), which includes a module called integrated site assessment, has as its objectives increased efficiency and shorter response times (EPA 1992f, EPA 1993c, EPA 1997b).

Sandia National Laboratories (SNL) uses the Observational Approach. This approach uses an iterative process of sample collection and real-time data evaluation to characterize a site. This process allows early field results to guide later data collection in the field. Data collection is limited to only that required for selecting a unique remedy for a site.[5]

At DOE's Hanford Site, the parties to the Tri-Party Agreement negotiated a method to implement the CERCLA process in order to 1) accelerate the assessment phase, and 2) coordinate RCRA

[5] Information on the Observational Approach recommended by Sandia National Laboratories is available on the internet at http://www.em.doe.gov/tie/strechar.html.

and CERCLA requirements whenever possible, thereby resulting in cost savings. The Hanford Past Practice Strategy (HPPS) was developed in 1991 to accelerate decisionmaking and initiation of remediation through activities that include maximizing the use of existing data consistent with data quality objectives.[6]

The adaptive sampling programs at the Environmental Assessment Division (EAD) of Argonne National Laboratory quantitatively fuse soft data (for example, historical records, aerial photos, nonintrusive geophysical data) with hard sampling results to estimate contaminant extent, measure the uncertainty associated with these estimates, determine the benefits from collecting additional samples, and assist in siting new sample locations to maximize the information gained.[7]

2.6.3.2 Superfund Soil Screening Guidance

The goal of the Soil Screening Guidance (EPA 1996b, EPA 1996c) is to help standardize and accelerate the evaluation and cleanup of contaminated soils at sites on the National Priorities List (NPL) designated for future residential land use. The guidance provides a methodology for calculating risk-based, site-specific, soil screening levels for chemical contaminants in soil that may be used to identify areas needing further investigation at NPL sites. While the Soil Screening Guidance was not developed for use with radionuclides, the methodology used is comparable to the MARSSIM guidance for demonstrating compliance using DCGLs. The Soil Screening Guidance assumes that there is a low probability of contamination, and does not account for small areas of elevated activity. These assumptions correlate to a Class 3 area in MARSSIM. Because the Soil Screening Guidance is designed as a screening tool instead of a final demonstration of compliance, the specific values for decision error levels, the bounds of the gray region, and the number and location of measurements are developed to support these objectives. However, MARSSIM guidance can be integrated with the survey design in the Soil Screening Guidance using this guidance as an alternate MARSSIM survey design.

The Soil Screening Guidance survey design is based on collecting samples, so scan surveys and direct measurements are not considered. To reduce analytical costs the survey design recommends compositing samples and provides a statistical test for demonstrating compliance. Compositing samples provides an additional source of uncertainty and prevents the detection of small areas of elevated activity.

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[6] Information on the Hanford Past Practice Strategy is available on the internet at http://www.bhi-erc.com/map/sec5.html.

[7] Information on the Argonne National Laboratory adaptive sampling programs can be obtained on the internet at http://www.ead.anl.gov/~web/newead/prgprj/proj/adaptive/adaptive.html.

3 HISTORICAL SITE ASSESSMENT

3.1 Introduction

The Radiation Survey and Site Investigation (RSSI) Process uses a graded approach that starts with the Historical Site Assessment (HSA) and is later followed by other surveys that lead to the final status survey. The HSA is an investigation to collect existing information describing a site's complete history from the start of site activities to the present time. The necessity for detailed information and amount of effort to conduct an HSA depend on the type of site, associated historical events, regulatory framework, and availability of documented information. For example, some facilities—such as Nuclear Regulatory Commission (NRC) licensees that routinely maintain records throughout their operations—already have HSA information in place. Other facilities, such as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) sites, may initiate a comprehensive search to gather HSA information (also see Appendix F for comparison of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), CERCLA, and RCRA). In the former case, the HSA is essentially complete and a review of the following sections ensures that all information sources are incorporated into the overall investigation. In still other cases, where sealed sources or small amounts of radionuclides are described by the HSA, the site may qualify for a simplified decommissioning procedure (see Appendix B).

The HSA

- identifies potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information
- identifies sites that need further action as opposed to those posing no threat to human health
- provides an assessment for the likelihood of contaminant migration
- provides information useful to scoping and characterization surveys
- provides initial classification of the site or survey unit[1] as impacted or non-impacted

The HSA may provide information needed to calculate derived concentration guideline levels (DCGLs, initially described in Section 2.2) and furthermore provide information that reveals the magnitude of a site's DCGLs. This information is used for comparing historical data to potential DCGLs and determining the suitability of the existing data as part of the assessment of the site. The HSA also supports emergency response and removal activities within the context of the

[1] Refer to Section 4.6 for a discussion of survey units.

EPA's Superfund program, fulfills public information needs, and furnishes appropriate information about the site early in the Site Investigation process. For a large number of sites (*e.g.* currently licensed facilities), site identification and reconnaissance may not be needed. For certain response activities, such as reports concerning the possible presence of radioactivity, preliminary investigations may consist more of a reconnaissance and a scoping survey in conjunction with efforts to gather historical information.

The HSA is typically described in three sections: identification of a candidate site (Section 3.3), preliminary investigation of the facility or site (Section 3.4), and site reconnaissance (Section 3.5). The reconnaissance however is not a scoping survey. The HSA is followed by an evaluation of the site based on information collected during the HSA.

3.2 Data Quality Objectives

The Data Quality Objectives (DQO) Process assists in directing the planning of data collection activities performed during the HSA. Information gathered during the HSA supports other DQOs when this process is applied to subsequent surveys.

Three HSA-DQO results are expected:

- identifying an individual or a list of planning team members—including the decision maker (DQO Step 1, Appendix D, Section D.1)

- concisely describing the problem (DQO Step 1, Appendix D, Section D.1)

- initially classifying site and survey unit as impacted or non-impacted (DQO Step 4, Appendix D, Section D.4)

Other results may accompany these three, and this added information may be useful in supporting subsequent applications of the DQO process.

The planning team clarifies and defines the DQOs for a site-specific survey. This multidisciplinary team of technical experts offers the greatest potential for solving problems when identifying every important aspect of a survey. Including a stakeholder group representative is an important consideration when assembling this team. Once formed, the team can also consider the role of public participation for this assessment and the possible surveys to follow. The number of team members is directly related to the scope and complexity of the problem. For a small site or simplified situations, planning may be performed by the site owner. For other specific sites (*e.g.*, CERCLA), a regulatory agency representative may be included.

The representative's role facilitates survey planning—without direct participation in survey plan development—by offering comments and information based on past precedent, current guidance, and potential pitfalls. For a large, complex facility, the team may include technical project managers, site managers, scientists, engineers, community and local government representatives, health physicists, statisticians, and regulatory agency representatives. A reasonable effort should be made to include other individuals—that is, specific decision makers or data users—who may use the study findings sometime in the future.

The planning team is generally led by a member who is referred to as the decision maker. This individual is often the person with the most authority over the study and may be responsible for assigning the roles and responsibilities to planning team members. Overall, the decision-making process arrives at final decisions based on the planning team's recommendations.

The problem or situation description provides background information on the fundamental issue to be addressed by the assessment (see EPA 1994a). The following steps may be helpful during DQO development:

- describe the conditions or circumstances regarding the problem or situation and the reason for undertaking the survey
- describe the problem or situation as it is currently understood by briefly summarizing existing information
- conduct literature searches and interviews, and examine past or ongoing studies to ensure that the problem is correctly defined
- if the problem is complex, consider breaking it into more manageable pieces

Section 3.4 provides guidance on gathering existing site data and determining the usability of this data.

The initial classification of the site involves developing a conceptual model based on the existing information collected during the preliminary investigation. Conceptual models describe a site or facility and its environs and present hypotheses regarding the radionuclides for known and potential residual contamination (EPA 1987b, 1987c). The classification of the site is discussed in Section 3.6, Evaluation of Historical Site Assessment Data.

Several results of the DQO Process may be addressed initially during the HSA. This information or decision may be based on limited or incomplete data. As the site assessment progresses and as decisions become more difficult, the iterative nature of the DQO Process allows for re-evaluation of preliminary decisions. This is especially important for classification of sites and survey units where the final classification is not made until the final status survey is planned.

3.3 Site Identification

A site may already be known for its prior use and presence of radioactive materials. Elsewhere, potential radiation sites may be identified through the following:

- records of authorization to possess or handle radioactive materials (*e.g.*, NRC or NRC Agreement State License, DOE facility records, Naval Radioactive Materials Permit, USAF Master Materials License, Army Radiation Authorization, State Authorization for Naturally Occurring and Accelerator Produced Radioactive Material (NARM))

- notification to government Agencies of possible releases of radioactive substances

- citizens filing a petition under section 105(d) of the Superfund Amendments and Reauthorization Act of 1986 (SARA; EPA 1986)

- ground and aerial radiological surveys

- contacts with knowledge of the site

- review of EPA's Environmental Radiation Ambient Monitoring System (ERAMS) database (Appendix G)

Once identified, the name, location, and current legal owner or custodian (where available) of the site should be recorded.

3.4 Preliminary HSA Investigation

This limited-scope investigation serves to collect readily available information concerning the facility or site and its surroundings. The investigation is designed to obtain sufficient information to provide initial classification of the site or survey unit as impacted or non-impacted. Information on the potential distribution of radioactive contamination may be used for classifying each site or survey unit as Class 2 or Class 1 and is useful for planning scoping and characterization surveys.

Table 3.1 provides a set of questions that can be used to assist in the preliminary HSA investigation. Apart from obvious cases (*e.g.*, NRC licensees), this table focuses on characteristics that identify a previously unrecognized or known but undeclared source of potential contamination. Furthermore, these questions may identify confounding factors for selecting reference sites.

Table 3.1 Questions Useful for the Preliminary HSA Investigation

1.	Was the site ever licensed for the manufacture, use, or distribution of radioactive materials under Agreement State Regulations, NRC licenses, or Armed Services permits, or for the use of 91B material?	Indicates a higher probability that the area is impacted.
2.	Did the site ever have permits to dispose of, or incinerate, radioactive material onsite? Is there evidence of such activities?	Evidence of radioactive material disposal indicates a higher probability that the area is impacted.
3.	Has the site ever had deep wells for injection or permits for such?	Indicates a higher probability that the area is impacted.
4.	Did the site ever have permits to perform research with radiation generating devices or radioactive materials except medical or dental x-ray machines?	Research that may have resulted in the release of radioactive materials indicates a higher probability that the area is impacted.
5.	As a part of the site's radioactive materials license were there ever any Soil Moisture Density Gauges (Americium-Beryllium or Plutonium-Beryllium sources), or Radioactive Thickness Monitoring Gauges stored or disposed of onsite?	Leak test records of sealed sources may indicate whether or not a storage area is impacted. Evidence of radioactive material disposal indicates a higher probability that the area is impacted.
6.	Was the site used to create radioactive material(s) by activation?	Indicates a higher probability that the area is impacted.
7.	Were radioactive sources stored at the site?	Leak test records of sealed sources may indicate whether or not a storage area is impacted.
8.	Is there evidence that the site was involved in the Manhattan Project or any Manhattan Engineering District (MED) activities (1942-1946)?	Indicates a higher probability that the area is impacted.
9.	Was the site ever involved in the support of nuclear weapons testing (1945-1962)?	Indicates a higher probability that the area is impacted.
10.	Were any facilities on the site used as a weapons storage area? Was weapons maintenance ever performed at the site?	Indicates a higher probability that the area is impacted.
11.	Was there ever any decontamination, maintenance, or storage of radioactively contaminated ships, vehicles, or planes performed onsite?	Indicates a higher probability that the area is impacted.

Table 3.1 Questions Useful for the Preliminary HSA Investigation (continued)

12.	Is there a record of any aircraft accident at or near the site (*e.g.*, depleted uranium counterbalances, thorium alloys, radium dials)?	May include other considerations such as evidence of radioactive materials that were not recovered.
13.	Was there ever any radiopharmaceutical manufacturing, storage, transfer, or disposal onsite?	Indicates a higher probability that the area is impacted.
14.	Was animal research ever performed at the site?	Evidence that radioactive materials were used for animal research indicates a higher probability that the area is impacted.
15.	Were uranium, thorium, or radium compounds (NORM) used in manufacturing, research, or testing at the site, or were these compounds stored at the site?	Indicates a higher probability that the area is impacted or results in a potential increase in background variability.
16.	Has the site ever been involved in the processing or production of Naturally Occurring Radioactive Material (*e.g.*, radium, fertilizers, phosphorus compounds, vanadium compounds, refractory materials, or precious metals) or mining, milling, processing, or production of uranium?	Indicates a higher probability that the area is impacted or results in a potential increase in background variability.
17.	Were coal or coal products used onsite? If yes, did combustion of these substances leave ash or ash residues onsite? If yes, are runoff or production ponds onsite?	May indicate other considerations such as a potential increase in background variability.
18.	Was there ever any onsite disposal of material known to be high in naturally occurring radioactive materials (*e.g.*, monazite sands used in sandblasting)?	May indicate other considerations such as a potential increase in background variability.
19.	Did the site process pipe from the oil and gas industries?	Indicates a higher probability that the area is impacted or results in a potential increase in background variability.
20.	Is there any reason to expect that the site may be contaminated with radioactive material (other than previously listed)?	See Section 3.6.3.

Appendix G of this document provides a general listing and cross-reference of information sources—each with a brief description of the information contained in each source. The *Site Assessment Information Directory* (EPA 1991e) contains a detailed compilation of data sources, including names, addresses, and telephone numbers of agencies that can provide HSA information.

3.4.1 Existing Radiation Data

Site files, monitoring data, former site evaluation data, Federal, State, or local investigations, or emergency actions may be sources of useful site information. Existing site data may provide specific details about the identity, concentration, and areal distribution of contamination. However, these data should be examined carefully because:

- Previous survey and sampling efforts may not be compatible with HSA objectives or may not be extensive enough to characterize the facility or site fully.

- Measurement protocols and standards may not be known or compatible with HSA objectives (*e.g.*, Quality Assurance/Quality Control (QA/QC) procedures, limited analysis rather than full-spectrum analysis) or may not be extensive enough to characterize the facility or site fully.

- Conditions may have changed since the site was last sampled (*i.e.*, substances may have been released, migration may have spread the contamination, additional waste disposal may have occurred, or decontamination may have been performed).

Existing data can be evaluated using the Data Quality Assessment (DQA) process described in Appendix E. (Also see DOE 1987 and EPA 1980c, 1992a, 1992b, 1996a for additional guidance on evaluating data.)

3.4.1.1 Licenses, Site Permits, and Authorizations

The facility or site radioactive materials license and supporting or associated documents are potential sources of information for licensed facilities. If a license does not exist, there may be a permit or other document that authorized site operations involving radioactivity. These documents may specify the quantities of radioactive material authorized for use at the site, the chemical and physical form of the materials, operations for which the materials are (or were) used, locations of these operations at the facility or site, and total quantities of material used at the site during its operating lifetime.

EPA and State agencies maintain files on a variety of environmental programs. These files may contain permit applications and monitoring results with information on specific waste types and quantities, sources, type of site operations, and operating status of the facility or site. Some of these information sources are listed in Appendix G (*e.g.*, Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), Resource Conservation and Recovery Information System (RCRIS), Ocean Data Evaluation System (ODES)).

3.4.1.2 Operating Records

Records and other information sources useful for site evaluations include those describing onsite activities; current and past contamination control procedures; and past operations involving demolition, effluent releases, discharge to sewers or onsite septic systems, production of residues, land filling, waste and material storage, pipe and tank leaks, spills and accidental releases, release of facilities or equipment from radiological controls, and onsite or offsite radioactive and hazardous waste disposal. Some records may be or may have been classified for National Security purposes and means should be established to review all pertinent records. Past operations should be summarized in chronological order along with information indicating the type of permits and approvals that authorized these operations. Estimates of the total activity disposed of or released at the site and the physical and chemical form of the radioactive material should also be included. Records on waste disposal, environmental monitoring, site inspection reports, license applications, operational permits, waste disposal material balance and inventory sheets, and purchase orders for radioactive materials are useful—for estimating total activity. Information on accidents, such as fires, flooding, spills, unintentional releases, or leakage, should be collected as potential sources of contamination. Possible areas of localized contamination should be identified.

Site plats or plots, blueprints, drawings, and sketches of structures are especially useful to illustrate the location and layout of buildings on the site. Site photographs, aerial surveys, and maps can help verify the accuracy of these drawings or indicate changes following the time when the drawings were prepared. Processing locations—plus waste streams to and from the site as well as the presence of stockpiles of raw materials and finished product—should be noted on these photographs and maps. Buildings or outdoor processing areas may have been modified or reconfigured such that former processing areas were converted to other uses or configurations. The locations of sewers, pipelines, electric lines, water lines, *etc.*, should also be identified. This information facilitates planning the Site Reconnaissance and subsequent surveys, developing a site conceptual model, and increasing the efficiency of the survey program.

Corporate contract files may also provide useful information during subsequent stages of the Radiation Survey and Site Investigation Process. Older facilities may not have complete operational records, especially for obsolete or discontinued processes. Financial records may also provide information on purchasing and shipping that in turn help to reconstruct a site's operational history.

While operating records can be useful tools during the HSA, the investigator should be careful not to place too much emphasis on this type of data. These records are often incomplete and lack information on substances previously not considered hazardous. Out-of-date blueprints and drawings may not show modifications made during the lifetime of a facility.

3.4.2 Contacts and Interviews

Interviews with current or previous employees are performed to collect first-hand information about the site or facility and to verify or clarify information gathered from existing records. Interviews to collect first-hand information concerning the site or facility are generally conducted early in the data-gathering process. Interviews cover general topics, such as radioactive waste handling procedures. Results of early interviews are used to guide subsequent data collection activities.

Interviews scheduled late in the data gathering process may be especially useful. This activity allows questions to be directed to specific areas of the investigation that need additional information or clarification. Photographs and sketches can be used to assist the interviewer and allow the interviewees to recall information of interest. Conducting interviews onsite where the employees performed their tasks often stimulates memories and facilitates information gathering. In addition to interviewing managers, engineers, and facility workers, interviews may be conducted with laborers and truck drivers to obtain information from their perspective. The investigator should be cautious in the use of interview information. Whenever possible, anecdotal evidence should be assessed for accuracy and results of interviews should be backed up with supporting data. Steps that ensure specific information is properly recorded may include hiring trained investigators and taking affidavits.

3.5 Site Reconnaissance

The objective of the Site Reconnaissance or Site Visit is to gather sufficient information to support a decision regarding further action. Reconnaissance activity is not a risk assessment, a scoping survey, or a study of the full extent of contamination at a facility or site. The reconnaissance offers an opportunity to record information concerning hazardous site conditions as they apply to conducting future survey work. In this regard, information describing physical hazards, structural integrity of buildings, or other conditions, defines potential problems that may impede future work. This section is most applicable to sites with less available information and may not be necessary at other sites having greater amounts of data, such as Nuclear Regulatory Commission (NRC) licensed facilities.

To prepare for the Site Reconnaissance, begin by reviewing what is known about the facility or site and identify data gaps. Given the site-specific conditions, consider whether or not a Site Reconnaissance is necessary and practical. This type of effort may be deemed necessary if a site is abandoned, not easily observed from areas of public access, or discloses little information during file searches. These same circumstances may also make a Site Reconnaissance risky for health and safety reasons—in view of the many unknowns—and may make entry difficult. This investigative step may be practical, but less critical, for active facilities whose operators grant

access and provide requested information. Remember to arrange for proper site access and prepare an appropriate health and safety plan, if required, before initiating the Site Reconnaissance.

Investigators should acquire signed consent forms from the site or equipment owner to gain access to the property to conduct the reconnaissance. Investigators are to determine if State and Federal officials, and local individuals, should be notified of the reconnaissance schedule. If needed, local officials should arrange for public notification. Guidance on obtaining access to sites can be found in *Entry and Continued Access Under CERCLA* (EPA 1987d).

A study plan should be prepared before the Site Reconnaissance to anticipate every reconnaissance activity and identify specific information to be gathered. This plan should incorporate a survey of the site's surroundings and provide details for activities that verify or identify the location of: nearby residents, worker populations, drinking water or irrigation wells, foods, and other site environs information.

Preparing for the Site Reconnaissance includes initially gathering necessary materials and equipment. This includes a camera to document site conditions, health and safety monitoring instruments including a radiation detection meter for use during the site visit, and extra copies of topographic maps to mark target locations, water distribution areas, and other important site features. A logbook is critical to keeping a record of field activities and observations as they occur. For documentation purposes MARSSIM recommends that the logbook be completed in waterproof ink, preferably by one individual. Furthermore, each page of the logbook should be signed and dated, including the time of day, after the last entry on the page. Corrections should be documented and approved.

3.6 Evaluation of Historical Site Assessment Data

The main purpose of the Historical Site Assessment (HSA) is to determine the current status of the site or facility, but the data collected may also be used to differentiate sites that need further action from those that pose little or no threat to human health and the environment. This screening process can serve to provide a site disposition recommendation or to recommend additional surveys. Because much of the data collected during HSA activities is qualitative or is analytical data of unknown quality, many decisions regarding a site are the result of professional judgment.

There are three possible recommendations that follow the HSA:

- An emergency action to reduce the risk to human health and the environment—this alternative is applicable to Superfund removal actions, which are discussed in detail by EPA (EPA 1988c).

- The site or area is impacted and further investigation is needed before a decision regarding final disposition can be made. The area may be Class 1, Class 2, or Class 3, and a scoping survey or a characterization survey should be performed. Information collected during the HSA can be very useful in planning these subsequent survey activities.

- The site or area is non-impacted. There is no possibility or an extremely low probability of residual radioactive materials being present at the site. The site or area can be released.

Historical analytical data indicating the presence of contamination in environmental media (surface soil, subsurface soil, surface water, ground water, air, or buildings) can be used to support the hypothesis that radioactive material was released at the facility or site. A decision that the site is contaminated can be made regardless of the quality of the data, its attribution to site operations, or its relationship to background levels. In such cases, analytical indications are sufficient to support the hypothesis—it is not necessary to definitively demonstrate that a problem exists. Conversely, historical analytical data can also be used to support the hypothesis that no release has occurred. However, these data should not be the sole basis for this hypothesis. Using historical analytical data as the principal reason for ruling out the occurrence of contamination forces the data to demonstrate that a problem does not exist.

In most cases it is assumed there will be some level of process knowledge available in addition to historical analytical data. If process knowledge suggests that no residual contamination should be present and the historical analytical data also suggests that no residual contamination is present, the process knowledge provides an additional level of confidence and supports classifying the area as non-impacted. However, if process knowledge suggests no residual contamination should be present but the historical analytical data indicate the presence of residual contamination, the area will probably be considered impacted.

The following sections describe the information recommended for assessing the status of a site. This information is needed to accurately and completely support a site disposition recommendation. If some of the information is not available, it should be identified as a data need for future surveys. Data needs are collected during Step 3 of the Data Quality Objective (DQO) process (Identify Inputs to the Decision) as described in Appendix D, Section D.3. Section 3.6.5 provides information on professional judgment and how it may be applied to the decision making process.

3.6.1 Identify Potential Contaminants

An efficient HSA gathers information sufficient to identify the radionuclides used at the site—including their chemical and physical form. The first step in evaluating HSA data is to estimate the potential for residual contamination by these radionuclides.

Site operations greatly influence the potential for residual contamination (NRC 1992a). An operation that only handled encapsulated sources is expected to have a low potential for contamination—assuming that the integrity of the sources was not compromised. A review of leak-test records for such sources may be adequate to demonstrate the low probability of residual contamination. A chemical manufacturing process facility would likely have contaminated piping, ductwork, and process areas, with a potential for soil contamination where spills, discharges, or leaks occurred. Sites using large quantities of radioactive ores—especially those with outside waste collection and treatment systems—are likely to have contaminated grounds. If loose dispersible materials were stored outside or process ventilation systems were poorly controlled, then windblown surface contamination may be possible.

Consider how long the site was operational. If enough time elapsed since the site discontinued operations, radionuclides with short half-lives may no longer be present in significant quantities. In this case, calculations demonstrating that residual activity could not exceed the DCGL may be sufficient to evaluate the potential residual contaminants at the site. A similar consideration can be made based on knowledge of a contaminant's chemical and physical form. Such a determination relies on records of radionuclide inventories, chemical and physical forms, total amounts of activity in waste shipments, and purchasing records to document and support this decision. However, a number of radionuclides experience significant decay product ingrowth, which should be included when evaluating existing site information.

3.6.2 Identify Potentially Contaminated Areas

Information gathered during the HSA should be used to provide an initial classification of the site areas as impacted or non-impacted.

Impacted areas have a reasonable potential for radioactive contamination (based on historical data) or contain known radioactive contamination (based on past or preliminary radiological surveillance). This includes areas where 1) radioactive materials were used and stored; 2) records indicate spills, discharges, or other unusual occurrences that could result in the spread of contamination; and 3) radioactive materials were buried or disposed. Areas immediately surrounding or adjacent to these locations are included in this classification because of the potential for inadvertent spread of contamination.

Non-impacted areas—identified through knowledge of site history or previous survey information—are those areas where there is no reasonable possibility for residual radioactive contamination. The criteria used for this segregation need not be as strict as those used to demonstrate final compliance with the regulations. However, the reasoning for classifying an area as non-impacted should be maintained as a written record. Note that—based on accumulated survey data—an impacted area's classification may change as the RSSI Process progresses.

All potential sources of radioactivity in impacted areas should be identified and their dimensions recorded (in 2 or 3 dimensions—to the extent they can be measured or estimated). Sources can be delineated and characterized through visual inspection during the site reconnaissance, interviews with knowledgeable personnel, and historical information concerning disposal records, waste manifests, and waste sampling data. The HSA should address potential contamination from the site whether it is physically within or outside of site boundaries. This approach describes the site in a larger context, but as noted in Chapter 1, MARSSIM's scope concerns releasing a site and not areas outside a site's boundaries.

3.6.3 Identify Potentially Contaminated Media

The next step in evaluating the data gathered during the HSA is to identify potentially contaminated media at the site. To identify media that may and media that do not contain residual contamination supports both preliminary area classification (Section 4.4) and planning subsequent survey activities.

This section provides guidance on evaluating the likelihood for release of radioactivity into the following environmental media: surface soil, subsurface soil, sediment, surface water, ground water, air, and buildings. While MARSSIM's scope is focused on surface soils and building surfaces, this section makes note of still other media to provide a starting place to identify and address all possible media. The evaluation will result in either a finding of "Suspected Contamination" or "No Suspected Contamination," which may be based on analytical data, professional judgment, or a combination of the two.

Subsequent sections describe the environmental media and pose questions pertinent to each type. Each question is accompanied by a commentary. Carefully consider the questions within the context of the site and the available data. Avoid spending excessive amounts of time answering each question because answers to every question are unlikely to be available at each site. Questions that cannot be answered based on existing data can be used to direct future surveys of the site. Also, keep in mind the numerous differences in site-specific circumstances and that the questions do not identify every characteristic that might apply to a specific site. Additional questions or characteristics identified during a specific site assessment should be included in the HSA report (Section 3.8; EPA 1991f).

3.6.3.1 Surface Soil

Surface soil is the top layer of soil on a site that is available for direct exposure, growing plants, resuspension of particles for inhalation, and mixing from human disturbances. Surface soil may also be defined as the thickness of soil that can be measured using direct measurement or scanning techniques. Typically, this layer is represented as the top 15 cm (6 in.) of soil (40 CFR 192). Surface sources may include gravel fill, waste piles, concrete, or asphalt paving. For many

sites where radioactive materials were used, one first assumes that surface contamination exists and the evaluation is used to identify areas of high and low probability of contamination (Class 1, Class 2 or Class 3 areas).

- Were all radiation sources used at the site encapsulated sources?

A site where only encapsulated sources were used would be expected to have a low potential for contamination. A review of the leak-test records and documentation of encapsulated source location may be adequate for a finding of "No Suspected Contamination."

- Were radiation sources used only in specific areas of the site?

Evidence that radioactive materials were confined to certain areas of the site may be helpful in determining which areas are impacted and which are non-impacted.

- Was surface soil regraded or moved elsewhere for fill or construction purposes?

This helps to identify additional potential radiation sites.

3.6.3.2 Subsurface Soil and Media

Subsurface soil and media are defined as any solid materials not considered to be surface soil. The purpose of these investigations is to locate and define the vertical extent of the potential contamination. Subsurface measurements can be expensive, especially for beta- or alpha-emitting radionuclides. Removing areas from consideration for subsurface measurements or defining areas as non-impacted for subsurface sampling conserves limited resources and focuses the site assessment on areas of concern.

- Are there areas of known or suspected surface soil contamination?

Surface soil contamination can migrate deeper into the soil. Surface soil sources should be evaluated based on radionuclide mobility, soil permeability, and infiltration rate to determine the potential for subsurface contamination. Computer modeling may be helpful for evaluating these types of situations.

- Is there a ground-water plume without an identifiable source?

Contaminated ground water indicates that a source of contamination is present. If no source is identified during the HSA, subsurface contamination is a probable source.

- Is there potential for enhanced mobility of radionuclides in soils?

Radionuclide mobility can be enhanced by the presence of solvents or other volatile chemicals that affect the ion-exchange capacity of soil.

- Is there evidence that the surface has been disturbed?

Recent or previous excavation activities are obvious sources of surface disturbance. Areas with developed plant life (forested or old growth areas) may indicate that the area remained undisturbed during the operating life of the facility. Areas where vegetation is removed during previous excavation activity may be distinct from mature plant growth in adjacent areas. If a site is not purposely replanted, vegetation may appear in a sequence starting with grasses that are later replaced by shrubs and trees. Typically, grasslands recover within a few years, sagebrush or low ground cover appears over decades, while mature forests may take centuries to develop.

- Is there evidence of subsurface disturbance?

Non-intrusive, non-radiological measurement techniques may provide evidence of subsurface disturbance. Magnetometer surveys can identify buried metallic objects, and ground-penetrating radar can identify subsurface anomalies such as trenches or dump sites. Techniques involving special equipment are discussed in Section 6.10.

- Are surface structures present?

Structures constructed at a site—during the operational history of that site—may cover below-ground contamination. Some consideration for contaminants that may exist beneath parking lots, buildings, or other onsite structures may be warranted as part of the investigation. There may be underground piping, drains, sewers, or tanks that caused contamination.

3.6.3.3 Surface Water

Surface waters include streams and rivers, lakes, coastal tidal waters, and oceans. Note that certain ditches and intermittently flowing streams qualify as surface water. The evaluation determines whether radionuclides are likely to migrate to surface waters or their sediments. Where a previous release is not suspected, the potential for future release depends on the distance to surface water and the flood potential at the site. With regard to the two preceding sections, one can also consider an interaction between soil and water in relation to seasonal factors including soil cracking due to freezing, thawing, and dessication that influence the dispersal or infiltration of radionuclides.

- Is surface water nearby?

The proximity of a contaminant to local surface water is essentially determined by runoff and radionuclide migration through the soil. The definition for *nearby* depends on site-specific conditions. If the terrain is flat, precipitation is low, and soils are sandy, nearby may be within several meters. If annual precipitation is high or occasional rainfall events are high, within 1,200 meters (3/4 mile) might be considered nearby. In general, sites need not include the surface water pathway where the overland flow distance to the nearest surface water is more than 3,200 meters (2 miles).

- Is the waste quantity particularly large?

Depending on the physical and chemical form of the waste and its location, *large* is a relative term. A *small* quantity of liquid waste may be of more importance—*i.e.*, a greater risk or hazard—than a *large* quantity of solid waste stored in water tight containers.

- Is the drainage area large?

The drainage area includes the area of the site itself plus the upgradient area that produces runoff flowing over the site. Larger drainage areas generally produce more runoff and increase the potential for surface water contamination.

- Is rainfall heavy?

If the site and surrounding area are flat, a combination of heavy precipitation and low infiltration rate may cause rainwater to pool on the site. Otherwise, these characteristics may contribute to high runoff rates that carry radionuclides overland to surface water. Total annual rainfall exceeding one meter (40 inches), or a once in two-year-24-hour precipitation exceeding five cm (two inches) might be considered “heavy.”

Rainfall varies for locations across the continental United States from high (*e.g.*, 89 in./y, Mt. Washington, NH) to low values (*e.g.*, 4.2 in./y, Las Vegas, NV). Precipitation rates will vary during the year at each location due to seasonal and geographic factors. A median value for rainfall within the United States, as found in van der Leeden *et al*. 1990, is about 26 in./y as is observed for Minneapolis, MN.

- Is the infiltration rate low?

Infiltration rates range from very high in gravelly and sandy soils to very low in fine silt and clay soils. Paved sites prevent infiltration and generate runoff.

- Are sources of contamination poorly contained or prone to runoff?

Proper containment which prevents radioactive material from migrating to surface water generally uses engineered structures such as dikes, berms, run-on and runoff control systems, and spill collection and removal systems. Sources prone to releases via runoff include leaks, spills, exposed storage piles, or intentional disposal on the ground surface. Sources not prone to runoff include underground tanks, above-ground tanks, and containers stored in a building.

- Is a runoff route well defined?

A well defined runoff route—along a gully, trench, berm, wall, *etc*.—will more likely contribute to migration to surface water than a poorly defined route. However, a poorly defined route may contribute to dispersion of contamination to a larger area of surface soil.

- Has deposition of waste into surface water been observed?

Indications of this type of activity will appear in records from past practice at a site or from information gathered during personal interviews.

- Is ground water discharge to surface water probable?

The hydrogeology and geographical information of the area around and inside the site may be sufficiently documented to indicate discharge locations.

- Does analytical or circumstantial evidence suggest surface water contamination?

Any condition considered suspicious—and that indicates a potential contamination problem—can be considered circumstantial evidence.

- Is the site prone to flooding?

The Federal Emergency Management Agency (FEMA) publishes flood insurance rate maps that delineate 100-year and 500-year flood plains. Ten-year floodplain maps may also be available. Generally, a site on a 500-year floodplain is not considered prone to flooding.

3.6.3.4 Ground Water

Proper evaluation of ground water includes a general understanding of the local geology and subsurface conditions. Of particular interest is descriptive information relating to subsurface stratigraphy, aquifers, and ground water use.

- Are sources poorly contained?

Proper containment which prevents radioactive material from migrating to ground water generally uses engineered structures such as liners, layers of low permeability soil (*e.g.*, clay), and leachate collection systems.

- Is the source likely to contaminate ground water?

Underground tanks, landfills,[2] surface impoundments and lagoons are examples of sources that are likely to release contaminants that migrate to ground water. Above ground tanks, drummed solid wastes, or sources inside buildings are less likely to contribute to ground-water contamination.

- Is waste quantity particularly large?

Depending on the physical and chemical form of the waste and its location, *large* is a relative term. A *small* quantity of liquid waste may be of more importance—*i.e.*, greater risk or hazard—than a *large* quantity of solid waste stored in water tight containers.

- Is precipitation heavy?

If the site and surrounding area are flat, a combination of heavy precipitation and low infiltration rate may cause rainwater to pool on the site. Otherwise, these characteristics may contribute to high runoff rates that carry radionuclides overland to surface water. Total annual rainfall exceeding one meter (40 in.), or a once in two-year-24-hour precipitation exceeding five cm (two in.) might be considered "heavy."

Rainfall varies for locations across the continental United States from high (*e.g.*, 89 in./y, Mt. Washington, NH) to low values (*e.g.*, 4.2 in./y, Las Vegas, NV). Precipitation rates will vary during the year at each location due to seasonal and geographic factors. A median value for rainfall within the United States, as found in van der Leeden *et al*. 1990, is about 26 in./y as is observed for Minneapolis, MN.

- Is the infiltration rate high?

Infiltration rates range from very high in gravelly and sandy soils to very low in fine silt and clay soils. Unobstructed surface areas are potential candidates for further examination to determine infiltration rates.

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[2] Landfills can affect the geology and hydrogeology of a site and produce heterogeneous conditions. It may be necessary to consult an expert on landfills and the conditions they generate.

- Is the site located in an area of karst terrain?

In karst terrain, ground water moves rapidly through channels caused by dissolution of the rock material (usually limestone) that facilitates migration of contaminants.

- Is the subsurface highly permeable?

Highly permeable soils favor downward movement of water that may transport radioactive materials. Well logs, local geologic literature, or interviews with knowledgeable individuals may help answer this question.

- What is the distance from the surface to an aquifer?

The shallower the source of ground water, the higher the threat of contamination. It is difficult to determine whether an aquifer may be a potential source of drinking water in the future (*e.g.*, next 1,000 years). This generally applies to the shallowest aquifer below the site.

- Are suspected contaminants highly mobile in ground water?

Mobility in ground water can be estimated based on the distribution coefficient (K_d) of the radionuclide. Elements with a high K_d, like thorium (*e.g.*, K_d = 3,200 cm^3/g), are not mobile while elements with a low K_d, like hydrogen (*e.g.*, K_d = 0 cm^3/g), are very mobile. The NRC (NRC 1992b) and Department of Energy (DOE) (Yu, *et al.*, 1993) provide a compilation of K_d values. These values can be influenced by site-specific considerations such that site-specific K_d values need to be evaluated or determined. Also, the mobility of a radionuclide can be enhanced by the presence of a solvent or volatile chemical.

- Does analytical or circumstantial evidence suggest ground water contamination?

Evidence for contamination may appear in current site data; historical, hydrogeological, and geographical information systems records; or as a result of personal interviews.

3.6.3.5 Air

Evaluation of air is different than evaluation of other potentially contaminated media. Air is rarely the source of contamination. Air is evaluated as a pathway for resuspending and dispersing radioactive contamination as well as a contaminated media.

- Were there observations of contaminant releases into the air?

Direct observation of a release to the air might occur where radioactive materials are suspected to be present in particulate form (*e.g.*, mine tailings, waste pile) or adsorbed to particulates (*e.g.*, contaminated soil), and where site conditions favor air transport (*e.g.*, dry, dusty, windy).

- Does analytical or circumstantial evidence suggest a release to the air?

Other evidence for releases to the air might include areas of surface soil contamination that do not appear to be caused by direct deposition or overland migration of radioactive material.

- For radon exposure only, are there elevated amounts of radium (^{226}Ra) in the soil or water that could act as a source of radon in the air?

The source, ^{226}Ra, decays to ^{222}Rn, which is radon gas. Once radon is produced, the gas needs a pathway to escape from its point of origin into the air. Radon is not particularly soluble in water, so this gas is readily released from water sources which are open to air. Soil, however, can retain radon gas until it has decayed (see Section 6.9). The rate that radon is emitted by a solid, *i.e.* radon flux, can be measured directly to evaluate potential sources of radon.

- Is there a prevailing wind and a propensity for windblown transport of contamination?

Information pertaining to geography, ground cover (*e.g.*, amount and types of local vegetation), meteorology (*e.g.*, windspeed at 7 meters above ground level) for and around the site, plus site-specific parameters related to surface soil characteristics enter into calculations used to describe particulate transport. Mean annual windspeed can be obtained from the National Weather Service surface station nearest to the site.

3.6.3.6 Structures

Structures used for storage, maintenance, or processing of radioactive materials are potentially contaminated by these materials. The questions presented in Table 3.1 help to determine if a building might be potentially contaminated. The questions listed in this section are for identifying potentially contaminated structures, or portions of structures, that might not be identified using Table 3.1. Section 4.8.3.1 also presents useful information on identifying structural contamination.

- Were adjacent structures used for storage, maintenance, or processing of radioactive materials?

Adjacent is a relative term for this question. A processing facility with a potential for venting radioactive material to the air could contaminate buildings downwind. A facility with little potential for release outside of the structures handling the material would be less likely to contaminate nearby structures.

- Is a building or its addition or a new structure located on a former radioactive waste burial site or contaminated land?

Comparing past and present photographs or site maps and retrieving building permits or other structural drawings and records in relation to historical operations information will reveal site locations where structures may have been built over buried waste or contaminated land.

- Was the building constructed using contaminated material?

Building materials such as concrete, brick, or cinder block may have been formed using contaminated material.

- Does the potentially non-impacted portion of the building share a drainage system or ventilation system with a potentially contaminated area?

Technical and architectural drawings for site structures along with visual inspections are required to determine if this is a concern in terms of current or past operations.

- Is there evidence that previously identified areas of contamination were remediated by painting or similar methods of immobilizing contaminants?

Removable sources of contamination immobilized by painting may be more difficult to locate, and may need special consideration when planning subsequent surveys.

3.6.4 Develop a Conceptual Model of the Site

Starting with project planning activities, one gathers and analyzes available information to develop a conceptual site model. The model is essentially a site diagram showing locations of known contamination, areas of suspected contamination, types and concentrations of radionuclides in impacted areas, potentially contaminated media, and locations of potential reference (background) areas. The diagram should include the general layout of the site including buildings and property boundaries. When possible, produce three dimensional diagrams. The conceptual site model will be upgraded and modified as information becomes

available throughout the RSSI Process. The process of developing this model is also briefly described in Attachment A of EPA 1996b.

The model is used to assess the nature and the extent of contamination, to identify potential contaminant sources, release mechanisms, exposure pathways, human and/or environmental receptors, and to develop exposure scenarios. Further, this model helps to identify data gaps, determine media to be sampled, and assists staff in developing strategies for data collection. Site history and preliminary survey data generally are extremely useful sources of information for developing this model. The conceptual site model should include known and suspected sources of contamination and the types of contaminants and affected media. Such a model can also illustrate known and potential routes of migration and known or potential human and environmental receptors.

The site should be classified or initially divided into similar areas. Classification may be based on the operational history of the site or observations made during the Site Reconnaissance (see Section 3.5.2). After the site is classified using current and past site characteristics, further divide the site or facility based on anticipated future use. This classification can help to a) assign limited resources to areas that are anticipated to be released without restrictions, and b) identify areas with little or no possibility of unrestricted release. Figure 3.1 shows an example of how a site might be classified in this manner. Further classification of a site may be possible based on site disposition recommendations (unrestricted vs. release with passive controls).

3.6.5 Professional Judgment

In some cases, traditional sources of information, data, models, or scientific principles are unavailable, unreliable, conflicting, or too costly or time consuming to obtain. In these instances professional judgment may be the only practical tool available to the investigator. Professional judgment is the expression of opinion, that is documented in written form and based on technical knowledge and professional experience, assumptions, algorithms, and definitions, as stated by an expert in response to technical problems (NRC 1990). For general applications, this type of judgment is a routine part of scientific investigation where knowledge is incomplete. Professional judgment can be used as an independent review of historical data to support decision making during the HSA. Professional judgment should only be used in situations where data are not reasonably obtainable by collection or experimentation.

The process of recruiting professionals should be documented and as unbiased as possible. The credentials of the selected individual or individuals enhance the credibility of the elicitation, and the ability to communicate their reasoning is a primary determinant of the quality of the results. Qualified professionals can be identified by different sources, including the planning team, professional organizations, government agencies, universities, consulting firms, and public interest groups. The selection criteria for the professionals should include potential conflict of interest (economic or personal), evidence of expertise in a required topic, objectiveness, and availability.

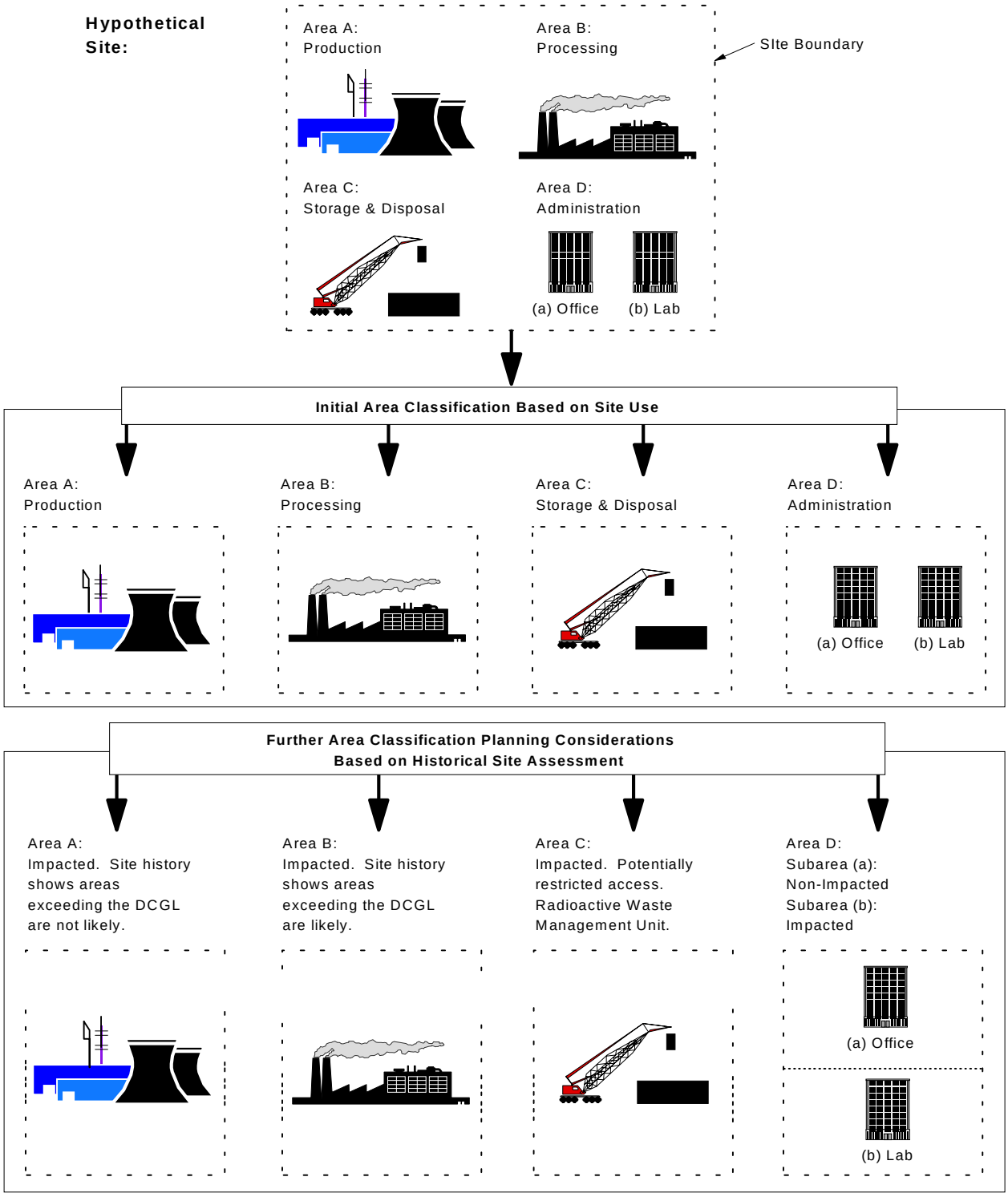


Figure 3.1 Example Showing how a Site Might be Classified Prior to Cleanup Based on the Historical Site Assessment

3.7 Determining the Next Step in the Site Investigation Process

As stated in Section 1.1, the purpose of this manual is to describe a process-oriented approach for demonstrating compliance with the release criterion for residual radioactivity. The highest probability of demonstrating compliance can be obtained by sequentially following each step in the RSSI Process. In some cases, however, performing each step in the process is not practical or necessary. This section provides guidance on how the results of the HSA can be used to determine the next step in the process.

The best method for determining the next step is to review the purpose for each type of survey described in Chapter 5. For example, a scoping survey is performed to provide sufficient information for determining 1) whether present contamination warrants further evaluation and 2) initial estimates of the level of effort for decontamination and preparing a plan for a more detailed survey. If the HSA demonstrates that this information is already available, do not perform a scoping survey. On the other hand, if the information obtained during the HSA is limited, a scoping survey may be necessary to narrow the scope of the characterization survey.

The exception to conducting additional surveys before a final status survey is the use of HSA results to release a site. Generally, the analytical data collected during the HSA are not adequate to statistically demonstrate compliance for impacted areas as described in Chapter 8. This means that the decision to release the site will be based on professional judgment. This determination will ultimately be decided by the responsible regulatory agency.

3.8 Historical Site Assessment Report

A narrative report is generally a useful product for an HSA. Use this report to summarize what is known about the site, what is assumed or inferred, activities conducted during the HSA, and all researched information. Cite a supporting reference for each factual statement given in the report. Attach copies of references (*i.e.*, those not generally available to the public) to the report. The narrative portion of the report should be written in plain English and avoid the use of technical terminology.

To encourage consistency in the content of HSA narratives, both the structure and content of each report should follow the outline shown in Figure 3.2. Additional information not identified in the outline may be requested by the regulatory agency at its discretion. The level of effort to produce the report should reflect the amount of information gathered during the HSA.

3.9 Review of the HSA

The planning team should ensure that someone (a first reviewer) conducts a detailed review of the HSA report for internal consistency and as a quality-control mechanism. A second reviewer with considerable site assessment experience should then examine the entire information package to assure consistency and to provide an independent evaluation of the HSA conclusions. The second reviewer also evaluates the package to determine if special circumstances exist where radioactivity may be present but not identified in the HSA. Both the first reviewer and a second independent reviewer should examine the HSA written products to ensure internal consistency in the report's information, summarized data, and conclusions. The site review ensures that the HSA's recommendations are appropriate.

An important quality assurance objective is to find and correct errors. A significant inconsistency indicating either an error or a flawed conclusion, if undetected, could contribute to an inappropriate recommendation. Identifying such a discrepancy directs the HSA investigator and site reviewers to reexamine and resolve the apparent conflict.

Under some circumstances, experienced investigators may have differing interpretations of site conditions and draw differing conclusions or hypotheses regarding the likelihood of contamination. Any such differences should be resolved during the review. If a reviewer's interpretations contradict those of the HSA investigator, the two should discuss the situation and reach a consensus. This aspect of the review identifies significant points about the site evaluation that may need detailed explanation in the HSA narrative report to fully support the conclusions. Throughout the review, the HSA investigator and site reviewers should keep in mind the need for conservative judgments in the absence of definitive proof to avoid underestimating the presence of contamination, which could lead to an inappropriate HSA recommendation.

1. Glossary of Terms, Acronyms and Abbreviations
2. Executive Summary
3. Purpose of the Historical Site Assessment
4. Property Identification
   - 4.1 Physical Characteristics
     - 4.1.1 Name - CERCLIS ID# (if applicable), owner/operator name, address
     - 4.1.2 Location - street address, city, county, state, geographic coordinates
     - 4.1.3 Topography - USGS 7.5 minute quadrangle or equivalent
     - 4.1.4 Stratigraphy
   - 4.2 Environmental Setting
     - 4.2.1 geology
     - 4.2.2 hydrogeology
     - 4.2.3 hydrology
     - 4.2.4 meteorology
5. Historical Site Assessment Methodology
   - 5.1 Approach and Rationale
   - 5.2 Boundaries of Site
   - 5.3 Documents Reviewed
   - 5.4 Property Inspections
   - 5.5 Personal Interviews
6. History and Current Usage
   - 6.1 History - years of operation, type of facility, description of operations, regulatory involvement; permits & licenses, waste handling procedures
   - 6.2 Current Usage - type of facility, description of operations, probable source types and sizes, description of spills or releases, waste manifests, radionuclide inventories, emergency or removal actions
   - 6.3 Adjacent Land Usage - sensitive areas such as wetlands or preschools
7. Findings
   - 7.1 Potential Contaminants
   - 7.2 Potential Contaminated Areas
     - 7.2.1 Impacted Areas—known and potential
     - 7.2.2 Non-Impacted Areas
   - 7.3 Potential Contaminated Media
   - 7.4 Related Environmental Concerns
8. Conclusions
9. References
10. Appendices
    - A. Conceptual Model and Site Diagram showing Classifications
    - B. List of Documents
    - C. Photo documentation Log
      Original photographs of the site and pertinent site features

Figure 3.2 Example of a Historical Site Assessment Report Format

4 PRELIMINARY SURVEY CONSIDERATIONS

4.1 Introduction

This chapter assists the MARSSIM user in designing a survey plan by presenting areas of consideration common to radiation surveys and site investigations in support of decommissioning. The topics discussed here should be addressed during the planning stages of each survey. Figure 4.1 illustrates the sequence of preliminary activities described in this chapter and their relationship to the survey design process.

Conducting radiological surveys in support of decommissioning serves to answer several basic questions, including:

- Is there residual radioactive contamination present from previous uses?
- What is the character (qualitative and quantitative) of the residual activity?
- Is the average residual activity level below the established derived concentration guideline level?
- Are there small localized areas of residual activity in excess of the investigation level?

The survey methods used to evaluate radiological conditions and develop answers to these questions depend on a number of factors including: contaminants, contaminant distribution, acceptable contaminant levels established by the regulatory agency, future site use, and physical characteristics of the site.

4.2 Decommissioning Criteria

The decommissioning process assures that residual radioactivity will not result in individuals being exposed to unacceptable levels of radiation or radioactive materials. Regulatory agencies establish radiation dose standards based on risk considerations and scientific data relating dose to risk. Residual levels of radioactive material that correspond to allowable radiation dose standards are calculated (derived) by analysis of various pathways and scenarios (direct radiation, inhalation, ingestion, *etc.*) through which exposures could occur. These derived levels, known as derived concentration guideline levels (DCGLs), are presented in terms of surface or mass activity concentrations. DCGLs usually refer to average levels of radiation or radioactivity above appropriate background levels. DCGLs applicable to building or other structural and miscellaneous surfaces are expressed in units of activity per surface area (typically Bq/m^2 or $dpm/100\ cm^2$). When applied to soil and induced activity from neutron irradiation, DCGLs are expressed in units of activity per unit of mass (typically Bq/kg or pCi/g).

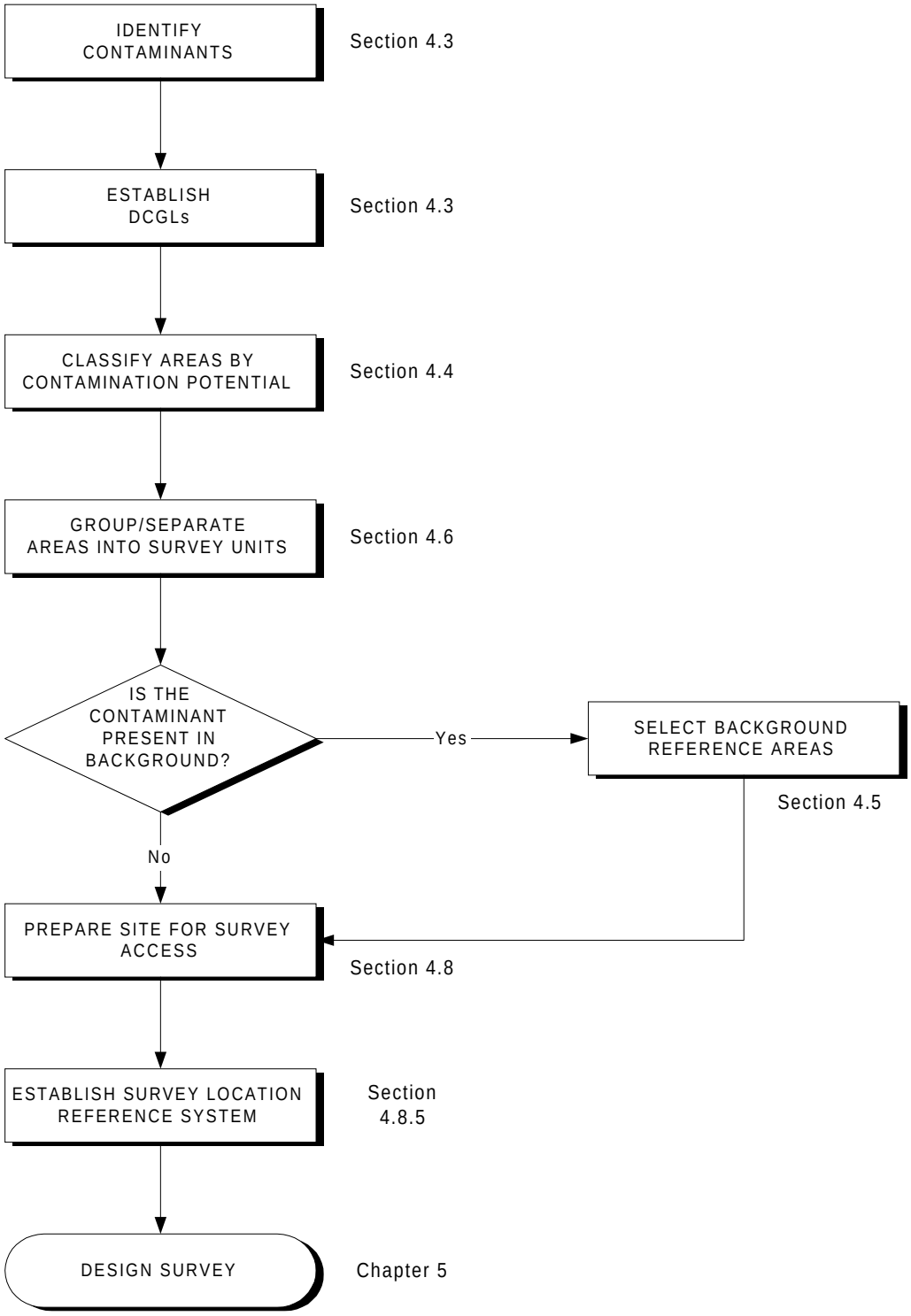


Figure 4.1 Sequence of Preliminary Activities Leading to Survey Design

The $DCGL_W$, based on pathway modeling, is the uniform residual radioactivity concentration level within a survey unit that corresponds to the release criterion (*e.g.*, regulatory limit in terms of dose or risk). Note that for the majority of MARSSIM users, the DCGL will simply be obtained using regulatory agency guidance based on default parameters—other users may elect to perform site-specific pathway modeling to determine DCGLs. In both cases, the DCGL is based on the spatial distribution of the contaminant, and each derivation can produce different values depending on the specific radionuclide distribution and pathway modeling.

In addition to the numerical DCGLs, criteria include conditions for implementing those guideline levels. Conditions applicable to satisfying decommissioning objectives described in Chapter 5 are as follows:

- The uniform residual contamination above background is below the $DCGL_W$.

- Individual measurements or samples, representing small areas of residual radioactivity, do not exceed the $DCGL_{EMC}$ for areas of elevated residual radioactivity. These small areas of residual radioactivity may exceed the $DCGL_W$ established for average residual radioactivity levels in a survey unit, provided these areas of residual radioactivity satisfy the criteria of the responsible regulatory agency.

The manner in which a DCGL is applied should be clearly documented in the survey plans and reports.

4.3 Identify Contaminants and Establish DCGLs

Some objectives of the scoping and characterization surveys, as discussed in Chapter 5, include identifying site contaminants, determining relative ratios of contaminants, and establishing DCGLs and conditions for the contaminants which satisfy the requirements of the responsible agency. Identification of potential radionuclide contaminants at the site is generally performed through laboratory analyses, such as alpha and gamma spectrometry. These analyses are used to determine the relative ratios of the identified contaminants, as well as isotopic ratios for common contaminants like uranium and thorium. This information is essential in establishing and applying the DCGLs for the site. DCGLs provide the goal for essentially all aspects of designing, implementing, and evaluating the final status survey. The DCGLs discussed in this manual are limited to structure surfaces and soil contamination; the user should consult the responsible regulatory agency if it is necessary to establish DCGLs for other environmental media (*e.g.*, ground water, and other water pathways). This section contains information regarding the selection and application of DCGLs.

The development of DCGLs is often an iterative process, where the DCGLs selected or developed early in the Radiation Survey and Site Investigation (RSSI) Process are modified as additional site-specific information is obtained from subsequent surveys. One example of the iterative nature of DCGLs is the development of final cleanup levels in EPA's Superfund program. Soil Screening Levels[1] (SSLs; EPA 1996b, EPA 1996c) are selected or developed at a point early in the process, usually corresponding to the scoping survey in MARSSIM. An SSL can be further developed, based on site-specific information, to become a preliminary remediation goal (PRG; EPA 1991h), usually at a point corresponding to the characterization survey. If the PRG is found to be acceptable during the characterization survey, it is documented as the final cleanup level in the Record of Decision (ROD) for the site. The ROD is typically in place prior to any remedial action, because the remedy is also documented in the ROD. Additional information on the Superfund program can be found in Appendix F.

4.3.1 Direct Application of DCGLs

In the simplest case, the DCGLs may be applied directly to survey data to demonstrate compliance. This involves assessing the surface activity levels and volumetric concentrations of radionuclides and comparing measured values to the appropriate DCGL. For example, consider a site that used only one radionuclide, such as ^{90}Sr throughout its operational lifetime. The default DCGL for ^{90}Sr on building surfaces and in soil may be obtained from the responsible agency. Survey measurements and samples are then compared to the surface and volume activity concentration DCGLs for ^{90}Sr directly to demonstrate compliance. While seemingly straightforward, this approach is not always possible (*e.g.*, when more than one radionuclide is present).

4.3.2 DCGLs and the Use of Surrogate Measurements

For sites with multiple contaminants, it may be possible to measure just one of the contaminants and still demonstrate compliance for all of the contaminants present through the use of surrogate measurements. Both time and resources can be saved if the analysis of one radionuclide is simpler than the analysis of the other. For example, using the measured ^{137}Cs concentration as a surrogate for ^{90}Sr reduces the analytical costs because wet chemistry separations do not have to be performed for ^{90}Sr on every sample. In using one radionuclide to measure the presence of others, a sufficient number of measurements, spatially separated throughout the survey unit, should be made to establish a "consistent" ratio. The number of measurements needed to determine the ratio is selected using the Data Quality Objectives (DQO) Process and based on the chemical, physical, and radiological characteristics of the nuclides and the site. If consistent

[1] Soil Screening Levels are currently available for chemical contaminants and are not designed for use at sites with radioactive contamination.

radionuclide ratios cannot be determined during the Historical Site Assessment (HSA) based on existing information, MARSSIM recommends that one of the objectives of scoping or characterization be a determination of the ratios rather than attempting to determine ratios based on the final status survey. If the ratios are determined using final status survey data, MARSSIM recommends that at least 10% of the measurements (both direct measurements and samples) include analyses for all radionuclides of concern.

In the use of surrogates, it is often difficult to establish a "consistent" ratio between two or more radionuclides. Rather than follow prescriptive guidance on acceptable levels of variability for the surrogate ratio, a more reasonable approach may be to review the data collected to establish the ratio and to use the DQO process to select an appropriate ratio from that data. An example is provided to illustrate the application of surrogate measurements.

Ten soil samples within the survey unit were collected and analyzed for ^{137}Cs and ^{90}Sr to establish a surrogate ratio. The ratios of ^{90}Sr to ^{137}Cs were as follows: 6.6, 5.7, 4.2, 7.9, 3.0, 3.8, 4.1, 4.6, 2.4, and 3.3. An assessment of this example data set results in an average ^{90}Sr to ^{137}Cs surrogate ratio of 4.6, with a standard deviation of 1.7. There are various approaches that may be used to develop a surrogate ratio from this data—but each must consider the variability and level of uncertainty in the data. One may consider the variability in the surrogate ratio by selecting the 95% upper bound of the surrogate ratio (to yield a conservative value of ^{90}Sr from the measured ^{137}Cs), which is 8.0 in this case. Similarly, one may select the most conservative value from the data set (7.9). The DQO process should be used to assess the use of surrogates. The benefit of using the surrogate approach is the reduced cost of not having to perform costly wet chemistry analyses on each sample. This benefit should be considered relative to the difficulty in establishing the surrogate ratio, as well as the potential consequence of unnecessary investigations that result from the error in using a "conservative" surrogate ratio. Selecting a conservative surrogate ratio ensures that potential exposures from individual radionuclides are not underestimated. The surrogate method can only be used with confidence when dealing with the same media in the same surroundings—for example, soil samples with similar physical and geological characteristics. The MARSSIM user will need to consult with the responsible regulatory agency for concurrence on the approach used to determine the surrogate ratio.

Once an appropriate surrogate ratio is determined, one needs to consider how compliance will be demonstrated using surrogate measurements. That is, the user must modify the DCGL of the measured radionuclide to account for the inferred radionuclide. Continuing with the above example, the modified DCGL for ^{137}Cs must be reduced according to the following equation:

$$DCGL_{Cs,\mathrm{mod}} = DCGL_{Cs} \times \frac{DCGL_{Sr}}{[(C_{Sr}/C_{Cs}) \times DCGL_{Cs}] + DCGL_{Sr}} \qquad 4\text{-}1$$

where C_{Sr}/C_{Cs} is the surrogate ratio of ^{90}Sr to ^{137}Cs.

Assuming that the $DCGL_{Sr}$ is 15 Bq/kg, the $DCGL_{Cs}$ is 10 Bq/kg, and the surrogate ratio is 8 (as derived previously), the modified DCGL for ^{137}Cs ($DCGL_{Cs,\ mod}$) can be calculated using Equation 4-1:

$$DCGL_{Cs,\mathrm{mod}} = 10 \times \frac{15}{[8 \times 10] + 15} = 1.6\ Bq/kg$$

This modified DCGL is then used for survey design purposes described in Chapter 5.

The potential for shifts or variations in the radionuclide ratios means that the surrogate method should be used with caution. Physical or chemical differences between the radionuclides may produce different migration rates, causing the radionuclides to separate and changing the radionuclide ratios. Remediation activities have a reasonable potential to alter the surrogate ratio established prior to remediation. MARSSIM recommends that when the ratio is established prior to remediation, additional post-remediation samples should be collected to ensure that the data used to establish the ratio are still appropriate and representative of the existing site condition. If these additional post-remediation samples are not consistent with the pre-remediation data, surrogate ratios should be re-established.

Compliance with surface activity DCGLs for radionuclides of a decay series (*e.g.*, thorium and uranium) that emit both alpha and beta radiation may be demonstrated by assessing alpha, beta, or both radiations. However, relying on the use of alpha surface contamination measurements often proves problematic due to the highly variable level of alpha attenuation by rough, porous, and dusty surfaces. Beta measurements typically provide a more accurate assessment of thorium and uranium contamination on most building surfaces because surface conditions cause significantly less attenuation of beta particles than alpha particles. Beta measurements, therefore, may provide a more accurate determination of surface activity than alpha measurements.

The relationship of beta and alpha emissions from decay chains or various enrichments of uranium should be considered when determining the surface activity for comparison with the $DCGL_W$ values. When the initial member of a decay chain has a long half-life, the radioactivity associated with the subsequent members of the series will increase at a rate determined by the individual half-lives until all members of the decay chain are present at activity levels equal to the activity of the parent. This condition is known as secular equilibrium.

Consider an example where the average surface activity $DCGL_W$ for natural thorium is 1,000 Bq/m^2 (600 dpm/100 cm^2), and all of the progeny are in secular equilibrium—that is, for each disintegration of ^{232}Th there are six alpha and four beta particles emitted in the thorium decay

series. Note that in this example, the surface activity $DCGL_W$ of 1,000 Bq/m^2 is assumed to apply to the total activity from all members of the decay chain. In this situation, the corresponding alpha activity $DCGL_W$ should be adjusted to 600 Bq/m^2 (360 dpm/100 cm^2), and the corresponding beta activity $DCGL_W$ to 400 Bq/m^2 (240 dpm/100 cm^2), in order to be equivalent to 1,000 Bq/m^2 of natural thorium surface activity. For a surface activity $DCGL_W$ of 1,000 Bq/m^2, the beta activity $DCGL_W$ is calculated as follows:

$$\frac{\left(\frac{1{,}000\ Bq\ of\ chain}{m^2}\right) \times \left(\frac{4\beta}{dis\ of\ Th\text{-}232}\right)}{\frac{10\ Bq\ of\ chain}{1\ Bq\ of\ Th\text{-}232}} = \frac{400\ \beta\ Bq}{m^2} \qquad 4\text{-}2$$

To demonstrate compliance with the beta activity $DCGL_W$ for this example, beta measurements (in cpm) must be converted to activity using a weighted beta efficiency that accounts for the energy and yield of each beta particle. For decay chains that have not achieved secular equilibrium, the relative activities between the different members of the decay chain can be determined as previously discussed for surrogate ratios.

Another example for the use of surrogates involves the measurement of exposure rates, rather than surface or volume activity concentrations, for radionuclides that deliver the majority of their dose through the direct radiation pathway. That is, instead of demonstrating compliance with soil or surface contamination DCGLs derived from the direct radiation pathway, compliance is demonstrated by direct measurement of exposure rates. To implement this surrogate method, Historical Site Assessment (HSA) documentation should provide reasonable assurance that no radioactive materials are buried at the site and that radioactive materials have not seeped into the soil or groundwater. This surrogate approach may still be possible for sites that contain radionuclides that *do not* deliver the majority of their dose through the direct radiation pathway. This requires that a consistent relative ratio for the radionuclides that *do* deliver the majority of their dose through the direct radiation pathway can be established. The appropriate exposure rate limit in this case accounts for the radionuclide(s) that *do not* deliver the majority of their dose to the direct radiation pathway. This is accomplished by determining the fraction of the total activity represented by radionuclide(s) that *do* deliver the majority of their dose through the direct radiation pathway, and weighting the exposure rate limit by this fraction. Note that the considerations for establishing consistent relative ratios discussed above apply to this surrogate approach as well. The responsible regulatory agency should be consulted prior to implementing this surrogate approach.

4.3.3 Use of DCGLs for Sites with Multiple Radionuclides

Typically, each radionuclide DCGL corresponds to the release criterion (*e.g.*, regulatory limit in terms of dose or risk). However, in the presence of multiple radionuclides, the total of the DCGLs for all radionuclides would exceed the release criterion. In this case, the individual DCGLs need to be adjusted to account for the presence of multiple radionuclides contributing to the total dose. One method for adjusting the DCGLs is to modify the assumptions made during exposure pathway modeling to account for multiple radionuclides. The surrogate measurements discussed in the previous section describe another method for adjusting the DCGL to account for multiple radionuclides. Other methods include the use of the unity rule and development of a gross activity DCGL for surface activity to adjust the individual radionuclide DCGLs.

The unity rule, represented in the expression below, is satisfied when radionuclide mixtures yield a combined fractional concentration limit that is less than or equal to one:

$$\frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \ldots \frac{C_n}{DCGL_n} \leq 1 \qquad \text{4-3}$$

where

C = concentration
DCGL = guideline value for each individual radionuclide (1, 2, ..., n)

For sites that have a number of significant radionuclides, a higher sensitivity will be needed in the measurement methods as the values of C become smaller. Also, this is likely to affect statistical testing considerations—specifically by increasing the numbers of data points necessary for statistical tests.

4.3.4 Integrated Surface and Soil Contamination DCGLs

Surface contamination DCGLs apply to the total of fixed plus removable surface activity. For cases where the surface contamination is due entirely to one radionuclide, the DCGL for that radionuclide is used for comparison to measurement data (Section 4.3.1).

For situations where multiple radionuclides with their own DCGLs are present, a gross activity DCGL can be developed. This approach enables field measurement of gross activity, rather than determination of individual radionuclide activity, for comparison to the DCGL. The gross activity DCGL for surfaces with multiple radionuclides is calculated as follows:

1. Determine the relative fraction (f) of the total activity contributed by the radionuclide.
2. Obtain the DCGL for each radionuclide present.
3. Substitute the values of f and DCGL in the following equation.

$$Gross\ Activity\ DCGL = \frac{1}{\left(\frac{f_1}{DCGL_1} + \frac{f_2}{DCGL_2} + \ldots \frac{f_n}{DCGL_n} \right)} \qquad 4\text{-}4$$

Example

Assume that 40% of the total surface activity was contributed by a radionuclide with a DCGL of 8,300 Bq/m^2 (5000 dpm/100 cm^2); 40% by a radionuclide with a DCGL of 1,700 Bq/m^2 (1000 dpm/100 cm^2); and 20% by a radionuclide with a DCGL of 830 Bq/m^2 (500 dpm/100 cm^2). Using Equation 4-4,

$$Gross\ Activity\ DCGL = \frac{1}{\frac{0.40}{8{,}300} + \frac{0.40}{1{,}700} + \frac{0.20}{830}}$$

$$= 1{,}900\ \text{Bq/m}^2$$

Note that Equation 4-4 may not work for sites exhibiting surface contamination from multiple radionuclides having unknown or highly variable concentrations of radionuclides throughout the site. In these situations, the best approach may be to select the most conservative surface contamination DCGL from the mixture of radionuclides present. If the mixture contains radionuclides that cannot be measured using field survey equipment, laboratory analyses of surface materials may be necessary.

Because gross surface activity measurements are not nuclide-specific, they should be evaluated by the two-sample nonparametric tests described in Chapter 8 to determine if residual contamination meets the release criterion. Therefore, gross surface activity measurements should be performed for both the survey units being evaluated and for background reference areas. The background reference areas for surface activity typically involve building surfaces and construction materials that are considered free of residual radioactivity (see Section 4.5). The total surface activity due to residual contamination should not exceed the gross activity DCGL calculated above.

For soil contamination, it is likely that specific radionuclides, rather than gross activity, will be measured for demonstrating compliance. For radionuclides that are present in natural background, the two-sample nonparametric test described in Section 8.4 should be used to determine if residual soil contamination exceeds the release criterion. The soil contamination due to residual activity should not exceed the DCGL. To account for multiple background radionuclides, the DCGL should be adjusted in a manner similar to the gross activity DCGL described above. For a known mixture of these radionuclides, each having a fixed relative fraction of the total activity, the site-specific DCGLs for each radionuclide may be calculated by first determining the gross activity DCGL and then multiplying that gross DCGL by the respective fractional contribution of each radionuclide. For example, if ^{238}U, ^{226}Ra, and ^{232}Th have DCGLs of 190 Bq/kg (5.0 pCi/g), 93 Bq/kg (2.5 pCi/g), and 37 Bq/kg (1.0 pCi/g) and activity ratios of 40%, 40%, and 20%, respectively, Equation 4-4 can be used to calculate the gross activity DCGL.

$$Gross\ Activity\ DCGL = \frac{1}{\frac{0.40}{190} + \frac{0.40}{93} + \frac{0.20}{37}}$$

$$= 85 \text{ Bq/kg}$$

The adjusted DCGLs for each of the contributory radionuclides, when present in the given activity ratios, are then 34 Bq/kg (0.40 × 85) for ^{238}U, 34 Bq/kg (0.40 × 85) for ^{226}Ra, and 17 Bq/kg (0.20 × 85) for ^{232}Th. Determining gross activity DCGLs to demonstrate compliance enables an evaluation of site conditions based on analysis for only one of the contributory contaminants (surrogate approach), provided the relative ratios of the contaminants do not change.

For situations where the background radionuclides occurring in background have unknown or variable relative concentrations throughout the site, it may be necessary to perform the two-sample nonparametric tests separately for each radionuclide present. The unity rule should be used to determine that the sum of each radionuclide concentration divided by its DCGL is less than or equal to one.

Therefore, at each measurement location calculate the quantity:

$$\frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \ldots + \frac{C_n}{DCGL_n} \qquad 4\text{-}5$$

where C is the radionuclide concentration.

The values of C are the data to be used in the statistical tests to determine if the average over the survey unit exceeds one.

The same approach applies for radionuclides that are not present in background, with the exception that the one-sample nonparametric statistical test described in Section 8.3 is used in place of the two-sample nonparametric test (see Section 5.5.2.3). Again, for multiple radionuclides either the surrogate approach or the unity rule should be used to demonstrate compliance, if relative ratios are expected to change.

4.4 Classify Areas by Contamination Potential

All areas of the site will not have the same potential for residual contamination and, accordingly, will not need the same level of survey coverage to achieve the established release criteria. The process will be more efficient if the survey is designed so areas with higher potential for contamination (based in part on results of the HSA in Chapter 3) will receive a higher degree of survey effort.

Classification is a critical step in the survey design process. The working hypothesis of MARSSIM is that all impacted areas being evaluated for release have a reasonable potential for radioactive contamination above the DCGL. This initial assumption means that all areas are initially considered Class 1 areas unless some basis for reclassification as non-impacted, Class 3, or Class 2 is provided.

Areas that have no reasonable potential for residual contamination do not need any level of survey coverage and are designated as non-impacted areas. These areas have no radiological impact from site operations and are typically identified during the HSA (Chapter 3). Background reference areas are normally selected from non-impacted areas (Section 4.5).

Impacted areas are areas that have reasonable potential for containing contaminated material. They can be subdivided into three classes:

- Class 1 areas: Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiological surveys). Examples of Class 1 areas include: 1) site areas previously subjected to remedial actions, 2) locations where leaks or spills are known to have occurred, 3) former burial or disposal sites, 4) waste storage sites, and 5) areas with contaminants in discrete solid pieces of material high specific activity. Note that areas containing contamination in excess of the $DCGL_W$ prior to remediation should be classified as Class 1 areas.

- Class 2 areas: These areas have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$. To justify changing an area's classification from Class 1 to Class 2, the existing data (from the HSA, scoping surveys, or characterization surveys) should provide a high degree of confidence that no individual measurement would exceed the $DCGL_W$. Other justifications for this change in an area's classification may be appropriate based on the outcome of the DQO process. Examples of areas that might be classified as Class 2 for the final status survey include: 1) locations where radioactive materials were present in an unsealed form (*e.g.*, process facilities), 2) potentially contaminated transport routes, 3) areas downwind from stack release points, 4) upper walls and ceilings of some buildings or rooms subjected to airborne radioactivity, 5) areas where low concentrations of radioactive materials were handled, and 6) areas on the perimeter of former contamination control areas.

- Class 3 areas: Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$, based on site operating history and previous radiological surveys. Examples of areas that might be classified as Class 3 include buffer zones around Class 1 or Class 2 areas, and areas with very low potential for residual contamination but insufficient information to justify a non-impacted classification.

Class 1 areas have the greatest potential for contamination and, therefore, receive the highest degree of survey effort, followed by Class 2 and then Class 3 areas.

The criteria used for designating areas as Class 1, 2, or 3 should be described in the final status survey plan. Compliance with the classification criteria should be demonstrated in the final status survey report. A thorough analysis of HSA findings (Chapter 3) and the results of scoping and characterization surveys provide the basis for an area's classification. As a survey progresses, reevaluation of this classification may be necessary based on newly acquired survey data. For example, if contamination is identified in a Class 3 area, an investigation and reevaluation of that area should be performed to determine if the Class 3 area classification is appropriate. Typically, the investigation will result in part or all of the area being reclassified as Class 1 or Class 2. If survey results identify residual contamination in a Class 2 area exceeding the DCGL or suggest that there may be a reasonable potential that contamination is present in excess of the DCGL, an investigation should be initiated to determine if all or part of the area should be reclassified to Class 1. More information on investigations and reclassifications is provided in Section 5.5.3.

4.5 Select Background Reference Areas

Certain radionuclides may also occur at significant levels as part of background in the media of interest (soil, building material, *etc.*). Examples include members of the naturally-occurring uranium, thorium, and actinium series; ^{40}K; ^{14}C; and tritium. ^{137}Cs and other radionuclides are also present in background as a result of nuclear weapons fallout (Wallo, *et al*., 1994). Establishing background concentrations that describe a distribution of measurement data is necessary to identify and evaluate contributions attributable to site operations. Determining background levels for comparison with the conditions determined in specific survey units entails conducting surveys in one or more reference areas to define the radiological conditions of the site. NUREG-1505 (NRC 1997a) provides additional information on background reference areas.

A site background reference area should have similar physical, chemical, geological, radiological, and biological characteristics as the survey unit being evaluated. Background reference areas are normally selected from non-impacted areas, but are not limited to natural areas undisturbed by human activities. In some situations, a reference area may be associated with the survey unit being evaluated, but cannot be potentially contaminated by site activities. For example, background measurements may be taken from core samples of a building or structure surface, pavement, or asphalt. This option should be discussed with the responsible regulatory agency during survey planning. Generally, reference areas should not be part of the survey unit being evaluated.

Reference areas provide a location for background measurements which are used for comparisons with survey unit data. The radioactivity present in a reference area would be ideally the same as the survey unit had it never been contaminated. If a site includes physical, chemical, geological, radiological, or biological variability that is not represented by a single reference background area, selecting more than one reference area may be necessary.

It may be difficult to find a reference area within an industrial complex for comparison to a survey unit if the radionuclides of potential concern are naturally occurring. Background may vary greatly due to different construction activities that have occurred at the site. Examples of construction activities that change background include: leveling; excavating; adding fill dirt; importing rocks or gravel to stabilize soil or underlay asphalt; manufacturing asphalt with different matrix rock; using different pours of asphalt or concrete in a single survey unit; layering asphalt over concrete; layering different thicknesses of asphalt, concrete, rock, or gravel; and covering or burying old features such as railroad beds or building footings. Background variability may also increase due to the concentration of fallout in low areas of parking lots where runoff water collects and evaporates. Variations in background of a factor of five or more can occur in the space of a few hectares.

There are a number of possible actions to address these concerns. Reviewing and reassessing the selection of reference areas may be necessary. Selecting different reference areas to represent individual survey units is another possibility. More attention may also be needed in selecting survey units and their boundaries with respect to different areas of potential or actual background variability. More detailed scoping or characterization surveys may be needed to better understand background variability. Using radionuclide-specific measurement techniques instead of gross radioactivity measurement techniques may also be necessary. If a background reference area that satisfies the above recommendations is not available, consultation and negotiation with the responsible regulatory agency is recommended. Alternate approaches may include using published studies of radionuclide distributions.

Verifying that a particular background reference area is appropriate for a survey can be accomplished using the techniques described or referenced in Chapter 8. Verification provides assurance that assumptions used to design the survey are appropriate and defensible. This approach can also prevent decision errors that may result from selecting an inappropriate background reference area.

If the radionuclide contaminants of interest do not occur in background, or the background levels are known to be a small fraction of the $DCGL_W$ (*e.g.*, <10%), the survey unit radiological conditions may be compared directly to the specified DCGL and reference area background surveys are not necessary. If the background is not well defined at a site, and the decision maker is willing to accept the increased probability of incorrectly failing to release a survey unit (Type II error), the reference area measurements can be eliminated and a one-sample statistical test performed as described in Section 8.3.

4.6 Identify Survey Units

A survey unit is a physical area consisting of structures or land areas of specified size and shape for which a separate decision will be made as to whether or not that area exceeds the release criterion. This decision is made as a result of the final status survey. As a result, the survey unit is the primary entity for demonstrating compliance with the release criterion.

To facilitate survey design and ensure that the number of survey data points for a specific site are relatively uniformly distributed among areas of similar contamination potential, the site is divided into survey units that share a common history or other characteristics, or are naturally distinguishable from other portions of the site. A site may be divided into survey units at any time before the final status survey. For example, HSA or scoping survey results may provide sufficient justification for partitioning the site into Class 1, 2, or 3 areas. Note, however, that dividing the site into survey units is critical only for the final status survey—scoping, characterization, and remedial action support surveys may be performed without dividing the site into survey units.

A survey unit should not include areas that have different classifications. The survey unit's characteristics should be generally consistent with exposure pathway modeling that is used to convert dose or risk into radionuclide concentrations. For indoor areas classified as Class 1, each room may be designated as a survey unit. Indoor areas may also be subdivided into several survey units of different classification, such as separating floors and lower walls from upper walls and ceilings (and other upper horizontal surfaces) or subdividing a large warehouse based on floor area.

Survey units should be limited in size based on classification, exposure pathway modeling assumptions, and site-specific conditions. The suggested areas for survey units are as follows:

Classification	Suggested Area
Class 1	
Structures	up to 100 m^2 floor area
Land areas	up to 2,000 m^2
Class 2	
Structures	100 to 1,000 m^2
Land areas	2,000 to 10,000 m^2
Class 3	
Structures	no limit
Land areas	no limit

The limitation on survey unit size for Class 1 and Class 2 areas ensures that each area is assigned an adequate number of data points. The rationale for selecting a larger survey unit area should be developed using the DQO Process (Section 2.3) and fully documented. Because the number of data points (determined in Sections 5.5.2.2 or 5.5.2.3) is independent of the survey unit size, disregarding locating small areas of elevated activity, the survey coverage in an area is determined by dividing the fixed number of data points obtained from the statistical tests by the survey unit area. That is, if the statistical test estimates that 20 data points are necessary to demonstrate compliance, then the survey coverage is determined by dividing 20 by the area over which the data points are distributed.

Special considerations may be necessary for survey units with structure surface areas less than 10 m^2 or land areas less than 100 m^2. In this case, the number of data points obtained from the statistical tests is unnecessarily large and not appropriate for smaller survey unit areas. Instead, some specified level of survey effort should be determined based on the DQO process and with the concurrence of the responsible regulatory agency. The data generated from these smaller survey units should be obtained based on judgment, rather than on systematic or random design, and compared individually to the DCGLs.

4.7 Select Instruments and Survey Techniques

Based on the potential radionuclide contaminants, their associated radiations, and the types of residual contamination categories (*e.g.*, soil, structure surfaces) to be evaluated, the detection sensitivities of various instruments and techniques are determined and documented. Instruments should be identified for each of the three types of measurements: 1) scans, 2) direct measurements, and 3) laboratory analysis of samples. In some cases, the same instrument (*e.g.*, sodium iodide detector) or same type of instrument (*e.g.*, gas-flow proportional counter) may be used for performing several types of measurements. Once the instruments are selected, appropriate survey techniques and standard operating procedures (SOPs) should be developed and documented. The survey techniques describe how the instrument will be used to perform the required measurements.

Chapter 6 of this manual, NRC report NUREG-1507 (NRC 1997b), and draft NRC report NUREG-1506 (NRC 1995) discuss the concept of detection sensitivities and provide guidance on determining sensitivities and selecting appropriate measurement methods. Chapter 6 also discusses instruments and survey techniques for scans and direct measurements, while Chapter 7 provides guidance on sampling and laboratory analysis. Appendix H describes typical field and laboratory equipment plus associated cost and instrument sensitivities.

4.7.1 Selection of Instruments

Choose reliable instruments that are suited to the physical and environmental conditions at the site and capable of detecting the radiations of concern to the appropriate minimum detectable concentration (MDC). During survey design, it is generally considered good practice to select a measurement system with an MDC between 10-50% of the DCGL. Sometimes this goal may not be achievable based on site-specific conditions (*e.g.*, best available technology, cost restrictions).

The MDC is calculated based on an hypothesis test for individual measurements (see Section 6.7), and results below the MDC are variable and lead to a high value for σ of the measured values in the survey unit or reference area. This high value for σ can be accounted for using the statistical tests described in Chapter 8 for the final status survey, but a large number of measurements are needed to account for the variability. σ is defined as the standard deviation of the measurements in the survey unit.

Early in decommissioning, during scoping and characterization, low MDCs help in the identification of areas that can be classified as non-impacted or Class 3 areas. These decisions are usually based on fewer numbers of samples, and each measurement is evaluated individually. Using an optimistic estimation of the MDC (see Section 2.3.5) for these surveys may result in the misclassification of a survey unit and cleaning up an uncontaminated area or performing a final status survey in a contaminated area. Selecting a measurement technique with a well defined

MDC or a conservative estimate of the MDC ensures the usefulness of the data for making decisions for planning the final status survey. For these reasons, MARSSIM recommends that a realistic or conservative estimate of the MDC be used instead of an optimistic estimate. A conservative estimate of the MDC uses reasonably conservative values for parameters with a high level of uncertainty, and results in a MDC value that is higher than a non-conservative or optimistic estimate.

The instrument should be calibrated for the radiations and energies of interest at the site. This calibration should be traceable to an accepted standards organization such as the National Institute of Science and Technology (NIST). Routine operational checks of instrument performance should be conducted to assure that the check source response is maintained within acceptable ranges and that any changes in instrument background are not attributable to contamination of the detector. If the radionuclide contaminants cannot be detected at desired levels by direct measurement (Section 6.7), the portion of the survey dealing with measurements at discrete locations should be designed to rely primarily on sampling and laboratory analysis (Chapter 7).

Assuming the contaminants can be detected, either directly or by measuring a surrogate radionuclide in the mixture, the next decision point depends on whether the radionuclide being measured is present in background. Gross measurement methods will likely be more appropriate for measuring surface contamination in structures, scanning for locations of elevated activity, and determining exposure rates. Nuclide-specific measurement techniques, such as gamma spectrometry, provide a marked increase in detection sensitivity over gross measurements because of their ability to screen out contributions from other sources. Figure 4.2 illustrates the sequence of steps in determining if direct measurement techniques can be applied at a particular site, or if laboratory analysis is more appropriate. Scanning surveys are typically performed at all sites. The selection of appropriate instruments for scanning, direct measurement, and sampling and analysis should be survey specific.

4.7.2 Selection of Survey Techniques

In practice, the DQO process is used to obtain a proper balance among the use of various measurement techniques. In general, there is an inverse correlation between the cost of a specific measurement technique and the detection levels being sought. Depending on the survey objectives, important considerations include survey costs and choosing the optimum instrumentation and measurement mix.

A certain minimum number of direct measurements or samples will be needed to demonstrate compliance with the release criterion based on the nonparametric statistical tests (see Section 5.5.2). In addition, the potential for areas of elevated contamination will have to be considered for designing scanning surveys. Areas of elevated activity may also affect the number of measurements; however, scanning with survey instruments should generally be sufficient to

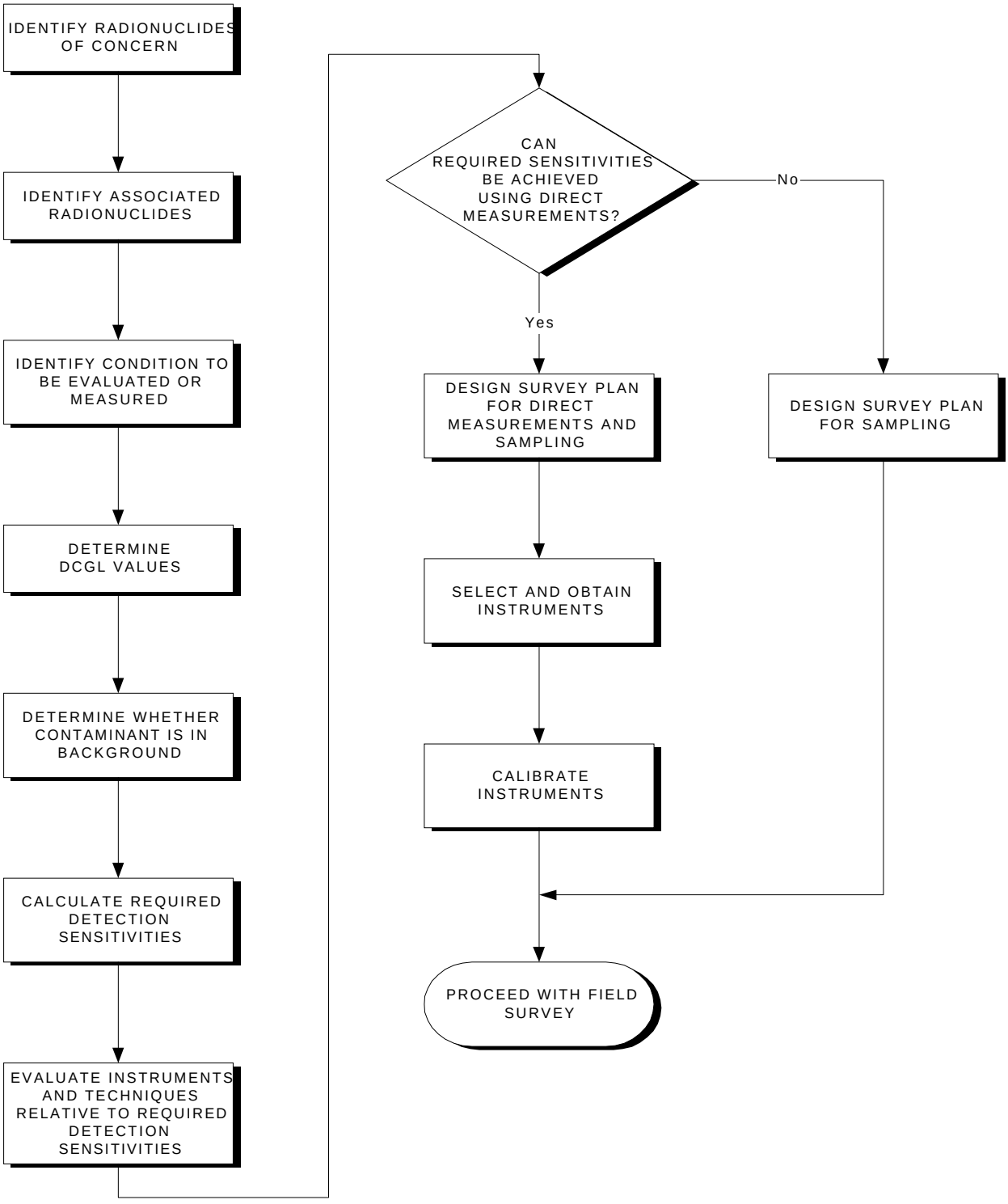


Figure 4.2 Flow Diagram for Selection of Field Survey Instrumentation for Direct Measurements and Analysis of Samples (Refer to Section 4.7)

ensure that no areas with unusually high levels of radioactivity are left in place. Some measurements may also provide information of a qualitative nature to supplement other measurements. An example of such an application is *in situ* gamma spectrometry to demonstrate the absence (or presence) of specific contaminants.

Table 4.1 presents a list of common contaminants along with recommended survey methods that have proven to be effective based on past survey experience in the decommissioning industry. This table provides a general indication of the detection capability of commercially-available instruments. As such, Table 4.1 may be used to provide an initial evaluation of instrument capabilities for some common radionuclides at the example DCGLs listed in the table. For example, consider the contamination of a surface with ^{241}Am. Table 4.1 indicates that ^{241}Am is detectable at the example DCGLs, and that viable direct measurement instruments include gas-flow proportional (α mode) and alpha scintillation detectors. Table 4.1 should not be interpreted as providing specific values for an instrument's detection sensitivity, which is discussed in Section 6.7. In addition, NRC draft report NUREG-1506 (NRC 1995) provides further information on factors that may affect survey instrumentation selection.

4.7.3 Criteria for Selection of Sample Collection and Direct Measurement Methods

Sample characteristics such as sample depth, volume, area, moisture level, and composition, as well as sample preparation techniques which may alter the sample, are important planning considerations for Data Quality Objectives. Sample preparation may include, but is not limited to, removing extraneous material, homogenizing, splitting, drying, compositing, and final preparation of samples. As is the case for determining survey unit characteristics, the physical sample characteristics and sampling method should be consistent with the dose or risk pathway modeling that is used to determine radionuclide DCGL's. If a direct measurement method is used, it should also be consistent with the pathway modeling.

For example, a sample depth of 15 cm (6 in.) for soil samples might be specified during the DQO process for a final status survey because this corresponds to the soil mixing or plow depth in several environmental pathway models (Yu *et al.*, 1993, NRC 1992b). If contamination exists at a depth less than this, a number of models uniformly mix it throughout this depth to simulate the soil mixing associated with plowing. Similarly, models may be based on dry weight, which may necessitate either drying samples or data transformation to account for dry weight.

The DQOs and subsequent direction to the laboratory for analysis might include removal of material not relevant for characterizing the sample, such as pieces of glass, twigs, or leaves. Table 4.2 provides examples of how a particular field soil composition of fine-, medium-, and coarse-grained materials might determine laboratory analysis DQOs for particular radionuclides. Fine materials consist of clay (less than 0.002 mm) and silt (0.002 to 0.062 mm). Medium materials consist of sand, which can be further divided into very fine, fine, medium, coarse, and very coarse sand. Coarse materials consist of gravel, which is composed of pebbles (2 to 64 mm), cobbles (64 to 256 mm), and boulders (greater than 256 mm) (Friedman 1978).

Table 4.1 Selection of Direct Measurement Techniques Based on Experience

Nuclide	Structure Surfaces		Land Areas		Direct Measurement Instruments[2]		
	Example DCGL[1] (Bq/m^2)	Detectable	Example DCGL[1] (Bq/kg)	Detectable	Surface Activity	Soil Activity	Exposure Rate
^{3}H	$1.6x10^{6}$	No	$1.5x10^{4}$	No	ND[6]	ND	ND
^{14}C	$4.7x10^{5}$	Yes	$1.4x10^{3}$	No	GPß	ND	ND
^{54}Mn	$1.3x10^{4}$	Yes	450	Yes	**GPß**[7],GM	**γS**,ISγ	**PIC**,γS,ISγ
^{55}Fe	$1.8x10^{6}$	No	$4.1x10^{5}$	No[5]	ND	ND(ISγ)	ND(ISγ)
^{60}Co	$3.1x10^{3}$	Yes	110	Yes	**GPß**,GM	**γS**,ISγ	**PIC**,γS,ISγ
^{63}Ni	$1.5x10^{6}$	Yes	$2.8x10^{5}$	No	GPß	ND	ND
^{90}Sr	$6.0x10^{3}$	Yes	420	No[5]	**GPß**,GM	ND (GM,GPß)	ND
^{99}Tc	$6.4x10^{5}$	Yes	$1.9x10^{3}$	No	**GPß**,GM	ND	ND
^{137}Cs	$8.2x10^{3}$	Yes	400	Yes	**GPß**,GM	**γS**,ISγ	**PIC**,γS,ISγ
^{152}Eu	$6.6x10^{3}$	Yes	240	Yes	**GPß**,GM	**γS**,ISγ	**PIC**,γS,ISγ
^{226}Ra (C)[3]	970	Yes	210	Yes	**GPα**,αS	**γS**,ISγ	**PIC**,γS,ISγ
^{232}Th (C)[3]	340	Yes	320	Yes	GPα,αS,**GPß**	**γS**,ISγ	**PIC**,γS,ISγ
U[4]	560	Yes	710	Yes	GPα,αS,**GPß**, ISγ	γS,**ISγ**, GPß	**PIC**,γS,ISγ
^{239}Pu, ^{240}Pu, ^{241}Pu	120	Yes	70	No[5]	**GPα**,αS	ND (ISγ)	ND
^{241}Am	110	Yes	70	Yes	**GPα**,αS	**γS**,ISγ	**PIC**,γS,ISγ

[1] Example DCGLs based on values given in NRC draft report NUREG-1500 (NRC 1994c).
[2] GPα = Gas-flow proportional counter (α mode)
GM = Geiger-Mueller survey meter
GPß = Gas-flow proportional counter (β mode)
PIC = Pressurized ionization chamber
αS = Alpha scintillation survey meter
γS = gamma scintillation (gross)
ISγ= *in situ* gamma spectrometry
[3] For decay chains having two or more radionuclides of significant half-life that reach secular equilibrium. The notation "(c)" indicates the direct measurement techniques assume the presence of progeny in the chain.
[4] Depleted, natural, and enriched.
[5] Possibly detectable at limits for areas of elevated activity.
[6] Not detectable.
[7] Bold indicates the preferred method where alternative methods are available.

Table 4.2 Example of DQO Planning Considerations

Separate out and evaluate fine-grain material because resuspension is associated with the fine grain fraction for the air pathway. If contamination resides on sand, pebbles, and cobbles, analyze these materials for direct exposure pathway and analyze the fine-grain fraction for the air pathway. Separation and homogenization are not necessary for analyses because direct exposure pathway depends upon the average concentration and presence of cobbles will usually not impact laboratory analysis. Determine if pathway modeling considered the presence of cobbles. Separate, homogenize, and evaluate fine-grain material because plant root uptake is associated with the fine-grain fraction for the plant ingestion pathway. Separate, homogenize, and evaluate fine-grain materials because of their relevance for the contaminant source term for contaminant migration to the sub-surface for the water pathway.

Both sample depth and area are considerations in determining appropriate sample volume, and sample volume is a key consideration for determining the laboratory MDC. The depth should also correlate with the conceptual model developed in Chapter 3 and upgraded throughout the Radiation Survey and Site Investigation (RSSI) Process. For example, if data collected during the Historical Site Assessment indicate contamination may exist to a depth of greater than 15 cm (6 in.), then samples should be deep enough to support the survey objectives, such as for the scoping or characterization survey. Taking samples as a function of depth might also be a survey design objective, such as for scoping, characterization, or remediation support.

The depth and area of the sample should be recorded as well as any observations, such as the presence of materials noted during sampling. Chapter 6 and Chapter 7 present more detail regarding the application of these survey planning considerations.

4.8 Site Preparation

Site preparation involves obtaining consent for performing the survey, establishing the property boundaries, evaluating the physical characteristics of the site, accessing surfaces and land areas of interest, and establishing a reference coordinate system. Site preparation may also include removing equipment and materials that restrict access to surfaces. The presence of furnishings or equipment will restrict access to building surfaces and add additional items that the survey should address.

4.8.1 Consent for Survey

When facilities or sites are not owned by the organization performing the surveys, consent from the site or equipment owner should be obtained before conducting the surveys. All appropriate local, State, and Federal officials as well as the site owner and other affected parties should be notified of the survey schedule. Section 3.5 discusses consent for access, and additional guidance based on the CERCLA program is available from EPA (EPA 1987d).

4.8.2 Property Boundaries

Property boundaries may be determined from property survey maps furnished by the owners or from plat maps obtained from city or county tax maps. Large-area properties and properties with obscure boundaries or missing survey markers may require the services of a professional land surveyor.

If the radiological survey is only performed inside buildings, a tax map with the buildings accurately located will usually suffice for site/building location designation.

4.8.3 Physical Characteristics of Site

The physical characteristics of the site will have a significant impact on the complexity, schedule, and cost of a survey. These characteristics include the number and size of structures, type of building construction, wall and floor penetrations, pipes, building condition, total area, topography, soil type, and ground cover. In particular, the accessibility of structures and land areas (Section 4.8.4) has a significant impact on the survey effort. In some cases survey techniques (*e.g., in situ* gamma spectrometry discussed in Chapter 6) can preclude or reduce the need to gain physical access or use intrusive techniques. This should be considered during survey planning.

4.8.3.1 Structures

Building design and condition will have a marked influence on the survey efforts. The time involved in conducting a survey of building interior surfaces is essentially directly proportional to the total surface area. For this reason the degree of survey coverage decreases as the potential for residual activity decreases. Judgment measurements and sampling, which are performed in addition to the measurements performed for the nonparametric tests, are recommended in areas likely to have accumulated deposits of residual activity. As discussed in Section 5.5.3.3 and Section 8.5, judgment measurements and samples are compared directly to the appropriate DCGL.

The condition of surfaces after decontamination may affect the survey process. Removing contamination that has penetrated a surface usually involves removing the surface material. As a result, the floors and walls of decontaminated facilities are frequently badly scarred or broken up and are often very uneven. Such surfaces are more difficult to survey because it is not possible to maintain a fixed distance between the detector and the surface. In addition, scabbled or porous surfaces may significantly attenuate radiations—particularly alpha and low-energy beta particles. Use of monitoring equipment on wheels is precluded by rough surfaces, and such surfaces also pose an increased risk of damage to fragile detector probe faces. These factors should be considered during the calibration of survey instruments; NRC report NUREG-1507 (NRC 1997b) provides additional information on how to address these surface conditions. The condition of the building should also be considered from a safety and health standpoint before a survey is conducted. A structural assessment may be needed to determine whether the structure is safe to enter.

Expansion joints, stress cracks, and penetrations into floors and walls for piping, conduit, and anchor bolts, *etc.*, are potential sites for accumulation of contamination and pathways for migration into subfloor soil and hollow wall spaces. Drains, sewers, and septic systems can also become contaminated. Wall/floor interfaces are also likely locations for residual contamination. Coring, drilling, or other such methods may be necessary to gain access for survey. Intrusive surveying may require permitting by local regulatory authorities. Suspended ceilings may cover areas of potential contamination such as ventilation ducts and fixtures.

Exterior building surfaces will typically have a low potential for residual contamination, however, there are several locations that should be considered during survey planning. If there are roof exhausts, roof accesses that allow for radioactive material movement, or the facility is proximal to the air effluent discharge points, the possibility of roof contamination should be considered. Because roofs are periodically resurfaced, contaminants may be trapped in roofing material, and sampling this material may be necessary. Roof drainage points such as driplines along overhangs, downspouts, and gutters are also important survey locations. Wall penetrations for process equipment, piping, and exhaust ventilation are potential locations for exterior

contamination. Window ledges and outside exits (doors, doorways, landings, stairways, *etc.*) are also building exterior surfaces that should be addressed.

4.8.3.2 Land Areas

Depending upon site processes and operating history, the radiological survey may include varying portions of the land areas. Potentially contaminated open land or paved areas to be considered include storage areas (*e.g.*, equipment, product, waste, and raw material), liquid waste collection lagoons and sumps, areas downwind (based on predominant wind directions on an average annual basis, if possible) of stack release points, and surface drainage pathways. Additionally, roadways and railways that may have been used for transport of radioactive or contaminated materials that may not have been adequately contained could also be potentially contaminated.

Buried piping, underground tanks, sewers, spill areas, and septic leach fields that may have received contaminated liquids are locations of possible contamination that may necessitate sampling of subsurface soil (Section 7.5.3). Information regarding soil type (*e.g.*, clay, sand) may provide insight into the retention or migration characteristics of specific radionuclides. The need for special sampling by coring or split-spoon equipment should be anticipated for characterization surveys.

If radioactive waste has been removed, surveys of excavated areas will be necessary before backfilling. If the waste is to be left in place, subsurface sampling around the burial site perimeter to assess the potential for future migration may be necessary.

Additionally, potentially contaminated rivers, harbors, shorelines, and other outdoor areas may require survey activities including environmental media (*e.g.*, sediment, marine biota) associated with these areas.

4.8.4 Clearing to Provide Access

In addition to the physical characteristics of the site, a major consideration is how to address inaccessible areas that have a potential for residual radioactivity. Inaccessible areas may need significant effort and resources to adequately survey. This section provides a description of common inaccessible areas that may have to be considered. The level of effort expended to access these difficult-to-reach areas should be commensurate with the potential for residual activity. For example, the potential for the presence of residual activity behind walls should be established before significant effort is expended to remove drywall.

4.8.4.1 Structures

Structures and indoor areas should be sufficiently cleared to permit completion of the survey. Clearing includes providing access to potentially contaminated interior surfaces (*e.g.*, drains, ducting, tanks, pits, ceiling areas, and equipment) by removing covers, disassembly, or other means of producing adequate openings.

Building features such as ceiling height, construction materials, ducts, pipes, *etc*., will determine the ease of accessibility of various surfaces. Scaffolding, cranes, lifts, or ladders may be necessary to reach some surfaces, and dismantling portions of the building may be required.

The presence of furnishings and equipment will restrict access to building surfaces and add additional items that the survey should address. Remaining equipment indirectly involved in the process may need to be dismantled in order to evaluate the radiological status, particularly of inaccessible parts of the equipment. Removing or relocating certain furnishings, such as lab benches and hoods, to obtain access to potentially contaminated floors and walls may also be necessary. The amount of effort and resources dedicated to such removal or relocation activities should be commensurate with the potential for contamination. Where the potential is low, a few spot-checks may be sufficient to provide confidence that covered areas are free of contamination. In other cases, complete removal may be warranted.

Piping, drains, sewers, sumps, tanks, and other components of liquid handling systems present special difficulties because of the inaccessibility of interior surfaces. Process information, operating history, and preliminary monitoring at available access points will assist in evaluating the extent of sampling and measurements included in the survey.

If the building is constructed of porous materials (*e.g.*, wood, concrete) and the surfaces were not sealed, contamination may be found in the walls, floors, and other surfaces. It may be necessary to obtain cores of these surfaces for laboratory analysis.

Another accessibility problem is the presence of contamination beneath tile or other floor coverings. This often occurs because the covering was placed over contaminated surfaces, or the joints in tile were not sealed to prevent penetration. The practice in some facilities has been to "fix" contamination (particularly alpha emitters) by painting over the surface of the contaminated area. Thus, actions to obtain access to potentially contaminated surfaces, such as removing wall and floor coverings (including paint, wax, or other sealer) and opening drains and ducts, may be necessary to enable representative measurements of the contaminant. If alpha radiation or very low energy beta radiation is to be measured, the surface should be free of overlying material, such as dust and water, which may significantly attenuate the radiations.

4.8.4.2 Land Areas

If ground cover needs to be removed or if there are other obstacles that limit access by survey personnel or necessary equipment, the time and expense of making land areas accessible should be considered. In addition, precautionary procedures need to be developed to prevent spreading surface contamination during ground cover removal or the use of heavy equipment.

Removal or relocation of equipment and materials that may entail special precautions to prevent damage or maintain inventory accountability should be performed by the property owner whenever possible. Clearing open land of brush and weeds will usually be performed by a professional land-clearing organization under subcontract arrangements. However, survey personnel may perform minor land-clearing activities as needed.

An important consideration prior to clearing is the possibility of bio-uptake and consequent radiological contamination of the material to be cleared. Special precautions to avoid exposure of personnel involved in clearing activities may be necessary. Initial radiological screening surveys should be performed to ensure that cleared material or equipment is not contaminated.

The extent of site clearing in specific areas depends primarily on the potential for radioactive contamination existing in those areas where: 1) the radiological history or results of previous surveys do not indicate potential contamination of an area (it may be sufficient to perform only minimum clearing to establish a reference coordinate system); 2) contamination is known to exist or a high potential for contamination necessitates completely clearing an area to provide access to all surfaces; and 3) new findings as the survey progresses may indicate that additional clearing be performed.

Open land areas may be cleared by heavy machinery (*e.g.*, bulldozers, bushhogs, and hydroaxes). However, care should be exercised to prevent relocation of surface contamination or damage to site features such as drainage ditches, utilities, fences, and buildings. Minor land clearing may be performed using manually operated equipment such as brushhooks, power saws, knives, and string trimmers. Brush and weeds should be cut to the minimum practical height necessary to facilitate measurement and sampling activities (approximately 15 cm). Care should be exercised to prevent unnecessary damage to or removal of mature trees or shrubs.

Potential ecological damage that might result from an extensive survey should be considered. If a survey is likely to result in significant or permanent damage to the environment, appropriate environmental analyses should be conducted prior to initiating the survey. In addition, environmental hazards such as poison ivy, ticks carrying Lyme disease, and poisonous snakes, spiders, or insects should be noted. These hazards can affect the safety and health of the workers as well as the schedule for performing the survey.

4.8.5 Reference Coordinate System

Reference coordinate systems are established at the site to:

- facilitate selection of measurement and sampling locations
- provide a mechanism for referencing a measurement to a specific location so that the same survey point can be relocated

A survey reference coordinate system consists of a grid of intersecting lines, referenced to a fixed site location or benchmark. Typically, the lines are arranged in a perpendicular pattern, dividing the survey location into squares or blocks of equal area; however, other types of patterns (*e.g.*, three-dimensional, polar) have been used.

The reference coordinate system used for a particular survey should provide a level of reproducibility consistent with the objectives of the survey. For example, a commercially available global positioning system will locate a position within tens of meters, while a differential global positioning system (DGPS) provides precision on the order of a few centimeters (see Section 6.10.1.1). On the other hand, a metal bar can be driven into the ground to provide a long-term reference point for establishing a local reference coordinate system.

Reference coordinate system patterns on horizontal surfaces are usually identified numerically on one axis and alphabetically on the other axis or in distances in different compass directions from the grid origin. Examples of structure interior and land area grids are shown in Figures 4.3 through 4.5. Grids on vertical surfaces may include a third designator, indicating position relative to floor or ground level. Overhead measurement and sampling locations (*e.g.*, ceiling and overhead beams) are referenced to corresponding floor grids.

For surveys of Class 1 and Class 2 areas, basic grid patterns at 1 to 2 meter intervals on structure surfaces and at 10 to 20 meter intervals of land areas may be sufficient to identify survey locations with a reasonable level of effort, while not being prohibitive in cost or difficulty of installation. Gridding of Class 3 areas may also be necessary to facilitate referencing of survey locations to a common system or origin but, for practical purposes, may typically be at larger intervals—*e.g.*, 5 to 10 meters for large structural surfaces and 20 to 50 meters for land areas.

Reference coordinate systems on structure surfaces are usually marked by chalk line or paint along the entire grid line or at line intersections. Land area reference coordinate systems are usually marked by wooden or metal stakes, driven into the surface at reference line intersections. The selection of an appropriate marker depends on the characteristics and routine uses of the surface. Where surfaces prevent installation of stakes, the reference line intersection can be marked by painting.

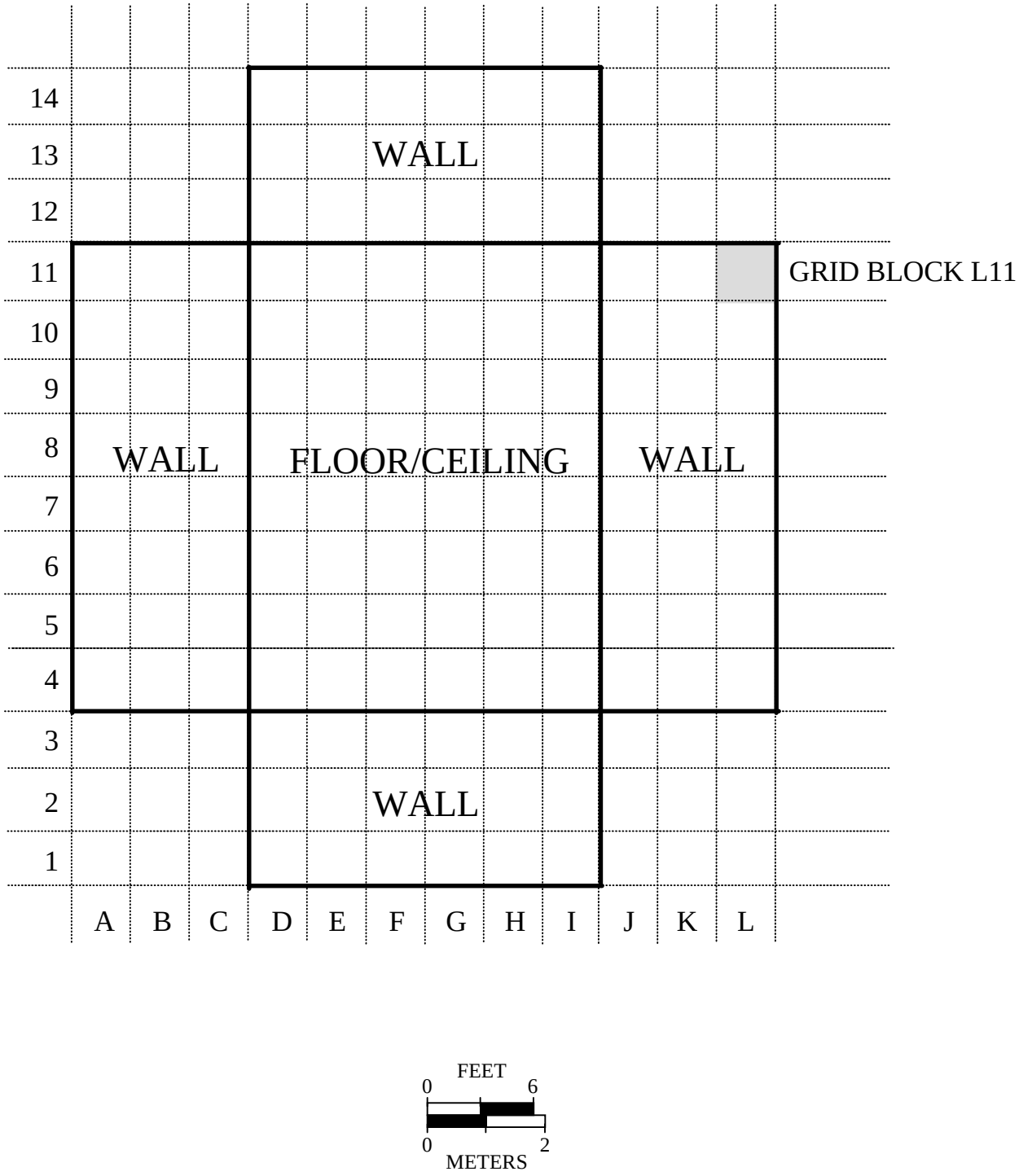
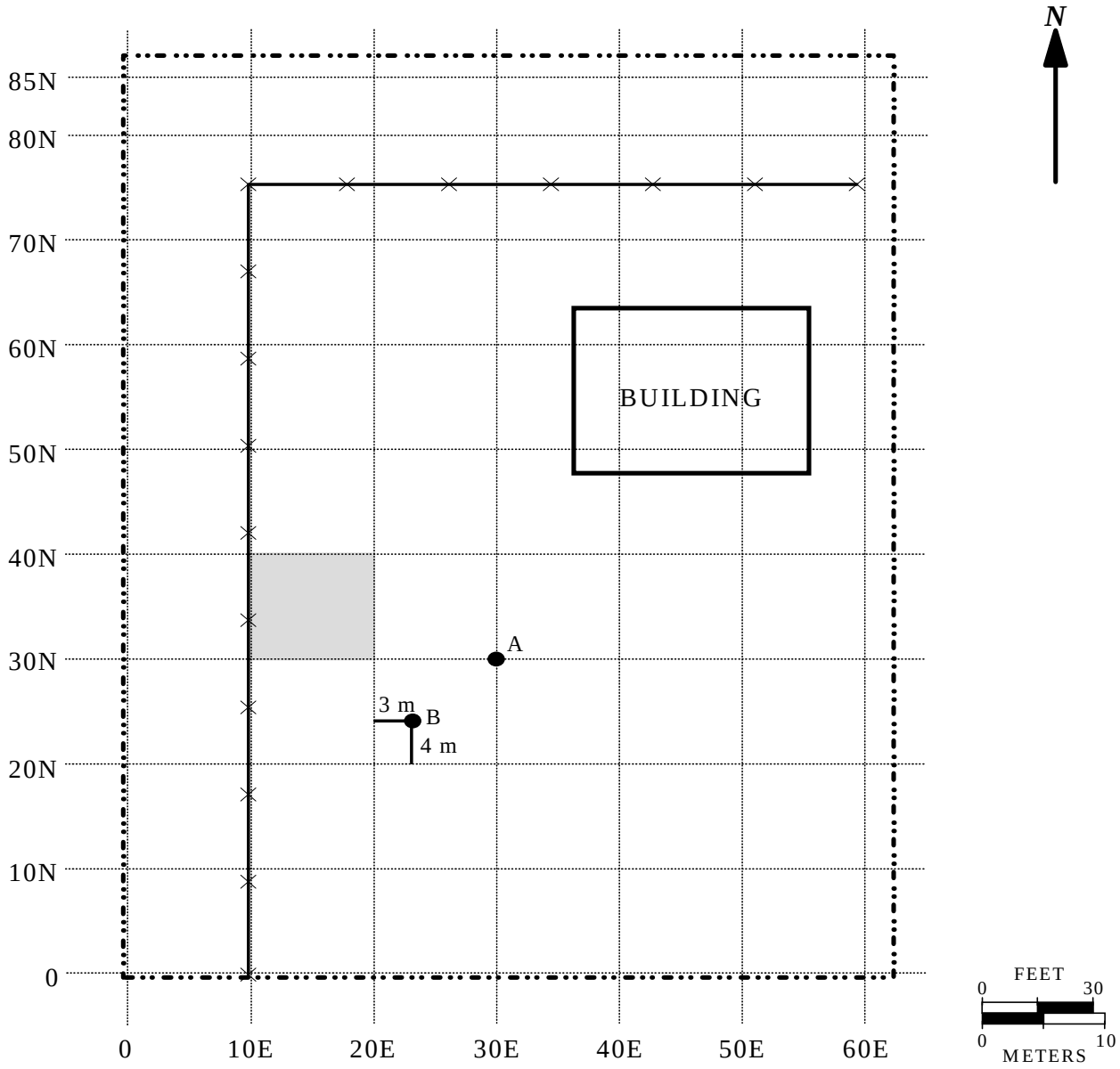


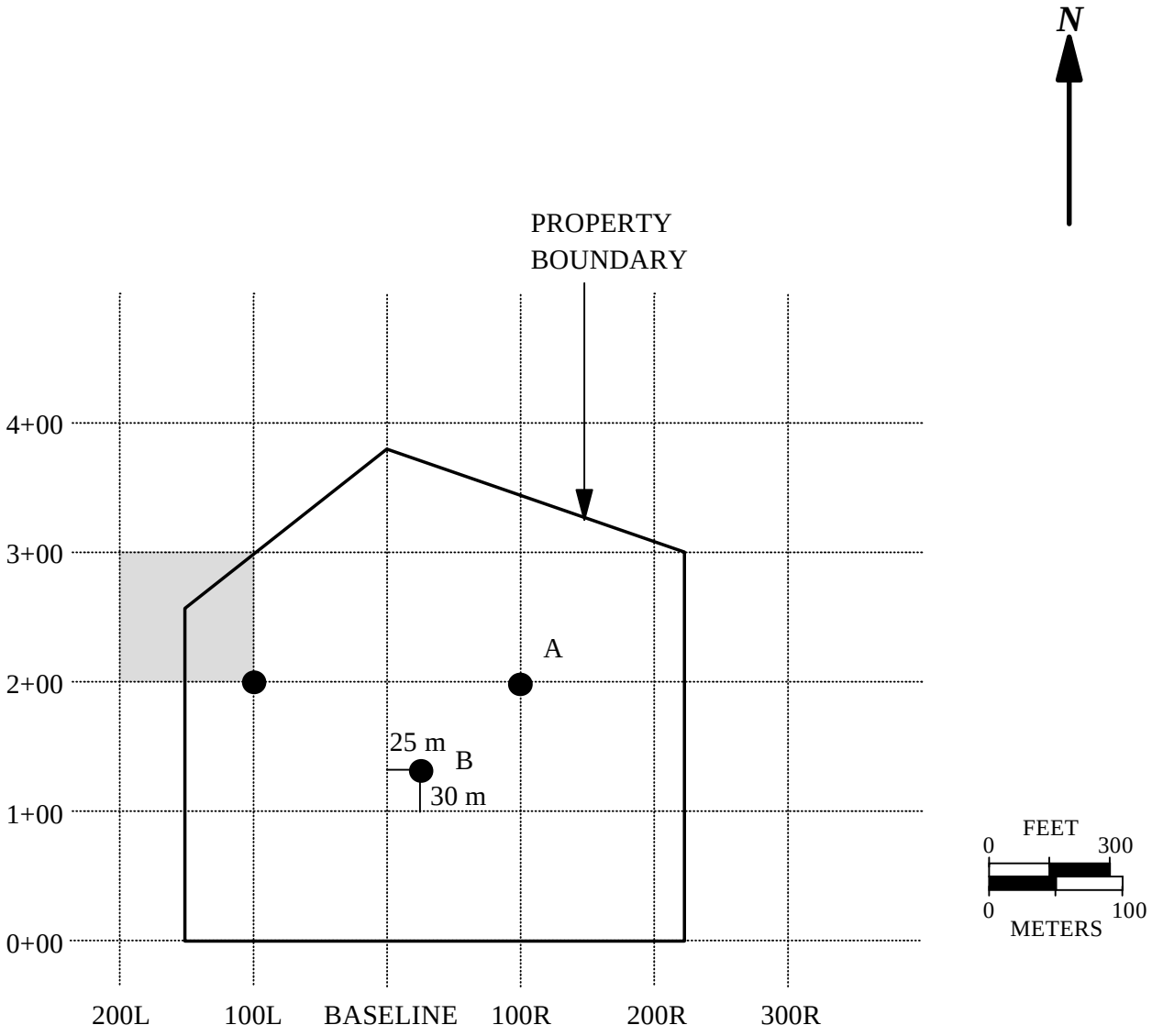
Figure 4.3 Indoor Grid Layout with Alphanumeric Grid Block Designation: Walls and Floors are Diagramed as Though They Lay Along the Same Horizontal Plane



POINT A GRID COORDINATES 30E, 30N
POINT B GRID COORDINATES 23E, 24N
SHADED BLOCK GRID COORDINATES 10E, 30N

SURVEY UNIT BOUNDARY
ONSITE FENCE

Figure 4.4 Example of a Grid System for Survey of Site Grounds Using Compass Directions



POINT A GRID COORDINATES 100R, 2+00
POINT B GRID COORDINATES 25R, 1+30
SHADED BLOCK GRID COORDINATES 200L, 2+00

Figure 4.5 Example of a Grid System for Survey of Site Grounds Using Distances Left or Right of the Baseline

Three basic coordinate systems are used for identifying points on a reference coordinate system. The reference system shown in Figure 4.3 references grid locations using numbers on the vertical axis and letters on the horizontal axis. The reference system shown on Figure 4.4 references distances from the 0,0 point using the compass directions N (north), S (south), E (east), and W (west). The reference system shown in Figure 4.5 references distances along and to the R (right) or L (left) of the baseline. In addition, a less frequently used reference system is the polar coordinate system, which measures distances along transects from a central point. Polar coordinate systems are particularly useful for survey designs to evaluate effects of stack emissions, where it may be desirable to have a higher density of samples collected near the stack and fewer samples with increasing distance from the stack.

Figure 4.5 shows an example grid system for an outdoor land area. The first digit or set of digits includes an L or R (separated from the first set by a comma) to indicate the distance from the baseline in units (meters) and the direction (left or right) from the baseline. The second digit or set of digits refers to the perpendicular distance from the 0,0 point on the baseline and is measured in hundreds of units. Point A in the example of a reference coordinate system for survey of site grounds, Figure 4.5, is identified 100R, 2+00 (*i.e.*, 200 m from the baseline and 100 m to the right of the baseline). Fractional distances between reference points are identified by adding the distance beyond the reference point and are expressed in the same units used for the reference coordinate system dimensions. Point B on Figure 4.5 is identified 25R, 1+30.

Open land reference coordinate systems should be referenced to a location on an existing State or local reference system or to a U.S. Geological Survey (USGS) bench mark. (This may require the services of a professional land surveyor.) Global positioning systems (GPS) are capable of locating reference points in terms of latitude and longitude (Section 6.10.1 provides descriptions of positioning systems).

Following establishment of the reference coordinate system, a drawing is prepared by the survey team or the land surveyor. This drawing indicates the reference lines, site boundaries, and other pertinent site features and provides a legend showing the scale and a reference compass direction. The process used to develop the reference coordinate system should be recorded in the survey planning documentation (*e.g.*, the Quality Assurance Project Plan or QAPP). An deviations from the requirements developed during planning should be documented when the reference coordinate system is established.

It should be noted that the reference coordinate systems described in this section are intended primarily for reference purposes and do not necessarily dictate the spacing or location of survey measurements or samples. Establishment of a measurement grid to demonstrate compliance with the DCGL is discussed in Section 5.5.2.5 and Chapter 8.

4.9 Quality Control

Site surveys should be performed in a manner that ensures results are accurate and sources of uncertainty are identified and controlled. This is especially the case for final status surveys that are vital to demonstrating a facility satisfies pre-established release criteria. Quality control (QC) and quality assurance (QA) are initiated at the start of a project and integrated into all surveys as DQOs are developed. This carries over to the writing of a Quality Assurance Project Plan (QAPP), which applies to each aspect of a survey. Section 9.2 provides guidance on developing a QAPP. Data quality is routinely a concern throughout the RSSI Process, and one should recognize that QA/QC procedures will change as data are collected and analyzed, and as DQOs become more rigorous for the different types of surveys that lead up to a final status survey.

In general, surveys performed by trained individuals are conducted with approved written procedures and properly calibrated instruments that are sensitive to the suspected contaminant. However, even the best approaches for properly performing measurements and acquiring accurate data need to consider QC activities. QC activities are necessary to obtain additional quantitative information to demonstrate that measurement results have the required precision and are sufficiently free of errors to accurately represent the site being investigated. The following two questions are the main focus of the rationale for the assessment of errors in environmental data collection activities (EPA 1990).

- How many and what type of measurements are required to assess the quality of data from an environmental survey?

- How can the information from the quality assessment measurements be used to identify and control sources of error and uncertainties in the measurement process?

These questions are introduced as part of guidance that also includes an example to illustrate the planning process for determining a reasonable number of quality control (QC) measurements. This guidance also demonstrates how the information from the process may be used to document the quality of the measurement data. This process was developed in terms of soil samples collected in the field and then sent to a laboratory for analysis (EPA 1990). For MARSSIM, these questions may be asked in relation to measurements of surface soils and building surfaces both of which include sampling, scanning, and direct measurements.

Quality control may be thought of in three parts: 1) determining the type of QC samples needed to detect precision or bias; 2) determining the number of samples as part of the survey design; and 3) scheduling sample collections throughout the survey process to identify and control sources of error and uncertainties. Section 4.9.1 introduces the concepts of precision and bias related to survey measurements and briefly discusses the types of QC measurements needed to detect and quantify precision and bias. Section 6.2 and Section 7.2 provide more detailed

guidance on the types of QC measurements. The number of QC measurements is addressed in Section 4.9.2, while Section 4.9.3 and Section 9.3 contain information on identifying and controlling sources of uncertainty. Overall, survey activities associated with MARSSIM include obtaining the additional information related to QA of both field and laboratory activities.

4.9.1 Precision and Systematic Errors (Bias)

Precision is a measure of agreement among repeated measurements. Precision is discussed further in Appendix N in statistical terms. Table N.2 presents the minimum considerations, impacts of not meeting these considerations, and corrective actions associated with assessing precision. Systematic errors, also called bias, accumulate during the measurement process and result from faults in sampling designs and procedures, analytical procedures, sample contamination, losses, interactions with containers, deterioration, inaccurate instrument calibration, and other sources. Bias causes the mean value of the sample data to be consistently higher or lower than the true mean value. Appendix N also discusses bias, and Table N.3 presents the minimum considerations associated with assessing bias, the impacts if the considerations are not met, and related corrective actions. Laboratories typically introduce QC samples into their sample load to assess possible bias. In simplest terms, spikes, repeated measurements, and blanks are used to assess bias, precision, and contamination, respectively. See Section 6.2 for further discussion of specific measurements for determining precision and bias for scans and direct measurements and Section 7.2 for further discussion of specific measurements for determining precision and bias for samples.

Field work using scanning or direct measurements eliminates some sources of error because samples are not removed, containerized, nor transported to another location for analysis. The operator's technique or field instrument becomes the source of bias. In this case, detecting bias might incorporate field replicates (see Section 7.2.2.1) by having a second operator to revisit measurement locations and following the same procedure with the same instrument as was used by the first operator. This is an approach used to assess precision of measurements. A field instrument's calibration can also be checked by one or more operators during the course of a survey and recorded on a control chart. Differences in set up or handling of instruments by different operators may reveal a significant source of bias that is quite different from sources of bias associated with laboratory work.

The following factors should be considered when evaluating sources of bias, error, and uncertainty. Contamination is an added factor to consider for each of the following items.

- sample collection methods
- handling and preparation of samples
- homogenization and aliquots of laboratory samples
- field methods for sampling, scanning, or direct measurements

- laboratory analytical process
- total bias contributed by all sources

The magnitude of the measurement system variability should be evaluated to determine if the variability approaches or exceeds the true but unknown variability in the population of interest. Errors, bias, or data variability may accumulate to the point of rendering data unusable to achieve survey objectives. Systematic investigations of field or laboratory processes can be initiated to assess and identify the extent of errors, bias, and data variability and to determine if the DQOs are achieved. An important aspect of each QC determination is the representative nature of a sample or measurement (see Appendix N for a description of representativeness). If additional samples or measurements are not taken according to the appropriate method, the resulting QC information will be invalid or unusable. For example, if an inadequate amount of sample is collected, the laboratory analytical procedure may not yield a proper result. The QC sample must represent the sample population being studied. Misrepresentation itself creates a bias that if undetected leads to inaccurate conclusions concerning an analysis. At the very least, misrepresentation leads to a need for additional QA investigation.

4.9.2 Number of Quality Control Measurements

The number of QC measurements is determined by the available resources and the degree to which one needs assurance that a measurement process is adequately controlled. The process is simplified, for example, when the scope of a survey is narrowed to a single method, one sampling crew, and a single laboratory to analyze field samples. Increasing the number of samples and scheduling sample collections and analyses over time or at different laboratories increases the level of difficulty and necessitates increasing the number of QC measurements. The number of QC measurements may also be driven upward as the action level approaches a given instrument's detection limit. This number is determined on a case-by-case basis, where the specific contaminant and instruments are assessed for detecting a particular radionuclide.

A widely used standard practice is to collect a set percentage, such as 5% (EPA 1987b), of samples for QA purposes. However, this practice has disadvantages. For example, it provides no real assessment of the uncertainties for a relatively small sample size. For surveys where the required number of measurements increases, there may be a point beyond which there is little added value in performing additional QC measurements. Aside from cost, determining the appropriate number of QC measurements essentially depends on site-specific factors. For example, soil may present a complex and variable matrix requiring many more QC measurements for surface soils than for building surfaces.

A performance based alternative (EPA 1990) to a set percentage or rule of thumb can be implemented. First, potential sources of error or uncertainty, the likelihood of occurrence, and the consequences in the context of the DQOs should be determined. Then, the appropriate type

and number of QC measurements based on the potential error or uncertainty are determined. For example, field replicate samples (*i.e.*, a single sample that is collected, homogenized, and split into equivalent fractions in the field) are used to estimate the combined contribution of several sources of variation. Hence, the number of field replicate samples to be obtained in the study should be dictated by how precise the estimate of the total measurement should be.

Factors influencing this estimate include the

- number of measurements
- number and experience of personnel involved
- current and historical performance of sampling and analytical procedures used
- the variability of survey unit and background reference area radioactivity measurement systems used
- number of laboratories used
- the level of radioactivity in the survey unit (which for a final status survey should be low)
- how close an action level (*e.g.*, DCGL) is to a detection limit (which may represent a greater concern after reducing or removing radionuclide concentrations by remediation)

The precision of an estimate of the "true" variance for precision or bias within a survey design depends on the number of degrees of freedom used to provide the estimate. Table 4.3 provides the one-sided upper confidence limits for selected degrees of freedom assuming the results of the measurements are normally distributed. Confidence limits are provided for 90, 95, 97.5, and 99 percent confidence levels. At the stated level of confidence, the "true" variance of the estimate of precision or bias for a specified number of QC measurements will be between zero and the multiple of the estimated variance listed in Table 4.3. For example, for five degrees of freedom one would be 90% confident that the true variance for precision falls between zero and 3.10 times the estimated variance. The number of QC measurements is equal to one greater than the degrees of freedom.

When planning surveys, the number of each type of QC measurement can be obtained from Table 4.3. For example, if the survey objective is to estimate the variance in the bias for a specific measurement system between zero and two times the estimated variance at a 95% confidence level, 15 degrees of freedom or 16 measurements of a material with known concentration (*e.g.*, performance evaluation samples) would be indicated. MARSSIM recommends that the survey objective be set such that the true variance falls between zero and two times the estimated variance. The level of confidence is then determined on a site-specific basis to adjust the number of each type of QC measurement to the appropriate level (*i.e.*, 11, 16, 21 or 31 measurements). The results of the QC measurements are evaluated during the assessment phase of the data life cycle (see Section 9.3 and Appendix N).

Table 4.3 Upper Confidence Limits for the True Variance as a Function of the Number of QC Measurements Used to Determine the Estimated Variance (EPA 1990)

Degrees of Freedom*	Level of Confidence (%)			
	90	95	97.5	99
2	9.49	19.49	39.21	99.50
5	3.10	4.34	6.02	9.02
10	2.05	2.54	3.08	3.91
15	1.76	2.07	2.40	2.87
20	1.61	1.84	2.08	2.42
25	1.52	1.71	1.91	2.17
30	1.46	1.62	1.78	2.01
40	1.38	1.51	1.64	1.80
50	1.33	1.44	1.61	1.68
100	1.21	1.28	1.35	1.43

* To obtain the necessary number of quality control measurements, add one to the degrees of freedom.

Example:

A site is contaminated with ^{60}Co and consists of four Class 1 interior survey units, nine Class 2 interior survey units, two Class 3 interior survey units, and one Class 3 exterior survey unit. Three different measurement systems are specified in the survey design for performing scanning surveys, one measurement system is specified for performing direct measurements for interior survey units, and one measurement system is specified for measuring samples collected from the exterior survey unit.

Repeated measurements are used to estimate precision. For scan surveys there is not a specified number of measurements. 10% of the scans in each Class 1 survey unit were repeated as replicates to measure operator precision (see Section 6.2.2.1) within 24 hours of the original scan survey. 5% of each Class 2 and Class 3 survey unit were similarly repeated as replicates to measure operator precision. The results of the repeated scans were evaluated based on professional judgment. For direct measurements and sample collection activities, a 95% confidence level was selected as consistent with the objectives of the survey. Using Table 4.3, it was determined that 16 repeated measurements were required for both the direct measurement technique and the sample collection and laboratory measurement technique. Because 72 direct measurements would be performed in Class 1 survey units, 99 in Class 2 survey units, and 20 in Class 3 survey units, it was anticipated that at least 16 direct measurements would have sufficient

activity above background to perform repeated measurements and obtain usable results (see Section 5.5.2 for guidance on determining the number of measurements and Appendix A for a more detailed discussion of the example site). The 16 direct measurement locations to be repeated would be selected based on the results of the direct measurements and would represent the entire usable range of activity found in the survey units rather than measuring the 16 locations with the highest activities. (The usable range of activity includes the highest measurement result in the survey unit and the lowest measurement result with an acceptable measurement uncertainty compared to the desired level of precision.) The repeated measurements would be performed by different operators using the same equipment, but they would not know the results of the original survey. To ensure that the measurements would be valid, the QC measurements to check for contamination would be performed at the same time. Because the laboratory's QA program called for periodic checks on the precision of the laboratory instruments, the total survey design precision for laboratory measurements was measured. Because the only samples collected would come from a Class 3 area, the sample activities were expected to be close to or below the measurement system MDC. This meant that field replicate samples would not provide any usable information. Also, QC samples for bias were repeated to obtain a usable estimate of precision for the survey design.

Measurements of materials with known concentrations above background (*e.g.*, performance evaluation samples) and known concentrations at or below background (*e.g.*, field blanks) are used to estimate bias. For scan surveys, the repeated scanning performed to estimate precision would also serves as a check for contamination using blanks. Because there was no appropriate material of known concentration on which to perform bias measurements, the calibration checks were used to demonstrate that the instruments were reading properly during the surveys. A control chart was developed using the instrument response for an uncalibrated check source. Measurements were obtained using a specified source-detector alignment that could be easily repeated. Measurements were obtained at several times during the day over a period of several weeks prior to taking the instruments into the field. Calibration checks were performed before and after each survey period in the field and the results immediately plotted on the control chart to determine if the instrument was performing properly. This method was also adopted for the direct measurement system. 20 samples were required by the survey design for the Class 3 exterior survey unit. To ensure that the samples were truly blind for the laboratory, samples three times the requested volume were collected. These samples were sent to a second laboratory for preparation. Each sample was weighed, dried, and reweighed to determine the moisture content. Then each sample was ground to a uniform particle size of 1 mm (approximately 16 mesh) and divided into three separate aliquots (each aliquot was the same size). For each sample one aliquot was packaged for transport to the laboratory performing the analysis. After these samples were packaged, 16 of the samples had both of the remaining aliquots spiked with the same level of activity using a

source solution traceable to the National Institute of Science and Technology (NIST). The 16 samples each had a different level of activity within a range that was accepted by the laboratory performing the analysis. These 32 samples were also packaged for transport to the laboratory. In addition, 16 samples of a soil similar to the soil at the site were prepared as blanks to check against contamination. The 20 samples, 32 spikes, and 16 blanks were transported to the laboratory performing the analyses in a single shipment so that all samples were indistinguishable from each other except by the sample identification.

4.9.3 Controlling Sources of Error

During the performance of a survey, it is important to identify sources of error and uncertainty early in the process so that problems can be resolved. The timing of the QC measurements within the survey design can be very important. In order to identify problems as early as possible, it may be necessary to perform a significant number of QC measurements early in the survey. This can be especially important for surveys utilizing an innovative or untested survey design. Survey designs that have been used previously and produced reliable results may be able to space the QC measurement evenly throughout the survey, or even wait to have samples analyzed at the end of the survey, as long as the objectives of the survey are achieved.

For example, a survey design requires a new scanning method to be used for several survey units when there are little performance data available for this technique. To ensure that the technique is working properly, the first few survey units are re-scanned to provide an initial estimate of the precision and bias. After the initial performance of the techniques has been verified, a small percentage of the remaining survey units is re-scanned to demonstrate that the technique is operating properly for the duration of the survey.

Identifying sources of error and uncertainty is only the first step. Once the sources of uncertainty have been identified, they should be minimized and controlled for the rest of the survey. Section 9.3 discusses the assessment of survey data and provides guidance on corrective actions that may be appropriate for controlling sources of error or uncertainty after they have been identified.

4.10 Health and Safety

Consistent with the approach for any operation, activities associated with the radiological surveys should be planned and monitored to assure the health and safety of the worker and other personnel, both onsite and offsite, are adequately protected. At the stage of determining the final status of the site, residual radioactivity is expected to be below the DCGL values; therefore, the final status survey should not include radiation protection controls. However, radiation protection controls may be necessary when performing scoping or characterization surveys where the potential for significant levels of residual radioactivity is unknown.

Significant health and safety concerns during any radiological survey include the potential industrial hazards commonly found at a construction site, such as exposed electrical circuitry, excavations, enclosed work spaces, hazardous atmospheres, insects, poisonous snakes, plants, and animals, unstable surfaces (*e.g.*, wet or swamp soil), heat and cold, sharp objects or surfaces, falling objects, tripping hazards, and working at heights. The survey plan should incorporate objectives and procedures for identifying and eliminating, avoiding, or minimizing these potential safety hazards.

5 SURVEY PLANNING AND DESIGN

5.1 Introduction

This chapter is intended to assist the user in planning a strategy for conducting a final status survey, with the ultimate objective being to demonstrate compliance with the derived concentration guideline levels (DCGLs). The survey types that make up the Radiation Survey and Site Investigation (RSSI) Process include scoping, characterization, remedial action support, and final status surveys. Although the scoping, characterization, and remedial action support surveys have multiple objectives, this manual focuses on those aspects related to supporting the final status survey and demonstrating compliance with DCGLs. In general, each of these survey types expands upon the data collected during the previous survey (*e.g.*, the characterization survey is planned with information collected during the scoping survey) up through the final status survey. The purpose of the final status survey is to demonstrate that the release criterion established by the regulatory agency has not been exceeded. This final release objective should be kept in mind throughout the design and planning phases for each of the other survey types. For example, scoping surveys may be designed to meet the objectives of the final status survey such that the scoping survey report is also the final status survey report. The survey and analytical procedures referenced in this chapter are described in Chapter 6, Chapter 7, and Appendix H. An example of a final status survey, as described in Section 5.5, appears in Appendix A. In addition, example checklists are provided for each type of survey to assist the user in obtaining the necessary information for planning a final status survey.

5.2 Scoping Surveys

5.2.1 General

If the data collected during the Historical Site Assessment (HSA) indicate that a site or area is impacted, a scoping survey could be performed. The objective of this survey is to augment the HSA for sites with potential residual contamination. Specific objectives may include: 1) performing a preliminary risk assessment and providing data to complete the site prioritization scoring process (CERCLA and RCRA sites only), 2) providing input to the characterization survey design, if necessary, 3) supporting the classification of all or part of the site as a Class 3 area for planning the final status survey, 4) obtaining an estimate of the variability in the residual radioactivity concentration for the site, and 5) identifying non-impacted areas that may be appropriate for reference areas and estimating the variability in radionuclide concentrations when the radionuclide of interest is present in background.

Scoping survey information needed when conducting a preliminary risk assessment (as noted above for CERCLA and RCRA sites) includes the general radiation levels at the site and gross levels of residual contamination on building surfaces and in environmental media. If unexpected

conditions are identified that prevent the completion of the survey, the MARSSIM user should contact the responsible regulatory agency for further guidance. Sites that meet the National Contingency Plan criteria for a removal should be referred to the Superfund Removal program (EPA 1988c).

If the HSA indicates that contamination is likely, a scoping survey could be performed to provide initial estimates of the level of effort for remediation and information for planning a more detailed survey, such as a characterization survey. Not all radiological parameters need to be assessed when planning for additional characterization because total surface activity or limited sample collection may be sufficient to meet the objectives of the scoping survey.

Once a review of pertinent site history indicates that an area is impacted, the minimum survey coverage at the site will include a Class 3 area final status survey prior to the site being released. For scoping surveys with this objective, identifying radiological decision levels is necessary for selecting instruments and procedures with the necessary detection sensitivities to demonstrate compliance with the release criterion. A methodology for planning, conducting, and documenting scoping surveys is described in the following sections.

5.2.2 Survey Design

Planning a scoping survey involves reviewing the HSA (Chapter 3). This process considers available information concerning locations of spills or other releases of radioactive material. Reviewing the radioactive materials license or similar documentation provides information on the identity, locations, and general quantities of radioactive material used at the site. This information helps to determine which areas are likely to contain residual radioactivity and, thus, areas where scoping survey activities will be concentrated. The information may also identify one or more non-impacted areas as potential reference areas when radionuclides of concern are present in background (Section 4.5). Following the review of the HSA, DCGLs that are appropriate for the site are selected. The DCGLs may be adjusted later if a determination is made to use site-specific information to support the development of DCGLs.

If residual radioactivity is identified during the scoping survey, the area may be classified as Class 1 or Class 2 for final status survey planning (refer to Section 4.4 for guidance on initial classification), and a characterization survey is subsequently performed. For scoping surveys that are designed to provide input for characterization surveys, measurements and sampling may not be as comprehensive or performed to the same level of sensitivity necessary for final status surveys. The design of the scoping survey should be based on specific data quality objectives (DQOs; see Section 2.3.1 and Appendix D) for the information to be collected.

For scoping surveys that potentially serve to release the site from further consideration, the survey design should consist of sampling based on the HSA data and professional judgment. If

residual radioactivity is *not* identified during judgment sampling, it may be appropriate to classify the area as Class 3 and perform a final status survey for Class 3 areas. Refer to Section 5.5 for a description of final status surveys. However, collecting additional information during subsequent surveys (*e.g.*, characterization surveys) may be necessary to make a final determination as to area classification.

5.2.3 Conducting Surveys

Scoping survey activities performed for preliminary risk assessment or to provide input for additional characterization include a limited amount of surface scanning, surface activity measurements, and sample collection (smears, soil, water, vegetation, paint, building materials, subsurface materials). In this case, scans, direct measurements, and samples are used to examine areas likely to contain residual radioactivity. These activities are conducted based on HSA data, preliminary investigation surveys, and professional judgment.

Background activity and radiation levels for the area should be determined, including direct radiation levels on building surfaces and radionuclide concentrations in media. Survey locations should be referenced to grid coordinates, if appropriate, or fixed site features. It may be considered appropriate to establish a reference coordinate system in the event that contamination is detected above the DCGLs (Section 4.8.5). Samples collected as part of a scoping survey should consider any sample tracking requirements, including chain of custody, if required (Section 7.8).

Scoping surveys that are expected to be used as Class 3 area final status surveys should be designed following the guidance in Section 5.5. These surveys should also include judgment measurements and sampling in areas likely to have accumulated residual radioactivity (Section 5.5.3).

5.2.4 Evaluating Survey Results

Survey data are converted to the same units as those in which DCGLs are expressed (Section 6.6). Identification of potential radionuclide contaminants at the site is performed using direct measurements or laboratory analysis of samples. The data are compared to the appropriate regulatory DCGLs.

For scoping survey activities that provide an initial assessment of the radiological hazards at the site, or provide input for additional characterization, the survey data are used to identify locations and general extent of residual radioactivity. Scoping surveys that are expected to be used as Class 3 area final status surveys should follow the methodology presented in Chapter 8 to determine if the release criterion has been exceeded.

5.2.5 Documentation

How the results of the scoping survey are documented depends on the specific objectives of the survey. For scoping surveys that provide additional information for characterization surveys, the documentation should provide general information on the radiological status of the site. Survey results should include identification of the potential contaminants (including the methods used for radionuclide identification), general extent of contamination (*e.g.*, activity levels, area of contamination, and depth of contamination), and possibly even relative ratios of radionuclides to facilitate DCGL application. A narrative report or a report in the form of a letter may suffice for scoping surveys used to provide input for characterization surveys. Sites being released from further consideration should provide a level of documentation consistent with final status survey reports.

EXAMPLE SCOPING SURVEY CHECKLIST

SURVEY DESIGN

_____ Enumerate DQOs: State the objectives of the survey; survey instrumentation capabilities should be appropriate for the specified survey objectives.

_____ Review the Historical Site Assessment for:

- _____ Operational history (*e.g.*, problems, spills, releases, or notices of violation) and available documentation (*e.g.*, radioactive materials license).
- _____ Other available resources—site personnel, former workers, residents, *etc.*
- _____ Types and quantities of materials that were handled and where radioactive materials were stored, handled, moved, relocated, and disposed.
- _____ Release and migration pathways.
- _____ Areas that are potentially affected and likely to contain residual contamination. Note: Survey activities will be concentrated in these areas.
- _____ Types and quantities of materials likely to remain onsite—consider radioactive decay.

_____ Select separate DCGLs for the site based on the HSA review. (It may be necessary to assume appropriate regulatory DCGLs in order to permit selection of survey methods and instrumentation for the expected contaminants and quantities.)

CONDUCTING SURVEYS

_____ Follow the survey design documented in the QAPP. Record deviations from the stated objectives or documented SOPs and document additional observations made when conducting the survey.

_____ Select instrumentation based on the specific DQOs of the survey. Consider detection capabilities for the expected contaminants and quantities.

_____ Determine background activity and radiation levels for the area; include direct radiation levels on building surfaces, radionuclide concentrations in media, and exposure rates.

_____ Record measurement and sample locations referenced to grid coordinates or fixed site features.

_____ For scoping surveys that are conducted as Class 3 area final status surveys, follow guidance for final status surveys.

_____ Conduct scoping survey, which involves judgment measurements and sampling based on HSA results:

- _____ Perform investigatory surface scanning.
- _____ Conduct limited surface activity measurements.
- _____ Perform limited sample collection (smears, soil, water, vegetation, paint, building materials, subsurface materials).
- _____ Maintain sample tracking.

EVALUATING SURVEY RESULTS

_____ Compare survey results with the DQOs.

_____ Identify radionuclides of concern.

_____ Identify impacted areas and general extent of contamination.

_____ Estimate the variability in the residual radioactivity levels for the site.

_____ Adjust DCGLs based on survey findings (the DCGLs initially selected may not be appropriate for the site).

_____ Determine the need for additional action (*e.g.*, none, remediate, more surveys)

_____ Prepare report for regulatory agency (determine if letter report is sufficient).

5.3 Characterization Surveys

5.3.1 General

Characterization surveys may be performed to satisfy a number of specific objectives. Examples of characterization survey objectives include: 1) determining the nature and extent of radiological contamination, 2) evaluating remediation alternatives (*e.g.*, unrestricted use, restricted use, onsite disposal, off-site disposal, *etc.*), 3) input to pathway analysis/dose or risk assessment models for determining site-specific DCGLs (Bq/kg, Bq/m^2), 4) estimating the occupational and public health and safety impacts during decommissioning, 5) evaluating remediation technologies, 6) input to final status survey design, and 7) Remedial Investigation/Feasibility Study requirements (CERCLA sites only) or RCRA Facility Investigation/Corrective Measures Study requirements (RCRA sites only).

The scope of this manual precludes detailed discussions of characterization survey design for each of these objectives, and therefore, the user should consult other references for specific characterization survey objectives not covered. For example, the *Decommissioning Handbook* (DOE 1994) is a good reference for characterization objectives that are concerned with evaluating remediation technologies or unrestricted/restricted use alternatives. Other references (EPA 1988b, 1988c, 1994a; NRC 1994) should be consulted for planning decommissioning actions, including decontamination techniques, projected schedules, costs, and waste volumes, and health and safety considerations during decontamination. Also, the types of characterization data needed to support risk or dose modeling should be determined from the specific modeling code documentation.

This manual concentrates on providing information for the final status survey design, with limited coverage on determining the specific nature and extent of radionuclide contamination. The specific objectives for providing information to the final status survey design include: 1) estimating the projected radiological status at the time of the final status survey, in terms of radionuclides present, concentration ranges and variances, spatial distribution, *etc.*, 2) evaluating potential reference areas to be used for background measurements, if necessary, 3) reevaluating the initial classification of survey units, 4) selecting instrumentation based on the necessary MDCs, and 5) establishing acceptable Type I and Type II errors with the regulatory agency (Appendix D provides guidance on establishing acceptable decision error rates). Many of these objectives are satisfied by determining the specific nature and extent of contamination of structures, residues, and environmental media. Additional detail on the performance of characterization surveys designed to determine the general extent of contamination can be found in the NRC's *Draft Branch Technical Position on Site Characterization for Decommissioning* (NRC 1994a) and EPA's RI/FS guidance (EPA 1988b; EPA 1993c).

Results of the characterization survey should include: 1) the identification and distribution of contamination in buildings, structures, and other site facilities; 2) the concentration and distribution of contaminants in surface and subsurface soils; 3) the distribution and concentration of contaminants in surface water, ground water, and sediments, and 4) the distribution and concentration of contaminants in other impacted media such as vegetation or paint. The characterization should include sufficient information on the physical characteristics of the site, including surface features, meteorology and climatology, surface water hydrology, geology, demography and land use, and hydrogeology. This survey should also address environmental conditions that could affect the rate and direction of contaminant transport in the environment, depending on the extent of contamination identified above.

The following sections describe a method for planning, conducting, and documenting characterization surveys. Alternative methodologies may also be acceptable to the regulatory agencies.

5.3.2 Survey Design

The design of the site characterization survey is based on the specific DQOs for the information to be collected, and is planned using the HSA and scoping survey results. The DQO Process ensures that an adequate amount of data with sufficient quality are collected for the purpose of characterization. The site characterization process typically begins with a review of the HSA, which includes available information on site description, operational history, and the type and extent of contamination (from the scoping survey, if performed). The site description, or conceptual site model as first developed in Section 3.6.4, consists of the general area, dimensions, and locations of contaminated areas on the site. A site map should show site boundaries, roads, hydrogeologic features, major structures, and other features that could affect decommissioning activities.

The operational history includes records of site conditions prior to operational activities, operational activities of the facility, effluents and on-site disposal, and significant incidents—including spills or other unusual occurrences—involving the spread of contamination around the site and on areas previously released from radiological controls. This review should include other available resources, such as site personnel, former workers, residents, *etc.* Historic aerial photographs and site location maps may be particularly useful in identifying potential areas of contamination.

The types and quantities of materials that were handled and the locations and disposition of radioactive materials should be reviewed using available documentation (*e.g.*, the radioactive materials license). Contamination release and migration pathways should be identified, as well as areas that are potentially affected and are likely to contain residual contamination. The types and quantities of materials likely to remain onsite, considering radioactive decay, should be determined.

The characterization survey should clearly identify those portions of the site (*e.g.*, soil, structures, and water) that have been affected by site activities and are potentially contaminated. The survey should also identify the portions of the site that have not been affected by these activities. In some cases where no remediation is anticipated, results of the characterization survey may indicate compliance with DCGLs established by the regulatory agency. When planning for the potential use of characterization survey data as part of the final status survey, the characterization data must be of sufficient quality and quantity for that use (see Section 5.5). There are several processes that are likely to occur in conjunction with characterization. These include considering and evaluating remediation alternatives, and calculating site-specific DCGLs.

The survey should also provide information on variations in the contaminant distribution in the survey area. The contaminant variation in each survey unit contributes to determining the number of data points based on the statistical tests used during the final status survey (Section 5.5.2). Additionally, characterization data may be used to justify reclassification for some survey units (*e.g.*, from Class 1 to Class 2).

Note that because of site-specific characteristics of contamination, performing all types of measurements described here may not be relevant at every site. For example, detailed characterization data may not be needed for areas with contamination well above the DCGLs that clearly require remediation. Judgment should be used in determining the types of characterization information needed to provide an appropriate basis for decontamination decisions.

5.3.3 Conducting Surveys

Characterization survey activities often involve the detailed assessment of various types of building and environmental media, including building surfaces, surface and subsurface soil, surface water, and ground water. The HSA data should be used to identify the potentially contaminated media onsite (see Section 3.6.3). Identifying the media that may contain contamination is useful for preliminary survey unit classification and for planning subsequent survey activities. Selection of survey instrumentation and analytical techniques are typically based on a knowledge of the appropriate DCGLs, because remediation decisions are made based on the level of the residual contamination as compared to the DCGL. Exposure rate measurements may be needed to assess occupational and public health and safety. The location of underground utilities should be considered before conducting a survey to avoid compounding the problems at the site.

5.3.3.1 Structure Surveys

Surveys of building surfaces and structures include surface scanning, surface activity measurements, exposure rate measurements, and sample collection (*e.g.*, smears, subfloor soil, water, paint, and building materials). Both field survey instrumentation (Chapter 6) and analytical laboratory equipment and procedures (Chapter 7) are selected based on their detection capabilities for the expected contaminants and their quantities. Field and laboratory instruments are described in Appendix H.

Background activity and radiation levels for the area should be determined from appropriate background reference areas. Background assessments include surface activity measurements on building surfaces, exposure rates, and radionuclide concentrations in various media (refer to Section 4.5).

Measurement locations should be documented using reference system coordinates, if appropriate, or fixed site features. A typical reference system spacing for building surfaces is 1 meter. This is chosen to facilitate identifying survey locations, evaluating small areas of elevated activity, and determining survey unit average activity levels.

Scans should be conducted in areas likely to contain residual activity, based on the results of the HSA and scoping survey.

Both systematic and judgment surface activity measurements are performed. Judgment direct measurements are performed at locations of elevated direct radiation, as identified by surface scans, to provide data on upper ranges of residual contamination levels. Judgment measurements may also be performed in sewers, air ducts, storage tanks, septic systems and on roofs of buildings, if necessary. Each surface activity measurement location should be carefully recorded on the appropriate survey form.

Exposure rate measurements and media sampling are performed as necessary. For example, subfloor soil samples may provide information on the horizontal and vertical extent of contamination. Similarly, concrete core samples are necessary to evaluate the depth of activated concrete in a reactor facility. Note that one type of radiological measurement may be sufficient to determine the extent of contamination. For example, surface activity measurements alone may be all that is needed to demonstrate that decontamination of a particular area is necessary; exposure rate measurements would add little to this determination.

Lastly, the measuring and sampling techniques should be commensurate with the intended use of the data, as characterization survey data may be used to supplement final status survey data, provided that the data meet the selected DQOs.

5.3.3.2 Land Area Surveys

Characterization surveys for surface and subsurface soils and media involve employing techniques to determine the lateral and vertical extent and radionuclide concentrations in the soil. This may be performed using either sampling and laboratory analyses, or *in situ* gamma spectrometry analyses, depending on the detection capabilities of each methodology for the expected contaminants and concentrations. Note that *in situ* gamma spectrometry analyses or any direct surface measurement cannot easily be used to determine vertical distributions of radionuclides. Sample collection followed by laboratory analysis introduces several additional sources of uncertainty that need to be considered during survey design. In many cases, a combination of direct measurements and samples is required to meet the objectives of the survey.

Radionuclide concentrations in background soil samples should be determined for a sufficient number of soil samples that are representative of the soil in terms of soil type, soil depth, *etc.* It is important that the background samples be collected in non-impacted areas. Consideration should be given to spatial variations in the background radionuclide concentrations as discussed in Section 4.5 and NRC draft report NUREG-1501 (NRC 1994b).

Sample locations should be documented using reference system coordinates (see Section 4.8.5), if appropriate, or fixed site features. A typical reference system spacing for open land areas is 10 meters (NRC 1992a). This spacing is somewhat arbitrary and is chosen to facilitate determining survey unit locations and evaluating areas of elevated radioactivity.

Surface scans for gamma activity should be conducted in areas likely to contain residual activity. Beta scans may be appropriate if the contamination is near the surface and represents the prominent radiation emitted from the contamination. The sensitivity of the scanning technique should be appropriate to meet the DQOs.

Both surface and subsurface soil and media samples may be necessary. Subsurface soil samples should be collected where surface contamination is present and where subsurface contamination is known or suspected. Boreholes should be constructed to provide samples representing subsurface deposits.

Exposure rate measurements at 1 meter above the sampling location may also be appropriate. Each surface and subsurface soil sampling and measurement location should be carefully recorded.

5.3.3.3 Other Measurements/Sampling Locations

Surface Water and Sediments. Surface water and sediment sampling may be necessary depending on the potential for these media to be contaminated. The contamination potential depends on several factors, including the proximity of surface water bodies to the site, size of the drainage area, total annual rainfall, and spatial and temporal variability in surface water flow rate and volume. Refer to Section 3.6.3.3 for further consideration of the necessity for surface water and sediment sampling.

Characterizing surface water involves techniques that determine the extent and distribution of contaminants. This may be performed by collecting grab samples of the surface water in a well-mixed zone. At certain sites, it may be necessary to collect stratified water samples to provide information on the vertical distribution of contamination. Sediment sampling should also be performed to assess the relationship between the composition of the suspended sediment and the bedload sediment fractions (*i.e.*, suspended sediments compared to deposited sediments). When judgment sampling is used to find radionuclides in sediments, contaminated sediments are more likely to be accumulated on fine-grained deposits found in low-energy environments (*e.g.*, deposited silt on inner curves of streams).

Radionuclide concentrations in background water samples should be determined for a sufficient number of water samples that are upstream of the site or in areas unaffected by site operations. Consideration should be given to any spatial or temporal variations in the background radionuclide concentrations.

Sampling locations should be documented using reference system coordinates, if appropriate, or scale drawings of the surface water bodies. Effects of variability of surface water flow rate should be considered. Surface scans for gamma activity may be conducted in areas likely to contain residual activity (*e.g.*, along the banks) based on the results of the document review and/or preliminary investigation surveys.

Surface water sampling should be performed in areas of runoff from active operations, at plant outfall locations, both upstream and downstream of the outfall, and any other areas likely to contain residual activity (see Section 3.6.3.3). Measurements of radionuclide concentrations in water should include gross alpha and gross beta assessments, as well as any necessary radionuclide-specific analyses. Non-radiological parameters, such as specific conductance, pH, and total organic carbon may be used as surrogate indicators of potential contamination, provided that a specific relationship exists between the radionuclide concentration and the level of the indicator (*e.g.*, a linear relationship between pH and the radionuclide concentration in water is found to exist, then the pH may be measured such that the radionuclide concentration can be calculated based on the known relationship rather than performing an expensive nuclide-specific analysis). The use of surrogate measurements is discussed in Section 4.3.2.

Each surface water and sediment sampling location should be carefully recorded on the appropriate survey form. Additionally, surface water flow models may be used to illustrate contaminant concentrations and migration rates.

Ground Water. Ground-water sampling may be necessary depending on the local geology, potential for subsurface contamination, and the regulatory framework. Because different agencies handle ground water contamination situations in different ways (*e.g.*, EPA's Superfund program and some States require compliance with maximum contaminant levels specified in the Safe Drinking Water Act), the responsible regulatory agency should be contacted if ground water contamination is expected. The need for ground-water sampling is described in Section 3.6.3.4.

If ground-water contamination is identified, the responsible regulatory agency should be contacted at once because: 1) ground water release criteria and DCGLs should be established by the appropriate agency (Section 4.3), and 2) the default DCGLs for soil may be inappropriate since they are usually based on initially uncontaminated ground water.

Characterization of ground-water contamination should determine the extent and distribution of contaminants, rates and direction of ground water migration, and the assessment of potential effects of ground water withdrawal on the migration of ground water contaminants. This may be performed by designing a suitable monitoring well network. The actual number and location of monitoring wells depends on the size of the contaminated area, the type and extent of the contaminants, the hydrogeologic system, and the objectives of the monitoring program.

When ground-water samples are taken, background should be determined by sufficient sampling and analysis of ground-water samples collected from the same aquifer upgradient of the site. The background samples should not be affected by site operations and should be representative of the quality of the ground water that would exist if the site had not been contaminated. Consideration should be given to any spatial or temporal variations in the background radionuclide concentrations.

Sampling locations should be referenced to grid coordinates, if appropriate, or to scale drawings of the ground-water monitoring wells. Construction specifications on the monitoring wells should also be provided, including elevation, internal and external dimensions, types of casings, type of screen and its location, borehole diameter, and other necessary information on the wells.

In addition to organic and inorganic constituents, ground-water sampling and analyses should include all significant radiological contaminants. Measurements in potential sources of drinking water should include gross alpha and gross beta assessments, as well as any other radionuclide-specific analyses. Non-radiological parameters, such as specific conductance, pH, and total organic carbon may be used as surrogate indicators of potential contamination, provided that a specific relationship exists between the radionuclide concentration and the level of the indicator.

Each ground-water monitoring well location should be carefully recorded on the appropriate survey form. Additionally, contaminant concentrations and sources should be plotted on a map to illustrate the relationship among contamination, sources, hydrogeologic features and boundary conditions, and property boundaries (EPA 1993b).

Other Media. Air sampling may be necessary at some sites depending on the local geology and the radionuclides of potential concern. This may include collecting air samples or filtering the air to collect resuspended particulates. Air sampling is often restricted to monitoring activities for occupational and public health and safety and is not required to demonstrate compliance with risk- or dose-based regulations. Section 3.6.3.5 describes examples of sites where air sampling may provide information useful to designing a final status survey. At some sites, radon measurements may be used to indicate the presence of radium, thorium, or uranium in the soil. Section 6.9 and Appendix H provide information on this type of sampling.

In rare cases, vegetation samples may be collected as part of a characterization survey to provide information in preparation for a final status survey. Because most risk- and dose-based regulations are concerned with potential future land use that may differ from the current land use, vegetation samples are unsuitable for demonstrating compliance with regulations. There is a relationship between radionuclide concentrations in plants and those in soil (the soil-to-plant transfer factor is used in many models to develop DCGLs) and the plant concentration could be used as a surrogate measurement of the soil concentration. In most cases, a measurement of the soil itself as the parameter of interest is more appropriate and introduces less uncertainty in the result.

5.3.4 Evaluating Survey Results

Survey data are converted to the same units as those in which DCGLs are expressed (Section 6.6). Identification of potential radionuclide contaminants at the site is performed through laboratory and *in situ* analyses. Appropriate regulatory DCGLs for the site are selected and the data are then compared to the DCGLs. For characterization data that are used to supplement final status survey data, the statistical methodology in Chapter 8 should be followed to determine if a survey unit satisfies the release criteria.

For characterization data that are used to help guide remediation efforts, the survey data are used to identify locations and general extent of residual activity. The survey results are first compared with DCGLs. Surfaces and environmental media are then differentiated as exceeding DCGLs, not exceeding DCGLs, or not contaminated, depending on the measurement results relative to the DCGL value. Direct measurements indicating areas of elevated activity are further evaluated and the need for additional measurements is determined.

5.3.5 Documentation

Documentation of the site characterization survey should provide a complete and unambiguous record of the radiological status of the site. In addition, sufficient information to characterize the extent of contamination, including all possible affected environmental media, should be provided in the report. This report should also provide sufficient information to support reasonable approaches or alternatives to site decontamination.

EXAMPLE CHARACTERIZATION SURVEY CHECKLIST

SURVEY DESIGN

_____ Enumerate DQOs: State objective of the survey; survey instrumentation capabilities should be appropriate for the specific survey objective.

_____ Review the Historical Site Assessment for:

- _____ Operational history (*e.g.*, any problems, spills, or releases) and available documentation (*e.g.*, radioactive materials license).
- _____ Other available resources—site personnel, former workers, residents, *etc.*
- _____ Types and quantities of materials that were handled and where radioactive materials were stored, handled, and disposed of.
- _____ Release and migration pathways.
- _____ Information on the potential for residual radioactivity that may be useful during area classification for final status survey design. Note: Survey activities will be concentrated in Class 1 and Class 2 areas.
- _____ Types and quantities of materials likely to remain on-site—consider radioactive decay.

CONDUCTING SURVEYS

_____ Select instrumentation based on detection capabilities for the expected contaminants and quantities and a knowledge of the appropriate DCGLs.

_____ Determine background activity and radiation levels for the area; include surface activity levels on building surfaces, radionuclide concentrations in environmental media, and exposure rates.

_____ Establish a reference coordinate system. Prepare scale drawings for surface water and ground-water monitoring well locations.

_____ Perform thorough surface scans of all potentially contaminated areas, *(e.g.*, indoor areas include expansion joints, stress cracks, penetrations into floors and walls for piping, conduit, and anchor bolts, and wall/floor interfaces); outdoor areas include radioactive material storage areas, areas downwind of stack release points, surface drainage pathways, and roadways that may have been used for transport of radioactive or contaminated materials.

_____ Perform systematic surface activity measurements.

_____ Perform systematic smear, surface and subsurface soil and media, sediment, surface water and groundwater sampling, if appropriate for the site.

_____ Perform judgment direct measurements and sampling of areas of elevated activity of residual radioactivity to provide data on upper ranges of residual contamination levels.

_____ Document survey and sampling locations.

_____ Maintain chain of custody of samples when necessary.

Note: One category of radiological data (*e.g.*, radionuclide concentration, direct radiation level, or surface contamination) may be sufficient to determine the extent of contamination; other measurements may not be necessary (*e.g.*, removable surface contamination or exposure rate measurements).

Note: Measuring and sampling techniques should be commensurate with the intended use of the data because characterization survey data may be used to supplement final status survey data.

EVALUATING SURVEY RESULTS

_____ Compare survey results with DCGLs. Differentiate surfaces/areas as exceeding DCGLs, not exceeding DCGLs, or not contaminated.

_____ Evaluate all locations of elevated direct measurements and determine the need for additional measurements/samples.

_____ Prepare site characterization survey report.

5.4 Remedial Action Support Surveys

5.4.1 General

Remedial action support surveys are conducted to 1) support remediation activities, 2) determine when a site or survey unit is ready for the final status survey, and 3) provide updated estimates of site-specific parameters to use for planning the final status survey. This manual does not discuss the routine operational surveys (*e.g.*, air sampling, dose rate measurements, environmental sampling) conducted to support remediation activities.

A remedial action support survey serves to monitor the effectiveness of decontamination efforts that are intended to reduce residual radioactivity to acceptable levels. This type of survey guides the cleanup in a real-time mode. The remedial action support survey typically relies on a simple radiological parameter, such as direct radiation near the surface, as an indicator of effectiveness. The investigation level (the level below which there is an acceptable level of assurance that the established DCGLs have been attained) is determined and used for immediate, in-field decisions (Section 5.5.2.6). Such a survey is intended for expediency and cost effectiveness and does not provide thorough or accurate data describing the radiological status of the site. Note that this survey does not provide information that can be used to demonstrate compliance with the DCGLs and is an interim step in the compliance demonstration process. Areas that are determined to satisfy the DCGLs on the basis of the remedial action support survey will then be surveyed in detail by the final status survey. Alternatively, the remedial action support survey can be designed to meet the objectives of a final status survey as described in Section 5.5. DCGLs may be recalculated based on the results of the remediation process as the regulatory program allows or permits.

Remedial activities result in changes to the distribution of contamination within a survey unit. The site-specific parameters used during final status survey planning (*e.g.*, variability in the radionuclide concentration within a survey unit or probability of small areas of elevated activity) will change during remediation. For most survey units, values for these parameters will need to be re-established following remediation. Obtaining updated values for these critical planning parameters should be considered when designing a remedial action support survey.

5.4.2 Survey Design

The objective of the remedial action support survey is to detect the presence of residual activity at or below the DCGL criteria. Although the presence of small areas of elevated radioactivity may satisfy the elevated measurement criteria, it may be more efficient to design the remedial action support survey to identify residual radioactivity at the $DCGL_W$ (and to remediate small areas of elevated activity that may potentially satisfy the release criteria). Survey instrumentation and techniques are therefore selected based on the detection capabilities for the known or suspected contaminants and DCGLs to be achieved.

There will be radionuclides and media that cannot be evaluated at the $DCGL_W$ using field monitoring techniques. For these cases, it may be feasible to collect and analyze samples by methods that are quicker and less costly than radionuclide-specific laboratory procedures. Field laboratories and screening techniques may be acceptable alternatives to more expensive analyses. Reviewing remediation plans may be required to get an indication of the location and amount of remaining contamination following remediation.

5.4.3 Conducting Surveys

Field survey instruments and procedures are selected based on their detection capabilities for the expected contaminants and their quantities. Survey methods typically include scans of surfaces followed by direct measurements to identify residual radioactivity. The surface activity levels are compared to the DCGLs, and a determination is made on the need for further decontamination efforts.

Survey activities for soil excavations include surface scans using field instrumentation sensitive to beta and gamma activity. Because it is difficult to correlate scanning results to radionuclide concentrations in soil, judgment should be carefully exercised when using scan results to guide the cleanup efforts. Field laboratories and screening techniques may provide a better approach for determining whether or not further soil remediation is necessary.

5.4.4 Evaluating Survey Results

Survey data (*e.g.*, surface activity levels and radionuclide concentrations in various media) are converted to standard units and compared to the DCGLs (Section 6.6). If results of these survey activities indicate that remediation has been successful in meeting the DCGLs, decontamination efforts are ceased and final status survey activities are initiated. Further remediation may be needed if results indicate the presence of residual activity in excess of the DCGLs.

5.4.5 Documentation

The remedial action support survey is intended to guide the cleanup and alert those performing remedial activities that additional remediation is needed or that the site may be ready to initiate a final survey. Data that indicate an area has been successfully remediated could be used to estimate the variance for the survey units in that area. Information identifying areas of elevated activity that existed prior to remediation may be useful for planning final status surveys.

EXAMPLE REMEDIAL ACTION SUPPORT SURVEY CHECKLIST

SURVEY DESIGN

_____ Enumerate DQOs: State the objectives of the survey; survey instrumentation capabilities should be able to detect residual contamination at the DCGL.

_____ Review the remediation plans.

_____ Determine applicability of monitoring surfaces/soils for the radionuclides of concern. Note: Remedial action support surveys may not be feasible for surfaces contaminated with very low energy beta emitters or for soils or media contaminated with pure alpha emitters.

_____ Select simple radiological parameters (*e.g.*, surface activity) that can be used to make immediate in-field decisions on the effectiveness of the remedial action.

CONDUCTING SURVEYS

_____ Select instrumentation based on its detection capabilities for the expected contaminants.

_____ Perform scanning and surface activity measurements near the surface being decontaminated.

_____ Survey soil excavations and perform field evaluation of samples (*e.g.*, gamma spectrometry of undried/non-homogenized soil) as remedial actions progress.

EVALUATING SURVEY RESULTS

_____ Compare survey results with DCGLs using survey data as a field decision tool to guide the remedial actions in a real-time mode.

_____ Document survey results.

5.5 Final Status Surveys

5.5.1 General

A final status survey is performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for release for unrestricted use or, where appropriate, for use with designated limitations. The survey provides data to demonstrate that all radiological parameters do not exceed the established DCGLs. For these reasons, more detailed guidance is provided for this category of survey. For the final status survey, survey units represent the fundamental elements for compliance demonstration using the statistical tests (see Section 4.6). The documentation specified in the following sections helps ensure a consistent approach among different organizations and regulatory agencies. This allows for comparisons of survey results between sites or facilities.

This section describes methods for planning and conducting final status surveys to satisfy the objectives of the regulatory agencies. The MARSSIM approach recognizes that alternative methods may be acceptable to those agencies. Flow diagrams and a checklist to assist the user in planning a survey are included in this section.

5.5.2 Survey Design

Figures 5.1 through 5.3 illustrate the process of designing a final status survey. This process begins with development of DQOs. On the basis of these objectives and the known or anticipated radiological conditions at the site, the numbers and locations of measurement and sampling points used to demonstrate compliance with the release criterion are then determined. Finally, survey techniques appropriate to develop adequate data (see Chapters 6 and 7) are selected and implemented.

Planning for the final status survey should include early discussions with the regulatory agency concerning logistics for confirmatory or verification surveys. A confirmatory survey (also known as an independent verification survey), may be performed by the responsible regulatory agency or by an independent third party (*e.g.*, contracted by the regulatory agency) to provide data to substantiate results of the final status survey. Actual field measurements and sampling may be performed. Another purpose of the confirmatory activities may be to identify any deficiencies in the final status survey documentation based on a thorough review of survey procedures and results. Independent confirmatory survey activities are usually limited in scope to spot-checking conditions at selected locations, comparing findings with those of the final status survey, and performing independent statistical evaluations of the data developed from the confirmatory survey and the final status survey.

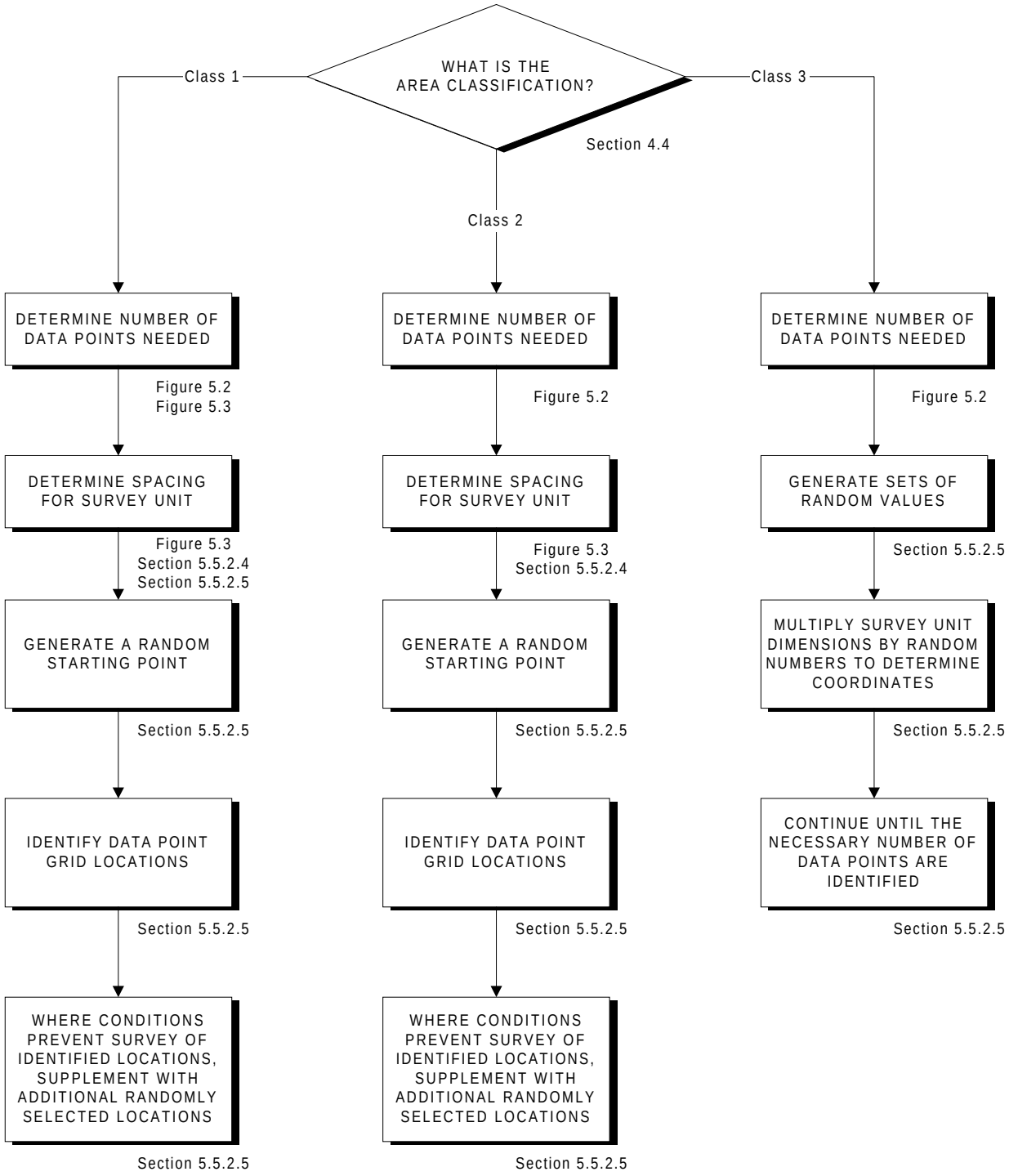


Figure 5.1 Flow Diagram Illustrating the Process for Identifying Measurement Locations (Refer to Section 5.5.2.5)

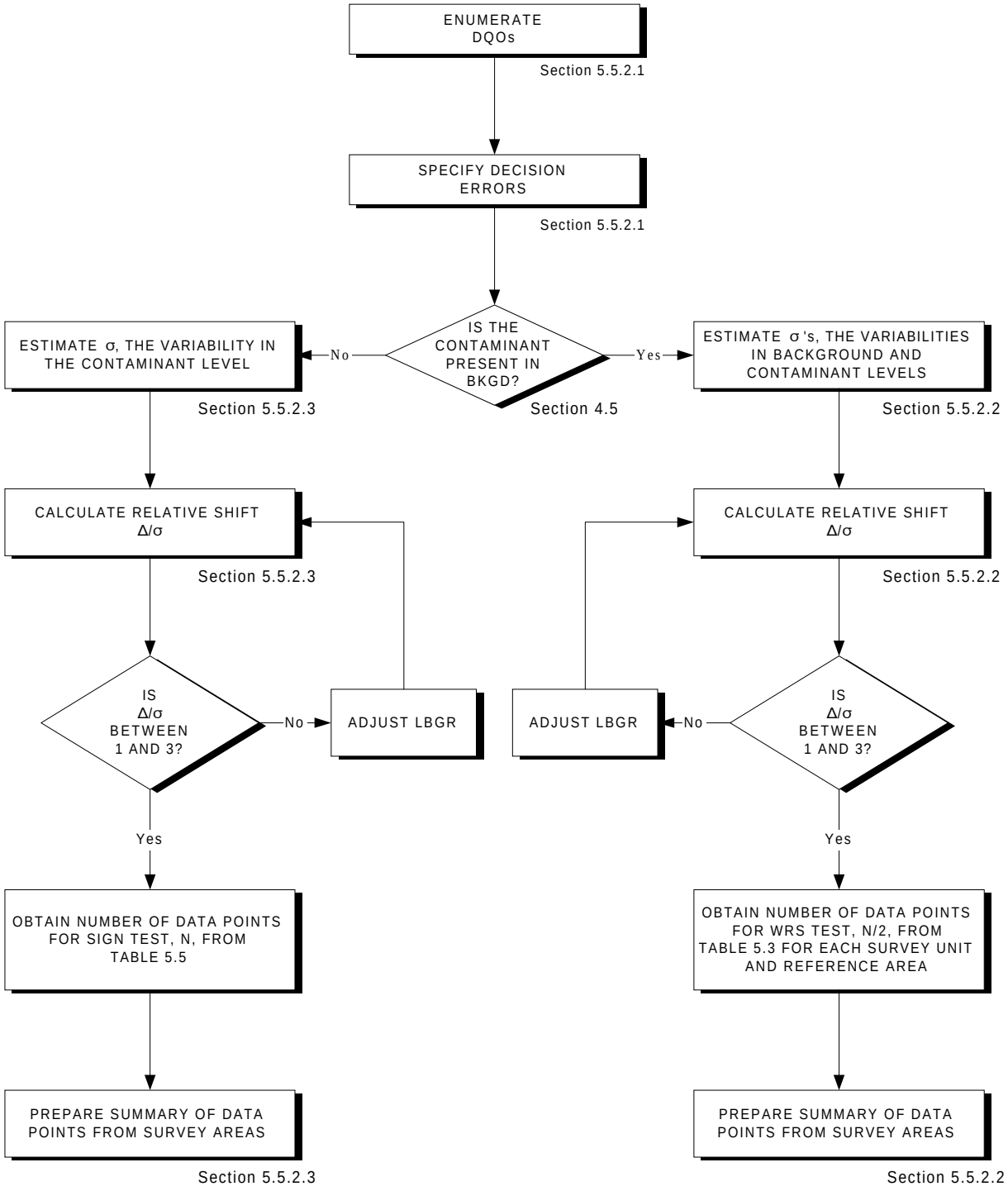


Figure 5.2 Flow Diagram for Identifying the Number of Data Points, N, for Statistical Tests

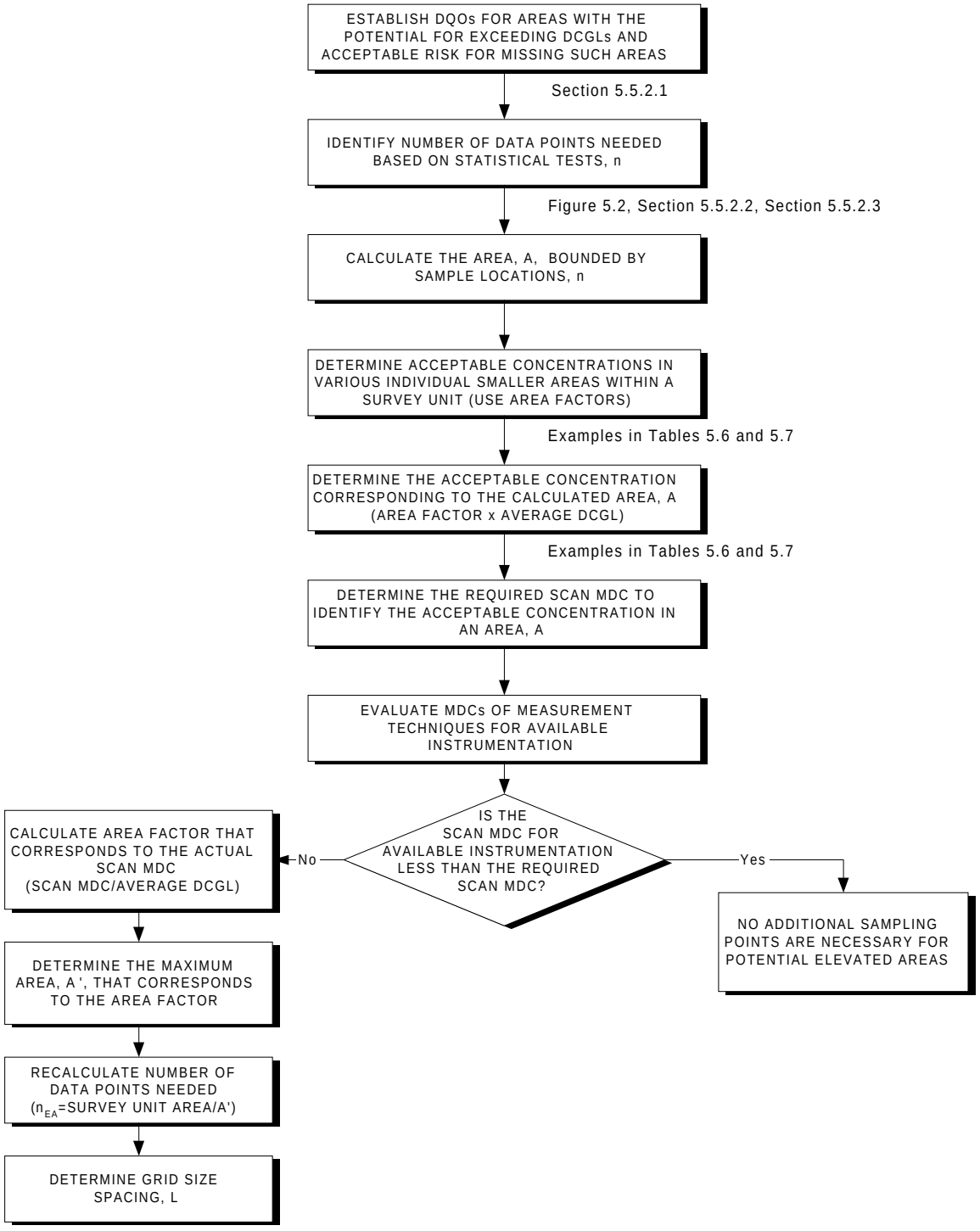


Figure 5.3 Flow Diagram for Identifying Data Needs for Assessment of Potential Areas of Elevated Activity in Class 1 Survey Units (Refer to Section 5.5.2.4)

5.5.2.1 Application of Decommissioning Criteria

The DQO Process, as it is applied to decommissioning surveys, is described in more detail in Appendix D of this manual and in EPA and NRC guidance documents (EPA 1994, 1987b, 1987c; NRC 1997a). As part of this process, the objective of the survey and the null and alternative hypotheses should be clearly stated. The objective of final status surveys is typically to demonstrate that residual radioactivity levels meet the release criterion. In demonstrating that this objective is met, the null hypothesis (H_o) tested is that residual contamination exceeds the release criterion; the alternative hypothesis (H_a) is that residual contamination meets the release criterion.

Two statistical tests are used to evaluate data from final status surveys. For contaminants that are present in background, the Wilcoxon Rank Sum (WRS) test is used. When contaminants are not present in background, the Sign test is used. To determine data needs for these tests, the acceptable probability of making Type I decision errors (α) and Type II decision errors (β) should be established (see Appendix D, Section D.6). The acceptable decision error rates are a function of the amount of residual radioactivity and are determined during survey planning using the DQO Process.

The final step of the DQO process includes selecting the optimal design that satisfies the DQOs. For some sites or survey units, the guidance provided in this section may result in a survey design that cannot be accomplished with the available resources. For these situations, the planning team will need to relax one or more of the constraints used to develop the survey design as described in Appendix D. Examples of survey design constraints discussed in this section include:

- increasing the decision error rates, not forgetting to consider the risks associated with making an incorrect decision
- increasing the width of the gray region by decreasing the lower bound of the gray region
- changing the boundaries—it may be possible to reduce measurement costs by changing or eliminating survey units that may require different decisions

5.5.2.2 Contaminant Present in Background—Determining Numbers of Data Points for Statistical Tests

The comparison of measurements from the reference area and survey unit is made using the WRS test, which should be conducted for each survey unit. In addition, the elevated measurement comparison (EMC) is performed against each measurement to ensure that the measurement result does not exceed a specified investigation level. If any measurement in the remediated survey unit exceeds the specified investigation level, then additional investigation is recommended, at least locally, regardless of the outcome of the WRS test.

The WRS test is most effective when residual radioactivity is uniformly present throughout a survey unit. The test is designed to detect whether or not this activity exceeds the $DCGL_W$. The advantage of this nonparametric test is that it does not assume the data are normally or log-normally distributed. The WRS test also allows for "less than" measurements to be present in the reference area and the survey units. As a general rule, this test can be used with up to 40 % "less than" measurements in either the reference area or the survey unit. However, the use of "less than" values in data reporting is not recommended. Wherever possible, the actual result of a measurement, together with its uncertainty, should be reported.

This section introduces several terms and statistical parameters that will be used to determine the number of data points needed to apply the nonparametric tests. An example is provided to better illustrate the application of these statistical concepts.

Calculate the Relative Shift. The lower bound of the gray region (LBGR) is selected during the DQO Process along with the target values for α and β. The width of the gray region, equal to (DCGL - LBGR), is a parameter that is central to the WRS test. This parameter is also referred to as the shift, Δ. The absolute size of the shift is actually of less importance than the relative shift, Δ/σ, where σ is an estimate of the standard deviation of the measured values in the survey unit. This estimate of σ includes both the real spatial variability in the quantity being measured and the precision of the chosen measurement system. The relative shift, Δ/σ, is an expression of the resolution of the measurements in units of measurement uncertainty.

The shift ($\Delta = DCGL_W$ - LBGR) and the estimated standard deviation in the measurements of the contaminant (σ_r and σ_s) are used to calculate the relative shift, Δ/σ (see Appendix D, Section D.6). The standard deviations in the contaminant level will likely be available from previous survey data (*e.g.*, scoping or characterization survey data for unremediated survey units or remedial action support surveys for remediated survey units). If they are not available, it may be necessary to 1) perform some limited preliminary measurements (about 5 to 20) to estimate the distributions, or 2) to make a reasonable estimate based on available site knowledge. If the first approach above is used, it is important to note that the scoping or characterization survey data or preliminary measurements used to estimate the standard deviation should use the same technique as that to be used during the final status survey. When preliminary data are not obtained, it may be reasonable to assume a coefficient of variation on the order of 30%, based on experience.

The value selected as an estimate of σ for a survey unit may be based on data collected only from within that survey unit or from data collected from a much larger area of the site. Note that survey units are not finalized until the planning stage of the final status survey. This means that there may be some difficulty in determining which individual measurements from a preliminary survey may later represent a particular survey unit. For many sites, the most practical solution is to estimate σ for each area classification (*i.e.*, Class 1, Class 2, and Class 3) for both interior and exterior survey units. This will result in all exterior Class 3 survey units using the same estimate

of σ, all exterior Class 2 survey units using a second estimate for σ, and all exterior Class 1 survey units using a third estimate for σ. If there are multiple types of surfaces within an area classification, additional estimates of σ may be required. For example, a Class 2 concrete floor may require a different estimate of σ than a Class 2 cinder block wall, or a Class 3 unpaved parking area may require a different estimate of σ than a Class 3 lawn. In addition, MARSSIM recommends that a separate estimate of σ be obtained for every reference area.

The importance of choosing appropriate values for σ_r and σ_s must be emphasized. *If the value is grossly underestimated*, the number of data points will be too few to obtain the desired power level for the test and a resurvey may be recommended (refer to Chapter 8). If, on the other hand, *the value is overestimated*, the number of data points determined will be unnecessarily large.

Values for the relative shift that are less than one will result in a large number of measurements needed to demonstrate compliance. The number of data points will also increase as Δ becomes smaller. Since the DCGL is fixed, this means that the lower bound of the gray region also has a significant effect on the estimated number of measurements needed to demonstrate compliance. When the estimated standard deviations in the reference area and survey units are different, the larger value should be used to calculate the relative shift (Δ/σ).

Determine P_r. The probability that a random measurement from the survey unit exceeds a random measurement from the background reference area by less than the $DCGL_W$ when the survey unit median is equal to the LBGR above background is defined as P_r. P_r is used in Equation 5-1 for determining the number of measurements to be performed during the survey. Table 5.1 lists relative shift values and values for P_r. Using the relative shift calculated in the preceding section, the value of P_r can be obtained from Table 5.1. Information on calculating individual values of P_r is available in NUREG-1505 (NRC 1997a).

If the actual value of the relative shift is not listed in Table 5.1, always select the next lower value that appears in the table. For example, Δ/σ=1.67 does not appear in Table 5.1. The next lower value is 1.6, so the value of P_r would be 0.871014.

Determine Decision Error Percentiles. The next step in this process is to determine the percentiles, $Z_{1-\alpha}$ and $Z_{1-ß}$, represented by the selected decision error levels, α and ß, respectively (see Table 5.2). $Z_{1-\alpha}$ and $Z_{1-ß}$ are standard statistical values (Harnett 1975).

Table 5.1 Values of P_r for Given Values of the Relative Shift, Δ/σ, when the Contaminant is Present in Background

Δ/σ	P_r	Δ/σ	P_r
0.1	0.528182	1.4	0.838864
0.2	0.556223	1.5	0.855541
0.3	0.583985	1.6	0.871014
0.4	0.611335	1.7	0.885299
0.5	0.638143	1.8	0.898420
0.6	0.664290	1.9	0.910413
0.7	0.689665	2.0	0.921319
0.8	0.714167	2.25	0.944167
0.9	0.737710	2.5	0.961428
1.0	0.760217	2.75	0.974067
1.1	0.781627	3.0	0.983039
1.2	0.801892	3.5	0.993329
1.3	0.820978	4.0	0.997658

If $\Delta/\sigma > 4.0$, use $P_r = 1.000000$

Table 5.2 Percentiles Represented by Selected Values of α and ß

α (or ß)	$Z_{1-\alpha}$ (or $Z_{1-ß}$)	α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)
0.005	2.576	0.10	1.282
0.01	2.326	0.15	1.036
0.015	2.241	0.20	0.842
0.025	1.960	0.25	0.674
0.05	1.645	0.30	0.524

Calculate Number of Data Points for WRS Test. The number of data points, N, to be obtained from each reference area/survey unit pair for the WRS test is next calculated using

$$N = \frac{(Z_{1-\alpha}+Z_{1-\beta})^2}{3(P_r-0.5)^2} \qquad (5\text{-}1)$$

The value of N calculated using equation 5-1 is an approximation based on estimates of σ and P_r, so there is some uncertainty associated with this calculation. In addition, there will be some missing or unusable data from any survey. The rate of missing or unusable measurements, R, expected to occur in survey units or reference areas and the uncertainty associated with the calculation of N should be accounted for during survey planning. The number of data points should be increased by 20%, and rounded up, over the values calculated using equation 5-1 to obtain sufficient data points to attain the desired power level with the statistical tests and allow for possible lost or unusable data. The value of 20% is selected to account for a reasonable amount of uncertainty in the parameters used to calculate N and still allow flexibility to account for some lost or unusable data. The recommended 20% correction factor should be applied as a minimum value. Experience and site-specific considerations should be used to increase the correction factor if required. If the user determines that the 20% increase in the number of measurements is excessive for a specific site, a retrospective power curve should be used to demonstrate that the survey design provides adequate power to support the decision (see Appendix I).

N is the total number of data points for each survey unit/reference area combination. The N data points are divided between the survey unit, n, and the reference area, m. The simplest method for distributing the N data points is to assign half the data points to the survey unit and half to the reference area, so n=m=N/2. This means that N/2 measurements are performed in each survey unit, and N/2 measurements are performed in each reference area. If more than one survey unit is associated with a particular reference area, N/2 measurements should be performed in each survey unit and N/2 measurements should be performed in the reference area.

Obtain Number of Data Points for WRS Test from Table 5.3. Table 5.3 provides a list of the number of data points used to demonstrate compliance using the WRS test for selected values of α, β, and Δ/σ. The values listed in Table 5.3 represent the number of measurements to be performed in each survey unit as well as in the corresponding reference area. The values were calculated using Equation 5-1 and increased by 20% for the reasons discussed in the previous section.

Example:

A site has 14 survey units and 1 reference area, and the same type of instrument and method is used to perform measurements in each area. The contaminant has a $DCGL_W$ which when converted to cpm equals 160 cpm. The contaminant is present in background at a level of 45 ± 7 (1σ) cpm. The standard deviation of the contaminant in the survey area is ± 20 cpm, based on previous survey results for

Table 5.3 Values of N/2 for Use with the Wilcoxon Rank Sum Test

	α=0.01					α=0.025					α=0.05					α=0.10					α=0.25				
	β					β					β					β					β				
Δ/σ	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25
0.1	5452	4627	3972	3278	2268	4627	3870	3273	2646	1748	3972	3273	2726	2157	1355	3278	2646	2157	1655	964	2268	1748	1355	964	459
0.2	1370	1163	998	824	570	1163	973	823	665	440	998	823	685	542	341	824	665	542	416	243	570	440	341	243	116
0.3	614	521	448	370	256	521	436	369	298	197	448	369	307	243	153	370	298	243	187	109	256	197	153	109	52
0.4	350	297	255	211	146	297	248	210	170	112	255	210	175	139	87	211	170	139	106	62	146	112	87	62	30
0.5	227	193	166	137	95	193	162	137	111	73	166	137	114	90	57	137	111	90	69	41	95	73	57	41	20
0.6	161	137	117	97	67	137	114	97	78	52	117	97	81	64	40	97	78	64	49	29	67	52	40	29	14
0.7	121	103	88	73	51	103	86	73	59	39	88	73	61	48	30	73	59	48	37	22	51	39	30	22	11
0.8	95	81	69	57	40	81	68	57	46	31	69	57	48	38	24	57	46	38	29	17	40	31	24	17	8
0.9	77	66	56	47	32	66	55	46	38	25	56	46	39	31	20	47	38	31	24	14	32	25	20	14	7
1.0	64	55	47	39	27	55	46	39	32	21	47	39	32	26	16	39	32	26	20	12	27	21	16	12	6
1.1	55	47	40	33	23	47	39	33	27	18	40	33	28	22	14	33	27	22	17	10	23	18	14	10	5
1.2	48	41	35	29	20	41	34	29	24	16	35	29	24	19	12	29	24	19	15	9	20	16	12	9	4
1.3	43	36	31	26	18	36	30	26	21	14	31	26	22	17	11	26	21	17	13	8	18	14	11	8	4
1.4	38	32	28	23	16	32	27	23	19	13	28	23	19	15	10	23	19	15	12	7	16	13	10	7	4
1.5	35	30	25	21	15	30	25	21	17	11	25	21	18	14	9	21	17	14	11	7	15	11	9	7	3
1.6	32	27	23	19	14	27	23	19	16	11	23	19	16	13	8	19	16	13	10	6	14	11	8	6	3
1.7	30	25	22	18	13	25	21	18	15	10	22	18	15	12	8	18	15	12	9	6	13	10	8	6	3
1.8	28	24	20	17	12	24	20	17	14	9	20	17	14	11	7	17	14	11	9	5	12	9	7	5	3
1.9	26	22	19	16	11	22	19	16	13	9	19	16	13	11	7	16	13	11	8	5	11	9	7	5	3
2.0	25	21	18	15	11	21	18	15	12	8	18	15	13	10	7	15	12	10	8	5	11	8	7	5	3
2.25	22	19	16	14	10	19	16	14	11	8	16	14	11	9	6	14	11	9	7	4	10	8	6	4	2
2.5	21	18	15	13	9	18	15	13	10	7	15	13	11	9	6	13	10	9	7	4	9	7	6	4	2
2.75	20	17	15	12	9	17	14	12	10	7	15	12	10	8	5	12	10	8	6	4	9	7	5	4	2
3.0	19	16	14	12	8	16	14	12	10	6	14	12	10	8	5	12	10	8	6	4	8	6	5	4	2
3.5	18	16	13	11	8	16	13	11	9	6	13	11	9	8	5	11	9	8	6	4	8	6	5	4	2
4.0	18	15	13	11	8	15	13	11	9	6	13	11	9	7	5	11	9	7	6	4	8	6	5	4	2

the same or similar contaminant distribution. When the estimated standard deviation in the reference area and the survey units are different, the larger value, 20 cpm in this example, should be used to calculate the relative shift. During the DQO process the LBGR is selected to be one-half the $DCGL_W$ (80 cpm) as an arbitrary starting point for developing an acceptable survey design,[1] and Type I and Type II error values (α and β) of 0.05 have been selected. Determine the number of data points to be obtained from the reference area and from each of the survey units for the statistical tests.

The value of the relative shift for the reference area, Δ/σ, is (160-80)/20 or 4. From Table 5.1, the value of P_r is 0.997658. Values of percentiles, represented by the selected decision error levels, are obtained from Table 5.2. In this case $Z_{1-\alpha}$ (for $\alpha = 0.05$) is 1.645 and $Z_{1-ß}$ ($\beta = 0.05$) is also 1.645.

The number of data points, N, for the WRS test of each combination of reference area and survey units can be calculated using Equation 5-1

$$N = \frac{(1.645+1.645)^2}{3(0.997658-0.5)^2} = 14.6$$

Adding an additional 20% gives 17.5 which is then rounded up to the next even number, 18. This yields 9 data points for the reference area and 9 for each survey unit.

Alternatively, the number of data points can be obtained directly from Table 5.3. For α=0.05, β=0.05, and Δ/σ=4.0 a value of 9 is obtained for N/2. The table value has already been increased by 20% to account for missing or unusable data.

5.5.2.3 Contaminant Not Present in Background—Determining Numbers of Data Points for Statistical Tests

For the situation where the contaminant is not present in background or is present at such a small fraction of the $DCGL_W$ as to be considered insignificant, a background reference area is not necessary. Instead, the contaminant levels are compared directly with the DCGL value. The general approach closely parallels that used for the situation when the contaminant is present in background as described in Section 5.5.2.2. However, the statistical tests differ slightly. The one-sample Sign test replaces the two-sample Wilcoxon Rank Sum test described above.

[1] Appendix D provides more detailed guidance on the selection of the LBGR.

Calculate the Relative Shift. The initial step in determining the number of data points in the one-sample case is to calculate the relative shift, $\Delta/\sigma_s = (DCGL-LBGR)/\sigma_s$, from the DCGL value, the lower bound of the gray region (LBGR), and the standard deviation of the contaminant in the survey unit, σ_s, as described in Section 5.5.2.2. Also as described in Section 5.5.2.2, the value of σ_s may be obtained from earlier surveys, limited preliminary measurements, or a reasonable estimate. Values of the relative shift that are less than one will result in a large number of measurements needed to demonstrate compliance.

Determine Sign p. Sign p is the estimated probability that a random measurement from the survey unit will be less than the $DCGL_W$ when the survey unit median is actually at the LBGR. The Sign p is used to calculate the minimum number of data points necessary for the survey to meet the DQOs. The value of the relative shift calculated in the previous section is used to obtain the corresponding value of Sign p from Table 5.4.

Table 5.4 Values of Sign p for Given Values of the Relative Shift, Δ/σ, when the Contaminant is Not Present in Background

Δ/σ	Sign p	Δ/σ	Sign p
0.1	0.539828	1.2	0.884930
0.2	0.579260	1.3	0.903199
0.3	0.617911	1.4	0.919243
0.4	0.655422	1.5	0.933193
0.5	0.691462	1.6	0.945201
0.6	0.725747	1.7	0.955435
0.7	0.758036	1.8	0.964070
0.8	0.788145	1.9	0.971284
0.9	0.815940	2.0	0.977250
1.0	0.841345	2.5	0.993790
1.1	0.864334	3.0	0.998650

If $\Delta/\sigma > 3.0$, use Sign p = 1.000000

Determine Decision Error Percentiles. The next step in this process is to determine the percentiles, $Z_{1-\alpha}$ and $Z_{1-ß}$, represented by the selected decision error levels, α and ß, respectively (see Table 5.2).

Calculate Number of Data Points for Sign Test. The number of data points, N, to be obtained for the Sign test is next calculated using the following formula:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(Sign\ p - 0.5)^2} \qquad 5\text{-}2$$

Finally, the number of anticipated data points should be increased by at least 20% as discussed in Section 5.5.2.2 to ensure sufficient power of the tests and to allow for possible data losses.

Obtain Number of Data Points for Sign Test from Table 5.5. Table 5.5 provides a list of the number of data points used to demonstrate compliance using the Sign test for selected values of α, β, and Δ/σ. The values listed in Table 5.5 represent the number of measurements to be performed in each survey unit. These values were calculated using Equation 5-2 and increased by 20% to account for missing or unusable data and uncertainty in the calculated value of N.

Example:

A site has 1 survey unit. The DCGL level for the contaminant of interest is 140 Bq/kg (3.9 pCi/g) in soil. The contaminant is not present in background; data from previous investigations indicate average residual contamination at the survey unit of 3.7 ± 3.7 (1σ) Bq/kg. The lower bound of the gray region was selected to be 110 Bq/kg. A value of 0.05 is next selected for the probability of Type I decision errors (α) and a value of 0.01 is selected for the probability of Type II decision errors (β) based on the survey objectives. Determine the number of data points to be obtained from the survey unit for the statistical tests.

The value of the shift parameter, Δ/σ, is (140-110)/3.7 or 8. From Table 5.4, the value of Sign p is 1.0. Since Δ/σ>3, the width of the gray region can be reduced. If the LBGR is raised to 125, then Δ/σ is (140-125)/3.7 or 4. The value of Sign p remains at 1.0. Thus, the number of data points calculated will not change. The probability of a Type II error is now specified at 125 Bq/kg (3.4 pCi/g) rather than 110 Bq/kg (3.0 pCi/g). As a consequence, the probability of a Type II error at 110 Bq/kg (3.0 pCi/g) will be even smaller.

Values of percentiles, represented by the selected decision error levels are obtained from Table 5.2. $Z_{1-\alpha}$ (for α = 0.05) is 1.645, and $Z_{1-ß}$ (β = 0.01) is 2.326.

Table 5.5 Values of N for Use with the Sign Test

	α=0.01					α=0.025					α=0.05					α=0.10					α=0.25				
	β					β					β					β					β				
Δ/σ	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25
0.1	4095	3476	2984	2463	1704	3476	2907	2459	1989	1313	2984	2459	2048	1620	1018	2463	1989	1620	1244	725	1704	1313	1018	725	345
0.2	1035	879	754	623	431	879	735	622	503	333	754	622	518	410	258	623	503	410	315	184	431	333	258	184	88
0.3	468	398	341	282	195	398	333	281	227	150	341	281	234	185	117	282	227	185	143	83	195	150	117	83	40
0.4	270	230	197	162	113	230	1921	162	131	87	197	162	136	107	68	162	131	107	82	48	113	87	68	48	23
0.5	178	152	130	107	75	152	126	107	87	58	130	107	89	71	45	107	87	71	54	33	75	58	45	33	16
0.6	129	110	94	77	54	110	92	77	63	42	94	77	65	52	33	77	63	52	40	23	54	42	33	23	11
0.7	99	83	72	59	41	83	70	59	48	33	72	59	50	40	26	59	48	40	30	18	41	33	26	18	9
0.8	80	68	58	48	34	68	57	48	39	26	58	48	40	32	21	48	39	32	24	15	34	26	21	15	8
0.9	66	57	48	40	28	57	47	40	33	22	48	40	34	27	17	40	33	27	21	12	28	22	17	12	6
1.0	57	48	41	34	24	48	40	34	28	18	41	34	29	23	15	34	28	23	18	11	24	18	15	11	5
1.1	50	42	36	30	21	42	35	30	24	17	36	30	26	21	14	30	24	21	16	10	21	17	14	10	5
1.2	45	38	33	27	20	38	32	27	22	15	33	27	23	18	12	27	22	18	15	9	20	15	12	9	5
1.3	41	35	30	26	17	35	29	24	21	14	30	24	21	17	11	26	21	17	14	8	17	14	11	8	4
1.4	38	33	28	23	16	33	27	23	18	12	28	23	20	16	10	23	18	16	12	8	16	12	10	8	4
1.5	35	30	27	22	15	30	26	22	17	12	27	22	18	15	10	22	17	15	11	8	15	12	10	8	4
1.6	34	29	24	21	15	29	24	21	17	11	24	21	17	14	9	21	17	14	11	6	15	11	9	6	4
1.7	33	28	24	20	14	28	23	20	16	11	24	20	17	14	9	20	16	14	10	6	14	11	9	6	4
1.8	32	27	23	20	14	27	22	20	16	11	23	20	16	12	9	20	16	12	10	6	14	11	9	6	4
1.9	30	26	22	18	14	26	22	18	15	10	22	18	16	12	9	18	15	12	10	6	14	10	9	6	4
2.0	29	26	22	18	12	26	21	18	15	10	22	18	15	12	8	18	15	12	10	6	12	10	8	6	3
2.5	28	23	21	17	12	23	20	17	14	10	21	17	15	11	8	17	14	11	9	5	12	10	8	5	3
3.0	27	23	20	17	12	23	20	17	14	9	20	17	14	11	8	17	14	11	9	5	12	9	8	5	3

The number of data points, N, for the Sign test can be calculated using Equation 5-2.

$$N = \frac{(1.645+2.326)^2}{4(1.0-0.5)^2} = 15.85$$

Adding an additional 20% gives 19.2 and rounding up yields 20 data points for the survey unit.

Alternatively, the number of data points can be obtained directly from Table 5.5. For α=0.05, β=0.01, and Δ/σ>3.0 a value of 20 is obtained for N. The table value has already been increased by 20% to account for missing or unusable data and uncertainty in the calculated value of N.

5.5.2.4 Determining Data Points for Small Areas of Elevated Activity

The statistical tests described above (also see Chapter 8) evaluate whether or not the residual radioactivity in an area exceeds the $DCGL_W$ for contamination conditions that are approximately uniform across the survey unit. In addition, there should be a reasonable level of assurance that any small areas of elevated residual radioactivity that could be significant relative to the $DCGL_{EMC}$ are not missed during the final status survey. The statistical tests introduced in the previous sections may not successfully detect small areas of elevated contamination. Instead, systematic measurements and sampling, in conjunction with surface scanning, are used to obtain adequate assurance that small areas of elevated radioactivity will still satisfy the release criterion or the $DCGL_{EMC}$. The procedure is applicable for all radionuclides, regardless of whether or not they are present in background, and is implemented for survey units classified as Class 1.

The number of survey data points needed for the statistical tests discussed in Section 5.5.2.2 or 5.5.2.3 is identified (the appropriate section depends on whether the contaminant is present in background or not). These data points are then positioned throughout the survey unit by first randomly selecting a start point and establishing a systematic pattern. This systematic sampling grid may be either triangular or square. The triangular grid is generally more efficient for locating small areas of elevated activity. Appendix D includes a brief discussion on the efficiency of triangular and square grids for locating areas of elevated activity. A more detailed discussion is provided by EPA (EPA 1994b).

The number of calculated survey locations, n, is used to determine the grid spacing, L, of the systematic sampling pattern (see Section 5.5.2.5). The grid area that is bounded by these survey locations is given by $A = 0.866 \times L^2$ for a triangular grid and $A = L^2$ for a square grid. The risk of not sampling a circular area—equal to A—of elevated activity by use of a random-start grid pattern is illustrated in Figure D.7 in Appendix D.

One method for determining values for the $DCGL_{EMC}$ is to modify the $DCGL_w$ using a correction factor that accounts for the difference in area and the resulting change in dose or risk. The area factor is the magnitude by which the concentration within the small area of elevated activity can exceed $DCGL_W$ while maintaining compliance with the release criterion. The area factor is determined based on specific regulatory agency guidance.

Tables 5.6 and 5.7 provide examples of area factors generated using exposure pathway models. The outdoor area factors listed in Table 5.6 were calculated using RESRAD 5.6. For each radionuclide, all exposure pathways were calculated assuming a concentration of 37 Bq/kg (1 pCi/g). The area of contamination in RESRAD 5.6 defaults to 10,000 m^2. Other than changing the area (*i.e.*, 1, 3, 10, 30, 100, 300, 1,000, or 3,000 m^2), the RESRAD default values were not changed. The area factors were then computed by taking the ratio of the dose or risk per unit concentration generated by RESRAD for the default 10,000 m^2 to that generated for the other areas listed. If the DCGL for residual radioactivity distributed over 10,000 m^2 is multiplied by this value, the resulting concentration distributed over the specified smaller area delivers the same calculated dose. The indoor area factors listed in Table 5.7 were calculated in a similar manner using RESRAD-BUILD 1.5. For each radionuclide, all exposure pathways were calculated assuming a concentration of 37 Bq/m^2 (1 pCi/m^2). The area of contamination in RESRAD-BUILD 1.5 defaults to 36 m^2. The other areas compared to this value were 1, 4, 9, 16, or 25 m^2. Removable surface contamination was assumed to be 10%. No other changes to the default values were made. Note that the use of RESRAD to determine area factors is for illustration purposes only. The MARSSIM user should consult with the responsible regulatory agency for guidance on acceptable techniques to determine area factors.

The minimum detectable concentration (MDC) of the scan procedure—needed to detect an area of elevated activity at the limit determined by the area factor—is calculated as follows:

$$Scan\ MDC\ (required) = (DCGL_W) \times (Area\ Factor) \qquad 5\text{-}3$$

The actual MDCs of scanning techniques are then determined for the available instrumentation (see Section 6.7). The actual MDC of the selected scanning technique is compared to the required scan MDC. If the actual scan MDC is less than the required scan MDC, no additional sampling points are necessary for assessment of small areas of elevated activity. In other words, the scanning technique exhibits adequate sensitivity to detect small areas of elevated activity.

Table 5.6 Illustrative Examples of Outdoor Area Dose Factors*

	Area Factor								
Nuclide	**1 m^2**	**3 m^2**	**10 m^2**	**30 m^2**	**100 m^2**	**300 m^2**	**1000 m^2**	**3000 m^2**	**10000 m^2**
Am-241	208.7	139.7	96.3	44.2	13.4	4.4	1.3	1.0	1.0
Co-60	9.8	4.4	2.1	1.5	1.2	1.1	1.1	1.0	1.0
Cs-137	11.0	5.0	2.4	1.7	1.4	1.3	1.1	1.1	1.0
Ni-63	1175.2	463.7	154.8	54.2	16.6	5.6	1.7	1.5	1.0
Ra-226	54.8	21.3	7.8	3.2	1.1	1.1	1.0	1.0	1.0
Th-232	12.5	6.2	3.2	2.3	1.8	1.5	1.1	1.0	1.0
U-238	30.6	18.3	11.1	8.4	6.7	4.4	1.3	1.0	1.0

* The values listed in Table 5.6 are for illustrative purposes only. Consult regulatory guidance to determine area factors to be used for compliance demonstration.

Table 5.7 Illustrative Examples of Indoor Area Dose Factors*

	Area Factor					
Nuclide	**1 m^2**	**4 m^2**	**9 m^2**	**16 m^2**	**25 m^2**	**36 m^2**
Am-241	36.0	9.0	4.0	2.2	1.4	1.0
Co-60	9.2	3.1	1.9	1.4	1.2	1.0
Cs-137	9.4	3.2	1.9	1.4	1.2	1.0
Ni-63	36.0	9.0	4.0	2.3	1.4	1.0
Ra-226	18.1	5.5	2.9	1.9	1.3	1.0
Th-232	36.0	9.0	4.0	2.2	1.4	1.0
U-238	35.7	9.0	4.0	2.2	1.4	1.0

* The values listed in Table 5.7 are for illustrative purposes only. Consult regulatory guidance to determine area factors to be used for compliance demonstration.

If the actual scan MDC is greater than the required scan MDC (*i.e.*, the available scan sensitivity is not sufficient to detect small areas of elevated activity), then it is necessary to calculate the area factor that corresponds to the actual scan MDC:

$$Area\ Factor = \frac{scan\ MDC\ (actual)}{DCGL} \qquad 5\text{-}4$$

The size of the area of elevated activity (in m^2) that corresponds to this area factor is then obtained from specific regulatory agency guidance, and may be similar to those illustrated in Table 5.6 or Table 5.7. The data needs for assessing small areas of elevated activity can then be determined by dividing the area of elevated activity acceptable to the regulatory agency into the survey unit area. For example, if the area of elevated activity is 100 m^2 (from Table 5.6) and the survey unit area is 2,000 m^2, then the calculated number of survey locations is 20. The calculated number of survey locations, n_{EA}, is used to determine a revised spacing, L, of the systematic pattern (refer to Section 5.5.2.5). Specifically, the spacing, L, of the pattern (when driven by the areas of elevated activity) is given by:

$$L = \sqrt{\frac{A}{0.866\ n_{EA}}} \quad for\ a\ triangular\ grid \qquad 5\text{-}5$$

$$L = \sqrt{\frac{A}{n_{EA}}} \quad for\ a\ square\ grid \qquad 5\text{-}6$$

where A is the area of the survey unit. Grid spacings should generally be rounded *down* to the nearest distance that can be conveniently measured in the field.

If the number of data points required to identify areas of elevated activity (n_{EA}) is greater than the number of data points calculated using Equation 5-1 (N/2) or Equation 5-2 (N), L should be calculated using Equation 5-5 or Equation 5-6. This value of L is then used to determine the measurement locations as described in Section 5.5.2.5. If n_{EA} is smaller than N/2 or N, L is calculated using Equation 5-7 or Equation 5-8 as described in Section 5.5.2.5. The statistical tests are performed using this larger number of data points. Figure 5.3 provides a concise overview of the procedure used to identify data needs for the assessment of small areas of elevated activity. If residual radioactivity is found in an isolated area of elevated activity—in addition to residual radioactivity distributed relatively uniformly across the survey unit—the unity rule (described in Section 4.3.3) can be used to ensure that the total dose or risk does not exceed the release criterion (see Section 8.5.2). If there is more than one elevated area, a separate term should be included for each. As an alternative to the unity rule, the dose or risk due to the actual residual radioactivity distribution can be calculated if there is an appropriate exposure pathway model available. Note that these considerations generally apply only to Class 1 survey units, since areas of elevated activity should not exist in Class 2 or Class 3 survey units.

When the detection limit of the scanning technique is very large relative to the $DCGL_{EMC}$, the number of measurements estimated to demonstrate compliance using the statistical tests may become unreasonably large. In this situation perform an evaluation of the survey objectives and considerations. These considerations may include the survey design and measurement methodology, exposure pathway modeling assumptions and parameter values used to determine the DCGLs, Historical Site Assessment conclusions concerning source terms and radionuclide distributions, and the results of scoping and characterization surveys. In most cases the result of this evaluation is not expected to justify an unreasonably large number of measurements.

Example 1:

A Class 1 land area survey unit of 1,500 m^2 is potentially contaminated with ^{60}Co. The $DCGL_W$ value for ^{60}Co is 110 Bq/kg (3 pCi/g) and the scan sensitivity for this radionuclide has been determined to be 150 Bq/kg (4 pCi/g). Calculations indicate the number of data points needed for statistical testing is 27. The distance between measurement locations for this number of data points and the given land area is 8 m. The area encompassed by a triangular sampling pattern of 8 m is approximately 55.4 m^2. From Table 5.6 an area factor of about 1.4 is determined by interpolation. The acceptable concentration in a 55.4 m^2 area is therefore 160 Bq/kg (1.4 × 110 Bq/kg). Since the scan sensitivity of the procedure to be used is less than the $DCGL_W$ times the area factor, no additional data points are needed to demonstrate compliance with the elevated measurement comparison criteria.

Example 2:

A Class 1 land area survey unit of 1500 m^2 is potentially contaminated with ^{60}Co. The DCGL for ^{60}Co is 110 Bq/kg (3 pCi/g). In contrast to Example 1, the scan sensitivity for this radionuclide has been determined to be 170 Bq/kg (4.6 pCi/g). Calculations indicate the number of data points needed for statistical testing is 15. The distance between measurement locations for this number of data points and land area is 10 m. The area encompassed by a triangular sampling pattern of 10 m is approximately 86.6 m^2. From Table 5.6 an area factor of about 1.3 is determined by interpolation. The acceptable concentration in a 86.6 m^2 area is therefore 140 Bq/kg (1.3 × 110 Bq/kg). Since the scan sensitivity of the procedure to be used is greater than the $DCGL_W$ times the area factor, the data points obtained for the statistical testing may not be sufficient to demonstrate compliance using the elevated measurement comparison. The area multiplier for elevated activity that would have to be achieved is 1.5 (170/110 Bq/kg). This is equivalent to an area of 30 m^2 (Table 5.6) which would be obtained with a spacing of about 6 m. A triangular pattern of 6 m spacing includes 50 data points, so 50 measurements should be performed in the survey unit.

5.5.2.5 Determining Survey Locations

A scale drawing of the survey unit is prepared, along with the overlying planar reference coordinate system or grid system. Any location within the survey area is thus identifiable by a unique set of coordinates. The maximum length, X, and width, Y, dimensions of the survey unit are then determined. Identifying and documenting a specific location for each measurement performed is an important part of a final status survey to ensure that measurements can be reproduced if necessary. The reference coordinate system described in Section 4.8.5 provides a method for relating measurements to a specific location within a survey unit.

If the same values for α, β, and Δ/σ are used in Equations 5-1 or Equation 5-2, the required number of measurements is independent of survey unit classification. This means that the same number of measurements could be performed in a Class 1, Class 2, or Class 3 survey unit. While this is a best case scenario, it points out the importance of identifying appropriate survey units (*e.g.*, size, classification) in defining the level of survey effort. The spacing of measurements is affected by the number of measurements, which is independent of classification. However, the spacing of measurements is also affected by survey unit area, the variability in the contaminant concentration, and the interface with the models used to develop the DCGLs which are dependent on classification.

Land Areas. Measurements and samples in Class 3 survey units and reference areas should be taken at random locations. These locations are determined by generating sets of random numbers (2 values, representing the X axis and Y axis distances). Random numbers can be generated by calculator or computer, or can be obtained from mathematical tables. Sufficient sets of numbers will be needed to identify the total number of survey locations established for the survey unit. Each set of random numbers is multiplied by the appropriate survey unit dimension to provide coordinates, relative to the origin of the survey unit reference grid pattern. Coordinates identified in this manner, which do not fall within the survey until area or which cannot be surveyed, due to site conditions, are replaced with other survey points determined in the same manner. Figure 5.4 is an example of a random sampling pattern. In this example, 8 data points were identified using the appropriate formula based on the statistical tests (*i.e.*, Equation 5-1 or Equation 5-2). The locations of these points were determined using the table of random numbers found in Appendix I, Table I.6.

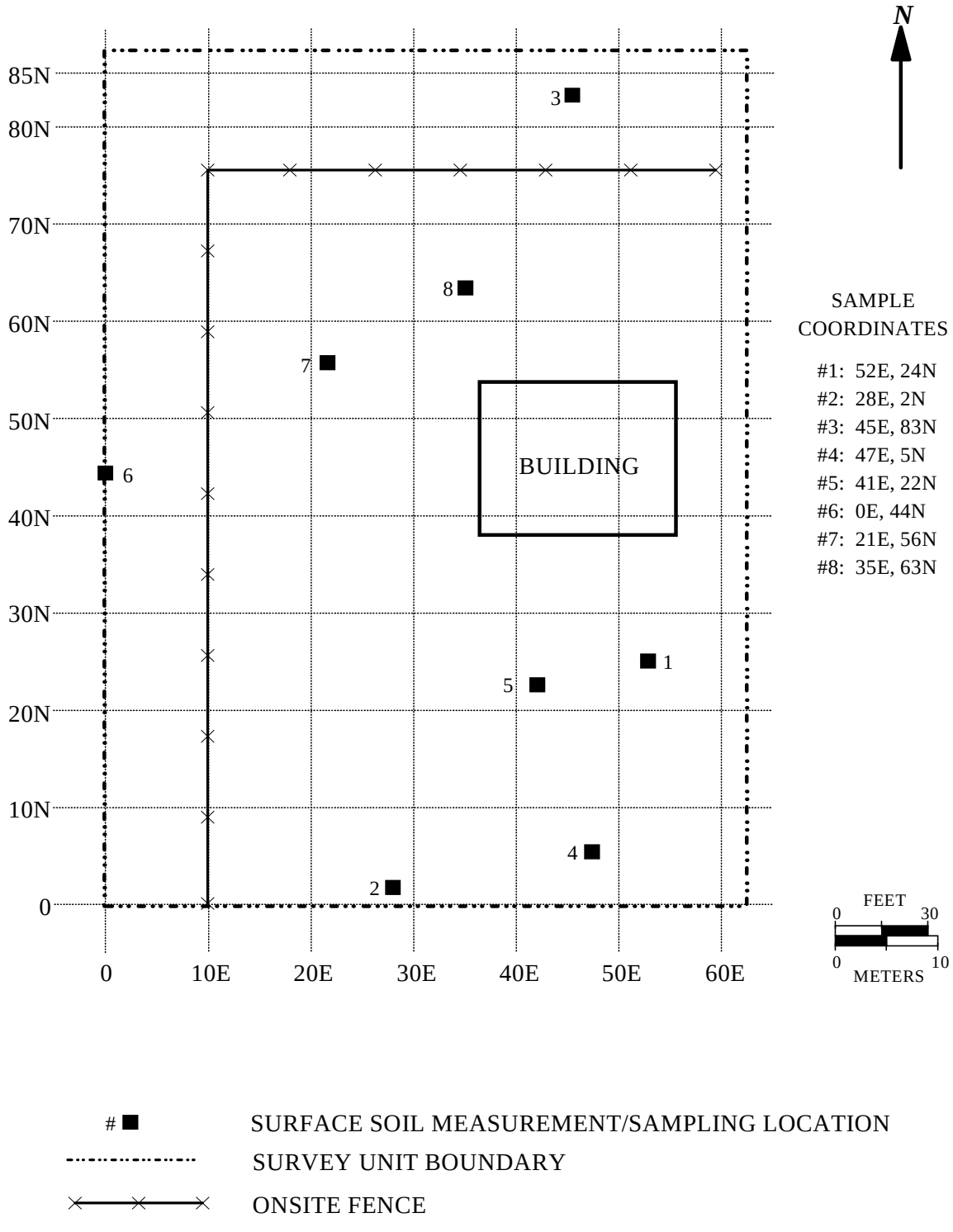


Figure 5.4 Example of a Random Measurement Pattern

Class 2 areas are surveyed on a random-start systematic pattern. The number of calculated survey locations, n, based on the statistical tests, is used to determine the spacing, L, of a systematic pattern by:

$$L = \sqrt{\frac{A}{0.866\ n}} \quad for\ a\ triangular\ grid \qquad 5\text{-}7$$

$$L = \sqrt{\frac{A}{n}} \quad for\ a\ square\ grid \qquad 5\text{-}8$$

where A is the area of the survey unit.

After L is determined, a random coordinate location is identified, as described previously, for a survey pattern starting location. Beginning at the random starting coordinate, a row of points is identified, parallel to the X axis, at intervals of L.

For a triangular grid, a second row of points is then developed, parallel to the first row, at a distance of 0.866 × L from the first row. Survey points along that second row are midway (on the X-axis) between the points on the first row. This process is repeated to identify a pattern of survey locations throughout the affected survey unit. If identified points fall outside the survey unit or at locations which cannot be surveyed, additional points are determined using the random process described above, until the desired total number of points is identified.

An example of such a survey pattern is shown in Figure 5.5. In this example, the statistical test calculations estimate 20 samples (Table 5.5, α=0.01, β=0.05, Δ/σ>3.0). The random-start coordinate was 27E, 53N. The grid spacing was calculated using Equation 5-7:

$$L = \sqrt{\frac{5{,}100\ m^2}{0.866\ \times\ 20}} = 17\ m.$$

Two points were identified on a row parallel to the X-axis, each 17 m from the starting point. The subsequent rows were positioned 0.866 × L, or 15 m, from the initial row. This random-start triangular sampling process resulted in 21 sampling locations, one of which was inaccessible because of the building location, which yields the desired number of data points.

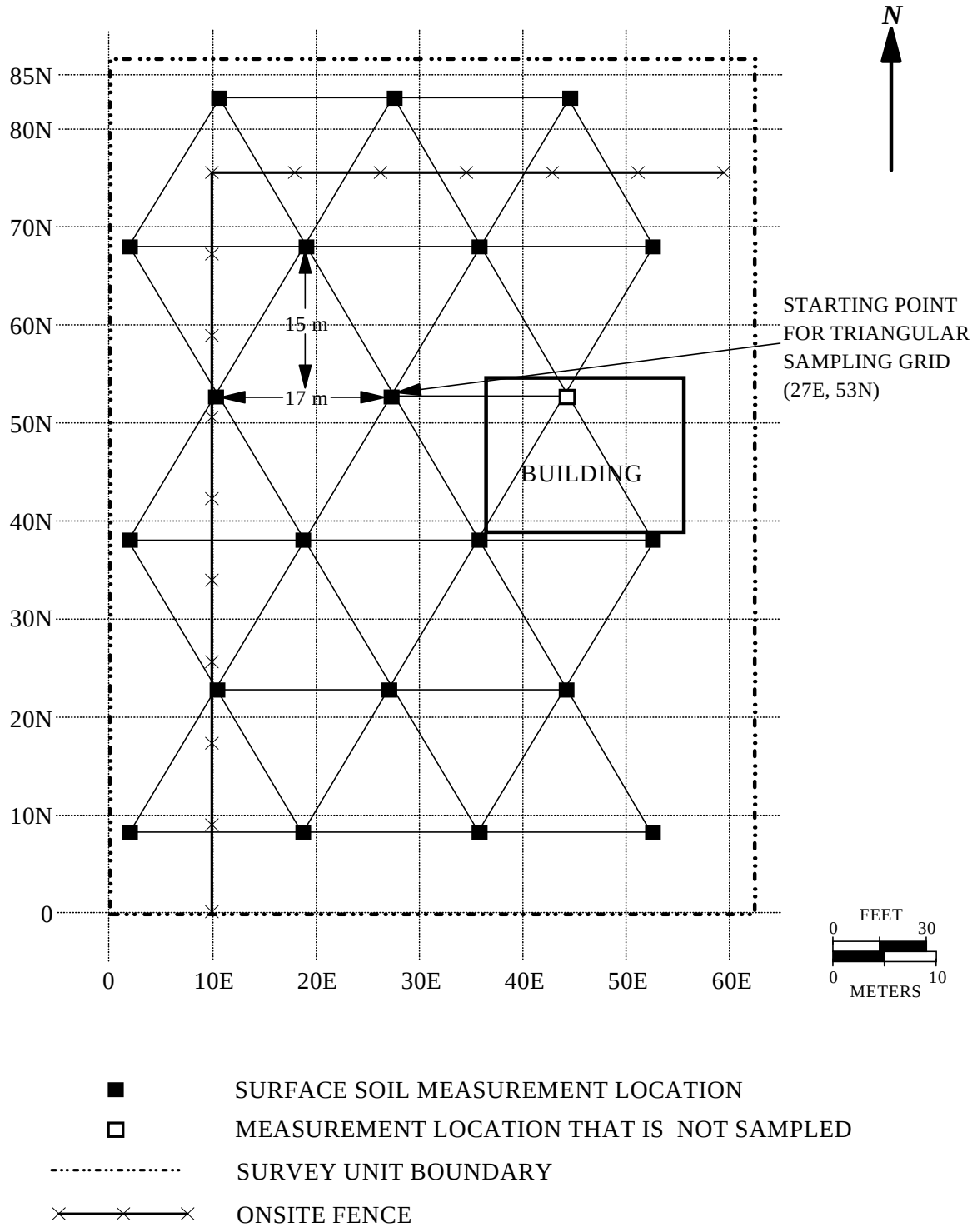


Figure 5.5 Example of a Random-Start Triangular Grid Measurement Pattern

For Class 1 areas a systematic pattern, having dimensions determined in Section 5.5.2.4, is installed on the survey unit. The starting point for this pattern is selected at random, as described above for Class 2 areas. The same process as described above for Class 2 areas applies to Class 1, only the estimated number of samples is different.

Structure Surfaces. All structure surfaces for a specific survey unit are included on a single reference grid system for purposes of identifying survey locations. The same methods as described above for land areas are then used to locate survey points for all classifications of areas.

In addition to the survey locations identified for statistical evaluations and elevated measurement comparisons, data will likely be obtained from judgment locations that are selected due to unusual appearance, location relative to contamination areas, high potential for residual activity, general supplemental information, *etc.* Data points selected based on professional judgment are not included with the data points from the random-start triangular grid for statistical evaluations; instead they are compared individually with the established DCGLs and conditions. Measurement locations selected based on professional judgment violate the assumption of unbiased measurements used to develop the statistical tests described in Chapter 8.

5.5.2.6 Determining Investigation Levels

An important aspect of the final status survey is the design and implementation of investigation levels. Investigation levels are radionuclide-specific levels of radioactivity used to indicate when additional investigations may be necessary. Investigation levels also serve as a quality control check to determine when a measurement process begins to get out of control. For example, a measurement that exceeds the investigation level may indicate that the survey unit has been improperly classified (see Section 4.4) or it may indicate a failing instrument.

When an investigation level is exceeded, the first step is to confirm that the initial measurement/sample actually exceeds the particular investigation level. This may involve taking further measurements to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion.[2] Depending on the results of the investigation actions, the survey unit may require reclassification, remediation, and/or resurvey. Table 5.8 illustrates an example of how investigation levels can be developed.

[2] Rather than, or in addition to, taking further measurements the investigation may involve assessing the adequacy of the exposure pathway model used to obtain the DCGLs and area factors, and the consistency of the results obtained with the Historical Site Assessment and the scoping, characterization and remedial action support surveys.

Table 5.8 Example Final Status Survey Investigation Levels

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement Result When:
Class 1	> $DCGL_{EMC}$ or > $DCGL_W$ and > a statistical parameter-based value	> $DCGL_{EMC}$
Class 2	> $DCGL_W$	> $DCGL_W$ or > MDC
Class 3	> fraction of $DCGL_W$	> $DCGL_W$ or > MDC

When determining an investigation level using a statistical-based parameter (*e.g.*, standard deviation) one should consider survey objectives, underlying radionuclide distributions and an understanding of corresponding types (*e.g.*, normal, log normal, non-parametric), descriptors (*e.g.*, standard deviation, mean, median), population stratifications (*i.e.*, are there sub-groups present?), and other prior survey and historical information. For example, a level might be arbitrarily established at the mean + 3s, where s is the standard deviation of the survey unit, assuming a normal distribution. A higher value might be used if locating discrete sources of higher activity was a primary survey objective. By the time the final status survey is conducted, survey units should be defined. Estimates of the mean, variance, and standard deviation of the radionuclide activity levels within the survey units should also be available.

For a Class 1 survey unit, measurements above the $DCGL_W$ are not necessarily unexpected. However, a measurement above the $DCGL_W$ at one of the discrete measurement locations might be considered unusual if it were much higher than all of the other discrete measurements. Thus, any discrete measurement that is both above the $DCGL_W$ and above the statistical-based parameter for the measurements should be investigated further. Any measurement, either at a discrete location or from a scan, that is above the $DCGL_{EMC}$ should be flagged for further investigation.

In Class 2 or Class 3 areas, neither measurements above the $DCGL_W$ nor areas of elevated activity are expected. Any measurement at a discrete location exceeding the $DCGL_W$ in these areas should be flagged for further investigation. Because the survey design for Class 2 and Class 3 survey units is not driven by the EMC, the scanning MDC might exceed the $DCGL_W$. In this case, any indication of residual radioactivity during the scan would warrant further investigation.

The basis for using the $DCGL_{EMC}$ rather than the more conservative criteria for Class 2 and Class 3 areas should be justified in survey planning documents. For example, where there is high uncertainty in the reported scanning MDC, a more conservative criteria would be warranted.

Similarly, DQA for scanning may warrant a more conservative flag, as would greater uncertainty from Historical Site Assessment or other surveys on the size of potential areas of elevated activity. In some cases, it may even be necessary to agree in advance with the regulatory agency responsible for the site on which site-specific investigation will be used if other than those presented in Table 5.8.

Because there is a low expectation for residual radioactivity in a Class 3 area, it may be prudent to investigate any measurement exceeding even a fraction of the $DCGL_W$. The level selected in these situations depends on the site, the radionuclides of concern, and the measurement and scanning methods chosen. This level should be set using the DQO Process during the survey design phase of the Data Life Cycle. In some cases, the user may also wish to follow this procedure for Class 2 and even Class 1 survey units.

5.5.3 Developing an Integrated Survey Strategy

The final step in survey design is to integrate the survey techniques (Chapter 6) with the number of measurements and measurement spacing determined earlier in this chapter. This integration along with the guidance provided in other portions of this manual produce an overall strategy for performing the survey. Table 5.9 provides a summary of the recommended survey coverage for structures and land areas. This survey coverage for different areas is the subject of this section.

Random measurement patterns are used for Class 3 survey units to ensure that the measurements are independent and support the assumptions of the statistical tests. Systematic grids are used for Class 2 survey units because there is an increased probability of small areas of elevated activity. The use of a systematic grid allows the decision maker to draw conclusions about the size of the potential areas of elevated activity based on the area between measurement locations. The random starting point of the grid provides an unbiased method for obtaining measurement locations to be used in the statistical tests. Class 1 survey units have the highest potential for small areas of elevated activity, so the areas between measurement locations are adjusted to ensure that these areas can be detected by scanning techniques.

The objectives of the scanning surveys are different. Scanning is used to identify locations within the survey unit that exceed the investigation level. These locations are marked and receive additional investigations to determine the concentration, area, and extent of the contamination.

For Class 1 areas, scanning surveys are designed to detect small areas of elevated activity that are not detected by the measurements using the systematic pattern. For this reason the measurement locations, and the number of measurements, may need to be adjusted based on the sensitivity of the scanning technique (Section 5.5.2.4). This is also the reason for recommending 100%

Table 5.9 Recommended Survey Coverage for Structures and Land Areas

Area Classification	Structures		Land Areas	
	Surface Scans	Surface Activity Measurements	Surface Scans	Soil Samples
Class 1	100%	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3); additional measurements may be necessary for small areas of elevated activity (Section 5.5.2.4)	100%	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3); additional measurements may be necessary for small areas of elevated activity (Section 5.5.2.4)
Class 2	10 to 100% (10 to 50% for upper walls and ceilings) Systematic and Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)	10 to 100% Systematic and Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)
Class 3	Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)	Judgmental	Number of data points from statistical tests (Sections 5.5.2.2 and 5.5.2.3)

coverage for the scanning survey. 100% coverage means that the entire surface area of the survey unit is covered by the field of view of the scanning instrument. If the field of view is two meters wide, the survey instrument can be moved along parallel paths two meters apart to provide 100% coverage. If the field of view of the detector is 5 cm, the parallel paths should be 5 cm apart.

Scanning surveys in Class 2 areas are also primarily performed to find areas of elevated activity not detected by the measurements using the systematic pattern. However, the measurement locations are not adjusted based on sensitivity of the scanning technique and scanning is performed in portions of the survey unit. The level of scanning effort should be proportional to the potential for finding areas of elevated activity based on the conceptual site model developed and refined from Section 3.6.4. A larger portion of the survey unit would be scanned in Class 2 survey units that have residual radioactivity close to the release criterion, but for survey units that are closer to background scanning, a smaller portion of the survey unit may be appropriate. Class 2 survey units have a lower probability for areas of elevated activity than Class 1 survey units, but some portions of the survey unit may have a higher potential than others. Judgmental

scanning surveys focus on the portions of the survey unit with the highest probability for areas of elevated activity. If the entire survey unit has an equal probability for areas of elevated activity, or the judgmental scans don't cover at least 10% of the area, systematic scans along transects of the survey unit or scanning surveys of randomly selected grid blocks are performed.

Class 3 areas have the lowest potential for areas of elevated activity. For this reason, scanning surveys are recommended for areas with the highest potential for contamination (*e.g.*, corners, ditches, drains) based on professional judgment. Such recommendations are typically provided by a health physics professional with radiation survey experience. This provides a qualitative level of confidence that no areas of elevated activity were missed by the random measurements or that there were no errors made in the classification of the area.

The sensitivity for scanning techniques used in Class 2 and Class 3 areas is not tied to the area between measurement locations, as they are in a Class 1 area (see Section 5.5.2.4). The scanning techniques selected should represent the best reasonable effort based on the survey objectives. Structure surfaces are generally scanned for alpha, beta, and gamma emitting radionuclides. Scanning for alpha emitters or low-energy (<100 keV) beta emitters for land area survey units is generally not considered effective because of problems with attenuation and media interferences. If one can reasonably expect to find any residual radioactivity, it is prudent to perform a judgmental scanning survey.

If the equipment and methodology used for scanning is capable of providing data of the same quality as direct measurements (*e.g.*, detection limit, location of measurements, ability to record and document results), then scanning may be used in place of direct measurements. Results should be documented for at least the number of locations estimated for the statistical tests. The same logic can be applied for using direct measurements instead of sampling. In addition, some direct measurement systems may be able to provide scanning data.

As previously discussed, investigation levels are determined and used to indicate when additional investigations may be necessary or when a measurement process begins to get out of control. The results of all investigations should be documented in the final status survey report, including the results of scan surveys that may have potentially identified areas of elevated direct radiation.

5.5.3.1 Structure Surveys

Class 1 Areas. Surface scans are performed over 100% of structure surfaces for radiations which might be emitted from the potential radionuclide contaminants. Locations of direct radiation, distinguishable above background radiation, are identified and evaluated. Results of initial and followup direct measurements and sampling at these locations are recorded and documented in the final status survey report. Measurements of total and removable contamination are performed at locations identified by scans and at previously determined

locations (Section 5.5.2.5). Where gamma emitting radionuclides are present, *in situ* gamma spectroscopy may be used to identify the presence of specific radionuclides or to demonstrate compliance with the release criterion.

Direct measurement or sample investigation levels for Class 1 areas should establish a course of action for individual measurements that approach or exceed the $DCGL_W$. Because measurements above the $DCGL_W$ are not necessarily unexpected in a Class 1 survey unit, additional investigation levels may be established to identify discrete measurements that are much higher than the other measurements. Any discrete measurement that is both above the $DCGL_W$ and exceeds three times the standard deviation (s) of the mean should be investigated further (Section 5.5.2.6). Any measurement (direct measurement, sample, or scan) that exceeds the $DCGL_{EMC}$ should be flagged for further investigation. The results of the investigation and any additional remediation that was performed should be included in the final status survey report. Data are reviewed as described in Section 8.2.2, additional data are collected as necessary, and the final complete data set evaluated as described in Section 8.3 or Section 8.4.

Class 2 Areas. Surface scans are performed over 10 to 100% of structure surfaces. Generally, upper wall surfaces and ceilings should receive surface scans over 10 to 50% of these areas. Locations of scanning survey results above the investigation level are identified and investigated. If small areas of elevated activity are confirmed by this investigation, all or part of the survey unit should be reclassified as Class 1 and the survey strategy for that survey unit redesigned accordingly.

Investigation levels for Class 2 areas should establish a course of action for individual measurements that exceed or approach the $DCGL_w$. The results of the investigation of the positive measurements and basis for reclassifying all or part of the survey unit as Class 1 should be included in the final status survey report. Where gamma emitting radionuclides are contaminants, *in situ* gamma spectroscopy may be used to identify the presence of specific radionuclides or to demonstrate compliance with the release criterion. Data are reviewed as described in Section 8.2.2, additional data are collected as necessary, and the final complete data set evaluated as described in Section 8.3 or Section 8.4.

Class 3 Areas. Scans of Class 3 area surfaces should be performed for all radiations which might be emitted from the potential radionuclide contaminants. MARSSIM recommends that the surface area be scanned. Locations of scanning survey results above the investigation level are identified and evaluated. Measurements of total and removable contamination are performed at the locations identified by the scans and at the randomly selected locations that are chosen in accordance with Section 5.5.2.5. Identification of contamination suggests that the area may be incorrectly classified. If so, a re-evaluation of the Class 3 area classification should be performed and, if appropriate, all or part of the survey unit should be resurveyed as a Class 1 or Class 2 area. In some cases the investigation may include measurements by *in situ* gamma spectroscopy at a

few locations in each structure in a Class 3 area. A gamma spectroscopy system might even be an appropriate substitution for surface scans.

Because there is a low expectation for residual radioactivity in a Class 3 area, it may be prudent to investigate any measurement exceeding even a fraction of the $DCGL_W$. The investigation level selected will depend on the site, the radionuclides of concern, and the measurement and scanning methods chosen. This level should be determined using the DQO Process during survey planning. In some cases, the user may wish to follow this procedure for Class 2 survey units.

The results of the investigation of the measurements that exceed the investigation level and the basis for reclassifying all or part of the survey unit as Class 1 or Class 2 should be included in the final status survey report. The data are tested relative to the preestablished criteria. If additional data are needed, they should be collected and evaluated as part of the entire data set.

5.5.3.2 Land Area Surveys

Class 1 Areas. As with structure surfaces, 100% scanning coverage of Class 1 land areas is recommended. Locations of scanning survey results above the investigation level are identified and evaluated. Results of initial and followup direct measurements and sampling at these locations are recorded. Soil sampling is performed at locations identified by scans and at previously determined locations (Section 5.5.2.5). Where gamma emitting radionuclides are contaminants, *in situ* gamma spectroscopy may be used to confirm the absence of specific radionuclides or to demonstrate compliance.

Direct measurement or sample investigation levels for Class 1 areas should establish a course of action for individual measurements that approach or exceed the $DCGL_W$. Because measurements above the $DCGL_W$ are not necessarily unexpected in a Class 1 survey unit, additional investigation levels may be established to identify discrete measurements that are much higher than the other measurements. Any discrete measurement that is both above the $DCGL_W$ and exceeds three standard deviations above the mean should be investigated further (Section 5.5.2.6). Any measurement (direct measurement, sample, or scan) that exceeds the $DCGL_{EMC}$ should be flagged for further investigation. The results of the investigation and any additional remediation that was performed should be included in the final status survey report. Data are reviewed as described in Section 8.2.2, additional data are collected as necessary, and the final complete data set evaluated as described in Section 8.3 or Section 8.4.

Class 2 Areas. Surface scans are performed over 10 to 100% of open land surfaces. Locations of direct radiation above the scanning survey investigation level are identified and evaluated. If small areas of elevated activity are identified, the survey unit should be reclassified as "Class 1" and the survey strategy for that survey unit redesigned accordingly.

If small areas of elevated activity above DCGL values are not identified, direct measurement or soil sampling is performed at previously determined locations (Section 5.5.2.5). Where gamma emitting radionuclides are contaminants, *in situ* gamma spectroscopy may be used to confirm the absence of specific radionuclides or to demonstrate compliance. Data are reviewed as described in Section 8.2.2, additional data are collected as necessary, and the final complete data set evaluated as described in Section 8.3 or Section 8.4.

Investigation levels for Class 2 areas should establish levels for investigation of individual measurements close to but below the $DCGL_w$. The results of the investigation of the positive measurements and basis for reclassifying all or part of the survey unit as Class 1 should be included in the final status survey report.

Class 3 Areas. Class 3 areas may be uniformly scanned for radiations from the radionuclides of interest, or the scanning may be performed in areas with the greatest potential for residual contamination based on professional judgment and the objectives of the survey. In some cases a combination of these approaches may be the most appropriate. Locations exceeding the scanning survey investigation level are evaluated, and, if the presence of contamination not occurring in background is identified, reevaluation of the classification of contamination potential should be performed.

Investigation levels for Class 3 areas should be established to identify areas of elevated activity that may indicate the presence of residual radioactivity. Scanning survey locations that exceed the investigation level should be flagged for further investigation. The results of the investigation and basis for reclassifying all or part of the survey unit as Class 1 or Class 2 should be included in the final status survey report. The data are tested relative to the preestablished criteria. If additional data are needed, they should be collected and evaluated as part of the entire data set. Soil sampling is performed at randomly selected locations (Section 5.5.2.5); if the contaminant can be measured at DCGL levels by *in situ* techniques, this method may be used to replace or supplement the sampling and laboratory analysis approach. For gamma emitting radionuclides, the above data should be supplemented by several exposure rate and/or *in situ* gamma spectrometry measurements. Survey results are tested for compliance with DCGLs and additional data are collected and tested, as necessary.

5.5.3.3 Other Measurement/Sampling Locations

In addition to the building and land surface areas described above, there are numerous other locations where measurements and/or sampling may be necessary. Examples include items of equipment and furnishings, building fixtures, drains, ducts, and piping. Many of these items or locations have both internal and external surfaces with potential residual radioactivity. Subsurface measurements and/or sampling may also be necessary. Guidance on conducting or evaluating these types of surveys is outside the scope of MARSSIM.

Special situations may be evaluated by judgment sampling and measurements. Data from such surveys should be compared directly with DCGLs developed for the specific situation. Areas of elevated direct radiation identified by surface scans are typically followed by direct measurements or samples. These direct measurements and samples are not included in the nonparametric tests described in this manual, but rather, should be compared directly with DCGLs developed for the specific situation.

Quality control measurements are recommended for all surveys, as described in Section 4.9, Section 6.2, and Section 7.2. Also, some regulatory programs require removable activity measurements (*e.g.*, NRC Regulatory Guide 1.86; NRC 1974). These additional measurements should be considered during survey planning.

5.5.4 Evaluating Survey Results

After data are converted to DCGL units, the process of comparing the results to the DCGLs, conditions, and objectives begins. Individual measurements and sample concentrations are first compared to DCGL levels for evidence of small areas of elevated activity and not to determine if reclassification is necessary. Additional data or additional remediation and resurvey may be necessary. Data are then evaluated using statistical methods to determine if they exceed the release criterion. If the release criterion has been exceeded or if results indicate the need for additional data points, appropriate further actions will be determined by the site management and the responsible regulatory agency. The scope of further actions should be agreed upon and developed as part of the DQO Process before the survey begins (Appendix D). Finally, the results of the survey are compared with the data quality objectives established during the planning phase of the project. Note that Data Quality Objectives may require a report of the semi-quantitative evaluation of removable contamination resulting from the analysis of smears. These results may be used to satisfy regulatory requirements or to evaluate the effectiveness of ALARA procedures. Chapter 8 describes detailed procedures for evaluating survey results.

5.5.5 Documentation

Documentation of the final status survey should provide a complete and unambiguous record of the radiological status of the survey unit, relative to the established DCGLs. In addition, sufficient data and information should be provided to enable an independent re-creation and evaluation at some future time. Much of the information in the final status report will be available from other decommissioning documents; however, to the extent practicable, this report should be a stand-alone document with minimum information incorporated by reference. The report should be independently reviewed (see Section 3.9) and should be approved by a designated person (or persons) who is capable of evaluating all aspects of the report prior to release, publication, or distribution.

EXAMPLE FINAL STATUS SURVEY CHECKLIST

SURVEY PREPARATIONS

_____ Ensure that residual radioactivity limits have been determined for the radionuclides present at the site, typically performed during earlier surveys associated with the decommissioning process.

_____ Identify the radionuclides of concern. Determine whether the radionuclides of concern exist in background. This will determine whether one-sample or two-sample tests are performed to demonstrate compliance. Two-sample tests are performed when radionuclides are present in the natural background; one-sample tests may be performed if the radionuclide is not present in background.

_____ Segregate the site into Class 1, Class 2, and Class 3 areas, based on contamination potential.

_____ Identify survey units.

_____ Select representative reference (background) areas for both indoor and outdoor survey areas. Reference areas are selected from non-impacted areas and

- _____ are free of contamination from site operations,
- _____ exhibit similar physical, chemical, and biological characteristics of the survey area,
- _____ have similar construction, but have no history of radioactive operations.

_____ Select survey instrumentation and survey techniques. Determine MDCs (select instrumentation based on the radionuclides present) and match between instrumentation and DCGLs—the selected instruments should be capable of detecting the contamination at 10-50% of the DCGLs.

_____ Prepare area if necessary—clear and provide access to areas to be surveyed.

_____ Establish reference coordinate systems (as appropriate).

SURVEY DESIGN

_____ Enumerate DQOs: State objective of survey, state the null and alternative hypotheses, specify the acceptable decision error rates (Type I (α) and Type II (β)).

_____ Specify sample collection and analysis procedures.

_____ Determine numbers of data points for statistical tests, depending on whether or not the radionuclide is present in background.

- _____ Specify the number of samples/measurements to be obtained based on the statistical tests.
- _____ Evaluate the power of the statistical tests to determine that the number of samples is appropriate.
- _____ Ensure that the sample size is sufficient for detecting areas of elevated activity.
- _____ Add additional samples/measurements for QC and to allow for possible loss.

_____ Specify sampling locations.

_____ Provide information on survey instrumentation and techniques. The decision to use portable survey instrumentation or *in situ* techniques, and/or a combination of both, depends on whether or not the radiation levels are elevated compared to natural background, and whether or not the residual radioactivity is present at some fraction of background levels.

_____ Specify methods of data reduction and comparison of survey units to reference areas.

_____ Provide quality control procedures and QAPP for ensuring validity of survey data:

- _____ properly calibrated instrumentation,
- _____ necessary replicate, reference and blank measurements,
- _____ comparison of field measurement results to laboratory sample analyses.

_____ Document the survey plan (*e.g.*, QAPP, SOPs, *etc.*)

CONDUCTING SURVEYS

_____ Perform reference (background) area measurements and sampling.

Conduct survey activities:

_____ Perform surface scans of the Class 1, Class 2, and Class 3 areas.

_____ Conduct surface activity measurements and sampling at previously selected sampling locations.

_____ Conduct additional direct measurements and sampling at locations based on professional judgment.

_____ Perform and document any necessary investigation activities, including survey unit reclassification, remediation, and resurvey.

_____ Document measurement and sample locations; provide information on measurement system MDC and measurement errors.

_____ Document any observations, abnormalities, and deviations from the QAPP or SOPs

EVALUATING SURVEY RESULTS

_____ Review DQOs.

_____ Analyze samples.

_____ Perform data reduction on survey results.

_____ Verify assumptions of statistical tests.

_____ Compare survey results with regulatory DCGLs:

_____ Conduct elevated measurement comparison.

_____ Determine area-weighted average, if appropriate.

_____ Conduct WRS or Sign tests.

_____ Prepare final status survey report.

_____ Obtain an independent review of the report.

6 FIELD MEASUREMENT METHODS AND INSTRUMENTATION

6.1 Introduction

Measurement is used in MARSSIM to mean 1) the act of using a detector to determine the level or quantity of radioactivity on a surface or in a sample of material removed from a media being evaluated, or 2) the quantity obtained by the act of measuring. Three methods are available for collecting radiation data while performing a survey—direct measurements, scanning, and sampling. This chapter discusses scanning and direct measurement methods and instrumentation. The collection and analysis of media samples are presented in Chapter 7. Information on the operation and use of individual field and laboratory instruments is provided in Appendix H. Quality assurance and quality control (QA/QC) are discussed in Chapter 9.

Total surface activities, removable surface activities, and radionuclide concentrations in various environmental media (*e.g.*, soil, water, air) are the radiological parameters typically determined using field measurements and laboratory analyses. Certain radionuclides or radionuclide mixtures may necessitate the measurement of alpha, beta, and gamma radiations. In addition to assessing each survey unit as a whole, any small areas of elevated activity should be identified and their extent and activities determined. Due to numerous detector requirements, no single instrument (detector and readout combination) is generally capable of adequately measuring all of the parameters required to satisfy the release criterion or meet all the objectives of a survey.

Selecting instrumentation requires evaluation of both site and radionuclide specific parameters and conditions. Instruments should be stable and reliable under the environmental and physical conditions where they are used, and their physical characteristics (size and weight) should be compatible with the intended application. The instrument and measurement method should be able to detect the type of radiation of interest, and should, in relation to the survey or analytical technique, be capable of measuring levels that are less than the derived concentration guideline level (DCGL). Numerous commercial firms offer a wide variety of instruments appropriate for the radiation measurements described in this manual. These firms can provide thorough information regarding capabilities, operating characteristics, limitations, *etc.*, for specific equipment.

If the field instruments and measurement methods cannot detect radiation levels below the DCGLs, laboratory methods discussed in Chapter 7 are typically used. A discussion of detection limits and detection levels for some typical instruments is presented in Section 6.7. There are certain radionuclides that will be essentially impossible to measure at the DCGLs *in situ* using current state-of-the-art instrumentation and techniques because of the types, energies, and abundances of their radiations. Examples of such radionuclides include very low energy, pure beta emitters such as ^{3}H and ^{63}Ni and low-energy photon emitters such as ^{55}Fe and ^{125}I. Pure alpha emitters dispersed in soil or covered with some absorbing layer may not be detectable because alpha radiation will not penetrate through the media or covering to reach the detector. A

common example of such a condition would be ^{230}Th surface contamination, covered by paint, dust, oil, or moisture. NRC report NUREG-1507 (NRC 1997a) provides information on the extent to which these surface conditions may affect detection sensitivity. In circumstances such as these, the survey design will usually rely on sampling and laboratory analysis to measure residual activity levels.

6.2 Data Quality Objectives

The third step of the Data Quality Objectives (DQO) Process involves identifying the data needs for a survey. One decision that can be made at this step is the selection of direct measurements for performing a survey or deciding that sampling methods followed by laboratory analysis are necessary.

6.2.1 Identifying Data Needs

The decision maker and the survey planning team need to identify the data needs for the survey being performed, including the:

- type of measurements to be performed (Chapter 5)
- radionuclide(s) of interest (Section 4.3)
- number of direct measurements to be performed (Section 5.5.2)
- area of survey coverage for surface scans based on survey unit classification (Section 5.5.3)
- type and frequency of field QC measurements to be performed (Section 4.9)
- measurement locations and frequencies (Section 5.5.2)
- standard operating procedures (SOPs) to be followed or developed (Chapter 6)
- analytical bias and precision (*e.g.*, quantitative or qualitative) (Appendix N, Section N.6)
- target detection limits for each radionuclide of interest (Section 6.4)
- cost of the methods being evaluated (cost per measurement as well as total cost) (Appendix H)
- necessary turnaround time
- specific background for the radionuclide(s) of interest (Section 4.5)
- derived concentration guideline level (DCGL) for each radionuclide of interest (Section 4.3)
- measurement documentation requirements
- measurement tracking requirements

Some of this information will be supplied by subsequent steps in the DQO process, and several iterations of the process may be needed to identify all of the data needs. Consulting with a health physicist or radiochemist may be necessary to properly evaluate the information before deciding

between direct measurements or sampling methods to perform the survey. Many surveys will involve a combination of direct measurements and sampling methods, along with scanning techniques, to demonstrate compliance with the release criterion.

6.2.2 Data Quality Indicators

The data quality indicators identified as DQOs in Section 2.3.1 and described in Appendix N should be considered when selecting a measurement method (*i.e.*, scanning, direct measurement, sampling) or a measurement system (*e.g.*, survey instrument, human operator, and procedure for performing measurements). In some instances, the data quality indicator requirements will help in the selection of a measurement system. In other cases, the requirements of the measurement system will assist in the selection of appropriate levels for the data quality indicators.

6.2.2.1 Precision

Precision is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions (ASQC 1995). Precision is determined quantitatively based on the results of replicate measurements (equations are provided in EPA 1990). The number of replicate analyses needed to determine a specified level of precision for a project is discussed in Section 4.9. Determining precision by replicating measurements with results at or near the detection limit of the measurement system is not recommended because the measurement uncertainty is usually greater than the desired level of precision. The types of replicate measurements applied to scanning and direct measurements are limited by the relatively uncomplicated measurement system (*i.e.*, the uncertainties associated with sample collection and preparation are eliminated). However, the uncertainties associated with applying a single calibration factor to a wide variety of site conditions mean these measurements are very useful for assessing data quality.

- Replicates to Measure Operator Precision. For scanning and direct measurements, replicates to measure operator precision provide an estimate of precision for the operator and the Standard Operating Procedure (SOP) or protocol used to perform the measurement. Replicates to measure operator precision are measurements performed using the same instrument at the same location, but with a different operator. Replicates to measure operator precision are usually non-blind or single-blind measurements.

- Replicates to Measure Instrument Precision. For scanning and direct measurements, replicates to measure instrument precision provide an estimate of precision for the type of instrument, the calibration, and the SOP or protocol used to perform the measurement. Replicates to measure instrument precision are measurements performed by the same operator at the same location, but with a different instrument. Replicates to measure instrument precision are usually non-blind or single-blind measurements.

For many surveys a combination of instrument and operator replicates are used to provide an estimate of overall precision for both scanning and direct measurements. Replicates of direct measurements can be compared with one another similar to the analytical results for samples. Results for scanning replicates may be obtained by stopping and recording instrument readings at specific intervals during the scanning survey (effectively performing direct measurements at specified locations). An alternative method for estimating the precision of scanning is to evaluate the effectiveness of the scanning survey for identifying areas of elevated activity. The results of scanning are usually locations that are identified for further investigation. A comparison of the areas identified by the replicate scanning surveys can be performed either quantitatively (using statistical methods) or qualitatively (using professional judgment). Because there is a necessity to evaluate whether the same number of locations were identified by both replicates as well as if the identified locations are the same, there is difficulty in developing precision as a DQO that can be evaluated.

6.2.2.2 Bias

Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (EPA 1997a). Bias is determined quantitatively based on the measurement of materials with a known concentration. There are several types of materials with known concentrations that may be used to determine bias for scans and direct measurements.

- Reference Material. Reference material is a material or substance one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials (ISO 1993). A certified reference material is reference material for which each certified property value is accompanied by an uncertainty at a stated level of confidence. Radioactive reference materials may be available for certain radionuclides in soil (*e.g.*, uranium in soil), but reference building materials may not be available. Because reference materials are prepared and homogenized as part of the certification process, they are rarely available as double-blind samples. When appropriate reference materials are available (*i.e.*, proper matrix, proper radionuclide, proper concentration range) they are recommended for use in determining the overall bias for a measurement system. For scanning and direct measurements a known amount of reference material is sealed in a known geometry. This known material is measured in the field using a specified protocol (*e.g.*, specified measurement time at a specified distance from the reference material) to evaluate the performance of the instrument only.

- Performance Evaluation (PE) Samples. PE samples are used to evaluate the bias of the instrument and detect any error in the instrument calibration. These samples are usually prepared by a third party, using a quantity of analyte(s) which is known to the preparer but unknown to the operator, and always undergo certification analysis. The analyte(s)

used to prepare the PE sample is the same as the analyte(s) of interest (EPA 1991g). PE samples are recommended for use in determining bias for a measurement system when appropriate reference materials are not available. PE samples are equivalent to matrix spikes prepared by a third party that undergo certification analysis and can be non-blind or single-blind when used to measure bias for scanning and direct measurements.

- Matrix Spike Samples. Matrix spike samples are environmental samples that are spiked in the laboratory with a known concentration of a target analyte(s) to verify percent recoveries. They are primarily used to check sample matrix interferences but can also be used in the field to monitor instrument performance (EPA 1991g). Matrix Spike samples are often replicated to monitor a method's performance and evaluate bias and precision (when four or more pairs are analyzed). These replicates are often collectively referred to as a matrix spike/matrix spike duplicate (MS/MSD).

- Calibration Checks. Calibration checks are measurements performed to verify instrument performance each time an instrument is used (see Section 6.5.4). These checks may be qualitative or quantitative. Operators use qualitative checks to determine if an instrument is operating properly and can be used to perform measurements. Quantitative calibration checks require a specified protocol to measure a calibration source with a known instrument response, and the results are documented to provide a record of instrument precision and bias. The results of quantitative calibration checks are typically recorded on a control chart (see Section 6.2.2.7). Note that the calibration check source does not need to be traceable for qualitative or quantitative calibration checks as long as the instrument response has been adequately established (see Section 6.5.4). Because calibration checks are non-blind measurements they are only recommended when other types of QC measurements are not available.

Quality control measurements can also be used to estimate bias caused by contamination.

- Background Measurement. A background measurement is a measurement performed upgradient of the area of potential contamination (either onsite or offsite) where there is little or no chance of migration of the contaminants of concern (EPA 1991g). Background measurements are performed in the background reference area (Section 4.5), determine the natural composition and variability of the material of interest (especially important in areas with high concentrations of naturally occurring radionuclides), and are considered "clean." They provide a basis for comparison of contaminant concentration levels with measurements performed in the survey unit when the statistical tests described in Chapter 8 are performed.

- Measurement Blanks. Measurement blanks are samples prepared in the laboratory using certified clean sand or soil and brought to the field to monitor contamination for scanning and direct measurements. A measurement blank is used to evaluate contamination error associated with the instrument used to perform measurements in the field. Measurement blanks are recommended for determining bias resulting from contamination of instruments used for scanning and direct measurements.

6.2.2.3 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point (ASQC 1995) or measurement location. Representativeness is a qualitative term that is reflected in the survey design through the selection of a measurement method (*e.g.*, direct measurement or sampling).

Sample collection and analysis is typically less representative of true radionuclide concentrations at a specific measurement location than performing a direct measurement. This is caused by the additional steps required in collecting and analyzing samples, such as sample collection, field sample preparation, laboratory sample preparation, and radiochemical analysis. However, direct measurement techniques with acceptable detection limits are not always available. The location of the direct measurement is determined in Section 5.5.2.5, where random and systematic survey designs are selected based on survey unit classification. The coverage for a survey unit using scanning techniques is discussed in Section 5.5.3 and is also based primarily on survey unit classification. Because scanning locations are often selected based on professional judgment for survey units with less than 100% coverage, representativeness of these locations may be a concern. For both scanning and direct measurements the measurement locations and method for performing the measurements should be compared to the modeling assumptions used to develop the DCGLs.

6.2.2.4 Comparability

Comparability is a qualitative term that expresses the confidence that two data sets can contribute to a common analysis and interpolation. Generally, comparability is provided by using the same measurement system for all analyses of a specific radionuclide. Comparability is usually not an issue except in cases where historical data has been collected and is being compared to current analytical results, or when multiple laboratories are used to provide results as part of a single survey design.

6.2.2.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system. This is expressed as a percentage of the number of valid measurements that should have been

collected. Completeness is of greater concern for laboratory analyses than for direct measurements because the consequences of incomplete data often require the collection of additional data. Completeness is a concern for scanning only if the scanning results are invalidated for some reason. Direct measurements and scans can usually be repeated fairly easily while the personnel performing the measurements are still in the field. For this reason MARSSIM strongly recommends that scanning and direct measurement results be evaluated as soon as possible. Direct measurements performed on a systematic grid to locate areas of elevated activity are also a concern for completeness. If one direct measurement result is not valid, the entire survey design for locating areas of elevated activity may be invalidated.

6.2.2.6 Other Data Quality Indicators

Several additional data quality indicators that influence the final status survey design are identified as DQOs in Section 2.3.1. Many of these (*e.g.*, selection and classification of survey units, decision error rates, variability in the contaminant concentration, lower bound of the gray region) are used to determine the number of measurements and are discussed in detail in Section 5.5.2. The method detection limit is directly related to the selection of a measurement method and a specific measurement system.

Scanning and direct measurement techniques should be capable of measuring levels below the established DCGLs— detection limits of 10-50% of the DCGL should be the target (see Section 6.7). Cost, time, best available technology, or other constraints may create situations where the above stated sensitivities are deemed impractical. Under these circumstances, higher detection sensitivities may be acceptable. Although service providers and instrument manufacturers will state detection limits, these sensitivities are usually based on ideal or optimistic situations and may not be achievable under site-specific measurement conditions. Detection limits are subject to variation from measurement to measurement, instrument to instrument, operator to operator, and procedure to procedure. This variation depends on geometry, background, instrument calibration, abundance of the radiations being measured, counting time, operator training, operator experience, self-absorption in the medium being measured, and interferences from radionuclides or other materials present in the medium. The detection limit that is achievable in practice should not exceed the DCGL.

6.2.2.7 Using Control Charts to Provide Control of Field Measurement Systems

Control charts are commonly used in radioanalytical laboratories to monitor the performance of laboratory instruments. Control charts are also useful for monitoring the performance of field instruments and can be used to help control field measurement systems.

A control chart is a graphical plot of measurement results with respect to time or sequence of measurement, together with limits within in which the measurement values are expected to lie

when the system is in a state of statistical control (DOE 1995). Calibration check results are typically plotted on control charts for field measurements. However, control charts may be developed for any measurements where the expected performance is established and documented. A separate set of control charts for monitoring each type of measurement (*e.g.*, calibration check, background, measurement of PE samples) should be developed for each instrument.

The control chart is constructed by preparing a graph showing the arithmetic mean and the control limits as horizontal lines. The recommended control limits are two standard deviations above and below the mean, and three standard deviations above and below the mean. The measurement results in the appropriate units are shown on the y-axis and time or sequence is plotted using the x-axis. Detailed guidance on the development and use of control charts is available in *Quality Assurance of Chemical Measurements* (Taylor 1987) and *Statistical Methods for Quality Improvement* (Kume 1985).

As the quality control or other measurements are performed, the results are entered on the control chart. If the results are outside the control limits or show a particular trend or tendency, then the process is not in control. The control chart documents the performance of the measurement system during the time period of interest.

Quality control measurements for field instruments may be difficult or expensive to obtain for some surveys. In these cases control charts documenting instrument performance may represent the only determination of precision and bias for the survey. Because control charts are non-blind measurements they are generally not appropriate for estimating precision and bias. However, the control chart documents the performance of the field instruments. Provided the checks for precision and bias fall within the control limits, the results obtained using that instrument should be acceptable for the survey.

6.3 Selecting a Service Provider to Perform Field Data Collection Activities

One of the first steps in designing a survey is to select a service provider to perform field data collection activities. MARSSIM recommends that this selection take place early in the planning process so that the service provider can provide information during survey planning and participate in the design of the survey. Service providers may include in-house experts in field measurements and sample collection, health physics companies, or environmental engineering firms among others.

When the service provider is not part of the organization responsible for the site, these services are obtained using some form of procurement mechanism. Examples of procurement mechanisms include purchase orders or contracts. A graded approach should be used in determining the appropriate method for procuring services.

Potential service providers should be evaluated to determine their ability to perform the necessary analyses. For large or complex sites, this evaluation may take the form of a pre-award audit. The results of this audit provide a written record of the decision to use a specific service provider. For less complex sites or facilities, a review of the potential service provider's qualifications is sufficient for the evaluation.

There are six criteria that should be reviewed during this evaluation:

- Does the service provider possess the validated Standard Operating Procedures (SOPs), appropriate instrumentation, and trained personnel necessary to perform the field data collection activities? Field data collection activities (e.g., scanning surveys, direct measurements, and sample collection) are defined by the data needs identified by the DQO process.
- Is the service provider experienced in performing the same or similar data collection activities?
- Does the service provider have satisfactory performance evaluation or technical review results? The service provider should be able to provide a summary of QA audits and QC measurement results to demonstrate proficiency. Equipment calibrations should be performed using National Institute of Standards and Technology (NIST) traceable reference radionuclide standards whenever possible.
- Is there an adequate capacity to perform all field data collection activities within the desired timeframe? This criterion considers the number of trained personnel and quantity of calibrated equipment available to perform the specified tasks.
- Does the service provider conduct an internal quality control review of all generated data that is independent of the data generators?
- Are there adequate protocols for method performance documentation, sample tracking and security (if necessary), and documentation of results?

Potential service providers should have an active and fully documented quality system in place.[1] This system should enable compliance with the objectives determined by the DQO process in Section 2.3 and Appendix D (see EPA 1994c). The elements of a quality management system are discussed in Section 9.1 (ASQC 1995, EPA 1994f).

[1] The quality management system is typically documented in one or more documents such as a Quality Management Plan (QMP) or Quality Assurance Manual (QAM). A description of quality systems is included in Section 9.1.

6.4 Measurement Methods

Measurement methods used to generate field data can be classified into two categories commonly known as scanning surveys and direct measurements. The decision to use a measurement method as part of the survey design is determined by the survey objectives and the survey unit classification. Scanning is performed to identify areas of elevated activity that may not be detected by other measurement methods. Direct measurements are analogous to collecting and analyzing samples to determine the average activity in a survey unit. Section 5.5.3 discusses combining scans and direct measurements in an integrated survey design.

6.4.1 Direct Measurements

To conduct direct measurements of alpha, beta, and photon surface activity, instruments and techniques providing the required detection sensitivity are selected. The type of instrument and method of performing the direct measurement are selected as dictated by the type of potential contamination present, the measurement sensitivity requirements, and the objectives of the radiological survey. Direct measurements are taken by placing the instrument at the appropriate distance[2] above the surface, taking a discrete measurement for a pre-determined time interval (*e.g.*, 10 s, 60 s, *etc.*), and recording the reading. A one minute integrated count technique is a practical field survey procedure for most equipment and provides detection sensitivities that are below most DCGLs. However, longer or shorter integrating times may be warranted (see Section 6.7.1 for information dealing with the calculation of direct measurement detection sensitivities).

Direct measurements may be collected at random locations in the survey unit. Alternatively, direct measurements may be collected at systematic locations and supplement scanning surveys for the identification of small areas of elevated activity (see Section 5.5.2.5). Direct measurements may also be collected at locations identified by scanning surveys as part of an investigation to determine the source of the elevated instrument response. Professional judgment may also be used to identify location for direct measurements to further define the areal extent of contamination and to determine maximum radiation levels within an area, although these types of direct measurements are usually associated with preliminary surveys (*i.e.*, scoping, characterization, remedial action support). All direct measurement locations and results should be documented.

[2] Measurements at several distances may be needed. Near-surface or surface measurements provide the best indication of the size of the contaminated region and are useful for model implementation. Gamma measurements at 1 m provide a good estimate of potential direct external exposure.

If the equipment and methodology used for scanning is capable of providing data of the same quality required for direct measurement (*e.g.*, detection limit, location of measurements, ability to record and document results), then scanning may be used in place of direct measurements. Results should be documented for at least the number of locations required for the statistical tests. In addition, some direct measurement systems may be able to provide scanning data, provided they meet the objectives of the scanning survey.

The following sections briefly describe methods used to perform direct measurements in the field. The instruments used to perform these measurements are described in more detail in Section 6.5.3 and Appendix H.

6.4.1.1 Direct Measurements for Photon Emitting Radionuclides

There are a wide variety of instruments available for measuring photons in the field (see Appendix H) but all of them are used in essentially the same way. The detector is set up at a specified distance from the surface being measured and data are collected for a specified period of time. The distance from the surface to the detector is generally determined by the calibration of the instrument because photons do not interact appreciably with air. When measuring x-rays or low-energy gamma rays, the detector is often placed closer to the surface to increase the counting efficiency. The time required to perform a direct measurement may vary from very short (*e.g.*, 10 seconds) to very long (*e.g.*, several days or weeks) depending on the type of detector and the required detection limit. In general, the lower the required detection limit the longer the time required to perform the measurement. A collimator may be used in areas where activity from adjacent or nearby areas might interfere with the direct measurement. The collimator (usually lead, tungsten, or steel) shields the detector from extraneous photons but allows activity from a specified area of the surface to reach the detector.

Example:

The portable germanium detector, or *in situ* gamma spectrometer, can be used to estimate gamma-emitting radionuclide concentrations in the field. As with the laboratory-based germanium detector with multichannel analyzer, *in situ* gamma spectrometry can discriminate among various radionuclides on the basis of characteristic gamma and x-ray energies to provide a nuclide-specific measurement. A calibrated detector measures the fluence rate of primary photons at specific energies that are characteristic of a particular radionuclide (NRC 1995b). This fluence rate can then be converted to units of concentration. Under certain conditions the fluence rate may be converted directly to dose or risk for a direct comparison to the release criterion rather than to the $DCGL_W$. Although this conversion is generally made, the fluence rate should be considered the fundamental parameter for assessing the level of radiation at a specific location because it is a directly measurable physical quantity.

For outdoor measurements, where the contaminant is believed to be distributed within the surface soil, it may be appropriate to assume a uniform depth profile when converting the fluence rate to a concentration. At sites where the soil is plowed or overturned regularly, this assumption is quite realistic because of the effects of homogenization. At sites where the activity was initially deposited on the surface and has gradually penetrated deeper over time, the actual depth profile will have a higher activity at the surface and gradually diminish with depth. In this case, the assumption of a uniform depth profile will estimate a higher radionuclide concentration relative to the average concentration over that depth. In cases where there is an inverted depth profile (*i.e.*, low concentration at the surface that increase with depth), the assumption of a uniform depth profile will underestimate the average radionuclide concentration over that depth. For this reason, MARSSIM recommends that soil cores be collected to determine the actual depth profile for the site. These soil cores may be collected during the characterization or remedial action support survey to establish a depth profile for planning a final status survey. The cores may also be collected during the final status survey to verify the assumptions used to develop the fluence-to-concentration correction.

For indoor measurements, uncollimated *in situ* measurements can provide useful information on the low-level average activity across an entire room. The position of the measurement within the room is not critical if the radionuclide of interest is not present in the building materials. A measurement of peak count rate can be converted to fluence rate, which can in turn be related to the average surface activity. The absence of a discernible peak would mean that residual activity could not exceed a certain average level. However, this method will not easily locate small areas of elevated activity. For situations where the activity is not uniformly distributed on the surface, a series of collimated measurements using a systematic grid allows the operator to identify general areas of elevated contamination.

The NRC draft report *Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria* (NRC 1995b) provides a detailed description of the theory and implementation of *in situ* gamma spectrometry. *In situ* spectrometry is provided as one example of a useful tool for performing direct measurements for particular scenarios, but interpretation of the instrument output in terms of radionuclide distributions is dependent on the assumptions used to calibrate the method site-specifically. The depth of treatment of this technique in this example is not meant to imply that *in situ* gamma spectrometry is preferred *a priori* over other appropriate measurement techniques described in this manual.

6.4.1.2 Direct Measurements for Alpha Emitting Radionuclides

Direct measurements for alpha-emitting radionuclides are generally performed by placing the detector on or near the surface to be measured. The limited range of alpha particles (*e.g.*, about 1 cm or 0.4 in. in air, less in denser material) means that these measurements are generally restricted to relatively smooth, impermeable surfaces such as concrete, metal, or drywall where the activity is present as surface contamination. In most cases, direct measurements of porous (*e.g.*, wood) and volumetric (*e.g.*, soil, water) material cannot meet the objectives of the survey. However, special instruments such as the long range alpha detector (see Appendix H) have been developed to measure the concentration of alpha emitting radionuclides in soil under certain conditions. Because the detector is used in close proximity to the potentially contaminated surface, contamination of the detector or damage to the detector caused by irregular surfaces need to be considered before performing direct measurements for alpha emitters.

6.4.1.3 Direct Measurements for Beta Emitting Radionuclides

Direct measurements for beta emitting radionuclides are generally performed by placing the detector on or near the surface to be measured, similar to measurements for alpha emitting radionuclides. These measurements are typically restricted to relatively smooth, impermeable surfaces where the activity is present as surface contamination. In most cases, direct measurements of porous (*e.g.*, wood) and volumetric (*e.g.*, soil, water) material cannot meet the objectives of the survey. However, special instruments such as large area gas-flow proportional counters (see Appendix H) and arrays of beta scintillators have been developed to measure the concentration of beta emitting radionuclides in soil under certain conditions. Similar to direct measurements for alpha emitting radionuclides, contamination of the detector and damage to the detector need to be considered before performing direct measurements for beta emitters.

6.4.2 Scanning Surveys

Scanning is the process by which the operator uses portable radiation detection instruments to detect the presence of radionuclides on a specific surface (*i.e.*, ground, wall, floor, equipment). The term scanning survey is used to describe the process of moving portable radiation detectors across a suspect surface with the intent of locating radionuclide contamination. Investigation levels for scanning surveys are determined during survey planning to identify areas of elevated activity. Scanning surveys are performed to locate radiation anomalies indicating residual gross activity that may require further investigation or action. These investigation levels may be based on the $DCGL_W$, the $DCGL_{EMC}$, or some other level as discussed in Section 5.5.2.6.

Small areas of elevated activity typically represent a small portion of the site or survey unit. Thus, random or systematic direct measurements or sampling on the commonly used grid spacing may have a low probability of identifying such small areas. Scanning surveys are often relatively quick and inexpensive to perform. For these reasons, scanning surveys are typically performed before direct measurements or sampling. This way time is not spent fully evaluating an area that may quickly prove to be contaminated above the investigation level during the scanning process. Scans are conducted which would be indicative of all radionuclides potentially present, based on the Historical Site Assessment, surfaces to be surveyed, and survey design objectives. Surrogate measurements may be utilized where appropriate (see Section 4.3.2). Documenting scanning results and observations from the field is very important. For example, a scan that identified relatively sharp increases in instrument response or identified the boundary of an area of increased instrument response should be documented. This information is useful when interpreting survey results.

The following sections briefly describe techniques used to perform scanning surveys for different types of radiation. The instruments used to perform these measurements are described in more detail in Section 6.5.3 and Appendix H.

6.4.2.1 Scanning for Photon Emitting Radionuclides

Sodium iodide survey meters (NaI(Tl) detectors) are normally used for scanning areas for gamma emitters because they are very sensitive to gamma radiation, easily portable and relatively inexpensive. The detector is held close to the ground surface (~6 cm or 2.5 in.) and moved in a serpentine (*i.e.*, snake like, "S" shaped) pattern while walking at a speed that allows the investigator to detect the desired investigation level. A scan rate of approximately 0.5 m/s is typically used for distributed gamma emitting contaminants in soil; however, this rate must be adjusted depending on the expected detector response and the desired investigation level. Discussion of scanning rates versus detection sensitivity for gamma emitters is provided in Section 6.7.2.1.

Sodium iodide survey meters are also used for scanning to detect areas with elevated areas of low-energy gamma and x-ray emitting radionuclides such as ^{241}Am and ^{239}Pu. Specially designed detectors, such as the FIDLER (field instrument for the detection of low energy radiation) probe with survey meter, are typically used to detect these types of radionuclides.

6.4.2.2 Scanning for Alpha Emitting Radionuclides

Alpha scintillation survey meters and thin window gas-flow proportional counters are typically used for performing alpha surveys. Alpha radiation has a very limited range and, therefore, instrumentation must be kept close to the surface—usually less than 1 cm (0.4 in.). For this reason, alpha scans are generally performed on relatively smooth, impermeable surfaces (*e.g.*,

concrete, metal, drywall) and not on porous material (*e.g.*, wood) or for volumetric contamination (*e.g.*, soil, water). In most cases, porous and volumetric contamination cannot be detected by scanning for alpha activity and meet the objectives of the survey because of high detection sensitivities. Under these circumstances, samples of the material are usually collected and analyzed as discussed in Chapter 7. Determining scan rates when surveying for alpha emitters is discussed in Section 6.7.2.2 and Appendix J.

6.4.2.3 Scanning for Beta Emitting Radionuclides

Thin window gas-flow proportional counters are normally used when surveying for beta emitters, although solid scintillators designed for this purpose are also available. Typically, the beta detector is held less than 2 cm from the surface and moved at a rate such that the desired investigation level can be detected. Low-energy (<100 keV) beta emitters are subject to the same interferences and self-absorption problems found with alpha emitting radionuclides, and scans for these radionuclides are performed under similar circumstances. Determination of scan rates when surveying for beta emitters is discussed in Section 6.7.2.1.

6.5 Radiation Detection Instrumentation

Traditional radiation instruments consist of two components: 1) a radiation detector, and 2) electronic equipment to provide power to the detector and to display or record radiation events. This section identifies and very briefly describes the types of radiation detectors and associated display or recording equipment that are applicable to survey activities in support of environmental assessment or remedial action. Each survey usually requires performing direct field measurements using portable instrumentation and collection of samples for laboratory analysis. The selection and proper use of appropriate instruments for both direct measurements and laboratory analyses will likely be the most critical factors in assuring that the survey accurately determines the radiological status of a site and meets the survey objectives. Chapter 7 provides specific information on laboratory analysis of collected samples. Appendix H contains instrument specific information for various types of field survey and laboratory analysis equipment currently in use.

6.5.1 Radiation Detectors

The particular capabilities of a radiation detector will establish its potential applications in conducting a specific type of survey. Radiation detectors can be divided into four general classes based on the detector material or the application. These categories are: 1) gas-filled detectors, 2) scintillation detectors, 3) solid-state detectors, and 4) passive integrating detectors.

6.5.1.1 Gas-Filled Detectors

Radiation interacts with the fill gas, producing ion-pairs that are collected by charged electrodes. Commonly used gas-filled detectors are categorized as ionization, proportional, or Geiger-Mueller (GM), referring to the region of gas amplification in which they are operated. The fill gas varies, but the most common are: 1) air, 2) argon with a small amount of organic methane (usually 10% methane by mass, referred to as P-10 gas), and 3) argon or helium with a small amount of a halogen such as chlorine or bromine added as a quenching agent.

6.5.1.2 Scintillation Detectors

Radiation interacts with a solid or liquid medium causing electronic transitions to excited states in a luminescent material. The excited states decay rapidly, emitting photons that in turn are captured by a photomultiplier tube. The ensuing electrical signal is proportional to the scintillator light output, which, under the right conditions, is proportional to the energy loss that produced the scintillation. The most common scintillant materials are NaI(Tl), ZnS(Ag), Cd(Te), and CsI(Tl) which are used in traditional radiation survey instruments such as the NaI(Tl) detector used for gamma surveys and the ZnS(Ag) detector for alpha surveys.

6.5.1.3 Solid-State Detectors

Radiation interacting with a semiconductor material creates electron-hole pairs that are collected by a charged electrode. The design and operating conditions of a specific solid-state detector determines the types of radiations (alpha, beta, and/or gamma) that can be measured, the detection level of the measurements, and the ability of the detector to resolve the energies of the interacting radiations. The semiconductor materials currently being used are germanium and silicon which are available in both n and p types in various configurations.

Spectrometric techniques using these detectors provide a marked increase in sensitivity in many situations. When a particular radionuclide contributes only a fraction of the total particle fluence or photon fluence, or both, from all sources (natural or manmade background), gross measurements are inadequate and nuclide-specific measurements are necessary. Spectrometry provides the means to discriminate among various radionuclides on the basis of characteristic energies. *In-situ* gamma spectrometry is particularly effective in field measurements since the penetrating nature of the radiation allows one to "see" beyond immediate surface contamination. The availability of large, high efficiency germanium detectors permits measurement of low abundance gamma emitters such as ^{238}U as well as low energy emitters such as ^{241}Am and ^{239}Pu.

6.5.1.4 Passive Integrating Detectors

There is an additional class of instruments that consists of passive, integrating detectors and associated reading/analyzing instruments. The integrated ionization is read using a laboratory or hand-held reader. This class includes thermoluminescence dosimeters (TLDs) and electret ion chambers (EICs). Because these detectors are passive and can be exposed for relatively long periods of time, they can provide better sensitivity for measuring low activity levels such as free release limits or for continuing surveillance. The ability to read and present data onsite is a useful feature and such systems are comparable to direct reading instruments.

The scintillation materials in Section 6.5.1.2 are selected for their prompt fluorescence characteristics. In another class of inorganic crystals, called TLDs, the crystal material and impurities are chosen so that the free electrons and holes created following the absorption of energy from the radiation are trapped by impurities in the crystalline lattice thus locking the excitation energy in the crystal. Such materials are used as passive, integrating detectors. After removal from the exposure area, the TLDs are heated in a reader which measures the total amount of light produced when the energy is released. The total amount of light is proportional to the number of trapped, excited electrons, which in turn is proportional to the amount of energy absorbed from the radiation. The intensity of the light emitted from the thermoluminescent crystals is thus directly proportional to the radiation dose. TLDs come in a large number of materials, the most common of which are LiF, CaF_2:Mn, CaF_2:Dy, $CaSO_4$:Mn, $CaSO_4$:Dy, Al_2O_3:C.

The electret ion chamber consists of a very stable electret (a charged Teflon® disk) mounted inside a small chamber made of electrically charged plastic. The ions produced inside this air filled chamber are collected onto the electret, causing a reduction of its surface charge. The reduction in charge is a function of the total ionization during a specific monitoring period and the specific chamber volume. This change in voltage is measured with a surface potential voltmeter.

6.5.2 Display and Recording Equipment

Radiation detectors are connected to electronic devices to 1) provide a source of power for detector operation, and 2) enable measurement of the quantity and/or quality of the radiation interactions that are occurring in the detector. The quality of the radiation interaction refers to the amount of energy transferred to the detector. In many cases, radiation interacts with other material (*e.g.*, air) prior to interacting with the detector, or only partially interacts with the detector (*e.g.*, Compton scattering for photons). Because the energy recorded by the detector is affected, there is an increased probability of incorrectly identifying the radionuclide.

The most common recording or display device used for portable radiation measurement systems is a ratemeter. This device provides a display on an analog meter representing the number of events occurring over some time period (*e.g.*, counts per minute). Digital ratemeters are also commercially available. The number of events can also be accumulated over a preset time period using a digital scaling device. The resulting information from a scaling device is the total number of events that occurred over a fixed period of time, where a ratemeter display varies with time and represents a short term average of the event rate. Determining the average level on a ratemeter will require judgment by the user, especially when a low frequency of events results in significant variations in the meter reading.

Pulse height analyzers are specialized electronic devices designed to measure and record the number of pulses or events that occur at different pulse height levels. These types of devices are used with detectors which produce output pulses that are proportional in height to the energy deposited within them by the interacting radiation. They can be used to record only those events occurring in a detector within a single band of energy or can simultaneously record the events in multiple energy ranges. In the former case, the equipment is known as a single-channel analyzer; the latter application is referred to as a multichannel analyzer.

6.5.3 Instrument Selection

Radiation survey parameters that might be needed for site release purposes include surface activities, exposure rates, and radionuclide concentrations in soil. To determine these parameters, field measurements and laboratory analyses may be necessary. For certain radionuclides or radionuclide mixtures, both alpha and beta radiations may have to be measured. In addition to assessing average radiological conditions, the survey objectives should address identifying small areas of elevated activity and determining the extent and level of residual radioactivity.

Additionally, the potential uses of radiation instruments can vary significantly depending on the specific design and operating criteria of a given detector type. For example, a NaI(Tl) scintillator can be designed to be very thin with a low atomic number entrance window (*e.g.*, beryllium) such that the effective detection capability for low energy photons is optimized. Conversely, the same scintillant material can be fabricated as a thick cylinder in order to optimize the detection probability for higher energy photons. On the recording end of a detection system, the output could be a ratemeter, scaler, or multichannel analyzer as described in Section 6.5.2. Operator variables such as training and level of experience with specific instruments should also be considered.

With so many variables, it is highly unlikely that any single instrument (detector and readout combination) will be capable of adequately measuring all of the radiological parameters necessary to demonstrate that criteria for release have been satisfied. It is usually necessary to select multiple instruments to perform the variety of measurements required.

Selection of instruments will require an evaluation of a number of situations and conditions. Instruments must be stable and reliable under the environmental and physical conditions where they will be used, and their physical characteristics (size and weight) should be compatible with the intended application. The instrument must be able to detect the type of radiation of interest, and the measurement system should be capable of measuring levels that are less than the DCGL (see Section 6.7).

For gamma radiation scanning, a scintillation detector/ratemeter combination is the usual instrument of choice. A large-area proportional detector with a ratemeter is recommended for scanning for alpha and beta radiations where surface conditions and locations permit; otherwise, an alpha scintillation or thin-window GM detector (for beta surveys) may be used.

For direct gamma measurements, a pressurized ionization chamber or *in-situ* gamma spectroscopy system is recommended. As an option, a NaI(Tl) scintillation detector may be used if cross-calibrated to a pressurized ion chamber or calibrated for the specific energy of interest. The same alpha and beta detectors identified above for scanning surveys are also recommended for use in direct measurements.

There are certain radionuclides that, because of the types, energies, and abundances of their radiations, will be essentially impossible to measure at the guideline levels, under field conditions, using state-of-the-art instrumentation and techniques. Examples of such radionuclides include very low energy pure beta emitters, such as ^{3}H and ^{63}Ni, and low energy photon emitters, such as ^{55}Fe and ^{125}I. Pure alpha emitters dispersed in soil or covered with some absorbing layer will not be detectable because the alpha radiation will not penetrate through the media or covering to reach the detector. A common example of such a condition would be ^{230}Th surface contamination covered by paint, dust, oil, or moisture. In such circumstances, sampling and laboratory analysis would be required to measure the residual activity levels unless surrogate radionuclides are present as discussed in Section 4.3.2.

The number of possible design and operating schemes for each of the different types of detectors is too large to discuss in detail within the context of this document. For a general overview, lists of common radiation detectors along with their usual applications during surveys are provided in Tables 6.1 through 6.3. Appendix H contains specific information for various types of field survey and laboratory analysis equipment currently in use. Continual development of new technologies will result in changes to these listings.

Table 6.1 Radiation Detectors with Applications to Alpha Surveys

Detector Type	Detector Description	Application	Remarks
Gas Proportional	<1 mg/cm^2 window; probe area 50 to 1000 cm^2 <0.1 mg/cm^2 window; probe area 10 to 20 cm^2 No window (internal proportional)	Surface scanning; surface contamination measurement Laboratory measurement of water, air, and smear samples Laboratory measurement of water, air, and smear samples	Requires a supply of appropriate fill gas
Air Proportional	<1 mg/cm^2 window; probe area ~50 cm^2	Useful in low humidity conditions	
Scintillation	ZnS(Ag) scintillator; probe area 50 to 100 cm^2 ZnS(Ag) scintillator; probe area 10 to 20 cm^2 Liquid scintillation cocktail containing sample	Surface contamination measurements, smears Laboratory measurement of water, air, and smear samples Laboratory analysis, spectrometry capabilities	
Solid State	Silicon surface barrier detector	Laboratory analysis by alpha spectrometry	
Passive, integrating electret ion chamber	<0.8 mg/cm^2 window, also window-less, window area 50-180 cm^2, chamber volume 50-1,000 ml	Contamination on surfaces, in pipes and in soils	Useable in high humidity and temperature

6.5.4 Instrument Calibration

Calibration refers to the determination and adjustment of the instrument response in a particular radiation field of known intensity. Proper calibration procedures are an essential requisite toward providing confidence in measurements made to demonstrate compliance with cleanup criteria. Certain factors, such as energy dependence and environmental conditions, require consideration in the calibration process, depending on the conditions of use of the instrument in the field. Routine calibration of radiation detection instruments refers to calibration for normal use under typical field conditions. Considerations for the use and calibration of instruments include:

Table 6.2 Radiation Detectors with Applications to Beta Surveys

Detector Type	Detector Description	Application	Remarks
Gas Proportional	<1 mg/cm^2 window; probe area 50 to 1,000 cm^2	Surface scanning; surface contamination measurement	Requires a supply of appropriate fill gas
	<0.1 mg/cm^2 window; probe area 10 to 20 cm^2	Laboratory measurement of water, air, smear, and other samples	
	No window (internal proportional)	Laboratory measurement of water, air, smear, and other samples	Can be used for measuring very low-energy betas
Ionization (non-pressurized)	1-7 mg/cm^2 window	Contamination measurements; skin dose rate estimates	
Geiger-Mueller	<2 mg/cm^2 window; probe area 10 to 100 cm^2	Surface scanning; contamination measurements; laboratory analyses	
	Various window thickness; few cm^2 probe face	Special scanning applications	
Scintillation	Liquid scintillation cocktail containing sample	Laboratory analysis; spectrometry capabilities	
	Plastic scintillator	Contamination measurements	
Passive, integrating electret ion chamber	7 mg/cm^2 window, also window-less, window area 50-180 cm^2, chamber volume 50-1,000 ml	Low energy beta including H-3 contamination on surfaces and in pipes	Useable in high humidity and temperature

- use of the instrument for radiation of the type for which the instrument is designed
- use of the instrument for radiation energies within the range of energies for which the instrument is designed
- use under environmental conditions for which the instrument is designed
- use under influencing factors, such as magnetic and electrostatic fields, for which the instrument is designed
- use of the instrument in an orientation such that geotropic effects are not a concern
- use of the instrument in a manner that will not subject the instrument to mechanical or thermal stress beyond that for which it is designed

Table 6.3 Radiation Detectors with Applications to Gamma Surveys

Detector Type	Detector Description	Application	Remarks
Gas Ionization	Pressurized ionization chamber; Non-pressurized ionization chamber	Exposure rate measurements	
Geiger-Mueller	Pancake (<2 mg/cm^2 window) or side window (~30 mg/cm^2)	Surface scanning; exposure rate correlation (side window in closed position)	Low relative sensitivity to gamma radiation
Scintillation	NaI(Tl) scintillator; up to 5 cm by 5 cm	Surface scanning; exposure rate correlation	High sensitivity; Cross calibrate with PIC (or equivalent) or for specific site gamma energy mixture for exposure rate measurements.
	NaI(Tl) scintillator; large volume and "well" configurations	Laboratory gamma spectrometry	
	CsI or NaI(Tl) scintillator; thin crystal	Scanning; low-energy gamma and x-rays	Detection of low-energy radiation
	Organic tissue equivalent (plastics)	Dose equivalent rate measurements	
Solid State	Germanium semi-conductor	Laboratory and field gamma spectrometry and spectroscopy	
Passive, integrating electret ion chamber	7 mg/cm^2 window, also window-less, window area 50-180 cm^2, chamber volume 50-1,000 ml		Useable in high humidity and temperature

Routine calibration commonly involves the use of one or more sources of a specific radiation type and energy, and of sufficient activity to provide adequate field intensities for calibration on all ranges of concern.

Actual field conditions under which the radiation detection instrument will be used may differ significantly from those present during routine calibration. Factors which may affect calibration validity include:

- the energies of radioactive sources used for routine calibration may differ significantly from those of radionuclides in the field
- the source-detector geometry (*e.g.*, point source or large area distributed source) used for routine calibration may be different than that found in the field
- the source-to-detector distance typically used for routine calibration may not always be achievable in the field
- the condition and composition of the surface being monitored (*e.g.*, sealed concrete, scabbled concrete, carbon steel, stainless steel, and wood) and the presence of overlaying material (*e.g.*, water, dust, oil, paint) may result in a decreased instrument response relative to that observed during routine calibration

If the actual field conditions differ significantly from the calibration assumptions, a special calibration for specific field conditions may be required. Such an extensive calibration need only be done once to determine the effects of the range of field conditions that may be encountered at the site. If responses under routine calibration conditions and proposed use conditions are significantly different, a correction factor or chart should be supplied with the instrument for use under the proposed conditions.

As a minimum, each measurement system (detector/readout combination) should be calibrated annually and response checked with a source following calibration (ANSI 1996). Instruments may require more frequent calibration if recommended by the manufacturer. Re-calibration of field instruments is also required if an instrument fails a performance check or if it has undergone repair or any modification that could affect its response.

The user may decide to perform calibrations following industry recognized procedures (ANSI 1996b, DOE Order 5484.1, NCRP 1978, NCRP 1985, NCRP 1991, ISO 1988, HPS 1994a, HPS 1994b), or the user can choose to obtain calibration by an outside service, such as a major instrument manufacturer or a health physics services organization.

Calibration sources should be traceable to the National Institute of Standards and Technology (NIST). Where NIST traceable standards are not available, standards obtained from an industry recognized organization (*e.g.*, the New Brunswick Laboratory for various uranium standards) may be used.

Calibration of instruments for measurement of surface contamination should be performed such that a direct instrument response can be accurately converted to the 4π (total) emission rate from the source. An accurate determination of activity from a measurement of count rate above a surface in most cases is an extremely complex task because of the need to determine appropriate chacteristics of the source including decay scheme, geometry, energy, scatter, and self-absorption. For the purpose of release of contaminated areas from radiological control, measurements must provide sufficient accuracy to ensure that cleanup standards have been

achieved. Inaccuracies in measurements should be controlled in a manner that minimizes the consequences of decision errors. The variables that affect instrument response should be understood well enough to ensure that the consequences of decision errors are minimized. Therefore, the calibration should account for the following factors (where necessary):

- Calibrations for point and large area source geometries may differ, and both may be necessary if areas of activity smaller than the probe area and regions of activity larger than the probe area are present.
- Calibration should either be performed with the radionuclide of concern, or with appropriate correction factors developed for the radionuclide(s) present based on calibrations with nuclides emitting radiations similar to the radionuclide of concern.
- For portable instrumentation, calibrations should account for the substrate of concern (*i.e.*, concrete, steel) or appropriate correction factors developed for the substrates relative to the actual calibration standard substrate. This is especially important for beta emitters because backscatter is significant and varies with the composition of the substrate. Conversion factors developed during the calibration process should be for the same counting geometry to be used during the actual use of the detector.

For cleanup standards for building surfaces, the contamination level is typically expressed in terms of the particle emission rate per unit time per unit area, normally Bq/m^2 or disintegrations per minute (dpm) per 100 cm^2. In many facilities, surface contamination is assessed by converting the instrument response (in counts per minute) to surface activity using one overall total efficiency. The total efficiency may be considered to represent the product of two factors, the instrument (detector) efficiency, and the source efficiency. Use of the total efficiency is not a problem provided that the calibration source exhibits characteristics similar to the surface contamination (*i.e.*, radiation energy, backscatter effects, source geometry, self-absorption). In practice, this is hardly the case; more likely, instrument efficiencies are determined with a clean, stainless steel source, and then those efficiencies are used to determine the level of contamination on a dust-covered concrete surface. By separating the efficiency into two components, the surveyor has a greater ability to consider the actual characteristics of the surface contamination.

The instrument efficiency is defined as the ratio of the net count rate of the instrument and the surface emission rate of a source for a specified geometry. The surface emission rate is defined as the number of particles of a given type above a given energy emerging from the front face of the source per unit time. The surface emission rate is the 2π particle fluence that embodies both the absorption and scattering processes that effect the radiation emitted from the source. Thus, the instrument efficiency is determined by the ratio of the net count rate and the surface emission rate.

The instrument efficiency is determined during calibration by obtaining a static count with the detector over a calibration source that has a traceable activity or surface emission rate. In many cases, a source emission rate is measured by the manufacturer and certified as NIST traceable. The source activity is then calculated from the surface emission rate based on assumed backscatter and self-absorption properties of the source. The maximum value of instrument efficiency is 1.

The source efficiency is defined as the ratio of the number of particles of a given type emerging from the front face of a source and the number of particles of the same type created or released within the source per unit time. The source efficiency takes into account the increased particle emission due to backscatter effects, as well as the decreased particle emission due to self-absorption losses. For an ideal source (*i.e.*, no backscatter or self-absorption), the value of the source efficiency is 0.5. Many real sources will exhibit values less than 0.5, although values greater than 0.5 are possible, depending on the relative importance of the absorption and backscatter processes.

Source efficiencies may be determined experimentally. Alternatively, ISO-7503-1 (ISO 1988) makes recommendations for default source efficiencies. A source efficiency of 0.5 is recommended for beta emitters with maximum energies above 0.4 MeV. Alpha emitters and beta emitters with maximum beta energies between 0.15 and 0.4 MeV have a recommended source efficiency of 0.25. Source efficiencies for some common surface materials and overlaying material are provided in NUREG-1507 (NRC 1997b).

Instrument efficiency may be affected by detector-related factors such as detector size (probe surface area), window density thickness, geotropism, instrument response time, counting time (in static mode), scan rate (in scan mode), and ambient conditions such as temperature, pressure, and humidity. Instrument efficiency also depends on solid angle effects, which include source-to-detector distance and source geometry.

Source efficiency may be affected by source-related factors such as the type of radiation and its energy, source uniformity, surface roughness and coverings, and surface composition (*e.g.*, wood, metal, concrete).

The calibration of gamma detectors for the measurement of photon radiation fields should also provide reasonable assurance of acceptable accuracy in field measurements. Use of these instruments for demonstration of compliance with cleanup standards is complicated by the fact that most cleanup levels produce exposure rates of at most a few µR/h. Several of the portable survey instruments currently available in the United States for exposure rate measurements of ~1 µR/h (often referred to as micro-R meters) have full scale intensities of ~3 to 5 µR/h on the first range. This is below the ambient background for most low radiation areas and most calibration laboratories. (A typical background dose equivalent rate of 100 mrem/y gives a

background exposure rate of about 10 μR/h.) Even on the second range, the ambient background in the calibration laboratory is normally a significant part of the range and must be taken into consideration during calibration. The instruments commonly are not energy-compensated and are very sensitive to the scattered radiation that may be produced by the walls and floor of the room or additional shielding required to lower the ambient background.

Low intensity sources and large distances between the source and detector can be used for low-level calibrations if the appropriate precautions are taken. Field characterization of low-level sources with traceable transfer standards is difficult because of the poor signal-to-noise ratio in the standard chamber. In order to achieve adequate ionization current, the distance between the standard chamber and the source generally will be as small as possible while still maintaining good geometry (5 to 7 detector diameters). Generally it is not possible to use a standard ionization chamber to characterize the field at the distance necessary to reduce the field to the level required for calibration. A high quality GM detector, calibrated as a transfer standard, may be useful at low levels.

Corrections for scatter can be made using a shadow-shield technique in which a shield of sufficient density and thickness to eliminate virtually all the primary radiation is placed about midway between the source and the detector. The dimensions of the shield should be the minimum required to reduce the primary radiation intensity at the detector location to less than 2% of its unshielded value. The change in reading caused by the shield being removed is attributed to the primary field from the source at the detector position.

In some instruments that produce pulses (GM counters or scintillation counters), the detector can be separated electronically from the readout electronics and the detector output can be simulated with a suitable pulser. Caution must be exercised to ensure that either the high voltage is properly blocked or that the pulser is designed for this application. If this can be accomplished, the instrument can first be calibrated on a higher range that is not affected by the ambient background and in a geometry where scatter is not a problem and, after disconnecting the detector, to provide the pulse-rate from the pulser which will give the same instrument response. The pulse rate can then be related to field strength and reduced to give readings on lower ranges (with the detector disconnected) even below the ambient background. This technique does not take account of any inherent detector background independent of the external background.

Ionization chambers are commonly used to measure radiation fields at very low levels. In order to obtain the sensitivity necessary to measure these radiation levels, the instruments are frequently very large and often pressurized. These instruments have the same calibration problems as the more portable micro-R meters described above. The same precautions (shadow shield) must be taken to separate the response of the instrument to the source and to scattered radiation. Generally, it is not possible to substitute an electronic pulser for the radiation field in these instruments.

For energy-dependent gamma scintillation instruments, such as NaI(Tl) detectors, calibration for the gamma energy spectrum at a specific site may be accomplished by comparing the instrument response to that of a pressurized ionization chamber, or equivalent detector, at different locations on the site. Multiple radionuclides with various photon energies may also be used to calibrate the system for the specific energy of interest.

In the interval between calibrations, the instrument should receive a performance check prior to use. In some cases, a performance check following use may also provide valuable information. This calibration check is merely intended to establish whether or not the instrument is operating within certain specified, rather large, uncertainty limits. The initial performance check should be conducted following the calibration by placing the source in a fixed, reproducible location and recording the instrument reading. The source should be identified along with the instrument, and the same check source should be used in the same fashion to demonstrate the instrument's operability on a daily basis when the instrument is in use. For analog readout (count rate) instruments, a variation of ± 20% is usually considered acceptable. Optionally, instruments that integrate events and display the total on a digital readout typically provide an acceptable average response range of 2 or 3 standard deviations. This is achieved by performing a series of repetitive measurements (10 or more is suggested) of background and check source response and determining the average and standard deviation of those measurements. From a practical standpoint, a maximum deviation of ± 20% is usually adequate when compared with other uncertainties associated with the use of the equipment. The amount of uncertainty allowed in the response checks should be consistent with the level of uncertainty allowed in the final data. Ultimately the decision maker determines what level of uncertainty is acceptable.

Instrument response, including both the background and check source response of the instrument, should be tested and recorded at a frequency that ensures the data collected with the equipment is reliable. For most portable radiation survey equipment, MARSSIM recommends that a response check be performed twice daily when in use—typically prior to beginning the day's measurements and again following the conclusion of measurements on that same day. Additional checks can be performed if warranted by the instrument and the conditions under which it is used. If the instrument response does not fall within the established range, the instrument is removed from use until the reason for the deviation can be resolved and acceptable response again demonstrated. If the instrument fails the post-survey source check, all data collected during that time period with the instrument must be carefully reviewed and possibly adjusted or discarded, depending on the cause of the failure. Ultimately, the frequency of response checks must be balanced with the stability of the equipment being used under field conditions and the quantity of data being collected. For example, if the instrument experiences a sudden failure during the course of the day's work due to physical harm, such as a punctured probe, then the data collected up until that point is probably acceptable even though a post-use performance check cannot be performed. Likewise, if no obvious failure occurred but the instrument failed the post-use response check, then the data collected with that instrument since

the last response check should be viewed with great skepticism and possibly re-collected or randomly checked with a different instrument. Additional corrective action alternatives are presented in Section 9.3. If re-calibration is necessary, acceptable response ranges must be reestablished and documented.

Record requirements vary considerably and depend heavily on the needs of the user. While Federal and State regulatory agencies all specify requirements, the following records should be considered a minimum.

Laboratory Quality Control

- records documenting the traceabililty of radiological standards
- records documenting the traceability of electronic test equipment

Records for Instruments to be Calibrated

- date received in the calibration laboratory
- initial condition of the instrument, including mechanical condition (*e.g.*, loose or broken parts, dents, punctures), electrical condition (*e.g.*, switches, meter movement, batteries), and radiological condition (presence or absence of contamination)
- calibrator's records including training records and signature on calibration records
- calibration data including model and serial number of instrument, date of calibration, recommended recalibration date, identification of source(s) used, "as found" calibration results, and final calibration results—"as returned" for use.

In addition, records of instrument problems, failures, and maintenance can be included and are useful in assessing performance and identifying possible needs for altered calibration frequencies for some instruments. Calibration records should be maintained at the facility where the instruments are used as permanent records, and should be available either as hard copies or in safe computer storage.

6.6 Data Conversion

This section describes methods for converting survey data to appropriate units for comparison to radiological criteria. As stated in Chapter 4, conditions applicable to satisfying decommissioning requirements include determining that any residual contamination will not result in individuals being exposed to unacceptable levels of radiation and/or radioactive materials.

Radiation survey data are usually obtained in units, such as the number of counts per unit time, that have no intrinsic meaning relative to DCGLs. For comparison of survey data to DCGLs, the survey data from field and laboratory measurements should be converted to DCGL units.

6.6.1 Surface Activity

When measuring surface activity, it is important to account for the physical surface area assessed by the detector in order to make probe area corrections and report data in the proper units (*i.e.*, Bq/m^2, dpm/100 cm^2). This is termed the *physical probe area*. A common misuse is to make probe area corrections using the *effective probe area* which accounts for the amount of the physical probe area covered by a protective screen. Figure 6.1 illustrates the difference between the physical probe area and the effective probe area. The physical probe area is used because the reduced detector response due to the screen is accounted for during instrument calibration.

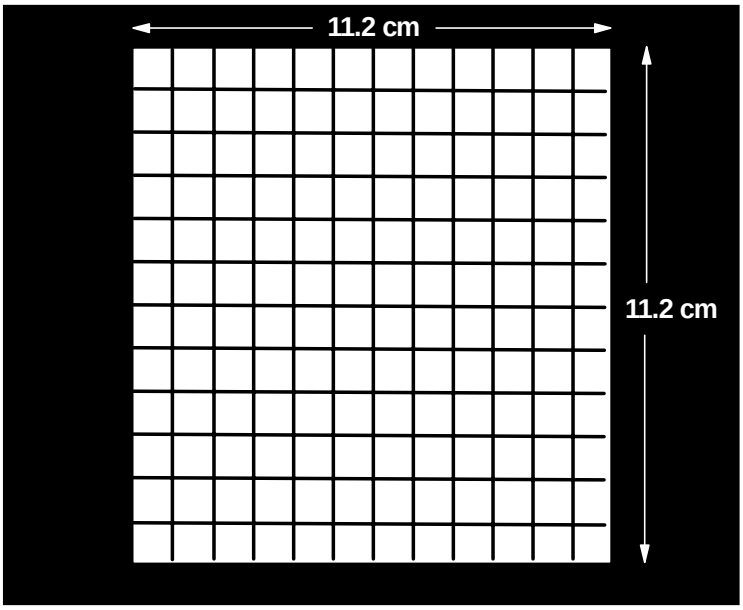


Figure 6.1 The Physical Probe Area of a Detector

The conversion of instrument display in counts to surface activity units is obtained using the following equation.

$$Bq/m^2 = \frac{\frac{C_s}{T_s}}{(\varepsilon_T \times A)} \qquad (6\text{-}1)$$

where

C_s	=	integrated counts recorded by the instrument
T_s	=	time period over which the counts were recorded in seconds
ε_T	=	total efficiency of the instrument in counts per disintegration, effectively the product of the instrument efficiency (ε_i) and the source efficiency (ε_s)
A	=	physical probe area in m^2

To convert instrument counts to conventional surface activity units, Equation 6-1 can be modified as shown in Equation 6-2.

$$\frac{dpm}{100\ cm^2} = \frac{\frac{C_s}{T_s}}{(\varepsilon_T) \times (A/100)} \qquad (6\text{-}2)$$

where T_s is recorded in minutes instead of seconds, and A is recorded in cm^2 instead of m^2.

Some instruments have background counts associated with the operation of the instrument. A correction for instrument background can be included in the data conversion calculation as shown in Equation 6-3. Note that the instrument background is not the same as the measurements in the background reference area used to perform the statistical tests described in Chapter 8.

$$Bq/m^2 = \frac{\frac{C_s}{T_s} - \frac{C_b}{T_b}}{(\varepsilon_T \times A)} \qquad (6\text{-}3)$$

where

C_b	=	background counts recorded by the instrument
T_b	=	time period over which the background counts were recorded in seconds

Equation 6-3 can be modified to provide conventional surface activity units as shown in Equation 6-4.

$$\frac{dpm}{100\ cm^2} = \frac{\frac{C_s}{T_s} - \frac{C_b}{T_b}}{(\varepsilon_T) \times (A/100)} \qquad (6\text{-}4)$$

where T_s and T_b are recorded in minutes instead of seconds and A is recorded in cm^2 instead of m^2.

The presence of multiple radionuclides at a site requires additional considerations for demonstrating compliance with a dose- or risk-based regulation. As demonstrated in Section 4.3.2, a gross activity DCGL should be determined. For example, consider a site contaminated with ^{60}Co and ^{63}Ni, with ^{60}Co representing 60% of the total activity. The relative fractions are 0.6 for ^{60}Co and 0.4 for ^{63}Ni. If the DCGL for ^{60}Co is 8,300 Bq/m^2 (5,000 dpm/100 cm^2) and the DCGL for ^{63}Ni is 12,000 Bq/m^2 (7,200 dpm/100 cm^2), the gross activity DCGL is 9,500 Bq/m^2 (5,700 dpm/100 cm^2) calculated using Equation 4-4.

When using the gross activity DCGL, it is important to use an appropriately weighted total efficiency to convert from instrument counts to surface activity units using Equations 6-1 through 6-4. In this example, the individual efficiencies for ^{60}Co and ^{63}Ni should be independently evaluated. The overall efficiency is then determined by weighting each individual efficiency by the relative fraction of each radionuclide.

6.6.2 Soil Radionuclide Concentration and Exposure Rates

Analytical procedures, such as alpha and gamma spectrometry, are typically used to determine the radionuclide concentration in soil in units of Bq/kg. Net counts are converted to soil DCGL units by dividing by the time, detector or counter efficiency, mass or volume of the sample, and by the fractional recovery or yield of the chemistry procedure (if applicable). Refer to Chapter 7 for examples of analytical procedures.

Instruments, such as a PIC or micro-R meter, used to measure exposure rate typically read directly in mSv/h. A gamma scintillation detector (*e.g.*, NaI(Tl)) provides data in counts per minute and conversion to mSv/h is accomplished by using site-specific calibration factors developed for the specific instrument (Section 6.5.4).

In situ gamma spectrometry data may require special analysis routines before the spectral data can be converted to soil concentration units or exposure rates.

6.7 Detection Sensitivity

The detection sensitivity of a measurement system refers to a radiation level or quantity of radioactive material that can be measured or detected with some known or estimated level of confidence. This quantity is a factor of both the instrumentation and the technique or procedure being used.

The primary parameters that affect the detection capability of a radiation detector are the background count rate, the detection efficiency of the detector and the counting time interval. It is important to use actual background count rate values and detection efficiencies when determining counting and scanning parameters, particularly during final status and verification surveys. When making field measurements, the detection sensitivity will usually be less than what can be achieved in a laboratory due to increased background and, often times, a significantly lower detection efficiency. It is often impossible to guarantee that pure alpha emitters can be detected *in situ* since the weathering of aged surfaces will often completely absorb the alpha emissions. NRC report NUREG-1507 (NRC 1997b) contains data on many of the parameters that affect detection efficiencies *in situ*, such as absorption, surface smoothness, and particulate radiation energy.

6.7.1 Direct Measurement Sensitivity

Prior to performing field measurements, an investigator must evaluate the detection sensitivity of the equipment proposed for use to ensure that levels below the DCGL can be detected (see Section 4.3). After a direct measurement has been made, it is then necessary to determine whether or not the result can be distinguished from the instrument background response of the measurement system. The terms that are used in this manual to define detection sensitivity for fixed point counts and sample analyses are:

Critical level (L_C)
Detection limit (L_D)
Minimum detectable concentration (MDC)

The critical level (L_C) is the level, in counts, at which there is a statistical probability (with a predetermined confidence) of incorrectly identifying a measurement system background value as "greater than background." Any response above this level is considered to be greater than background. The detection limit (L_D) is an *a priori* estimate of the detection capability of a measurement system, and is also reported in units of counts. The minimum detectable concentration (MDC) is the detection limit (counts) multiplied by an appropriate conversion factor to give units consistent with a site guideline, such as Bq/kg.

The following discussion provides an overview of the derivation contained in the well known publication by Currie (Currie 1968) followed by a description of how the resulting formulae should be used. Publications by Currie (Currie 1968, NRC 1984) and Altshuler and Pasternack (Altshuler and Pasternak 1963) provide details of the derivations involved.

The two parameters of interest for a detector system with a background response greater than zero are:

L_C the net response level, in counts, at which the detector output can be considered "above background"

L_D the net response level, in counts, that can be expected to be seen with a detector with a fixed level of certainty

Assuming that a system has a background response and that random uncertainties and systematic uncertainties are accounted for separately, these parameters can be calculated using Poisson statistics. For these calculations, two types of decision errors should be considered. A Type I error (or "false positive") occurs when a detector response is considered to be above background when, in fact, only background radiation is present. A Type II error (or "false negative") occurs when a detector response is considered to be background when in fact radiation is present at levels above background. The probability of a Type I error is referred to as α (alpha) and is associated with L_C; the probability of a Type II error is referred to as ß (beta) and is associated with L_D. Figure 6.2 graphically illustrates the relationship of these terms with respect to each other and to a normal background distribution.

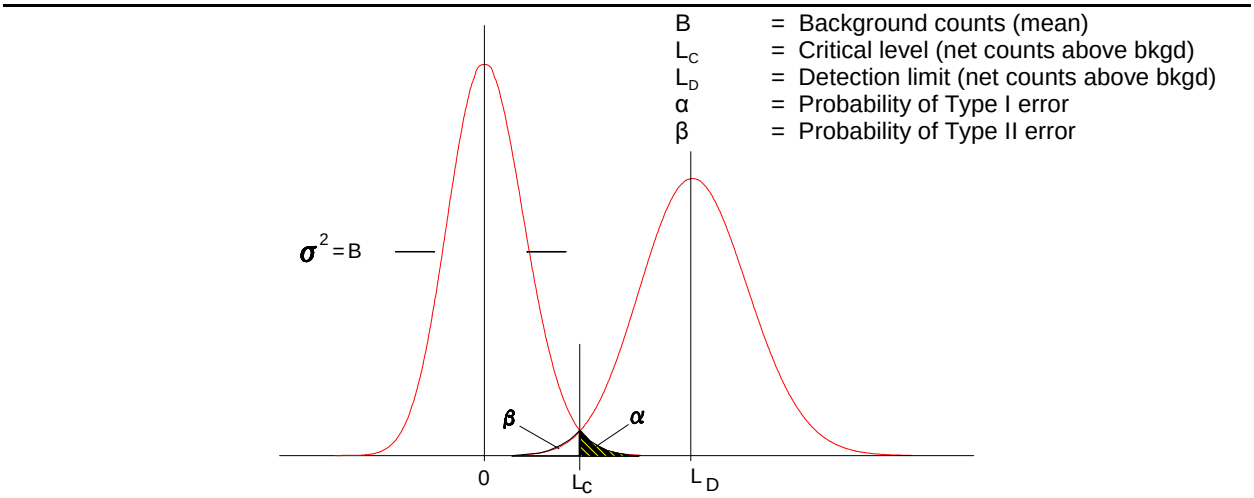


Figure 6.2 Graphically Represented Probabilities for Type I and Type II Errors in Detection Sensitivity for Instrumentation with a Background Response

If α and β are assumed to be equal, the variance (σ^2) of all measurement values is assumed to be equal to the values themselves. If the background of the detection system is not well known, then the critical detection level and the detection limit can be calculated by using the following formulae:

$$L_C = k\sqrt{2B}$$
$$L_D = k^2 + 2k\sqrt{2B} \quad (6\text{-}5)$$

where

L_C	=	critical level (counts)
L_D	=	detection limit (counts)
k	=	Poisson probability sum for α and β (assuming α and β are equal)
B	=	number of background counts that are expected to occur while performing an actual measurement

The curve to the left in the diagram is the background distribution minus the mean of the background distribution. The result is a Poisson distribution with a mean equal to zero and a variance, σ^2, equal to B. Note that the distribution accounts only for the expected statistical variation due to the stochastic nature of radioactive decay. Currie assumed "paired blanks" when deriving the above stated relationships (Currie 1968), which is interpreted to mean that the sample and background count times are the same.

If values of 0.05 for both α and β are selected as acceptable, then k = 1.645 (from Appendix I, Table I.1) and Equation 6-5 can be written as:

$$L_C = 2.33\sqrt{B}$$
$$L_D = 3 + 4.65\sqrt{B} \quad (6\text{-}6)$$

Note: In Currie's derivation, the constant factor of 3 in the L_D formula was stated as being 2.71, but since that time it has been shown (Brodsky 1992) and generally accepted that a constant factor of 3 is more appropriate. If the sample count times and background count times are different, a slightly different formulation is used.

For an integrated measurement over a preset time, the MDC can be obtained from Equation 6-6 by multiplying by the factor, C. This factor is used to convert from counts to concentration as shown in Equation 6-7:

$$MDC = C \times (3 + 4.65\sqrt{B}) \quad (6\text{-}7)$$

The total detection efficiency and other constants or factors represented by the variable C are usually not truly constants as shown in Equation 6-7. It is likely that at least one of these factors

will have a certain amount of variability associated with it which may or may not be significant. These varying factors are gathered together into the single constant, C, by which the net count result will be multiplied when converting the final data. If C varies significantly between measurements, then it might be best to select a value, C′, from the observed distribution of C values that represents a conservative estimate. For example, a value of C might be selected to ensure that at least 95% of the possible values of C are less than the chosen value, C′. The MDC calculated in this way helps assure that the survey results will meet the Data Quality Objectives. This approach for including uncertainties into the MDC calculation is recommended in both NUREG/CR-4007 (NRC 1984) and Appendix A to ANSI N13.30 (ANSI 1996a). Underestimating an MDC can have adverse consequences, especially if activity is later detected at a level above the stated MDC.

Summary of Direct Measurement Sensitivity Terms

- The MDC is the *a priori* net activity level above the critical level that an instrument can be expected to detect 95% of the time. This value should be used when stating the detection capability of an instrument. The MDC is the detection limit, $L_{D,}$ multiplied by an appropriate conversion factor to give units of activity. Again, this value is used before any measurements are made and is used to estimate the level of activity that can be detected using a given protocol.

- The critical level, L_C, is the lower bound on the 95% detection interval defined for L_D and is the level at which there is a 5% chance of calling a background value "greater than background." This value should be used when actually counting samples or making direct radiation measurements. Any response above this level should be considered as above background (*i.e.*, a net positive result). This will ensure 95% detection capability for L_D.

- From a conservative point of view, it is better to overestimate the MDC for a measurement method. Therefore, when calculating MDC and L_C values, a measurement system background value should be selected that represents the high end of what is expected for a particular measurement method. For direct measurements, probes will be moved from point to point and, as a result, it is expected that the background will most likely vary significantly due to variations in background, source materials, and changes in geometry and shielding. Ideally, the MDC values should be calculated for each type of area, but it may be more economical to simply select a background value from the highest distribution expected and use this for all calculations. For the same reasons, realistic values of detection efficiencies and other process parameters should be used when possible and should be reflective of the actual conditions. To a great degree, the selection of these parameters will be based on judgment and will require evaluation of site-specific conditions.

MDC values for other counting conditions may be derived from Equation 6-7 depending on the detector and contaminants of concern. For example, it may be required to determine what level of contamination, distributed over 100 cm^2, can be detected with a 500 cm^2 probe or what contamination level can be detected with any probe when the contamination area is smaller than the probe active area. Table 6.4 lists several common field survey detectors with estimates of MDC values for ^{238}U on a smooth, flat plane. As such, these represent minimum MDC values and may not be applicable at all sites. Appropriate site-specific MDC values should be determined using the DQO Process.

Table 6.4 Examples of Estimated Detection Sensitivities for Alpha and Beta Survey Instrumentation

(Static one minute counts for ^{238}U calculated using Equations 6-6 and 6-7)

Detector	Probe area (cm^2)	Background (cpm)	Efficiency (cpm/dpm)	Approximate Sensitivity		
				L_C (counts)	L_D (counts)	MDC (Bq/m^2) [a]
Alpha proportional	50	1	0.15	2	7	150
Alpha proportional	100	1	0.15	2	7	83
Alpha proportional	600	5	0.15	5	13	25
Alpha scintillation	50	1	0.15	2	7	150
Beta proportional	100	300	0.20	40	83	700
Beta proportional	600	1500	0.20	90	183	250
Beta GM pancake	15	40	0.20	15	32	1800

[a] Assumes that the size of the contamination area is at least as large as the probe area.

Sample Calculation 1:

The following example illustrates the calculation of an MDC in Bq/m^2 for an instrument with a 15 cm^2 probe area when the measurement and background counting times are each one minute:

B = 40 counts
C = (5 dpm/count)(Bq/60 dpm)(1/15 cm^2 probe area)(10,000 cm^2/m^2)
= 55.6 Bq/m^2-counts

The MDC is calculated using Equation 6-7:

$$MDC = 55.6 \times (3 + 4.65\sqrt{40}) = 1{,}800\ Bq/m^2\ (1{,}100\ dpm/100\ cm^2)$$

The critical level, L_c, for this example is calculated from Equation 6-6:

$$L_C = 2.33\sqrt{B} = 15 \text{ counts}$$

Given the above scenario, if a person asked what level of contamination could be detected 95% of the time using this method, the answer would be 1,800 Bq/m^2 (1,100 dpm/100 cm^2). When actually performing measurements using this method, any count yielding greater than 55 total counts, or greater than 15 net counts (55-40=15) during a period of one minute, would be regarded as greater than background.

6.7.2 Scanning Sensitivity

The ability to identify a small area of elevated radioactivity during surface scanning is dependent upon the surveyor's skill in recognizing an increase in the audible or display output of an instrument. For notation purposes, the term "scanning sensitivity" is used throughout this section to describe the ability of a surveyor to detect a pre-determined level of contamination with a detector. The greater the sensitivity, the lower the level of contamination that can be detected.

Many of the radiological instruments and monitoring techniques typically used for occupational health physics activities may not provide the detection sensitivities necessary to demonstrate compliance with the DCGLs. The detection sensitivity for a given application can be improved (*i.e.*, lower the MDC) by: 1) selecting an instrument with a higher detection efficiency or a lower background, 2) decreasing the scanning speed, or 3) increasing the size of the effective probe area without significantly increasing the background response.

Scanning is usually performed during radiological surveys in support of decommissioning to identify the presence of any areas of elevated activity. The probability of detecting residual contamination in the field depends not only on the sensitivity of the survey instrumentation when used in the scanning mode of operation, but is also affected by the surveyor's ability—*i.e.*, human factors. The surveyor must make a decision whether the signals represent only the

background activity, or residual contamination in excess of background. The greater the sensitivity, the lower the level of contamination that may be detected by scanning. Accounting for these human factors represents a significant change from the traditionally accepted methods of estimating scanning sensitivities.

An empirical method for evaluating the detection sensitivity for contamination surveys is by actual experimentation or, since it is certainly feasible, by simulating an experimental setup using computer software. The following steps provide a simple example of how one can perform this empirical evaluation:

1) A desired nuclide contamination level is selected.
2) The response of the detector to be used is determined for the selected nuclide contamination level.
3) A test source is constructed which will give a detector count rate equivalent to what was determined in step 2. The count rate is equivalent to what would be expected from the detector when placed on an actual contamination area equal in value to that selected in step 1.
4) The detector of choice is then moved over the source at different scan rates until an acceptable speed is determined.

The most useful aspect of this approach is that the source can then be used to show surveyors what level of contamination is expected to be targeted with the scan. They, in turn, can gain experience with what the expected response of the detector will be and how fast they can survey and still feel comfortable about detecting the target contamination level. The person responsible for the survey can then use this information when developing a fixed point measurement and sampling plan.

The remainder of this section is dedicated to providing the reader with information pertaining to the underlying processes involved when performing scanning surveys for alpha, beta, and gamma emitting radionuclides. The purpose is to provide relevant information that can be used for estimating realistic scanning sensitivities for survey activities.

6.7.2.1 Scanning for Beta and Gamma Emitters

The minimum detectable concentration of a scan survey (scan MDC) depends on the intrinsic characteristics of the detector (efficiency, physical probe area, *etc.*), the nature (type and energy of emissions) and relative distribution of the potential contamination (point versus distributed source and depth of contamination), scan rate, and other characteristics of the surveyor. Some factors that may affect the surveyor's performance include the costs associated with various outcomes—*e.g.*, fatigue, noise, level of training, experience—and the survey's *a priori* expectation of the likelihood of contamination present. For example, if the surveyor believes that

the potential for contamination is very low, as in a Class 3 area, a relatively large signal may be required for the surveyor to conclude that contamination is present. NRC draft report NUREG/CR-6364 (NRC 1997d) provides a complete discussion of the human factors as they relate to the performance of scan surveys.

Signal Detection Theory. Personnel conducting radiological surveys for residual contamination at decommissioning sites must interpret the audible output of a portable survey instrument to determine when the signal ("clicks") exceeds the background level by a margin sufficient to conclude that contamination is present. It is difficult to detect low levels of contamination because both the signal and the background vary widely. Signal detection theory provides a framework for the task of deciding whether the audible output of the survey meter during scanning is due to background or signal plus background levels. An index of sensitivity (d') that represents the distance between the means of the background and background plus signal (refer to Figure 6.2 for determining L_D), in units of their common standard deviation, can be calculated for various decision errors (correct detection and false positive rate). As an example, for a correct detection rate of 95% (complement of a false negative rate of 5%) and a false positive rate of 5%, d' is 3.29 (similar to the static MDC for the same decision error rates). The index of sensitivity is independent of human factors, and therefore, the ability of an ideal observer (theoretical construct), may be used to determine the minimum d' that can be achieved for particular decision errors. The ideal observer makes optimal use of the available information to maximize the percent correct responses, providing an effective upper bound against which to compare actual surveyors. Table 6.5 lists selected values of d'.

Two Stages of Scanning. The framework for determining the scan MDC is based on the premise that there are two stages of scanning. That is, surveyors do not make decisions on the basis of a single indication, rather, upon noting an increased number of counts, they pause briefly and then decide whether to move on or take further measurements. Thus, scanning consists of two components: continuous monitoring and stationary sampling. In the first component, characterized by continuous movement of the probe, the surveyor has only a brief "look" at potential sources, determined by the scan speed. The surveyor's willingness to decide that a signal is present at this stage is likely to be liberal, in that the surveyor should respond positively on scant evidence, since the only "cost" of a false positive is a little time. The second component occurs only after a positive response was made at the first stage. This response is marked by the surveyor interrupting his scanning and holding the probe stationary for a period of time, while comparing the instrument output signal during that time to the background counting rate. Owing to the longer observation interval, sensitivity is relatively high. For this decision, the criterion should be more strict, since the cost of a "yes" decision is to spend considerably more time taking a static measurement or a sample.

Table 6.5 Values of *d′* for Selected True Positive and False Positive Proportions

False Positive Proportion	True Positive Proportion							
	0.60	**0.65**	**0.70**	**0.75**	**0.80**	**0.85**	**0.90**	**0.95**
0.05	1.90	2.02	2.16	2.32	2.48	2.68	2.92	3.28
0.10	1.54	1.66	1.80	1.96	2.12	2.32	2.56	2.92
0.15	1.30	1.42	1.56	1.72	1.88	2.08	2.32	2.68
0.20	1.10	1.22	1.36	1.52	1.68	1.88	2.12	2.48
0.25	0.93	1.06	1.20	1.35	1.52	1.72	1.96	2.32
0.30	0.78	0.91	1.05	1.20	1.36	1.56	1.80	2.16
0.35	0.64	0.77	0.91	1.06	1.22	1.42	1.66	2.02
0.40	0.51	0.64	0.78	0.93	1.10	1.30	1.54	1.90
0.45	0.38	0.52	0.66	0.80	0.97	1.17	1.41	1.77
0.50	0.26	0.38	0.52	0.68	0.84	1.04	1.28	1.64
0.55	0.12	0.26	0.40	0.54	0.71	0.91	1.15	1.51
0.60	0.00	0.13	0.27	0.42	0.58	0.82	1.02	1.38

Since scanning can be divided into two stages, it is necessary to consider the survey's scan sensitivity for each of the stages. Typically, the minimum detectable count rate (MDCR) associated with the first scanning stage will be greater due to the brief observation intervals of continuous monitoring—provided that the length of the pause during the second stage is significantly longer. Typically, observation intervals during the first stage are on the order of 1 or 2 seconds, while the second stage pause may be several seconds long. The greater value of MDCR from each of the scan stages is used to determine the scan sensitivity for the surveyor.

Determination of MDCR and Use of Surveyor Efficiency. The minimum detectable number of net source counts in the interval is given by s_i. Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the detectability value associated with the desired performance (as reflected in *d′*) as shown in Equation 6-8:

$$s_i = d' \sqrt{b_i} \qquad (6\text{-}8)$$

where the value of *d′* is selected from Table 6.5 based on the required true positive and false positive rates and b_i is the number of background counts in the interval.

For example, suppose that one wished to estimate the minimum count rate that is detectable by scanning in an area with a background of 1,500 cpm. Note that the minimum detectable count rate must be considered for both scan stages—and the more conservative value is selected as the minimum count rate that is detectable. It will be assumed that a typical source remains under the probe for 1 second during the first stage, therefore, the average number of background counts in the observation interval is 25 ($b_i = 1500 \times (1/60)$). Furthermore, as explained earlier, it can be assumed that at the first scanning stage a high rate (*e.g.*, 95%) of correct detections is required, and that a correspondingly high rate of false positives (*e.g.*, 60%) will be tolerated. From Table 6.5, the value of *d′*, representing this performance goal, is 1.38. The net source counts needed to support the specified level of performance (assuming an ideal observer) will be estimated by multiplying 5 (the square root of 25) by 1.38. Thus, the net source counts per interval, s_i, needed to yield better than 95% detections with about 60% false positives is 6.9. The minimum detectable source count rate, in cpm, may be calculated by:

$$MDCR = s_i \times (60/i) \tag{6-9}$$

For this example, MDCR is equivalent to 414 cpm (1,914 cpm gross). Table 6.6 provides the scan sensitivity for the ideal observer (MDCR) at the first scanning stage for various background levels, based on an index of sensitivity (*d′*) of 1.38 and a 2-second observation interval.

Table 6.6 Scanning Sensitivity (MDCR) of the Ideal Observer for Various Background Levels[a]

Background (cpm)	MDCR (net cpm)	Scan Sensitivity (gross cpm)
45	50	95
60	60	120
260	120	380
300	130	430
350	140	490
400	150	550
1,000	240	1,240
3,000	410	3,410
4,000	480	4,480

*The sensitivity of the ideal observer during the first scanning stage is based on an index of sensitivity (d′) of 1.38 and a 2-second observation interval.

The minimum number of source counts required to support a given level of performance for the final detection decision (second scan stage) can be estimated using the same method. As explained earlier, the performance goal at this stage will be more demanding. The required rate of true positives remains high (*e.g.*, 95%), but fewer false positives (*e.g.*, 20%) can be tolerated, such that d' (from Table 6.5) is now 2.48. One will assume that the surveyor typically stops the probe over a suspect location for about 4 seconds before making a decision, so that the average number of background counts in an observation interval is 100 ($b_i = 1{,}500 \times (4/60)$). Therefore, the minimum detectable number of net source counts, s_i, needed will be estimated by multiplying 10 (the square root of 100) by 2.48 (the d' value); so s_i equals 24.8. The MDCR is calculated by $2.48 \times (60/4)$ and equals 372 cpm. The value associated with the first scanning stage (this example, 414 cpm) will typically be greater, owing to the relatively brief intervals assumed.

Laboratory studies using simulated sources and backgrounds were performed to assess the abilities of surveyors under controlled conditions. The methodology and analysis of results for these studies are described in draft NUREG/CR-6364 (NRC 1997d) and NUREG-1507 (NRC 1997b). The surveyor's actual performance as compared with that which is ideally possible (using the ideal observer construct) provided an indication of the efficiency of the surveyors. Based on the results of the confidence rating experiment, this surveyor efficiency (p) was estimated to be between 0.5 and 0.75.

MARSSIM recommends assuming an efficiency value at the lower end of the observed range (*i.e.*, 0.5) when making MDC estimates. Thus, the required number of net source counts for the surveyor, $MDCR_{surveyor}$, is determined by dividing the MDCR by the square root of p. Continuing with this example, the surveyor MDCR is calculated by 414 cpm/0.707, or 585 cpm (2,085 cpm gross).

Scan MDCs for Structure Surfaces and Land Areas. The survey design for determining the number of data points for areas of elevated activity (see Section 5.5.2.4) depends on the scan MDC for the selected instrumentation. In general, alpha or beta scans are performed on structure surfaces to satisfy the elevated activity measurements survey design, while gamma scans are performed for land areas. Because of low background levels for alpha emitters, the approach described here is not generally applied to determining scan MDCs for alpha contaminants—rather, the reader is referred to Section 6.7.2.2 for an appropriate method for determining alpha scan MDCs for building surfaces. In any case, the data requirements for assessing potential elevated areas of direct radiation depend on the scan MDC of the survey instrument (*e.g.*, floor monitor, GM detector, NaI scintillation detector).

Scan MDCs for Building/Structure Surfaces. The scan MDC is determined from the minimum detectable count rate (MDCR) by applying conversion factors that account for detector and surface characteristics and surveyor efficiency. As discussed above, the MDCR accounts for the background level, performance criteria (d'), and observation interval. The observation interval

during scanning is the actual time that the detector can respond to the contamination source—this interval depends on the scan speed, detector size in the direction of the scan, and area of elevated activity. Because the actual dimensions of potential areas of elevated activity in the field cannot be known *a priori*, MARSSIM recommends postulating a certain area (*e.g.*, perhaps 50 to 200 cm^2), and then selecting a scan rate that provides a reasonable observation interval.

Finally, the scan MDC for structure surfaces may be calculated:

$$Scan\ MDC = \frac{MDCR}{\sqrt{p}\ \varepsilon_i\ \varepsilon_s\ \frac{probe\ area}{100\ cm^2}} \qquad (6\text{-}10)$$

where

MDCR	=	minimum detectable count rate
ε_i	=	instrument efficiency
ε_s	=	surface efficiency
p	=	surveyor efficiency

As an example, the scan MDC (in dpm/100 cm^2) for ^{99}Tc on a concrete surface may be determined for a background level of 300 cpm and a 2-second observation interval using a hand-held gas proportional detector (126 cm^2 probe area). For a specified level of performance at the first scanning stage of 95% true positive rate and 60% false positive rate (and assuming the second stage pause is sufficiently long to ensure that the first stage is more limiting), d' equals 1.38 (Table 6.5) and the MDCR is 130 cpm (Table 6.6). Using a surveyor efficiency of 0.5, and assuming instrument and surface efficiencies of 0.36 and 0.54, respectively, the scan MDC is calculated using Equation 6-10:

$$Scan\ MDC = \frac{130}{\sqrt{0.5}\ (0.36)\ (0.54)\ (1.26)} = 750\ dpm/100\ cm^2$$

Additional examples for calculating the scan MDC may be found in NUREG-1507 (NRC 1997b).

Scan MDCs for Land Areas. In addition to the MDCR and detector characteristics, the scan MDC (in pCi/g) for land areas is based on the area of elevated activity, depth of contamination, and the radionuclide (*i.e.*, energy and yield of gamma emissions). If one assumes constant parameters for each of the above variables, with the exception of the specific radionuclide in question, the scan MDC may be reduced to a function of the radionuclide alone. NaI scintillation detectors are generally used for scanning land areas.

An overview of the approach used to determine scan MDCs for land areas follows. The NaI(Tl) scintillation detector background level and scan rate (observation interval) are postulated, and the MDCR for the ideal observer, for a given level of performance, is obtained. After a surveyor efficiency is selected, the relationship between the surveyor MDCR ($MDCR_{surveyor}$) and the radionuclide concentration in soil (in Bq/kg or pCi/g)is determined. This correlation requires two steps—first, the relationship between the detector's net count rate to net exposure rate (cpm per µR/h) is established, and second, the relationship between the radionuclide contamination and exposure rate is determined.

For a particular gamma energy, the relationship of NaI(Tl) scintillation detector count rate and exposure rate may be determined analytically (in cpm per µR/h). The approach used to determine the gamma fluence rate necessary to yield a fixed exposure rate (1 µR/h)—as a function of gamma energy—is provided in NUREG-1507 (NRC 1997b). The NaI(Tl) scintillation detector response (cpm) is related to the fluence rate at specific energies, considering the detector's efficiency (probability of interaction) at each energy. From this, the NaI(Tl) scintillation detector versus exposure rates for varying gamma energies are determined. Once the relationship between the NaI(Tl) scintillation detector response (cpm) and the exposure rate is established, the $MDCR_{surveyor}$ (in cpm) of the NaI(Tl) scintillation detector can be related to the minimum detectable net exposure rate. The minimum detectable exposure rate is used to determine the minimum detectable radionuclide concentration (*i.e.*, the scan MDC) by modeling a specified small area of elevated activity.

Modeling (using Microshield™) of the small area of elevated activity (soil concentration) is used to determine the net exposure rate produced by a radionuclide concentration at a distance 10 cm above the source. This position is selected because it relates to the average height of the NaI(Tl) scintillation detector above the ground during scanning.

The factors considered in the modeling include:

- radionuclide of interest (considering all gamma emitters for decay chains)
- expected concentration of the radionuclide of interest
- areal dimensions of the area of elevated activity
- depth of the area of elevated activity
- location of dose point (NaI(Tl) scintillation detector height above the surface)
- density of soil

Modeling analyses are conducted by selecting a radionuclide (or radioactive material decay series) and then varying the concentration of the contamination. The other factors are held constant—the areal dimension of a cylindrical area of elevated activity is 0.25 m^2 (radius of 28 cm), the depth of the area of elevated activity is 15 cm, the dose point is 10 cm above the surface, and the density of soil is 1.6 g/cm^3. The objective is to determine the radionuclide concentration that is correlated to the minimum detectable net exposure rate.

As an example, the scan MDC for ^{137}Cs using a 1.5 in. by 1.25 in. NaI(Tl) scintillation detector is considered in detail. Assume that the background level is 4,000 cpm and that the desired level of performance, 95% correct detections and 60% false positive rate, results in a d' of 1.38. The scan rate of 0.5m/s provides an observation interval of 1-second (based on a diameter of about 56 cm for the area of elevated activity). The $MDCR_{surveyor}$ may be calculated assuming a surveyor efficiency (p) of 0.5 as follows:

1) $b_i = (4{,}000 \text{ cpm}) \times (1 \text{ sec}) \times (1 \text{ min}/60 \text{ sec}) = 66.7 \text{ counts}$

2) $MDCR = (1.38) \times (\sqrt{66.7}) \times (60 \text{ sec}/1 \text{ min}) = 680 \text{ cpm}$

3) $MDCR_{surveyor} = 680/\sqrt{0.5} = 960 \text{ cpm}$

The corresponding minimum detectable exposure rate is determined for this detector and radionuclide. The manufacturer of this particular 1.5 in. by 1.25 in. NaI(Tl) scintillation detector quotes a count rate to exposure rate ratio for ^{137}Cs of 350 cpm per µR/h. The minimum detectable exposure rate is calculated by dividing the count rate (960 cpm) by the count rate to exposure rate ratio for the radionuclide of interest (350 cpm per µR/h). The minimum detectable exposure rate for this example is 2.73 µR/h.

Both ^{137}Cs and its short-lived progeny, ^{137m}Ba, were chosen from the Microshield™ library. The source activity and other modeling parameters were entered into the modeling code. The source activity was selected based on an arbitrary concentration of 5 pCi/g. The modeling code performed the appropriate calculations and determined an exposure rate of 1.307 µR/h (which accounts for buildup). Finally, the radionuclide concentrations of ^{137}Cs and ^{137m}Ba (scan MDC) necessary to yield the minimum detectable exposure rate (2.73 μR/h) may be calculated using the following formula.

$$scan\ MDC = \frac{(5\ pCi/g)(2.73\ \mu R/h)}{1.307\ \mu R/h} = 10.4\ pCi/g \qquad (6\text{-}11)$$

It must be emphasized that while a single scan MDC value can be calculated for a given radionuclide—other scan MDC values may be equally justifiable depending on the values chosen for the various factors, including the MDCR (background level, acceptable performance criteria, observation interval), surveyor efficiency, detector parameters and the modeling conditions of the contamination. It should also be noted that determination of the scan MDC for radioactive materials—like uranium and thorium—must consider the gamma radiation emitted from the entire decay series. NUREG-1507 (NRC 1997b) provides a detailed example of how the scan MDC can be determined for enriched uranium.

Table 6.7 provides scan MDCs for common radionuclides and radioactive materials in soil. It is important to note that the variables used in the above examples to determine the scan MDCs for the 1.25 in. by 1.5 in. NaI(Tl) scintillation detector—*i.e.*, the $MDCR_{surveyor}$ detector parameters (*e.g.*, cpm per µR/h), and the characteristics of the area of elevated activity—have all been held constant to facilitate the calculation of scan MDCs provided in Table 6.7. The benefit of this approach is that generally applicable scan MDCs are provided for different radioactive contaminants. Additionally, the relative detectability of different contaminants is evident because the only variable in Table 6.7 is the nature of the contaminant.

As noted above, the scan MDCs calculated using the approach in this section are dependent on several factors. One way to validate the appropriateness of the scan MDC is by tracking the residual radioactivity (both surface activity and soil concentrations) levels identified during investigations performed as a result of scanning surveys. The measurements performed during these investigations may provide an *a posteriori* estimate of the scan MDC that can be used to validate the *a priori* scan MDC used to design the survey.

6.7.2.2 Scanning for Alpha Emitters

Scanning for alpha emitters differs significantly from scanning for beta and gamma emitters in that the expected background response of most alpha detectors is very close to zero. The following discussion covers scanning for alpha emitters and assumes that the surface being surveyed is similar in nature to the material on which the detector was calibrated. In this respect, the approach is purely theoretical. Surveying surfaces that are dirty, non-planar, or weathered can significantly affect the detection efficiency and therefore bias the expected MDC for the scan. The use of reasonable detection efficiency values instead of optimistic values is highly recommended. Appendix J contains a complete derivation of the alpha scanning equations used in this section.

Since the time a contaminated area is under the probe varies and the background count rate of some alpha instruments is less than 1 cpm, it is not practical to determine a fixed MDC for scanning. Instead, it is more useful to determine the probability of detecting an area of contamination at a predetermined DCGL for given scan rates.

For alpha survey instrumentation with backgrounds ranging from <1 to 3 cpm, a single count provides a surveyor sufficient cause to stop and investigate further. Assuming this to be true, the probability of detecting given levels of alpha surface contamination can be calculated by use of Poisson summation statistics.

Table 6.7 NaI(Tl) Scintillation Detector Scan MDCs for Common Radiological Contaminants[a]

Radionuclide/Radioactive Material	1.25 in. by 1.5 in. NaI Detector		2 in. by 2 in. NaI Detector	
	Scan MDC (Bq/kg)	Weighted cpm/μR/h	Scan MDC (Bq/kg)	Weighted cpm/μR/h
Am-241	1,650	5,830	1,170	13,000
Co-60	215	160	126	430
Cs-137	385	350	237	900
Th-230	111,000	4,300	78,400	9,580
Ra-226 (in equilibrium with progeny)	167	300	104	760
Th-232 decay series (Sum of all radionuclides in he thorium decay series)	1,050	340	677	830
Th-232 (In equilibrium with progeny in decay series)	104	340	66.6	830
Depleted Uranium[b] (0.34% U-235)	2,980	1,680	2,070	3,790
Natural Uranium[b]	4,260	1,770	2,960	3,990
3% Enriched Uranium[b]	5,070	2,010	3,540	4,520
20% Enriched Uranium[b]	5,620	2,210	3,960	4,940
50% Enriched Uranium[b]	6,220	2,240	4,370	5,010
75% Enriched Uranium[b]	6,960	2,250	4,880	5,030

[a] Refer to text for complete explanation of factors used to calculate scan MDCs. For example, the background level for the 1.25 in. by 1.5 in. NaI detector was assumed to be 4,000 cpm, and 10,000 cpm for the 2 in. by 2 in. NaI detector. The observation interval was 1-sec and the level of performance was selected to yield d' of 1.38.

[b] Scan MDC for uranium includes sum of ^{238}U, ^{235}U, and ^{234}U.

Given a known scan rate and a surface contamination DCGL, the probability of detecting a single count while passing over the contaminated area is

$$P(n \geq 1) = 1 - e^{\frac{-GEd}{60v}} \quad (6\text{-}12)$$

where

$P(n \geq 1)$	=	probability of observing a single count
G	=	contamination activity (dpm)
E	=	detector efficiency (4π)
d	=	width of detector in direction of scan (cm)
v	=	scan speed (cm/s)

Note: Refer to Appendix J for a complete derivation of these formulas.

Once a count is recorded and the guideline level of contamination is present the surveyor should stop and wait until the probability of getting another count is at least 90%. This time interval can be calculated by

$$t = \frac{13{,}800}{CAE} \quad (6\text{-}13)$$

where

t	=	time period for static count (s)
C	=	contamination guideline (dpm/100 cm^2)
A	=	physical probe area (cm^2)
E	=	detector efficiency (4π)

Many portable proportional counters have background count rates on the order of 5 to 10 cpm, and a single count should not cause a surveyor to investigate further. A counting period long enough to establish that a single count indicates an elevated contamination level would be prohibitively inefficient. For these types of instruments, the surveyor usually will need to get at least 2 counts while passing over the source area before stopping for further investigation.

Assuming this to be a valid assumption, the probability of getting two or more counts can be calculated by:

$$P(n \geq 2) = 1 - P(n=0) - P(n=1)$$

$$= 1 - \left(1 + \frac{(GE + B)t}{60}\right)\left(e^{-\frac{(GE + B)t}{60}}\right) \quad (6\text{-}14)$$

where

$P(n \geq 2)$	=	probability of getting 2 or more counts during the time interval t
$P(n=0)$	=	probability of not getting any counts during the time interval t
$P(n=1)$	=	probability of getting 1 count during the time interval t
B	=	background count rate (cpm)

All other variables are the same as for Equation 6-12.

Appendix J provides a complete derivation of Equations 6-12 through 6-14 and a detailed discussion of the probability of detecting alpha surface contamination for several different variables. Several probability charts are included at the end of Appendix J for common detector sizes. Table 6.8 provides estimates of the probability of detecting 300 dpm/100 cm^2 for some commonly used alpha detectors.

Table 6.8 Probability of Detecting 300 dpm/100 cm^2 of Alpha Activity While Scanning with Alpha Detectors Using an Audible Output (calculated using Equation 6-12)

Detector Type	Detection Efficiency cpm/dpm	Probe Dimension in Direction of Scan (cm)	Scan Rate (cm/s)	Probability of detecting 300 dpm/100 cm^2
Proportional	0.20	5	3	80%
Proportional	0.15	15	5	90%
Scintillation	0.15	5	3	70%
Scintillation	0.15	10	3	90%

6.8 Measurement Uncertainty (Error)

The quality of measurement data will be directly impacted by the magnitude of the measurement uncertainty associated with it. Some uncertainties, such as statistical counting uncertainties, can be easily calculated from the count results using mathematical procedures. Evaluation of other

sources of uncertainty require more effort and in some cases is not possible. For example, if an alpha measurement is made on a porous concrete surface, the observed instrument response when converted to units of activity will probably not exactly equal the true activity under the probe. Variations in the absorption properties of the surface for particulate radiation will vary from point to point and therefore will create some level of variation in the expected detection efficiency. This variability in the expected detector efficiency results in uncertainty in the final reported result. In addition, QC measurement results provide an estimate of random and systematic uncertainties associated with the measurement process.

The measurement uncertainty for every analytical result or series of results, such as for a measurement system, should be reported. This uncertainty, while not directly used for demonstrating compliance with the release criterion, is used for survey planning and data assessment throughout the Radiation Survey and Site Investigation (RSSI) process. In addition, the uncertainty is used for evaluating the performance of measurement systems using QC measurement results. Uncertainty can also be used for comparing individual measurements to the DCGL. This is especially important in the early stages of decommissioning (*i.e.*, scoping, characterization, remedial action support) when decisions are made based on a limited number of measurements.

For most sites, evaluations of uncertainty associated with field measurements is important only for data being used as part of the final status survey documentation. The final status survey data, which is used to document the final radiological status of a site, should state the uncertainties associated with the measurements. Conversely, detailing the uncertainties associated with measurements made during scoping or characterization surveys may or may not be of value depending on what the data will be used for—*i.e.* the data quality objectives (DQOs). From a practical standpoint, if the observed data are obviously greater than the DCGL and will be eventually cleaned up, then the uncertainty may be relatively unimportant. Conversely, data collected during early phases of a site investigation that may eventually be used to show that the area is below the DCGL—and therefore does not require any clean-up action—will need the same uncertainty evaluation as the final status survey data. In summary, the level of effort needs to match the intended use of the data.

6.8.1 Systematic and Random Uncertainties

Measurement uncertainties are often broken into two sub-classes of uncertainty termed systematic (*e.g.*, methodical) uncertainty and random (*e.g.*, stochastic) uncertainty. Systematic uncertainties derive from a lack of knowledge about the true distribution of values associated with a numerical parameter and result in data that is consistently higher (or lower) than the true value. An example of a systematic uncertainty would be the use of a fixed counting efficiency value even though it is known that the efficiency varies from measurement to measurement but without knowledge of the frequency. If the fixed counting efficiency value is higher than the true

but unknown efficiency—as would be the case for an unrealistically optimistic value—then every measurement result calculated using that efficiency would be biased low. Random uncertainties refer to fluctuations associated with a known distribution of values. An example of a random uncertainty would be a well documented chemical separation efficiency that is known to fluctuate with a regular pattern about a mean. A constant recovery value is used during calculations, but the true value is known to fluctuate from sample to sample with a fixed and known degree of variation.

To minimize the need for estimating potential sources of uncertainty, the sources of uncertainty themselves should be reduced to a minimal level by using practices such as:

- The detector used should minimize the potential uncertainty. For example, when making field surface activity measurements for ^{238}U on concrete, a beta detector such as a thin-window Geiger-Mueller "pancake" may provide better quality data than an alpha detector depending on the circumstances. Less random uncertainty would be expected between measurements with a beta detector such as a pancake since beta emissions from the uranium will be affected much less by thin absorbent layers than will the alpha emissions.

- Calibration factors should accurately reflect the efficiency of a detector being used on the surface material being measured for the contaminant radionuclide or mixture of radionuclides (see Section 6.5.4). For most field measurements, variations in the counting efficiency on different types of materials will introduce the largest amount of uncertainty in the final result.

- Uncertainties should be reduced or eliminated by use of standardized measurement protocols (*e.g.*, SOPs) when possible. Special effort should be made to reduce or eliminate systematic uncertainties, or uncertainties that are the same for every measurement simply due to an error in the process. If the systematic uncertainties are reduced to a negligible level, then the random uncertainties, or those uncertainties that occur on a somewhat statistical basis, can be dealt with more easily.

- Instrument operators should be trained and experienced with the instruments used to perform the measurements.

- QA/QC should be conducted as described in Chapter 9.

Uncertainties that cannot be eliminated need to be evaluated such that the effect can be understood and properly propagated into the final data and uncertainty estimates. As previously stated, non-statistical uncertainties should be minimized as much as possible through the use of good work practices.

Overall random uncertainty can be evaluated using the methods described in the following sections. Section 6.8.2 describes a method for calculating random counting uncertainty. Section 6.8.3 discusses how to combine this counting uncertainty with other uncertainties from the measurement process using uncertainty propagation.

Systematic uncertainty is derived from calibration errors, incorrect yields and efficiencies, non-representative survey designs, and "blunders." It is difficult—and sometimes impossible—to evaluate the systematic uncertainty for a measurement process, but bounds should always be estimated and made small compared to the random uncertainty, if possible. If no other information on systematic uncertainty is available, Currie (NRC 1984) recommends using 16% as an estimate for systematic uncertainties (1% for blanks, 5% for baseline, and 10% for calibration factors).

6.8.2 Statistical Counting Uncertainty

When performing an analysis with a radiation detector, the result will have an uncertainty associated with it due to the statistical nature of radioactive decay. To calculate the total uncertainty associated with the counting process, both the background measurement uncertainty and the sample measurement uncertainty must be accounted for. The standard deviation of the net count rate, or the statistical counting uncertainty, can be calculated by

$$\sigma_n = \sqrt{\frac{C_{s+b}}{T_{s+b}^2} + \frac{C_b}{T_b^2}} \qquad (6\text{-}15)$$

where

σ_n = standard deviation of the net count rate result
C_{s+b} = number of gross counts (sample)
T_{s+b} = gross count time
C_b = number of background counts
T_b = background count time

6.8.3 Uncertainty Propagation

Most measurement data will be converted to different units or otherwise included in a calculation to determine a final result. The standard deviation associated with the final result, or the total uncertainty, can then be calculated. Assuming that the individual uncertainties are relatively small, symmetric about zero, and independent of one another, then the total uncertainty for the final calculated result can be determined by solving the following partial differential equation:

$$\sigma_u = \sqrt{\left(\frac{\partial u}{\partial x}\right)^2 \sigma_x^2 + \left(\frac{\partial u}{\partial y}\right)^2 \sigma_y^2 + \left(\frac{\partial u}{\partial z}\right)^2 \sigma_z^2 + \ldots} \qquad (6\text{-}16)$$

where

u	=	function, or formula, that defines the calculation of a final result as a function of the collected data. All variables in this equation, *i.e.*, x, y, z..., are assumed to have a measurement uncertainty associated with them and do not include numerical constants
σ_u	=	standard deviation, or uncertainty, associated with the final result
σ_x, σ_y,...	=	standard deviation, or uncertainty, associated with the parameters x, y, z, ...

Equation 6-16, generally known as the error propagation formula, can be solved to determine the standard deviation of a final result from calculations involving measurement data and their associated uncertainties. The solutions for common calculations along with their uncertainty propagation formulas are included below.

Data Calculation	Uncertainty Propagation
u = x + y , or u= x - y :	$\sigma_u = \sqrt{\sigma_x^2 + \sigma_y^2}$
u = x ÷ y , or u = x × y :	$\sigma_u = u\sqrt{\left(\frac{\sigma_x}{x}\right)^2 + \left(\frac{\sigma_y}{y}\right)^2}$
u = c × x, where c is a positive constant:	$\sigma_u = c\sigma_x$
u = x ÷ c, where c is a positive constant:	$\sigma_u = \frac{\sigma_x}{c}$

Note: In the above examples, x and y are measurement values with associated standard deviations, or uncertainties, equal to σ_x and σ_y respectively. The symbol "c" is used to represent a numerical constant which has no associated uncertainty. The symbol σ_u is used to denote the standard deviation, or uncertainty, of the final calculated value u.

6.8.4 Reporting Confidence Intervals

Throughout Section 6.8, the term "measurement uncertainty" is used interchangeably with the term "standard deviation." In this respect, the uncertainty is qualified as numerically identical to

the standard deviation associated with a normally distributed range of values. When reporting a confidence interval for a value, one provides the range of values that represent a pre-determined level of confidence (*i.e.*, 95%). To make this calculation, the final standard deviation, or total uncertainty σ_u as shown in Equation 6-16, is multiplied by a constant factor k representing the area under a normal curve as a function of the standard deviation. The values of k representing various intervals about a mean of normal distributions as a function of the standard deviation is given in Table 6.9. The following example illustrates the use of this factor in context with the propagation and reporting of uncertainty values.

Table 6.9 Areas Under Various Intervals About the Mean of a Normal Distribution

Interval ($\bar{\mu} \pm k\sigma$)	Area
$\bar{\mu} \pm 0.674\sigma$	0.500
$\bar{\mu} \pm 1.00\sigma$	0.683
$\bar{\mu} \pm 1.65\sigma$	0.900
$\bar{\mu} \pm 1.96\sigma$	0.950
$\bar{\mu} \pm 2.00\sigma$	0.954
$\bar{\mu} \pm 2.58\sigma$	0.990
$\bar{\mu} \pm 3.00\sigma$	0.997

Example:

Uncertainty Propagation and Confidence Interval: A measurement process with a zero background yields a count result of 28 ± 5 counts in 5 minutes, where the ± 5 counts represents one standard deviation about a mean value of 28 counts. The detection efficiency is 0.1 counts per disintegration ± 0.01 counts per disintegration, again representing one standard deviation about the mean.

Calculate the activity of the sample, in dpm, total measurement uncertainty, and the 95% confidence interval for the result.

1) The total number of disintegrations is:

$$\frac{28\ counts}{0.1\,c/d} = 280$$

2) Using the equation for error propagation for division, total uncertainty is:

$$280\sqrt{\left(\frac{5}{28}\right)^2 + \left(\frac{0.01}{0.1}\right)^2} = 57 \text{ disintegrations}$$

3) The activity will then be 280 ÷ 5 minutes = 56 dpm and the total uncertainty will be 57 ÷ 5 minutes = 11 dpm. (Since the count time is considered to have trivial variance, this is assumed to be a constant.)

Referring to Table 6.9, a k value of ±1.96 represents a confidence interval equal to 95% about the mean of a normal distribution. Therefore, the 95% confidence interval would be 1.96 × 11 dpm = 22 dpm. The final result would be 56 ± 22 dpm.

6.9 Radon Measurements

There are three radon isotopes in nature: ^{222}Rn (radon) in the ^{238}U decay chain, ^{220}Rn (thoron) in the ^{232}Th chain, and ^{219}Rn (actinon) in the ^{235}U chain. ^{219}Rn is the least abundant of these three isotopes, and because of its short half-life of 4 seconds it has the least probability of emanating into the atmosphere before decaying. ^{220}Rn with a 55 second half-life is somewhat more mobile. ^{222}Rn with a 3.8 d half-life is capable of migrating through several decimeters of soil or building material and reaching the atmosphere. Therefore, in most situations, ^{222}Rn should be the predominant airborne radon isotope.

Many techniques have been developed over the years for measuring radon (Jenkins 1986) and radon progeny in air. In addition, considerable attention is given by EPA to measurement of radon and radon progeny in homes (EPA 1992d). Radon and radon progeny emit alpha and beta particles and gamma rays. Therefore, numerous techniques can and have been developed for measuring these radionuclides based on detecting alpha particles, beta particles, or gamma rays, independently or in some combination. It is even difficult to categorize the various techniques that are presently in use. This section contains an overview of information dealing with the measurement of radon and radon progeny. The information is focused on the measurement of ^{222}Rn, however the information may be adapted for the measurement of ^{219}Rn and ^{220}Rn.

Radon concentrations within a fixed structure can vary significantly from one section of the building to another and can fluctuate over time. If a home has a basement, for instance, it is usually expected that a higher radon concentration will be found there. Likewise, a relatively small increase in the relative pressure between the soil and the inside of a structure can cause a significant increase in the radon emanation rate from the soil into the structure. Many factors play a role in these variations, but from a practical standpoint it is only necessary to recognize

that fluctuations are expected and that they should be accounted for. Long term measurement periods are required to determine a true mean concentration inside a structure and to account for the fluctuations.

Two analytical end points are of interest when performing radon measurements. The first and most commonly used is radon concentration, which is stated in terms of activity per unit volume (Bq/m^3 or pCi/L). Although this terminology is consistent with most federal guidance values, it only infers the potential dose equivalent associated with radon. The second analytical end point is the radon progeny working level. Radon progeny usually attach very quickly to charged aerosols in the air following creation. The fraction that remains unattached is usually quite small (*i.e.*, 5-10%). Since most aerosol particles carry an electrical charge and are relatively massive ($\geq$ 0.1 µm), they are capable of attaching to the surfaces of the lung. Essentially all dose or risk from radon is associated with alpha decays from radon progeny attached to tissues of the respiratory system. If an investigator is interested in accurately determining the potential dose or risk associated with radon in the air of a room, the radon progeny concentration must be known.

Radon progeny concentrations are usually reported in units of working levels (WL), where one working level is equal to the potential alpha energy associated with the radon progeny in secular equilibrium with 100 pCi/L of radon. One working level is equivalent to 1.28×10^5 MeV/L of potential alpha energy. Given a known breathing rate and lung attachment probability, the expected mean lung dose from exposure to a known working level of radon progeny can be calculated.

Radon progeny are not usually found in secular equilibrium with radon indoors due to plating out of the charged aerosols onto walls, furniture, *etc.* The ratio of ^{222}Rn progeny activity to ^{222}Rn activity usually ranges from 0.2 to as high as 0.8 indoors (NCRP 1988). If only the ^{222}Rn concentration is measured and it is not practical to measure the progeny concentrations, then general practice is to assume a progeny to ^{222}Rn equilibrium ratio of 0.5 for indoor areas. This allows one to estimate the expected dose or risk associated with a given radon concentration.

In general, the following generic guidelines should be followed when performing radon measurements during site investigations:

- The radon measurement method used should be well understood and documented.
- Long term measurements are used to determine the true mean radon concentration.
- The impact of variable environmental conditions (*e.g.*, humidity, temperature, dust loading, and atmospheric pressure) on the measurement process should be accounted for when necessary. Consideration should be given to effects on both the air collection process and the counting system.

- The background response of the detection system should be accounted for.

- If the quantity of interest is the working level, then the radon progeny concentrations should be evaluated. If this is not practical, then the progeny activities can be estimated by assuming they are 50% of the measured radon activity (NCRP 1988).

For a general overview, a list of common radiation detectors with their usual applications during radon surveys is provided in Table 6.10. Descriptions and costs for specific equipment used for the measurement of radon are contained in Appendix H.

Table 6.10 Radiation Detectors with Applications to Radon Surveys

System	Description	Application	Remarks
Large area activated charcoal collector	A canister containing activated charcoal is twisted into the surface and left for 24 hours.	Short term radon flux measurements	The LLD is 0.007 Bq $m^{-2}s^{-1}$ (0.2 pCi $m^{-2}s^{-1}$).
Continuous radon monitor	Air pump and scintillation cell or ionization chamber.	Track the real time concentration of radon	Takes 1 to 4 hours for system to equilibrate before starting. The LLD is 0.004-0.04 Bq/L (0.1-1.0 pCi/L).
Activated charcoal adsorption	Activated charcoal is opened to the ambient air, then gamma counted on a gamma scintillator or in a liquid scintillation counter.	Measure radon concentration in indoor air	Detector is deployed for 2 to 7 days. The LLD is 0.007-0.04 Bq/L (0.2 to 1.0 pCi/L).
Electret ion chamber	This is a charged plastic vessel that can be opened for air to pass through.	Measure short-term or long-term radon concentration in indoor air	Must correct reading for gamma background concentration. Electret is sensitive to extremes of temperature and humidity. LLD is 0.007-0.02 Bq/L (0.2-0.5 pCi/L).
Alpha track detection	A small piece of special plastic or film inside a small container. Damage tracks from alpha particles are chemically etched and tracks counted.	Measure indoor or outdoor radon concentration in air	LLD is 0.04 Bq $L^{-1}d^{-1}$ (1 pCi $L^{-1}d^{-1}$).

The following provides a general overview of radon sampling and measurement concepts. The intent of this section is to provide an overview of common methods and terminology.

6.9.1 Direct Radon Measurements

Direct radon measurements are performed by gathering radon into a chamber and measuring the ionizations produced. A variety of methods have been developed, each making use of the same fundamental mechanics but employing different measurement processes. The first step is to get the radon into a chamber without collecting any radon progeny from the ambient air. A filter is normally used to capture charged aerosols while allowing the radon gas to pass through. Most passive monitors rely on diffusion of the ambient radon in the air into the chamber to establish an equilibrium between the concentrations of radon in the air and in the chamber. Active monitors use some type of air pump system for the air exchange method.

Once inside the chamber, the radon decays by alpha emission to form ^{218}Po which usually takes on a positive charge within thousandths of a second following formation. Some monitor types collect these ionic molecules and subsequently measure the alpha particles emitted by the radon progeny. Other monitor types, such as the electret ion chamber, measure the ionization produced by the decay of radon in the air within the chamber by directly collecting the ions produced inside the chamber. Simple systems measure the cumulative radon during the exposure period based on the total alpha decays that occur. More complicated systems actually measure the individual pulse height distributions of the alpha and/or beta radiation emissions and derive the radon plus progeny isotopic concentration in the air volume.

Care must be taken to accurately calibrate a system and to understand the effects of humidity, temperature, dust loading, and atmospheric pressure on the system. These conditions create a small adverse effect on some systems and a large influence on others.

6.9.1.1 Integrating Methods for Radon Measurement

With integrating methods, measurements are made over a period of days, weeks, or months and the device is subsequently read by an appropriate device for the detector media used. The most common detectors used are activated charcoal adsorbers, electret ion chamber (EIC), and alpha track plastics. Short term fluctuations are averaged out, thus making the measurement representative of average concentration. Results in the form of an average value provide no way to determine the fluctuations of the radon concentration over the measurement interval. Successive short term measurements can be used in place of single long term measurements to gain better insight into the time dependence of the radon concentration.

6.9.1.2 Continuous Methods for Radon Measurement

Devices that measure direct radon concentrations over successive time increments are generally called continuous radon monitors. These systems are more complex than integrating devices in that they measure the radon concentration and log the results to a data recording device on a real

time basis. Continuous radon measurement devices normally allow the noble gas radon to pass through a filter into a detection chamber where the radon decays and the radon and/or the resulting progeny are measured. The most common detectors used for real time measurements are ion chambers, solid state surface barrier detectors, and ZnS(Ag) scintillation detectors.

Continuous methods offer the advantage of providing successive, short-term results over long periods of time. This allows the investigator not only to determine the average radon concentration, but also to analyze the fluctuations in the values over time. More complicated systems are available that measure the relative humidity and temperature at the measurement location and log the values along with the radon concentrations to the data logging device. This allows the investigator to make adjustments, if necessary, to the resulting data prior to reporting the results.

6.9.2 Radon Progeny Measurements

Radon progeny measurements are performed by collecting charged aerosols onto filter paper and subsequently counting the filter for attached progeny. Some systems pump air through a filter and then automatically count the filter for alpha and/or beta emissions. An equivalent but more labor intensive method is to collect a sample using an air sampling pump and then count the filter in stand alone alpha and/or beta counting systems. The measurement system may make use of any number of different techniques ranging from full alpha and beta spectrometric analysis of the filters to simply counting the filter for total alpha and or beta emissions.

When performing total (gross) counting analyses, the assumption is usually made that the only radioisotopes in the air are due to ^{222}Rn and its progeny. This uncertainty, which is usually very small, can be essentially eliminated when performing manual sampling and analysis by performing a follow up measurement of the filter after the radon progeny have decayed to a negligible level. This value can then be used as a background value for the air. Of course, such a simple approach is only applicable when ^{222}Rn is the isotope of concern. For ^{219}Rn or ^{220}Rn, other methods would have to be used.

Time is a significant element in radon progeny measurements. Given any initial equilibrium condition for the progeny isotopes, an investigator must be able to correlate the sampling and measurement technique back to the true concentration values. When collecting radon progeny, the buildup of total activity on the filter increases asymptotically until the activity on the filter becomes constant. At this point, the decay rate of the progeny atoms on the filter is equal to the collection rate of progeny atoms. This is an important parameter to consider when designing a radon sampling procedure.

Note that the number of charged aerosol particles in the air can affect the results for radon progeny measurements. If the number of particles is few, as is possible when humidity is low and a room is very clean, then most of the progeny will not be attached and can plate out on room

surfaces prior to reaching the sample filter. This is not a problem if the same conditions always exist in the room, however the calculated dose would underestimate the dose that would be received in a higher humidity or dust concentration state with the same radon progeny concentration.

6.9.3 Radon Flux Measurements

Sometimes it is desirable to characterize the source of radon in terms of the rate at which radon is emanating from a surface—that is, soil, uranium mill tailings, or concrete. One method used for measuring radon flux is briefly described here.

The measurement of radon flux can be achieved by adsorption onto charcoal using a variety of methods such as a charcoal canister or a large area collector (*e.g.*, 25 cm PVC end cap). The collector is deployed by firmly twisting the end cap into the surface of the material to be measured. After 24 hours of exposure, the activated charcoal is removed and transferred to plastic containers. The amount of radon adsorbed on the activated charcoal is determined by gamma spectroscopy. Since the area of the surface is well defined and the deployment period is known, the radon flux (in units of Bq/m^2-s or pCi/m^2-s) can be calculated.

This method is reliable for measuring radon flux in normal environmental situations. However, care should be taken if an extremely large source of radon is measured with this method. The collection time should be chosen carefully to avoid saturating the canister with radon. If saturation is approached, the charcoal loses its ability to absorb radon and the collection rate decreases. Even transporting and handling of a canister that is saturated with radon can be a problem due to the dose rate from the gamma rays being emitted. One would rarely encounter a source of radon that is so large that this would become a problem; however, it should be recognized as a potential problem. Charcoal can also become saturated with water, which will affect the absorption of radon. This can occur in areas with high humidity.

An alternative method for making passive radon flux measurements has been developed recently using electret ionization chambers (EICs). EIC technology has been widely used for indoor radon measurements. The passive EIC procedure is similar to the procedures used with large area activated charcoal canisters. In order to provide the data for the background corrections, an additional passive monitor is located side by side on a radon impermeable membrane. These data are used to calculate the net radon flux. The Florida State Bureau of Radiation Protection has compared the results from measurements of several phosphogypsum flux beds using the charcoal canisters and EICs and has shown that the two methods give comparable results. The passive method seems to have overcome some of the limitations encountered in the use of charcoal. The measurement periods can be extended from hours to several days in order to obtain a better average, if needed. EIC flux measurements are not affected by environmental conditions such as temperature, humidity, and air flow. The measured sensitivities are

comparable to the charcoal method but, unlike charcoal, EICs do not become saturated by humidity. Intermediate readings can be made if needed.. In view of the low cost of the EIC reading/analyzing equipment, the cost per measurement can be as much as 50% lower than the charcoal method with additional savings in time.

6.10 Special Equipment

Various specialized systems have been developed which can be used during the performance of radiation surveys and site investigations. These range from specially designed quick radiation scanning systems to commercial global positioning systems (GPSs). The equipment may be designed to detect radiation directly, detect and locate materials associated with the contamination (*e.g.*, metal containers), or locate the position where a particular measurement is performed (*e.g.*, GPS). Because these specialized systems are continuously being modified and developed for site-specific applications, it is not possible to provide detailed descriptions of every system. The following sections provide examples of specialized equipment that have been applied to radiation surveys and site investigations.

6.10.1 Positioning Systems

As stated in Section 4.8.5, documenting the location of measurements is important for demonstrating the reproducibility of the results. There are a variety of positioning systems available that provide a range of accuracy and precision that can be evaluated during survey planning to determine their applicability to a particular site. These positioning systems can be used to establish a reproducible reference coordinate system or to locate individual measurements using an established reference coordinate system (*e.g.*, longitude and latitude).

6.10.1.1 Differential Global Positioning Systems

A variety of practical and versatile GPSs based on radio signals tracked from satellite beacons are available (e.g., Trimble™, Novatel™, Garmin™). These systems are generally used to aid in recording and retrieving location data with precision on the order of tens of meters. With a stationary base station and a separate moving locator, the system is deployed in the "differential global positioning system" (DGPS) mode. DGPSs can record and retrieve location data with a precision in the centimeter range.

DGPS can be used to provide position information on surface features in areas being surveyed, linking the survey results to previously published maps and aerial photographs. In addition, survey results may be positioned using the DGPS readings to accurately and precisely locate the results as well as the results of any subsequent analyses to these same maps or photographs. A process called waypointing uses the DGPS to locate specific points and allows the user to find

predetermined locations and set up gridded locations for measurements based on location data that are tied into local or state coordinate systems.

Limitations on the use of DGPS are related to the number of satellite beacons available to the system. When three or fewer satellites are available the accuracy and precision of the location data will be reduced. There are short periods of time (usually less than one hour even on the worst days) when a limited number of satellites are overhead in the continental United States. Satellites may also be blocked by excess tree cover or tall buildings. Distance between the moving locator and the stationary base station may be several kilometers or may be limited to line-of-sight. This limitation can be mitigated through the strategic use of repeater stations to re-transmit the signal between the moving locator and the base station.

6.10.1.2 Local Microwave and Sonar Positioning Systems

Local microwave or sonar beacons and receivers may provide useful location data in small areas and tree-covered locales. One example of a sonar-based system is the ultrasonic ranging and data system (USRADS). With a number of fixed beacons in place, a roving unit can be oriented and provide location data with similar accuracy and precision as the DGPS. If the beacons are located at known points, the resulting positions can be determined using simple calculations based on the known reference locations of the beacons.

The logistics of deploying the necessary number of beacons properly and the short range of the signals are the major limitations of the system. In addition, multipathing of signals within wooded areas can cause jumps in the positioning data.

6.10.2 Mobile Systems with Integrated Positioning Systems

In recent years, the advent of new technologies has introduced mobile sensor systems for acquiring data that include fully-integrated positioning systems. Portable and vehicle-based versions of these systems record survey data while moving over surfaces to be surveyed and simultaneously recording the location data from either a roving DGPS receiver or local microwave/sonar receiver. All measurement data are automatically stored and processed with the measurement location for later posting (see Section 8.2.2.2 for a discussion of posting plots) or for mapping the results. These systems are designed with a variety of detectors for different applications. For example, alpha or beta detectors have been mounted on a robot a fixed distance over a smooth surface. The robot moves at a predetermined speed over the surface to provide scanning results, and also records individual direct measurements at predetermined intervals. This type of system not only provides the necessary measurement data, but also reduces the uncertainty associated with human factors. Other systems are equipped with several types of radiation detectors, magnetometers, electromagnetic sensors, or various combinations of multiple sensors. The limitations of each system should be evaluated on a site-specific basis to determine

if the positioning system, the detector, the transport system, or some combination based on site-specific characteristics will represent the limits of the system.

6.10.3 Radar, Magnetometer, and Electromagnetic Sensors

The number of sensors and sensor systems applicable to the detection and location of buried waste have increased in use and reliability in recent years. These systems are typically applicable to scoping and characterization surveys where the identification of subsurface contamination is a primary concern. However, the results of these surveys may be used during final status survey planning to demonstrate that subsurface contamination is not a concern for a particular site or survey unit. Some of the major technologies are briefly described in the following sections.

6.10.3.1 Ground Penetrating Radar

For most sites, ground penetrating radar (GPR) is the only instrument capable of collecting images of buried objects *in situ*, as compared to magnetometers (Section 6.10.3.2) and electromagnetic sensors (Section 6.10.3.3) which detect the strength of signals as measured at the ground surface. Additionally, GPR is unique in its ability to detect both metallic and non-metallic (*e.g.*, plastic, glass) containers.

Subsurface radar detection systems have been the focus of study for locating and identifying buried or submerged objects that otherwise could not be detected. There are two major categories of radar signals: 1) time domain, and 2) frequency domain. Time-domain radar uses short impulses of radar-frequency energy directed into the ground being investigated. Reflections of this energy, based on changes in dielectric properties, are then received by the radar. Frequency-domain radar, on the other hand, uses a continuous transmission where the frequency of the transmission can be varied either stepwise or continuously. The changes in the frequency characteristics due to effects from the ground are recorded. Signal processing, in both cases, converts this signal to represent the location of radar reflectors against the travel time of the return signal. Greater travel time corresponds to a greater distance beneath the surface. Table 6.11 lists the typical penetration depth for various geologic materials (fresh water is included as a baseline for comparison).

Examples of existing GPR technologies currently being applied to subsurface investigations include:

- narrow-band radar
- ultra-wideband radar
- synthetic aperture radar
- frequency modulated continuous radar
- polarized radar waves

Table 6.11 Typical Radar Penetration Depths for Various Geologic Materials

Material	Penetration Depth m (ft)
Fresh Water	100 (330)
Sand (desert)	5 (16)
Sandy Soil	3 (10)
Loam Soil	3 (10)
Clay Soil	2 (6)
Salt Flats (dry)	1 (3)
Coal	20 (66)
Rocks	20 (66)
Walls	0.3 (1)

The major limitation to GPR is the difficulty in interpreting the data, which is often provided in the form of hazy, "waterfall-patterned" data images requiring an experienced professional to interpret. Also, GPR can vary depending on the soil type as shown in Table 6.10. Highly conductive clay soils often absorb a large amount of the radar energy, and may even reflect the energy. GPR can be deployed using ground-based or airborne systems.

6.10.3.2 Magnetometers

Although contaminated soil and most radioactive waste possess no ferromagnetic properties, the containers commonly used to hold radioactive waste (*e.g.*, 55-gallon drums) are made from steel. These containers possess significant magnetic susceptibility making the containers detectable using magnetometry.

Magnetometers sense the pervasive magnetic field of the Earth. This field, when encountering an object with magnetic susceptibility, induces a secondary magnetic field in that object. This secondary field creates an increase or decrease in Earth's ambient magnetic field. Magnetometers measure these changes in the expected strength of the ambient magnetic field. Some magnetometers, called "vector magnetometers," can sense the direction as well as the magnitude of these changes. However, for subsurface investigations only the magnitude of the changes are used.

The ambient magnetic field on Earth averages 55,000 gamma in strength. The variations caused by the secondary magnetic fields typically range from 10 to 1,000 gamma, and average around 100 gamma. Most magnetometers currently in use have a sensitivity in the 0.1 to 0.01 gamma range and are capable of detecting these secondary fields.

An alternate magnetometer survey can be performed using two magnetometers in a gradiometric configuration. This means that the first magnetometer is placed at the ground surface, while the second is mounted approximately 0.5 meters above the first. Data is recorded from both sensors and compared. When the readings from both detectors are nearly the same, it implies that there is no significant disturbance in the Earth's ambient magnetic field or that such disturbances are broad and far away from the gradiometer. When a secondary magnetic field is induced in an object, it affects one sensor more strongly than the other, producing a difference in the readings from the two magnetometers. This approach is similar to the use of a guard detector in anti-coincidence mode in a low-background gas-flow proportional counter in a laboratory (see Appendix H for a description of gas-flow proportional counters). The gradiometric configuration filters out the Earth's ambient magnetic field, large scale variations, and objects located far from the sensor to measure the effects of nearby objects, all without additional data processing.

Fifty-five gallon drums buried 5 to 7 meters below the surface may be detectable using a magnetometer. At many sites, multiple drums have been buried in trenches or pits and detection is straightforward. A single operator carrying a magnetometer with the necessary electronics in a backpack can cover large areas in a relatively small amount of time.

The limitations on the system are related to the size of the objects and their depth below the surface. Objects that are too small or buried too deep will not provide a secondary magnetic field that can be detected at the ground surface.

6.10.3.3 Electromagnetic Sensors

Electromagnetic sensors emit an electromagnetic wave, in either a pulsed or continuous wave mode, and then receive the result of that transmission. The result of the transmission is two signals; quadrature and in-phase. As the wave passes through some material other than air, it is slowed down by a resistive medium or sped up by a conductor through dielectric effects. This produces the quadrature signal. If the electromagnetic wave encounters a highly conductive object it induces a magnetic field in the object. This induced electromagnetic field returns to the sensor as a reflection of the original electromagnetic wave and forms the in-phase signal.

The in-phase signal is indicative of the presence, size, and conductivity of nearby objects (*e.g.*, 55-gallon drums), while the quadrature signal is a measure of the dielectric properties of the nearby objects such as soil. This means that electromagnetic sensors can detect all metallic objects (including steel, brass, and aluminum), such as the metal in waste containers, and also sample the soil for changes in properties, such as those caused by leaks of contaminants.

Depths of interest are largely determined by the spacing between the coil used to transmit the primary electromagnetic wave, and the receiver used to receive that transmission. The rule of thumb is that the depth of interest is on the order of the distance between the transmitter and the receiver. A system designed with the transmitter and receiver placed tens of meters apart can detect signals from tens of meters below the surface. A system with the transmitter and receiver collocated can only detect signals from depths on the order of the size of the coil, which is typically about one meter. The limitations of electromagnetic sensors include a lack of clearly defined signals, and decreasing resolution of the signal as the distance below the surface increases.

6.10.4 Aerial Radiological Surveys

Low–altitude aerial radiological surveys are designed to encompass large areas and may be useful in:

- providing data to assist in the identification of radioactive contaminants and their corresponding concentrations and spatial distributions
- characterizing the nature, extent, and impact of contamination

The measurement sensitivity and data processing procedures provide total area coverage and a detailed definition of the extent of gamma-producing isotopes for a specific area. The gamma radiation spectral data are processed to provide a qualitative and quantitative analysis of the radionuclides in the survey area. Helicopter flights establish a grid pattern (*e.g.*, east–west) of parallel lines approximately 61 m (200 ft) above the ground surface.

The survey consists of airborne measurements of natural and man–made gamma radiation from the terrain surface. These measurements allow for the determination of terrestrial spatial distribution of isotopic concentrations and equivalent gamma exposure rates (*e.g.*, ^{60}Co, ^{234m}Pa, and ^{137}Cs). The results are reported as isopleths for the isotopes and are usually superimposed on scale maps of the area.

7 SAMPLING AND PREPARATION FOR LABORATORY MEASUREMENTS

7.1 Introduction

There are three methods for collecting radiation data while performing a survey. A direct measurement is obtained by placing the detector near or against the surface or in the media being surveyed and reading the radioactivity level directly. Scanning is an evaluation technique performed by moving a portable radiation detection instrument at a constant speed and distance above the surface to semi-quantitatively detect elevated areas of radiation. These measurement techniques are discussed in Chapter 6. Sampling is the process of collecting a portion of an environmental medium as representative of the locally remaining medium. The collected portion of the medium is then analyzed to determine the radionuclide concentration. This chapter discusses issues involved in collecting and preparing samples in the field for analysis, and in evaluating the results of these analyses. In addition, a general discussion on laboratory sample preparation and analysis is provided to assist in communications with the laboratory during survey planning.

Samples should be collected and analyzed by qualified individuals using the appropriate equipment and procedures. This manual assumes that the samples taken during the survey will be submitted to a qualified laboratory for analysis. The laboratory should have written procedures that document its analytical capabilities for the radionuclides of interest and a Quality Assurance/Quality Control (QA/QC) program that documents the compliance of the analytical process with established criteria. The method used to assay for the radionuclides of concern should be recognized as a factor affecting analysis time.

Commonly used radiation detection and measuring equipment for radiological survey field applications is described in Chapter 6 and Appendix H. Many of these equipment types are also used for laboratory analyses, usually under more controlled conditions that provide for lower detection limits and greater delineation between radionuclides. Laboratory methods often involve combinations of both chemical and instrument techniques to quantify the low levels expected in the samples. This chapter provides guidance to assist the MARSSIM user in selecting appropriate procedures for collecting and handling samples for laboratory analysis. More detailed information is available in documents listed in the reference section of this manual.

7.2 Data Quality Objectives

The survey design is developed and documented using the Data Quality Objectives (DQO) Process (see Appendix D). The third step of the DQO Process involves identifying the data needs for a survey. One decision that can be made at this step is the selection of direct

measurements for performing a survey or deciding that sampling methods followed by laboratory analysis are necessary.

7.2.1 Identifying Data Needs

The decision maker and the survey planning team need to identify the data needs for the survey being performed, including the:

- type of samples to be collected or measurements to be performed (Chapter 5)
- radionuclide(s) of interest (Section 4.3)
- number of samples to be collected (Section 5.5.2)
- type and frequency of field QC samples to be collected (Section 4.9)
- amount of material to be collected for each sample (Section 4.7.3 and Section 7.5)
- sampling locations and frequencies (Section 5.5.2)
- standard operating procedures (SOPs) to be followed or developed (Chapter 7)
- analytical bias and precision (*e.g.*, quantitative or qualitative) (Appendix N)
- target detection limits for each radionuclide of interest (Section 6.4 and Table 7.2)
- cost of the methods being evaluated (cost per analysis as well as total cost) (Appendix H)
- necessary turnaround time
- sample preservation and shipping requirements (Section 7.6 and Section 7.9)
- specific background for the radionuclide(s) of interest (Section 4.5)
- derived concentration guideline level (DCGL) for each radionuclide of interest (Section 4.3)
- measurement documentation requirements (Section 9.4.2.2)
- sample tracking requirements (Section 7.8)

Some of this information will be supplied by subsequent steps in the DQO process, and several iterations of the process may be needed to identify all of the data needs. Consulting with a radiochemist or health physicist may be necessary to properly evaluate the information before deciding between direct measurements or sampling methods to perform the survey. Surveys may require data from all three collection methods (*i.e.*, sample analysis, direct measurements, and scans) in order to demonstrate compliance with the regulation.

7.2.2 Data Quality Indicators

The data quality indicators identified as DQOs in Section 2.3.1 and described in Appendix N, Section N.6, should be considered when selecting a measurement method (*i.e.*, scanning, direct measurement, sampling) or an analytical technique (*e.g.*, radionuclide-specific analytical procedure). In some instances, the data quality indicator requirements will help in the selection of an analytical technique. In other cases, the analytical requirements will assist in the selection of appropriate levels for the data quality indicators.

7.2.2.1 Precision

Precision is a measure of agreement among replicate measurements of the same property under prescribed similar conditions (ASQC 1995). Precision is determined quantitatively based on the results of replicate measurements (equations are provided in EPA 1990). The number of replicate analyses needed to determine a specified level of precision for a project is discussed in Section 4.9. There are several types of replicate analyses available to determine the level of precision, and these replicates are typically distinguished by the point in the sample collection and analysis process where the sample is divided. Determining precision by replicating measurements with results at or near the detection limit of the measurement system is not recommended because the measurement uncertainty is usually greater than the desired level of precision.

- Collocated Samples. Collocated samples are samples collected adjacent to the routine field sample to determine local variability of the radionuclide concentration. Typically, collocated samples are collected about one-half to three feet away from the selected sample location. Analytical results from collocated samples can be used to assess site variation, but only in the immediate sampling area. Collocated samples should not be used to assess variability across a site and are not recommended for assessing error (EPA 1991g). Collocated samples can be non-blind, single-blind, or double-blind.

- Field Replicates. Field replicates are samples obtained from one location, homogenized, divided into separate containers and treated as separate samples throughout the remaining sample handling and analytical processes. These samples are used to assess error associated with sample heterogeneity, sample methodology and analytical procedures. Field replicates are used when determining total error for critical samples with contamination concentrations near the action level. For statistical analysis to be valid in such a case, a minimum of eight replicate samples would be required (EPA 1991g). Field replicates (or field split samples) can be non-blind, single-blind, or double-blind and are recommended for determining the level of precision for a radiation survey or site investigation.

- Analytical Laboratory Replicate. An analytical laboratory replicate is a subsample of a routine sample that is homogenized, divided into separate containers, and analyzed using the same analytical method. It is used to determine method precision, but because it is a non-blind sample, or known to the analyst, it can only be used by the analyst as an internal control tool and not as an unbiased estimate of analytical precision (EPA 1990).

- Laboratory Instrument Replicate. A laboratory instrument replicate is the repeated measurement of a sample that has been prepared for counting (*i.e.*, laboratory sample preparation and radiochemical procedures have been completed). It is used to determine

precision for the instrument (repeated measurements using same instrument) and the instrument calibration (repeated measurements using different instruments, such as two different germanium detectors with multichannel analyzers). A laboratory instrument replicate is generally performed as part of the laboratory QC program and is a non-blind sample. It is typically used as an internal control tool and not as an unbiased estimate of analytical precision.

7.2.2.2 Bias

Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (ASQC 1995). Bias is determined quantitatively based on the analysis of samples with a known concentration. There are several types of samples with known concentrations. QC samples used to determine bias should be included as early in the analytical process as possible.

- Reference Material. A material or substance one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials (ISO 1993). A certified reference material is reference material for which each certified property value is accompanied by an uncertainty at a stated level of confidence. Radioactive reference materials may be available for certain radionuclides in soil (*e.g.*, uranium in soil), but reference building materials may not be available. Because reference materials are prepared and homogenized as part of the certification process, they are rarely available as double-blind samples. When appropriate reference materials are available (*i.e.*, proper matrix, proper radionuclide, proper concentration range), they are recommended for use in determining the overall bias for a measurement system.

- Performance Evaluation (PE) Samples. PE sample are samples that evaluate the overall bias of the analytical laboratory and detect any error in the analytical method used. These samples are usually prepared by a third party, using a quantity of analyte(s) which is known to the preparer but unknown to the laboratory, and always undergo certification analysis. The analyte(s) used to prepare the PE sample is the same as the analyte(s) of interest. Laboratory procedural error is evaluated by the percentage of analyte identified in the PE sample (EPA 1991g). PE samples are recommended for use in determining overall bias for a measurement system when appropriate reference material are not available. PE samples are equivalent to matrix spikes prepared by a third party that undergo certification analysis and can be non-blind, single-blind, or double-blind.

- Matrix Spike Samples. Matrix spike samples are environmental samples that are spiked in the laboratory with a known concentration of a target analyte(s) to verify percent recoveries. They are used primarily to check sample matrix interferences but can also be used to monitor laboratory performance. However, a data set of at least three or more

results is necessary to distinguish between laboratory performance and matrix interference (EPA 1991g). Matrix Spike samples are often replicated to monitor method performance and evaluate error due to laboratory bias and precision (when four or more pairs are analyzed). These replicates are often collectively referred to as a matrix spike/matrix spike duplicate (MS/MSD).

There are several additional terms applied to samples prepared by adding a known amount of the radionuclide of interest to the sample. The majority of these samples are designed to isolate individual sources of bias within a measurement system by preparing pre- and post-operation spikes. For example, the bias from the digestion phase of the measurement system can be determined by comparing the result from a pre-digest spike to the result from a post-digest spike.

There are also several types of samples used to estimate bias caused by contamination.

- Background Sample. A background sample is a sample collected upgradient of the area of potential contamination (either onsite or offsite) where there is little or no chance of migration of the contaminants of concern (EPA 1991g). Background samples are collected from the background reference area (Section 4.5), determine the natural composition and variability of the soil (especially important in areas with high concentrations of naturally occurring radionuclides), and are considered "clean" samples. They provide a basis for comparison of contaminant concentration levels with samples collected from the survey unit when the statistical tests described in Chapter 8 are performed.

- Field Blanks. Field blanks are samples prepared in the field using certified clean sand or soil and then submitted to the laboratory for analysis (EPA 1991g). A field blank is used to evaluate contamination error associated with sampling methodology and laboratory procedures. It also provides information about contaminants that may be introduced during sample collection, storage, and, transport. Field blanks are recommended for determining bias resulting from contamination for a radiation survey or site investigation.

- Method Blank. A method blank is an analytical control sample used to demonstrate that reported analytical results are not the result of laboratory contamination (ATSDR 1992). It contains distilled or deionized water and reagents, and is carried through the entire analytical procedure (laboratory sample preparation, digestion, and analysis). The method blank is also referred to as a reagent blank. The method blank is generally used as an internal control tool by the laboratory because it is a non-blind sample.

7.2.2.3 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point (ASQC 1995). Representativeness is a qualitative term that is reflected in the survey design through the selection of a measurement method (*e.g.*, direct measurement or sampling) and the size of a sample collected for analysis.

Sample collection and analysis is typically less representative of true radionuclide concentrations at a specific measurement location than performing a direct measurement. This is caused by the additional steps required in collecting and analyzing samples, such as sample collection, field sample preparation, laboratory sample preparation, and radiochemical analysis. However, direct measurement techniques with acceptable detection limits are not always available. When sampling is required as part of a survey design, it is critical that the sample collection procedures consider representativeness. The location of the sample is determined in Section 5.5.2.5, but the size and content of the sample are usually determined as the sample is collected. Sample size and content are discussed in Section 4.7.3 and Section 7.5. Sample collection procedures also need to consider the development of the DCGLs when determining the representativeness of the samples.

7.2.2.4 Comparability

Comparability is a qualitative term that expresses the confidence that two data sets can contribute to a common analysis and interpolation. Generally, comparability is provided by using the same measurement system for all analyses of a specific radionuclide. In many cases, equivalent procedures used within a measurement system are acceptable. For example, using a liquid-liquid extraction purification step to determine the concentration of ^{238}Pu using alpha spectrometry may be equivalent to using an ion-exchange column purification step. However, using a gross alpha measurement on a gas proportional counting system would not be considered equivalent. Comparability is usually not an issue except in cases where historical data have been collected and are being compared to current analytical results, or when multiple laboratories are used to provide results as part of a single survey design.

7.2.2.5 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system, expressed as a percentage of the number of valid measurements that should have been collected. Completeness is of greater concern for laboratory analyses than for direct measurements because the consequences of incomplete data often require the collection of additional samples. Direct measurements can usually be repeated fairly easily. The collection of additional samples generally requires a remobilization of sample collection personnel which can be expensive. Conditions at the site may have changed making it difficult or impossible to collect

representative and comparable samples without repeating the entire survey. On the other hand, if it is simply an analytical problem and sufficient sample was originally collected, the analysis can be repeated using archived sample material. Samples collected on a grid to locate areas of elevated activity are also a concern for completeness. If one sample analysis is not valid, the entire survey design for locating areas of elevated activity may be invalidated.

7.2.2.6 Other Data Quality Indicators

Several additional data quality indicators that influence the final status survey design are identified as DQOs in Section 2.3.1. Many of these (*e.g.*, selection and classification of survey units, decision error rates, variability in the contaminant concentration, lower bound of the gray region) are used to determine the number of measurements and are discussed in detail in Section 5.5. The method detection limit is directly related to the selection of a measurement method and a radionuclide-specific analytical technique.

Analytical methods should be capable of measuring levels below the established DCGLs, detection limits of 10-50% of the DCGL should be the target (see Section 6.7). Cost, time, best available technology, or other constraints may create situations where the above stated sensitivities are deemed impracticable. Under these circumstances, higher detection sensitivities may be acceptable. Although laboratories will state detection limits, these sensitivities are usually based on ideal or optimistic situations and may not be achievable under actual measurement conditions. Detection limits are subject to variation from sample to sample, instrument to instrument, and procedure to procedure, depending on sample size, geometry, background, instrument efficiency, chemical recovery, abundance of the radiations being measured, counting time, self-absorption in the prepared sample, and interferences from radionuclides or other materials present in the sample. The detection limit that is achievable in practice should not exceed the DCGL.

7.3 Communications with the Laboratory

Laboratory analyses of samples are generally performed by personnel not directly involved in the collection of the samples being analyzed. Samples are typically collected by one group working in the field, and analyzed by a second group located in a laboratory. This separation of tasks can potentially lead to problems based on the lack of communication between the two groups. For this reason, communications between the Project Manager, field personnel, and laboratory personnel are vital to ensuring the success of a project.

7.3.1 Communications During Survey Planning

The radioanalytical laboratory is a valuable resource during survey planning. Information on available analytical techniques, analytical bias and precision, method detection limits, analytical costs, and turnaround times can easily be provided by the laboratory. All of this information is used to make the decision to perform direct measurements or collect samples for laboratory measurements. Additional information, such as required sample size/volume, type of sample container, preservative requirements, and shipping requirements, including the availability of the laboratory for receipt of samples on weekends or holidays, can be obtained and factored into the survey plan.

Involving the radioanalytical laboratory during survey planning also provides the laboratory with site-specific information about the project. Information on the radionuclides of interest, possible chemical and physical form of the contamination, and mechanism for release of the contamination to the environment is used to modify or develop the analytical method for site-specific conditions if required. The laboratory should also be provided with the site-specific action levels (i.e., DCGLs, investigation levels) early in the survey planning process.

In some cases, it is not practical to select a radioanalytical laboratory early in the survey process to participate in the survey planning activities. For example, Federal procurement procedures require that a statement of work (SOW) identifying the tasks to be performed by the laboratory be developed prior to selecting a laboratory. Unfortunately, the details of the tasks for the laboratory to perform are developed during survey planning. This means that the information provided by the laboratory and used during survey planning will be obtained from another source, usually a radiochemist or health physicist trained in radiochemistry. The uncertainty associated with this information and subsequent decisions made based on this information increases. This may lead to increased costs caused by specifying an unnecessarily expensive analytical method in the SOW or repeated sampling and analysis of samples that did not meet the target detection limits because the specified analytical method was not sensitive enough. In addition, unnecessary or inappropriate analytical methods may be selected by the laboratory because site-specific information concerning the samples was not provided.

The laboratory should be consulted when planning the schedule for the survey to insure that the expected turnaround times can be met based on the projected laboratory workload.

7.3.2 Communications Before and During Sample Collection

In most situations, the sample collection and shipping containers are supplied by the laboratory; therefore, the laboratory should be notified well in advance of the sampling trip so that these items will be available to the sampling team during the survey.

The main purpose of communications with the laboratory during sample collection is to inform the laboratory of modifications to the survey design specified in the planning documents (*e.g.*, QAPP and SOPs). The laboratory should have a copy of the survey design in their possession prior to samples being collected.

Modifications to the survey design are often minor deviations from the SOPs caused by site-specific conditions and usually affect a small number of samples. For example, a rock outcropping covered by a thin layer of soil may restrict the depth of the surface soil sample to 5 cm (2 in.) instead of the 10 cm (4 in.) specified in the SOP. The mass of the samples collected from this area of the site is one-half the expected sample mass, and the laboratory needs to be informed of this deviation from the SOP.

In other situations, there may be an extensive modification to the number or types of samples collected at the site that will affect the analytical methods, detection capabilities, analytical costs, or even the assumptions used to develop the DCGL. For example, a large portion of the site may have been converted to a parking lot. A large pile of material that may represent the former surface soil will be sampled as well as soil collected from beneath the parking lot surface. The number of samples to be analyzed has doubled compared to the original SOW.

If the expected timing of receipt of samples at the laboratory changes due to sample collection schedule deviations, the laboratory should be notified. Most laboratories require prior notification for samples to be received on weekends.

7.3.3 Communications During Sample Analysis

The laboratory should communicate with the Project Manager and field personnel during sample analysis. The laboratory should provide a list of missing or damaged samples as soon after the samples are received as practical. This allows the Project Manager to determine if resampling is required to replace the missing or damaged samples. The Project Manager may also request notification from the laboratory when samples are spilled or lost during analysis. Preliminary reports of analytical results may be useful to help direct sampling activities and provide early indications of whether the survey objectives defined by the DQOs are being met. However, if preliminary results have not been verified or validated, their usefulness is limited.

7.3.4 Communications Following Sample Analysis

Following sample analysis, the laboratory will provide documentation of the analytical results as specified in the survey design. Laboratory personnel should be available to assist with data verification and validation.

7.4 Selecting a Radioanalytical Laboratory

Once the decision to perform sampling activities is made, the next step is to select the analytical methods and determine the data needs for these methods. It is advisable to select a radiochemical laboratory early in the survey planning process in order that it may be consulted on the analytical methodology[1] and the sampling activities. In addition, mobile laboratories can provide on-site analytical capability. Obtaining laboratory or other services may involve a specific procurement process. Federal procurement procedures may require additional considerations beyond the method described here.

The procurement of laboratory services usually starts with the development of a request for proposal that includes a statement-of-work describing the analytical services to be procured. The careful preparation of the statement-of-work is essential to the selection of a laboratory capable of performing the required services in a technically competent and timely manner.

The technical proposals received in response to the procurement request for proposal must be reviewed by personal familiar with radioanalytical laboratory operations in order to select the most qualified offerer. For complicated sites with a large number of laboratory analyses, it is recommended that a portion of this evaluation take the form of a pre-award audit. The provision for this audit must be in the request for proposal. The results of this audit provide a written record of the decision to use a specific laboratory. Smaller sites or facilities may decide that a review of the laboratory's qualifications is sufficient for the evaluation.

There are six criteria that should be reviewed during this evaluation:

- Does the laboratory possess the appropriate well-documented procedures, instrumentation, and trained personnel to perform the necessary analyses? Necessary analyses are defined by the data needs (radionuclide(s) of interest and target detection limits) identified by the DQO process.

- Is the laboratory experienced in performing the same or similar analyses?

- Does the laboratory have satisfactory performance evaluation results from formal monitoring or accreditation programs? The laboratory should be able to provide a summary of QA audits and proof of participation in interlaboratory cross-check programs. Equipment calibrations should be performed using National Institute of Standards and Technology (NIST) traceable reference radionuclide standards whenever possible.

[1] The laboratory provides information on personnel, capabilities, and current workload that are necessary inputs to the decision-making process.

- Is there an adequate capacity to perform all analyses within the desired timeframe? This criterion considers whether or not the laboratory possesses a radioactive materials handling license or permit for the samples to be analyzed. Very large survey designs may indicate that more than one analytical laboratory is necessary to meet the survey objectives.[2]

- Does the laboratory provide an internal quality control review of all generated data that is independent of the data generators?

- Are there adequate protocols for method performance documentation and sample security?

Providers of radioanalytical services should have an active and fully documented QA program in place.[3] This program should comply with the objectives determined by the DQO process in Section 2.3. The QA program should include:

- laboratory organizational structure
- personnel qualifications
- written standard operating procedures and instructions
- inter- and intralaboratory performance analyses
- design control to define the flow of samples through the laboratory
- a corrective action plan
- an internal audit program

Chain-of-Custody requirements and numbers of samples are also specified. The analytical procedures as well as the documentation and reporting requirements should be specified and agreed upon. These topics are discussed in detail in the following sections of this chapter.

7.5 Sampling

This section provides guidance on developing appropriate sample collection procedures for surveys designed to demonstrate compliance with a dose- or risk-based regulation. Sample collection procedures are concerned mainly with ensuring that a sample is representative of the sample media, is large enough to provide sufficient material to achieve the desired detection limit, and is consistent with assumptions used to develop the conceptual site model and the DCGLs. Additional considerations for sample collection activities are discussed in Section 4.7.3.

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[2] If several laboratories are performing analyses as part of the survey, the analytical methods used to perform the analyses should be similar to ensure comparability of results (see Appendix N, Section N.6.5).

[3] The QA program is typically documented in one or more documents such as a Quality Management Plan, Quality Assurance Manual, or Quality Assurance Project Plan.

The presence of radioactive and hazardous chemical wastes (mixed wastes) at a site can influence the survey design. The external exposure rates or radioactivity concentration of a specific sample may limit the time that workers will be permitted to remain in intimate contact with the samples, or may dictate that smaller samples be taken and special holding areas be provided for collected samples prior to shipment. These special handling considerations may conflict with the size specifications for the analytical method, normal sampling procedures, or equipment. There is a potential for biasing sampling programs by selecting samples that can be safely handled or legally shipped to support laboratories. Because final status surveys are performed to demonstrate that a site can be safely released, issues associated with high levels of radioactivity are not expected to be a concern.

7.5.1 Surface Soil

The purpose of surface soil sampling is to collect samples that accurately and precisely represent the radionuclides and their concentrations at the location being sampled. In order to do this and plan for sampling, a decision must be made as to the survey design. The selection of a survey design is based on the Historical Site Assessment, results from preliminary surveys (*i.e.*, scoping characterization, remedial action support), and the objectives of the survey developed using the Data Quality Objectives (DQO) Process. The selection between judgmental, random, and systematic survey designs is discussed in Section 5.5.3.

7.5.1.1 Sample Volume

The volume of soil collected should be specified in the sample collection procedure. In general, large volumes of soil are more representative than small volumes of soil. In addition, large samples provide sufficient sample to ensure that required detection limits can be achieved and that sample reanalysis can be done if there is a problem. However, large samples may cause problems with shipping, storage, and disposal. All of these issues should be discussed with the sample collection team and the analytical laboratory during development of sample collection procedures. In general, surface soil samples range in size from 100 g up to several kilograms.

The sample collection procedure should also make clear if it is more important to meet the volume requirement of the survey design or the surface area the sample represents. Constant volume is related to comparability of the results while surface area is more closely related to the representativeness of the results. Maintaining a constant surface area and depth for samples collected for a particular survey can eliminate problems associated with different depth profiles. The actual surface area included as part of the sample may be important for estimating the probability of locating areas of elevated concentration.

7.5.1.2 Sample Content

The material present in the field at the sample location may or may not provide a representative sample. Vegetative cover, soil particle size distribution, inaccessibility, or lack of sample material are examples of problems that may be identified during sample collection. All deviations from the survey design as documented in the Standard Operating Procedures (SOPs) should be recorded as part of the field sample documentation.

Sample content is generally defined by the assumptions used to develop the conceptual site model and the DCGLs. A typical agricultural scenario assumes that the top few centimeters of soil are available for resuspension in air, that the top 15 cm (6 in.) are homogenized by agricultural activities (*e.g.*, plowing), that roots can extend down several meters to obtain water and nutrients depending on the plant, and that external exposure is based on an assumed thickness of contaminated soil (usually at the surface). Depending on the dominant exposure pathways for each radionuclide, this can result in a complicated set of instructions for collecting representative samples. This situation can be further complicated by the fact that the site is not currently being used for agricultural purposes. For this situation it is necessary to look at the analytical results from the preliminary surveys (*i.e.*, scoping, characterization, remedial action support) to determine the expected depth of contamination.

In most situations the vegetative cover is not considered part of the surface soil sample and is removed in the field. For agricultural scenarios where external exposure is not the primary concern, soil particles greater than 2 mm (0.08 in.) are generally not considered as part of the sample (EPA 1990). Foreign material (*e.g.*, plant roots, glass, metal, or concrete) is also generally not considered part of the sample, but should be reviewed on a site-specific basis. It is important that the sample collection procedure clearly indicate what is and what is not considered part of the sample.

7.5.1.3 Sampling Equipment

The selection of proper sampling equipment is important to ensure that samples are collected effectively and efficiently. Sampling equipment generally consists of a tool to collect the sample and a container to place the collected sample in. Sample tracking begins as soon as the sample is collected, so it may be necessary to consider security of collected samples required by the objectives of the survey.

Sampling tools are selected based on the type of soil, sample depth, number of samples required, and training of available personnel. The selection of a sampling tool may also be based on the expected use of the results. For example, if a soil sample is collected to verify the depth profile used to develop the calibration for *in situ* gamma spectrometry, it is important to preserve the soil core. Table 7.1 lists several examples of tools used for collecting soil samples, situations where they are applicable, and some advantages and disadvantages involved in their use.

Table 7.1 Soil Sampling Equipment*

Equipment	Application	Advantages/Disadvantages
Tier	Soft surface soil	Inexpensive; easy to use and decontaminate; difficult to use in stone or dry soil.
Scoop or trowel	Soft surface soil	Inexpensive; easy to use and decontaminate; trowels with painted surfaces should be avoided
Bulb Planter	Soft Soil, 0-15 cm (0-6 in.)	Easy to use and decontaminate: uniform diameter and sample volume; preserves soil core; limited depth capability; can be difficult to decontaminate
Soil Coring Device	Soft soil, 0-60 cm (0-24 in.)	Relatively easy to use; preserves soil core; limited depth capability; can be difficult to decontaminate
Thin-wall tube sampler	Soft soil, 0-3 m (0-10 ft)	easy to use; preserves soil core; easy to decontaminate; can be difficult to remove cores
Split spoon sampler	Soil, to bedrock	Excellent depth range; preserves soil core; useful for hard soils; often used in conjunction with drill rig for obtaining deep cores
Shelby tube sampler	Soft soil, to bedrock	Excellent depth range; preserves soil core; tube may be used for shipping core to lab.; may be used in conjunction with drill rig for obtaining deep cores
Bucket auger	Soft soil, 7.5 cm - 3 m (3 in. - 10 ft)	Easy to use; good depth range; uniform diameter and sample volume; may disrupt and mix soil horizons greater than 15 cm
Hand -operated power auger	Soil, 15 cm - 4.5 m (6 in. -15 ft)	Good depth range; generally used in conjunction with bucket auger; destroys soil core; requires two or more operators; can be difficult to decontaminate

* Reproduced from EPA 1991g

Sample containers are generally not a major concern for collecting surface soil samples. Polyethylene bottles with screw caps and wide mouths are recommended. These containers are fairly economical, provide easy access for adding and removing samples, and resist chemicals, breaking, and temperature extremes. Glass containers are also acceptable, but they are fragile and tend to break during shipment. Metal containers are sometimes used, but sealing the container can present a problem and corrosion can be an issue if the samples are stored for a significant length of time.

7.5.2 Building Surfaces

Because building surfaces tend to be relatively smooth and the radioactivity is assumed to be on or near the surface, direct measurements are typically used to provide information on contaminant concentrations. Sometimes, however, it is necessary to collect actual samples of the building material surface for analysis in a laboratory.

7.5.2.1 Sample Volume

The sample volume collected from building surfaces is usually a less significant DQO concern than the area from which the sample was collected. This is because building surface DCGLs are usually expressed in terms of activity per unit area. It is still necessary to consider the sample volume to account for sample matrix effects that may reduce the chemical recovery, which in turn has an affect on the detection limit.

7.5.2.2 Sample Content

If residual activity is covered by paint or some other treatment, the underlying surface and the coating itself may be contaminated. If the activity is a pure alpha or low-energy beta emitter, measurements at the surface will probably not be representative of the actual residual activity level. In this case the surface layer is removed from the known area, such as by using a commercial stripping agent or by physically abrading the surface. The removed coating material is analyzed for activity content and the level converted to appropriate units (*i.e.*, Bq/m^2, $dpm/100\ cm^2$) for comparison with surface activity DCGLs. Direct measurements can be performed on the underlying surface after removal of the coating.

Residual radioactivity may be incorporated into building materials, such as pieces of concrete or other unusual matrices. Development of SOPs for collecting these types of samples may involve consultation with the analytical laboratory to help ensure that the objectives of the survey are achieved.

The thickness of the layer of building surface to be removed as a sample should be consistent with the development of the conceptual site model and the DCGLs. For most sites the surface layer will only be the first few millimeters of the material being sampled.

7.5.2.3 Sampling Equipment

Tools used to provide samples of building surfaces depend on the material to be sampled. Concrete may require chisels, hammers, drills, or other tools specifically designed to remove a thin layer of the surface. Wood surfaces may require using a sander or a saw to collect a sample. Paint may be chemically or physically stripped from the surface.

Sample containers for these samples are generally the same as those recommended for soil samples. If chemicals are used to strip paint or other surface materials, the chemical resistance of the container should be considered.

7.5.3 Other Media

Surface soil and building surfaces are the media addressed in MARSSIM during the final status survey design. Other media may be involved and may have been remediated. Data collection activities during preliminary surveys (*i.e.*, scoping, characterization, remedial action support) may involve collecting samples of other media to support the final status survey design. Examples of other media that may be sampled include:

- subsurface soil
- ground water
- surface water
- sediments
- sewers and septic systems
- flora and fauna (plants and animals)
- airborne particulates
- air (gas)

Appendix M provides a list of resources that can be used to develop sample collection procedures for other media that may required by preliminary surveys to support the development of a final status survey design.

7.6 Field Sample Preparation and Preservation

Proper sample preparation and preservation are essential parts of any radioactivity sampling program. The sampling objectives should be specified before sampling activities begin. Precise records of sample collection and handling are necessary to ensure that data obtained from different locations or time frames are correctly compared.

The appropriateness of sample preparation techniques is a function of the analysis to be performed (EPA 1992a, 1992b). Field sample preparation procedures are a function of the specified analysis and the objectives of the survey. It is essential that these objectives be clearly established and agreed upon in the early stages of survey planning (see Section 2.3).

7.6.1 Surface Soil

Soil and sediment samples, in most protocols, require no field preparation and are not preserved. In some protocols, cooling of soil samples to 4 ^{o}C is required during shipping and storage of soil samples. This is not a practice normally followed for the radiochemical analysis of soil samples.

When replicate samples are prepared in the field, it is necessary to homogenize the sample prior to separation into replicates. There are standard procedures for homogenizing soil in the laboratory (ASTM 1995), but the equipment required for these procedures may not be available in the field. Simple field techniques, such as cone and quarter, or using a riffle splitter to divide the sample may be appropriate if the sample can be dried (ASTM 1993, EPA 1991g). If the sample contains significant amounts of residual water (*e.g.*, forms clumps of soil) and there are no facilities for drying the sample, it is recommended that the homogenization and separation into replicates be performed in a laboratory. It is preferable to use non-blind replicates where the same laboratory prepares and analyzes the replicates rather than use poorly homogenized or heterogeneous samples to prepare replicates samples.

7.6.2 Building Surfaces

Field preparation and preservation of building and associated materials, including smear samples, is not generally required. Homogenization of samples to prepare replicates is the same for building surface material and soil.

7.6.3 Other Media

Other media may have significant requirements related to field sample preparation and preservation. For example, water samples may need filtering and acidification. Storage at reduced temperatures (*i.e.*, cooling or freezing) to reduce biological activity may be necessary for some samples. Addition of chemical preservatives for specific radionuclides or media may also be required.

7.7 Analytical Procedures

The selection of the appropriate radioanalytical methods is normally made prior to the procurement of analytical services and is included in the statement-of-work of the request for proposal. The statement-of-work may dictate the use of specific methods or be performance based. Unless there is a regulatory requirement, such as conformance to the EPA drinking water methods (EPA 1980a), the specification of performance based methodology is encouraged. One reason for this is that a laboratory will usually perform better using the methods routinely employed in its laboratory as contrasted to using other methods with which it has less experience.

The laboratory is also likely to have historical data on performance for methods routinely used by that laboratory. However, the methods employed in a laboratory should be derived from a reliable source, such as those listed in Table 7.2.

Table 7.2 Examples of References for Routine Analytical Methods

- *Methods of Air Sampling and Analysis* (Lodge 1988)
- *Annual Book of ASTM Standards, Water and Environmental technology. Volume 11.04, Environmental Assessment; Hazardous Substances and Oil Spill Responses; Waste Management; Environmental Risk Assessment* (ASTM 1997)
- *Standard Methods for the Examination of Water and Wastewater* (APHA 1995)
- *EML Procedures Manual* (DOE 1990b)
- *Radiochemical Analytical Procedures for Analysis of Environmental Samples* (EPA 1979)
- *Radiochemistry Procedures Manual* (EPA 1984a)
- *Indoor Radon and Radon Decay Product Measurement Protocols* (EPA 1992d)
- *USAEHA Environmental Sampling Guide* (Department of the Army 1993)

This section briefly describes specific equipment and procedures to be used once the sample is prepared for analysis. The results of these analyses (*i.e.*, the levels of radioactivity found in these samples) are the values used to determine the level of residual activity at a site. In a decommissioning effort, the DCGLs are expressed in terms of the concentrations of certain radionuclides. It is of vital importance, therefore, that the analyses be accurate and of adequate sensitivity for the radionuclides of concern. The selection of analytical procedures should be coordinated with the laboratory and specified in the survey plan.

Analytical methods should be adequate to meet the data needs identified in the DQO process. Consultation with the laboratory performing the analysis is recommended before selecting a course of action. MARSSIM is not intended to limit the selection of analytical procedures, rather all applicable methods should be reviewed to provide results that meet the objectives of the survey. The decision maker and survey planning team should decide whether routine methods will be used at the site or if non-routine methods may be acceptable.

- Routine analytical methods are documented with information on minimum performance characteristics, such as detection limit, precision and accuracy, and useful range of radionuclide concentrations and sample sizes. Routine methods may be issued by a recognized organization (*e.g.*, Federal or State agency, professional organization), published in a refereed journal, or developed by an individual laboratory. Table 7.2 lists examples of sources for routine methods.

- Non-routine methods address situations with unusual or problematic matrices, low detection limits, or new parameters, procedures or techniques. Non-routine methods include adjustments to routine methods, new techniques published in refereed literature, and development of new methods.

References that provide information on radiochemical methodology and should be considered in the methods review and selection process are available from such organizations as:

- National Council on Radiation Protection and Measurements (NCRP)
- American Society of Testing and Materials (ASTM)
- Radiological and Environmental Sciences Laboratory (RESL), Idaho Falls, Idaho (Operated by the DOE)
- DOE Technical Measurements Center, Grand Junction, CO
- Environmental Measurements Laboratory (EML); formerly the Health and Safety Laboratory of the DOE

Equipment vendor literature, catalogs, and instrument manuals are often a source of useful information on the characteristics of radiation detection equipment. Table 7.3 provides a summary of common laboratory methods with estimated detection limits.

Analytical procedures in the laboratory consist of several parts that are assembled to produce an SOP for a specific project or sample type. These parts include:

- laboratory sample preparation
- sample dissolution
- sample purification
- preparation for counting
- counting
- data reduction

Table 7.3 Typical Measurement Sensitivities for Laboratory Radiometric Procedures

Sample Type	Radionuclides or Radiation Measured	Procedure	Approximate Measurement Sensitivity
Smears (filter paper)	Gross alpha	Gas-flow proportional counter; 5-min count Alpha scintillation detector with scaler; 5-min count	5 dpm 20 dpm
	Gross beta	Gas-flow proportional counter; 5-min count End window GM with scaler; 5-min count (unshielded detector)	10 dpm 80 dpm
	Low energy beta (^{3}H, ^{14}C, ^{63}Ni)	Liquid scintillation spectrometer; 5-min count	30 dpm
Soil Sediment	^{137}Cs, ^{60}Co, ^{226}Ra (^{214}Bi)[a], ^{232}Th (^{228}Ac), ^{235}U	Germanium detector (25% relative efficiency) with multichannel analyzer; pulse height analyzer; 500-g sample; 15-min analysis	0.04-0.1 Bq/g (1-3 pCi/g)
	$^{234, 235, 238}$U; $^{238, 239, 240}$Pu; $^{227, 228, 230, 232}$Th; other alpha emitters	Alpha spectroscopy with multichannel analyzer - pyrosulfate fusion and solvent extraction; surface barrier detector; pulse height analyzer; 1-g sample; 16-hr count	0.004-0.02 Bq/g (0.1-0.5 pCi/g)
Water	Gross alpha	Gas-flow proportional counter; 100-ml sample, 200-min count	0.04 Bq/L (1 pCi/l)
	Gross beta	Gas-flow proportional counter; 100-ml sample, 200-min count	0.04 Bq/L (1 pCi/L)
	^{137}Cs, ^{60}Co, ^{226}Ra (^{214}Bi), ^{232}Th (^{228}Ac), ^{235}U	Germanium detector (25% relative efficiency) with multichannel analyzer; pulse height analyzer; 3.5L sample, 16-hr count	0.4 Bq/L (10 pCi/L)
	$^{234, 235, 238}$U; $^{238, 239, 240}$Pu; $^{227, 228, 230, 232}$Th; other alpha emitters	Alpha spectroscopy with multichannel analyzer - solvent extraction; surface barrier detector; pulse height analyzer; 100 ml sample, 30 min count	0.004-0.02 Bq/L (0.1-0.5 pCi/L)
	^{3}H	Liquid scintillation spectrometry; 5-ml sample, 30-min count	10 Bq/L (300 pCi/L)

[a] Indicates that a member of the decay series is measured to determine activity level of the parent radionuclide of primary interest.

7.7.1 Photon Emitting Radionuclides

There is no special sample preparation required for counting samples using a germanium detector or a sodium iodide detector beyond placing the sample in a known geometry for which the detector has been calibrated. The samples can be measured as they arrive at the laboratory, or the sample can be dried, ground to a uniform particle size, and mixed to provide a more homogeneous sample if required by the SOPs.

The samples are typically counted using a germanium detector with a multichannel analyzer or a sodium iodide detector with a multichannel analyzer. Germanium detectors have better resolution and can identify peaks (and the associated radionuclides) at lower concentrations. Sodium iodide detectors often have a higher efficiency and are significantly less expensive than germanium detectors. Low-energy photons (*i.e.*, x-rays and gamma rays below 50 keV) can be measured using specially designed detectors with an entrance window made from a very light metal, typically beryllium. Descriptions of germanium and sodium iodide detectors are provided in Appendix H.

Data reduction is usually the critical step in measuring photon emitting radionuclides. There are often several hundred individual gamma ray energies detected within a single sample. Computer software is usually used to identify the peaks, associate them with the proper energy, associate the energy with one or more radionuclides, correct for the efficiency of the detector and the geometry of the sample, and provide results in terms of concentrations with the associated uncertainty. It is important that the software be either a well-documented commercial package or thoroughly evaluated and documented before use.

7.7.2 Beta Emitting Radionuclides

Laboratory sample preparation is an important step in the analysis of surface soil and other solid samples for beta emitting radionuclides. The laboratory will typically have a sample preparation procedure that involves drying the sample and grinding the soil so that all of the particles are less than a specified size to provide a homogeneous sample. A small portion of the homogenized sample is usually all that is required for the individual analysis.

Once the sample has been prepared, a small portion is dissolved, fused, or leached to provide a clear solution containing the radionuclide of interest. The only way to ensure that the sample is solubilized is to completely dissolve the sample. However, this can be an expensive and time-consuming step in the analysis. In some cases, leaching with strong acids can consistently provide greater than 80% recovery of the radionuclide of interest (NCRP 1976a) and may be acceptable for certain applications. Gross beta measurements may be performed on material that has not been dissolved.

After dissolution, the sample is purified using a variety of chemical reactions to remove bulk chemical and radionuclide impurities. The objective is to provide a chemically and radiologically pure sample for measurement. Examples of purification techniques include precipitation, liquid-liquid extraction, ion-exchange chromatography, distillation, and electrodeposition. Gross beta measurements may be performed on material that has not been purified.

After the sample is purified, it is prepared for counting. Beta emitting radionuclides are usually prepared for a specific type of counter in a specified geometry. Solid material is usually precipitated and collected on a filter in a circular geometry to provide a homogeneous sample. Liquid samples are typically converted to the appropriate chemical form and diluted to a specified volume in preparation for counting.

Measurements of solid samples are typically performed using a gas-flow proportional counter. Because total beta activity is measured, it is important that the purification step be performed to remove any interfering radionuclides. Liquid samples are usually diluted using a liquid scintillation cocktail and counted using a liquid scintillation spectrometer. Liquid scintillation spectrometers can be used for low-energy beta emitting radionuclides, such as ^{3}H and ^{63}Ni. They also have high counting efficiencies, but often have a high instrument background as well. Gas-flow proportional counters have a very low background. Appendix H provides a description of both the gas-flow proportional counter and the liquid scintillation spectrometer.

Data reduction for beta emitting radionuclides is less complicated than that for photon emitting radionuclides. Since the beta detectors report total beta activity, the calculation to determine the concentration for the radionuclide of interest is straightforward.

7.7.3 Alpha Emitting Radionuclides

Laboratory sample preparation for alpha emitting radionuclides is similar to that for beta emitting radionuclides. Sample dissolution and purification tasks are also similar to those performed for beta emitting radionuclides.

Because of the limited penetrating power of alpha particles, the preparation for counting is often a critical step. Gross alpha measurements can be made using small sample sizes with a gas-flow proportional counter, but self-absorption of the alpha particles results in a relatively high detection limit for this technique. Liquid scintillation spectrometers can also be used to measure alpha emitting radionuclides but the resolution limits the usefulness of this technique. Most alpha emitting radionuclides are measured in a vacuum (to limit absorption by air) using alpha spectroscopy. This method requires that the sample be prepared as a virtually weightless mount in a specific geometry. Electrodeposition is the traditional method for preparing samples for counting. This technique provides the highest resolution, but it requires a significant amount of

training and expertise on the part of the analyst to produce a high quality sample. Precipitation of the radionuclide of interest on the surface of a substrate is often used to prepare samples for alpha spectroscopy. While this technique generally produces a spectrum with lower resolution, the preparation time is relatively short compared to electrodeposition, and personnel can be trained to prepare acceptable samples relatively quickly.

Alpha emitting radionuclides are typically measured using alpha spectroscopy. The data reduction requirements for alpha spectroscopy are greater than those for beta emitting radionuclides, and similar to those for photon emitting radionuclides. Alpha spectroscopy produces a spectrum of alpha particles detected at different energies, but because the sample is purified prior to counting, all of the alpha particles come from radionuclides of a single element. This simplifies the process of associating each peak with a specific radionuclide, but the lower resolution associated with alpha spectroscopy increases the difficulty of identifying the peaks. Although commercial software packages are available for interpreting alpha spectroscopy results, an experienced operator is required to ensure that the software is working properly.

7.8 Sample Tracking

Sample tracking refers to the identification of samples, their location, and the individuals responsible for their custody and transfer of the custody. This process covers the entire process from collection of the samples and remains intact through the analysis and final holding or disposal. It begins with the taking of a sample where its identification and designation of the sample are critical to being able to relate the analytical result to a site location.

Tracking samples from collection to receipt at the analytical laboratory is normally done through a Chain of Custody process, and documented on a Chain-of-Custody (COC) record. Once samples are received by the laboratory, internal tracking (*e.g.*, COC) procedures should be in place and codified through SOPs that assure integrity of the samples. Documentation of changes in the custody of a sample(s) is important. This is especially true for samples that may be used as evidence to establish compliance with a release criterion. In such cases, there should be sufficient evidence to demonstrate that the integrity of the sample is not compromised from the time it is collected to the time it is analyzed. During this time, the sample should either be under the positive control of a responsible individual or secured and protected from any activity that could change the true value of the results or the nature of the sample. When this degree of sample handling or custody is necessary, written procedures should be developed for field operations and for interfacing between the field operations and the analytical laboratory. This ensures that a clear transfer of the custodial responsibility is well documented and no questions exist as to who is responsible for the sample at any time.

7.8.1 Field Tracking Considerations

- Field personnel are responsible for maintaining field logbooks with adequate information to relate the sample identifier (sample number) to its location and for recording other information necessary to adequately interpret results of sample analytical data.
- The sample collector is responsible for the care and custody of the samples until they are properly transferred or dispatched. This means that samples are in their possession, under constant observation, or secured. Samples may be secured in a sealed container, locked vehicle, locked room, *etc*.
- Sample labels should be completed for each sample using waterproof ink.
- The survey manager or designee determines whether or not proper custody procedures were followed during the field work, and decides if additional sampling is indicated.
- If photographs are included as part of the sampling documentation, the name of the photographer, date, time, site location, and site description should be entered sequentially in a logbook as the photos are taken. After the photographs are developed, the prints should be serially numbered.

7.8.2 Transfer of Custody

- All samples leaving the site should be accompanied by a Chain-of-Custody record. This record documents sample custody transfer from the sampler, often through another person, to the laboratory. The individuals relinquishing the samples should sign and date the record. The record should include a list, including sample designation (number), of the samples in the shipping container and the analysis requested for each sample.
- Shipping containers should be sealed and include a tamper indicating seal that will indicate if the container seal has been disturbed. The method of shipment, courier name, or other pertinent information should be listed in the Chain-of-Custody record.
- The original Chain-of-Custody record should accompany the samples. A copy of the record should be retained by the individual or organization relinquishing the samples.
- Discuss the custody objectives with the shipper to ensure that the objectives are met. For example, if the samples are sent by mail and the originator of the sample requires a record that the shipment was delivered, the package should be registered with return receipt requested. If, on the other hand, the objective is to simply provide a written record of the shipment, a certificate of mailing may be a less expensive and appropriate alternative.
- The individual receiving the samples should sign and date the record. The condition of the container and the tamper indicating seal should be noted on the Chain-of-Custody record. Any problems with the individual samples, such as a broken container, should be noted on the record.

7.8.3 Laboratory Tracking

When the samples are received by the laboratory they are prepared for radiochemical analyses. This includes the fractionation of the sample into aliquots. The tracking and Chain-of-Custody documentation within the laboratory become somewhat complicated due to the fact that several portions of the original sample may exist in the laboratory at a given time. The use of a computer based Laboratory Information System (LIMS) can greatly assist in tracking samples and fractions through the analytical system.

The minimal laboratory tracking process consists of the following:

- transfer of custody on receipt of the samples (original Chain-of-Custody form is retained by the laboratory and submitted with the data package for the samples)
- documentation of sample storage (location and amount)
- documentation of removal and return of sample aliquots (amount, date and time, person removing or returning, and reason for removal)
- transfer of the samples and residues to the receiving authority (usually the site from which they were taken)

The procedure for accomplishing the above varies from laboratory to laboratory, but the exact details of performing the operations of sample tracking should be contained in a SOP.

7.9 Packaging and Transporting Samples

All samples being shipped for radiochemical analysis should be properly packaged and labeled before transport offsite or within the site. The primary concern is the possibility of spills, leaks, or breakage of the sample containers. In addition to resulting in the loss of samples and cross-contamination, the possible release of hazardous material poses a threat to the safety of persons handling and transporting the package.

Suggestions on packaging and shipping radioactive environmental samples are listed below.

1) Review NRC requirements (10 CFR part 71) and Department of Transportation (DOT) requirements (49 CFR parts 170 through 189) for packaging and shipping radioactive environmental samples.

2) Visually inspect each sample container for indication of leaks or defects in the sample container.

a) Liquid samples should be shipped in plastic containers, if possible, and the caps on the containers should be secured with tape. One exception to the use of plastic bottles is samples collected for ^{3}H analyses which may require glass containers.

b) Heavy plastic bags, with sealable tops, can be used to contain solid samples (*e.g.*, soil, sediment, air filters). The zip-lock should be secured with tape. Heavy plastic lawn bags can be used to contain vegetation samples. The tops should be closed with a "tie" that is covered by tape to prevent it from loosening and slipping off.

3) Wipe individual sample containers with a damp cloth or paper towel to remove any exterior contamination. The outer surfaces of containers holding samples collected in a contaminated area should be surveyed with a hand-held instrument(s), appropriate for the suspected type of radioactivity (β/γ or α).

4) If glass sample containers are used, place sample containers inside individual plastic bags and seal in order to contain the sample in case of breakage.

5) Use packing material (*e.g.*, paper, styrofoam, "bubble wrap") to immobilize and isolate each sample container and buffer hard knocks on the outer container during shipping. This is especially important in cold weather when plastic containers may become brittle and water samples may freeze.

6) When liquid samples are shipped, include a sufficient quantity of an absorbent material (*e.g.*, vermiculite) to absorb all liquid packed in the shipping container in case of breakage. This absorbent material may suffice as the packing material described above in item 5.

7) Include the original, signed and dated, Chain-of-Custody (COC) form, identifying each sample in the package. It is good practice to place the COC form in a plastic bag to prevent it from becoming wet or contaminated in case of a spill during shipment. If possible, avoid having multiple packages of samples covered by a single COC form.

8) Seal closed the package and apply COC tape in such a manner that it must be torn (broken) in order to open the package. The tape should carry the signature of the sender, and the date and time, so that it cannot be removed and replaced undetected.

9) Ice chests, constructed of metal or hard plastic, make excellent shipping containers for radioactive environmental samples.

If samples are sent offsite for analysis, the shipper is responsible for complying with all applicable Federal, State, and local regulations. Applicable Federal regulations are briefly addressed below. Any State or local regulation will very likely reflect a Federal regulation.

7.9.1 U.S. Nuclear Regulatory Commission Regulations

NRC regulations for packaging, preparation, and shipment of licensed material are contained in 10 CFR Part 71: "Packaging and Transportation of Radioactive materials".

Samples containing low levels of radioactivity are exempted as set forth in §§ 71.10. A licensee is exempt from all requirements of Part 71 if the specific activity of the sample being shipped is not greater than 74,000 Bq/kg (2,000 pCi/g).

Low Specific Activity Material (LSAM) is defined in §§ 71.4: “Definitions.” Samples classified as LSAM need only meet the requirements of the U.S. Department of Transportation (DOT), discussed below, and the requirements of §§ 71.88: “Air transport of plutonium.” Most environmental samples will fall into this category.

7.9.2 U.S. Department of Transportation Regulations

The U.S. Department of Transportation provides regulations governing the transport of hazardous materials under the Hazardous Materials Transportation Act of 1975 (88 Stat. 2156, Public Law 93-633). Applicable requirements of the regulations are found in 49 CFR Parts 170 through 189. Shippers of samples containing radioactivity should be aware of the current rules in the following areas.

- Accident Reporting - 49 CFR 171
- Marking and Labeling Packages for Shipment - 49 CFR 172
- Packaging - 49 CFR 173
- Placarding a Package - 49 CFR 172
- Registration of Shipper/Carrier - 49 CFR 107
- Shipper Required Training - 49 CFR 172
- Shipping Papers & Emergency Information - 49 CFR 172
- Transport by Air - 49 CFR 175

- Transport by Rail - 49 CFR 174
- Transport by Vessel - 49 CFR 176
- Transport on Public Highway - 49 CFR 177

7.9.3 U.S. Postal Service Regulations

Any package containing radioactive materials is nonmailable if required to bear the U.S. Department of Transportation's Radioactive White-1 (49 CFR 172.436), Radioactive Yellow-II (49 CFR 172.438), or Radioactive Yellow-III (49 CFR 172.440) label, or if it contains quantities of radioactive material in excess of those authorized in Publication 6, Radioactive Material, of the U.S. Postal Service.

8 INTERPRETATION OF SURVEY RESULTS

8.1 Introduction

This chapter discusses the interpretation of survey results, primarily those of the final status survey. Interpreting a survey's results is most straightforward when measurement data are entirely higher or lower than the $DCGL_W$. In such cases, the decision that a survey unit meets or exceeds the release criterion requires little in terms of data analysis. However, formal statistical tests provide a valuable tool when a survey unit's measurements are neither clearly above nor entirely below the $DCGL_W$. Nevertheless, the survey design *always* makes use of the statistical tests in helping to assure that the number of sampling points and the measurement sensitivity are adequate, but not excessive, for the decision to be made.

Section 8.2 discusses the assessment of data quality. The remainder of this chapter deals with application of the statistical tests used in the decision-making process, and the evaluation of the test results. In addition, an example checklist is provided to assist the user in obtaining the necessary information for interpreting the results of a final status survey.

8.2 Data Quality Assessment

Data Quality Assessment (DQA) is a scientific and statistical evaluation that determines if the data are of the right type, quality, and quantity to support their intended use. An overview of the DQA process appears in Section 2.3 and Appendix E. There are five steps in the DQA process:

- Review the Data Quality Objectives (DQOs) and Survey Design
- Conduct a Preliminary Data Review
- Select the Statistical Test
- Verify the Assumptions of the Statistical Test
- Draw Conclusions from the Data

The effort expended during the DQA evaluation should be consistent with the graded approach used in developing the survey design. More information on DQA is located in Appendix E, and the EPA Guidance Document QA/G-9 (EPA 1996a). Data should be verified and validated as described in Section 9.3 prior to the DQA evaluation.

8.2.1 Review the Data Quality Objectives (DQOs) and Sampling Design

The first step in the DQA evaluation is a review of the DQO outputs to ensure that they are still applicable. For example, if the data suggest the survey unit was misclassified as Class 3 instead of Class 1, then the original DQOs should be redeveloped for the correct classification.

The sampling design and data collection documentation should be reviewed for consistency with the DQOs. For example, the review should check that the appropriate number of samples were taken in the correct locations and that they were analyzed with measurement systems with appropriate sensitivity. Example checklists for different types of surveys are given in Chapter 5.

Determining that the sampling design provides adequate power is important to decision making, particularly in cases where the levels of residual radioactivity are near the $DCGL_W$. This can be done both prospectively, during survey design to test the efficacy of a proposed design, and retrospectively, during interpretation of survey results to determine that the objectives of the design are met. The procedure for generating power curves for specific tests is discussed in Appendix I. Note that the accuracy of a prospective power curve depends on estimates of the data variability, σ, and the number of measurements. After the data are analyzed, a sample estimate of the data variability, namely the sample standard deviation (s) and the actual number of valid measurements will be known. The consequence of inadequate power is that a survey unit that actually meets the release criterion has a higher probability of being incorrectly deemed *not* to meet the release criterion.

8.2.2 Conduct a Preliminary Data Review

To learn about the structure of the data—identifying patterns, relationships, or potential anomalies—one can review quality assurance (QA) and quality control (QC) reports, prepare graphs of the data, and calculate basic statistical quantities.

8.2.2.1 Data Evaluation and Conversion

Radiological survey data are usually obtained in units, such as the number of counts per unit time, that have no intrinsic meaning relative to DCGLs. For comparison of survey data to DCGLs, the survey data from field and laboratory measurements are converted to DCGL units. Further information on instrument calibration and data conversion is given in Section 6.2.7.

Basic statistical quantities that should be calculated for the sample data set are the:

- mean
- standard deviation
- median

Example:

Suppose the following 20 concentration values are from a survey unit:

90.7, 83.5, 86.4, 88.5, 84.4, 74.2, 84.1, 87.6, 78.2, 77.6,
86.4, 76.3, 86.5, 77.4, 90.3, 90.1, 79.1, 92.4, 75.5, 80.5.

First, the average of the data (83.5) and the sample standard deviation (5.7) should be calculated.

The average of the data can be compared to the reference area average and the $DCGL_W$ to get a preliminary indication of the survey unit status. Where remediation is inadequate, this comparison may readily reveal that a survey unit contains excess residual radioactivity—even before applying statistical tests. For example, if the average of the data exceeds the $DCGL_W$ and the radionuclide of interest does not appear in background, then the survey unit clearly does not meet the release criterion. On the other hand, if every measurement in the survey unit is below the $DCGL_W$, the survey unit clearly meets the release criterion.[1]

The value of the sample standard deviation is especially important. If too large compared to that assumed during the survey design, this may indicate an insufficient number of samples were collected to achieve the desired power of the statistical test. Again, inadequate power can lead to unnecessary remediation.

The median is the middle value of the data set when the number of data points is odd, and is the average of the two middle values when the number of data points is even. Thus 50% of the data points are above the median, and 50% are below the median. Large differences between the mean and the median would be an early indication of skewness in the data. This would also be evident in a histogram of the data. For the example data above, the median is 84.25 (*i.e.*, (84.1 + 84.4)/2). The difference between the median and the mean (*i.e.*, 84.25 - 83.5 = 0.75) is a small fraction of the sample standard deviation (*i.e.*, 5.7). Thus, in this instance, the mean and median would not be considered significantly different.

Examining the minimum, maximum, and range of the data may provide additional useful information. The minimum in this example is 74.2 and the maximum is 92.4, so the range is 92.4 - 74.2 = 18.2. This is only 3.2 standard deviations. Thus, the range is not unusually large. When there are 30 or fewer data points, values of the range much larger than about 4 to 5 standard deviations would be unusual. For larger data sets the range might be wider.

[1] It can be verified that if every measurement is below the $DCGL_W$, the conclusion from the statistical tests will always be that the survey unit does not exceed the release criterion.

8.2.2.2 Graphical Data Review

At a minimum, a graphical data review should consist of a posting plot and a histogram. Quantile plots are also useful diagnostic tools, particularly in the two-sample case, to compare the survey unit and reference area. These are discussed in Appendix I, Section I.8.

A *posting plot* is simply a map of the survey unit with the data values entered at the measurement locations. This potentially reveals heterogeneities in the data—especially possible patches of elevated residual radioactivity. Even in a reference area, a posting plot can reveal spatial trends in background data that might affect the results of the two-sample statistical tests.

If the data above were obtained using a triangular grid in a rectangular survey unit, the posting plot might resemble the display in Figure 8.1. Figure 8.1a shows no unusual patterns in the data. Figure 8.1b shows a different plot of the same values, but with individual results associated with different locations within the survey unit. In this plot there is an obvious trend towards smaller values as one moves from left to right across the survey unit. This trend is not apparent in the simple initial listing of the data. The trend may become more apparent if isopleths are added to the posting plot.

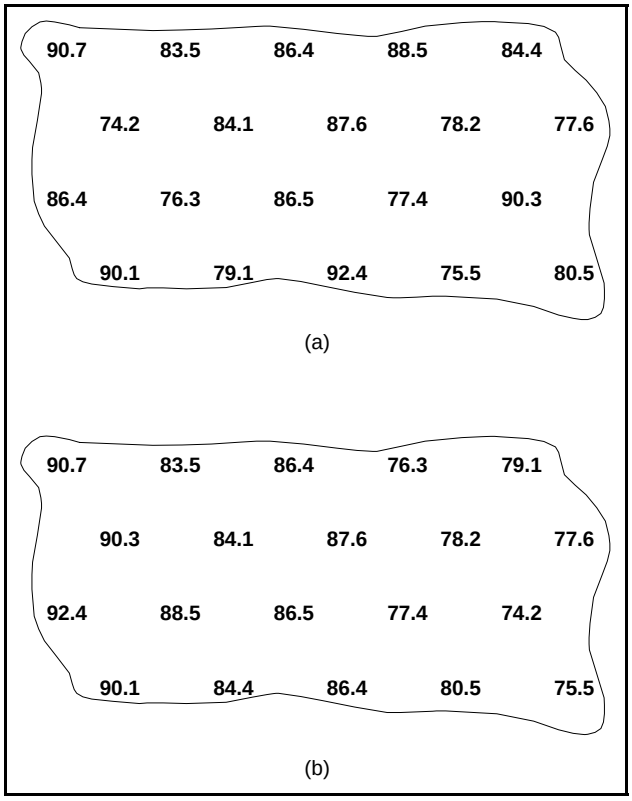

Figure 8.1 Examples of Posting Plots

If the posting plot reveals systematic spatial trends in the survey unit, the cause of the trends would need to be investigated. In some cases, such trends could be due to residual radioactivity, but may also be due to inhomogeneities in the survey unit background. Other diagnostic tools for examining spatial data trends may be found in EPA Guidance Document QA/G-9 (EPA 1996a). The use of geostatistical tools to evaluate spatial data trends may also be useful in some cases (EPA 1989a).

A *frequency plot* (or a histogram) is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. A frequency plot of the example data is shown in Figure 8.2). A simple method for generating a

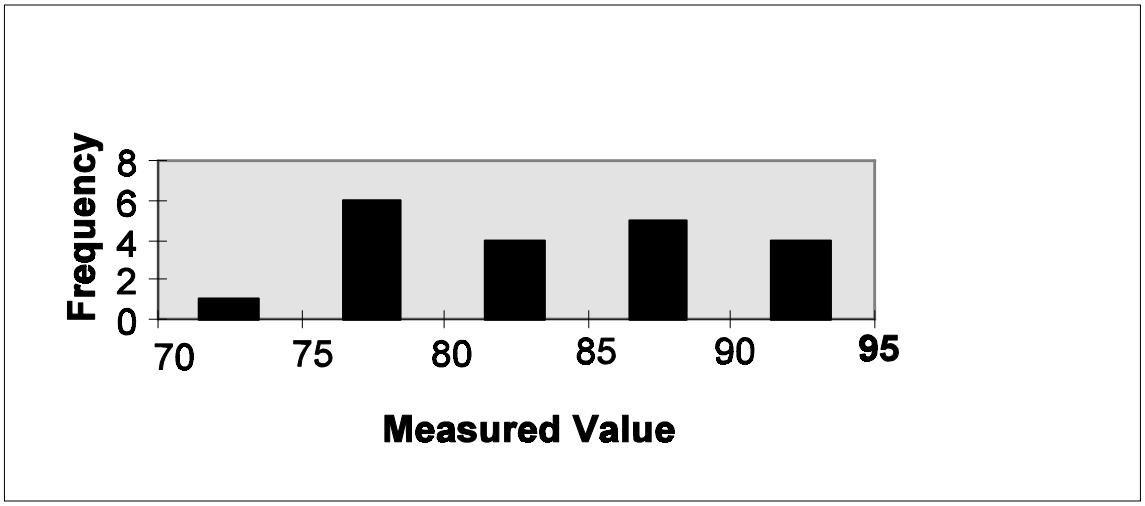

Figure 8.2 Example of a Frequency Plot

rough frequency plot is the stem and leaf display discussed in Appendix I, Section I.7. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distributions for the survey unit or reference area. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity. In some cases it may be possible to determine an appropriate background for the survey unit using this information. The interpretation of the data for this purpose will generally be highly dependent on site-specific considerations and should only be pursued after a consultation with the responsible regulatory agency.

The presence of two peaks in the background reference area or survey unit frequency plot may indicate a mixture of background concentration distributions due to different soil types, construction materials, *etc.* The greater variability in the data due to the presence of such a mixture will reduce the power of the statistical tests to detect an adequately remediated survey unit. These situations should be avoided whenever possible by carefully matching the background reference areas to the survey units, and choosing survey units with homogeneous backgrounds.

Skewness or other asymmetry can impact the accuracy of the statistical tests. A data transformation (*e.g.*, taking the logarithms of the data) can sometimes be used to make the distribution more symmetric. The statistical tests would then be performed on the transformed data. When the underlying data distribution is highly skewed, it is often because there are a few high areas. Since the EMC is used to detect such measurements, the difference between using the median and the mean as a measure for the degree to which uniform residual radioactivity remains in a survey unit tends to diminish in importance.

8.2.3 Select the Tests

An overview of the statistical considerations important for final status surveys appears in Section 2.5 and Appendix D. The most appropriate procedure for summarizing and analyzing the data is chosen based on the preliminary data review. The parameter of interest is the mean concentration in the survey unit. The nonparametric tests recommended in this manual, in their most general form, are tests of the median. If one assumes that the data are from a symmetric distribution—where the median and the mean are effectively equal—these are also tests of the mean. If the assumption of symmetry is violated, then nonparametric tests of the median approximately test the mean. Computer simulations (*e.g.,* Hardin and Gilbert, 1993) have shown that the approximation is a good one. That is, the correct decision will be made about whether or not the mean concentration exceeds the DCGL, even when the data come from a skewed distribution. In this regard, the nonparametric tests are found to be correct more often than the commonly used Student's t test. The robust performance of the Sign and WRS tests over a wide range of conditions is the reason that they are recommended in this manual.

When a given set of assumptions is true, a parametric test designed for exactly that set of conditions will have the highest power. For example, if the data are from a normal distribution, the Student's t test will have higher power than the nonparametric tests. It should be noted that for large enough sample sizes (*e.g.*, large number of measurements), the Student's t test is not a great deal more powerful than the nonparametric tests. On the other hand, when the assumption of normality is violated, the nonparametric tests can be very much more powerful than the t test. Therefore, any statistical test may be used provided that the data are consistent with the assumptions underlying their use. When these assumptions are violated, the prudent approach is to use the nonparametric tests which generally involve fewer assumptions than their parametric equivalents.

The one-sample statistical test (Sign test) described in Section 5.5.2.3 should only be used if the contaminant is not present in background and radionuclide-specific measurements are made. The one-sample test may also be used if the contaminant is present at such a small fraction of the $DCGL_W$ value as to be considered insignificant. In this case, background concentrations of the radionuclide are included with the residual radioactivity (*i.e.*, the entire amount is attributed to facility operations). Thus, the total concentration of the radionuclide is compared to the release criterion. This option should only be used if one expects that ignoring the background concentration will not affect the outcome of the statistical tests. The advantage of ignoring a small background contribution is that no reference area is needed. This can simplify the final status survey considerably.

The one-sample Sign test (Section 8.3.1) evaluates whether the median of the data is above or below the $DCGL_W$. If the data distribution is symmetric, the median is equal to the mean. In cases where the data are severely skewed, the mean may be above the $DCGL_W$, while the median

is below the $DCGL_W$. In such cases, the survey unit does *not* meet the release criterion regardless of the result of the statistical tests. On the other hand, if the largest measurement is below the $DCGL_W$, the Sign test will always show that the survey unit meets the release criterion.

For final status surveys, the two-sample statistical test (Wilcoxon Rank Sum test, discussed in Section 5.5.2.2) should be used when the radionuclide of concern appears in background or if measurements are used that are not radionuclide specific. The two-sample Wilcoxon Rank Sum (WRS) test (Section 8.4.1) assumes the reference area and survey unit data distributions are similar except for a possible shift in the medians. When the data are severely skewed, the value for the mean difference may be above the $DCGL_W$, while the median difference is below the $DCGL_W$. In such cases, the survey unit does *not* meet the release criterion regardless of the result of the statistical test. On the other hand, if the difference between the largest survey unit measurement and the smallest reference area measurement is less than the $DCGL_W$, the WRS test will always show that the survey unit meets the release criterion.

8.2.4 Verify the Assumptions of the Tests

An evaluation to determine that the data are consistent with the underlying assumptions made for the statistical procedures helps to validate the use of a test. One may also determine that certain departures from these assumptions are acceptable when given the actual data and other information about the study. The nonparametric tests described in this chapter assume that the data from the reference area or survey unit consist of independent samples from each distribution.

Spatial dependencies that potentially affect the assumptions can be assessed using posting plots (Section 8.2.2.2). More sophisticated tools for determining the extent of spatial dependencies are also available (*e.g.*, EPA QA/G-9). These methods tend to be complex and are best used with guidance from a professional statistician.

Asymmetry in the data can be diagnosed with a stem and leaf display, a histogram, or a Quantile plot. As discussed in the previous section, data transformations can sometimes be used to minimize the effects of asymmetry.

One of the primary advantages of the nonparametric tests used in this report is that they involve fewer assumptions about the data than their parametric counterparts. If parametric tests are used, (*e.g.*, Student's *t* test), then any additional assumptions made in using them should be verified (*e.g.*, testing for normality). These issues are discussed in detail in EPA QA/G-9 (EPA 1996a).

One of the more important assumptions made in the survey design described in Chapter 5 is that the sample sizes determined for the tests are sufficient to achieve the data quality objectives set for the Type I (α) and Type II (β) error rates. Verification of the power of the tests ($1-\beta$) to detect adequate remediation may be of particular interest. Methods for assessing the power are discussed in Appendix I.9. If the hypothesis that the survey unit residual radioactivity exceeds the release criterion is accepted, there should be reasonable assurance that the test is equally effective in determining that a survey unit has residual contamination less than the $DCGL_W$. Otherwise, unnecessary remediation may result. For this reason, it is better to plan the surveys cautiously—even to the point of:

- overestimating the potential data variability
- taking too many samples
- overestimating minimum detectable concentrations (MDCs)

If one is unable to show that the DQOs were met with reasonable assurance, a resurvey may be needed. Examples of assumptions and possible methods for their assessment are summarized in Table 8.1.

Table 8.1 Methods for Checking the Assumptions of Statistical Tests

Assumption	Diagnostic
Spatial Independence	Posting Plot
Symmetry	Histogram, Quantile Plot
Data Variance	Sample Standard Deviation
Power is Adequate	Retrospective Power Chart

8.2.5 Draw Conclusions from the Data

The types of measurements that can be made in a survey unit are 1) direct measurements at discrete locations, 2) samples collected at discrete locations, and 3) scans. The statistical tests are only applied to measurements made at discrete locations. Specific details for conducting the statistical tests are given in Sections 8.3 and 8.4. When the data clearly show that a survey unit meets or exceeds the release criterion, the result is often obvious without performing the formal statistical analysis. Table 8.2 describes examples of circumstances leading to specific conclusions based on a simple examination of the data.

Table 8.2 Summary of Statistical Tests

Radionuclide not in background and radionuclide-specific measurements made:

Survey Result	Conclusion
All measurements less than $DCGL_W$	Survey unit meets release criterion
Average greater than $DCGL_W$	Survey unit does not meet release criterion
Any measurement greater than $DCGL_W$ and the average less than $DCGL_W$	Conduct Sign test and elevated measurement comparison

Radionuclide in background or radionuclide non-specific (gross) measurements made:

Survey Result	Conclusion
Difference between largest survey unit measurement and smallest reference area measurement is less than $DCGL_W$	Survey unit meets release criterion
Difference of survey unit average and reference area average is greater than $DCGL_W$	Survey unit does not meet release criterion
Difference between any survey unit measurement and any reference area measurement greater than $DCGL_W$ and the difference of survey unit average and reference area average is less than $DCGL_W$	Conduct WRS test and elevated measurement comparison

Both the measurements at discrete locations and the scans are subject to the elevated measurement comparison (EMC). The result of the EMC is not conclusive as to whether the survey unit meets or exceeds the release criterion, but is a flag or trigger for further investigation. The investigation may involve taking further measurements to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion.[2] The investigation should also provide adequate assurance, using the DQO process, that there are no other undiscovered areas of elevated residual radioactivity in the survey unit that might otherwise result in a dose or risk exceeding the release criterion. In some cases, this may lead to re-classifying all or part of a survey unit—unless the results of the investigation indicate that reclassification is not necessary. The investigation level appropriate for each class of survey unit and type of measurement is shown in Table 5.8 and is described in Section 5.5.2.6.

[2] Rather than, or in addition to, taking further measurements the investigation may involve assessing the adequacy of the exposure pathway model used to obtain the DCGLs and area factors, and the consistency of the results obtained with the Historical Site Assessment and the scoping, characterization and remedial action support surveys.

8.2.6 Example

To illustrate the data interpretation process, consider an example facility with 14 survey units consisting of interior concrete surfaces, one interior survey unit with drywall surfaces, and two exterior survey units. The contaminant of concern is ^{60}Co. The interior surfaces were measured with a gas-flow proportional counter (see Appendix H) with an active surface area of 20 cm^2 to determine total beta-gamma activity. Because these measurements are not radionuclide specific, appropriate reference areas were chosen for comparison. The exterior soil was measured with a germanium spectrometer to provide radionuclide-specific results. A reference area is not needed because ^{60}Co does not have a significant background in soil.

The exterior Class 3 survey unit incorporates areas that are not expected to contain residual radioactivity. The exterior Class 2 survey unit is similar to the Class 3 survey unit, but is expected to contain residual radioactivity below the $DCGL_W$. The Class 1 Interior Concrete survey units are expected to contain small areas of elevated activity that may or may not exceed the $DCGL_W$. The Class 2 Interior Drywall survey unit is similar to the Class 1 Interior Concrete survey unit, but the drywall is expected to have a lower background, less measurement variability, and a more uniform distribution of contamination. The Class 2 survey unit is not expected to contain areas of activity above the $DCGL_W$. Section 8.3 describes the Sign test used to evaluate the survey units where the contaminant is not present in background. Section 8.4 describes the WRS test used to evaluate the survey units where the contaminant is present in background. Section 8.5 discusses the evaluation of the results of the statistical tests and the decision regarding compliance with the release criterion. The survey design parameters and DQOs developed for these survey units are summarized in Table 8.3.

Table 8.3 Final Status Survey Parameters for Example Survey Units

Survey Unit	Type	DQO		$DCGL_W$	Estimated Standard Deviation, σ		Test/Section
		α	β		Survey	Reference	
Interior Concrete	Class 1	.05	.05	5000 dpm per 100 cm^2	625 dpm per 100 cm^2	220 dpm per 100 cm^2	WRS/App. A
Interior Drywall	Class 2	.025	.05	5000 dpm per 100 cm^2	200 dpm per 100 cm^2	200 dpm per 100 cm^2	WRS/8.4.3
Exterior Lawn	Class 2	.025	.025	140 Bq/kg	3.8 Bq/kg	N/A	Sign/8.3.3
Exterior Lawn	Class 3	.025	.01	140 Bq/kg	3.8 Bq/kg	N/A	Sign/8.3.4

8.3 Contaminant Not Present in Background

The statistical test discussed in this section is used to compare each survey unit directly with the applicable release criterion. A reference area is not included because the measurement technique is radionuclide-specific and the radionuclide of concern is not present in background (see Section 8.2.6). In this case the contaminant levels are compared directly with the $DCGL_W$. The method in this section should only be used if the contaminant is not present in background or is present at such a small fraction of the $DCGL_W$ value as to be considered insignificant. In addition, one-sample tests are applicable only if radionuclide-specific measurements are made to determine the concentrations. Otherwise, the method in Section 8.4 is recommended.

Reference areas and reference samples are not needed when there is sufficient information to indicate there is essentially no background concentration for the radionuclide being considered. With only a single set of survey unit samples, the statistical test used here is called a one-sample test. See Section 5.5 for further information appropriate to following the example and discussion presented here.

8.3.1 One-Sample Statistical Test

The Sign test is designed to detect uniform failure of remedial action throughout the survey unit. This test does not assume that the data follow any particular distribution, such as normal or log-normal. In addition to the Sign Test, the $DCGL_{EMC}$ (see Section 5.5.2.4) is compared to each measurement to ensure none exceeds the $DCGL_{EMC}$. If a measurement exceeds this DCGL, then additional investigation is recommended, at least locally, to determine the actual areal extent of the elevated concentration.

The hypothesis tested by the Sign test is

Null Hypothesis
H_0: The median concentration of residual radioactivity in the survey unit is greater than the $DCGL_W$

versus

Alternative Hypothesis
H_a: The median concentration of residual radioactivity in the survey unit is less than the $DCGL_W$

The null hypothesis is assumed to be true unless the statistical test indicates that it should be rejected in favor of the alternative. The null hypothesis states that the probability of a measurement less than the $DCGL_W$ is less than one-half, *i.e.*, the 50th percentile (or median) is

greater than the $DCGL_W$. Note that some individual survey unit measurements may exceed the $DCGL_W$ even when the survey unit as a whole meets the release criterion. In fact, a survey unit average that is close to the $DCGL_W$ might have almost half of its individual measurements greater than the $DCGL_W$. Such a survey unit may still not exceed the release criterion.

The assumption is that the survey unit measurements are independent random samples from a symmetric distribution. If the distribution of measurements is symmetric, the median and the mean are the same.

The hypothesis specifies a release criterion in terms of a $DCGL_W$. The test should have sufficient power (1-β, as specified in the DQOs) to detect residual radioactivity concentrations at the Lower Boundary of the Gray Region (LBGR). If σ is the standard deviation of the measurements in the survey unit, then Δ/σ expresses the size of the shift (*i.e.*, $\Delta = DCGL_W$ - LBGR) as the number of standard deviations that would be considered "large" for the distribution of measurements in the survey unit. The procedure for determining Δ/σ is given in Section 5.5.2.3.

8.3.2 Applying the Sign Test

The Sign test is applied as outlined in the following five steps, and further illustrated by the examples in Sections 8.3.3 and 8.3.4.

1. List the survey unit measurements, X_i , i = 1, 2, 3..., N.

2. Subtract each measurement, X_i , from the $DCGL_W$ to obtain the differences:
   $$D_i = DCGL_W - X_i, \; i = 1, 2, 3..., N.$$

3. Discard each difference that is exactly zero and reduce the sample size, N, by the number of such zero measurements.

4. Count the number of positive differences. The result is the test statistic S+. Note that a positive difference corresponds to a measurement below the $DCGL_W$ and contributes evidence that the survey unit meets the release criterion.

5. Large values of S+ indicate that the null hypothesis (that the survey unit exceeds the release criterion) is false. The value of S+ is compared to the critical values in Table I.3. If S+ is greater than the critical value, k, in that table, the null hypothesis is rejected.

8.3.3 Sign Test Example: Class 2 Exterior Soil Survey Unit

For the Class 2 Exterior Soil survey unit, the one-sample nonparametric statistical test is appropriate since the radionuclide of concern does not appear in background and radionuclide-specific measurements were made.

Table 8.3 shows that the DQOs for this survey unit include $\alpha = 0.025$ and $\beta = 0.025$. The $DCGL_W$ is 140 Bq/kg (3.8 pCi/g) and the estimated standard deviation of the measurements is σ = 3.8 Bq/kg (0.10 pCi/g). Since the estimated standard deviation is much smaller than the $DCGL_W$, the LBGR should be set so that Δ/σ is about 3.

If $\Delta/\sigma = (DCGL_W - LBGR)/\sigma$
$= 3$
then $LBGR = DCGL_W - 3\sigma$
$= 140 - (3 \times 3.8)$
$= 128$ Bq/kg (3.5 pCi/g).

Table 5.5 indicates the number of measurements estimated for the Sign Test, N, is 20 ($\alpha = 0.025$, $\beta = 0.025$, and $\Delta/\sigma = 3$). (Table I.2a in Appendix I also lists the number of measurements estimated for the Sign test.) This survey unit is Class 2, so the 20 measurements needed were made on a random-start triangular grid. When laying out the grid, 22 measurement locations were identified.

The 22 measurements taken on the exterior lawn Class 2 survey unit are shown in the first column of Table 8.4. The mean of these data is 129 Bq/kg (3.5 pCi/g) and the standard deviation is 11 Bq/kg (0.30 pCi/g). Since the number of measurements is even, the median of the data is the average of the two middle values (126+128)/2 = 127 Bq/kg (3.4 pCi/g). A Quantile Plot of the data is shown in Appendix I.8, Figure I.3.

There are five measurements that exceed the $DCGL_W$ value of 140 Bq/kg: 142, 143, 145, 148, and 148. However, none exceed the mean of the data plus three standard deviations: $127 + (3 \times 11) = 160$ Bq/kg (4.3 pCi/g). Thus, these values appear to reflect the overall variability of the concentration measurements rather than to indicate an area of elevated activity—*provided* that these measurements were scattered through the survey unit. However, if a posting plot demonstrates that the locations of these measurements are grouped together, then that portion of the survey unit containing these locations merits further investigation.

The middle column of Table 8.4 contains the differences, $DCGL_W$ - *Data*, and the last column contains the signs of the differences. The bottom row shows the number of measurements with positive differences, which is the test statistic S+. In this case, S+ = 17.

The value of S+ is compared to the appropriate critical value in Table I.3. In this case, for $N = 22$ and $\alpha = 0.025$, the critical value is 16. Since S+ = 17 exceeds this value, the null hypothesis that the survey unit exceeds the release criterion is rejected.

Table 8.4 Example Sign Analysis: Class 2 Exterior Soil Survey Unit

Data (Bq/kg)	$DCGL_W$-Data (Bq/kg)	Sign
121	19	1
143	-3	-1
145	-5	-1
112	28	1
125	15	1
132	8	1
122	18	1
114	26	1
123	17	1
148	-8	-1
115	25	1
113	27	1
126	14	1
134	6	1
148	-8	-1
130	10	1
119	21	1
136	4	1
128	12	1
125	15	1
142	-2	-1
129	11	1
Number of positive differences S+ = 17		

8.3.4 Sign Test Example: Class 3 Exterior Soil Survey Unit

For the Class 3 exterior soil survey unit, the one-sample nonparametric statistical test is again appropriate since the radionuclide of concern does not appear in background and radionuclide-specific measurements were made.

Table 8.3 shows that the DQOs for this survey unit include $\alpha = 0.025$ and $\beta = 0.01$. The $DCGL_W$ is 140 Bq/kg (3.8 pCi/g) and the estimated standard deviation of the measurements is $\sigma = 3.8$ Bq/kg (0.10 pCi/g). Since the estimated standard deviation is much smaller than the $DCGL_W$, the lower bound for the gray region should be set so that Δ/σ is about 3.

If $\Delta/\sigma = (DCGL_W - LBGR)/\sigma$
$= 3$
then $LBGR = DCGL_W - 3\sigma$
$= 140 - (3 \times 4)$
$= 128$ Bq/kg (3.5 pCi/g).

Table 5.5 indicates that the sample size estimated for the Sign Test, N, is 23 ($\alpha = 0.025$, $\beta = 0.01$, and $\Delta/\sigma = 3$). This survey unit is Class 3, so the measurements were made at random locations within the survey unit.

The 23 measurements taken on the exterior lawn are shown in the first column of Table 8.5. Notice that some of these measurements are negative (-0.37 in cell A6). This might occur if an analysis background (*e.g.*, the Compton continuum under a spectrum peak) is subtracted to obtain the net concentration value. The data analysis is both easier and more accurate when numerical values are reported *as obtained* rather than reporting the results as "less than" or not detected. The mean of these data is 2.1 Bq/kg (0.057 pCi/g) and the standard deviation is 3.3 Bq/kg (0.089 pCi/g). None of the data exceed $2.1 + (3 \times 3.3) = 12.0$ Bq/kg (0.32 pCi/g). Since N is odd, the median is the middle (12th highest) value, namely 2.6 Bq/kg (0.070 pCi/g).

An initial review of the data reveals that every data point is below the $DCGL_W$, so the survey unit meets the release criterion specified in Table 8.3. For purely illustrative purposes, the Sign test analysis is performed. The middle column of Table 8.5 contains the quantity $DCGL_W$ - Data. Since every data point is below the $DCGL_W$, the sign of $DCGL_W$ - Data is always positive. The number of positive differences is equal to the number of measurements, N, and so the Sign test statistic S+ is 23. The null hypothesis will always be rejected at the maximum value of S+ (which in this case is 23) and the survey unit passes. Thus, the application of the Sign test in such cases requires no calculations and one need not consult a table for a critical value. If the survey is properly designed, the critical value must always be less than N.

Passing a survey unit without making a single calculation may seem an unconventional approach. However, the key is in the survey design which is intended to ensure enough measurements are made to satisfy the DQOs. As in the previous example, after the data are collected the conclusions and power of the test can be checked by constructing a retrospective power curve as outlined in Appendix I, Section I..9.

One final consideration remains regarding the survey unit classification: "Was any definite amount of residual radioactivity found in the survey unit?" This will depend on the MDC of the measurement method. Generally the MDC is at least 3 or 4 times the estimated measurement standard deviation. In the present case, the largest observation, 9.3 Bq/kg (0.25 pCi/g), is less than three times the estimated measurement standard deviation of 3.8 Bq/kg (0.10 pCi/g). Thus, it is unlikely that any of the measurements could be considered indicative of positive contamination. This means that the Class 3 survey unit classification was appropriate.

Table 8.5 Sign Test Example Data for Class 3 Exterior Survey Unit

	A	B	C
1	Data	$DCGL_W$-Data	Sign
2	3.0	137.0	1
3	3.0	137.0	1
4	1.9	138.1	1
5	0.37	139.6	1
6	-0.37	140.4	1
7	6.3	133.7	1
8	-3.7	143.7	1
9	2.6	137.4	1
10	3.0	137.0	1
11	-4.1	144.1	1
12	3.0	137.0	1
13	3.7	136.3	1
14	2.6	137.4	1
15	4.4	135.6	1
16	-3.3	143.3	1
17	2.1	137.9	1
18	6.3	133.7	1
19	4.4	135.6	1
20	-0.37	140.4	1
21	4.1	135.9	1
22	-1.1	141.1	1
23	1.1	138.9	1
24	9.3	130.7	1
25	Number of positive differences S+ =		23

If one determines that residual radioactivity is definitely present, this would indicate that the survey unit was initially mis-classified. Ordinarily, MARSSIM recommends a resurvey using a Class 1 or Class 2 design. If one determines that the survey unit is a Class 2, a resurvey might be avoided if the survey unit does not exceed the maximum size for such a classification. In this case, the only difference in survey design would be whether the measurements were obtained on a random or on a triangular grid. Provided that the initial survey's scanning methodology is sufficiently sensitive to detect areas at $DCGL_W$ without the use of an area factor, this difference in the survey grids alone would not affect the outcome of the statistical analysis. Therefore, if the above conditions were met, a resurvey might not be necessary.

8.4 Contaminant Present in Background

The statistical tests discussed in this section will be used to compare each survey unit with an appropriately chosen, site-specific reference area. Each reference area should be selected on the basis of its similarity to the survey unit, as discussed in Section 4.5.

8.4.1 Two-Sample Statistical Test

The comparison of measurements from the reference area and survey unit is made using the Wilcoxon Rank Sum (WRS) test (also called the Mann-Whitney test). The WRS test should be conducted for each survey unit. In addition, the EMC is performed against each measurement to ensure that it does not exceed a specified investigation level. If any measurement in the remediated survey unit exceeds the specified investigation level, then additional investigation is recommended, at least locally, regardless of the outcome of the WRS test.

The WRS test is most effective when residual radioactivity is uniformly present throughout a survey unit. The test is designed to detect whether or not this activity exceeds the $DCGL_W$. The advantage of the nonparametric WRS test is that it does not assume that the data are normally or log-normally distributed. The WRS test also allows for "less than" measurements to be present in the reference area and the survey units. As a general rule, the WRS test can be used with up to 40 percent "less than" measurements in either the reference area or the survey unit. However, the use of "less than" values in data reporting is not recommended as discussed in Section 2.3.5. When possible, report the actual result of a measurement together with its uncertainty.

The hypothesis tested by the WRS test is

> Null Hypothesis
> H_0: The median concentration in the survey unit exceeds that in the reference area by more than the $DCGL_W$
>
> versus
>
> Alternative Hypothesis
> H_a: The median concentration in the survey unit exceeds that in the reference area by less than the $DCGL_W$

The null hypothesis is assumed to be true unless the statistical test indicates that it should be rejected in favor of the alternative. One assumes that any difference between the reference area and survey unit concentration distributions is due to a shift in the survey unit concentrations to higher values (*i.e.*, due to the presence of residual radioactivity in addition to background). Note that some or all of the survey unit measurements may be larger than some reference area

measurements, while still meeting the release criterion. Indeed, some survey unit measurements may exceed some reference area measurements by more than the $DCGL_W$. The result of the hypothesis test determines whether or not the survey unit as a whole is deemed to meet the release criterion. The EMC is used to screen individual measurements.

Two assumptions underlying this test are: 1) samples from the reference area and survey unit are independent, identically distributed random samples, and 2) each measurement is independent of every other measurement, regardless of the set of samples from which it came.

8.4.2 Applying the Wilcoxon Rank Sum Test

The WRS test is applied as outlined in the following six steps and further illustrated by the examples in Section 8.4.3 and Appendix A.

1. Obtain the adjusted reference area measurements, Z_i , by adding the $DCGL_W$ to each reference area measurement, X_i. $Z_i = X_i + DCGL_W$

2. The m adjusted reference sample measurements, Z_i , from the reference area and the n sample measurements, Y_i , from the survey unit are pooled and ranked in order of increasing size from 1 to N, where $N = m+n$.

3. If several measurements are tied (*i.e.*, have the same value), they are all assigned the average rank of that group of tied measurements.

4. If there are t "less than" values, they are all given the average of the ranks from 1 to t. Therefore, they are all assigned the rank $t(t+1)/(2t) = (t+1)/2$, which is the average of the first t integers. If there is more than one detection limit, all observations below the largest detection limit should be treated as "less than" values.[3]

5. Sum the ranks of the adjusted measurements from the reference area, W_r. Note that since the sum of the first N integers is $N(N+1)/2$, one can equivalently sum the ranks of the measurements from the survey unit, W_s, and compute $W_r = N(N+1)/2 - W_s$.

6. Compare W_r with the critical value given in Table I.4 for the appropriate values of n, m, and α. If W_r is greater than the tabulated value, reject the hypothesis that the survey unit exceeds the release criterion.

---

[3] If more than 40 percent of the data from either the reference area or survey unit are "less than," the WRS test *cannot* be used. Such a large proportion of non-detects suggest that the DQO process be re-visited for this survey to determine if the survey unit was properly classified or the appropriate measurement method was used. As stated previously, the use of "less than" values in data reporting is not recommended. Wherever possible, the actual result of a measurement, together with its uncertainty, should be reported.

8.4.3 Wilcoxon Rank Sum Test Example: Class 2 Interior Drywall Survey Unit

In this example, the gas-flow proportional counter measures total beta-gamma activity (see Appendix H) and the measurements are not radionuclide specific. The two-sample nonparametric test is appropriate for the Class 2 interior drywall survey unit because gross beta-gamma activity contributes to background even though the radionuclide of interest does not appear in background.

Table 8.3 shows that the DQOs for this survey unit include $\alpha = 0.025$ and $\beta = 0.05$. The $DCGL_W$ is 8,300 Bq/m^2 (5,000 dpm per 100 cm^2) and the estimated standard deviation of the measurements is about σ = 1,040 Bq/m^2 (625 dpm per 100 cm^2). The estimated standard deviation is 8 times less than the $DCGL_W$. With this level of precision, the width of the gray region can be made fairly narrow. As noted earlier, sample sizes do not decrease very much once Δ/σ exceeds 3 or 4. In this example, the lower bound for the gray region was set so that Δ/σ is about 4.

If $\Delta/\sigma = (DCGL_W - LBGR)/\sigma$
$= 4$
then $LBGR = DCGL_W - 4\sigma$
$= 8{,}300 - (4 \times 1{,}040)$
$= 4{,}100$ Bq/m^2 (2,500 dpm per 100 cm^2).

In Table 5.3, one finds that the number of measurements estimated for the WRS test is 11 in each survey unit and 11 in each reference area ($\alpha = 0.025$, $\beta = 0.05$, and $\Delta/\sigma = 4$). (Table I.2b in Appendix I also lists the number of measurements estimated for the WRS test.) This survey unit was classified as Class 2, so the 11 measurements needed in the survey unit and the 11 measurements needed in the reference area were made using a random-start triangular grid.[4]

Table 8.6 lists the data obtained from the gas-flow proportional counter in units of counts per minute. A reading of 160 cpm with this instrument corresponds to the $DCGL_W$ of 8,300 Bq/m^2 (5,000 dpm per 100 cm^2). Column A lists the measurement results as they were obtained. The average and standard deviation of the reference area measurements are 44 and 4.4 cpm, respectively. The average and standard deviation of the survey unit measurements are 98 and 5.3 cpm, respectively.

[4]A random start systematic grid is used in Class 2 and 3 survey units primarily to limit the size of any potential elevated areas. Since areas of elevated activity are not an issue in the reference areas, the measurement locations can be either random or on a random start systematic grid (see Section 5.5.2.5).

Table 8.6 WRS Test for Class 2 Interior Drywall Survey Unit

	A	B	C	D	E
1	**Data (cpm)**	**Area**	**Adjusted Data**	**Ranks**	**Reference Area Ranks**
2	49	R	209	22	22
3	35	R	195	12	12
4	45	R	205	17.5	17.5
5	45	R	205	17.5	17.5
6	41	R	201	14	14
7	44	R	204	16	16
8	48	R	208	21	21
9	37	R	197	13	13
10	46	R	206	19	19
11	42	R	202	15	15
12	47	R	207	20	20
13	104	S	104	9.5	0
14	94	S	94	4	0
15	98	S	98	6	0
16	99	S	99	7	0
17	90	S	90	1	0
18	104	S	104	9.5	0
19	95	S	95	5	0
20	105	S	105	11	0
21	93	S	93	3	0
22	101	S	101	8	0
23	92	S	92	2	0
24	Sum =			253	**187**

In column B, the code "R" denotes a reference area measurement, and "S" denotes a survey unit measurement. Column C contains the Adjusted Data. The Adjusted Data are obtained by adding the $DCGL_W$ to the reference area measurements (see Section 8.4.2, Step 1). The ranks of the adjusted data appear in Column D. They range from 1 to 22, since there is a total of 11+11 measurements (see Section 8.4.2, Step 2).

Note that there were two cases of measurements tied with the same value, at 104 and 209. Each tied measurement is always assigned the average of the ranks. Therefore, both measurements at 104, are assigned rank (9+10)/2 = 9.5 (see Section 8.4.2, Step 3). Also note that the sum of *all* of the ranks is still 22(22+1)/2 = 253. Checking this value with the formula in Step 5 of Section 8.4.2 is recommended to guard against errors in the rankings.

Column E contains only the ranks belonging to the reference area measurements. The total is 187. This is compared with the entry for the critical value of 156 in Table I.4 for $\alpha = 0.025$, with $n = 11$ and $m = 11$. Since the sum of the reference area ranks is greater than the critical value, the null hypothesis (*i.e.*, that the average survey unit concentration exceeds the $DCGL_W$) is rejected.

The analysis for the WRS test is very well suited to the use of a computer spreadsheet. The spreadsheet formulas used for the example above are given in Appendix I.10, Table I.11.

8.4.4 Class 1 Interior Concrete Survey Unit

As in the previous example, the gas-flow proportional counter measures total beta-gamma activity (see Appendix H) and the measurements are not radionuclide specific. The two-sample nonparametric test is appropriate for the Class 1 interior concrete survey unit because gross beta-gamma activity contributes to background even though the radionuclide of interest does not appear in background.

Appendix A provides a detailed description of the calculations for the Class 1 interior concrete survey unit.

8.4.5 Multiple Radionuclides

The use of the unity rule when there is more than one radionuclide to be considered is discussed in Appendix I.11. An example application appears in Section I.11.4.

8.5 Evaluating the Results: The Decision

Once the data and the results of the tests are obtained, the specific steps required to achieve site release depend on the procedures instituted by the governing regulatory agency and site-specific ALARA considerations. The following suggested considerations are for the interpretation of the test results with respect to the release limit established for the site or survey unit. Note that the tests need not be performed in any particular order.

8.5.1 Elevated Measurement Comparison

The Elevated Measurement Comparison (EMC) consists of comparing each measurement from the survey unit with the *investigation levels* discussed in Section 5.5.2.6 and Section 8.2.5. The EMC is performed for both measurements obtained on the systematic-sampling grid and for locations flagged by scanning measurements. Any measurement from the survey unit that is equal to or greater than an *investigation level* indicates an area of relatively high concentrations that should be investigated—regardless of the outcome of the nonparametric statistical tests.

The statistical tests may not reject H_0 when only a very few high measurements are obtained in the survey unit. The use of the EMC against the investigation levels may be viewed as assurance that unusually large measurements will receive proper attention regardless of the outcome of those tests and that any area having the potential for significant dose contributions will be identified. The EMC is intended to flag potential failures in the remediation process. This should not be considered the primary means to identify whether or not a site meets the release criterion.

The derived concentration guideline level for the EMC is:

$$DCGL_{EMC} = A_m \times DCGL_W \qquad 8\text{-}1$$

where A_m is the area factor for the area of the systematic grid area. Note that $DCGL_{EMC}$ is an *a priori* limit, established both by the $DCGL_W$ and by the survey design (*i.e.*, grid spacing and scanning MDC). The true extent of an area of elevated activity can only be determined after performing the survey and taking additional measurements. Upon the completion of further investigation, the *a posteriori* limit, $DCGL_{EMC} = A_m \times DCGL_W$, can be established using the value of A_m appropriate for the *actual area of elevated concentration*. The area of elevated activity is generally bordered by concentration measurements below the $DCGL_W$. An individual elevated measurement on a systematic grid could conceivably represent an area four times as large as the systematic grid area used to define the $DCGL_{EMC}$. This is the area bounded by the nearest neighbors of the elevated measurement location. The results of the investigation should show that the appropriate $DCGL_{EMC}$ is not exceeded. Area factors are discussed in Section 5.5.2.4.

If measurements above the stated scanning MDC are found by sampling or by direct measurement at locations that were not flagged by the scanning survey, this may indicate that the scanning method did not meet the DQOs.

The preceding discussion primarily concerns Class 1 survey units. Measurements exceeding $DCGL_W$ in Class 2 or Class 3 areas may indicate survey unit mis-classification. Scanning coverage for Class 2 and Class 3 survey units is less stringent than for Class 1. If the investigation levels of Section 8.2.5 are exceeded, an investigation should: 1) ensure that the area of elevated activity discovered meets the release criterion, and 2) provide reasonable assurance that other undiscovered areas of elevated activity do not exist. If further investigation determines that the survey unit was mis-classified with regard to contamination potential, then a resurvey using the method appropriate for the new survey unit classification may be appropriate.

8.5.2 Interpretation of Statistical Test Results

The result of the statistical test is the decision to reject or not to reject the null hypothesis. Provided that the results of investigations triggered by the EMC were resolved, a rejection of the null hypothesis leads to the decision that the survey unit meets the release criterion. However, estimating the average residual radioactivity in the survey unit may also be necessary so that dose or risk calculations can be made. This estimate is designated δ. The average concentration is generally the best estimator for δ (EPA 1992g). However, only the unbiased measurements from the statistically designed survey should be used in the calculation of δ.

If residual radioactivity is found in an isolated area of elevated activity—in addition to residual radioactivity distributed relatively uniformly across the survey unit—the unity rule (Section 4.3.3) can be used to ensure that the total dose is within the release criterion:

$$\frac{\delta}{DCGL_W} + \frac{(average\ concentration\ in\ elevated\ area - \delta)}{(area\ factor\ for\ elevated\ area)(DCGL_W)} < 1 \qquad \textbf{8-2}$$

If there is more than one elevated area, a separate term should be included for each. When calculating δ for use in this inequality, measurements falling within the elevated area may be excluded providing the overall average in the survey unit is less than the $DCGL_W$. As an alternative to the unity rule, the dose or risk due to the actual residual radioactivity distribution can be calculated if there is an appropriate exposure pathway model available. Note that these considerations generally apply only to Class 1 survey units, since areas of elevated activity should not exist in Class 2 or Class 3 survey units.

A retrospective power analysis for the test will often be useful, especially when the null hypothesis is not rejected (see Appendix I.9). When the null hypothesis is not rejected, it may be because it is in fact true, or it may be because the test did not have sufficient power to detect that it is not true. The power of the test will be primarily affected by changes in the actual number of measurements obtained and their standard deviation. An effective survey design will slightly overestimate both the number of measurements and the standard deviation to ensure adequate power. This insures that a survey unit is not subjected to additional remediation simply because the final status survey is not sensitive enough to detect that residual radioactivity is below the guideline level. When the null hypothesis is rejected, the power of the test becomes a somewhat moot question. Nonetheless, even in this case, a retrospective power curve can be a useful diagnostic tool and an aid to designing future surveys.

8.5.3 If the Survey Unit Fails

The guidance provided in MARSSIM is fairly explicit concerning the steps that should be taken to show that a survey unit meets release criteria. Less has been said about the procedures that should be used if at any point the survey unit fails. This is primarily because there are many different ways that a survey unit may fail the final status survey. The overall level of residual

radioactivity may not pass the nonparametric statistical tests. Further investigation following the elevated measurement comparison may show that there is a large enough area with a concentration too high to meet the release criterion. Investigation levels may have caused locations to be flagged during scanning that indicate unexpected levels of residual radioactivity for the survey unit classification. Site-specific information is needed to fully evaluate all of the possible reasons for failure, their causes, and their remedies.

When a survey unit fails to demonstrate compliance with the release criterion, the first step is to review and confirm the data that led to the decision. Once this is done, the DQO Process (Appendix D) can be used to identify and evaluate potential solutions to the problem. The level of residual radioactivity in the survey unit should be determined to help define the problem. Once the problem has been stated the decision concerning the survey unit should be developed into a decision rule. Next, determine the additional data, if any, needed to document that the survey unit demonstrates compliance with the release criterion. Alternatives to resolving the decision statement should be developed for each survey unit that fails the tests. These alternatives are evaluated against the DQOs, and a survey design that meets the objectives of the project is selected.

For example, a Class 2 survey unit passes the nonparametric statistical tests, but has several measurements on the sampling grid that exceed the $DCGL_W$. This is unexpected in a Class 2 area, and so these measurements are flagged for further investigation. Additional sampling confirms that there are several areas where the concentration exceeds the $DCGL_W$. This indicates that the survey unit was mis-classified. However, the scanning technique that was used was sufficient to detect residual radioactivity at the $DCGL_{EMC}$ calculated for the sample grid. No areas exceeding the $DCGL_{EMC}$ where found. Thus, the only difference between the final status survey actually done, and that which would be required for a Class 1 area, is that the scanning may not have covered 100% of the survey unit area. In this case, one might simply increase the scan coverage to 100%. Reasons why the survey unit was misclassified should be noted. If no areas exceeding the $DCGL_{EMC}$ are found, the survey unit essentially demonstrates compliance with the release criterion as a Class 1 survey unit.

If, in the example above, the scanning technique was not sufficiently sensitive, it may be possible to re-classify as Class 1 only that portion of the survey unit containing the higher measurements. This portion would be re-sampled at the higher measurement density required for a Class 1 survey unit, with the rest of the survey unit remaining Class 2.

A second example might be a Class 1 Survey unit that passes the nonparametric statistical tests and contains some areas that were flagged for investigation during scanning. Further investigation, sampling and analysis indicates one area is truly elevated. This area has a concentration that exceeds the $DCGL_W$ by a factor greater than the area factor calculated for its actual size. This area is then remediated. Remediation control sampling shows that the residual

radioactivity was removed, and no other areas were contaminated with removed material. In this case one may simply document the original final status survey, the fact that remediation was performed, the results of the remedial action support survey, and the additional remediation data. In some cases, additional final status survey data may not be needed to demonstrate compliance with the release criterion.

As a last example, consider a Class 1 area which fails the nonparametric statistical tests. Confirmatory data indicates that the average concentration in the survey unit does exceed the $DCGL_W$ over a majority of its area. This indicates remediation of the entire survey unit is necessary, followed by another final status survey. Reasons for performing a final status survey in a survey unit with significant levels of residual radioactivity should be noted.

These examples are meant to illustrate the actions that may be necessary to secure the release of a survey unit that has failed to meet the release criterion. The DQO Process should be revisited to plan how to attain the original objective, that is to safely release the survey unit by showing that it meets the release criterion. Whatever data are necessary to meet this objective will be in addition to the final status survey data already in hand.

8.5.4 Removable Activity

Some regulatory agencies may require that smear samples be taken at indoor grid locations as an indication of removable surface activity. The percentage of removable activity assumed in the exposure pathway models has a great impact on dose calculations. However, measurements of smears are very difficult to interpret quantitatively. Therefore, the results of smear samples should not be used for determining compliance. Rather, they should be used as a diagnostic tool to determine if further investigation is necessary.

8.6 Documentation

Documentation of the final status survey should provide a complete and unambiguous record of the radiological status of the survey unit relative to the established DCGLs. In addition, sufficient data and information should be provided to enable an independent evaluation of the results of the survey including repeating measurements at some future time. The documentation should comply with all applicable regulatory requirements. Additional information on documentation is provided in Chapter 3, Chapter 5, Chapter 9, and Appendix N.

Much of the information in the final status report will be available from other decommissioning documents. However, to the extent practicable, this report should be a stand-alone document with minimum information incorporated by reference. This document should describe the

instrumentation or analytical methods used, how the data were converted to DCGL units, the process of comparing the results to the DCGLs, and the process of determining that the data quality objectives were met.

The results of actions taken as a consequence of individual measurements or sample concentrations in excess of the investigation levels should be reported together with any additional data, remediation, or re-surveys performed to demonstrate that issues concerning potential areas of elevated activity were resolved. The results of the data evaluation using statistical methods to determine if release criteria were satisfied should be described. If criteria were not met or if results indicate a need for additional data, appropriate further actions should be determined by the site management in consultation with the responsible regulatory agency.

EXAMPLE DATA INTERPRETATION CHECKLIST

CONVERT DATA TO STANDARD UNITS

_____ Structure activity in Bq/m^2 (dpm/100 cm^2)
_____ Solid media (soil, *etc.*) activity in Bq/kg (pCi/g)

EVALUATE ELEVATED MEASUREMENTS

_____ Identify elevated data
_____ Compare data with derived elevated area criteria
_____ Determine need to remediate and/or reinvestigate elevated condition
_____ Compare data with survey unit classification criteria
_____ Determine need to investigate and/or reclassify

ASSESS SURVEY DATA

_____ Review DQOs and survey design
_____ Verify that data of adequate quantity and quality were obtained
_____ Perform preliminary assessments (graphical methods) for unusual or suspicious trends or results—investigate further as appropriate

PERFORM STATISTICAL TESTS

_____ Select appropriate tests for category of contaminant
_____ Conduct tests
_____ Compare test results against hypotheses
_____ Confirm power level of tests

COMPARE RESULTS TO GUIDELINES

_____ Determine average or median concentrations
_____ Confirm that residual activity satisfies guidelines

COMPARE RESULTS WITH DQOs*

_____ Determine whether all DQOs are satisfied
_____ Explain/describe deviations from design-basis DQOs

* ALARA may be included in the DQOs.

9 QUALITY ASSURANCE AND QUALITY CONTROL

9.1 Introduction

The goal of quality assurance and quality control (QA/QC) is to identify and implement sampling and analytical methodologies which limit the introduction of error into analytical data. For MARSSIM data collection and evaluation, a system is needed to ensure that radiation surveys produce results that are of the type and quality needed and expected for their intended use. A *quality system* is a management system that describes the elements necessary to plan, implement, and assess the effectiveness of QA/QC activities. This system establishes many functions including: quality management policies and guidelines for the development of organization- and project-specific quality plans; criteria and guidelines for assessing data quality; assessments to ascertain effectiveness of QA/QC implementation; and training programs related to QA/QC implementation. A quality system ensures that MARSSIM decisions will be supported by sufficient data of adequate quality and usability for their intended purpose, and further ensures that such data are authentic, appropriately documented, and technically defensible.

Any organization collecting and evaluating data for a particular program must be concerned with the quality of results. The organization must have results that: meet a well-defined need, use, or purpose; comply with program requirements; and reflect consideration of cost and economics. To meet the objective, the organization should control the technical, administrative, and human factors affecting the quality of results. Control should be oriented toward the appraisal, reduction, elimination, and prevention of deficiencies that affect quality.

Quality systems already exist for many organizations involved in the use of radioactive materials. There are self-imposed internal quality management systems (*e.g.*, DOE) or there are systems required by regulation by another entity (*e.g.*, NRC) which require a quality system as a condition of the operating license.[1] These systems are typically called Quality Assurance Programs. An organization may also obtain services from another organization that already has a quality system in place. When developing an organization-specific quality system, there is no need to develop new quality management systems, to the extent that a facility's current Quality Assurance Program can be used. Standard ANSI/ASQC E4-1994 (ASQC 1995) provides national consensus quality standards for environmental programs. It addresses both quality systems and the collection and evaluation of environmental data. Annex B of ANSI/ASQC E4-1994

[1] Numerous quality assurance and quality control (QA/QC) requirements and guidance documents have been applied to environmental programs. Until now, each Federal agency has developed or chosen QA/QC requirements to fit its particular mission and needs. Some of these requirements include DOE Order 5700.6c (DOE 1991c); EPA QA/R-2 (EPA 1994f); EPA QA/R-5 (EPA 1994c); 10 CFR 50, App. B; NUREG-1293, Rev. 1 (NRC 1991); Reg Guide 4.15 (NRC 1979); and MIL-Q-9858A (DOD 1963). In addition, there are several consensus standards for QA/AC, including ASME NQA-1 (ASME 1989), and ISO 9000/ASQC Q9000 series (ISO 1987). ANSI/ASQC E4-1994 (ASQC 1995) is a consensus standard specifically for environmental data collection.

(ASQC 1995) and Appendix K of MARSSIM illustrate how existing quality system documents compare with organization- and project-specific environmental quality system documents.

Table 9.1 illustrates elements of a quality system as they relate to the Data Life Cycle. Applying a quality system to a project is typically done in three phases as described in Section 2.3: 1) the planning phase where the Data Quality Objectives (DQOs) are developed following the process described in Appendix D and documented in the Quality Assurance Project Plan (QAPP),[2] 2) the implementation phase involving the collection of environmental data in accordance with approved procedures and protocols, and 3) the assessment phase including the verification and validation of survey results as discussed in Section 9.3 and the evaluation of the environmental data using Data Quality Assessment (DQA) as discussed in Section 8.2 and Appendix E. Detailed guidance on quality systems is not provided in MARSSIM because a quality system should be in place and functioning prior to beginning environmental data collection activities.

Table 9.1 The Elements of a Quality System Related to the Data Life Cycle

Data Life Cycle	Quality System Elements
Planning	Data Quality Objectives (DQOs) Quality Assurance Project Plans (QAPPs) Standard Operating Procedures (SOPs)
Implementation	QAPPs SOPs Data collection Assessments and audits
Assessment	Data validation and verification Data Quality Assessment (DQA)

A graded approach bases the level of controls on the intended use of the results and the degree of confidence needed in their quality. Applying a graded approach may mean that some organizations (*e.g.*, those using the simplified procedures in Appendix B) make use of existing plans and procedures to conduct surveys. For many other organizations, the need for cleanup and restoration of contaminated facilities may create the need for one or more QAPPs suitable to the special needs of environmental data gathering, especially as it relates to the demonstration of compliance with regulatory requirements. There may even be a need to update or revise an existing quality management system.

[2] The quality assurance project plan is sometimes abbreviated QAPjP. MARSSIM adopts the terminology and abbreviations used in ANSI/ASQC E4-1994 (ASQC 1995) and EPA QA/R-5 (EPA 1994c).

9.2 Development of a Quality Assurance Project Plan

The Quality Assurance Project Plan (QAPP)[3] is the critical planning document for any environmental data collection operation because it documents how QA/QC activities will be implemented during the life cycle of a project (EPA 1997a). The QAPP is the blueprint for identifying how the quality system of the organization performing the work is reflected in a particular project and in associated technical goals. This section provides information on how to develop a QAPP based on the DQO process. The results of the DQO process provide key inputs to the QAPP and will largely determine the level of detail in the QAPP.

The consensus standard ANSI/ASQC E4-1994 (ASQC 1995) describes the minimum set of quality elements required to conduct programs involving environmental data collection and evaluation. Table 9.2 lists the quality elements for collection and evaluation of environmental data from ANSI/ASQC E4-1994. These quality elements are provided as examples that should be addressed when developing a QAPP. This table also includes references for obtaining additional information on each of these quality elements. Many of these elements will be addressed in existing documents, such as the organization's Quality Assurance Program or Quality Management Plan. Each of these quality elements should be considered during survey planning to determine the degree to which they will be addressed in the QAPP. Additional quality elements may need to be added to this list as a result of organizational preferences or requirements of Federal and State regulatory authorities. For example, safety and health or public participation may be included as elements to be considered during the development of a QAPP.

The QAPP should be developed using a graded approach as discussed in Section 9.1. In other words, existing procedures and survey designs can be included by reference. This is especially useful for sites using a simplified survey design process (*e.g.*, surveys designed using Appendix B).

A QAPP should be developed to document the results of the planning phase of the Data Life Cycle (see Section 2.3). The level of detail provided in the QAPP for relevant quality elements is determined using the DQO process during survey planning activities. Information that is already provided in existing documents does not need to be repeated in the QAPP, and can be included by reference (EPA 1997a).

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[3] MARSSIM uses the term Quality Assurance Project Plan to describe a single document that incorporates all of the elements of the survey design. This term is consistent with ANSI/ASQC E4-1994 (ASQC 1995) and EPA guidance (EPA 1994c, EPA 1997a), and is recommended to promote consistency. The use of the term QAPP in MARSSIM does not exclude the use of other terms (*e.g.*, Decommissioning Plan, Sampling and Analysis Plan, Field Sampling Plan) to describe survey planning documentation as long as the information in the documentation supports the objectives of the survey.

Table 9.2 Examples of QAPP Elements for Site Surveys and Investigations

QAPP Element	Information Source	
Planning and Scoping (reference the QA Manual for information on the quality system)	ASQC 1995 EPA 1994c EPA 1997a NRC 1997c EPA 1993d	Part A, Sections 2.1 and 2.7; Part B, Section 3.1 Sections A4, A5, A6 and A7 Chapter III, Sections A4, A5, A6, and A7 Chapter 14 Project Objectives
Design of Data Collection Operations (including training)	ASQC 1995 EPA 1994c EPA 1997a EPA 1993d	Part A, Section 2.3; Part B, Section 3.2 Sections A9 and B1 Chapter III, Sections A9 and B1 Sampling Design
Implementation of Planned Operations (including documents and records)	ASQC 1995 EPA 1994c EPA 1997a NRC 1997c EPA 1993d	Part A, Section 2.8; Part B, Section 3.3 Sections A1, A2, A3, B2, B3, B4, B5, B6, B7, B8, B9, and B10 Chapter III, Sections A1, A2, A3, B2, B3, B4, B5, B6, B7, B8, B9, and B10 Chapter 5 Sampling Execution, Sample Analysis
Assessment and Response	ASQC 1995 EPA 1994c EPA 1997a EPA 1993d	Part A, Section 2.9, Part B, Section 3.4 Sections C1 and C2 Chapter III, Sections C1 and C2 Exhibit 3, Reference Box 3
Assessment and Verification of Data Usability	ASQC 1995 EPA 1994c EPA 1997a NRC 1997c EPA 1993d	Part B, Section 3.5 Sections D1, D2, and D3 Chapter III, Sections D1, D2, and D3 Chapter 20, Appendix J, Appendix Q Assessment of Data Quality

For example, the quality system description, personnel qualifications and requirements, and Standard Operating Procedures (SOPs) for the laboratory analysis of samples may simply be references to existing documents (*e.g.*, Quality Management Plan, Laboratory Procedure Manual). SOPs for performing direct measurements with a specific instrument may be attached to the QAPP because this information may not be readily available from other sources.

There is no particular format recommended for developing a QAPP. Figure 9.1 provides an example of a QAPP format presented in EPA QA/R-5 (EPA 1994c). Appendix K compares the quality elements presented in this example to the quality elements found in EPA QAMS-005-80 (EPA 1980d), ASME NQA-1 (ASME 1989), DOE Order 5700.6c (DOE 1991c), MIL-Q-9858A (DOD 1963), and ISO 9000 (ISO 1987).

Project Management
- Title and Approval Sheet
- Table of Contents
- Distribution List
- Project/Task Organization
- Problem Definition/Background
- Project Task Description
- Quality Objectives and Criteria for Measurement Data
- Special Training Requirements/Certification

Measurement/Data Acquisition
- Sampling Process Design (Experimental Design)
- Sampling Methods Requirements
- Sample Handling and Custody Requirements
- Analytical Methods Requirements
- Quality Control Requirements
- Instrument/Equipment Testing, Inspection, and Maintenance Requirements
- Instrument Calibration and Frequency
- Inspection/Acceptance Requirements for Supplies and Consumables

Assessment/Oversight
- Assessments and Response Actions
- Reports to Management

Data Validation and Usability
- Data Review, Validation, and Verification Requirements
- Validation and Verification Methods
- Reconciliation with User Requirements

Figure 9.1 Example of a QAPP Format

9.3 Data Assessment

Assessment of environmental data is used to evaluate whether the data meet the objectives of the survey, and whether the data are sufficient to determine compliance with the DCGL (EPA 1992a, 1992b, 1996a). The assessment phase of the Data Life Cycle consists of three phases: data verification, data validation, and Data Quality Assessment (DQA). This section provides guidance on verifying and validating data collected during a final status survey designed to demonstrate compliance with a dose- or risk-based regulation. Guidance on DQA is provided in Chapter 8 and Appendix E. As with all components of a successful survey, the level of effort associated with the assessment of survey data should be consistent with the objectives of the survey (*i.e.*, a graded approach).

9.3.1 Data Verification

Data verification ensures that the requirements stated in the planning documents (*e.g.*, Quality Assurance Project Plan, Standard Operating Procedures) are implemented as prescribed. This means that deficiencies or problems that occur during implementation should be documented and reported. This also means that activities performed during the implementation phase are assessed regularly with findings documented and reported to management. Corrective actions undertaken should be reviewed for adequacy and appropriateness and documented in response to the findings. Data verification activities should be planned and documented in the QAPP. These assessments may include but are not limited to inspections, QC checks, surveillance, technical reviews, performance evaluations, and audits.

To ensure that conditions requiring corrective actions are identified and addressed promptly, data verification activities should be initiated as part of data collection during the implementation phase of the survey. The performance of tasks by personnel is generally compared to a prescribed method documented in the SOPs, and is generally assessed using inspections, surveillance, or audits. Self-assessments and independent assessments may be planned, scheduled, and performed as part of the survey. Self-assessment also means that personnel doing work should document and report deficiencies or problems that they encounter to their supervisors or management.

The performance of equipment such as radiation detectors or measurement systems such as an instrument and human operator can be monitored using control charts. Control charts are used to record the results of quantitative QC checks such as background and daily calibration or performance checks. Control charts document instrument and measurement system performance on a regular basis and identify conditions requiring corrective actions on a real time basis. Control charts are especially useful for surveys that extend over a significant period of time (*e.g.*, weeks instead of days) and for equipment that is owned by a company that is frequently used to collect survey data. Surveys that are accomplished in one or two days and use rented instruments may not benefit significantly from the preparation and use of control charts. The use of control charts is usually documented in the SOPs.

A technical review is an independent assessment that provides an in-depth analysis and evaluation of documents, activities, material, data, or items that require technical verification to ensure that established requirements are satisfied (ASQC 1995). A technical review typically requires a significant effort in time and resources and may not be necessary for all surveys. A complex survey using a combination of scanning, direct measurements, and sampling for multiple survey units is more likely to benefit from a detailed technical review than a simple survey design calling for relatively few measurements using one or two measurement techniques for a single survey unit.

9.3.2 Data Validation

Data validation activities ensure that the results of data collection activities support the objectives of the survey as documented in the QAPP, or support a determination that these objectives should be modified. Data Usability is the process of ensuring or determining whether the quality of the data produced meets the intended use of the data (EPA 1992a, EPA 1997a). Data verification compares the collected data with the prescribed activities documented in the SOPs; data validation compares the collected data to the DQOs documented in the QAPP. Corrective actions may improve data quality and reduce uncertainty, and may eliminate the need to qualify or reject data.

9.3.2.1 Data Qualifiers

Qualified data are any data that have been modified or adjusted as part of statistical or mathematical evaluation, data validation, or data verification operations (ASQC 1995). Data may be qualified or rejected as a result of data validation or data verification activities. Data qualifier codes or flags are often used to identify data that has been qualified. Any scheme used should be fully explained in the QAPP and survey documentation. The following are examples of data qualifier codes or flags derived from national qualifiers assigned to results in the contract laboratory program (CLP; EPA 1994g).

U or <MDC — The radionuclide of interest was analyzed for, but the radionuclide concentration was below the minimum detectable concentration (MDC). Section 2.3.5 recommends that the actual result of the analysis be reported so this qualifier would inform the reader that the result reported is also below the MDC.

J — The associated value reported is a modified, adjusted, or estimated quantity. This qualifier might be used to identify results based on surrogate measurements (see Section 4.3.2) or gross activity measurements (*e.g.*, gross alpha, gross beta). The implication of this qualifier is that the estimate may be inaccurate or imprecise which might mean the result is inappropriate for the statistical evaluation of the results. Surrogate measurements that are not inaccurate or imprecise may or may not be associated with this qualifier. It is recommended that the potential uncertainties associated with surrogate or gross measurements be quantified and included with the results.

R — The associated value reported is unusable. The result is rejected due to serious analytical deficiencies or quality control results. These data would be rejected because they do not meet the data quality objectives of the survey.

O — The associated value reported was determined to be an outlier.

9.3.2.2 Data Validation Descriptors

Data validation is often defined by six data descriptors. These six data descriptors are summarized in Table 9.3 and discussed in detail in Appendix N. The decision maker or reviewer examines the data, documentation, and reports for each of the six data descriptors to determine if performance is within the limits specified in the DQOs during planning. The data validation process for each data descriptor should be conducted according to procedures documented in the QAPP.

Table 9.3 Suggested Content or Consideration, Impact if Not Met, and Corrective Actions for Data Descriptors

Data Descriptor	Suggested Content or Consideration	Impact if Not Met	Corrective Action
Reports to Decision Maker	• Site description • Survey design with measurement locations • Analytical method and detection limit • Detection limits (MDCs) • Background radiation data • Results on per measurement basis, qualified for analytical limitations • Field conditions for media and environment • Preliminary reports • Meteorological data, if indicated by DQOs • Field reports	• Unable to perform a quantitative radiation survey and site investigation	• Request missing information • Perform qualitative or semi-quantitative site investigation
Documentation	• Chain-of-custody records • SOPs • Field and analytical records • Measurement results related to geographic location	• Unable to identify appropriate concentration for survey unit measurements • Unable to have adequate assurance of measurement results	• Request that locations be identified • Resurveying or resampling • Correct deficiencies
Data Sources	• Historical data used meets DQO's	• Potential for Type I and Type II decision errors • Lower confidence of data quality	• Resurveying, resampling, or reanalysis for unsuitable or questionable measurements

Table 9.3 (continued)

Data Descriptor	Suggested Content or Consideration	Impact if Not Met	Corrective Action
Analytical Method and Detection Limit	• Routine methods used to analyze radionuclides of potential concern	• Unquantified precision and accuracy • Potential for Type I and Type II decision errors	• Reanalysis • Resurveying, resampling, or reanalysis • Documented statements of limitation
Data Review	• Defined level of data review for all data	• Potential for Type I and Type II decision errors • Increased variability and bias due to analytical process, calculation errors, or transcription errors	• Perform data review
Data Quality Indicators	• Surveying and sampling variability identified for each radionuclide • QC measurements to identify and quantify precision and accuracy • Surveying, sampling, and analytical precision and accuracy quantified	• Unable to quantify levels for uncertainty • Potential for Type I and Type II decision errors	• Resurveying or resampling • Perform qualitative site investigation • Documented discussion of potential limitations

Data collected should meet performance objectives for each data descriptor. If they do not, deviations should be noted and any necessary corrective action performed. Corrective action should be taken to improve data usability when performance fails to meet objectives.

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Low-Level Radioactive Waste Policy Amendments Act of 1985.

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Nuclear Waste Policy Amendments Act of 1987.

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Safe Drinking Water Act of 1974 (SDWA).

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West Valley Demonstration Project Act of 1980.

APPENDIX A
Example of MARSSIM Applied to a Final Status Survey

A.1 Introduction

This appendix presents the final status survey for a relatively simple example of a radiation site. Portions of this example appear earlier in Chapter 5 and Chapter 8. This appendix highlights the major steps for implementing a final status survey and gathering information needed to prepare a report. The report's format will vary with the requirements of the responsible regulatory agency. The Final Status Survey Checklist given at the end of Section 5.5 serves as a general outline for this appendix—although not every point is discussed in detail. Chapters providing discussions on particular points are referenced at each step. This example presents detailed calculations for a single Class 1 survey unit. Section A.2 addresses the completion of steps 1-4 of the Data Quality Objectives (DQO) Process (see Appendix D, Sections D.1 to D.4). Section A.3 addresses the completion of steps 5-7 of the DQO Process (see Appendix D, Sections D.5 to D.7). Section A.4 covers survey performance. Section A.5 discusses evaluating the survey results using Data Quality Assessment (DQA, see Appendix E).

A.2 Survey Preparations

(Chapter 3- Historical Site Assessment)

The Specialty Source Manufacturing Company produced low-activity encapsulated sources of radioactive material for use in classroom educational projects, instrument calibration, and consumer products. The manufacturing process—conducted between 1978 and 1993—involved combining a liquid containing a known quantity of the radioactive material with a plastic binder. This mixture was poured into a metal form and allowed to solidify. After drying, the form and plastic were encapsulated in a metal holder which was pressure sealed. A variety of radionuclides were used in this operation, but the only one having a half-life greater than 60 days was ^{60}Co. Licensed activities were terminated as of April 1993 and stock materials containing residual radioactivity were disposed using authorized procedures. Decontamination activities included the initial identification and removal of contaminated equipment and facilities. The site was then surveyed to demonstrate that the radiological conditions satisfy regulatory agency criteria for release.

A.2.1 Identify the Radionuclides of Concern

(Section 4.3)

More than 15 half-lives have passed for the materials with a half-life of 60 days or less. Based on radioactive decay and the initial quantities of the radionuclides, the quantities that could remain at the site are negligible. A characterization survey confirmed that no radioactive contaminants, other than ^{60}Co, were present.

A.2.2 Determine Residual Radioactivity Limits (DCGLs)
(Section 4.3)

The objective of this survey is to demonstrate that residual contamination in excess of the release criterion is not present at the site. The $DCGL_W$ for ^{60}Co used for evaluating survey results is 8,300 Bq/m^2 (5,000 dpm/100 cm^2) for surface contamination of structures. The $DCGL_W$ for contamination in soil is 140 Bq/kg (3.8 pCi/g).[1]

A.2.3 Classify Areas Based on Contamination Potential.
(Section 4.4)

This facility consists of one administration/manufacturing building situated on approximately 0.4 hectares (1.0 acres) of land as shown in Figure A.1. The building is a concrete block structure on a poured concrete slab with a poured concrete ceiling. The northern portion of the building housed the manufacturing operations, and consists of a high-bay area of approximately 20 m x 20 m with a 7 m high ceiling. The remainder of the building is single-story with numerous small rooms partitioned by drywall construction. This portion of the building, used for administration activities, occupies an area of approximately 600 m^2 (20 m x 30 m). The license does not authorize use of radioactive materials in this area. Operating records and previous radiological surveys do not identify a potential for residual contamination in this section of the building. Figure A.2 is a drawing of the building.

The property is surrounded by a chain-link security fence. At the northern end of the property, the surface is paved and was used as a parking lot for employees and for truck access to the manufacturing and shipping/receiving areas. The remainder of the property is grass-covered. There are no indications of incidents or occurrences leading to radioactive material releases from the building. Previous surveys were reviewed and the results were determined to be appropriate for planning the final status survey. These surveys identified no radioactive contamination outside the building.

A.2.4 Identify Survey Units
(Section 4.6)

Based on the results of other decommissioning surveys at the site and the operating history, the following survey units were used to design the final status survey. All of the interior survey units consist of concrete surfaces (either poured concrete or cinder block) with the exception of the administration areas which are drywall. The results of previous surveys demonstrated that the same reference area could be used to represent the poured concrete and cinder block surfaces.

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[1] The DCGL values used in this appendix are meant to be illustrative examples and are not meant to be generally applied.

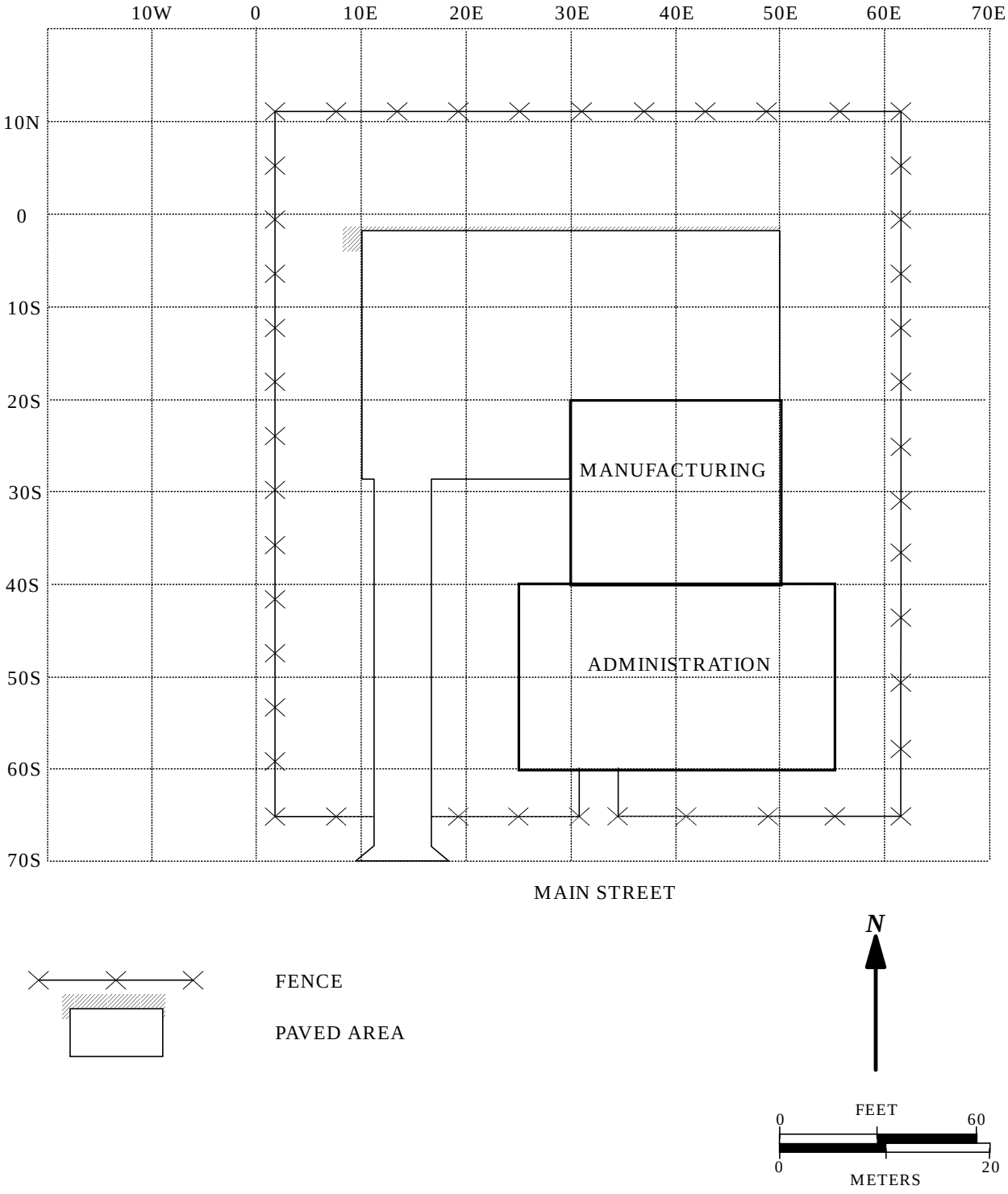


Figure A.1 Plot Plan of the Specialty Source Manufacturing Company

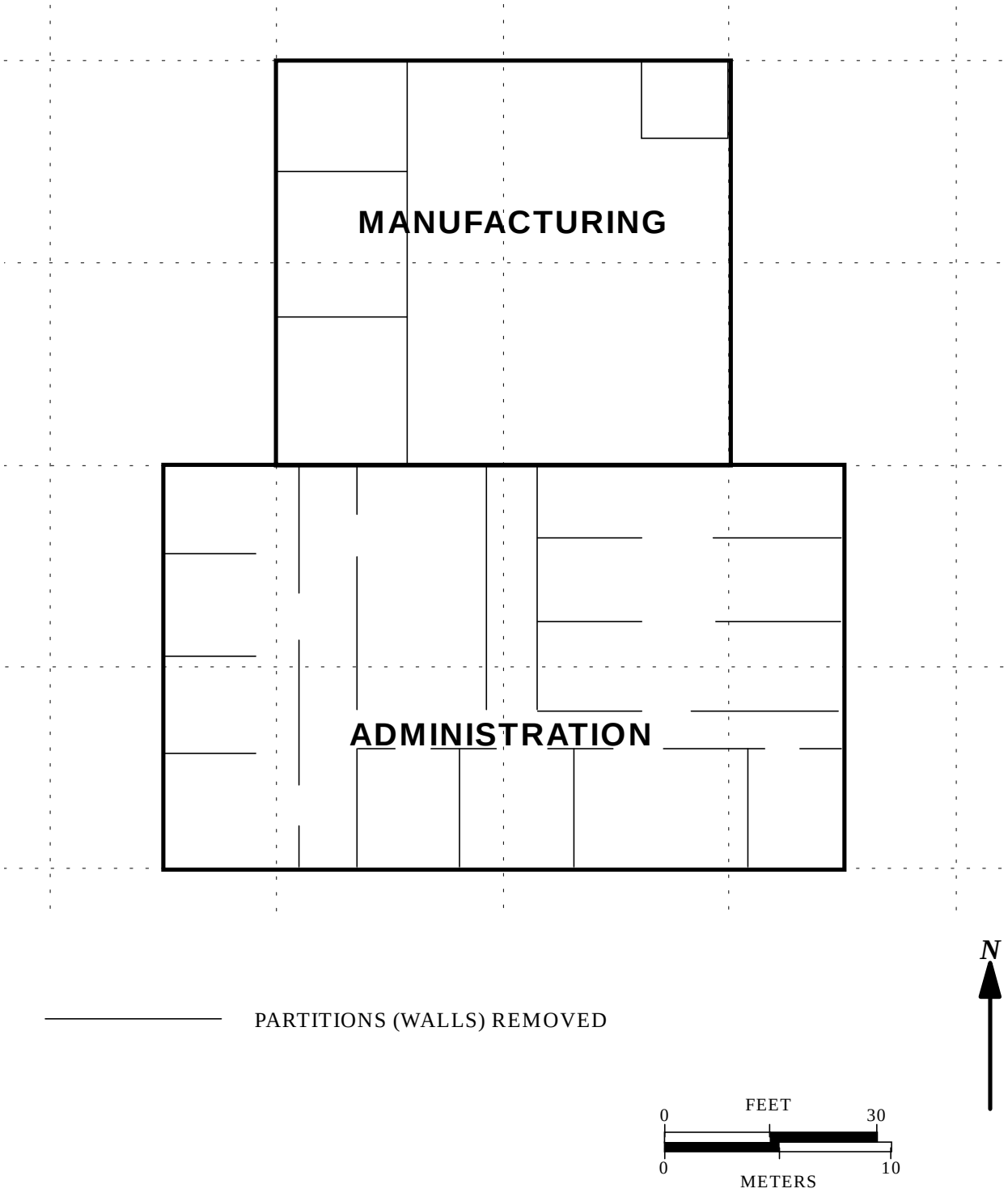


Figure A.2 Building Floor Plan

Structures

Class 1	Floor and lower walls (up to 2 meters above the floor) of manufacturing area - 4 survey units of 140 m^2 each.
Class 2	Upper walls (over 2 meters above the floor) of manufacturing area - 4 survey units of 100 m^2 each. Ceiling of manufacturing area - 4 survey units of 100 m^2 each. Paved area outside manufacturing area roll-up door - 1 survey unit of 60 m^2.
Class 3	Floors and lower walls of administration areas - 1 survey unit. Remainder of paved surfaces - 1 survey unit.

Land Areas

Class 3	Lawn areas - 1 survey unit.

A.2.5 Select Survey Instrumentation and Survey Techniques

(Section 4.7, Chapter 6, Chapter 7, Appendix H, and Appendix M)

For interior surfaces, direct measurements of gross beta activity were made using one minute counts on a gas flow proportional counter with an MDC of 710 Bq/m^2 (425 dpm/100 cm^2). This is actually less than 10% of the DCGL for ^{60}Co. Surfaces were scanned using either a 573 cm^2 floor monitor with an MDC of 6,000 Bq/m^2 (3,600 dpm/100 cm^2) or a 126 cm^2 gas flow proportional counter with an MDC of 3,300 Bq/m^2 (2,000 dpm/100 cm^2).

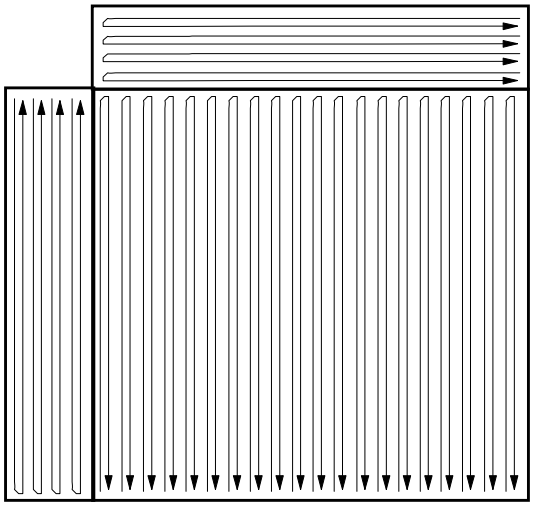
Exterior soil surfaces were sampled and counted in a laboratory using a Ge spectrometer with an MDC of 20 Bq/kg (0.5 pCi/g). This is actually slightly greater than 10% of the DCGL for ^{60}Co. Soil surfaces were scanned using a NaI(Tl) scintillator with an MDC of 185 Bq/kg (5.0 pCi/g) of ^{60}Co.

Examples of scanning patterns used in each of the Class 1, 2, and 3 areas are shown in Figure A.3.

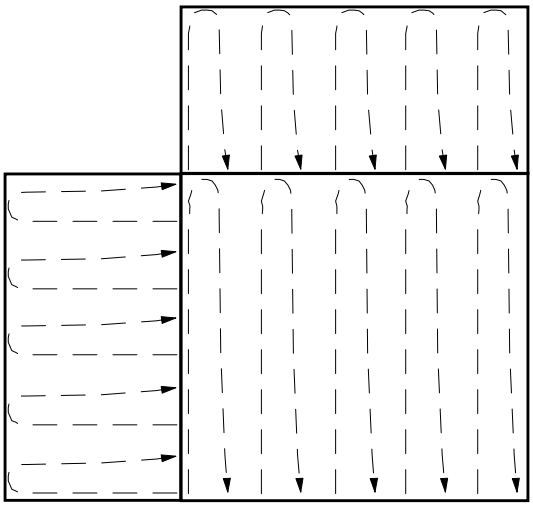
A.2.6 Select Representative Reference (Background) Areas

(Section 4.5)

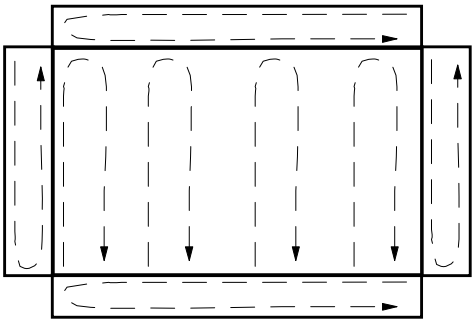
For the purposes of evaluating gross beta activity on structure surfaces, a building of similar construction was identified on the property immediately east of the site. This building served as a reference for surface activity measurements. Two reference areas—one for concrete surfaces and one for drywall surfaces—were required. Because ^{60}Co is not a constituent of background and evaluation of the soil concentrations was radionuclide-specific, a reference area was not needed for the land area surveys.



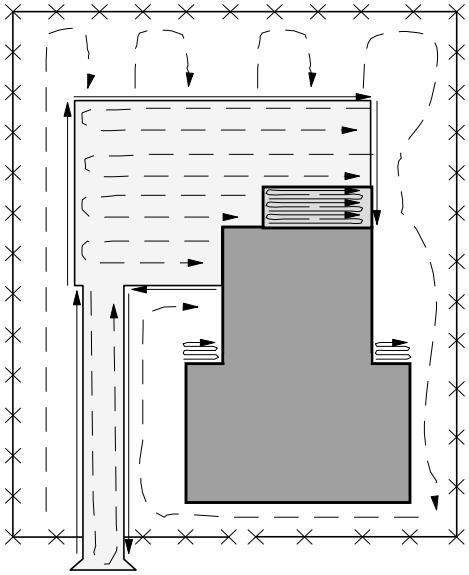
Interior Concrete Survey Units
Class 1 Floors - 100% Scan with Floor Monitor
Class 1 Walls - 100% Scans with Gas Flow
Proportional Counter



Manufacturing Area Upper Walls and Ceiling
Class 2 Areas - 25% Scans with Gas Flow
Proportional Counter



Administration/Office Areas
Class 3 Floors - 25% Scan with Floor Monitor
Class 3 Walls - 25% Scan with Gas Flow
Proportional Counter



Class 2 Paved Area - 100% Scan with Floor Monitor
Class 3 Paved Area - 25% Scan with NaI(Tl)
Class 3 Lawn Area - 100% Scan with NaI(Tl) at Downspouts
and Edge of Pavement (Runoff Areas)
10% Scan with NaI(Tl) on Remaining Lawn Area

Figure A.3 Examples of Scanning Patterns for Each Survey Unit Classification

A.2.7 Prepare Area
(Section 4.8)

Prior to the survey, and as part of the decommissioning process, all internal partitions were removed from the manufacturing area. Other items removed include the radioactive material control exhaust system, a liquid waste collection system, and other furnishings and fixtures not considered an integral part of the structure.

A.2.8 Establish Reference Coordinate Systems
(Section 4.8.5)

Land areas were gridded at 10 m intervals along north-south and east-west axes in preparation for the characterization survey as shown in Figure A.1. The grid was checked to verify its use for the final status survey.

Structure surfaces were already gridded at 2 m intervals, incorporating the floors and the lower 2 m of the walls. Figure A.4 is an example of the coordinate system installed for one of the Class 1 interior concrete survey units.

A.3 Survey Design

A.3.1 Quantify DQOs
(Section 2.3, Appendix D)

The null hypothesis for each survey unit is that the residual radioactivity concentrations exceed the release criterion (Scenario A, Figure D.5). Acceptable decision error probabilities for testing the hypothesis were determined to be α=0.05 and β=0.05 for the Class 1 interior concrete survey units, and α=0.025 and β=0.05 for all other survey units.

A.3.2 Construct the Desired Power Curve
(Section 2.3, Appendix D.6, Appendix I.9)

The desired power curve for the Class 1 interior concrete survey units is shown in Figure A.5. The gray region extends from 4,200 to 8,300 Bq/m^2 (2,500 to 5,000 dpm/100 cm^2). The survey was designed for the statistical test to have 95% power to decide that a survey unit containing less than 4,200 Bq/m^2 (2,500 dpm/100 cm^2) above background meets the release criterion. For the same test, a survey unit containing over 17,000 Bq/m^2 (10,000 dpm/100 cm^2) above background had less than a 2.5% probability of being released.

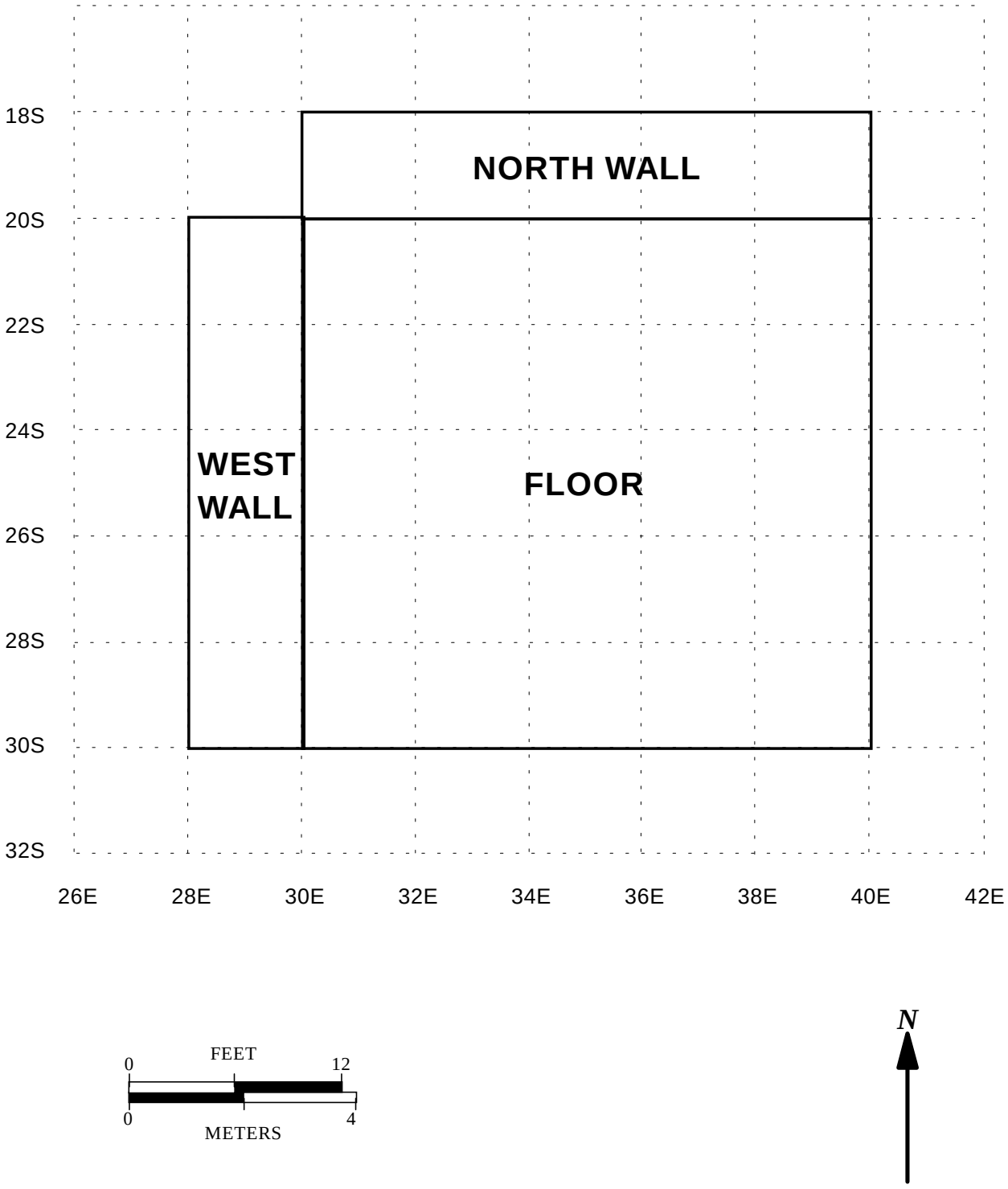


Figure A.4 Reference Coordinate System for the Class 1 Interior Concrete Survey Unit

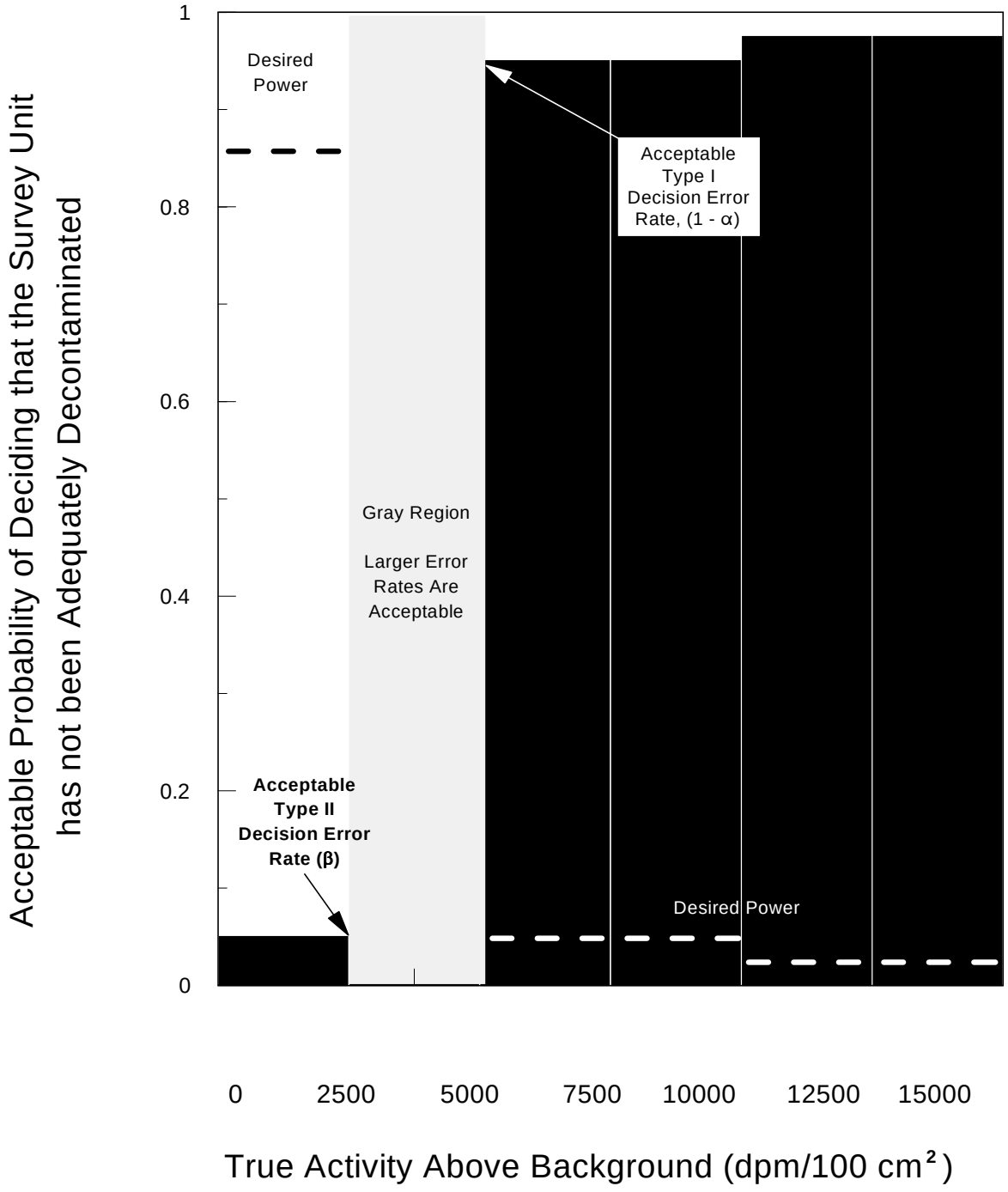


Figure A.5 Power Chart for the Class 1 Interior Concrete Survey Unit

A.3.3 Specify Sample Collection and Analysis Procedures
(Chapter 7)

In the Class 3 exterior survey unit soil cores were taken to a depth of 7.5 cm (3 in.) based on development of DQOs, the conceptual site model, and the assumptions used to develop the DCGLs. Each sample was labeled with the location code, date and time of sampling, sealed in a plastic bag, and weighed prior to shipment to the analytical laboratory. At the laboratory, the samples were weighed, dried, and weighed again. The samples were ground to a uniform particle size to homogenize the samples consistent with the modeling assumptions used to develop the DCGLs. One hundred gram (100 g) aliquots were gamma counted using a germanium detector with multichannel analyzer.

The decision to use radionuclide-specific measurements for soil means that the survey of the Class 3 exterior soil surface survey unit was designed for use with the one-sample Sign test.

A.3.4 Provide Information on Survey Instrumentation and Techniques
(Chapter 6)

A gas flow proportional counter with 20 cm^2 probe area and 16% 4π response was placed on the surface at each direct measurement location, and a one minute count taken. Calibration and background were checked before and after each series of measurements. The $DCGL_W$, adjusted for the detector size and efficiency, is:

$$(5{,}000 \text{ dpm}/100 \text{ cm}^2)\ (0.20)\ (0.16) = 160 \text{ cpm} \qquad \text{A-1}$$

The decision to use total activity measurements for interior surfaces means that the survey of all the interior survey units was designed for use with the two-sample WRS test for comparison with an appropriate reference area.

A.3.5 Determine Numbers of Data Points
(Section 5.5.2.2)

This facility contains 15 survey units consisting of interior concrete surfaces, interior drywall surfaces, exterior surface soil, and exterior paved surfaces.

Concrete Surfaces

The site has 12 interior concrete survey units to be compared with 1 reference area. The same type of instrument and method were used to perform measurements in each area.

The lower bound of the gray region is selected to be one-half the DCGL, and Type I and Type II error values (α and β) of 0.05 were selected. The number of samples/measurements to be obtained, based on the requirements of the statistical tests, was determined using Equation 5-1 in Section 5.5.2.2:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3(P_r - 0.5)^2} \qquad \text{A-2}$$

From Table 5.2 it is found that $Z_{1-\alpha} = Z_{1-\beta} = 1.645$ for $\alpha = \beta = 0.05$.

The parameter P_r depends on the relative shift, Δ/σ. The width of the gray region, Δ, in Figure A.5 is 4,200 Bq/m^2 (2,500 dpm/100 cm^2), which corresponds to 80 cpm. Data from previous scoping and characterization surveys indicate that the background level is 45 ± 7 (1σ) cpm. The standard deviation of the contaminant in the survey unit (σ_s) is estimated at ± 20 cpm. When the estimated standard deviation in the reference area and the survey units are different, the larger value should be used to calculate the relative shift. Thus, the value of the relative shift, Δ/σ, is (160-80)/20 or 4.[2] From Table 5.1, the value of P_r is approximately 1.000.

The number of data points for the WRS test of each combination of reference area and survey units according to the allocation formula was:

$$N = \frac{(1.645+1.645)^2}{3(1.000-0.5)^2} = 14.4 \qquad \text{A-3}$$

Adding an additional 20% and rounding up yielded 18 data points total for the reference area and each survey unit combined. Note that the same result is obtained by simply using Table 5.3 or Table I.2b with $\alpha = \beta = 0.05$ and $\Delta/\sigma = 4$. Of this total number, 9 were planned from the reference area and 9 from each survey unit. The total number of measurements calculated based on the statistical tests was 9 + (12)(9) = 117.

A.3.6 Evaluate the power of the statistical tests against the DQOs.
(Appendix I.9.2)

Using Equation I-8, the prospective power expected of the WRS test was calculated using the fact that 9 samples were planned in each of the survey units and the reference area. The value of σ_s was taken to be 20 cpm, the larger of the two values anticipated for the reference area (7 cpm) and the survey unit (20 cpm). This prospective power curve is shown in Figure A.6.

[2] Ordinarily Δ/σ would be adjusted to a value between 1 and 3. For this example the adjustment was not made.

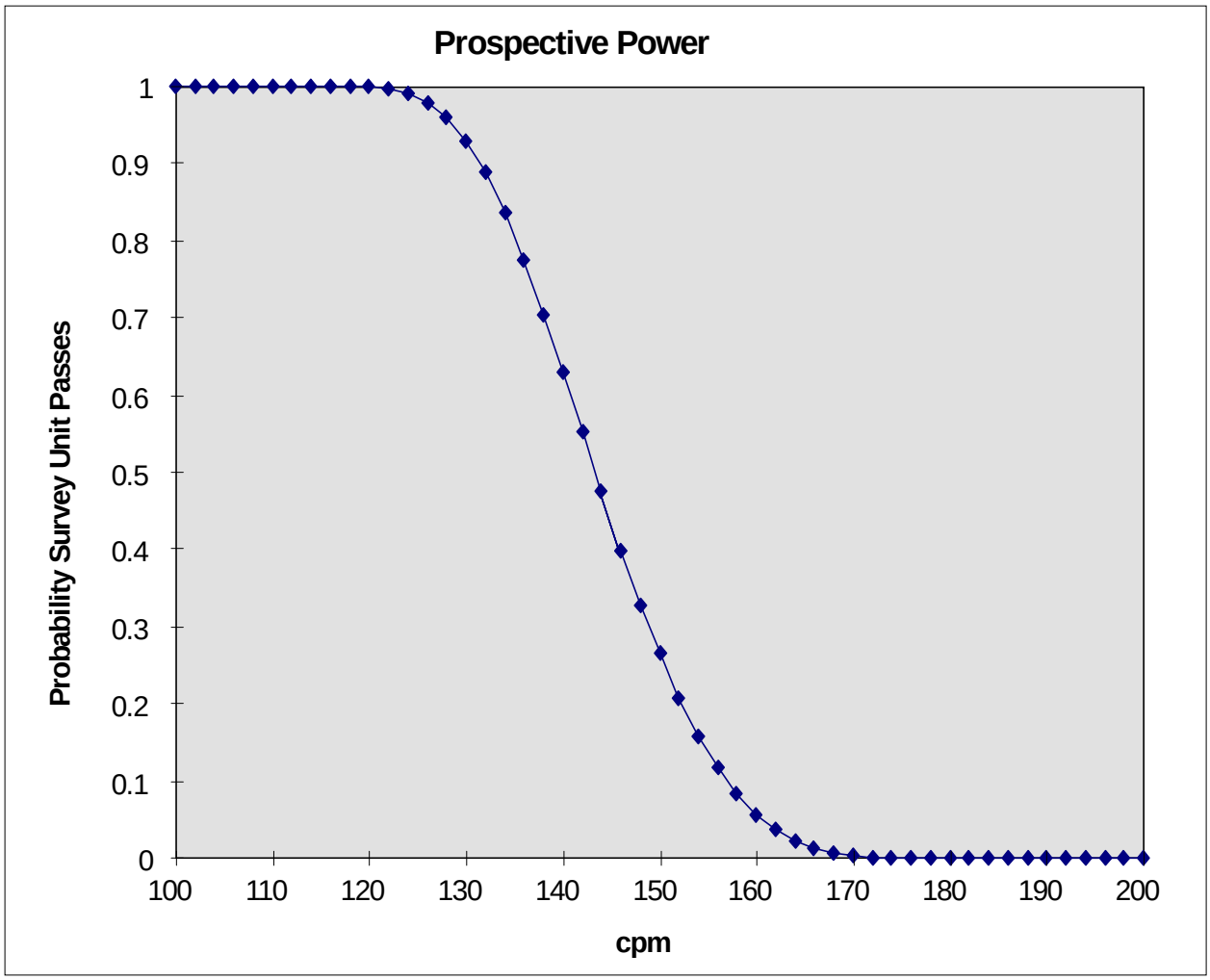


Figure A.6 Prospective Power Curve for the Class 1 Interior Concrete Survey Unit

A.3.7 Ensure that the Sample Size is Sufficient for Detecting Areas of Elevated Activity (Chapter 5.5.2.4)

The Class 1 concrete interior survey units each have an area of 140 m^2 (Figure A.7). The distance between measurement locations in these survey units was:

$$L = \sqrt{\frac{A}{0.866n}} = \sqrt{\frac{140}{0.866\ (10)}} = 4.2\ m \qquad \text{A-4}$$

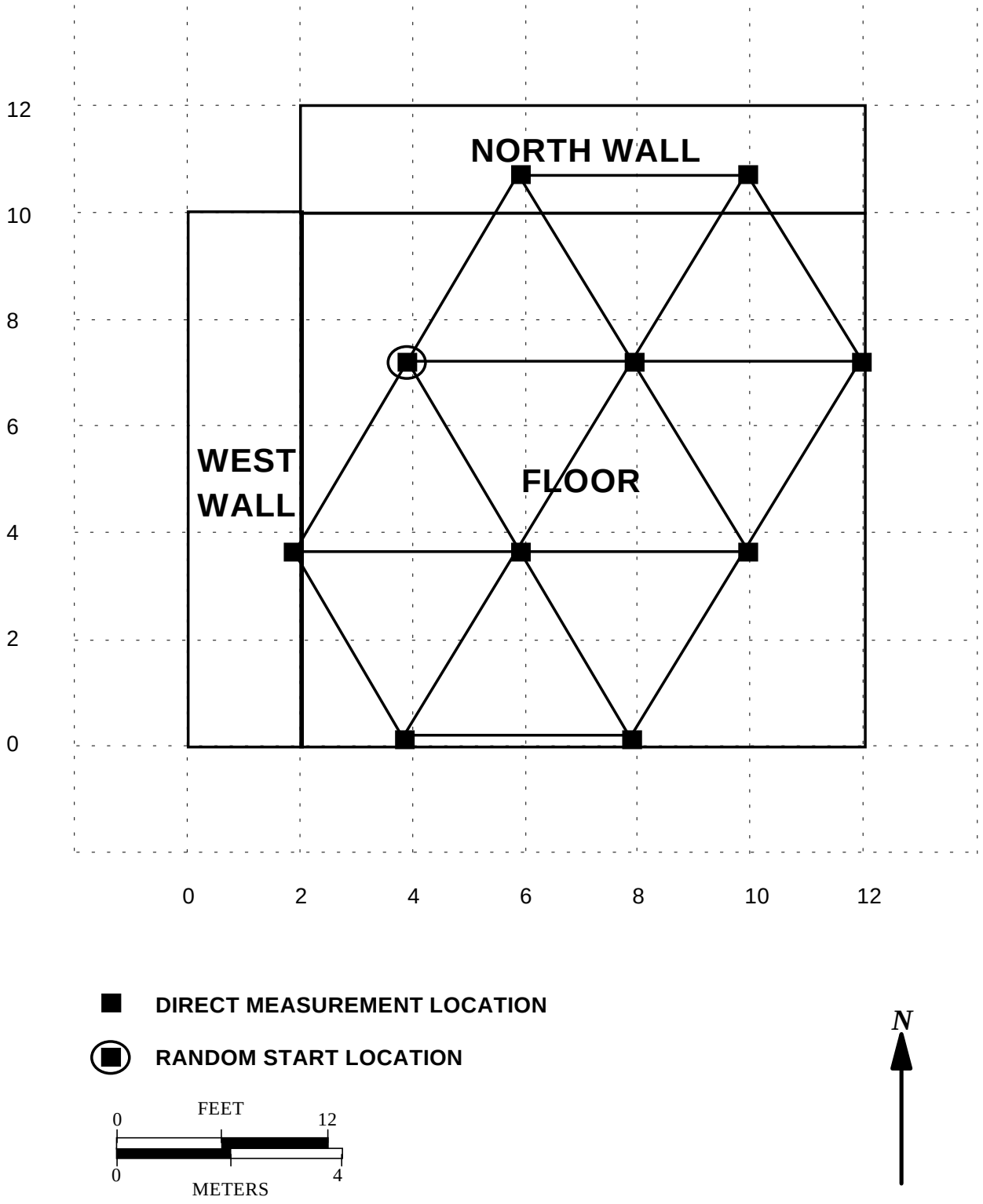


Figure A.7 Measurement Grid for the Class 1 Interior Concrete Survey Unit

The result for L was rounded *down* to the nearest meter, giving L = 4 m. This resulted in an area between sampling points of $0.866L^2 = 13.9\ m^2$. The $DCGL_W$ of 8,300 Bq/m^2 (5,000 dpm/100 cm^2) was well above the scanning MDC of 6,000 Bq/m^2 (3,600 dpm/100 m^2) for the least sensitive of the two scanning instruments (the floor monitor). Therefore, no adjustment to the number of data points to account for areas of elevated activity was necessary.

A.3.8 Specify Sampling Locations
(Chapter 5.5.2.5)

Two random numbers between zero and one were generated to locate the random start for the sampling grid. Using Table I.6 in Appendix I, 0.322467 and 0.601951 were selected. The random start for triangular sampling pattern was found by multiplying these numbers by the length of the reference grid X and Y axes:

$$X = 0.322467 \times 12\ m = 3.9 \quad \text{A-5}$$
$$Y = 0.601951 \times 12\ m = 7.2 \quad \text{A-6}$$

The first row of measurement locations was laid out at 4m intervals parallel to one axis of the reference grid. The second row was positioned (0.866)(4) = 3.5 m from the first row, with measurement locations offset by 2 m from those in the first row. The measurement grid is shown in Figure A.7. When the measurement grid was constructed it was found that 10 measurement locations were identified within the boundaries of the survey unit, which is greater than the 9 measurement locations calculated to be required for the statistical test. Because the spacing between the measurements (L) is important for identifying areas of elevated activity, *all* of the identified sampling locations should be used.

A.3.9 Develop Quality Control Procedures
(Section 4.9)

A.3.10 Document Results of Planning into a Quality Assurance Project Plan
(Section 9.2)

A.4 Conducting Surveys

A.4.1 Perform Reference (Background) Area Measurements and Scanning
(Chapter 6)

A.4.2 Collect and Analyze Samples
(Chapter 7)

A.5 Evaluating Survey Results

A.5.1 Perform Data Quality Assessment
(Chapter 8.2)

The data from the one Class 1 interior concrete survey unit and its associated reference area are given in Table A.1. Since ten sampling locations were identified, ten results are listed for the survey unit.[3] The average measurement in the survey unit is 206 cpm, and in the reference area the average is 46 cpm. The means and the medians are nearly equal in both cases. The standard deviations are also consistent with those estimated during the survey design. The survey unit clearly contains residual radioactivity close to the $DCGL_W$ of 160 cpm (calculated using Equation A-1).

Table A.1 Class 1 Interior Concrete Survey Unit and Reference Area Data

	Reference Area (cpm)	Survey Unit (cpm)
	45	205
	36	207
	32	203
	57	196
	46	211
	60	208
	39	172
	45	216
	53	233
	42	209
mean	46	206
standard deviation	9	15.4
median	45	207.5

[3] There are also ten results listed for the reference area. This is only because there were also ten locations identified there when the grid was laid out. Had nine locations been found, the survey would proceed using those nine locations. There is no requirement that the number of sampling locations in the survey unit and reference area be equal. It is only necessary that at least the minimum number of samples required for the statistical tests is obtained in each.

The stem and leaf displays (see Appendix I.7) for the data appear in Table A.2. They indicate that the data distributions are unimodal with no notable asymmetry. There are two noticeably extreme values in the survey unit data set, at 172 and 233 cpm. These are both about 2 standard deviations from the mean. A check of the data logs indicated nothing unusual about these points, so there was no reason to conclude that these values were due to anything other than random measurement variability.

Table A.2 Stem and Leaf Displays for Class 1 Interior Concrete Survey Unit

Reference Area				
30	6	2	9	
40	5	5	6	2
50	7	3		
60	0			

Survey Unit					
170	2				
180					
190	6				
200	5	7	3	8	9
210	1	6			
220					
230	3				

A Quantile-Quantile plot (see Appendix I.8) of this data, shown in Figure A.8, is consistent with these conclusions. The median and spread of the survey unit data are clearly above those in the reference area. The middle part of the curve has no sharp rises. However, the lower and upper portion of the curve both show a steep rise due to the two extreme measurements in the survey unit data set.

A.5.2 Conduct Elevated Measurement Comparison
(Section 8.5.1)

The $DCGL_W$ is 160 cpm above background. Based on an area between measurement locations 13.9 m^2 for L = 4 m, the area factor (from Table 5.7) is approximately 1.5. This means the $DCGL_{EMC}$ is 240 cpm above background. Even without subtracting the average background value of 46, there were no survey unit measurements exceeding this value. All of the survey unit measurements exceed the $DCGL_W$ and six exceed 206 cpm—the $DCGL_W$ plus the average background. If any of these data exceeded three standard deviations of the survey unit mean, they might have been considered unusual, but this was not the case. Thus, while the amount of residual radioactivity appeared to be near the release criterion, there was no evidence of smaller areas of elevated residual radioactivity.

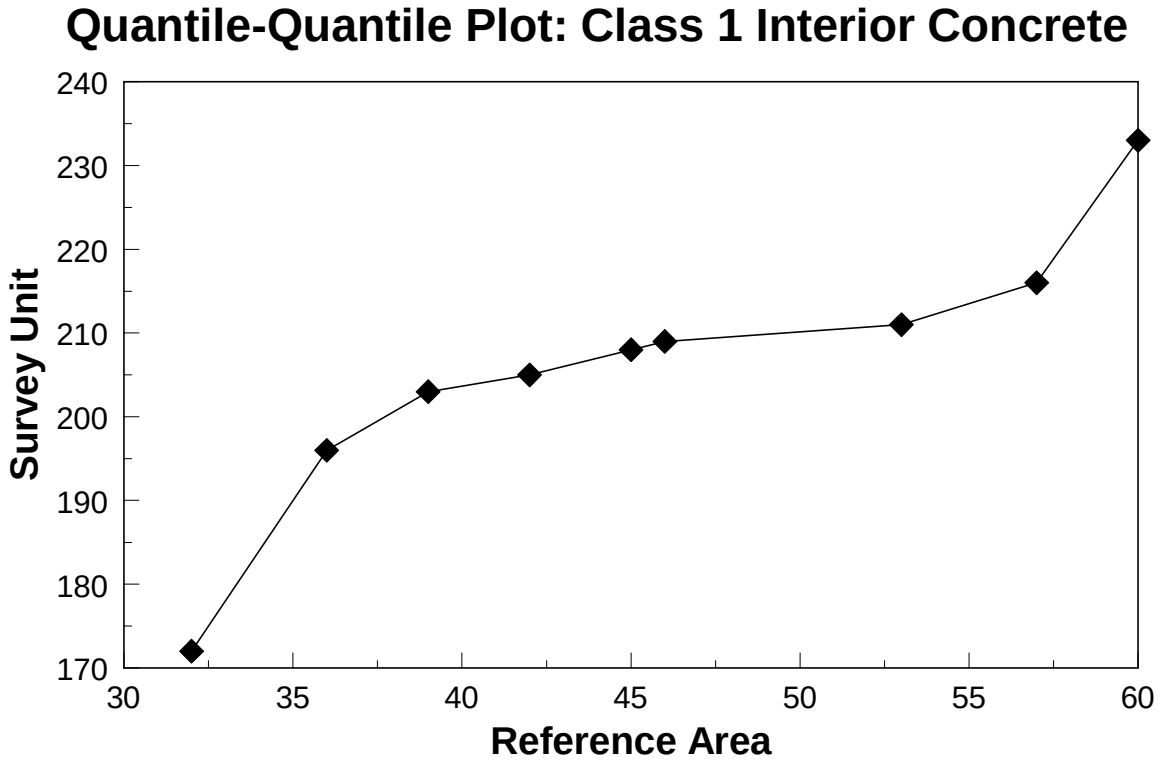


Figure A.8 Quantile-Quantile Plot for the Class 1 Interior Concrete Survey Unit

A.5.3 Conduct Statistical Tests
(Section 8.3, 8.4)

For the Class 1 interior concrete survey unit, the two-sample nonparametric statistical tests of Section 8.4 were appropriate since, although the radionuclide of concern does not appear in background, radionuclide specific measurements were not made. This survey unit was classified as Class 1, so the 10 measurements performed in the reference area and the 10 measurements performed in the survey unit were made on random start triangular grids.

Table A.3 shows the results of the twenty measurements in the first column. The average and standard deviation of the reference area measurements were 46 and 9, respectively. The average and standard deviation of the survey unit measurements were 206 and 15, respectively.

Table A.3 WRS Test for Class 1 Interior Concrete Survey Unit

Data	Area	Adjusted Data	Ranks	Reference Area Ranks
45	R	205	7.5	7.5
36	R	196	4	4
32	R	192	3	3
57	R	217	15	15
46	R	206	9	9
60	R	220	16	16
39	R	199	5	5
45	R	205	7.5	7.5
53	R	213	13	13
42	R	202	6	6
211	S	211	12	0
208	S	208	10	0
172	S	172	1	0
216	S	216	14	0
233	S	233	18	0
209	S	209	11	0
237	S	237	19	0
176	S	176	2	0
253	S	253	20	0
229	S	229	17	0
Sum=			210	86

The analysis proceeded as described in Section 8.6.3. In the “Area” column, the code "R" is inserted to denote a reference area measurement, and "S" to denote a survey unit measurement. In the “Data” column, the data were simply listed as obtained. The Adjusted Data were obtained by adding the $DCGL_W$ to the reference area measurements and leaving the survey unit measurements unchanged. The ranks of the Adjusted Data appear in the “Ranks” column. They range from 1 to 20, since there is a total of 20 (10+10) measurements. The sum of *all* of the ranks is 20(20+1)/2 = 210. It is recommended to check this value as a guard against errors in the rankings.

The “Reference Area Ranks” column contains only the ranks belonging to the reference area measurements. The total is 86. This was compared with the entry in Table I.4 for $\alpha = 0.05$, with $n = 10$ and $m = 10$. This critical value is 127. Thus, the sum of the reference area ranks was *less* than the critical value and the null hypothesis—that the survey unit concentrations exceed the $DCGL_W$—was accepted.

Again, as in Section 8.6.3, the retrospective power curve for the WRS test was constructed as described in Appendix I.9, using Equations I-8, I-9, and I-10, together with the actual number of concentration measurements obtained, N. The power as a function of Δ/s was calculated using the observed standard deviation, s = 15.4, in place of σ. The values of Δ/σ were converted to cpm using:

$$\text{cpm} = \text{DCGL}_W - (\Delta/\sigma)(\text{observed standard deviation}) \qquad \text{A-7}$$

The results for this example are plotted in Figure A.9, showing the probability that the survey unit would have passed the release criterion using the WRS test versus cpm of residual radioactivity. This curve shows that the data quality objectives were easily met. The curve shows that a survey unit with less than about 130 cpm above background would almost always pass and that a survey unit with more than about 170 cpm above background would almost always fail.

A.5.4 Estimate Amount of Residual Radioactivity

(Chapter 8.5.2.1)

The amount of residual radioactivity in the survey unit above background was estimated following the WRS test using the difference between the mean measurement in the survey unit and the mean measurement in the reference area: $\delta = 206 - 46 = 160$. This was converted to a surface area activity concentration of 8,300 Bq/m^2 (5,000 dpm/100 cm^2), which is just at the limiting value, DCGL_W.

The difference in the median measurements (207.5 - 45 = 162.5) was converted to a surface activity concentration of 8,500 Bq/m^2 (5,100 dpm/100 cm^2). This slightly exceeds the DCGL_W.

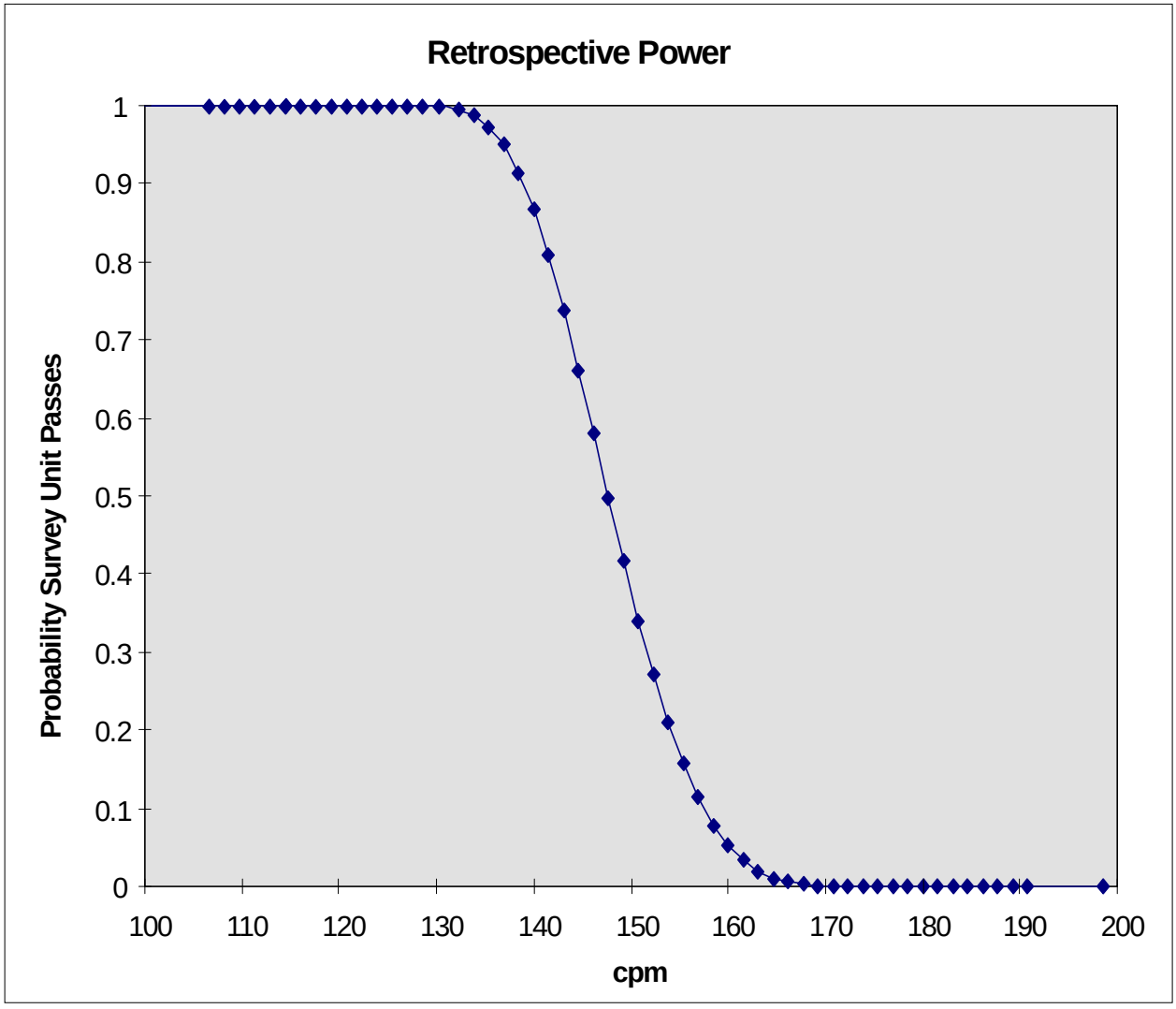


Figure A.9 Retrospective Power Curve for the Class 1 Interior Concrete Survey Unit

APPENDIX B

SIMPLIFIED PROCEDURE FOR CERTAIN USERS OF SEALED SOURCES, SHORT HALF-LIFE MATERIALS, AND SMALL QUANTITIES

A large number of users of radioactive materials may use a simplified procedure to demonstrate regulatory compliance for decommissioning, avoiding complex final status surveys. Sites that qualify for simplified decommissioning procedures are those where radioactive materials have been used or stored only in the form of: non-leaking, sealed sources; short half-life radioactive materials (*e.g.*, $t_{1/2} \leq 120$ days) that have since decayed to insignificant quantities; small quantities exempted or not requiring a specific license from a regulatory authority; or combinations of the above.

The user of a site that may qualify for implementation of a simplified procedure should provide the regulatory authority with a minimum of: (1) a certification that no residual radioactive contamination attributable to the user's activities is detectable by generally accepted survey methods for decommissioning; and (2) documentation on the disposal of nuclear materials, such as the information required in Form NRC-314 (Certification of Disposition of Materials). This minimum information may be used by the regulatory authority to document protection of both the public health and safety and the environment, based on the transfer, decay, or disposal of radioactive material in some authorized manner.

Normally, the absence of radioactive contamination can be demonstrated by: (1) documenting the amounts, kinds and uses of radionuclides as well as the processes involved; (2) conducting a radiation survey of the site; and (3) submitting a report on this survey. More specifically, a user of a qualified site should document from process knowledge and the nature of the use that either no or unmeasurable quantities of radioactive material remain onsite—whether on surfaces, buried, imbedded, submersed, or dissolved. The submittal to the regulatory authority should include possession history, use of the radioactive materials, and, if applicable, results of all leak tests. Where only small quantities or short half-life materials were handled, the regulatory authority may consider the documentation on a case-by-case basis.

For those sites where a simple final status survey is conducted to demonstrate compliance with the release criterion, the following information should be included in the final status survey report:

- basis for selecting the instrumentation used for the survey
- nature of the radionuclides surveyed
- measurement techniques and instruments used, including references for procedures and protocols used to perform the measurements

- minimum detectable concentrations (MDCs) of the instruments and measurement systems used to perform the measurements
- calibration, field testing, and maintenance of the instrumentation
- qualifications of the personnel using the instrumentation
- methods used to interpret the survey measurements
- qualifications of the personnel interpreting the survey measurements
- measurement results and measurement locations including the operator's name, instrument model and serial number, date the measurement was performed, and traceability of the measurement location

The number of measurements in each survey unit and each reference area can be determined using Table 5.3 for sites where the radionuclide of potential interest is present in background. The number of measurements for each survey unit where the radionuclide is not present in background can be determined using Table 5.5. Values for acceptable decision error levels (α and β) and the relative shift (Δ/σ) can be determined as described in Section 5.5.2. For sites where the simplified approach in this appendix is appropriate, reasonably conservative values for these parameters would be $\alpha = 0.05$, $\beta = 0.05$, and $\Delta/\sigma = 1$. After increasing the number of measurements by 20% to ensure adequate power for the statistical tests, Table 5.3 and Table 5.5 list a value of approximately 30 measurements for each survey unit and each reference. Therefore, 30 measurements may be used in place of the guidance in Section 5.5.2 at sites that qualify for the simplified survey design process.

The results of the survey should be compared to derived concentration guideline levels (DCGLs) using an appropriate statistical test, such as the Student's *t* test or Wilcoxon test. If all measurements are less than the $DCGL_W$, then the statistics do not need to be addressed because the conclusions are obvious. If the mean of the measurements exceeds the $DCGL_W$, the survey unit obviously fails to demonstrate compliance and the statistics do not need to be addressed.

Radiation levels and concentrations should be reported as follows:

- For external dose rates, units of:
  - milli-Sieverts (micro-rem) per hour at one meter from surfaces;

- For levels of radioactive materials, including alpha and beta measurements, units of:
  - Bq/m^2 (dpm/100 cm^2, pCi/100 cm^2) (removable and fixed) for surfaces;
  - Bq/L (pCi/mL) for water;
  - Bq/kg (pCi/g) for solids such as soils or concrete.

APPENDIX C
REGULATIONS AND REQUIREMENTS ASSOCIATED WITH RADIATION SURVEYS AND SITE INVESTIGATIONS[1]

C.1 EPA Statutory Authorities

The U.S. Environmental Protection Agency administers several statutes that address various aspects of the cleanup of radioactively contaminated sites. Listed below are the statutes, the implementing regulations, and the responsible EPA offices.

C.1.1 The Office of Air and Radiation (OAR) administers several statutes and implementing regulations:

- Clean Air Act (CAA) as amended (42 U.S.C. 7401-7671 q.): The CAA protects and enhances the nation's air quality through national ambient air quality standards, new source performance standards, and other provisions. Radionuclides are a hazardous air pollutant regulated under Section 112 of the Act.

  - National Emissions Standard for Hazardous Air Pollutants for Radionuclides (40 CFR Part 61, 10 CFR 20.101-20.108)

- Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (42 U.S.C. 2022): UMTRCA requires stabilization and control of byproduct materials (primarily mill tailings) at licensed commercial uranium and thorium processing sites. NRC and DOE implement standards under this Act.

  - Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR Part 192)

    This regulation, along with "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content" (10 CFR 40, Appendix A), issued by the NRC and EPA, establish technical criteria related to the operation, decontamination, decommissioning, and reclamation of uranium or thorium mills and mill tailings. Both regulations provide design requirements for closure of the mill's waste disposal area.

[1] The user of this manual should consult the text of the statutes and regulations listed in this Appendix to ensure compliance with all requirements applicable to a specific site and to ensure the use of current versions of applicable statutes and regulations.

The principal radiological hazards from uranium milling operations and mill tailings disposal are due to radon gas emissions originating from uranium and thorium daughters. Release rates to the atmosphere are limited to an average rate of 0.7 Bq (20 pCi) per square meter per second. This rate is applicable to any portion of a licensed or disposal site unless land areas do not contain radium concentrations—averaged over 100 square meters—greater than (i) 185 Bq/kg (5 pCi/g) of radium averaged over the first 15 centimeters below the surface and (ii) 555 Bq/kg (15 pCi/g) of radium averaged over 15 cm thick layers more than 15 centimeters below the surface.

- Atomic Energy Act (AEA) as amended (42 U.S.C. 2011-2296): The AEA requires the management, processing, and utilization of radioactive materials in a manner that protects public health and the environment. This is the principal basis for EPA, NRC and DOE authorities.

  The AEA requires that source, special nuclear, and byproduct materials be managed, processed, and used in a manner that protects public health and the environment. Under the AEA and Reorganization Plan No. 3 of 1970, EPA is authorized to issue federal guidance on radiation protection matters as deemed necessary by the Agency or as mandated by Congress. This guidance may be issued as regulations, given that EPA possesses the authority to promulgate generally applicable radiation protection standards under Reorganization Plan No. 3. For example, under AEA authority EPA promulgated its environmental radiation protection standards for nuclear power operations in 40 CFR Part 190.

  In conjunction with the AEA, EPA presently supports the following:

  – Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear, High-Level and Transuranic Radioactive Wastes (40 CFR 191)

- Nuclear Waste Policy Act (NWPA), as amended (Pub. L. 100-507, 42 U.S.C. 10101): The NWPA is intended to provide an orderly scheme for the selection and development of repositories for high-level radioactive waste and spent nuclear fuel.

- Low Level Radioactive Waste Policy Act (LLRWPA), as amended (Pub. L. 99-240, 42 U.S.C. 2021b): LLRWPA assigns States responsibility for ensuring adequate disposal capacity for low-level radioactive waste generated within their borders.

- Indoor Radon Abatement Act of 1988 (15 U.S.C. 2601 Sec. 301-311)

C.1.2 The Office of Emergency and Remedial Response (OERR) administers the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended (Pub. L. 99-499, 42 U.S.C. 9601-9657)

- CERCLA authorizes EPA, consistent with the National Oil and Hazardous Substances Contingency Plan (NCP, 40 CFR 300) to provide for remedial action in response to releases or substantial threats of releases of hazardous substances into the environment. Hazardous substances are defined as any substance designated or listed under the Clean Air Act, the Federal Water Pollution Control Act, the Toxic Substances Control Act, and the Resource Conservation and Recovery Act. Because the CAA designated radionuclides as a hazardous air pollutant, the provisions of CERCLA apply to radionuclides.

C.1.3 The Office of Solid Waste (OSW) administers the Resource Conservation and Recovery Act of 1976 (RCRA), as amended (Pub. L. 94-580, 42 U.S.C. 6901 *et seq*.)

- RCRA provides for detailed regulation of hazardous waste from generation to final disposal. Hazardous waste generators and transporters must comply with EPA standards. Owners and operators of treatment, storage, or disposal facilities must obtain RCRA permits. Materials defined in the AEA are expressly excluded from the definition of solid waste, and, thus from regulation under RCRA. Naturally occurring and accelerator produced radioactive materials, however, are not excluded.

C.1.4 The Office of Water (OW) administers several statutes and implementing regulations:

- Section 14.2 of the Public Health Service Act as amended by the Safe Drinking Water Act (SDWA) as amended (Pub. L. 93-523, 42 U.S.C. 300f *et seq*.). As amended in 1986, SDWA seeks to protect public water supply systems through protection of groundwater. Any radioactive substance that may be found in water is regulated under the Act (although the current regulations only specify a limited number of individual substances).

  - Maximum Contaminant Levels (includes certain radionuclides). (40 CFR 141.11-141.16)

- Clean Water Act as amended (Pub. L. 92-500, 33 U.S.C. 1251 *et seq.*)

  - Requirements (40 CFR Parts 131, 400-469) established pursuant to sections 301, 302, 303 (including State water quality standards), 306, 307, (including Federal Pretreatment requirements for discharge into a publicly owned treatment works), and 403 of the Clean Water Act.

C.1.5 The Office of Prevention, Pesticides and Toxic Substances administers the Toxic Substances and Control Act (TSCA; 15 U.S.C. 2601)

- TSCA regulates the manufacture, distribution in commerce, processing, use, and disposal of chemical substances and mixtures. Materials defined in the AEA are expressly excluded from TSCA. However, naturally occurring and accelerator produced radionuclides are not excluded.

C.2 DOE Regulations and Requirements

C.2.1 Authorities of the Department of Energy

The Department of Energy Organization Act, which created DOE, the Energy Reorganization Act of 1974, which created the Energy Research and Development Administration, and the Atomic Energy Act of 1954[2] provide the basic authorities of the Department of Energy. The principal DOE statutory authorities and regulations that pertain to radiation protection are shown in Table C.1.

C.2.1.1 Atomic Energy Act of 1954, as amended

The Atomic Energy Act of 1954 established a program of private ownership and use of nuclear materials and nuclear facilities, such as nuclear research reactors, and a program for government regulation of those applications. (Prior to 1954, all source, byproduct, and special nuclear materials were government owned). The Atomic Energy Commission was given both the regulatory authorities and the mission to develop both the peaceful and military uses of atomic energy. The Act also retained the Atomic Energy Commission as the civilian agency responsible for weapons programs production, development and research consistent with the Atomic Energy Act of 1946.

Under the Act, the Atomic Energy Commission was responsible for establishing regulations ensuring the safety of commercial facilities and establishing requirements that ensure public protection from radiation and radioactive materials resulting from or used in its research, development, and production activities.

[2]The Atomic Energy Commission was created by the Atomic Energy Act of 1946, not the 1954 act.

Table C.1

DOE AUTHORITIES, ORDERS AND REGULATIONS RELATED TO RADIATION PROTECTION

Statutes

Atomic Energy Act of 1954, as amended

Energy Reorganization Act of 1974

Uranium Mill Tailings Radiation Control Act of 1978, as amended

Nuclear Non-Proliferation Act of 1978

Department of Energy Organization Act of 1980

West Valley Demonstration Project Act of 1980

Nuclear Waste Policy Act of 1982

Low-Level Waste Policy Act of 1980

Low-Level Waste Policy Amendments Act of 1985

Energy Policy Act of 1992

Waste Isolation Pilot Plant Land Withdrawal Act

Price Anderson Act

DOE Regulations

10 CFR Part 835, "Occupational Radiation Protection"

Executive Orders

Executive Order 12580

DOE Orders

Order 5400.1, "General Environmental Protection Program"

Order 5400.2A, "Environmental Compliance Issue Coordination"

Order DOE 5400.5, "Radiation Protection of the Public and the Environment"

Order DOE 5400.4, "Comprehensive Environmental, Response, Compensation and Liability Act Requirements"

Order DOE 5440.1E, "National Environmental Policy Act Compliance Program"

Order DOE 5480.1B, "Environment, Safety and Health Program for Department of Energy Facilities"

Order DOE 5480.3, "Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances & Hazardous Wastes"

Order DOE 5480.4, "Environment, Safety and Health Protection Standards"

Order DOE 5480.6, "Safety of Department of Energy Owned Nuclear Reactors"

Order DOE 5480.11, "Occupational Radiation Protection"

Order DOE 5480.24, "Nuclear Criticality Safety"

Order DOE 5480.25, "Safety at Accelerator Facilities"

Order DOE 5484.1, "Environmental Protection, Safety and Health Protection Information Reporting Requirements"

Order DOE 5820.2A, "Radioactive Waste Management"

C.2.1.2 Energy Reorganization Act of 1974 (Public Law 93-438 (1974), as amended)

The Energy Reorganization Act of 1974 divided the former Atomic Energy Commission and created the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission. The ERDA was responsible for radiation protection at its facilities, to provide for worker and public health, worker safety, and environmental protection. ERDA was abolished with the creation of the Department of Energy in 1980.

C.2.1.3 Department of Energy Organization Act of 1977 Public Law 95-91

The Department of Energy Organization Act created the Department of Energy (DOE) by combining the Energy Research & Development Administration, the Federal Energy Administration, Federal Power Commission, and part of the Department of Interior.

The DOE was intended to identify potential environmental, health, safety, socioeconomic, institutional, and technological issues associated with the development and use of energy sources. Through this Act, DOE retained the responsibilities and authorities—held by its predecessor agencies—to take actions necessary to protect the public from radiation associated with radioactive materials production, research, and development. DOE established requirements through a directives system that largely used DOE Orders as its regulatory procedures. With the passage of the Price-Anderson Act Amendments of 1990, DOE began converting its health and safety Orders to rules.

C.2.1.4 Uranium Mill Tailings Radiation Control Act of 1978, as amended

The Uranium Mill Tailings Radiation Control Act (UMTRCA) provides a program of assessment and remedial action at active and inactive uranium mill sites to control their tailings in a safe and environmentally sound manner and to reduce radiation hazards to the public residing in the vicinity of these sites. The DOE was directed to complete remedial action at 21 sites of inactive uranium mills.

C.2.1.5 West Valley Demonstration Project Act of 1980

This act authorized DOE to carry out a project at West Valley, New York to demonstrate solidification techniques which could be used for preparing high level radioactive waste for disposal. The Act provides for informal review and project consultation by the NRC.

C.2.1.6 Low-Level Waste Policy Act of 1980

This act established the policy that each State is responsible for providing for the disposal of low-level radioactive waste generated within its borders, except for waste from defense activities of

DOE or Federal research and development activities, and authorized States to enter into compacts to carry out this policy. DOE was required to take actions to assist the States in carrying out this policy.

C.2.1.7 Nuclear Waste Policy Act of 1982 (Public Law 97-425, 1983)

This Act gives DOE the responsibility to develop repositories and to establish a program of research, development, and demonstration for the disposal of high-level radioactive waste and spent nuclear fuel. Title to and custody of commercial low-level waste sites under certain conditions could be transferred to DOE.

C.2.1.8 Low-Level Waste Policy Amendments Act of 1985

This act amends the Low-Level Waste Policy Act of 1980 to improve the procedures for State compacts. It also assigns responsibility to the Federal government for the disposal of low-level waste generated or owned by the DOE, specific other Federally generated or owned wastes, and wastes with concentrations of radionuclides that exceed the limits established by the NRC for class C radioactive waste. The Act provides that all class C radioactive wastes designated as a Federal responsibility—those that result from activities licensed by the NRC—shall be disposed of in a facility licensed by the NRC. The Act also assigns responsibilities to DOE to provide financial and technical assistance to the States in carrying out the Act.

C.2.1.9 Waste Isolation Pilot Plant Land Withdrawal Act

The Waste Isolation Pilot Plant (WIPP) is a repository intended for the disposal of transuranic radioactive waste produced by defense activities. The Act establishes the following:

1) an isolated parcel of land for the WIPP
2) provisions concerning testing and limits on the quantities of waste which may be disposed at the WIPP
3) EPA certification of compliance with disposal standards

C.2.1.10 Price Anderson Act

C.2.2 Executive Orders

Executive Order (E.O.) 12580 delegates to various Federal officials the responsibilities vested in the President for implementing the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA).

C.2.3 DOE Regulations and Orders

C.2.3.1 10 CFR Part 835, "Occupational Radiation Protection"

This rule, which became effective on January 13, 1993, provides for the protection of radiation workers at DOE owned facilities. The requirements contained in Part 835 are generally similar to those in Order DOE 5480.11 and those used in NRC Regulations pertaining to the commercial nuclear industry. In addition to the rule, DOE issued a dozen implementation guides, including the "DOE Radiological Control Manual," (DOE/EH-0256T, Rv.1, April 1994).

C.2.3.2 Order DOE 5400.5, "Radiation Protection of the Public and the Environment"

This Order, issued in February 1990, contains DOE's requirements for ensuring the protection of the public from the hazards of radiation. This regulation includes dose limits for protection of the public and environment, plus requirements:

1) to apply the ALARA process—to reduce doses to the public as far below the release criterion as is practicable
2) to apply the best available control technology to liquid effluents
3) for control of property containing residual radioactive material

DOE 5400.5 is supported by numerous guidance documents, including those listed in this section.

DOE 5400.5 is the primary directive relating to the release of property subject to radiological contamination by DOE operations. DOE 5400.5 will be replaced by 10 CFR Part 834 and its guidance will be adopted for Part 834 when it is issued.

Under DOE 5400.5 and the guidance included in this section (C.2.3), DOE established requirements for a case-by-case review and approval for release of real or non-real property containing residual radioactive material. Authorized limits and measurement procedures must be developed by DOE before facilities can release property from their control. The principle requirement is to reduce doses to levels that are as low as practicable using the ALARA process and assuming realistic but conservative use scenarios that are not likely to underestimate dose. This requirement ensures that doses are as far below the primary dose limit (1 mSv/y [100 mrem/y]) as is reasonably achievable. Because the primary dose limit is for doses from all sources and pathways, authorized limits should be selected at levels below a DOE dose constraint of 0.3 mSv/y (30 mrem/y). However, the goal is to reduce doses under likely-use scenarios to a few fractions of a mSv/year or less.

In addition to the requirement to apply ALARA and the dose constraint, DOE also utilizes surface contamination guidelines similar to those in NRC Regulatory Guide 1.86 and the 40 CFR Part 192 soil concentration limits for radium and thorium. The ALARA requirement ensures that the 40 CFR Part 192 limits are appropriately used. DOE also permits the use of supplemental limits for situations where cleanups to authorized limits are not practicable or where the scenarios used to develop the authorized limits are not appropriate. DOE 5400.5 permits the release of property for restricted use and requires procedures to ensure these restrictions are maintained.

Most DOE remedial action and restoration activities are also subject to CERCLA. In such cases, DOE requirements are integrated into the CERCLA process.

The following sections describe the scope and importance of several guidance documents.

A. Residual Radioactive Material Control:

DOE/CH-8901, Manual for Implementing Residual Radioactive Material Guidelines - A Supplement to the U.S. Department of Energy Guidelines for Residual Radioactive Material at FUSRAP and SFMP Sites, Department of Energy, June 1989.

DOE Guidance Memorandum, "Unrestricted Release of Radioactively Contaminated Personal Property," J. Maher, DOE Office of Nuclear Safety, Mar. 15, 1984.

ANL/EAD/LD-2, Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0, Published by Argonne National Laboratory and prepared by ANL and DOE staff, September 1993.

ANL/EAIS-8, Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil, Argonne National Laboratory, April 1993.

ANL/EAIS/TM-103, A Compilation of Radionuclide Transfer Factors for Plant, Meat, Milk and Aquatic Food Pathways and Suggested Default Values for the RESRAD Code, Argonne National Laboratory, August 1993.

PNL-8724, Radiation Dose Assessments to Support Evaluations of Radiological Control Levels for Recycling or Reuse of Material and Equipment, Pacific Northwest Laboratory, July 1995.

ANL/EAD.LD-3, RESRAD-Build: A Computer Model for Analyzing the Radiological Doses Resulting from the Remediation and Occupancy of Buildings Contaminated with Radioactive Material, Argonne National Laboratory, November 1994.

B. ALARA

DOE Guidance: DOE Guidance on the Procedures in Applying the ALARA Process for Compliance with DOE 5400.5, Department of Energy, Office of Environmental Guidance, March 8, 1991.

ANL/EAD/LD-2, Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0, Chapters 1 and 5 and App. M, September 1993.

C. Measurement and Data Reporting

DOE Manual for use and Comment, Environmental Implementation Guide for Radiological Survey Procedures, Department of Energy, Office of Environmental Guidance, Nov. 1992.

DOE/EH-0173T, Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance, Department of Energy, Jan. 1991.

D. Dose Factors

DOE/EH-0071, Internal Dose Conversion Factors for Calculation of Dose to the public, DOE, July 1988. DOE currently recommends use of EPA-520-1-88-020, Federal Guidance Report No. 11, Limiting Radionuclide Intake and Air Concentrations and Dose Conversion Factors for Inhalation, Submersion and Ingestion, Environmental Protection Agency, Sept. 1988, as an alternative to DOE/EH-0071.

DOE/EH-0070, External Dose-Rate Conversion Factors for Calculation of Dose to the Public, DOE, July 1988. DOE currently recommends use of EPA 402-R-93-081, Federal Guidance Report No. 12, External Exposure to Radionuclides in Air, Water and Soil, Environmental Protection Agency, Sept. 1993, as an alternative to DOE/EH-0070.

E. Liquid Effluents

Implementation Guidance for DOE 5400.5, Section II.3 (Management and Control of Radioactive Materials in Liquid Discharges and the Phaseout of Soil Columns), DOE Office of Environment, June 1992.

C.2.3.3 Order DOE 5820.2A, "Radioactive Waste Management"

Order DOE 5820.2A establishes the policies, guidelines, and requirements by which the DOE manages its radioactive and mixed waste and contaminated facilities. The Order implements DOE's responsibilities and authorities for prediction of public and worker health and safety and

the environment under the Atomic Energy Act. It contains the requirements for management and disposal of high-level waste, transuranic waste, low-level waste, NARM waste, and for the decommissioning of radioactively contaminated facilities.

A. High-level Waste

The Order specifies: (1) requirements for storage operations including requirements for waste characterization, transfer operations, monitoring, surveillance, and leak detection, and (2) specifies that disposal shall be in accordance with the requirements of the Nuclear Waste Policy Act of 1982.

B. Transuranic Waste

The Order requires waste to be certified in compliance with the Waste Isolation Pilot Plant-Waste Acceptance Criteria and sent to the WIPP. There are requirements for waste classification, waste generation and treatment, waste certification, waste packaging, temporary storage, transportation and shipping, and interim storage. There are provisions for use of the WIPP, and for assessing the disposition of previously buried transuranic-contaminated wastes.

C. Low-level Waste

The Order specifies performance objectives which assure that external exposure waste concentrations of radioactive material—which may be released into surface water, ground water, soil, plants, and animals—result in an effective dose equivalent that does not exceed 0.25 mSv/y (25 mrem/y) to a member of the public. Releases to the atmosphere shall meet the requirements of 40 CFR Part 61. Reasonable efforts should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable. Radiological performance assessments are required for the disposal of waste for the purpose of demonstrating compliance with these performance objectives.

For low-level waste, there are also requirements on waste generation, waste characterization, waste acceptance criteria, waste treatment, and long term storage. The Order includes additional disposal requirements concerning disposal facility and disposal site design and waste characteristic, site selection, facility operations, site closure and post closure, and environmental monitoring.

D. NARM Waste

For management of Naturally-Occurring and Accelerator-Produced Radioactive Materials (NARM) and 11(e)(2) byproduct materials (the tailings or wastes resulting from the concentration of uranium or thorium), the order specifies that storage and disposal shall be

consistent with the requirements of the residual radioactive material guidelines contained in 40 CFR 192.

E. Decommissioning of Radioactively Contaminated Facilities

For the decommissioning of contaminated facilities, the order requires DOE organizations to develop and document decommissioning programs which include provisions for surveillance and maintenance. There are requirements for facility design, post-operational activities, characterization, and environmental review.

C.3 NRC Regulations and Requirements

C.3.1 NRC's Mission and Statutory Authority

The mission of the U.S. Nuclear Regulatory Commission (NRC) is to ensure adequate protection of the public health and safety, the common defense and security, and the environment in the use of nuclear materials in the United States. The NRC's scope of responsibility includes regulation of commercial nuclear power reactors; nonpower research, test, and training reactors; fuel cycle facilities; medical, academic, and industrial uses of nuclear materials; and the storage and disposal of nuclear materials and waste.

The NRC is an independent agency created by the Energy Reorganization Act of 1974. This Act abolished the Atomic Energy Commission (AEC), moved the AEC's regulatory function to NRC, and, along with the Atomic Energy Act of 1954, as amended, provides the foundation for regulation of the nation's commercial nuclear power industry.

NRC regulations are issued under the United States Code of Federal Regulations (CFR) Title 10, Chapter 1. Principal statutory authorities that govern NRC's work are:

- Atomic Energy Act of 1954, as amended
- Energy Reorganization Act of 1974, as amended
- Uranium Mill Tailings Radiation Control Act of 1978, as amended
- Nuclear Non-Proliferation Act of 1978
- Low-Level Radioactive Waste Policy Act of 1980
- West Valley Demonstration Project Act of 1980
- Nuclear Waste Policy Act of 1982
- Low-Level Radioactive Waste Policy Amendments Act of 1985
- Diplomatic Security and Anti-Terrorism Act of 1986
- Nuclear Waste Policy Amendments Act of 1987
- Solar, Wind, Waste and Geothermal Power Production Incentives Act of 1990
- Energy Policy Act of 1992

The Atomic Energy Act of 1954, as amended, allows the NRC to issue orders to both licensees and persons not licensed by the NRC. NRC orders may be a means of compelling decommissioning at sites where the license has been terminated or at sites that were not previously licensed but currently contain radioactive material that is under the jurisdiction of the NRC.

The NRC and its licensees share a common responsibility to protect the public health and safety. Federal regulations and the NRC regulatory program are important elements in the protection of the public. NRC licensees, however, have the primary responsibility for the safe use of nuclear materials.

C.3.2 NRC Criteria for Decommissioning

This section of the survey manual contains information on the existing cleanup criteria for decommissioning sites regulated by the NRC. Additional cleanup criteria established by State and local governments may also be applicable at NRC-licensed sites at the time of decommissioning.

NRC's requirements for decommissioning and license termination are contained in 10 CFR 30.36, 40.42, 50.82, 70.38, and 72.54. The radiological criteria for license termination are contained in 10 CFR 20.1401 through 1406 (62 FR 39058, July 21, 1997).

Prior to the adoption of the current regulations on radiological criteria for license termination, the Commission's position on residual contamination criteria, site characterization, and other related decommissioning issues was outlined in a NRC document entitled "Action Plan to Ensure Timely Cleanup of Site Decommissioning Management Plan Sites," which was published in the Federal Register on April 6, 1993 (57 FR 13389). Other documents that were used in the past and which may continue to have some applicability in special cases include:

"Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content" (10 CFR 40, Appendix A) and Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192, Subparts D and E)

> These regulations, issued by the NRC and EPA, establish technical criteria related to the operation, decontamination, decommissioning, and reclamation of uranium or thorium mills and mill tailings. Both regulations provide design requirements for closure of the mill's waste disposal area, which requires an earthen cover over tailings or waste piles to control radiological hazards from uranium and thorium tailings for 200 to 1,000 years, according to Technical Criterion 6 of Appendix A to 10 CFR Part 40.

The principal radiological hazards from uranium milling operations and mill tailings disposal are radon from uranium and thorium daughters. The atmospheric release rates of these gaseous radionuclides to the atmosphere are limited to an average rate of 0.7 Bq (20 pCi) per square meter per second. This rate is applicable to any portion of a licensed or disposal site unless land areas do not contain radium concentrations—averaged over 100 square meters—greater than: (i) 0.2 Bq/g (5 pCi/g) of radium averaged over the first 15 centimeters below the surface, and (ii) 0.6 Bq/g (15 pCi/g) of radium averaged over 15-centimeter thick layers more than 15 centimeters below the surface.

Criterion 6 allows radon release rates to be averaged over a period of at least 1 year (but much less than 100 years) to account for the wide variability in atmospheric radon concentrations over short time periods and seasons. In addition, this criterion applies only to emissions from uranium daughters and does not include radon emissions from earthen materials used to cover the tailings piles. If appropriate, radon emissions from cover materials are evaluated when developing a closure plan for each site to account for this additional contribution from naturally occurring radon. However, direct gamma exposure rates from tailings or wastes should be reduced to background levels according to this standard.

C.3.3 NRC Decommissioning Process and Staff Plans for Implementing Survey Procedures in this Manual

NRC licensees are required to conduct radiation surveys of the premises where the licensed activities were conducted and submit a report describing the survey results. The survey process follows requirements contained in 10 CFR 30.36, 40.42, 50.82, 70.38, and 72.54, which pertain to decommissioning of a site and termination of a license. This process leads to the unrestricted release of a site; however, many of the requirements may not be necessary if the licensee demonstrates that the premises are suitable for release in some other manner. Each year, the NRC staff routinely evaluates licensee requests to discontinue licensed operations. The majority of these requests are straightforward, requiring little, if any, site remediation before radiological surveys are conducted and evaluated. However, some NRC sites require substantial remediation because buildings and lands contain nonroutine amounts of radiological contamination. Radiological surveys may also be performed by the NRC at sites where there is not a license.

The NRC decommissioning process for a site requiring substantial remediation can be described by the activities listed below:

- licensee notifies the NRC they intend to decommission all or part of the site
- site characterization, including preparation of the characterization plan and performance of site characterization
- development and submission of decommissioning plan

- NRC review and approval of decommissioning plan
- performance of decommissioning actions described in the plan
- performance of termination survey and submittal of termination survey report
- NRC performance and documentation of confirmatory survey
- NRC termination of license

The NRC staff plans to use the information contained in this manual as primary guidance for conducting radiological surveys of routine licensee requests for license termination and nonroutine license termination requests that require more extensive decommissioning actions. Supplementary guidance may be used by the NRC staff to assist licensees in conducting such surveys or aid the NRC staff in evaluating licensee's survey plans and survey results to determine compliance with decommissioning criteria. Examples of supplementary guidance include NRC Information Notices, Bulletins, Generic Letters, Branch Technical Positions, NUREG reports, Regulatory Guides, and other regulatory documents that transmit NRC requirements and guidance.

C.4 DOD Regulations and Requirements

The Department of Defense (DOD) consists of four primary military services: the United States Air Force, the United States Army, the United States Navy, and the United States Marine Corps.

DOD installations use sources of ionizing radiation and support radiation protection programs for the control of these radioactive materials. As a Federal agency, the DOD complies with all applicable environmental regulations under the Federal Facilities Compliance Act of 1992.

C.4.1 DOD Sources of Ionizing Radiation

DOD's list of radioactive materials includes:

- Special nuclear material such as plutonium or enriched uranium
- Source material such as uranium or thorium
- Byproduct material such as any radioactive material yielded in or made radioactive by exposure to radiation incident to the process of producing special nuclear material
- Naturally occurring or accelerator-produced radioactive material (NARM), such as radium, and not classified as source material
- Materials containing induced or deposited radioactivity

Ionizing Radiation Producing Devices: Electronic devices that are capable of emitting ionizing radiation. Examples are linear accelerators, cyclotrons, radiofrequency generators that use klystrons or magnetrons, and other electron tubes that produce x-rays. These devices may have

components that contain radioactive material or they may induce radioactivity in certain other materials.

C.4.2 Commodities Containing Radioactive Material Within the DOD System

The DOD uses a variety of manufactured items (commodities) incorporating in whole or in part both sealed and unsealed radioactive material. A sealed source is any radioactive material that is permanently bound or fixed in a capsule or matrix designed to prevent the release or dispersal of such material under the most severe conditions encountered in normal use.

Ionizing radiation is used directly in DOD systems as calibration and check sources for RADIAC or other survey-type instruments, as a source of radioluminescence in meters and gauges, as an ionization source in various devices, and as radiographic sources.

Indirectly, ionizing radiation may be emitted from a DOD material system as natural radioactivity or induced radioactivity incorporated into material or a component of the system.

Specific examples of commodities include instrument calibration sources, luminescent compasses and exit signs, certain electron tubes and spark gaps, depleted uranium counterweights and munitions, and magnesium-thorium aircraft components.

C.4.3 Licensed Radioactive Material

Licensed radioactive material is source, special nuclear, or byproduct material received, stored, possessed, used, or transferred under a specific or general license issued by the NRC or an NRC Agreement State.

Radioactive material licensed or controlled by the individual military services:

- The Department of the Air Force has been designated by the NRC, through the issuance of a Master Materials License, regulatory authority for the receipt, possession, distribution, use, transportation, transfer, and disposal of radioactive material at Air Force activities. The Air Force Radioisotope Committee was established to provide administrative control of all radioactive material used in the Air Force except for reactors and associated radioactivity, nuclear weapons, and certain components of weapons delivery systems. Air Force Radioactive Material Permits are used to maintain this control.

- The Department of the Army, through the issuance of NRC specific licenses to Army installations and activity commanders, maintains the regulatory authority for the receipt, possession, distribution, use, transportation, transfer, and disposal of radioactive material

at Army activities. In addition, within the Department of the Army, radioactive material classified as NARM may be used under a Department of the Army Radioactive Material Authorization (DARA) issued by the Army Material Command (AMC) or the Office of The Army Surgeon General. A Department of the Army Radiation Permit is required for use, storage, possession, and disposal of radiation sources by non-Army agencies (including contractors) on Army installations.

- The Department of the Navy is designated by the NRC to have—through the issuance of a Master Materials License—regulatory authority for the receipt, possession, distribution, use, transportation, transfer, and disposal of radioactive material at Navy and Marine Corps activities. The Navy Radiation Safety Committee was established to provide administrative control of all radioactive material used in the Navy and Marine Corps except for nuclear propulsion reactors and associated radioactivity, nuclear weapons, and certain components of weapons delivery systems. Navy Radioactive Material Permits are used to maintain this control.

C.4.4 Other Controlled Radioactive Material

Certain radioactive material on DOD installations may not be controlled or regulated by either the NRC or the DOE. However, during Base Realignment and Closure actions, DOD installation property which is identified to be returned to civilian use may have the potential for radioactive contamination by such material. The DOD complies with applicable State limits, guidelines, and procedures for this material. The methodologies and technical approaches for environmental radiological surveys outlined in this manual will provide guidance for dealing with issues concerning this material.

Naturally Occurring and Accelerator-Produced Radioactive Material

- Naturally occurring and accelerator-produced radioactive material (NARM) is controlled and regulated by the individual military services, as is similarly done by certain States for corporations and other users residing within their boundaries.

Special Nuclear Material Used in Military Applications

- Special nuclear material used in military applications is a unique category of radioactive material. This may be buried as radioactive waste on DOD installations, used in military weapons or utilization facilities, or used in nuclear reactors involving military applications on DOD installations. Radioactive material used or associated with weapons systems or reactors associated with such military applications is exempt from NRC and State regulations under Section 91b, Chapter 9, Military Application of Atomic Energy, Atomic Energy Act of 1954.

C.4.5 DOD Regulations Concerning Radiation and the Environment

The DOD, with its global mission, supports several directives and instructions concerning environmental compliance. The individual military services have regulations implementing these directives and instructions. The documents describing these regulations are used as guidance in developing environmental radiological surveys within DOD.

The DOD and each military service also have specific regulations addressing the use of radioactive sources and the development of occupational health programs and radiation protection programs. These regulations may help in identifying potential locations and sources of radioactive contamination on DOD installations.

C.4.6 DOD Regulations and Requirements

Regulations and Requirements Concerning Development of Environmental Radiological Surveys

1. DOD Directive 4165.60, Solid and Hazardous Waste Management-Collection, Disposal, Resource Recovery, and Recycling Program.
2. DOD Directive 4210.15, Hazardous Material Pollution Prevention.
3. DOD Directive 5100.50, Protection and Enhancement of Environmental Quality.
4. DOD Directive 6050.1, Environmental Effects in the United States of Department of Defense Actions.
5. DOD Directive 6050.7, Environmental Effects Abroad of Major Department of Defense Actions.
6. DOD Directive 6050.8, Storage and Disposal of Non-DOD-Owned-Hazardous or Toxic Materials on DOD Installations.
7. DOD Instruction 4120.14, Environmental Pollution Prevention, Control, and Abatement.
8. DOD Instruction 5100.5, Protection and Enhancement of Environmental Quality.

Regulations and Requirements Concerning Use of Radioactive Sources and Development of Occupational Health Programs and Radiation Protection Programs:

1. DOD Instruction 6055.5-M, Occupational Health Surveillance Manual.
2. DOD Instruction 6055.8, Occupational Radiation Protection Program.

Examples of Air Force Instructions (AFIs):

1. AFI 40-201, Managing Radioactive Materials in the Air Force.
2. AFI 32-7020, Environmental Restoration Program.
3. AFI 32-7066, Environmental Baseline and Close-out Surveys in Real Estate Transactions.

Examples of Army Regulations (ARs):

1. AR 11-9, The Army Radiation Safety Program
2. AR 40-5, Preventive Medicine.
3. AR 40-10, Health Hazard Assessment Program in Support of the Army Materiel Acquisition Decision Process.
4. AR 200-1, Environmental Protection and Enhancement.
5. AR 200-2, Environmental Effects of Army Actions.
6. AR 385-30, Safety Color Code Markings and Signs.
7. AR 700-64, Radioactive Commodities in the DOD Supply System.
8. AR 750-25, Army Test, Measurement, and Diagnostic Equipment (TMDE) Calibration and Repair Support Program.
9. TB MED 521, Management and Control of Diagnostic X-Ray, Therapeutic X-Ray, and Gamma Beam Equipment.
10. TB MED 522, Control of Health Hazards from Protective Material Used in Self-Luminous Devices.
11. TB MED 525, Control of Hazards to Health from Ionizing Radiation Used by the Army Medical Department.
12. TB 43-180, Calibration and Repair Requirements for the Maintenance of Army Materiel.
13. TB 43-0108, Handling, Storage, and Disposal of Army Aircraft Components Containing Radioactive Material.
14. TB 43-0116, Identification of Radioactive Items in the Army.
15. TB 43-0122, Identification of U.S. Army Communications-Electronic Command Managed Radioactive items in the Army.
16. TB 43-0141, Safe Handling, Maintenance, Storage, and Disposal of Radioactive Commodities Managed by U.S. Army Troop Support and Aviation Material Readiness Command (Including Aircraft Components).
17. TB 43-0197, Instructions for Safe Handling, Maintenance, Storage, and Disposal of Radioactive Items Managed by U.S. Army Armament Material Command.
18. TB 43-0216, Safety and Hazard Warnings for Operation and Maintenance of TACOM Equipment.
19. TM 3-261, Handling and Disposal of Unwanted Radioactive Material.
20. TM 55-315, Transportability Guidance for Safe Transport of Radioactive Materials.

Examples of Navy Regulations:

1. NAVMED P-5055, Radiation Health Protection Manual.
2. NAVSEA SO420-AA-RAD-010, Radiological Affairs Support Program (RASP) Manual.
3. OPNAV 6470.3, Navy Radiation Safety Committee.
4. NAVSEA 5100.18A, Radiological Affairs Support Program.
5. OPNAV 5100.8G, Navy Safety and Occupational Safety and Health Program.

6. NAVMEDCOM 6470.10, Initial Management of Irradiated or Radioactively Contaminated Personnel.
7. OPNAV 3710.31, Carrying Hazardous Materials; Operational Procedures.
8. NAVSUP 5101.11, Procedures for the Receipt, Storage, and Handling of Radioactive Material Shipments.
9. NAVSUP 5101.6, Procedures for the Requisitioning, Labeling, Handling, Storage, & Disposal of Items Which Contain Radioactive By-Product Material.
10. NAVSUP 4000.34, Radioactive Commodities in the DOD Supply System.
11. NAVSEA 9639.1, Radioluminescent Sources and Radioactively Contaminated Equipment Aboard Inactive Naval Ships and Craft.
12. NAVSUP 4510.28, Special Restrictions on Issue and Disposal of Radiological Control Materials.
13. NAVMED 6470.7, Procedures and Responsibilities for Use of Radioactive Materials at NAVMED Activities.

C.5 State and Local Regulations and Requirements

An Agreement State is a state that has signed an agreement with the NRC allowing the State to regulate the use of radioactive materials—*i.e.*, specifically Atomic Energy Act materials—within that state. Table C.2 lists the Agreement States as of April 15, 2000 (see Appendix L for contacts and addresses). Each Agreement State provides regulations governing the use of radioactive materials that may relate to radiation site investigations.[3] Table C.3 lists the states that regulate naturally occurring radioactive material (NORM) as of January 1, 2000 (PGA 2000). A number of other states are in the process of developing regulations governing the use of NORM. The decision maker should check with the state to ensure compliance with all applicable regulations.

[3] A current list of agreement states can be obtained through the U.S. Nuclear Regulatory Commission on the Internet on the State Program Directory page operated by the Oak Ridge National Laboratory at http://www.hsrd.ornl.gov/nrc/asframe.htm.

Table C.2 Agreement States		
Alabama	Louisiana	North Carolina
Arizona	Maine	North Dakota
Arkansas	Maryland	Ohio
California	Massachusetts	Oregon
Colorado	Mississippi	Rhode Island
Florida	Nebraska	South Carolina
Georgia	Nevada	Tennessee
Illinois	New Hampshire	Texas
Iowa	New Mexico	Utah
Kansas	New York	Washington
Kentucky		

Table C.3 States That Regulate Diffuse NORM		
Alabama (proposed)	Michigan	Oklahoma (proposed)
Arkansas	Mississippi	Oregon
Colorado (proposed)	New Jersey	South Carolina
Georgia	New Mexico	Texas
Illinois (proposed)	North Dakota	Utah
Louisiana	Ohio	

APPENDIX D

THE PLANNING PHASE OF THE DATA LIFE CYCLE

The planning phase of the Data Life Cycle is carried out using the Data Quality Objectives (DQO) Process. The DQO Process is a series of planning steps based on the scientific method for establishing criteria for data quality and developing survey designs (EPA 1994a, 1987b, 1987c). The level of effort associated with planning is based on the complexity of the survey. Large, complicated sites generally receive a significant amount of effort during the planning phase, while smaller sites may not require as much planning effort.

Planning radiological surveys using the DQO Process can improve the survey effectiveness and efficiency, and thereby the defensibility of decisions. It also can minimize expenditures related to data collection by eliminating unnecessary, duplicative, or overly precise data. The use of the DQO Process assures that the type, quantity, and quality of environmental data used in decision making will be appropriate for the intended application. It provides systematic procedures for defining the criteria that the survey design should satisfy, including when and where to perform measurements, the level of decision errors for the survey, and how many measurements to perform.

The expected output of planning a survey using the DQO Process is a quality assurance project plan (QAPP). The QAPP integrates all technical and quality aspects of the Data Life Cycle, and defines in detail how specific quality assurance and quality control activities will be implemented during the survey.

The DQO Process provides for early involvement of the decision maker and uses a graded approach to data quality requirements. This graded approach defines data quality requirements according to the type of survey being designed, the risk of making a decision error based on the data collected, and the consequences of making such an error. This approach provides a more effective survey design combined with a basis for judging the usability of the data collected.

DQOs are qualitative and quantitative statements derived from the outputs of the DQO Process that:

- clarify the study objective
- define the most appropriate type of data to collect
- determine the most appropriate conditions for collecting the data
- specify limits on decision errors which will be used as the basis for establishing the quantity and quality of data needed to support the decision

The DQO Process consists of seven steps, as shown in Figure D.1. The output from each step influences the choices that will be made later in the Process. Even though the DQO Process is depicted as a linear sequence of steps, in practice it is iterative; the outputs of one step may lead to reconsideration of prior steps as illustrated in Figure D.2. For example, defining the survey unit boundaries may lead to classification of the survey unit, with each area or survey unit having a different decision statement. This iteration is encouraged since it ultimately leads to a more efficient survey design. The first six steps of the DQO Process produce the decision performance criteria that are used to develop the survey design. The final step of the Process develops a survey design based on the DQOs. The first six steps should be completed before the final survey design is developed, and every step should be completed before data collection begins.

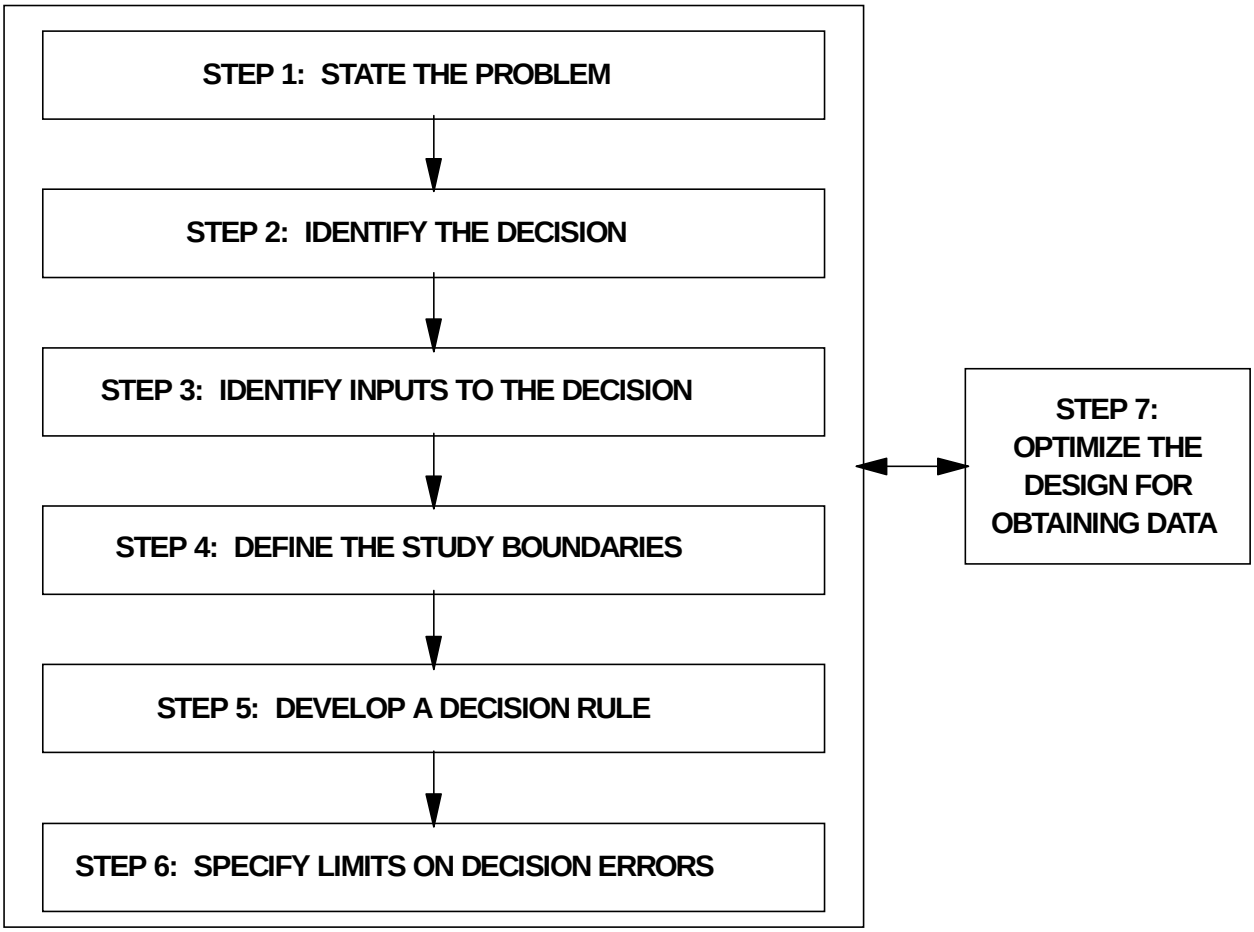


Figure D.1 The Data Quality Objectives Process

When the DQO Process is used to design a survey, it helps ensure that planning is performed properly the first time and establishes measures of performance for the data collector (implementation) and the decision maker (assessment) during subsequent phases of the Data Life Cycle. DQOs provide up-front planning and define decision maker/data collector relationships by presenting a clear statement of the decision maker's needs. This information is recorded in the QAPP.

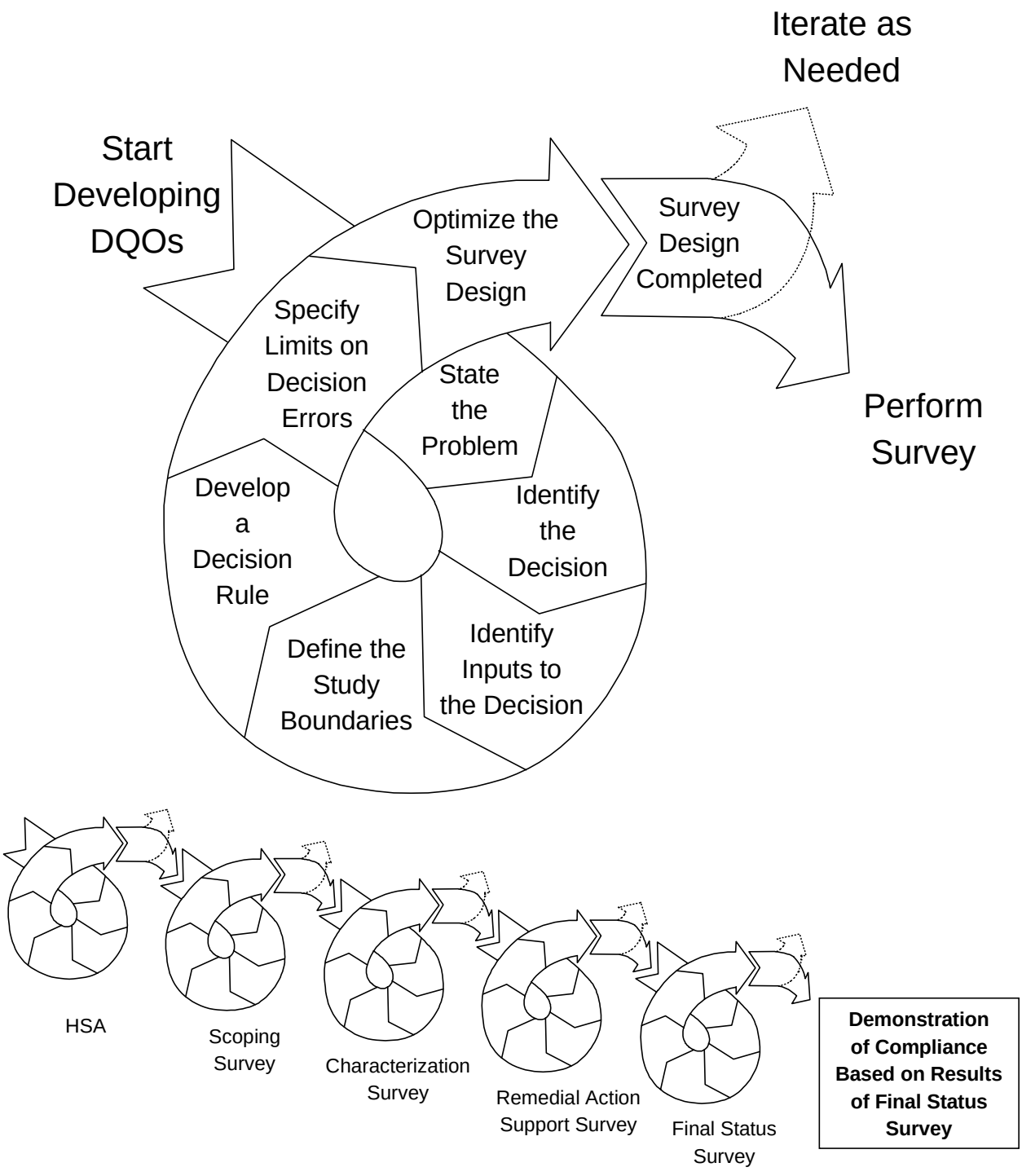


Figure D.2 Repeated Applications of the DQO Process Throughout the Radiation Survey and Site Investigation Process

DQOs for data collection activities describe the overall level of uncertainty that a decision maker is willing to accept for survey results. This uncertainty is used to specify the quality of the measurement data required in terms of objectives for precision, accuracy, representativeness, comparability, and completeness. These objectives are presented in detail in Section 9.3.2 and Appendix N.

The DQO Process is a flexible planning tool that can be used more or less intensively as the situation requires. For surveys that have multiple decisions, such as characterization or final status surveys, the DQO Process can be used repeatedly throughout the performance of the survey. Decisions made early in decommissioning are often preliminary in nature. For this reason, a scoping survey may only require a limited planning and evaluation effort. As the site investigation process nears conclusion the necessity of avoiding a decision error becomes more critical.

The following sections briefly discuss the steps of the DQO Process, especially as they relate to final status survey planning, and list the outputs for each step in the process. The outputs from the DQO Process should be included in the documentation for the survey plan.

D.1 State the Problem

The first step in any decision making process is to define the problem so that the focus of the survey will be unambiguous. Since many sites or facilities present a complex interaction of technical, economic, social, and political factors, the success of a project is critically linked to a complete but uncomplicated definition of the problem .

There are four activities associated with this step:

- identifying members of the planning team and stakeholders
- identifying the primary decision maker or decision-making method
- developing a concise description of the problem
- specifying available resources and relevant deadlines for the study

The expected outputs of this step are:

- a list of the planning team members and identification of the decision maker
- a concise description of the problem
- a summary of available resources and relevant deadlines for the survey

For a final status survey, examples of planning team members and stakeholders are described in Section 3.2. A description of the problem would typically involve the release of all or some portion of a site to demonstrate compliance with a regulation. The resources and deadlines are typically identified on a site-specific basis.

D.2 Identify the Decision

The goal of this step is to define the question that the survey will attempt to resolve and identify alternative actions that may be taken based on the outcome of the survey. The combination of these two elements is called the decision statement. The decision statement would be different for each type of survey in the Radiation Survey and Site Investigation Process, and would be developed based on the survey objectives described in Chapter 5.

There are four activities associated with this step in the DQO Process:

- identifying the principal study question
- defining the alternative actions that could result from resolution of the principal study question
- combining the principal study question and the alternative actions into a decision statement
- organizing multiple decisions

The expected output from this step is a decision statement that links the principal study question to possible solutions to the problem.

For a final status survey, the principal study question could be: "Is the level of residual radioactivity in the survey units in this portion of the site below the release criterion?" Alternative actions may include further remediation, re-evaluation of the modeling assumptions used to develop the DCGLs, re-assessment of the survey unit to see if it can be released with passive controls, or a decision not to release the survey unit. The decision statement may be: "Determine whether or not all the survey units in this portion of the site satisfy the release criterion."

D.3 Identify the Inputs to the Decision

Collecting data or information is necessary to resolve most decision statements. In this step, the planning team focuses on the information needed for the decision and identifies the different types of information needed to resolve the decision statement.

The key activities for this step include:

- Identifying the information required to resolve the decision statement. Ask general questions such as: "Is information on the physical properties of the site required?" or: "Is information on the chemical characteristics of the radionuclide or the matrix required?" Determine which environmental variables or other information are needed to resolve the decision statement.

- Determining the sources for each item of information. Identify and list the sources for the required information.
- Identifying the information needed to establish the action level or the derived concentration guideline level (DCGL) based on the release criterion. The actual numerical value will be determined in Step 5 (*i.e.*, Section D.5).
- Confirming that appropriate measurement methods exist to provide the necessary data. A list of potentially appropriate measurement techniques should be prepared based on the information requirements determined previously in this step. Field and laboratory measurement techniques for radionuclides are discussed in Chapters 6 and 7 of this manual. Information on using field and laboratory equipment, their detection limits and analytical costs are listed in Appendix H. This performance information will be used in Steps 5 and 7 of the DQO Process.

The expected outputs of this step are:

- a list of informational inputs needed to resolve the decision statement
- a list of environmental variables or characteristics that will be measured

For the final status survey, the list of information inputs generally involves measurements of the radioactive contaminants of concern in each survey unit. These inputs include identifying survey units, classifying survey units, identifying appropriate measurement techniques including measurement costs and detection limits, and whether or not background measurements from a reference area or areas need to be performed. The list of environmental variables measured during the final status survey is typically limited to the level of residual radioactivity in the affected media for each survey unit.

D.4 Define the Boundaries of the Study

During this step the planning team should develop a conceptual model of the site based on existing information collected in Step 1 of the DQO Process or during previous surveys. Conceptual models describe a site or facility and its environs, and present hypotheses regarding the radionuclides present and potential migration pathways. These models may include components from computer models, analytical models, graphic models, and other techniques. Additional data collected during decommissioning are used to expand the conceptual model.

The purpose of this step is to define the spatial and temporal boundaries that will be covered by the decision statement so data can be easily interpreted. These attributes include:

- spatial boundaries that define the physical area under consideration for release (site boundaries)

- spatial boundaries that define the physical area to be studied and locations where measurements could be performed (actual or potential survey unit boundaries)
- temporal boundaries that describe the time frame the study data represents and when measurements should be performed
- spatial and temporal boundaries developed from modeling used to determine DCGLs

There are seven activities associated with this step:

- specifying characteristics that define the true but unknown value of the parameter of interest
- defining the geographic area within which all decisions must apply
- when appropriate, dividing the site into areas or survey units that have relatively homogeneous characteristics
- determining the time frame to which the decision applies
- determining when to collect data
- defining the scale of decision making
- identifying any practical constraints on data collection

The expected outputs of this step are:

- a detailed description of the spatial and temporal boundaries of the problem (a conceptual model)
- any practical constraints that may interfere with the full implementation of the survey design

Specifying the characteristics that define the true but unknown value of the parameter of interest for the final status survey typically involves identifying the radionuclides of concern. If possible, the physical and chemical form of the radionuclides should be described. For example, describing the residual radioactivity in terms of total uranium is not as specific or informative as describing a mixture of uraninite (UO_2) and uranium metaphosphate ($U(PO_3)_4$) for natural abundances of ^{234}U, ^{235}U, and ^{238}U.

As an example, the study boundary may be defined as the property boundary of a facility or, if there is only surface contamination expected at the site, the soil within the property boundary to a depth of 15 cm. When appropriate (typically during and always before final status survey design), the site is subdivided into survey units with relatively homogeneous characteristics based on information collected during previous surveys. The radiological characteristics are defined by the area classification (Class 1, Class 2, or Class 3) while the physical characteristics may include structures vs. land areas, transport routes vs. grassy areas, or soil types with different radionuclide transfer characteristics.

The time frame to which the final status survey decision applies is typically defined by the regulation. For example: "The data are used to reflect the condition of radionuclides leaching into ground water over a period of 1,000 years." Temporal boundaries may also include seasonal conditions such as winter snow cover or summer drought that affect the accessibility of certain media for measurement.

For the final status survey, the smallest, most appropriate subsets of the site for which decisions will be made are defined as survey units. The size of the survey unit and the measurement frequency within a survey unit are based on classification, site-specific conditions, and relevant decisions used during modeling to determine the DCGLs.

D.5 Develop a Decision Rule

The purpose of this step is to define the parameter of interest, specify the action level (or DCGL), and integrate previous DQO outputs into a single statement that describes a logical basis for choosing among alternative actions.

There are three activities associated with this step:

- specifying the statistical parameter that characterizes the parameter of interest
- specifying the action level for the study
- combining the outputs of the previous DQO steps into an "if...then..." decision rule that defines the conditions that would cause the decision maker to choose among alternative actions

Certain aspects of the site investigation process, such as the HSA, are not so quantitative that a statistical parameter can be specified. Nevertheless, a decision rule should still be developed that defines the conditions that would cause the decision maker to choose among alternatives.

The expected outputs of this step are:

- the parameter of interest that characterizes the level of residual radioactivity
- the action level
- an "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative actions

The parameter of interest is a descriptive measure (such as a mean or median) that specifies the characteristic or attribute that the decision maker would like to know about the residual contamination in the survey unit.

The mean is the value that corresponds to the "center" of the distribution in the sense of the "center of gravity" (EPA 1989a). Positive attributes of the mean include: 1) it is useful when the action level is based on long-term, average health effects, 2) it is useful when the population is uniform with relatively small spread, and 3) it generally requires fewer samples than other parameters of interest. Negative attributes include: 1) it is not a very representative measure of central tendency for highly skewed distributions, and 2) it is not useful when a large proportion of the measurements are reported as less than the detection limit (EPA 1994a).

The median is also a value that corresponds to the "center" of a distribution, but where the mean represents the center of gravity the median represents the "middle" value of a distribution. The median is that value such that there are the same number of measurements greater than the median as less than the median. The positive attributes of the median include: 1) it is useful when the action level is based on long-term, average health effects, 2) it provides a more representative measure of central tendency than the mean for skewed populations, 3) it is useful when a large proportion of the measurements are reported as less than the detection limit, and 4) it relies on few statistical assumptions. Negative attributes include: 1) it will not protect against the effects of extreme values, and 2) it is not a very representative measure of central tendency for highly skewed distributions (EPA 1994a).

The nonparametric statistical tests discussed in Chapter 8 are designed to determine whether or not the level of residual activity uniformly distributed throughout the survey unit exceeds the $DCGL_W$. Since these methods are based on ranks, the results are generally expressed in terms of the median. When the underlying measurement distribution is symmetric, the mean is equal to the median. The assumption of symmetry is less restrictive than that of normality because the normal distribution is itself symmetric. If, however, the measurement distribution is skewed to the right, the average will generally be greater than the median. In severe cases, the average may exceed the $DCGL_W$ while the median does not. For this reason, MARSSIM recommends comparing the arithmetic mean of the survey unit data to the $DCGL_W$ as a first step in the interpretation of the data (see Section 8.2.2.1).

The action level is a measurement threshold value of the parameter of interest that provides the criterion for choosing among alternative actions. MARSSIM uses the investigation level, a radionuclide-specific level of radioactivity based on the release criterion that results in additional investigation when it is exceeded, as an action level. Investigation levels are developed for both the Elevated Measurement Comparison (EMC) using scanning techniques and the statistical tests using direct measurements and samples. Section 5.5.2.6 provides information on investigation levels used in MARSSIM.

The mean concentration of residual radioactivity is the parameter of interest used for making decisions based on the final status survey. The definition of residual radioactivity depends on whether or not the contaminant appears as part of background radioactivity in the reference area. If the radionuclide is not present in background, residual radioactivity is defined as the mean

concentration in the survey unit. If the radionuclide is present in background, residual radioactivity is defined as the difference between the mean concentration in the survey unit and the mean concentration in the reference area selected to represent background. The term *1-sample case* is used when the radionuclide does not appear in background, because measurements are only made in the survey unit. The term *2-sample case* is used when the radionuclide appears in background, because measurements are made in both the survey unit and the reference area.

Figure D.3 contains a simple, hypothetical example of the 1-sample case. The upper portion of the figure shows a probability distribution of residual radionuclide concentrations in the surface soil of the survey unit. The parameter of interest is the location of the mean of this distribution, represented by the vertical dotted line and denoted by the symbol D.

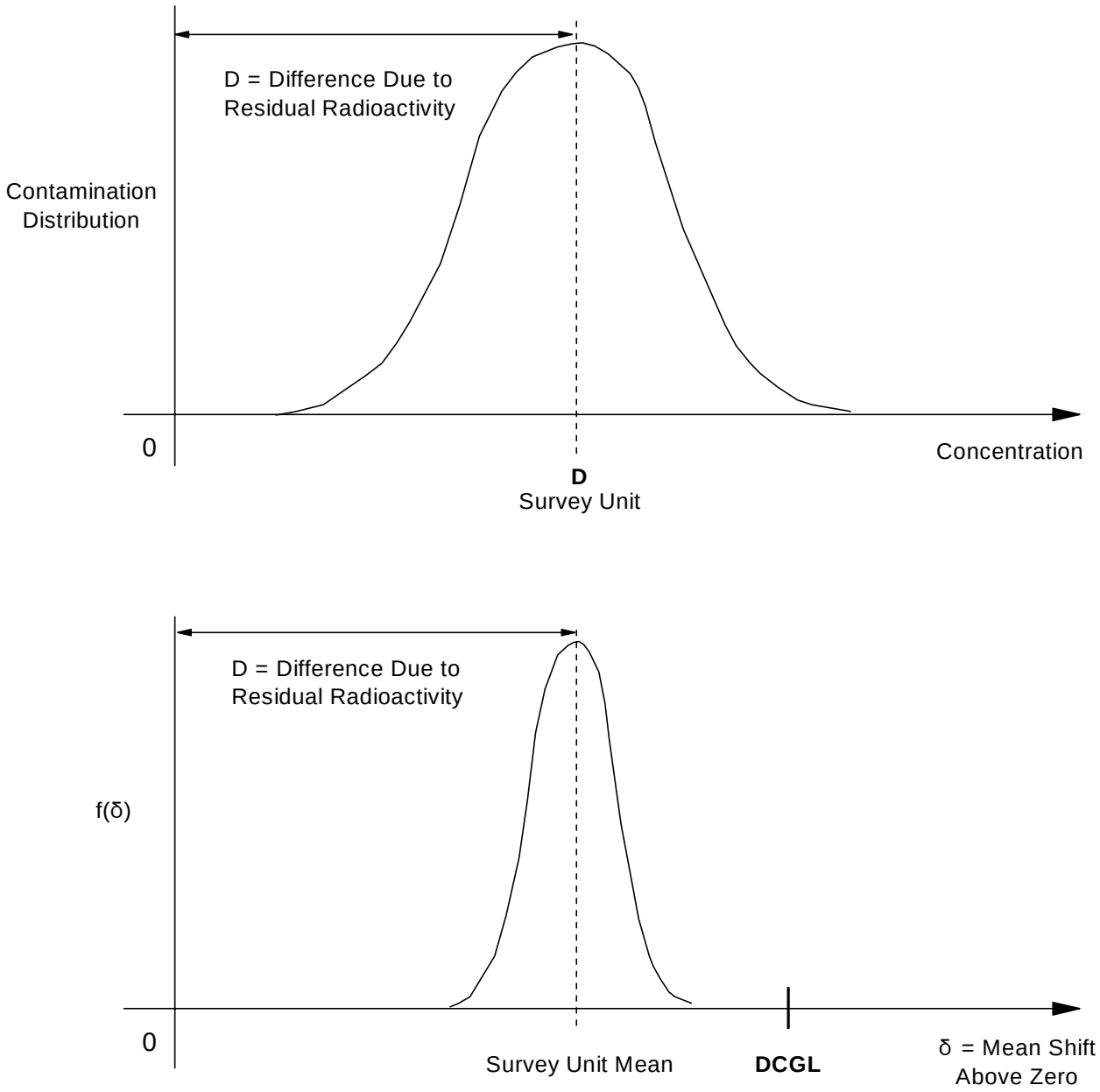
The decision rule for the 1-sample case is: "If the mean concentration in the survey unit is less than the investigation level, then the survey unit is in compliance with the release criterion." To implement the decision rule, an estimate of the mean concentration in the survey unit is required. An estimate of the mean of the survey unit distribution may be obtained by measuring radionuclide concentrations in soil at a set of n randomly selected locations in the survey unit. A point estimate for the survey unit mean is obtained by calculating the simple arithmetic average of the n measurements. Due to measurement variability, there is a distribution of possible values for the point estimate for the survey unit mean, δ. This distribution is referred to as $f(\delta)$, and is shown in the lower graph of Figure D.3. The investigation level for the Sign test used in the 1-sample case is the $DCGL_W$, shown on the horizontal axis of the graph.

If $f(\delta)$ lies far to the left (or to the right) of the $DCGL_W$, a decision of whether or not the survey unit demonstrates compliance can be easily made. However, if $f(\delta)$ overlaps the $DCGL_W$, statistical decision rules are used to assist the decision maker. Note that the width of the distribution for the estimated mean may be reduced by increasing the number of measurements. Thus, a large number of samples will reduce the probability of making decision errors.

Figure D.4 shows a simple, hypothetical example of the 2-sample case. The upper portion of the figure shows one probability distribution representing background radionuclide concentrations in the surface soil of the reference area, and another probability distribution representing radionuclide concentrations in the surface soil of the survey unit. The graph in the middle portion of the figure shows the distributions of the estimated mean concentrations in the reference area and the survey unit. In this case, the parameter of interest is the difference between the means of these two distributions, D, represented by the distance between the two vertical dotted lines.

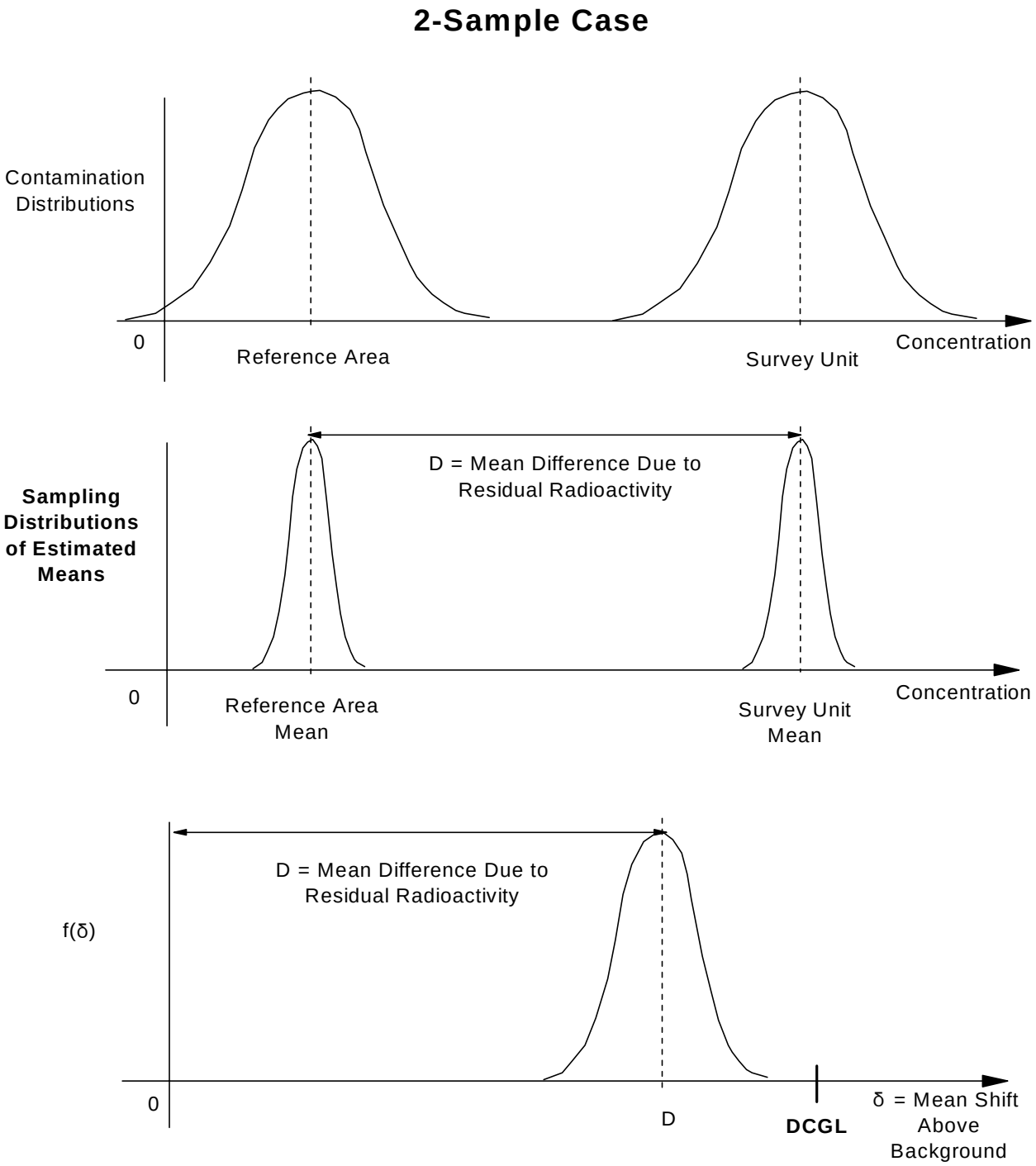
The decision rule for the 2-sample case is: "If the difference between the mean concentration in the survey unit and the mean concentration in the reference area is less than the investigation level, then the survey unit is in compliance with the release criterion." To implement the

1-Sample Case



f(δ) is the sampling distribution of the estimated survey unit mean.

Figure D.3 Example of the Parameter of Interest for the 1-Sample Case



f(δ) is the sampling distribution of the difference between the survey unit mean and the reference area mean.

Figure D.4 Example of the Parameter of Interest for the 2-Sample Case

decision rule, an estimate of the difference is required. This estimate may be obtained by measuring radionuclide concentrations at a set of "n" randomly selected locations in the survey unit and "m" randomly selected locations in the reference area. A point estimate of the survey unit mean is obtained by calculating the simple arithmetic average of the n measurements in the survey unit. A point estimate of the reference area mean is similarly calculated. A point estimate of the difference between the two means is obtained by subtracting the reference area average from the survey unit average.

The measurement distribution of this difference, $f(\delta)$, is centered at D, the true value of the difference. This distribution is shown in the lower graph of Figure D.4.

Once again, if $f(\delta)$ lies far to the left (or to the right) of the $DCGL_W$, a decision of whether or not the survey unit demonstrates compliance can be easily made. However, if $f(\delta)$ overlaps the $DCGL_W$, statistical decision rules are used to assist the decision maker.

D.6 Specify Limits on Decision Errors

Decisions based on survey results can often be reduced to a choice between "yes" or "no", such as determining whether or not a survey unit meets the release criterion. When viewed in this way, two types of incorrect decisions, or decision errors, are identified: 1) incorrectly deciding that the answer is "yes" when the true answer is "no", and 2) incorrectly deciding the answer is "no" when the true answer is "yes". The distinctions between these two types of errors are important for two reasons: 1) the consequences of making one type of error versus the other may be very different, and 2) the methods for controlling these errors are different and involve tradeoffs. For these reasons, the decision maker should specify levels for each type of decision error.

The purpose of this section is to specify the decision maker's limits on decision errors, which are used to establish performance goals for the data collection design. The goal of the planning team is to develop a survey design that reduces the chance of making a decision error.

While the possibility of a decision error can never be totally eliminated, it can be controlled. To control the possibility of making decision errors, the planning team attempts to control uncertainty in the survey results caused by sampling design error and measurement error. Sampling design error may be controlled by collecting a large number of samples. Using more precise measurement techniques or field duplicate analyses can reduce measurement error. Better sampling designs can also be developed to collect data that more accurately and efficiently represent the parameter of interest. Every survey will use a slightly different method of controlling decision errors, depending on the largest source of error and the ease of reducing those error components.

The estimate of the standard deviation for the measurements performed in a survey unit (σ_s) includes the individual measurement uncertainty as well as the spatial and temporal variations captured by the survey design. For this reason, individual measurement uncertainties are not used during the final status survey data assessment. However, individual measurement uncertainties may be useful for determining an *a priori* estimate of σ_s during survey planning. Since a larger value of σ_s results in an increased number of measurements needed to demonstrate compliance during the final status survey, the decision maker may seek to reduce measurement uncertainty through various methods (*e.g.*, different instrumentation). There are trade-offs that should be considered during survey planning. For example, the costs associated with performing additional measurements with an inexpensive measurement system may be less than the costs associated with a measurement system with better sensitivity (*i.e.*, lower measurement uncertainty, lower minimum detectable concentration). However, the more expensive measurement system with better sensitivity may reduce σ_s and the number of measurements used to demonstrate compliance to the point where it is more cost effective to use the more expensive measurement system. For surveys in the early stages of the Radiation Survey and Site Investigation Process, the measurement uncertainty and instrument sensitivity become even more important. During scoping, characterization, and remedial action support surveys, decisions about classification and remediation are made based on a limited number of measurements. When the measurement uncertainty or the instrument sensitivity values approach the value of the DCGL, it becomes more difficult to make these decisions. From an operational standpoint, when operators of a measurement system have an *a priori* understanding of the sensitivity and potential measurement uncertainties, they are able to recognize and respond to conditions that may warrant further investigation—*e.g.*, changes in background radiation levels, the presence of areas of elevated activity, measurement system failure or degradation, *etc.*

The probability of making decision errors can be controlled by adopting a scientific approach, called hypothesis testing. In this approach, the survey results are used to select between one condition of the environment (the null hypothesis, H_0) and an alternative condition (the alternative hypothesis, H_a). The null hypothesis is treated like a baseline condition that is assumed to be true in the absence of strong evidence to the contrary. Acceptance or rejection of the null hypothesis depends upon whether or not the particular survey results are consistent with the hypothesis.

A decision error occurs when the decision maker rejects the null hypothesis when it is true, or accepts the null hypothesis when it is false. These two types of decision errors are classified as Type I and Type II decision errors, and can be represented by a table as shown in Table D.1.

A Type I decision error occurs when the null hypothesis is rejected when it is true, and is sometimes referred to as a false positive error. The probability of making a Type I decision error, or the level of significance, is denoted by alpha (α). Alpha reflects the amount of evidence the decision maker would like to see before abandoning the null hypothesis, and is also referred to as the *size* of the test.

Table D.1 Example Representation of Decision Errors for a Final Status Survey

H_0: The Residual Activity in the Survey Unit Exceeds the Release Criterion			
		DECISION	
		Reject H_0 (Meets Release Criterion)	Accept H_0 (Exceeds Release Criterion)
TRUE CONDITION OF SURVEY UNIT	Meets Release Criterion	(No decision error)	Incorrectly Fail to Release Survey Unit (Type II)
	Exceeds Release Criterion	Incorrectly Release Survey Unit (Type I)	(No decision error)

A Type II decision error occurs when the null hypothesis is accepted when it is false. This is sometimes referred to as a false negative error. The probability of making a Type II decision error is denoted by beta (β). The term (1-β) is the probability of rejecting the null hypothesis when it is false, and is also referred to as the *power* of the test.

There is a relationship between α and β that is used in developing a survey design. In general, increasing α decreases β and vice versa, holding all other variables constant. Increasing the number of measurements typically results in a decrease in both α and β. The number of measurements that will produce the desired values of α and β from the statistical test can be estimated from α, β, the $DCGL_W$, and the estimated variance of the distribution of the parameter of interest.

There are five activities associated with specifying limits on decision errors:

- Determining the possible range of the parameter of interest. Establish the range by estimating the likely upper and lower bounds based on professional judgement.
- Identifying the decision errors and choosing the null hypothesis.
  a. Define both types of decision errors (Type I and Type II) and establish the true condition of the survey unit for each decision error.
  b. Specify and evaluate the potential consequences of each decision error.
  c. Establish which decision error has more severe consequences near the action level. Consequences include health, ecological, political, social, and resource risks.

d. Define the null hypothesis and the alternative hypothesis and assign the terms "Type I" and "Type II" to the appropriate decision error.

- Specifying a range of possible parameter values, a gray region, where the consequences of decision errors are relatively minor. It is necessary to specify a gray region because variability in the parameter of interest and unavoidable imprecision in the measurement system combine to produce variability in the data such that a decision may be "too close to call" when the true but unknown value of the parameter of interest is very near the action level. Additional guidance on specifying a gray region is available in *Guidance for the Data Quality Objectives Process* (EPA 1994a).
- Assigning probability limits to points above and below the gray region that reflect the probability for the occurrence of decision errors.
- Graphically representing the decision rule.

The expected outputs of this step are decision error rates based on the consequences of making an incorrect decision. Certain aspects of the site investigation process, such as the Historical Site Assessment (HSA), are not so quantitative that numerical values for decision errors can be specified. Nevertheless, a "comfort region" should be identified where the consequences of decision errors are relatively minor.

In Section D.5, the parameter of interest was defined as the difference between the survey unit mean concentration of residual radioactivity and the reference area mean concentration in the 2-sample case, or simply the survey unit mean concentration in the 1-sample case. The possible range of values for the parameter of interest is determined based on existing information (such as the Historical Site Assessment or previous surveys) and best professional judgement. The likely lower bound for $f(\delta)$ is either background or zero. For a final status survey when the residual radioactivity is expected to meet the release criterion, and a conservative upper bound might be approximately three times $DCGL_W$.

Hypothesis testing is used to determine whether or not a statement concerning the parameter of interest should be verified. The statement about the parameter of interest is called the null hypothesis. The alternative hypothesis is the opposite of what is stated in the null hypothesis. The decision maker needs to choose between two courses of action, one associated with the null hypothesis and one associated with the alternative hypothesis.

To make a decision using hypothesis testing, a test statistic is compared to a critical value. The *test statistic*[1] is a number calculated using data from the survey. The critical value of the test statistic defines a rejection region based on some assumptions about the true distribution of data in the survey unit. If the value of the test statistic falls within the rejection region, the null

[1] The test statistic is not necessarily identical to the parameter of interest, but is functionally related to it through the statistical analysis.

hypothesis is rejected. The decision rule, developed in Section D.5, is used to describe the relationship between the test statistic and the critical value.

MARSSIM considers two ways to state H_0 for a final status survey. The primary consideration in most situations will be compliance with the release criterion. This is shown as Scenario A in Figure D.5. The null hypothesis is that the survey unit exceeds the release criterion. Using this statement of H_0 means that significant evidence that the survey unit does not exceed the release criterion is required before the survey unit would be released.

In some situations, however, the primary consideration may be determining if any residual radioactivity at the site is distinguishable from background, shown as Scenario B in Figure D.6. In this manual, Scenario A is used as an illustration because it directly addresses the compliance issue and allows consideration of decision errors. More information on Scenario B can be found in the NRC draft report NUREG-1505 (NRC 1995a).

For Scenario A, the null hypothesis is that the survey unit does not meet the release criterion. A Type I decision error would result in the release of a survey unit containing residual radioactivity above the release criterion. The probability of making this error is α. Setting a high value for α would result in a higher risk that survey units that might be somewhat in excess of the release criterion would be passed as meeting the release criterion. Setting a low value for α would result in fewer survey units where the null hypothesis is rejected. However, the cost of setting a low value for α is either a higher value for β or an increased number of samples used to demonstrate compliance.

For Scenario A, the alternative hypothesis is that the survey unit does meet the release criterion. A Type II decision error would result in either unnecessary costs due to remediation of survey units that are truly below the release criterion or additional survey activities to demonstrate compliance. The probability of making a Type II error is β. Selecting a high value for β (low power) would result in a higher risk that survey units that actually meet the release criterion are subject to further investigation. Selecting a low value for β (high power) will minimize these investigations, but the tradeoff is either a higher value for α or an increased number of measurements used to demonstrate compliance. Setting acceptable values for α and β, as well as determining an appropriate gray region, is a crucial step in the DQO process.

In the MARSSIM framework, the gray region is always bounded from above by the DCGL corresponding to the release criterion. The *Lower Bound of the Gray Region* (LBGR) is selected during the DQO process along with the target values for α and β. The *width* of the gray region, equal to (DCGL - LBGR), is a parameter that is central to the nonparametric tests discussed in this manual. It is also referred to as the *shift*, Δ. The absolute size of the shift is actually of less importance than the *relative shift* Δ/σ, where σ is an estimate of the standard deviation of the measured values in the survey unit. The estimated standard deviation, σ, includes both the real spatial variability in the quantity being measured, and the precision of the chosen measurement

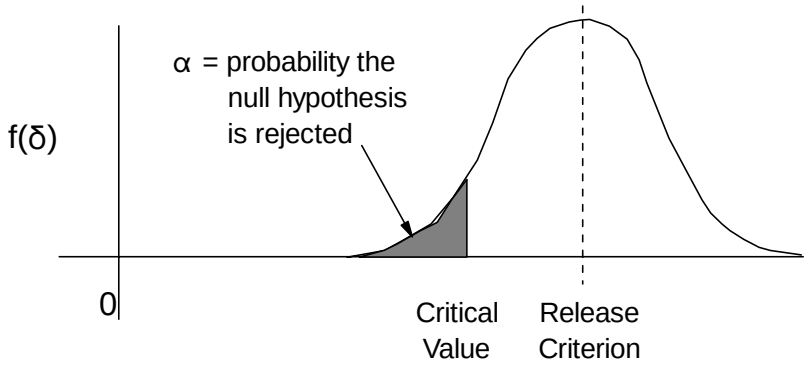
SCENARIO A

Assume as a null hypothesis that the survey unit exceeds the release criterion. This requires significant evidence that the residual radioactivity in the survey unit is less than the release criterion to reject the null hypothesis (and pass the survey unit). If the evidence is not significant at level α, the null hypothesis of a non-complying survey unit is accepted (and the survey unit fails).

HYPOTHESIS TEST

H_0: Survey unit does not meet release criterion
H_a: Survey unit does meet the release criterion

Survey unit passes if and only if the test statistic falls in the rejection region.



This test directly addresses the compliance question.

The mean shift for the survey unit must be significantly below the release criterion for the null hypothesis to be rejected.

With this test, site owners face a trade-off between additional sampling costs and unnecessary remediation costs. They may choose to increase the number of measurements in order to decrease the number of Type II decision errors (reduce the chance of remediating a clean survey unit for survey units at or near background levels.

Distinguishability from background is not directly addressed. However, sample sizes may be selected to provide adequate power at or near background levels, hence ensuring that most survey units near background would pass. Additional analyses, such as point estimates and/or confidence intervals, may be used to address this question.

A high percentage of survey units slightly below the release criterion may fail the release criterion, unless large numbers of measurements are used. This achieves a high degree of assurance that most survey units that are at or above the release criterion will not be improperly released.

Figure D.5 Possible Statement of the Null Hypothesis for the Final Status Survey Addressing the Issue of Compliance

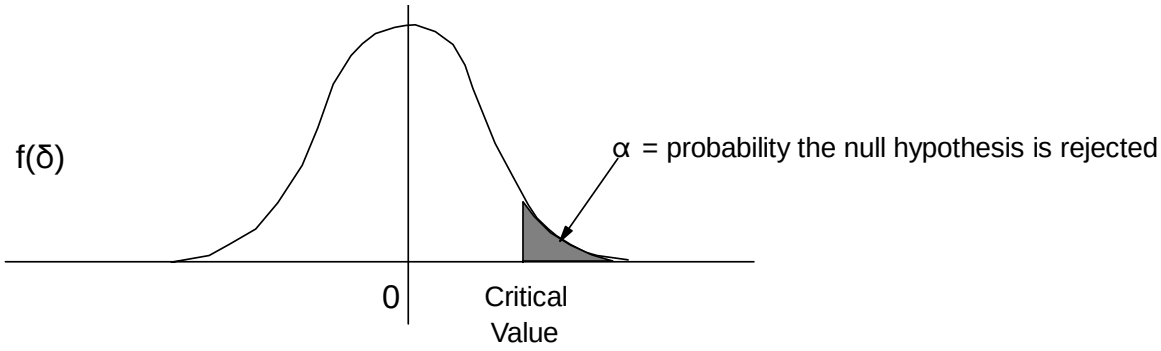
SCENARIO B

Assume as a null hypothesis that the survey unit is indistinguishable from background. This requires significant evidence that the survey unit residual radioactivity is greater than background to reject the null hypothesis (and fail the survey unit). If the evidence is not significant at level α, the null hypothesis of a clean survey unit is accepted (and the survey unit passes).

HYPOTHESIS TEST

H_0: Survey unit is indistinguishable from background
H_a: Survey unit is distinguishable from background

Survey unit passes if and only if the test statistic falls in the rejection region.



Distinguishability from background may be of primary importance to some stakeholders.

The residual radioactivity in the survey unit must be significantly above background for the null hypothesis to be rejected.

Compliance with the DCGLs is not directly addressed. However, the number of measurements may be selected to provide adequate power at or near the DCGL, hence ensuring that most survey units near the DCGL would not be improperly released. Additional analysis, based on point estimates and/or confidence intervals, is required to determine compliance if the null hypothesis is rejected by the test.

A high percentage of survey units slightly below the release criterion will fail unless large numbers of measurements are used. This is necessary to achieve a high degree of assurance that for most sites at or above the release criterion the null hypothesis will fail to be improperly released.

Figure D.6 Possible Statement of the Null Hypothesis for the Final Status Survey Addressing the Issue of Indistinguishability from Background

method. The relative shift, Δ/σ, is an expression of the resolution of the measurements in units of measurement uncertainty. Expressed in this way, it is easy to see that relative shifts of less than one standard deviation, $\Delta/\sigma < 1$, will be difficult to detect. On the other hand, relative shifts of more than three standard deviations, $\Delta/\sigma > 3$, are generally easier to detect. The number of measurements that will be required to achieve given error rates, α and β, depends almost entirely on the value of Δ/σ (see Chapter 5).

Since small values of Δ/σ result in large numbers of samples, it is important to design for $\Delta/\sigma > 1$ whenever possible. There are two obvious ways to increase Δ/σ. The first is to increase the width of the gray region by making LBGR small. Only Type II decision errors occur in the gray region. The disadvantage of making this gray region larger is that the probability of incorrectly failing to release a survey unit will increase. The target false negative rate β will be specified at lower residual radioactivity levels, i.e., a survey unit will generally have to be lower in residual radioactivity to have a high probability of being judged to meet the release criterion. The second way to increase Δ/σ is to make σ smaller. One way to make σ small is by having survey units that are relatively homogeneous in the amount of measured radioactivity. This is an important consideration in selecting survey units that have both relatively uniform levels of residual radioactivity and also have relatively uniform background radiation levels. Another way to make σ small is by using more precise measurement methods. The more precise methods might be more expensive, but this may be compensated for by the decrease in the number of required measurements. One example would be in using a radionuclide specific method rather than gross radioactivity measurements for residual radioactivity that does not appear in background. This would eliminate the variability in background from σ, and would also eliminate the need for reference area measurements.

The effect of changing the width of the gray region and/or changing the measurement variability on the estimated number of measurements (and cost) can be investigated using the DEFT (Decision Error Feasibility Trials) software developed by EPA (EPA 1995a). This program can only give approximate sample sizes and costs since it assumes that the measurement data are normally distributed, that a Student's t test will be used to evaluate the data, and that there is currently no provision for comparison to a reference area. Nevertheless, as a rough rule of thumb, the sample sizes calculated by DEFT are about 85% of those required by the one-sample nonparametric tests recommended in this manual. This rule of thumb works better for large numbers of measurements than for smaller numbers of measurements, but can be very useful for estimating the relative impact on costs of decisions made during the planning process.

Generally, the design goal should be to achieve Δ/σ values between one and three. The number of samples needed rises dramatically when Δ/σ is smaller than one. Conversely, little is usually gained by making Δ/σ larger than about three. If Δ/σ is greater than three or four, one should take advantage of the measurement precision available by making the width of the gray region smaller. It is even more important, however, that overly optimistic estimates for σ be avoided. The consequence of taking fewer samples than are needed given the actual measurement variations will be unnecessary remediations (increased Type II decision errors).

Once the preliminary estimates of Δ and σ are available, target values for α and β can be selected. The values of α and β should reflect the risks involved in making Type I and Type II decision errors, respectively.

One consideration in setting the false positive rate are the health risks associated with releasing a survey unit that might actually contain residual radioactivity in excess of the $DCGL_W$. If a survey unit did exceed the $DCGL_W$, the first question that arises is "How much above the $DCGL_W$ is the residual radioactivity likely to be?" The DEFT software can be used to evaluate this.

For example, if the $DCGL_W$ is 100 Bq/kg (2.7 pCi/g), the LBGR is 50 Bq/kg (1.4 pCi/g), σ is 50 Bq/kg (1.4 pCi/g), $\alpha = 0.10$ and $\beta = 0.05$, the DEFT calculations show that while a survey unit with residual radioactivity equal to the $DCGL_W$ has a 10% chance of being released, a survey unit at a level of 115 Bq/kg (3.1 pCi/g) has less than a 5% chance of being released, a survey unit at a level of 165 Bq/kg (4.5 pCi/g) has virtually no chance of being released. However, a survey unit with a residual radioactivity level of 65 Bq/kg (1.8 pCi/g) will have about an 80% chance of being released and a survey unit with a residual radioactivity level of 80 Bq/kg (2.2 pCi/g) will only have about a 40% chance of being released. Therefore, it is important to examine the probability of deciding that the survey unit does not meet the release criterion over the entire range of possible residual radioactivity values, and not only at the boundaries of the gray region. Of course, the gray region can be made narrower, but at the cost of additional sampling. Since the equations governing the process are not linear, small changes can lead to substantial changes in survey costs.

As stated earlier, the values of α and β that are selected in the DQO process should reflect the risk involved in making a decision error. In setting values for α, the following are important considerations:

- In radiation protection practice, public health risk is modeled as a linear function of dose (BEIR 1990). Therefore a 10% change in dose, say from 15 to 16.5, results in a 10% change in risk. This situation is quite different from one in which there is a threshold. In the latter case, the risk associated with a decision error can be quite high, and low values of α should be selected. When the risk is linear, much higher values of α at the release criterion might be considered adequately protective when the survey design results in smaller decision error rates at doses or risks greater than the release criterion. False positives will tend to be balanced by false negatives across sites and survey units, resulting in approximately equal human health risks.
- The DCGL itself is not free of error. The dose or risk cannot be measured directly, and many assumptions are made in converting doses or risks to derived concentrations. To be adequately protective of public health, these models are generally designed to over predict the dose or risk. Unfortunately, it is difficult to quantify this. Nonetheless, it is probably safe to say that most models have uncertainty sufficiently large such that the true dose or risk delivered by residual radioactivity at the DCGL is very likely to be lower than the

release criterion. This is an additional consideration for setting the value of α, that could support the use of larger values in some situations. In this case, one would prospectively address, as part of the DQO process, the magnitude, significance, and potential consequences of decision errors at values above the release criterion. The assumptions made in any model used to predict DCGLs for a site should be examined carefully to determine if the use of site specific parameters results in large changes in the DCGLs, or whether a site-specific model should be developed rather than designing a survey around DCGLs that may be too conservative.

- The risk of making the second type of decision error, β, is the risk of requiring additional remediation when a survey unit already meets the release criterion. Unlike the health risk, the cost associated with this type of error may be highly non-linear. The costs will depend on whether the survey unit has already had remediation work performed on it, and the type of residual radioactivity present. There may be a threshold below which the remediation cost rises very rapidly. If so, a low value for β is appropriate at that threshold value. This is primarily an issue for survey units that have a substantial likelihood of falling at or above the gray region for residual radioactivity. For survey units that are very lightly contaminated, or have been so thoroughly remediated that any residual radioactivity is expected to be far below the DCGL, larger values of β may be appropriate especially if final status survey sampling costs are a concern. Again, it is important to examine the probability of deciding that the survey unit does not meet the release criterion over the entire range of possible residual radioactivity values, below as well as above the gray region.
- Lower decision error rates may be possible if alternative sampling and analysis techniques can be used that result in higher precision. The same might be achieved with moderate increases in sample sizes. These alternatives should be explored before accepting higher design error rates. However, in some circumstances, such as high background variations, lack of a radionuclide specific technique, and/or radionuclides that are very difficult and expensive to quantify, error rates that are lower than the uncertainties in the dose or risk estimates may be neither cost effective nor necessary for adequate radiation protection.

None of the above discussion is meant to suggest that under any circumstances a less than rigorous, thorough, and professional approach to final status surveys would be satisfactory. The decisions made and the rationale for making these decisions should be thoroughly documented.

For Class 1 Survey Units, the number of samples may be driven more by the need to detect small areas of elevated activity than by the requirements of the statistical tests. This in turn will depend primarily on the sensitivity of available scanning instrumentation, the size of the area of elevated activity, and the dose or risk model. A given concentration of residual radioactivity spread over a smaller area will, in general, result in a smaller dose or risk. Thus, the $DCGL_{EMC}$ used for the elevated measurement comparison is usually larger than the $DCGL_W$ used for the statistical test. In some cases, especially radionuclides that deliver dose or risk primarily via internal pathways,

dose or risk is approximately proportional to inventory, and so the difference in the DCGLs is approximately proportional to the areas.

However, this may not be the case for radionuclides that deliver a significant portion of the dose or risk via external exposure. The exact relationship between the $DCGL_{EMC}$ and the $DCGL_W$ is a complicated function of the dose or risk modeling pathways, but area factors to relate the two DCGLs can be tabulated for most radionuclides (see Chapter 5), and site-specific area factors can also be developed.

For many radionuclides, scanning instrumentation is readily available that is sensitive enough to detect residual radioactivity concentrations at the $DCGL_{EMC}$ derived for the sampling grid of direct measurements used in the statistical tests. Where instrumentation of sufficient sensitivity (MDC, see Chapter 6) is not available, the number of samples in the survey unit can be increased until the area between sampling points is small enough (and the resulting area factor is large enough) that $DCGL_{EMC}$ can be detected by scanning. The details of this process are discussed in Chapter 5. For some radionuclides (*e.g.*, ^3H) the scanning sensitivity is so low that this process would never terminate—*i.e.*, the number of samples required could increase without limit. Thus, an important part of the DQO process is to determine the smallest size of an area of elevated activity that it is important to detect, A_{min} , and an acceptable level of risk , R_A , that it may go undetected. The probability of sampling a circular area of size A with either a square or triangular sampling pattern is shown in Figure D.7. The ELIPGRID-PC (Davidson 1995) computer code can also be used to calculate these probabilities.

In this part of the DQO process, the concern is less with areas of elevated activity that are found than with providing adequate assurance that negative scanning results truly demonstrate the absence of such areas. In selecting acceptable values for A_{min} and R_A, maximum use of information from the HSA and all surveys prior to the final status surveys should be used to determine what sort of areas of elevated activity could possibly exist, their potential size and shape, and how likely they are to exist. When the detection limit of the scanning technique is very large relative to the $DCGL_{EMC}$, the number of measurements estimated to demonstrate compliance using the statistical tests may become unreasonably large. In this situation an evaluation of the survey objectives and considerations be performed. These considerations may include the survey design and measurement methodology, exposure pathway modeling assumptions and parameter values used to determine the DCGLs, Historical Site Assessment conclusions concerning source terms and radionuclide distributions, and the results of scoping and characterization surveys. In most cases the results of this evaluation is not expected to justify an unreasonably large number of measurements.

A convenient method for visualizing the decision rule is to graph the probability of deciding that the survey unit does not meet the release criterion, *i.e.*, that the null hypothesis of Scenario A is accepted. An example of such a chart is shown in Figure D.8.

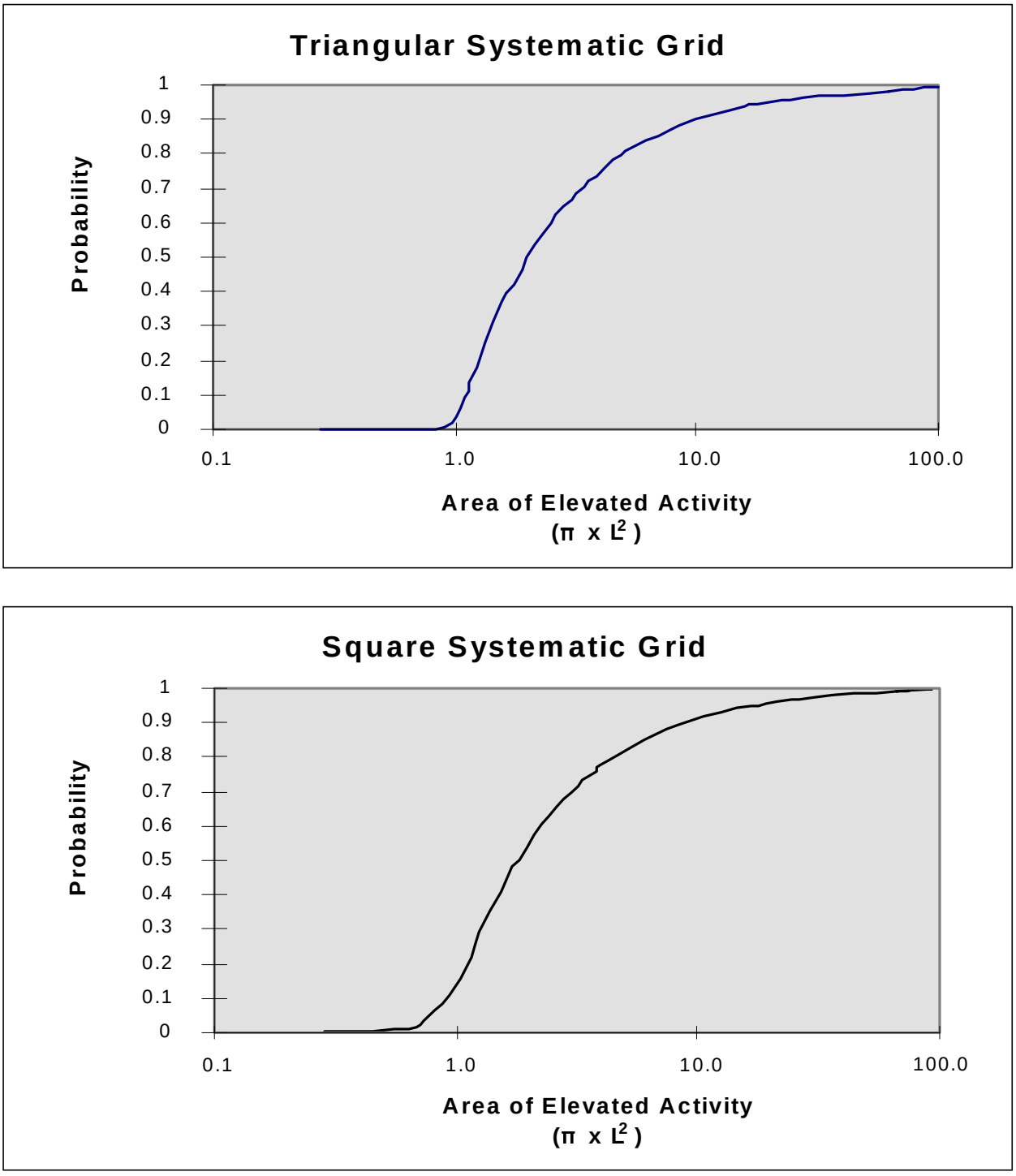


Figure D.7 Geometric Probability of Sampling at Least One Point of an Area of Elevated Activity as a Function of Sample Density with Either a Square or Triangular Sampling Pattern

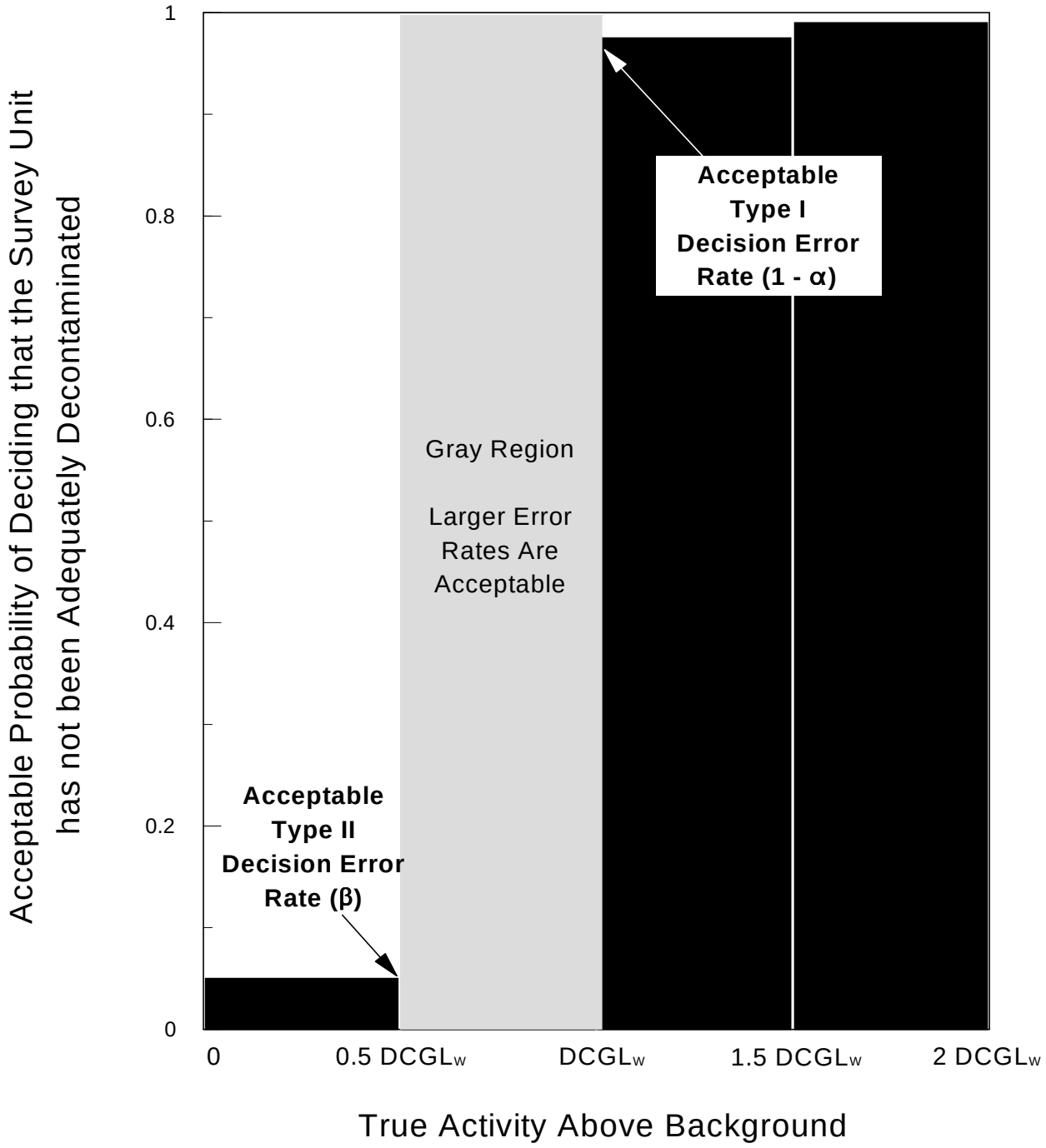


Figure D.8 Example of a Power Chart Illustrating the Decision Rule for the Final Status Survey

In this example α is 0.025 and β is 0.05, providing an expected power (1-β) of 0.95 for the test. A second method for presenting the information is shown in Figure D.9. This figure shows the probability of making a decision error for possible values of the parameter of interest, and is referred to as an error chart. In both examples a gray region, where the consequences of decision errors are deemed to be relatively minor, is shown. These charts are used in the final step of the DQO Process, combined with the outputs from the previous steps, to produce an efficient and cost-effective survey design. It is clear that setting acceptable values for α and β, as well as determining an appropriate gray region, is a crucial step in the DQO Process. Instructions for creating a prospective power curve, which can also be used to visualize the decision rule, are provided in Appendix I.

After the survey design is implemented, the expected values of α and β determined in this step are compared to the actual significance level and power of the statistical test based on the measurement results during the assessment phase of the Data Life Cycle. This comparison is used to verify that the objectives of the survey have been achieved.

EPA QA/G-9 (EPA 1996a) discusses considerations for selecting a particular null hypothesis. Because of the basic hypothesis testing philosophy, the null hypothesis is generally specified in terms of the *status quo* (*e.g.*, no change or action will take place if the null hypothesis is not rejected). Also, since the classical hypothesis testing approach exercises direct control over the Type I (false positive) error rate, this rate is generally associated with the error of most concern. In the case of the null hypothesis in which the residual radioactivity in the survey unit exceeds the release criterion, a Type I decision error would conclude that the residual activity was less than the release criterion when in fact it was above the release criterion. One difficulty, therefore, may be obtaining a consensus on which error should be of most concern (i.e., releasing a site where the residual activity exceeds the release criterion or failing to release a site where the residual activity is less than the release criterion). It is likely that the regulatory agency's public health-based protection viewpoint will differ from the viewpoint of the regulated party. The ideal approach is not only to define the null hypothesis in such a way that the Type I decision error protects human health and the environment but also in a way that encourages quality (high precision and accuracy) and minimizes expenditure of resources in situations where decisions are relatively "easy" (*e.g.*, all observations are far below the threshold level of interest or DCGL).

To avoid excessive expense in performing measurements, compromises are sometimes necessary. For example, suppose that a significance level (α) of 0.05 is to be used. However, the affordable sample size may be expected to yield a test with power (β) of only 0.40 at some specified parameter value chosen to have practical significance. One possible compromise may be to relax the Type I decision error rate (α) and use a value of 0.10, 0.15, or even 0.20. By relaxing the Type I decision error rate, a higher power (*i.e.*, a lower Type II decision error rate) can be achieved. An argument can be made that survey designs should be developed and number of measurements determined in such a way that both the Type I (α) and Type II (β) decision error rates are treated simultaneously and in a balanced manner (i.e., $\alpha = \beta = 0.15$). This approach of

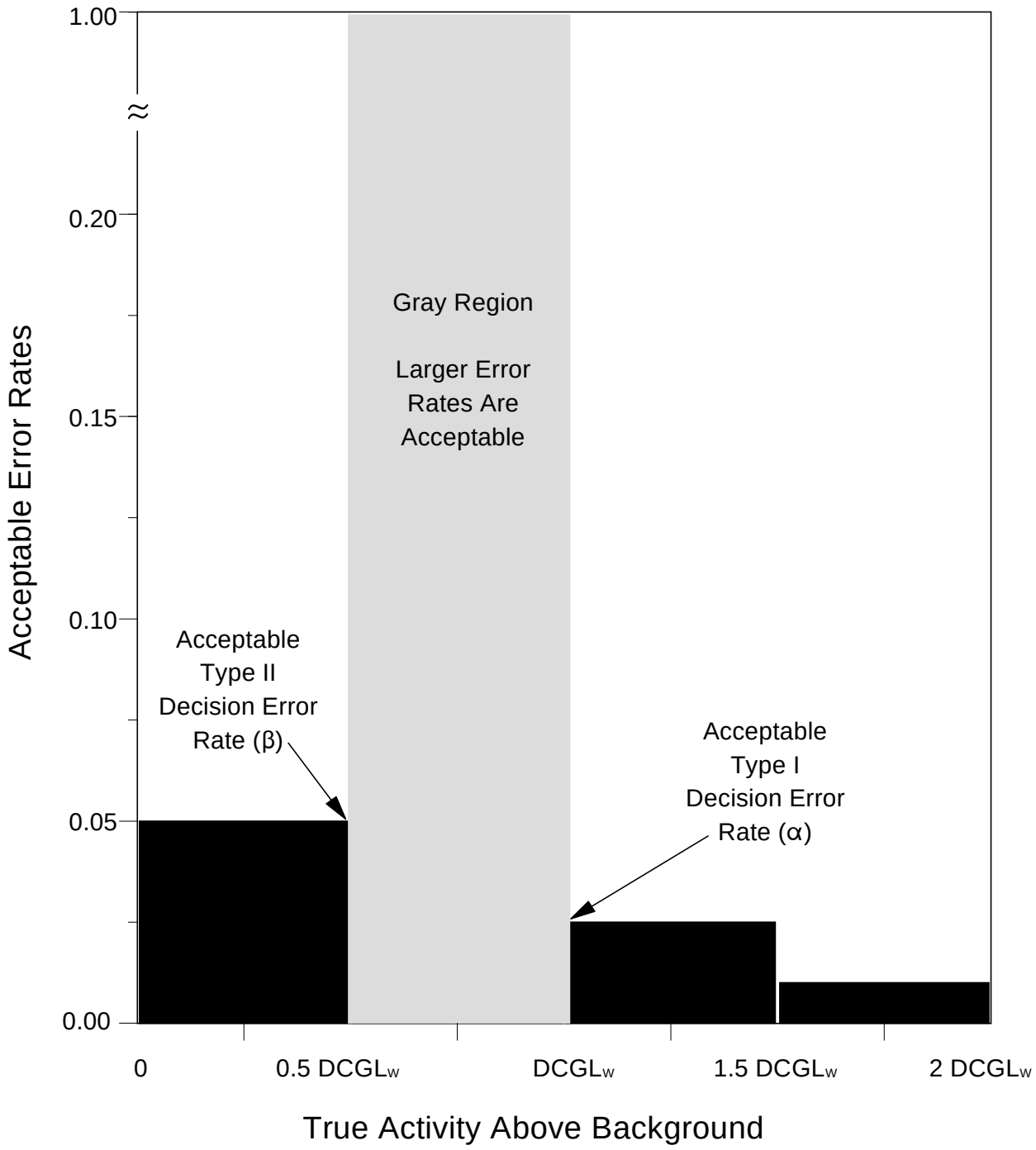


Figure D.9 Example of an Error Chart Illustrating the Decision Rule for the Final Status Survey

treating the Type I and Type II decision error rates simultaneously is taken by the DQO Process. It is recommended that several different values for α and β be investigated before specific values are selected.

D.7 Optimize the Design for Collecting Data

This step is designed to produce the most resource-effective survey design that is expected to meet the DQOs. It may be necessary to work through this step more than once after revisiting previous steps in the DQO Process.

There are six activities included in this step:

- Reviewing the DQO outputs and existing environmental data to ensure they are internally consistent.
- Developing general data collection design alternatives. Chapter 5 describes random and systematic sampling designs recommended for final status surveys based on survey unit classification.
- Formulating the mathematical expressions needed to solve the design problem for each data collection design alternative.
- Selecting the optimal design that satisfies the DQOs for each data collection design alternative. If the recommended design will not meet the limits on decision errors within the budget or other constraints, then the planning team will need to relax one or more constraints. Examples include:
  a. increasing the budget for sampling and analysis
  b. using exposure pathway modeling to develop site-specific DCGLs
  c. increasing the decision error rates, not forgetting to consider the risks associated with making an incorrect decision
  d. increasing the width of the gray region by decreasing the LBGR
  e. relaxing other project constraints—*e.g.*, schedule
  f. changing the boundaries—it may be possible to reduce measurement costs by changing or eliminating survey units that will require different decisions
  g. evaluating alternative measurement techniques with lower detection limits or lower survey costs
  h. considering the use of passive controls when releasing the survey unit rather than unrestricted release
- Selecting the most resource-effective survey design that satisfies all of the DQOs. Generally, the survey designs described in Chapter 5 will be acceptable for demonstrating compliance. Atypical sites (*e.g.*, mixed-waste sites) may require the planning team to consider alternative survey designs on a site-specific basis.

- Documenting the operational details and theoretical assumptions of the selected design in the QAPP, the field sampling plan, the sampling and analysis plan, or the decommissioning plan. All of the decisions that will be made based on the data collected during the survey should be specified along with the alternative actions that may be adopted based on the survey results.

Chapters 4 and 5 present a framework for a final status survey design. When this framework is combined with the site-specific DQOs developed using the guidance in this section, the survey design should be acceptable for most sites. The key inputs to Chapters 4 and 5 are:

- investigation levels and DCGLs for each radionuclide of interest
- acceptable measurement techniques for scanning, sampling, and direct measurements, including detection limits and estimated survey costs
- identification and classification of survey units
- an estimate of the variability in the distribution of residual radioactivity for each survey unit, and in the reference area if necessary
- the decision maker's acceptable *a priori* values for decision error rates (α and β)

APPENDIX E

THE ASSESSMENT PHASE OF THE DATA LIFE CYCLE

The assessment phase of the Data Life Cycle includes verification and validation of the survey data and assessment of quality of the data. Data verification is used to ensure that the requirements stated in the planning documents are implemented as prescribed. Data validation is used to ensure that the results of the data collection activities support the objectives of the survey as documented in the Quality Assurance Project Plan (QAPP), or permit a determination that these objectives should be modified. Data Quality Assessment (DQA) is the scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support their intended use (EPA 1996a). DQA helps complete the Data Life Cycle by providing the assessment needed to determine that the planning objectives are achieved. Figure E.1 illustrates where data verification, data validation and DQA fit into the Assessment Phase of the Data Life Cycle.

There are five steps in the DQA Process:

- Review the Data Quality Objectives (DQOs) and Survey Design
- Conduct a Preliminary Data Review
- Select the Statistical Test
- Verify the Assumptions of the Statistical Test
- Draw Conclusions from the Data

These five steps are presented in a linear sequence, but the DQA process is applied in an iterative fashion much like the DQO process. The strength of the DQA process is that it is designed to promote an understanding of how well the data will meet their intended use by progressing in a logical and efficient manner.

E.1 Review DQOs and Survey Design

The DQA process begins by reviewing the key outputs from the Planning phase of the Data Life Cycle that are recorded in the planning documents (*e.g.*, the QAPP). The DQOs provide the context for understanding the purpose of the data collection effort. They also establish qualitative and quantitative criteria for assessing the quality of the data set for the intended use. The survey design (documented in the QAPP) provides important information about how to interpret the data.

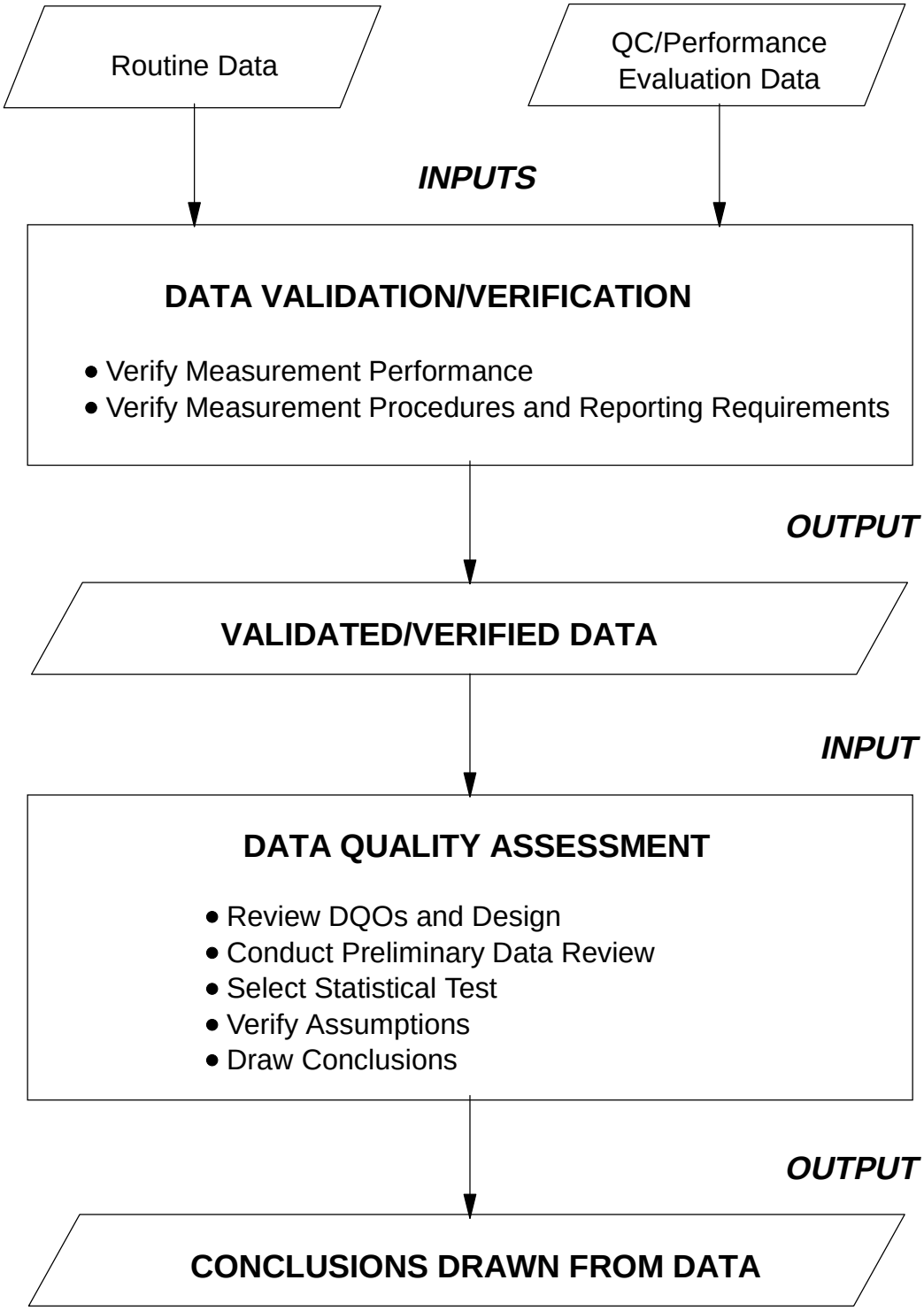


Figure E.1 The Assessment Phase of the Data Life Cycle (EPA 1996a)

There are three activities associated with this step in the DQA process:

- Translating the data user's objectives into a statement of the hypotheses to be tested using environmental data. These objectives should be documented as part of the DQO Process, and this activity is reduced to translating these objectives into the statement of hypotheses. If DQOs have not been developed, which may be the case for historical data, review Appendix D for assistance in developing these objectives.

- Translating the objectives into limits on the probability of committing Type I or Type II decision errors. Appendix D, Section D.6 provides guidance on specifying limits on decision errors as part of the DQO process.

- Reviewing the survey design and noting any special features or potential problems. The goal of this activity is to familiarize the analyst with the main features of the survey design used to generate the environmental data. Review the survey design documentation (*e.g.*, the QAPP) with the data user's objectives in mind. Look for design features that support or contradict these objectives.

For the final status survey, this step would consist of a review of the DQOs developed using Appendix D and the QAPP developed in Chapter 9.

E.2 Conduct a Preliminary Data Review

In this step of the DQA process, the analyst conducts a preliminary evaluation of the data set, calculating some basic statistical quantities and looking at the data through graphical representations. By reviewing the data both numerically and graphically, the analyst can learn the "structure" of the data and thereby identify appropriate approaches and limitations for their use.

This step includes three activities:

- reviewing quality assurance reports
- calculating statistical quantities (*e.g.*, relative standing, central tendency, dispersion, shape, and association)
- graphing the data (*e.g.*, histograms, scatter plots, confidence intervals, ranked data plots, quantile plots, stem-and-leaf diagrams, spatial or temporal plots)

Chapter 8 discusses the application of these activities to a final status survey.

E.3 Select the Statistical Test

The statistical tests presented in Chapter 8 are applicable for most sites contaminated with radioactive material. Chapter 2 discusses the rationale for selecting the statistical methods recommended for the final status survey in more detail. Additional guidance on selecting alternate statistical methods can be found in Section 2.6 and in EPA's DQA guidance document (EPA 1995).

E.4 Verify the Assumptions of the Statistical Test

In this step, the analyst assesses the validity of the statistical test by examining the underlying assumptions in light of the environmental data. The key questions to be resolved are: "Do the data support the underlying assumptions of the test?", and: "Do the data suggest that modifications to the statistical analysis are warranted?"

The underlying assumptions for the statistical tests are discussed in Section 2.5. Graphical representations of the data, such as those described in Section 8.2 and Appendix I, can provide important qualitative information about the validity of the assumptions. Documentation of this step is always important, especially when professional judgement plays a role in accepting the results of the analysis.

There are three activities included in this step:

- Determining the approach for verifying assumptions. For this activity, determine how the assumptions of the hypothesis test will be verified, including assumptions about distributional form, independence, dispersion, type, and quantity of data. Chapter 8 discusses methods for verifying assumptions for the final status survey statistical test during the preliminary data review.

- Performing tests of the assumptions. Perform the calculations selected in the previous activity for the statistical tests. Guidance on performing the tests recommended for the final status survey are included in Chapter 8.

- Determining corrective actions (if any). Sometimes the assumptions underlying the hypothesis test will not be satisfied and some type of corrective action should be performed before proceeding. In some cases, the data for verifying some key assumption may not be available and existing data may not support the assumption. In this situation, it may be necessary to collect new data, transform the data to correct a problem with the distributional assumptions, or select an alternate hypothesis test. Section 9.3 discusses potential corrective actions.

E.5 Draw Conclusions from the Data

The final step of the DQA process is performing the statistical test and drawing conclusions that address the data user's objectives. The procedure for implementing the statistical test is included in Chapter 8.

There are three activities associated with this final step:

- Performing the calculations for the statistical hypothesis test (see Chapter 8).

- Evaluating the statistical test results and drawing the study conclusions. The results of the statistical test will be either accept the null hypothesis, or reject the null hypothesis.

- Evaluating the performance of the survey design if the design is to be used again. If the survey design is to be used again, either in a later phase of the current study or in a similar study, the analyst will be interested in evaluating the overall performance of the design. To evaluate the survey design, the analyst performs a statistical power analysis that describes the estimated power of the test over the full range of possible parameter values. This helps the analyst evaluate the adequacy of the sampling design when the true parameter value lies in the vicinity of the action level (which may not have been the outcome of the current study). It is recommended that a statistician be consulted when evaluating the performance of a survey design for future use.

APPENDIX F

THE RELATIONSHIP BETWEEN THE RADIATION SURVEY AND SITE INVESTIGATION PROCESS, THE CERCLA REMEDIAL OR REMOVAL PROCESS, AND THE RCRA CORRECTIVE ACTION PROCESS

This appendix presents a discussion of the relationship between the Radiation Survey and Site Investigation Process, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial or Removal Process, and the Resource Conservation and Recovery Act (RCRA) Corrective Action Process. Each of these processes has been designed to incorporate survey planning using the Data Quality Objectives (DQO) Process and data interpretation using Data Quality Assessment (DQA) using a series of surveys to accomplish the project objectives. At this basic level, MARSSIM is consistent with the other processes.

Figure F.1 illustrates the relationship between the major steps in each of these processes. As shown in Figure F.1, the scope of MARSSIM (Section 1.1) results in steps in the CERCLA Remedial or Removal Process and the RCRA Process that are not directly addressed by MARSSIM (*e.g.*, Feasibility Study or Corrective Measure Study). MARSSIM's focus on the demonstration of compliance for sites with residual radioactivity using a final status survey integrates with the remedial design/remedial action (RD/RA) step of the CERCLA Remedial Process described in Sec. 300.435(b)(1) of Part 40 of the Code of Federal Regulations. However, MARSSIM's focus is not directly addressed by the major steps of the CERCLA Removal Process or the RCRA Corrective Action Process.

Much of the guidance presented in MARSSIM for designing surveys and assessing the survey results is taken directly from the corresponding CERCLA or RCRA guidance. MARSSIM users familiar with the Superfund Preliminary Assessment guidance (EPA 1991f) will recognize the guidance provided on performing the Historical Site Assessment (Chapter 3) for identifying potentially contaminated soil, water, or sediment. In addition, MARSSIM provides guidance for identifying potentially contaminated structures which is not covered in the original CERCLA guidance. The survey designs and statistical tests for relatively uniform distributions of residual radioactivity discussed in MARSSIM are also discussed in CERCLA guidance (EPA 1989a, EPA 1994b). However, MARSSIM includes scanning for radioactive materials which isn't discussed in the more general CERCLA guidance that doesn't specifically address radionuclides. MARSSIM is not designed to replace or conflict with existing CERCLA or RCRA guidance, it is designed to provide supplemental guidance for specific applications of the CERCLA Remedial or Removal Process or the RCRA Corrective Action Process.

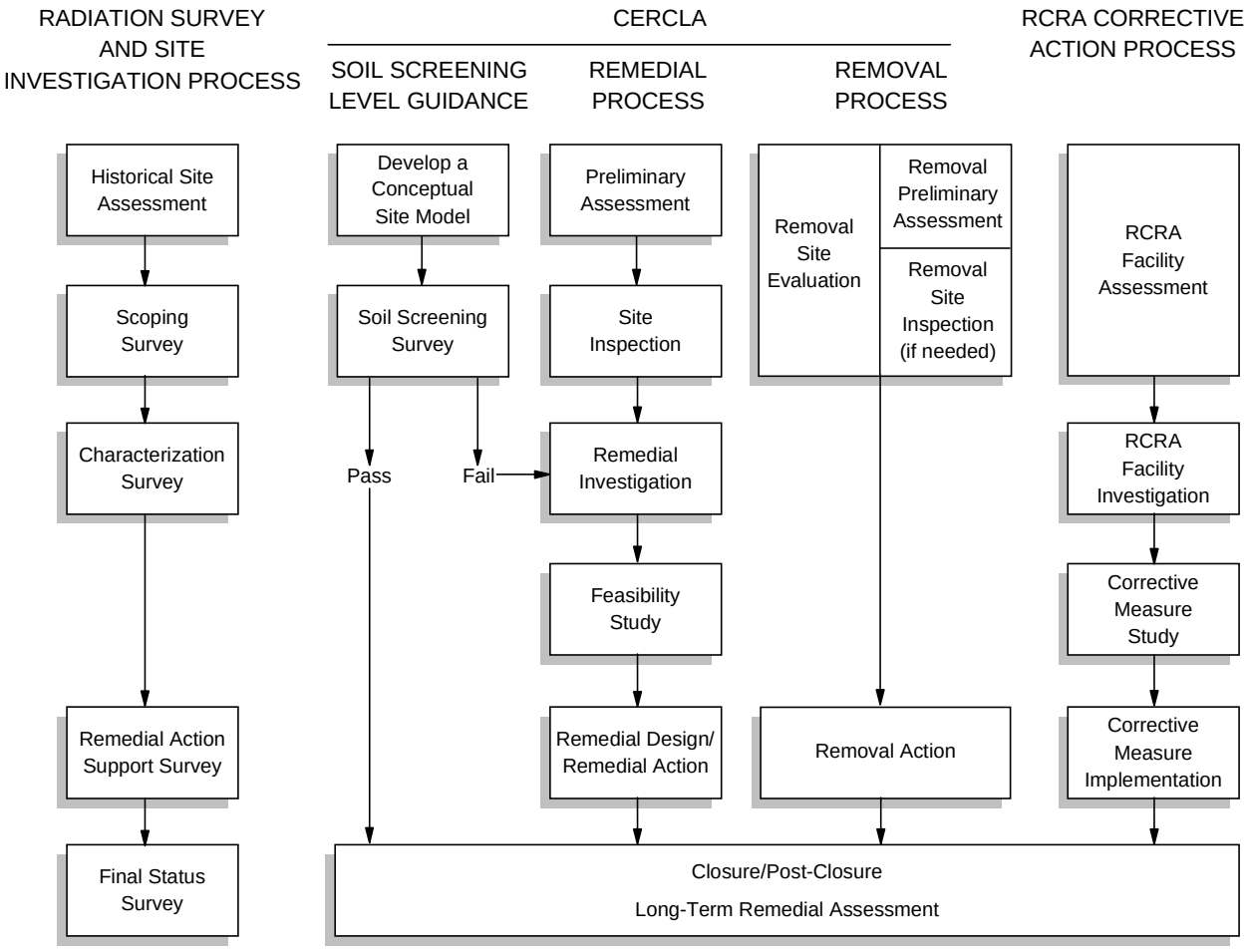


Figure F.1 Comparison of the Radiation Survey and Site Investigation Process with the CERCLA Superfund Process and the RCRA Corrective Action Process

Table F.1 lists the major steps in MARSSIM and other CERCLA and RCRA processes and describes the objectives of each step. This table provides a direct comparison of these processes, and it shows the correlation between the processes. This correlation is the result of carefully integrating CERCLA and RCRA guidance with guidance from other agencies participating in the development of MARSSIM to produce a multi-agency consensus document.

The first step in the CERCLA Remedial Process is the preliminary assessment to obtain existing information about the site and determine if there is a threat to human health and the environment. The next step is the site inspection which includes risk prioritization using the Hazard Ranking System—sites with a score above a certain level are put on the National Priorities List (NPL). Following the site assessment, the remedial investigation (RI) is performed to characterize the

extent and type of release, and to evaluate the risk to human health and the environment. A Sampling and Analysis Plan is constructed as part of the remedial investigation which consists of a Quality Assurance Project Plan, a Field Sampling Plan, a Health and Safety Plan, and a Community Relations Plan. The site feasibility study (FS) is the next step in the CERCLA Remedial Process (although the RI and FS are intended to be done concurrently) which involves an evaluation of alternative remedial actions. For sites listed on the NPL the next action would be to obtain a Record of Decision (ROD) which provides the remedy selected for the site. The remedial design/remedial action (RD/RA), which includes the development of the selected remedy and its implementation, follows development of the ROD. After the RD/RA activities there is a period of operation and maintenance when the site is given a long term remedial assessment followed by closure/post-closure of the site (or removal from the NPL). A removal action may occur at any stage of the CERCLA Remedial Process.

The CERCLA Removal Process is similar to the Remedial Process for the first few steps. 40 CFR § 300.400 (NCP Subpart E—Hazardous Substance Response) establishes methods and criteria for determining the extent of response when there is a release into the environment of a hazardous substance or any pollutant or contaminant that may present an imminent and substantial danger to the public health or welfare of the United States. The first step in the Removal Process is a removal site evaluation which includes a removal preliminary assessment and, if warranted, a removal site inspection. A removal preliminary assessment may be based on available information and should include an evaluation of the factors necessary to make the determination of whether a removal is necessary. A removal site inspection is performed, if warranted, in a similar manner as in the CERCLA Remedial Process. If environmental samples are to be collected, a sampling and analysis plan should be developed which consists of a field sampling plan and a quality assurance project plan. Post-removal site controls are those activities necessary to sustain the effectiveness and integrity of the removal action. In the case of all CERCLA removal actions taken pursuant to § 300.415, a designated spokesperson will inform the community of actions taken, respond to inquiries, and provide information concerning the release—this may include a formal community relations plan specifying the community relations activities expected during the removal response.

Comparisons have been made between the CERCLA Remedial Process and CERCLA Removal Process (EPA, 1993c). Table F.2 presents the data elements that are common to both programs and those that are generally common to one program rather than the other. Table F.3 shows the emphasis placed on sampling for remedial site assessment versus removal site assessment.

Another guidance document that can be compared to MARSSIM is the Soil Screening Guidance (EPA 1996b, EPA 1996c), which facilitates removing sites from consideration early in the CERCLA Process. Although not written to specifically address radioactive contaminants, the Soil Screening Guidance leads the user from the initial site conceptualization and planning stages through data collection and evaluation to the final testing step. MARSSIM also leads the user through similar planning, evaluation, and testing stages, but the guidance focuses on the final compliance demonstration step.

The Soil Screening Guidance provides a way to calculate risk-based, site-specific, soil screening levels (SSLs) for contaminants in soil. SSLs can be used as preliminary remediation goals (PRGs) if the conditions found at a specific site are similar to the conditions assumed in calculating the SSLs.

Both the Soil Screening Guidance and MARSSIM provide examples of acceptable sampling and analysis plans (SAP) for site contaminants. The Soil Screening Guidance recommended default survey design for surface soils is very specific—recommendations for the grid size for sampling, the number of soil samples collected from each subarea and composited, and data analysis and interpretation techniques are described in detail. MARSSIM provides guidance that is consistent and compatible with the Soil Screening Guidance with respect to the approaches, framework, tools, and overall objectives.

SSLs calculated using the CERCLA Soil Screening Guidance could also be used for RCRA Corrective Action sites as action levels. The RCRA Corrective Action program views action levels as generally fulfilling the same purpose as soil screening levels. Table F.1 shows other similarities between the RCRA Corrective Action Process, CERCLA Remedial or Removal Process, and MARSSIM.

The similarities between the CERCLA Remedial Process and Removal Process have led to a number of streamlined approaches to expedite site cleanups by reducing sampling and preventing duplication of effort. One example of these approaches is the Superfund Accelerated Cleanup Model (SACM) where the concept of integrating the removal and remedial site assessment was introduced (EPA, 1993c). A memorandum from EPA, DOE, and DOD (August 22,1994) discusses guidance on accelerating and developing streamlined approaches for the cleanup of hazardous waste at federal facility sites.

Table F.1 Program Comparison

MARSSIM	CERCLA REMEDIAL PROCESS	CERCLA REMOVAL PROCESS	RCRA
Historical Site Assessment Performed to gather existing information about radiation sites. Designed to distinguish between sites that possess no potential for residual radioactivity and those that require further investigation. Performed in three stages: 1) Site Identification 2) Preliminary Investigation 3) Site Reconnaissance	Preliminary Assessment Performed to gather existing information about the site and surrounding area. The emphasis is on obtaining comprehensive information on people and resources that might be threatened by a release from the site. Designed to distinguish between sites that pose little or no threat to human health and the environment and sites that require further investigation.	Preliminary Assessment Performed in a similar manner as in the CERCLA Remedial Process. The removal preliminary assessment may be based on available information. A removal preliminary assessment may include an identification of the source, nature and magnitude of the release, evaluation by ATSDR of the threat to public health, and evaluation of factors necessary to make the determination of whether a removal is necessary.	Facility Assessment Performed to identify and gather information at RCRA facilities, make preliminary determinations regarding releases of concern and identify the need for further actions and interim measures at the facility. Performed in three stages: 1) Preliminary Review 2) Visual Site Inspection 3) Sampling Visit (if necessary) The RCRA Facility Assessment accomplishes the same objectives as the Preliminary Assessment and Site Inspection under the Superfund Process. The RCRA Facility Assessment often forms the basis for the first conceptual model of the site.
Scoping Survey Performed to provide a preliminary assessment of the radiological hazards of the site. Supports classification of all or part of the site as Class 3 areas and identifying non-impacted areas of the site. Scoping surveys provide data to complete the site prioritization scoring process for CERCLA or RCRA sites.	Site Inspection Performed to identify the substances present, determine whether hazardous substances are being released to the environment, and determine whether hazardous substances have impacted specific targets. Designed to gather information on identified sites in order to complete the Hazard Ranking System to determine whether removal actions or further investigations are necessary.	Site Inspection Performed in a similar manner as in the Remedial Process. A removal site inspection may be performed as part of the removal site evaluation (§ 300.410) if warranted. A removal site inspection may include an perimeter or on-site inspection. If the removal site evaluation shows that removal is not required, but that remedial action under § 300.430 may be necessary, a remedial site evaluation pursuant to § 300.420 would be initiated.	

Table F.1 Program Comparison

MARSSIM	CERCLA REMEDIAL PROCESS	CERCLA REMOVAL PROCESS	RCRA
Characterization Survey Performed to support planning for final status surveys to demonstrate compliance with a dose- or risk-based regulation. Objectives include determining the nature and extent of contamination at the site, as well as meeting the requirements of RI/FS and FI/CMS.	Remedial Investigation Performed to characterize the extent and type of release of contaminants. The RI is the mechanism for collecting data to characterize site conditions, determine the nature of the waste, assess risk to human health and the environment, and conduct treatability testing as necessary to evaluate the potential performance and cost of the treatment technologies that are being considered. EPA guidance presents a combined RI/FS Model Statement of Work. The RI is generally performed in seven tasks: 1) project planning (scoping): - summary of site location - history and nature of problem - history of regulatory and response actions - preliminary site boundary - development of site operations plans 2) field investigations 3) sample/analysis verification 4) data evaluation 5) assessment of risks 6) treatability study/pilot testing 7) RI reporting	Removal Action Performed once the decision has been made to conduct a removal action at the site (under § 300.415). Whenever a planning period of at least six months exists before on-site activities must be initiated, an engineering evaluation/cost analysis or its equivalent is conducted. If environmental samples are to be collected, a sampling and analysis plan is developed to provide a process for obtaining data of sufficient quality and quantity to satisfy data needs. The sampling and analysis plan consists of: 1) The field sampling plan, which describes the number, type, and location of samples and the type of analysis 2) The quality assurance project plan, which describes policy, organization, and functional activities and the data quality objectives and measures necessary to achieve adequate data for use in removal actions.	Facility Investigation Defines the presence, magnitude, extent, direction, and rate of movement of any hazardous wastes and hazardous constituents within and beyond the facility boundary. The scope is to : 1) characterize the potential pathways of contaminant migration 2) characterize the source(s) of contamination 3) define the degree and extent of contamination 4) identify actual or potential receptors 5) support the development of alternatives from which a corrective measure will be selected by the EPA The Facility Investigation is performed in seven tasks: 1) description of current conditions 2) identification of preliminary remedial measures technologies 3) FI work plan requirements - project management plan - data collection QAPP - data management plan - health and safety plan - community relations plan 4) facility investigation 5) investigation analysis 6) laboratory and bench-scale studies 7) reports

Table F.1 Program Comparison

MARSSIM	CERCLA REMEDIAL PROCESS	CERCLA REMOVAL PROCESS	RCRA
DCGLs Residual levels of radioactive material that correspond to allowable radiation dose standards are calculated (derived concentration guideline levels) and provided to the user. The survey unit is then evaluated against this radionuclide-specific DCGL. The DCGLs in this manual are for structure surfaces and soil contamination. MARSSIM does not provide equations or guidance for calculating DCGLs.	PRGs Preliminary remediation goals are developed early in the RI/FS process. PRGs may then be used as the basis for final cleanup levels based on the nine criteria in the National Contingency Plan. Soil Screening Levels (SSLs) can be used as PRGs provided conditions at a specific site are similar to those assumed in calculating the SSLs. SSLs are derived with exposure assumptions for suburban residential land use only. SSLs are based on a 10^{-6} risk for carcinogens, a hazard index quotient of 1 for noncarcinogens (child ingestion assumptions), or MCLGs, MCLs, or HBLs for the migration to groundwater. The User's Guide provides equations and guidance for calculating site-specific SSLs.	Removal Levels The removal level is established by identification of applicable or relevant and appropriate requirements (ARARs), or by health assessments. Concern is for protection of human health and the environment from the immediate hazard of a release rather than a permanent remedy.	Action Levels At certain facilities subject to RCRA corrective action, contamination will be present at concentrations (action levels) that may not justify further study or remediation. Action levels are health- or environmental-based concentrations derived using chemical-specific toxicity information and standardized exposure assumptions. The SSLs developed under CERCLA guidance can be used as action levels since the RCRA corrective action program currently views them as serving the same purpose.

Table F.1 Program Comparison

MARSSIM	CERCLA REMEDIAL PROCESS	CERCLA REMOVAL PROCESS	RCRA
No Direct Correlation (MARSSIM characterization and remedial action support surveys may provide data to the Feasibility Study or the Corrective Measures Study)	Feasibility Study The FS serves as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions. As noted above, the RI and the FS are intended to be performed concurrently. However, the FS is generally considered to be composed of four general tasks. These tasks are: 1) development and screening of remedial alternatives 2) detailed analysis of alternatives 3) community relations 4) FS reporting	No Direct Correlation	Corrective Measures Study The purpose of the CMS is to identify , develop, and evaluate potentially applicable corrective measures and to recommend the corrective measures to be taken. The CMS is performed following an FI and consists of the following four tasks: 1) identification and development of the corrective measures alternatives 2) evaluation of the corrective measures alternatives 3) justification and recommendations of the corrective measures alternatives 4) reports

Table F.1 Program Comparison

MARSSIM	CERCLA REMEDIAL PROCESS	CERCLA REMOVAL PROCESS	RCRA
Remedial Action Support Survey Performed to support remediation activities and determine when a site or survey unit is ready for the final status survey. These surveys monitor the effectiveness of decontamination efforts in reducing residual radioactivity to acceptable levels. Remedial action support surveys do not include routine operational surveys conducted to support remedial activities.	Remedial Design/Remedial Action This activity includes the development of the selected remedy and implementation of the remedy through construction. A period of operation and maintenance may follow the RD/RA activities. Generally, the RD/RA includes: 1) plans and specifications - preliminary design - intermediate design - prefinal/final design - estimated cost - correlation of plans and specifications - selection of appropriate RCRA facilities - compliance with requirements of other environmental laws - equipment startup and operator training 2) additional studies 3) operation and maintenance plan 4) QAPP 5) site safety plan	No Direct Correlation	Corrective Measures Implementation The purpose of the CMI is to design, construct, operate, maintain, and monitor the performance of the corrective measures selected in the CMS. The CMI consists of four activities: 1) Corrective Measure Implementation Program Plan 2) corrective measure design - design plans and specifications - operation and maintenance plan - cost estimate - schedule - construction QA objectives - health and safety plan - design phases 3) corrective measures construction (includes a construction QA program) 4) reporting
Final Status Survey Performed to demonstrate that residual radioactivity in each survey unit satisfies the release criterion.	Long Term Remedial Assessment Closure/Post-Closure NPL De-Listing	Post-Removal Site Control Those activities that are necessary to sustain the integrity of a removal action following its conclusion.	Closure/Post-Closure

Table F.2 Data Elements for Site Visits[a]

Data Elements Common to Both Remedial and Removal Assessment	Generally Remedial Site Assessment Only	Generally Removal Assessment Only
-Current human exposure identification -Sources identification, including locations, sizes, volumes -Information on substances present -Labels on drums and containers -Containment evaluation -Evidence of releases (*e.g.*, stained soils) -Locations of wells on site and in immediate vicinity -Nearby wetlands identification -Nearby land uses -Distance measurements or estimates for wells, land uses (residences and schools), surface waters, and wetlands -Public accessibility -Blowing soils and air contaminants -Photodocumentation -Site sketch	-Perimeter survey -Number of people within 200 feet -Some sensitive environments -Review all pathways	-Petroleum releases -Fire and explosion threat -Urgency of need for response -Response and treatment alternatives evaluation -Greater emphasis on specific pathways (*e.g.*, direct contact) -Sampling

[a]From EPA, 1993c

Table F.3 Comparison of Sampling Emphasis Between Remedial Site Assessment and Removal Assessment[a]

Remedial Site Assessment Emphasis	Removal Assessment Emphasis
-Attribution to the site -Background samples -Ground water samples -Grab samples from residential soils -Surface water sediment samples -HRS factors related to surface water sample locations -Fewer samples on average (10-30) than removal assessment -Strategic sampling for HRS -Contract Laboratory Program usage -Full screening organics and inorganics analyses -Definitive analyses -Documentation, including targets and receptors -Computing HRS scores -Standardized reports	-Sampling from containers -Physical characteristics of wastes -Treatability and other engineering concerns -On-site contaminated soils -Composite and grid sampling -Rapid turnaround on analytical services -Field/screening analyses -PRP-lead removal actions -Goal of characterizing site -Focus on NCP removal action criteria

[a]From EPA, 1993c

APPENDIX G

HISTORICAL SITE ASSESSMENT INFORMATION SOURCES

This appendix provides lists of information sources often useful to site assessment. The lists are organized in two ways:

- Table G.1, beginning on page G-2, identifies information needs by category and lists appropriate information sources for each. The categories are:

  -- General site information, p. G-2
  -- Source and waste characteristics, p. G-2
  -- Ground water use and characteristics, p. G-3
  -- Surface water use and characteristics, p. G-4
  -- Soil exposure characteristics, p. G-5
  -- Air characteristics, p. G-6

- The reverse approach is provided in Table G.2, beginning on page G-7. Categories of information sources are listed with a brief explanation of the information provided by each source. A contact is provided for additional information. The categories are:

  -- Databases, p. G-7
  -- Maps and aerial photographs, p. G-13
  -- Files, p. G-17
  -- Expert and other sources, p. G-19

More complete listings of site assessment information sources are available in the *Site Assessment Information Directory* (EPA91e).

Table G.1 Site Assessment Information Sources
(Organized by Information Needed)

General Site Information	
Site Location, Latitude/Longitude CERCLIS USGS Topographic Maps State Department of Transportation Maps Site Reconnaissance USGS Global Land Information System U.S. Census Bureau Tiger Mapping Services	*Type of Operation and Site Status* EPA Regional Libraries State Environmental Agency Files Site Reconnaissance
Owner/Operator Information EPA Regional Libraries State Environmental Agency Files Local Tax Assessor	*Environmental Setting, Size of Site* USGS Topographic Maps Aerial Photographs Site Reconnaissance
Source and Waste Characteristics	
Source Types, Locations, Sizes EPA Regional Libraries State Environmental Agency Files Aerial Photographs Site Reconnaissance DOE Field Offices	*Hazardous Substances Present* EPA Regional Libraries State Environmental Agency Files RCRIS Local Health Department Local Fire Department ERAMS Local Public Works Department
Waste Types and Quantities EPA Regional Office Files State Environmental Agency Files RCRIS Local Fire Department Aerial Photographs Site Reconnaissance Aerial Radiation Surveys	

Table G.1 Site Assessment Information Sources (continued)
(Organized by Information Needed)

Ground Water Use and Characteristics	
General Stratigraphy USGS Topographic Maps U.S. Geological Survey State Geological Surveys Geologic and Bedrock Maps Local Experts Local University or College	*Private and Municipal Wells* Local Water Authority Local Health Department Local Well Drillers State Environmental Agency Files WellFax WATSTORE
Karst Terrain USGS Topographic Maps U.S. Geological Survey State Geological Surveys Geologic and Bedrock Maps Local Experts Local University or College	*Distance to Nearest Drinking Water Well* USGS Topographic Maps Local Water Authority Local Well Drillers Local Health Department WellFax WATSTORE Site Reconnaissance
Depth to Aquifer U.S. Geological Survey State Geological Surveys Geologic and Bedrock Maps Local Experts Local Well Drillers WATSTORE	*Wellhead Protection Areas* State Environmental Agency Local Water Authority Local Well Drillers Local Health Department EPA Regional Water Officials

Table G.1 Site Assessment Information Sources (continued)
(Organized by Information Needed)

Surface Water Use and Characteristics	
Surface Water Body Types USGS Topographic Maps State Department of Transportation Maps Aerial Photographs Site Reconnaissance	*Drinking Water Intakes* Local Water Authority USGS Topographic Maps U.S. Army Corps of Engineers State Environmental Agency
Distance to Nearest Surface Water Body USGS Topographic Maps State Department of Transportation Aerial Photographs Site Reconnaissance	*Fisheries* U.S. Fish and Wildlife Service State Environmental Agency Local Fish and Wildlife Officials
Surface Water Flow Characteristics U.S. Geological Survey State Environmental Agency U.S. Army Corps of Engineers STORET WATSTORE	*Sensitive Environments* USGS Topographic Maps State Department of Transportation Maps State Environmental Agency U.S. Fish and Wildlife Service Local Fish and Wildlife Officials National Wetland Inventory Maps Ecological Inventory Maps Natural Heritage Program
Flood Frequency at the Site Federal Emergency Management Agency State Environmental Agency	

Table G.1 Site Assessment Information Sources (continued)
(Organized by Information Needed)

Soil Exposure Characteristics	
Number of People Living Within 200 Feet Site Reconnaissance USGS Topographic Maps Aerial Photographs U.S. Census Bureau Tiger Mapping Service	*Schools or Day Care Within 200 Feet* Site Reconnaissance USGS Topographic Maps Local Street Maps
Number of Workers Onsite Site Reconnaissance Owner/Operator Interviews	*Locations of Sensitive Environment* USGS Topographic State Department of Transportation Maps State Environmental Agency U.S. Fish and Wildlife Service Ecological Inventory Maps Natural Heritage Program

Table G.1 Site Assessment Information Sources (continued)
(Organized by Information Needed)

Air Pathway Characteristics	
Populations Within Four Miles GEMS NPDC USGS Topographic Maps Site Reconnaissance U.S. Census Bureau Tiger Mapping Services	*Locations of Sensitive Environments, Acreage of Wetlands* USGS Topographic Maps State Department of Transportation Maps State Environmental Agency U.S. Fish and Wildlife Service National Wetland Inventory Maps Ecological Inventory Maps Natural Heritage Program
Distance to Nearest Individual USGS Topographic Maps Site Reconnaissance	

Table G.2 Site Assessment Information Sources
(Organized by Information Source)

Databases	
Source:	CERCLIS (Comprehensive Environmental Response, Compensation, and Liability Information System)
Provides:	EPA's inventory of potential hazardous waste sites. Provides site name, EPA identification number, site address, and the date and types of previous investigations
Supports:	General Site Information
Contact:	U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response Office of Emergency and Remedial Response Mike Cullen 703/603-8881 Fax 703/603-9133
Source:	RODS (Records of Decision System)
Provides:	Information on technology justification, site history, community participation, enforcement activities, site characteristics, scope and role of response action, and remedy.
Supports:	General Site Information, Source and Waste Characteristics
Contacts:	U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response Office of Emergency and Remedial Response Mike Cullen 703/603-8881 Fax 703/603-9133

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Databases	
Source:	RCRIS (Resource Conservation and Recovery Information System)
Provides:	EPA's inventory of hazardous waste generators. Contains facility name, address, phone number, and contact name; EPA identification number; treatment, storage and disposal history; and date of notification.
Supports:	General Site Information, Source and Waste Characteristics
Contacts:	U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response Office of Solid Waste Kevin Phelps 202/260-4697 Fax 202/260-0284
Source:	ODES (Ocean Data Evaluation System)
Provides:	Information associated with both marine and fresh water supplies with the following programs: •301(h) sewage discharge •National Pollutant Discharge Elimination System (NPDES) •Ocean Dumping •National Estuary Program •403c Industrial Discharge •Great Lakes Remedial Action Program •National Coastal Waters Program Houses a variety of data pertaining to water quality, oceanographic descriptions, sediment pollutants, physical/chemical characteristics, biological characteristics, and estuary information.
Supports:	General Site Information, Source and Waste Characteristics, Surface Water Use and Characteristics
Contact:	U.S. Environmental Protection Agency Office of Water Robert King 202/260-7026 Fax 202/260-7024

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Databases	
Source:	EMMI (Environmental Monitoring Methods Index)
Provides:	U.S. Environmental Protection Agency's official methods compendium. Serves as a source of standard analytical methods.
Supports:	General Site Information
Contact:	U.S. Environmental Protection Agency User Support 703/519-1222 Annual updates may be purchased from the National Technical Information Service at 703/487-4650
Source:	WellFax
Provides:	National Water Well Association's inventory of municipal and community water supplies. Identifies public and private wells within specified distances around a point location and the number of households served by each.
Supports:	Ground Water Use and Characteristics
Contact:	National Water Well Association (NWWA) 6375 Riverside Drive Dublin, OH 43017
Source:	Geographic Resources Information Data System (GRIDS)
Provides:	National access to commonly requested geographic data products such as those maintained by the U.S. Geologic Survey, the Bureau of the Census, and the U.S. Fish and Wildlife Service.
Supports:	General Site Information, Ground Water Use and Characteristics, Surface Water Use and Characteristics, Soil Exposure Characteristics, Air Pathway Characteristics
Contact:	U.S. Environmental Protection Agency Office of Administration and Resources Management Office of Information Resources Management Bob Pease 703/235-5587 Fax 703/557-3186

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Databases	
Source:	National Planning Data Corporation (NPDC)
Provides:	Commercial database of U.S. census data. Provides residential populations in specified distance rings around a point location.
Supports:	Soil Exposure Characteristics, Air Pathway Characteristics
Contact:	National Planning Data Corporation 20 Terrace Hill Ithaca, NY 14850-5686
Source:	STORET (Storage and Retrieval of U.S. Waterways Parametric Data)
Provides:	EPA's repository of water quality data for waterways within the U.S. The system is capable of performing a broad range of reporting, statistical analysis, and graphics functions.
Supports:	Geographic and descriptive information on various waterways; analytical data from surface water, fish tissue, and sediment samples; stream flow data.
Contact:	U.S. Environmental Protection Agency Office of Water Office of Wetlands, Oceans, and Watersheds and Office of Information Resources Management Louie H. Hoelman 202/260-7050 Fax 202/260-7024

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Databases	
Source:	Federal Reporting Data System (FRDS)
Provides:	General information on public water supplies, including identification information, noncompliance related events, violations of the State Drinking Water Act, enforcement actions, identification of significant noncompliers, and information on variances, exemptions, and waivers.
Supports:	Ground Water Use and Characteristics, Surface Water Use and Characteristics
Contact:	U.S. Environmental Protection Agency Office of Water Office of Ground Water and Drinking Water Abe Seigel 202/260-2804 Fax 202/260-3464
Source:	WATSTORE
Provides:	U.S. Geological Survey's National Water Data Storage and Retrieval System. Administered by the Water Resources Division and contains the Ground Water Site Inventory file (GWSI). This provides physical, hydrologic, and geologic data about test holes, springs, tunnels, drains, ponds, other excavations, and outcrops.
Supports:	General Site Information, Ground Water Use and Characteristics, Surface Water Use and Characteristics
Contact:	U.S. Geological Surgery or USGS Regional Field Office 12201 Sunrise Valley Drive Reston, VA 22092

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Databases	
Source:	ISI (Information Systems Inventory)
Provides:	Abstracts and contacts who can provide information on U.S. Environmental Protection Agency databases.
Supports:	All information needs
Contacts:	U.S. Environmental Protection Agency Office of Information and Resources Management Information Management and Services Division ISI System Manager 202/260-5914 Fax 202/260-3923
Source:	ERAMS (Environmental Radiation Ambient Monitoring System)
Provides;	A direct assessment of the population intake of radioactive pollutants due to fallout, data for developing dose computational models, population exposures from routine and accidental releases of radioactivity from major sources, data for indicating additional measurement needs or other actions required in the event of a major release of radioactivity in the environment, and a reference for data comparison with other localized and limited monitoring programs.
Supports:	Source and waste characteristics
Contact:	U.S. Environmental Protection Agency National Air and Radiation Environmental Laboratory 540 South Morris Avenue Montgomery, AL 36115 Phone 334/270-3400 Fax 334/270-3454

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Maps and Aerial Photographs			
Source:	U.S. Geological Survey (USGS) Topographic Quadrangles		
Provides:	Maps detailing topographic, geographical, political, and cultural features. Available in 7.5- and 15-minutes series.		
Supports:	Site location and environmental setting; latitude/longitude; houses, schools, and other buildings; distances to targets; surface water body types; drainage routes; wetlands and sensitive environments; karst terrain features.		
Contacts:	U.S. Geological Survey 12201 Sunrise Valley Drive Reston, VA 22092	or	USGS Regional or Field Office
Source:	National Wetland Inventory Maps		
Provides;	Maps delineating boundaries and acreage of wetlands.		
Supports:	Environmental setting and wetlands locations.		
Contact:	U.S. Geological Survey 12201 Sunrise Valley Drive Reston, VA 22092	or	U.S. Fish and Wildlife Service 18th and C Street, NW Washington, DC 20240
Source:	Ecological Inventory Maps		
Provides:	Maps delineating sensitive environments and habitats, including special land use areas, wetlands, study areas, and native plant and animal species.		
Supports:	Environmental setting, sensitive environments, wetland locations and size.		
Contact:	U.S. Geological Survey 12201 Sunrise Valley Drive Reston, VA 22092	or	U.S. Fish and Wildlife Service 18th and C Streets, NW Washington, DC 20240

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Maps and Aerial Photographs	
Source:	Flood Insurance Rate Maps (FIRM)
Provides:	Maps delineating flood hazard boundaries for flood insurance purposes.
Supports:	Flood frequency.
Contact:	Federal Emergency Management Agency (FEMA) or Local Zoning and Planning Office Federal Insurance Administration Office of Risk Assessment 500 C Street, SW Washington, DC 20472
Source:	State Department of Transportation Maps
Provides:	State maps detailing road systems, surface water systems, and other geographical, cultural, and political features.
Supports:	Site location and environmental setting, distances to targets, wetlands, and sensitive environments.
Contact:	State or Local Government Agency
Source:	Geologic and Bedrock Maps
Provides:	Maps detailing surficial exposure and outcrop of formations for interpreting subsurface geology. Bedrock maps describe depth and lateral distribution of bedrock.
Supports:	General stratigraphy beneath and surrounding the site.
Contact:	U.S. Geological Survey or USGS Regional or Field Office 12201 Sunrise Valley Drive State Geological Survey Office Reston, VA 22092

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Maps and Aerial Photographs	
Source:	Aerial Photographs
Provides:	Black and white and/or color photographic images detailing topographic, physical, and cultural features.
Supports:	Site location and size, location and extent of waste sources, identification of surrounding surficial geology, distances to targets, wetlands and sensitive environments. May provide information on historical site operations, waste quantity, and waste handling practices.
Contact:	State Department of Transportation Local Zoning and Planning Office County Tax Assessor's Office Colleges and Universities (geology or geography departments) EPA's Environmental Monitoring Services Laboratory (EMSL) EPA's Environmental Photographic Interpretation Center (EPIC) U.S. Army Corps of Engineers U.S. Department of Agriculture, Forest Service U.S. Geological Survey
Source:	Global Land Information System (GLIS)
Provides:	An interactive computer system about the Earth's land surfaces information. GLIS contains abstract, description, and search information for each data set. Through GLIS, scientists can evaluate data sets, determine their availability, place online requests for products, or, in some cases, download products. GLIS also offers online samples of earth science data.
Supports:	Site location and environmental setting; latitude/longitude; houses, schools, and other buildings; distances to targets; surface water body types; drainage routes; wetlands and sensitive environments; karst terrain features.
Contact:	Internet: http://mapping.usgs.gov or U.S. Geological Survey 12202 Sunrise Valley Drive Reston, VA 20192, USA

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Maps and Aerial Photographs	
Source:	Topologically Integrated Geographic Encoding and Referencing (TIGER) System
Provides:	Automates the mapping and related geographic activities required to support the decennial census and sample survey programs of the U.S. Census Bureau starting with the 1990 decennial census. The topological structure of the TIGER data base defines the location and relationship of streets, rivers, railroads, and other features to each other and to the numerous geographic entities for which the Census Bureau tabulates data from its censuses and sample surveys.
Supports:	General Site Information, Soil Exposure Characteristics, Air Pathway Characteristics
Contacts:	http://www.census.gov/geo/www/tiger Public Information Office Room 2705, FB-3 Census Bureau U.S. Department of Commerce Washington, DC 20233

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Files	
Source:	Office project files
Provides:	Site investigation reports, logbooks, telecons, references, etc.
Supports:	Information on nearby sites such as town populations, public and private water supplies, well locations, targets, and general stratigraphy descriptions.
Source:	State Environmental Agency files
Provides;	Historical site information, permits, violations, and notifications.
Supports:	General site information and operational history, source descriptions, waste quantities and waste handling practices. May provide results of previous site investigations.

Table G.2 Site Assessment Information Source (continued)
(Organized by Information Source)

Files		
Source:	EPA Regional Libraries	
Provides:	Historical information on CERCLIS sites, permits, violations, and notification. Additionally provides interlibrary loan services.	
Supports:	General site information and operational history, source descriptions, waste quantities and waste handling practices. May provide results of previous site investigations.	
Contact:	USEPA Region 1 Library JFK Federal Building Boston, MA 02203 617/565-3300 USEPA Region 2 Library 290 Broadway 16th Floor New York, NY 10007-1866 212/264-2881 USEPA Region 3 Information Resources Center, 3PM52 841 Chestnut Street Philadelphia, PA 19107 215/597-0580 USEPA Region 4 Library Atlanta Federal Center 61 Forsyth Street, SW Atlanta, GA 30303-8909 404/562-8190 USEPA Region 5 Library 77 W. Jackson Blvd., 12th Floor Chicago, IL 60604-3590 312/353-2022	USEPA Region 6 Library, 6M-A1 1445 Ross Avenue, Suite 1200 First Interstate Bank Tower Dallas, TX 75202-2733 214/655-6427 USEPA Region 7 Information Resources Center 726 Minnesota Avenue Kansas City, KS 66101 913/551-7358 USEPA Region 8 Library, 8PM-IML 999 18th Street Suite 500 Denver, CO 80202-2405 303/293-1444 USEPA Region 9 Library, MS:P-5-3 75 Hawthorne Street San Francisco, CA 94105 415/744-1510 USEPA Region 10 Library, MD-108 1200 Sixth Avenue Seattle, WA 98101 206/553-1289 or 1259

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Expert and Other Sources	
Source:	U.S. Geological Survey
Provides:	Geologic, hydrogeologic, and hydraulic information including maps, reports, studies, and databases.
Supports:	General stratigraphy descriptions, karst terrain, depth to aquifer, stream flow, ground water and surface water use and characteristics.
Contact:	U.S. Geological Survey or USGS Regional or Field Office 12201 Sunrise Valley Drive Reston, VA 22092
Source:	U.S. Army Corps of Engineers
Provides:	Records and data surrounding engineering projects involving surface waters.
Supports:	Ground water and surface water characteristics, stream flow, locations of wetlands and sensitive environments.
Contact:	U.S. Army Corps of Engineers
Source:	State Geological Survey
Provides:	State-specific geologic and hydrogeologic information including maps, reports, studies, and databases.
Supports:	General stratigraphy descriptions, karst terrain, depth to aquifer, ground water use and characteristics.
Contact:	State Geological Survey (Local or Field Office)
Source:	Natural Heritage Program
Provides:	Information on Federal and State designated endangered and threatened plants, animals, and natural communities. Maps, lists and general information may be available.
Supports:	Location of sensitive environments and wetlands.
Contact:	State Environmental Agency

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Expert and Other Sources	
Source:	U.S. Fish and Wildlife Service
Provides:	Environmental Information
Supports:	Locations of sensitive environments, wetlands, fisheries; surface water characteristics and stream flow.
Contact:	U.S. Fish and Wildlife Service 18th and C Streets, NW Washington, DC 20240 or U.S. Fish and Wildlife Service Regional office
Source:	Local Fish and Wildlife Officials
Provides:	Local Environmental Information
Supports:	Locations of sensitive environments, wetlands, fisheries; surface water characteristics and stream flow.
Contact:	State or Local Environmental Agency State or Local Game or Conservation Office
Source:	Local Tax Assessor
Provides:	Past and present land ownership records, lot and building sizes, assessors maps. May also provide historical aerial photographs.
Supports:	Name of present and past owners/operators, years of ownership, size of site, and operational history.
Contact:	Local Town Government Office

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Expert and Other Sources	
Source:	Local Water Authority
Provides:	Public and private water supply information, including service area maps, well locations and depths, well logs, surface water intake locations, information regarding water supply contamination.
Supports:	Locations and populations served by municipal and private drinking water sources (wells and surface water intakes), pumpage and production, blended systems, depth to aquifer, general stratigraphic descriptions, ground water and surface water characteristics, stream flow.
Contact:	Local Town Government Office
Source:	Local Health Department
Provides:	Information and reports regarding health-related problems that may be associated with a site. Information on private and municipal water supplies, and onsite monitoring wells.
Supports:	Primary/secondary targets differentiation, locations and characteristics of public substances present at the site.
Contact:	Local Town Government Office
Source:	Local Zoning Board or Planning Commission
Provides:	Records of local land development, including historical land use and ownership, and general stratigraphy descriptions.
Supports:	General site description and history, previous ownership, and land use.
Contact:	Local Town Government Office

Table G.2 Site Assessment Information Sources (continued)
(Organized by Information Source)

Expert and Other Sources	
Source:	Local Fire Department
Provides:	Records of underground storage tanks in the area, material safety data sheets (MSDS) for local commercial and industrial businesses, and other information on hazardous substances used by those businesses.
Supports:	Location and use of underground storage tanks and other potential sources of hazardous substances, identification of hazardous substances present at the site.
Contact:	Local Town Government Office
Source:	Local Well Drillers
Provides:	Public and Private water supply information including well locations and depths, well logs, pumpage and production.
Supports:	Populations served by private and municipal drinking water wells, depth to aquifer, general stratigraphic information.
Source:	Local University or College
Provides:	Geology/Environmental Studies departments may have relevant published materials (reports, theses, dissertations) and faculty experts knowledgeable in local geologic, hydrologic, and environmental conditions.
Supports:	General stratigraphic information, ground water and surface water use and characteristics, stream flow.
Source:	Site Reconnaissance
Provides:	Onsite and /or offsite visual observation of the site and surrounding area.
Supports:	General site information; source identification and descriptions; general ground water, surface water, soil, and air pathway characteristics; nearby targets; probable point of entry to surface water.

APPENDIX H

DESCRIPTION OF FIELD SURVEY AND LABORATORY ANALYSIS EQUIPMENT

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H.1 INTRODUCTION

This appendix provides information on various field and laboratory equipment used to measure radiation levels and radioactive material concentrations. The descriptions provide general guidance, and those interested in purchasing or using the equipment are encouraged to contact vendors and users of the equipment for specific information and recommendations. Although most of this equipment is in common use, a few specialty items are included to demonstrate promising developments.

The equipment is divided into two broad groupings of field survey and laboratory instruments, and each group is subdivided into equipment that measures alpha, beta, gamma, x-rays, and radon. A single sheet provides information for each system and includes its type of use (field or lab), the primary and secondary radiation detected, applicability for site surveys, operation, specificity/sensitivity, and cost of the equipment and surveys performed.

The Applicability for Site Surveys section discusses how the equipment is most useful for performing site radiological surveys. The Operation section provides basic technical information on what the system includes, how it works, how to use it practically in the field, and its features. The Specificity/Sensitivity section addresses the system's strengths and weaknesses, and the levels of radioactivity it can measure. Information for the Cost section was obtained primarily from discussions with manufacturers, users, and reviews of product literature. The cost per measurement is an estimate of the cost of producing and documenting a single data point, generally as part of a multipoint survey. It assumes times for instrument calibration (primarily if conducted at the time of the survey), use, sample analysis, and report preparation and review. It should be recognized that these values will change over time due to factors like inflation and market expansion.

It is assumed that the user of this appendix has a basic familiarity with field and laboratory equipment. Some of the typical instrument features and terms are listed below and may not be described separately for the individual instruments:

- Field survey equipment consists of a detector, a survey meter, and interconnected cables, although these are sometimes packaged in a single container. **The detector** or probe is the portion which is sensitive to radiation. It is designed in such a manner, made of selected materials, and operated at a high voltage that makes it sensitive to one or more types of radiation. Some detectors feature a window or a shield whose construction material and thickness make the detector more or less sensitive to a particular radiation. The size of the detector can vary depending on the specific need, but is often limited by the characteristics of the construction materials and the physics of the detection process. **The survey meter** contains the electronics and provides high voltage to the detector, processes the detector's signal, and displays the readings in analog or digital fashion. An analog survey meter has a continuous swing needle and typically a manually operated

scale switch, used to keep the needle on scale. The scaling switch may not be required on a digital survey meter. **The interconnecting cables** serve to transfer the high voltage and detector signals in the proper direction. These cables may be inside those units which combine the meter and detector into a single box, but they are often external with connectors that allow the user to interchange detectors.

- Scanning and measuring surveys. In a scanning survey, the field survey meter is operated while moving the detector over an area to search for a change in readings. Since the meter's audible signal responds faster than the meter display, listening to the built-in speaker or using headphones allows the user to more quickly discern changes in radiation level. When a scanning survey detects a change, the meter can be held in place for a more accurate static measurement.

- Integrated readings. Where additional sensitivity is desired, the reading can be integrated using internal electronics or an external scaler to give total values over time. The degree to which the sensitivity can be improved depends largely on the integration time selected.

- Units of measure. Survey meters with conventional meter faces measure radiation levels in units of counts, microRoentgen (µR), millirad (mrad), or millirem (mrem) in terms of unit time, *e.g.*, cpm or µR/hr. Those with SI meter faces use units of microSievert (µSv) or milliGray per unit time, *e.g.*, µSv/hr or mGy/hr.

H.2 FIELD SURVEY EQUIPMENT

H.2.1 Alpha Particle Detectors

System: ALPHA SCINTILLATION SURVEY METER
Lab/Field: Field
Radiation Detected: **Primary:** Alpha **Secondary**: None (in relatively low gamma fields)

Applicability to Site Surveys: The alpha scintillation survey meter is useful for determining the presence or absence of alpha-emitting contamination on nonporous surfaces, swipes, and air filters, or on irregular surfaces if the degree of surface shielding is known.

Operation: This survey meter uses an alpha radiation detector with a sensitive area of approximately 50 to 100 cm^2 (8 to 16 $in.^2$). The detector has a thin, aluminized window of mylar that blocks ambient light but allows alpha radiation to pass through. The detecting medium is silver activated zinc sulfide, ZnS(Ag). When the discriminator is appropriately adjusted, the meter is sensitive only to alpha radiation. Light pulses are amplified by a photomultiplier tube and passed to the survey meter.

The probe is generally placed close to the surface due to the short range of alpha particles in air. A scanning survey is used to identify areas of elevated surface contamination and then a direct survey is performed to obtain actual measurements. Integrating the readings over time improves the sensitivity enough to make the instrument very useful for alpha surface contamination measurements for many isotopes. The readings are displayed in counts per minute, but factors can usually be obtained to convert readings from cpm to dpm. Conversion factors, however, can be adversely affected by the short range of alpha particles which allows them to be shielded to often uncertain degrees if they are embedded in the surface. Systems typically use 2 to 6 "C" or "D" cells and will operate for 100-300 hours.

Specificity/Sensitivity: When the alpha discriminator is correctly adjusted, the alpha scintillation survey meter measures only alpha radiation, even if there are other radiations present. A scanning survey gives a quick indication of the presence or absence of surface contamination, while integrating the readings provides a measure of the activity on a surface, swipe, or filter. Alpha radiation is easily adsorbed by irregular, porous, moist, or over painted surfaces, and this should be carefully considered when converting count rate data to surface contamination levels. This also requires wet swipes and filters to be dried before counting. The minimum sensitivity is around 10 cpm using the needle deflection or 1 to 2 cpm when using headphones or a scaler. Some headphones or scalers give one click for every two counts, so the manual should be consulted to preclude underestimating the radioactivity by a factor of two.

Cost of Equipment: $1000

Cost per Measurement: $5

System: ALPHA TRACK DETECTOR
Lab/Field: Field and Indoor Surfaces
Radiation Detected: **Primary:** Alpha **Secondary:** None

Applicability to Site Surveys: Alpha track detectors measure gross alpha surface contamination, soil activity levels, or the depth profile of contamination.

Operation: This is a passive integrating detector. It consists of a l mm-thick sheet of polycarbonate material which is deployed directly on the soil surface or in close proximity to the contaminated surface. When alpha particles strike the detector surface, they cause microscopic damage centers to form in the plastic matrix. After deployment, the detector is etched in a caustic solution which preferentially attacks the damage centers. The etch pits may then be counted in an optical scanner. The density of etch pits, divided by the deployment time, is proportional to the soil or surface alpha activity. The measurement may be converted to isotopic concentration if the isotopes are known or measured separately. The area of a standard detector is 2 cm^2 (0.3 $in.^2$), but it may be cut into a variety of shapes and sizes to suit particular needs.

Specificity/Sensitivity: Alpha track detectors are relatively inexpensive, simple, passive, and have no measurable response to beta/gamma radiation. They provide a gross alpha measurement where the lower limit of detection is a function of deployment time. For surface contamination it is 330 Bq/m^2 (200 $dpm/100cm^2$) @ l hour, 50 Bq/m^2 (30 $dpm/100cm^2$) @ 8 hours, and 17 Bq/m^2 (10 $dpm/100cm^2$) @ 48 hours. For soil contamination it is 11,000 Bq/kg (300 pCi/g) @ 1 hour, 3,700 Bq/kg (100 pCi/g) @ 8 hours, and 740 Bq/kg (20 pCi/g) @ 96 hours. High surface contamination or soil activity levels may be measured with deployment times of a few minutes, while activity down to background levels may require deployment times of 48-96 hours. When placed on a surface, they provide an estimate of alpha surface contamination or soil concentration. When deployed against the side of a trench, they can provide an estimate of the depth profile of contamination. They may also be used in pipes and under/inside of equipment.

For most applications, the devices are purchased for a fixed price per measurement, which includes readout. This requires that the detectors be returned to the vendor and the data are not immediately available. For programs having continuing needs and a large number of measurements, automated optical scanners may be purchased. The cost per measurement is then a function of the number of measurements required.

Cost of Equipment: $65,000

Cost per Measurement: $5 to $10

System: ELECTRET ION CHAMBER
Lab/Field: Field
Radiation Detected: **Primary:** Alpha, beta, gamma, or radon **Secondary:** None
Applicability to Site Surveys: An electret is a passive integrating detector for measurements of alpha- or beta-emitting contaminants on surfaces and in soils, gamma radiation dose, or radon air concentration.

Operation: The system consists of a charged Teflon disk (electret), open-faced ionization chamber, and electret voltage reader/data logger. When the electret is screwed into the chamber, a static electric field is established and a passive ionization chamber is formed. For alpha or beta radiation, the chamber is opened and deployed directly on the surface or soil to be measured so the particles can enter the chamber. For gammas, however, the chamber is left closed and the gamma rays incident on the chamber penetrate the 2 mm-thick plastic detector wall. These particles or rays ionize the air molecules, the ions are attracted to the charged electret, and the electret's charge is reduced. The electret charge is measured before and after deployment with the voltmeter, and the rate of change of the charge is proportional to the alpha or beta surface or soil activity, with appropriate compensation for background gamma levels. A thin Mylar window may be used to protect the electret from dust. In low-level gamma measurements, the electret is sealed inside a Mylar bag during deployment to minimize radon interference. For alpha and beta measurements, corrections must be made for background gamma radiation and radon response. This correction is accomplished by deploying additional gamma or radon-sensitive detectors in parallel with the alpha or beta detector. Electrets are simple and can usually be reused several times before recharging by a vendor. Due to their small size (3.8 cm tall by 7.6 cm diameter or l.5 in. tall by 3 in. diameter), they may be deployed in hard-to-access locations.

Specificity/Sensitivity: This method gives a gross alpha, gross beta, gross gamma, or gross radon measurement. The lower limit of detection depends on the exposure time and the volume of the chamber used. High surface alpha or beta contamination levels or high gamma radiation levels may be measured with deployment times of a few minutes. Much lower levels can be measured by extending the deployment time to 24 hours or longer. For gamma radiation, the response of the detector is nearly independent of energy from 15 to 1200 keV, and fading corrections are not required. To quantify ambient gamma radiation fields of 10 µR/hr, a 1000 mL chamber may be deployed for two days or a 50 mL chamber deployed for 30 days. The smallest chamber is particularly useful for long-term monitoring and reporting of monthly or quarterly measurements. For alpha and beta particles, the measurement may be converted to isotopic concentration if the isotopes are known or measured separately. The lower limit of detection for alpha radiation is 83 Bq/m^2 (50 dpm/100 cm^2) @ 1 hour, 25 Bq/m^2 (l5 dpm/100 cm^2) @ 8 hours, and 13 Bq/m^2 (8 dpm/100 cm) @ 24 hours. For beta radiation from tritium it is 10,000 Bq/m^2 (6,000 dpm/cm^2) @ 1 hour and 500 Bq/m^2 (300 dpm/cm^2) @ 24 hours. For beta radiation from ^{99}Tc it is 830 Bq/m^2 (500 dpm/cm^2) @ 1 hour and 33 Bq/m^2 (20 dpm/cm^2) @ 24 hours.

Cost of Equipment: $4,000 to $25,000, for system if purchased.
Cost per Measurement: $8-$25, for use under service contract

System: GAS-FLOW PROPORTIONAL COUNTER
Lab/Field: Field
Radiation Detected: **Primary:** Alpha, Beta **Secondary:** Gamma
Applicability to Site Surveys: This equipment measures gross alpha or gross beta/gamma surface contamination levels on relatively flat surfaces like the floors and walls of facilities. It also serves as a screen to determine whether or not more nuclide-specific analyses may be needed.
Operation: This system consists of a gas-flow proportional detector, gas supply, supporting electronics, and a scaler or rate meter. Small detectors (~100 cm^2) are hand-held and large detectors (~400-600 cm^2) are mounted on a rolling cart. The detector entrance window can be <1 to almost 10 mg/cm^2 depending on whether alpha, alpha-beta, or gamma radiation is monitored. The gas used is normally P-10, a mixture of 10% methane and 90% argon. The detector is positioned as close as practical to the surface being monitored for good counting efficiency without risking damage from the detector touching the surface. Quick disconnect fittings allow the system to be disconnected from the gas bottle for hours with little loss of counting efficiency. The detector operating voltage can be set to make it sensitive only to alpha radiation, to both alpha and beta radiation, or to beta and low energy gamma radiation. These voltages are determined for each system by placing either an alpha source, such as ^{230}Th or ^{241}Am, or a beta source, such as ^{90}Sr, facing and near the detector window, then increasing the high voltage in incremental steps until the count rate becomes constant. The alpha plateau, the region of constant count rate, will be almost flat. The beta plateau will have a slope of 5 to 15 percent per 100 volts. Operation on the beta plateau allows detection of some gamma radiation, but the efficiency is very low. Some systems use a spectrometer to separate alpha, and beta/gamma events, allowing simultaneous determination of both the alpha and beta/gamma surface contamination levels.
Specificity/Sensitivity: These systems do not identify the alpha or beta energies detected and cannot be used to identify specific radionuclides. Background for operation on the alpha plateau is very low, 2 to 3 counts per minute, which is higher than for laboratory detectors because of the larger detector size. Background for operation on the beta plateau is dependent on the ambient gamma and cosmic ray background, and typically ranges from several hundred to a thousand counts per minute. Typical efficiencies for unattenuated alpha sources are 15-20%. Beta efficiency depends on the window thickness and the beta energy. For $^{90}Sr/^{90}Y$ in equilibrium, efficiencies range from 5% for highly attenuated to about 35% for unattenuated sources. Typical gamma ray efficiency is <1%. The presence of natural radionuclides in the surfaces could interfere with the detection of other contaminants. Unless the nature of the contaminant and any naturally-occurring radionuclides is well known, this system is better used for assessing gross surface contamination levels. The texture and porosity of the surface can hide or shield radioactive material from the detector, causing levels to be underestimated. Changes in temperature can affect the detectors's sensitivity. Incomplete flushing with gas can cause a nonuniform response over the detector's surface. Condensation in the gas lines or using the quick disconnect fittings can cause count rate instability.
Cost of Equipment: $2,000 to $4,000
Cost per Measurement: $2-$10 per m^2

System: LONG RANGE ALPHA DETECTOR (LRAD)
Lab/Field: Field
Radiation Detected: **Primary:** Alpha **Secondary:** None

Applicability to Site Surveys: The LRAD is a rugged field-type unit for measuring alpha surface soil concentration over a variety of dry, solid, flat terrains.

Operation: The LRAD system consists of a large (1 m x 1 m) aluminum box, open on the bottom side, containing copper plates that collect ions produced in the soil or surface under the box, and used to measure alpha surface contamination or soil concentration. It is attached to a lifting device on the front of a tractor and can be readily moved to new locations. Bias power is supplied by a 300-V dry cell battery, and the electrometer and computer are powered by an automobile battery and DC-to-AC inverter. A 50 cm grounding rod provides electrical grounding. A notebook computer is used for data logging and graphical interpretation of the data. Alpha particles emitted by radionuclides in soil travel only about 3 cm in air. However, these alpha particles interact with the air and produce ions that travel considerably farther. The LRAD detector box is lowered to the ground to form an enclosed ionization region. The copper detector plate is raised to +300V along with a guard detector mounted above the detector plate to control leakage current. The ions are then allowed to collect on the copper plate producing a current that is measured with a sensitive electrometer. The signal is then averaged and processed on a computer. The electric current produced is proportional to the ionization within the sensitive area of the detector and to the amount of alpha contamination present on the surface soil.

Due to its size and weight (300 lb), the unit can be mounted on a tractor for ease of movement. All metal surfaces are covered with plastic to reduce the contribution from ion sources outside the detector box. At each site, a ground rod is driven into the ground. Each location is monitored for at least 5 min. After each location is monitored, its data is fed into a notebook computer and an interpolative graph of alpha concentration produced. The unit is calibrated using standard alpha sources.

Sensitivity/Specificity: The terrain over which this system is used must be dry, to prevent the shielding of alpha particles by residual moisture, and flat, to prevent air infiltration from outside the detector, both of which can lead to large errors. The unit can detect a thin layer of alpha surface contamination at levels of 33-83 Bq/m^2 (20-50 dpm/100 cm^2), but does not measure alpha contamination of deeper layers. Alpha concentration errors are $\pm$74-740 Bq/kg ($\pm$2-20 pCi/g), with daily repeat accuracies of $\pm$370-3,700 Bq/kg ($\pm$10-100 pCi/g), depending on the contamination level. The dynamic measurement range appears to be 370-110,00 Bq/kg (10-3,000 pCi/g).

Cost of Equipment: $25,000 (est. for tractor, computer, software, electrometer, and detector)
Cost per Measurement: $80 (based on 30 min per point and a 2 person team)

H.2 FIELD SURVEY EQUIPMENT

H.2.2 Beta Particle Detectors

System: ELECTRET ION CHAMBER
Lab/Field: Field
Radiation Detected: **Primary:** Low energy beta (*e.g.* tritium, ^{99}Tc, ^{14}C, ^{90}Sr, ^{63}Ni), alpha, gamma, or radon **Secondary:** None

Applicability to Site Surveys: This system measures alpha- or beta-emitting contaminants on surfaces and in soils, gamma radiation dose, or radon air concentration, depending on how it is configured.

Operation: The system consists of a charged Teflon disk (electret), open-faced ionization chamber, and electret voltage reader/data logger. When the electret is screwed into the chamber, a static electric field is established and a passive ionization chamber is formed. For alpha or beta radiation, the chamber is opened and deployed directly on the surface or soil to be measured so the particles can enter the chamber. For gammas, however, the chamber is left closed and the gamma rays incident on the chamber penetrate the 2 mm-thick plastic detector wall. These particles or rays ionize the air molecules, the ions are attracted to the charged electret, and the electret's charge is reduced. The electret charge is measured before and after deployment with the voltmeter, and the rate of change of the charge is proportional to the alpha or beta surface or soil activity, with appropriate compensation for background gamma levels. A thin Mylar window may be used to protect the electret from dust. In low-level gamma measurements, the electret is sealed inside a Mylar bag during deployment to minimize radon interference. For alpha and beta measurements, corrections must be made for background gamma radiation and radon response. This correction is accomplished by deploying additional gamma or radon-sensitive detectors in parallel with the alpha or beta detector. Electrets are simple and can usually be reused several times before recharging by a vendor. Due to their small size (3.8 cm tall by 7.6 cm diameter or l.5 in. tall by 3 in. diameter), they may be deployed in hard-to-access locations.

Specificity/Sensitivity: This method gives a gross alpha, gross beta, gross gamma, or gross radon measurement. The lower limit of detection depends on the exposure time and the volume of the chamber used. High surface alpha or beta contamination levels or high gamma radiation levels may be measured with deployment times of a few minutes. Much lower levels can be measured by extending the deployment time to 24 hours or longer. For gamma radiation, the response of the detector is nearly independent of energy from 15 to 1200 keV, and fading corrections are not required. To quantify ambient gamma radiation fields of 10 µR/hr, a 1000 mL chamber may be deployed for two days or a 50 mL chamber deployed for 30 days. The smallest chamber is particularly useful for long-term monitoring and reporting of monthly or quarterly measurements. For alpha and beta particles, the measurement may be converted to isotopic concentration if the isotopes are known or measured separately. The lower limit of detection for alpha radiation is 83 Bq/m^2 (50 dpm/100 cm^2) @ 1 hour, 25 Bq/m^2 (15 dpm/100 cm^2) @ 8 hours, and 13 Bq/m^2 (8 dpm/100 cm^2) @ 24 hours. For beta radiation from tritium it is 10,000 Bq/m^2 (6,000 dpm/cm^2) @ 1 hour and 500 Bq/m^2 (300 dpm/cm^2) @ 24 hours. For beta radiation from ^{99}Tc it is 830 Bq/m^2(500 dpm/cm^2) @ 1 hour and 33 Bq/m^2 (20 dpm/cm^2) @ 24 hours.

Cost of Equipment: $4,000 to $25,000, for system if purchased.
Cost per Measurement: $8-$25, for use under service contract

System: GAS-FLOW PROPORTIONAL COUNTER
Lab/Field: Field
Radiation Detected: **Primary:** Alpha, Beta **Secondary:** Gamma
Applicability to Site Surveys: This equipment measures gross alpha or gross beta/gamma surface contamination levels on relatively flat surfaces like the floors and walls of facilities. It would serve as a screen to determine whether or not more nuclide-specific analyses were needed.
Operation: This system consists of a gas-flow proportional detector, gas supply, supporting electronics, and a scaler or rate meter. Small detectors (~100 cm^2) are hand-held and large detectors (~400-600 cm^2) are mounted on a rolling cart. The detector entrance window can be <1 to almost 10 mg/cm^2 depending on whether alpha, alpha-beta, or gamma radiation is monitored. The gas used is normally P-10, a mixture of 10% methane and 90% argon. The detector is positioned as close as practical to the surface being monitored for good counting efficiency without risking damage from the detector touching the surface. Quick disconnect fittings allow the system to be disconnected from the gas bottle for hours with little loss of counting efficiency. The detector operating voltage can be set to make it sensitive only to alpha radiation, to both alpha and beta radiation, or to beta and low energy gamma radiation. These voltages are determined for each system by placing either an alpha source, such as ^{230}Th or ^{241}Am, or a beta source, such as ^{90}Sr, facing and near the detector window, then increasing the high voltage in incremental steps until the count rate becomes constant. The alpha plateau, the region of constant count rate, will be almost flat. The beta plateau will have a slope of 5 to 15 percent per 100 volts. Operation on the beta plateau allows detection of some gamma radiation, but the efficiency is very low. Some systems use a spectrometer to separate alpha, and beta/gamma events, allowing simultaneous determination of both the alpha and beta/gamma surface contamination levels.
Specificity/Sensitivity: These systems do not identify the alpha or beta energies detected and cannot be used to identify specific radionuclides. Background for operation on the alpha plateau is very low, 2 to 3 counts per minute, which is higher than for laboratory detectors because of the larger detector size. Background for operation on the beta plateau is dependent on the ambient gamma and cosmic ray background, and typically ranges from several hundred to a thousand counts per minute. Typical efficiencies for unattenuated alpha sources are 15-20%. Beta efficiency depends on the window thickness and the beta energy. For $^{90}Sr/^{90}Y$ in equilibrium, efficiencies range from 5% for highly attenuated to about 35% for unattenuated sources. Typical gamma ray efficiency is <1%. The presence of natural radionuclides in the surfaces could interfere with the detection of other contaminants. Unless the nature of the contaminant and any naturally-occurring radionuclides is well known, this system is better used for assessing gross surface contamination levels. The texture and porosity of the surface can hide or shield radioactive material from the detector, causing levels to be underestimated. Changes in temperature can affect the detectors's sensitivity. Incomplete flushing with gas can cause a nonuniform response over the detector's surface. Condensation in the gas lines or using the quick disconnect fittings can cause count rate instability.
Cost of Equipment: $2,000 to $4,000
Cost per Measurement: $2-$10 per m^2

System: GM SURVEY METER WITH BETA PANCAKE PROBE
Lab/Field: Field
Radiation Detected: **Primary:** Beta **Secondary:** Gamma and alpha
Applicability to Site Surveys: This instrument is used to find and measure low levels of beta/gamma contamination on relatively flat surfaces.
Operation: This instrument consists of a flat "pancake" type Geiger-Mueller detector connected to a survey meter which measures radiation response in counts per minute. The detector housing is typically a rigid metal on all sides except the radiation entrance face or window, which is made of Mylar, mica, or a similar material. A steel, aluminum, lead, or tungsten housing surrounds the detector on all sides except the window, giving the detector a directional response. The detector requires approximately 900 volts for operation. It is held within a few cm of the surface to minimize the thickness of air shielding in between the radioactive material and the detector. It is moved slowly to scan the surface in search of elevated readings, then held in place long enough to obtain a stable measurement. Radiation entering the detector ionizes the gas, causes a discharge throughout the entire tube, and results in a single count being sent to the meter. The counts per minute meter reading is converted to a beta surface contamination level in the range of 1,700 Bq/m^2 (1,000 dpm/100 cm^2) using isotope specific factors.

Specificity/Sensitivity: Pancake type GM detectors primarily measure beta count rate in close contact with surfaces to indicate the presence of contamination. They are sensitive to any alpha, beta, or gamma radiation that enters the detector and causes ionization. As a result, they cannot determine the type or energy of that radiation, except by using a set of absorbers. To be detected, beta particles must have enough energy to penetrate through any surface material that the contamination is absorbed in, plus the detector window, and the layer of air and other shielding materials in between. Low energy beta particles from emitters like ^{3}H (17 keV) that cannot penetrate the window alone are not detectable, while higher energy betas like those from ^{60}Co (314 keV) can be readily detected. The beta detection efficiency at a field site is primarily a function of the beta energy, window thickness, and the surface condition. The detection sensitivity can be improved by using headphones or the audible response during scans. By integrating the count rate over a longer period or by counting the removable radioactive material collected on a swipe , the ability to detect surface contamination can be improved. The nominal 2 in. diameter detector can measure an increase of around 100 cpm above background, which equates to 4,200 Bq/m^2 (2,500 dpm/100 cm^2) of ^{60}Co on a surface under the detector or 20 Bq (500 pCi) on a swipe. Larger 100 cm^2 detectors improve sensitivity and eliminate the need to swipe. A swipe's collection efficiency may be below 100%, and depends on the wiping technique, the actual surface area covered, the texture and porosity of the surface, the affinity of the contamination for the swipe material, and the dryness of the swipe. This will proportionately change the values above. The sensitivity to gamma radiation is around 10% or less of the beta sensitivity, while the alpha detection efficiency is difficult to evaluate.

Cost of equipment: $400 to $1,500
Cost per Measurement: $5 to $10 per location

H.2 FIELD SURVEY EQUIPMENT

H.2.3 Gamma Ray Detectors

System: ELECTRET ION CHAMBER
Lab/Field: Field
Radiation Detected: **Primary:** Low energy beta (*e.g.* tritium, ^{99}Tc, ^{14}C, ^{90}Sr, ^{63}Ni), alpha, gamma, or radon **Secondary:** None

Applicability to Site Surveys: This system measures alpha- or beta-emitting contaminants on surfaces and in soils, gamma radiation dose, or radon air concentration, depending on how it is configured.

Operation: The system consists of a charged Teflon disk (electret), open-faced ionization chamber, and electret voltage reader/data logger. When the electret is screwed into the chamber, a static electric field is established and a passive ionization chamber is formed. For alpha or beta radiation, the chamber is opened and deployed directly on the surface or soil to be measured so the particles can enter the chamber. For gammas, however, the chamber is left closed and the gamma rays incident on the chamber penetrate the 2 mm-thick plastic detector wall. These particles or rays ionize the air molecules, the ions are attracted to the charged electret, and the electret's charge is reduced. The electret charge is measured before and after deployment with the voltmeter, and the rate of change of the charge is proportional to the alpha or beta surface or soil activity, with appropriate compensation for background gamma levels. A thin Mylar window may be used to protect the electret from dust. In low-level gamma measurements, the electret is sealed inside a Mylar bag during deployment to minimize radon interference. For alpha and beta measurements, corrections must be made for background gamma radiation and radon response. This correction is accomplished by deploying additional gamma or radon-sensitive detectors in parallel with the alpha or beta detector. Electrets are simple and can usually be reused several times before recharging by a vendor. Due to their small size (3.8 cm tall by 7.6 cm diameter or l.5 in. tall by 3 in. diameter), they may be deployed in hard-to-access locations.

Specificity/Sensitivity: This method gives a gross alpha, gross beta, gross gamma, or gross radon measurement. The lower limit of detection depends on the exposure time and the volume of the chamber used. High surface alpha or beta contamination levels or high gamma radiation levels may be measured with deployment times of a few minutes. Much lower levels can be measured by extending the deployment time to 24 hours or longer. For gamma radiation, the response of the detector is nearly independent of energy from 15 to 1200 keV, and fading corrections are not required. To quantify ambient gamma radiation fields of 10 µR/hr, a 1000 mL chamber may be deployed for two days or a 50 mL chamber deployed for 30 days. The smallest chamber is particularly useful for long-term monitoring and reporting of monthly or quarterly measurements. For alpha and beta particles, the measurement may be converted to isotopic concentration if the isotopes are known or measured separately. The lower limit of detection for alpha radiation is 83 Bq/m^2 (50 dpm/100 cm^2) @ 1 hour, 25 Bq/m^2 (15 dpm/100 cm^2) @ 8 hours, and 13 Bq/m^2 (8 dpm/100 cm^2) @ 24 hours. For beta radiation from tritium it is 10,000 Bq/m^2 (6,000 dpm/cm^2) @ 1 hour and 500 Bq/m^2 (300 dpm/cm^2) @ 24 hours. For beta radiation from ^{99}Tc it is 830 Bq/m^2(500 dpm/cm^2) @ 1 hour and 33 Bq/m^2 (20 dpm/cm^2) @ 24 hours.

Cost of Equipment: $4,000 to $25,000, for system if purchased.
Cost per Measurement: $8-$25, for use under service contract

System: GM SURVEY METER WITH GAMMA PROBE
Lab/Field: Field
Radiation Detected: **Primary:** Gamma **Secondary:** Beta

Applicability to Site Surveys: This instrument is used to give a quick indication of gamma-radiation levels present at a site. Due to its high detection limit, the GM survey meter may be useful during characterization surveys but may not meet the needs of final status surveys.

Operation: This instrument consists of a cylindrical Geiger Mueller detector connected to a survey meter. It is calibrated to measure gamma exposure rate in mR/hr. The detector is surrounded on all sides by a protective rigid metal housing. Some units called end window or side window have a hinged door or rotating sleeve that opens to expose an entry window of Mylar, mica, or a similar material, allowing beta radiation to enter the sensitive volume. The detector requires approximately 900 volts for operation. It is normally held at waist height, but is sometimes placed in contact with an item be evaluated. It is moved slowly over the area to scan for elevated readings, observing the meter or, preferably, listening to the audible signal. Then it is held in place long enough to obtain a stable measurement. Radiation entering the detector ionizes the gas, causes a discharge throughout the entire tube, and results in a single count being sent to the meter. Conversion from count rate to exposure rate is accomplished at calibration by exposing the detector at discrete levels and adjusting the meter scale(s) to read accordingly. In the field, the exposure rate is read directly from the meter. If the detector housing has an entry window , an increase in “open-door” over “closed-door” reading indicates the presence of beta radiation in the radiation field, but the difference is not a direct measure of the beta radiation level.

Specificity/Sensitivity: GM meters measure gamma exposure rate, and those with an entry window can identify if the radiation field includes beta radiation. Since GM detectors are sensitive to any energy of alpha, beta, or gamma radiation that enters the detector, instruments that use these detectors cannot identify the type or energy of that radiation, or the specific radionuclide(s) present. The sensitivity can be improved by using headphones or the audible response during scans, or by integrating the exposure rate over time. The instrument has two primary limitations for environmental work. First, its minimum sensitivity is high, around 0.1 mR/hr in rate meter mode or 0.01 mR/hr in integrate mode. Some instruments use a large detector to improve low end sensitivity. However, in many instances the instrument is not sensitive enough for site survey work. Second, the detector’s energy response is nonlinear. Energy compensated survey meters are commercially available, but the instrument's sensitivity may be reduced.

Cost of Equipment: $400 to $1,500.

Cost per Measurement: $5 per measurement for survey and report.

System: HAND-HELD ION CHAMBER SURVEY METER
Lab/Field: Field
Radiation Detected: **Primary:** Gamma **Secondary:** None

Applicability to Site Surveys: The hand-held ion chamber survey meter measures true gamma radiation exposure rate, in contrast to most other survey meter/probe combinations which are calibrated to measure exposure rate at one energy and approximate the exposure rate at all other energies. Due to their high detection limit, these instruments are not applicable for many final status surveys.

Operation: This device uses an ion chamber operated at a bias voltage sufficient to collect all ion pairs created by the passage of ionizing radiation, but not sufficiently high to generate secondary ion pairs as a proportional counter does. The units of readout are mR/hr, or some multiple of mR/hr. If equipped with an integrating mode, the operator can measure the total exposure over a period of time. The instrument may operate on two "D" cells or a 9 volt battery that will last for 100 to 200 hours of operation.

Specificity/Sensitivity: Ion chamber instruments respond only to gamma or x-radiation. They have no means to provide the identity of contaminants. Typical ion chamber instruments have a lower limit of detection of 0.5 mR/hr. These instruments can display readings below this, but the readings may be erratic and have large errors associated with them. In integrate mode, the instrument sensitivity can be as low as 0.05 mR/hr.

Cost of Equipment: $800 to $1,200

Cost per Measurement: $5, or higher for making integrated exposure measurements.

System: HAND-HELD PRESSURIZED ION CHAMBER (PIC) SURVEY METER
Lab/Field: Field
Radiation Detected: **Primary:** Gamma **Secondary:** None

Applicability to Site Surveys: The hand-held pressurized ion chamber survey meter measures true gamma radiation exposure rate, in contrast to most other survey meter/probe combinations which are calibrated to measure exposure rate at one energy and approximate the exposure rate at all other energies. Due to their high detection limit, these instruments are not applicable for many final status surveys.

Operation: This device uses a pressurized air ion chamber operated at a bias voltage sufficient to collect all ion pairs created by the passage of ionizing radiation, but not sufficiently high to cause secondary ionization.. The instrument is identical to the ion chamber meter on the previous page, except in this case the ion chamber is sealed and pressurized to 2 to 3 atmospheres to increase the sensitivity of the instrument by the same factors. The units of readout are µR/hr or mR/hr. A digital meter will allow an operator to integrate the total exposure over a period of time. The unit may use two "D" cells or a 9-volt battery that will last for 100 to 200 hours of operation.

Specificity/Sensitivity: Since the ion chamber is sealed, pressurized ion chamber instruments respond only to gamma or X-radiation. They have no means to provide the identity of contaminants. Typical instruments have a lower limit of detection of 0.1 mR/hr, or as low as 0.01 mR in integrate mode. These instruments can display readings below this, but the readings may be erratic and have large errors associated with them.

Cost of Equipment: $1,000 to $1,500

Cost per Measurement: $5, or higher for making integrated exposure measurements.

System: PORTABLE GERMANIUM MULTICHANNEL ANALYZER (MCA) SYSTEM
Lab/Field: Field
Radiation Detected: **Primary:** Gamma **Secondary:** None

Applicability for Site Surveys: This system produces semi-quantitative estimates of concentration of uranium and plutonium in soil, water, air filters, and quantitative estimates of many other gamma-emitting isotopes. With an appropriate dewar, the detector may be used in a vertical orientation to determine, *in situ*, gamma isotopes concentrations in soil.

Operation: This system consists of a portable germanium detector connected to a dewar of liquid nitrogen, high voltage power supply, and multichannel analyzer. It is used to identify and quantify gamma-emitting isotopes in soil or other surfaces.

Germanium is a semiconductor material. When a gamma ray interacts with a germanium crystal, it produces electron-hole pairs. An electric field is applied which causes the electrons to move in the conduction band and the holes to pass the charge from atom to neighboring atoms. The charge is collected rapidly and is proportional to the deposited energy.

The typical system consists of a portable multichannel analyzer (MCA) weighing about 7-10 lbs with batteries, a special portable low energy germanium detector with a built-in shield, and the acquisition control and spectrum analysis software. The detector is integrally mounted to a liquid nitrogen dewar. The liquid nitrogen is added 2-4 hours before use and replenished every 4-24 hours based on capacity.

The MCA includes all required front end electronics, such as a high voltage power supply, an amplifier, a digital stabilizer, and an analog-to-digital converter (ADC), which are fully controllable from a laptop computer and software.

One method uses the 94-104 keV peak region to analyze the plutonium isotopes from either “fresh” or aged materials. It requires virtually no user input or calibration. The source-to-detector distance for this method does not need to be calibrated as long as there are enough counts in the spectrum to perform the analysis.

For *in situ* applications, a collimated detector is positioned at a fixed distance from a surface to provide multichannel spectral data for a defined surface area. It is especially useful for qualitative and (based on careful field calibration or appropriate algorithms) quantitative analysis of freshly deposited contamination. Additionally, with prior knowledge of the depth distribution of the primary radionuclides of interest, which is usually not known, or using algorithms that match the site, the *in situ* system can be used to estimate the content of radionuclides distributed below the surface (dependent, of course, on adequate detection capability.)

Calibration based on Monte Carlo modeling of the assumed source-to-detector geometry or computation of fluence rates with analytical expressions is an important component to the accurate use of field spectrometry, when it is not feasible or desirable to use real radioactive sources. Such modeling used in conjunction with field spectrometry is becoming much more common recently, especially using the MCNP Monte Carlo computer software system.

Specificity/Sensitivity: With proper calibration or algorithms, field spectrometers can identify and quantify concentrations of gamma emitting radionuclides in the middle to upper energy range (*i.e.,* 50 keV with a P-type detector or 10 keV with an N-type detector).

For lower energy photons, as are important for plutonium and americium, an N-type detector or a planar crystal is preferred with a very thin beryllium (Be) window. This configuration allows measurement of photons in the energy range 5 to 80 keV. The Be window is quite fragile and a target of corrosion, and should be protected accordingly.

The detector high voltage should only be applied when the cryostat has contained sufficient liquid nitrogen for several hours. These systems can accurately identify plutonium, uranium, and many gamma-emitting isotopes in environmental media, even if a mixture of radionuclides is present. Germanium has an advantage over sodium iodide because it can produce a quantitative estimate of concentrations of multiple radionuclides in samples like soil, water, and air filters.

A specially designed low energy germanium detector that exhibits very little deterioration in the resolution as a function of count rate may be used to analyze uranium and plutonium, or other gamma-emitting radionuclides. When equipped with a built-in shield, it is unnecessary to build complicated shielding arrangements while making field measurements. Tin filters can be used to reduce the count rate from the ^{241}Am 59 keV line which allows the electronics to process more of the signal coming from Pu or U.

A plutonium content of 10 mg can be detected in a 55 gallon waste drum in about 30 minutes, although with high uncertainty. A uranium analysis can be performed for an enrichment range from depleted to 93% enrichment. The measurement time can be in the order of minutes depending on the enrichment and the attenuating materials.

Cost of Equipment: $40,000

Cost per Measurement: $100 to $200

System: PRESSURIZED IONIZATION CHAMBER (PIC)
Lab/Field: Field
Radiation Detected: **Primary:** Moderate (>80 keV) to high energy photons
Secondary: None

Applicability to Site Surveys: The PIC is a highly accurate ionization chamber for measuring gamma exposure rate in air, and for correcting for the energy dependence of other instruments due to their energy sensitivities. It is excellent for characterizing and evaluating the effectiveness of remediation of contaminated sites based on exposure rate. However, most sites also require nuclide-specific identification of the contributing radionuclides. Under these circumstances, PICs must be used in conjunction with other soil sampling or spectrometry techniques to evaluate the success of remediation efforts.

Operation: The PIC detector is a large sphere of compressed argon-nitrogen gas at 10 to 40 atmospheres pressure surrounded by a protective box. The detector is normally mounted on a tripod and positioned to sit about three feet off the ground. It is connected to an electronics box in which a strip chart recorder or digital integrator measures instantaneous and integrated exposure rate. It operates at a bias voltage sufficient to collect all ion pairs created by the passage of ionizing radiation, but not sufficiently high to amplify or increase the number of ion pairs . The high pressure inside the detector and the integrate feature make the PIC much more sensitive and precise than other ion chambers for measuring low exposures. The average exposure rate is calculated from the integrated exposure and the operating time. Arrays of PIC systems can be linked by telecommunications so their data can be observed from a central and remote location.

Specificity/Sensitivity: The PIC measures gamma or x-radiation and cosmic radiation. It is highly stable, relatively energy independent, and serves as an excellent tool to calibrate (in the field) other survey equipment to measure exposure rate. Since the PIC is normally uncollimated, it measures cosmic, terrestrial, and foreign source contributions without discrimination. Its rugged and stable behavior makes it an excellent choice for an unattended sensor where area monitors for gamma emitters are needed. PICs are highly sensitive, precise, and accurate to vast changes in exposure rate (1 µR/ hr up to 10 R/hr). PICs lack any ability to distinguish either energy spectral characteristics or source type. If sufficient background information is obtained , the data can be processed using algorithms that employ time and frequency domain analysis of the recorded systems to effectively separate terrestrial, cosmic, and "foreign" source contributions. One major advantage of PIC systems is that they can record exposure rate over ranges of 1 to 10,000,000 µR per hour (*i.e.*, µR/hr to 10 R/hr) with good precision and accuracy.

Cost of Equipment: $15,000 to $50,000 depending on the associated electronics, data processing, and telecommunications equipment.

Cost per Measurement: $50 to $500 based on the operating time at each site and the number of measurements performed.

System: SODIUM IODIDE SURVEY METER
Lab/Field: Field
Radiation Detected: **Primary:** Gamma **Secondary:** None
Applicability to Site Surveys: Sodium iodide survey meters can be response checked against a pressurized ionization chamber(PIC) and then used in its place so readings can be taken more quickly. This check should be performed often, possibly several times each day. They are useful for determining ambient radiation levels and for estimating the concentration of radioactive materials at a site.
Operation: The sodium iodide survey meter measures gamma radiation levels in µR/hr (10^{-6} R/hr) or counts per minute (cpm). Its response is energy and count rate dependent, so comparison with a pressurized ion chamber necessitates a conversion factor for adjusting the meter readings to true µR/hr values. The conversion factor obtained from this comparison is valid only in locations where the radionuclide mix is identical to that where the comparison is performed, and over a moderate range of readings. The detector is held at waist level or suspended near the surface and walked through an area listening to the audio and watching the display for changes. It is held in place and the response allowed to stabilize before each measurement is taken, with longer times required for lower responses. Generally, the center of the needle swing or the integrated reading is recorded. The detector is a sodium iodide crystal inside an aluminum container with an optical glass window that is connected to a photomultiplier tube. A gamma ray that interacts with the crystal produces light that travels out of the crystal and into the photomultiplier tube. There, electrons are produced and multiplied to produce a readily measurable pulse whose magnitude is proportional to the energy the gamma ray incident on the crystal. Electronic filters accept the pulse as a count if certain discrimination height restrictions are met. This translates into a meter response. Instruments with pulse height discrimination circuitry can be calibrated to view the primary gamma decay energy of a particular isotope. If laboratory analysis has shown a particular isotope to be present, the discrimination circuitry can be adjusted to partially tune out other isotopes, but this also limits its ability to measure exposure rate.
Specificity/Sensitivity: Sodium iodide survey meters measure gamma radiation in µR/hr or cpm with a minimum sensitivity of around 1-5 µR per hour, or 200-1,000 cpm, or lower in digital integrate mode. The reading error of 50% can occur at low count rates because of a large needle swing, but this decreases with increased count rate. The instrument is quite energy sensitive, with the greatest response around 100-120 keV and decreasing in either direction. Measuring the radiation level at a location with both a PIC and the survey meter gives a factor for converting subsequent readings to actual exposure rates. This ratio can change with location. Some meters have circuitry that looks at a few selected ranges of gamma energies, or one at a time with the aide of a single channel analyzer. This feature is used to determine if a particular isotope is present. The detector should be protected against thermal or mechanical shock which can break the sodium iodide crystal or the photomultiplier tube. Covering at least the crystal end with padding is often sufficient. The detector is heavy, so adding a carrying strap to the meter and a means of easily attaching and detaching the detector from the meter case helps the user endure long surveys.
Cost of Equipment: $2,000
Cost per Measurement: $5

System: THERMOLUMINESCENCE DOSIMETER (TLD)
Lab/Field: Field and lab
Radiation Detected: **Primary:** Gamma **Secondary:** Neutron, beta, x-ray
Applicability to Site Surveys: TLDs can be used to measure such a low dose equivalent that they can identify gamma levels slightly above natural background. TLDs should be placed in areas outside the site but over similar media to determine the average natural background radiation level in the area. Other TLDs should be posted on site to determine the difference from background. Groups should be posted quarterly for days to quarters and compared to identify locations of increased onsite doses.
Operation: A TLD is a crystal that measures radiation dose. TLDs are semiconductor crystals that contain small amounts of added impurities. When radiation interacts with the crystal, electrons in the valence band are excited into the conduction band. Many lose their energy and return directly to the valence band, but some are trapped at an elevated energy state by the impurity atoms. This trapped energy can be stored for long periods, but the signal can fade with age, temperature, and light. Heating the TLD in a TLD reader releases the excess energy in the form of heat and light. The quantity or intensity of the light given off gives a measure of the radiation dose the TLD received. If the TLDs are processed at an off site location, the transit dose (from the location to the site and return) must be determined and subtracted from the net dose. The ability to determine this transit dose affects the net sensitivity of the measurements. The TLD is left in the field for a period of a day to a quarter and then removed from the field and read in the laboratory on a calibrated TLD reader. The reading is the total dose received by the TLD during the posting period. TLDs come in various shapes (thin-rectangles, rods, and powder), sizes (0.08 cm to 0.6 cm (1/32 in. to 1/4 in.) on a side), and materials (CaF_2:Mn, $CaSO_4$:Dy, ^{6}LiF:Mn, ^{7}LiF:Mn, $LiBO_4$, LiF:Mg,Cu,P and Al_2O_3:C). The TLD crystals can be held loosely inside a holder, sandwiched between layers of Teflon, affixed to a substrate, or attached to a heater strip and surrounded by a glass envelope. Most are surrounded by special thin shields to correct for an over response to low-energy radiation. Many have special radiation filters to allow the same type TLD to measure various types and energies of radiation.
Specificity/Sensitivity: TLDs are primarily sensitive to gamma radiation, but selected TLD/filter arrangements can be used to measure beta, x-ray, and neutron radiation. They are posted both on site and off site in comparable areas. These readings are compared to determine if the site can cause personnel to receive more radiation exposure than would be received from background radiation. The low-end sensitivity can be reduced by specially calibrating each TLD and selecting those with high accuracy and good precision. The new Al_2O_3 TLD may be capable of measuring doses as low as 0.1 µSv (0.01 mrem) while specially calibrated CaF_2 TLDs posted quarterly can measure dose differences as low as 0.05 mSv/y (5 mrem/y). This is in contrast to standard TLDs that are posted monthly and may not measure doses below 1 mSv/y (100 mrem/y). TLDs should be protected from damage as the manufacturer recommends. Some are sensitive to visible light, direct sunlight, fluorescent light, excessive heat, or high humidity.
Cost of Equipment: $5K-$ 100K (reader), $25-$40 (TLD). TLDs cost $5 to $40 per rental.
Cost per Measurement: $25 to $125

H.2 FIELD SURVEY EQUIPMENT

H.2.4 Radon Detectors

System: ACTIVATED CHARCOAL ADSORPTION
Lab/Field: Field
Radiation Detected: **Primary:** Radon gas **Secondary:** None

Applicability to Site Surveys: Activated charcoal adsorption is a passive low cost screening method for measuring indoor air radon concentration. The charcoal adsorption method is not designed for outdoor measurements. For contaminated structures, charcoal is a good short-term indicator of radon contamination. Vendors provide measurement services which includes the detector and subsequent readout.

Operation: For this method, an airtight container with activated charcoal is opened in the area to be sampled and radon in the air adsorbs onto the charcoal. The detector, depending on its design, is deployed for 2 to 7 days. At the end of the sampling period, the container is sealed and sent to a laboratory for analysis. Proper deployment and analysis will yield accurate results.

Two analysis methods are commonly used in activated charcoal adsorption. The first method calculates the radon concentration based on the gamma decay from the radon progeny analyzed on a gamma scintillation or semiconductor detection system. The second method is liquid scintillation which employs a small vial containing activated charcoal for sampling. After exposure, scintillation fluid is added to the vial and the radon concentration is determined by the alpha and beta decay of the radon and progeny when counted in a liquid scintillation spectrometer.

Specificity/Sensitivity: Charcoal absorbers are designed to measure radon concentrations in indoor air. Some charcoal absorbers are sensitive to drafts, temperature and humidity. However, the use of a diffusion barrier over the charcoal reduces these effects. The minimum detectable concentration for this method ranges from 0.007-0.04 Bq/L (0.2-1.0 pCi/L).

Cost of Equipment: $10,000 for a liquid scintillation counter, $10,000 for a sodium iodide multichannel analyzer system, or $30,000+ for a germanium multichannel analyzer system. The cost of the activated charcoal itself is minimal.

Cost per Measurement: $5 to $30 including canister.

System: ALPHA TRACK DETECTOR
Lab/Field: Field
Radiation Detected: **Primary:** Radon Gas (Alpha Particles) **Secondary:** None
Applicability to Site Surveys: An alpha track detector is a passive, low cost, long term method used for measuring radon. Alpha track detectors can be used for site assessments both indoors and outdoors (with adequate protection from the elements).

Operation: Alpha track detectors employ a small piece of special plastic or film inside a small container. Air being tested diffuses through a filtering mechanism into the container. When alpha particles from the decay of radon and its progeny strike the detector, they cause damage tracks. At the end of exposure, the container is sealed and returned to the laboratory for analysis.

The plastic or film detector is chemically treated to amplify the damage tracks and then the number of tracks over a predetermined area are counted using a microscope, optical reader, or spark counter. The radon concentration is determined by the number of tracks per unit area. Detectors are usually exposed for 3 to 12 months, although shorter time frames may be used when measuring high radon concentrations.

Specificity/Sensitivity: Alpha track detectors are primarily used for indoor air measurements but specially designed detectors are available for outdoor measurements. Alpha track results are usually expressed as the radon concentration over the exposure period (Bq/L-days). The sensitivity is a function of detector design and exposure duration, and is on the order of 0.04 Bq/L-day (1 pCi/L-day).

Cost of Equipment: Not applicable when provided by a vendor

Cost per Measurement: $5 to $25

System: CONTINUOUS RADON MONITOR
Lab/Field: Field
Radiation Detected: **Primary:** Radon gas **Secondary:** None

Applicability to Site Surveys: Continuous radon monitors are devices that measure and record real-time measurements of radon gas or variations in radon concentration on an hourly basis. Since continuous monitors display real-time hourly radon measurements, they are useful for short-term site investigation.

Operation: Continuous radon monitors are precision devices that track and record real-time measurements and variations in radon gas concentration on an hourly basis. Air either diffuses or is pumped into a counting chamber. The counting chamber is typically a scintillation cell or ionization chamber. Using a calibration factor, the counts are processed electronically, and radon concentrations for predetermined intervals are stored in memory or directly transmitted to a printer.

Most continuous monitors are used for a relatively short measurement period, usually 1 to 7 days. These devices do require some operator skills and often have a ramp-up period to equilibrate with the surrounding atmosphere. This ramp-up time can range from 1 to 4 hours depending on the size of the counting chamber and rate of air movement into the chamber.

Specificity/Sensitivity: Most continuous monitors are designed for both indoor and outdoor radon measurements. The limiting factor for outdoor usage is the need for electrical power. In locations where external power is unavailable, the available operating time depends on the battery lifetime of the monitor. The minimum detectable concentration for these detectors ranges from 0.004-0.04 Bq/L (0.1-1.0 pCi/L).

Cost of Equipment: $1,000 to $5,000.

Cost per Measurement: $80+ based on duration of survey.

System: ELECTRET ION CHAMBER
Lab/Field: Field
Radiation Detected: **Primary:** Radon gas (alpha, beta) **Secondary:** Gamma

Applicability to Site Surveys: Electrets are used to measure radon concentration in indoor environments. For contaminated structures, the electret ion chamber is a good indicator of short-term and long-term radon concentrations.

Operation: For this method, an electrostatically charged disk (electret) is situated within a small container (ion chamber). During the measurement period, radon diffuses through a filter into the ion chamber, where the ionization produced by the decay of radon and its progeny reduces the charge on the electret. A calibration factor relates the voltage drop, due to the charge reduction, to the radon concentration. Variations in electret design enable the detector to make long-term or short-term measurements. Short-term detectors are deployed for 2 to 7 days, whereas long-term detectors may be deployed from 1 to 12 months.

Electrets are relatively inexpensive, passive, and can be used several times before discarding or recharging, except in areas of extreme radon concentrations. These detectors need to be corrected for the background gamma radiation during exposure since this ionization also discharges the electret.

Specificity/Sensitivity: Electrets are designed to make radon measurements primarily in indoor environments. Care must be taken to measure the background gamma radiation at the site during the exposure period. Extreme temperatures and humidity encountered outdoors may affect electret voltage. The minimum detectable concentration ranges from 0.007-0.02 Bq/L (0.2 to 0.5 pCi/L).

Cost of Equipment: Included in rental price

Cost per Measurement: $8 to $25 rental for an electret supplied by a vendor

System: LARGE AREA ACTIVATED CHARCOAL COLLECTOR
Lab/Field: Field
Radiation Detected: **Primary:** Radon gas **Secondary:** None

Applicability to Site Surveys: This method is used to make radon flux measurements (the surface emanation rate of radon gas) and involves the adsorption of radon on activated carbon in a large area collector.

Operation: The collector consists of a 10 inch diameter PVC end cap, spacer pads, charcoal distribution grid, retainer pad with screen, and a steel retainer spring. Between 170 and 200 grams of activated charcoal is spread in the distribution grid and held in place by the retainer pad and spring.

The collector is deployed by firmly twisting the end cap into the surface of the material to be measured. After 24 hours of exposure, the activated charcoal is removed and transferred to plastic containers. The amount of radon adsorbed on the activated charcoal is determined by gamma spectroscopy. This data is used to calculate the radon flux in units of Bq m^{-2} s^{-1}.

Specificity/Sensitivity: These collectors give an accurate short-term assessment of the radon gas surface emanation rate from a material. The minimum detectable concentration of this method is 0.007 Bq m^{-2} s^{-1} (0.2 pCi m^{-2} s^{-1}).

Exposures greater than 24 hours are not recommended due to atmospheric and surface moisture and temperature extremes which may affect charcoal efficiency.

Cost of Equipment: Not applicable

Cost per Measurement: $20 - $50 including canister

H.2 FIELD SURVEY EQUIPMENT

H.2.5 X-Ray and Low Energy Gamma Detectors

System: FIDLER PROBE WITH SURVEY METER
Lab/Field: Field
Radiation Detected: **Primary:** X-ray **Secondary:** Low Energy Gamma
Applicability to Site Surveys: The FIDLER (Field Instrument for the Detection of Low Energy Radiation) probe is a specialized detector consisting of a thin layer of sodium or cesium iodide which is optimized to detect gamma and x-radiation below 100 keV. It is most widely used for determining the presence of Pu and ^{241}Am, and can be used for estimating radionuclide concentrations in the field.
Operation: The FIDLER consists of a thin beryllium or aluminum window, a thin crystal of sodium iodide, a quartz light pipe, and photomultiplier tube. The probe can have either a 3 in. or 5 in. crystal. The discussion below is applicable to 5 in. crystals. The survey meter requires electronics capable of setting a window about an x-ray or gamma ray energy. This window allows the probe and meter to detect specific energies and, in most cases, provide information about a single element or radionuclide. The window also lowers the background count. Two types of survey meters are generally used with FIDLER probes. One type resembles those used with GM and alpha scintillation probes. They have an analog meter and range switch. The second type is a digital survey meter, which can display the count rate or accumulate counts in a scaler mode for a preset length of time. Both types have adjustable high voltage and window settings. The advantage of the digital meter is that both background and sample counts can be acquired in scaler mode, yielding a net count above background. The activity of a radionuclide can then be estimated in the field.
Specificity/Sensitivity: The FIDLER probe is quite sensitive to x-ray and low energy gamma radiation. Since it has the ability to discriminate energies, an energy window can be set that makes it possible to determine the presence of specific radionuclides when the nature of the contamination is known. If the identity of a contaminant is known, the FIDLER can be used to quantitatively determine the concentration. However, interferences can cause erroneous results if other radionuclides are present. The FIDLER can also be used as a survey instrument to detect the presence of x-ray or low energy gamma contaminates, and to determine the extent of the contamination. FIDLER probes are most useful for determining the presence of Pu and ^{241}Am. These isotopes have a complex of x-rays and gamma rays from 13-21 keV that have energies centered around 17 keV, and ^{241}Am has a gamma at 59 keV. There is an interference at 13 keV from both americium and uranium x-rays. The FIDLER cannot distinguish which isotope of Pu is present. ^{241}Am can be identified based on the 59 keV gamma. Typical sensitivities for ^{238}Pu and ^{239}Pu at one foot above the surface of a contaminated area are 500 to 700 and 250 to 350 counts per minute per µCi per square meter (cpm/µCi/m^2), respectively. Assuming a soil density of 1.5, uniform contamination of the first 1 mm of soil, and a typical background of 400 counts per minute, the MDC for ^{238}Pu and ^{239}Pu would be 370 and 740 Bq/kg (10 and 20 pCi/g), or 1500 and 3000 Bq/m^2 (900 and 1,800 dpm/100 cm^2). This MDC is for fresh deposition; and will be significantly less as the plutonium migrates into the soil. Because the window is fragile, most operations with a FIDLER probe require a low mass protective cover to prevent damaging the window. Styrofoam, cardboard, and other cushioning materials are common choices for a protective cover.
Cost of Equipment: $4,000 to $7,000
Cost per Measurement: $10 to $20

System: FIELD X-RAY FLUORESCENCE SPECTROMETER
Lab/Field: Field
Radiation Detected: **Primary:** X-ray and low energy gamma radiation
Secondary: None

Applicability to Site Surveys: The system accurately measures relative concentrations of metal atoms in soil or water samples down to the ppm range.

Operation: This system is a rugged form of x-ray fluorescence system that measures the characteristic x-rays of metals as they are released from excited electron structures. The associated electronic and multi-channel analyzer systems are essentially identical to those used with germanium spectrometry systems. The spectra of characteristic x-rays gives information for both quantitative and qualitative analysis; however, most frequently, the systems are only calibrated for relative atomic abundance or percent composition.

Specificity/Sensitivity: This is ideal for cases of contamination by metals that have strong x-ray emissions within 5-100 keV. Application for quantification of the transition metals (in the periodic table) is most common because of the x-ray emissions. Operation of this equipment is possible with only a moderate amount of training. The sensitivity ranges from a few percent to ppm depending on the particular atoms and their characteristic x-rays. When converted to activity concentration, the minimum detectable concentration for ^{238}U is around 1,850 Bq/kg (50 pCi/g) for typical soil matrices.

Cost of Equipment: $15,000 - $75,000 depending on size, speed of operation and auxiliary features employed for automatic analysis of the results.

Cost per Measurement: $200

H.2 FIELD SURVEY EQUIPMENT

H.2.6 Other Field Survey Equipment

System: CHEMICAL SPECIES LASER ABLATION MASS SPECTROMETER
Lab/Field: Field
Radiation Detected: None

Applicability to Site Surveys: Chemical Species Laser Ablation Mass Spectrometry has been successfully applied to the analysis of organic and inorganic molecular species in condensed material with high sensitivity and specificity.

Operation: Solids can be converted into aerosol particles which contain much of the molecular species information present in the original material. (One way this is done is by laser excitation of one component of a solid mixture which, when volatilized, carries along the other molecular species without fragmentation.) Aerosol particles can be carried hundreds of feet without significant loss in a confined or directed air stream before analysis by mass spectrometry. Some analytes of interest already exist in the form of aerosol particles. Laser ablation is also preferred over traditional means for the conversion of the aerosol particles into molecular ions for mass spectral analysis. Instrument manufacturers are working with scientists at national laboratories and universities in the development of compact portable laser ablation mass spectrometry instrumentation for field based analyses.

Specificity/Sensitivity: This system can analyze soils and surfaces for organic and inorganic molecular species, with extremely good sensitivity. Environmental concentrations in the range of 10^{-9} - 10^{-14} g/g can be determined, depending on environmental conditions. It is highly effective when used by a skilled operator, but of limited use due to high costs. It may be possible to quantify an individual radionuclide if no other nuclides of that isotope are present in the sample matrix. Potential MDC's are $4x10^{-8}$ Bq/kg ($1x10^{-9}$ pCi/g) for ^{238}U, 0.04 Bq/kg (10^{-3} pCi/g) for ^{239}Pu, 4 Bq/kg (1 pCi/g) for ^{137}Cs, and 37 Bq/kg (10 pCi/g) for ^{60}Co.

Cost of Equipment: Very expensive (prototype)

Cost per Measurement: May be comparable to laser ablation inductively coupled plasma atomic emission spectrometry (LA-ICP-AES) and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). When using the Atomic Emission Spectrometer, the reported cost is $4,000 per sample, or 80% of conventional sampling and analysis costs. This high cost for conventional samples is partly due to the 2-3 day time to analyze a sample for thorium by conventional methods. When using the mass spectrometer, the time required is about 30 minutes per sample.

System: LA-ICP-AES AND LA-ICP-MS
Lab/Field: Field
Radiation Detected: None

Applicability to Site Surveys: LA-ICP-AES and LA-ICP-MS are acronyms for Laser Ablation-Inductively Coupled Plasma-Atomic Emission Spectrometry or Mass Spectrometry. LA-ICP-AES/MS techniques are used to screen/characterize very small samples of soils and concrete (non-destructively) *in situ* to determine the level of contamination. It is particularly suited to measuring the surface concentration of uranium and thorium. The unit can assess the concentrations at various depths when lower levels are exposed by some means. It has the advantages of not consuming surface material, providing real time response, reducing sampling and analysis time, and keeping personnel clear of the materials being sampled. The information developed can assist in identifying locations for excavation. It is currently being tested.

Operation: Components of the system include a sampling system, fiber optics cables, spectrometer, potable water supply, cryogenic and high-pressure gas supply, a robotics arm, control computers, inductively coupled plasma torch, and video monitor.

Sampling probes have been developed and prototyped that will screen/characterize surface soils, concrete floors or pads, and subsurface soils. The sampling probes, both surface and subsurface, contain the laser (a 50-Hz Nd/YAG laser), associated optics, and control circuitry to raster the laser (ablation) energy across one square inch of sample surface. Either sampling probe is connected by an umbilical, currently 20 m long, to the Mobile Demonstration Laboratory for Environmental Screening Technologies (MDLEST), a completely self-contained mobile laboratory containing the instrumentation to immediately analyze the samples generated by the laser ablation.

A fiber optic cable delivers laser light to the surface of interest. This ablates a small quantity of material that is carried away in a stream of argon gas. The material enters the plasma torch where it is vaporized, atomized, ionized, and electrically excited at about 8,000 K. This produces an ionic emission spectrum that is analyzed on the atomic emission spectrometer.

The analysis instrumentation (ICP-AES/MS) in the MDLEST does not depend on radioactive decay for detection but looks directly at the atomic make up of the elements(s) of interest. A large number of metals including the longer half-life radioactive elements can be detected and quantified. The spectrometer is set up using either hardware, software, or both to simultaneously detect all elements of interest in each sample.

The MDLEST can be set up on site to monitor soil treatment processes. This function enables the remediation manager to monitor, in real time, the treatment processes removing the contaminants and ensure that satisfactory agreement with both regulatory agency and QC/QA requirements is attained.

Specificity/Sensitivity: This system measures the surface or depth concentration of atomic species, and is particularly suited to uranium and thorium analysis. It is highly effective with skilled operators. Some advantages are no contact with the soil, real time results, and no samples to dispose of. The sample results are quickly available for field remediation decisions, with the LA-ICP-AES taking about 10 minutes and LA-ICP-MS taking about 30 minutes. The detection limits for the two spectrometers that have been used are as follows:

1) The AES (atomic emission spectrometer) can see ppm levels for some 70 elements and reportedly detects uranium and thorium concentrations at 1 ppm, or 10 Bq/kg (0.3 pCi/g) for ^{238}U and 0.4 Bq/kg (0.1 pCi/g) for ^{232}Th. However, the technique is only sensitive to elements; it cannot discriminate between the different isotopes of uranium and thorium. This prevents it from being used for assessing lower Z elements that have stable isotopes, or from determining relative abundances of isotopes of any element. This may significantly limit its use at some sites.
2) The MS (mass spectrometer) can see sub-ppb levels and is capable of quantifying the uranium and thorium isotopes. This system has been used to search for ^{230}Th and ^{226}Ra and is reportedly useful in reaching 0.8 ppm or 0.6 Bq/g (15 pCi/g) for ^{230}Th content for remediated soil. It appears to measure uranium and thorium concentration of soil more sensitively than the LA-ICP-AES system.

Cost of Equipment: Very expensive, >$1M.

Cost per Measurement: When using the Atomic Emission Spectrometer, the reported cost is $4,000 per sample. When using the mass spectrometer, a dollar price was not provided.

H.3 LABORATORY INSTRUMENTS

H.3.1 Alpha Particle Analysis

System: ALPHA SPECTROSCOPY WITH MULTICHANNEL ANALYZER
Lab/Field: Lab
Radiation Detected: **Primary:** Alpha **Secondary:** None
Applicability to Site: This is a very powerful tool for accurately identifying and quantifying the activity of multiple alpha-emitting radionuclides in a sample of soil, water, air filters, etc. Methods exist for the analyses of most alpha emitting radionuclides including uranium, thorium, plutonium, polonium, and americium. Samples must first be prepared in a chemistry lab to isolate the radionuclides of interest from the environmental matrix.
Operation: This system consists of an alpha detector housed in a light-tight vacuum chamber, a bias supply, amplifier, analog-to-digital converter, multichannel analyzer, and computer. The bias is typically 25 to 100 volts. The vacuum is typically less than 10 microns (0.1 millitorr). The detector is a silicon diode that is reverse biased. Alpha particles which strike the diode create electron-hole pairs; the number of pairs is directly related to the energy of each alpha. These pairs cause a breakdown of the diode and a current pulse to flow. The charge is collected by a preamplifier and converted to a voltage pulse which is proportional to the alpha energy. It is amplified and shaped by an amplifier. The MCA stores the resultant pulses and displays a histogram of the number of counts vs. alpha energy. Since most alphas will loose all of their energy to the diode, peaks are seen on the MCA display that can be identified by specific alpha energies. Two system calibrations are necessary. A source with at least two known alpha energies is counted to correlate the voltage pulses with alpha energy. A standard source of known activity is analyzed to determine the system efficiency for detecting alphas. Since the sample and detector are in a vacuum, most commonly encountered alpha energies will be detected with approximately the same efficiency, provided there is no self-absorption in the sample. Samples are prepared in a chemistry lab. The sample is placed in solution and the element of interest (uranium, plutonium, *etc.*) separated. A tracer of known activity is added before separation to determine the overall recovery of the sample from the chemical procedures. The sample is converted to a particulate having very little mass and collected on a special filter, or it is collected from solution by electroplating onto a metal disk. It is then placed in the vacuum chamber at a fixed distance from the diode and analyzed. For environmental levels, samples are typically analyzed for 1000 minutes or more.
Specificity/Sensitivity: The system can accurately identify and quantify the various alpha emitting radioactive isotopes of each elemental species provided each has a different alpha energy that can be resolved by the system. For soils, a radionuclide can be measured below 0.004 Bq/g (0.1 pCi/g) . The system is appropriate for all alphas except those from gaseous radionuclides.
Cost of Equipment: $10,000 - $100,000 based on the number of detectors and sophistication of the computer and data reduction software. This does not include the cost of equipment for the chemistry lab.
Cost per Measurement: $250-$400 for the first element, $100-200 for each additional element per sample. The additional element cost depends on the separation chemistry involved and may not always be less. $200-$300 additional for a rush analysis.

System: GAS-FLOW PROPORTIONAL COUNTER
Lab/Field: Lab
Radiation Detected: **Primary:** Alpha, Beta **Secondary:** Gamma
Applicability to Site Surveys: This system can determine the gross alpha or gross beta activity of water, soil, air filters, or swipes. Results can indicate if nuclide-specific analysis is needed.
Operation: The system consists of a gas-flow detector, supporting electronics, and an optional guard detector for reducing background count rate. A thin window can be placed between the gas-flow detector and sample to protect the detector from contamination, or the sample can be placed directly into the detector. Systems with guard detectors operate sample and guard detectors in anticoincidence mode to reduce the background and MDC. The detector high voltage and discriminator are set to count alpha radiation, beta radiation, or both simultaneously. The alpha and beta operating voltages are determined for each system by placing an alpha source, like ^{230}Th or ^{241}Am, in the detector and increasing the high voltage incrementally until the count rate becomes constant, then repeating with a beta source, like ^{90}Sr. The alpha plateau, or region of constant count rate, should have a slope <2%/100V and be >800V long. The beta plateau should have a slope of <2.5%/100V and be >200V long. Operation on the beta plateau will also allow detection of some gamma radiation and bremsstrahlung (x-rays), but the efficiency is very low. Crosstalk between the α-to-β channels is typically around 10% while β-to-α channels should be <1%. The activity in soil samples is chemically extracted, separated if necessary, deposited in a thin layer in a planchet to minimize self absorption, and heated to dryness. Liquids are deposited and dried, while air filters and swipes are placed directly in the planchet. After each sample is placed under the detector, P-10 counting gas constantly flows through the detector. Systems with automatic sample changers can analyze tens to hundreds of planchet samples in a single run.
Specificity/Sensitivity: Natural radionuclides present in soil samples can interfere with the detection of other contaminants. Unless the nature of the contaminant and any naturally-occurring radionuclides is well known, this system is better used for screening samples. Although it is possible to use a proportional counter to roughly determine the energies of alpha and beta radiation, the normal mode of operation is to detect all alpha events or all alpha and beta events. Some systems use a discriminator to separate alpha and beta events, allowing simultaneous determination of both the alpha and beta activity in a sample. These systems do not identify the alpha or beta energies detected and cannot be used to identify specific radionuclides. The alpha channel background is very low, <0.2 cpm (<0.04 cpm guarded), depending on detector size. Typical, 4-pi, efficiencies for very thin alpha sources are 35-45% (window) and 40-50% (windowless). Efficiency depends on window thickness, particle energy, source-detector geometry, backscatter from the sample and holder, and detector size. The beta channel background ranges from 2 to 15 cpm (<0.5 cpm guarded). The 4-pi efficiency for a thin ^{90}Sr/^{90}Y source is >50% (window) to >60% (windowless), but can reduce to <5% for a thick source. MDA's for guarded gas-flow proportional counters are somewhat lower for beta emitters than for internal proportional counters because of the lower backgrounds. Analyzing a high radioactivity sample or flushing the detector with P10 gas at too high a flow rate can suspend fine particles and contaminate the detector.
Cost of Equipment: $4K-$5K (manual), $25K-$30K (automatic)
Cost per Measurement: $30 to $50 plus radiochemistry

System: LIQUID SCINTILLATION SPECTROMETER
Lab/Field: Lab (primarily), field (secondarily)
Radiation Detected: **Primary:** Alpha, beta **Secondary:** Gamma
Applicability to Site Surveys: Liquid Scintillation can be a very effective tool for measuring the concentration of radionuclides in soil, water, air filters, and swipes. Liquid scintillation has historically been applied more to beta emitters, particularly the low energy beta emitters ^{3}H and ^{14}C, but it can also apply to other radionuclides. More recently it has been used for measuring radon in air and water. Initial scoping surveys may be done (particularly for loose surface contamination) with surface swipes or air particulate filters. They may be counted directly in liquid scintillation cocktails with no paper dissolution or other sample preparation.
Operation: The liquid scintillation process involves detection of light pulses (usually in the near visible range) by photo-multiplier tubes (or conceptually similar devices). The detected light pulses originate from the re-structuring of previously excited molecular electron structures. The molecular species that first absorb and then re-admit the visible light are called "liquid scintillators" and the solutions in which they reside are called "liquid scintillation cocktails." For gross counting, samples may be placed directly into a LSC vial of cocktail, and counted with no preparation. Inaccuracies result when the sample itself absorbs the radiation before it can reach the LSC cocktail, or when the sample absorbs the light produced by the cocktail. For accurate results, these interferences are minimized. Interferences in liquid scintillation counting due to the inability of the solution to deliver the full energy pulse to the photo-multiplier detector, for a variety of reasons, are called "pulse quenching." Raw samples that cloud or color the LSC cocktail so the resulting scintillations are absorbed will "quench" the sample and result in underestimates of the activity. Such samples are first processed by ashing, radiochemical or solvent extraction, or pulverizing to place the sample in intimate contact with the LSC cocktail. Actions like bleaching the sample may also be necessary to make the cocktail solution transparent to the wavelength of light it emits. The analyst has several reliable computational or experimental procedures to account for "quenching." One is by exposing the sample and pure cocktail to an external radioactive standard and measuring the difference in response.
Specificity/Sensitivity: The method is extremely flexible and accurate when used with proper calibration and compensation for quenching effects. Energy spectra are 10 to 100 times broader than gamma spectrum photopeaks so that quantitative determination of complex multi-energy beta spectra is impossible. Sample preparation can range from none to complex chemical reactions. In some cases, liquid scintillation offers many unique advantages; no sample preparation before counting in contrast to conventional sample preparation for gas proportional counting. Recent advances in electronic stability and energy pulse shape discrimination has greatly expanded uses. Liquid scintillation counters are ideal instruments for moderate to high energy beta as well as alpha emitters, where the use of pulse shape discrimination has allowed dramatic increases in sensitivity by electronic discrimination against beta and gamma emitters. Additionally, very high energy beta emitters (above 1.5 MeV) may be counted using liquid scintillation equipment without "liquid scintillation cocktails" by use of the Cerenkov light pulse emitted as high energy charged particles move through water or similar substances.
Cost of Equipment: $20,000 to $70,000 based on the specific features and degree of automation
Cost per Measurement: $50 -200 plus cost of chemical separation, if required

System: LOW-RESOLUTION ALPHA SPECTROSCOPY
Lab/Field: Lab (Soil Samples)
Radiation Detected: **Primary:** Alpha **Secondary:**

Applicability to Site Surveys: Low-resolution alpha spectroscopy is a method for measuring alpha activity in soils with a minimum of sample preparation. Some isotopic information can be obtained.

Operation: The system consists of a 2 in. diameter silicon detector, small vacuum chamber, roughing pump, multichannel analyzer, laptop or benchtop computer, and analysis software. Soil samples are dried, milled to improve homogeneity, distributed into 2 in. planchets, loaded into the vacuum chamber, and counted. The accumulated alpha spectrum is displayed in real time. When sufficient counts have been accumulated, the spectrum is transferred to a data file and the operator inputs the known or suspected contaminant isotopes. The analysis software then fits the alpha spectrum with a set of trapezoidal peaks, one for each isotope, and outputs an estimate of the specific activity of each isotope.

Specificity/Sensitivity: This method fills the gap between gross alpha analysis and radiochemical separation/high-resolution alpha spectroscopy. Unlike gross alpha analysis, it does provide some isotopic information. Because this is a low-resolution technique, isotopes with energies closer than ~0.2 MeV cannot be separated. For example, ^{238}U (4.20 MeV) can be readily distinguished from ^{234}U (4.78 MeV), but ^{230}Th (4.69 MeV) cannot be distinguished from ^{234}U.

Because no chemical separation of isotopes is involved, only modest MDC's can be achieved. Detection limits are determined by the background alpha activity in the region of interest of the contaminant of concern, and also by the counting time. Typical MDC's are 1,500 Bq/kg (40 pCi/g) @ l5 min counting time, 260 Bq/kg (7 pCi/g) @ 8 hours, and 185 Bq/kg (5 pCi/g) @ 24 hours. The method does not generate any new waste streams and does not require a sophisticated laboratory or highly-trained personnel.

Cost of Equipment: $11,000

Cost per Measurement: $25-$100

H.3 LABORATORY INSTRUMENTS

H.3.2 Beta Particle Analysis

System: GAS-FLOW PROPORTIONAL COUNTER
Lab/Field: Lab
Radiation Detected: **Primary:** Alpha, Beta **Secondary:** Gamma
Applicability to Site Surveys: This system can determine the gross alpha or gross beta activity of water, soil, air filters, or swipes. Results can indicate if nuclide-specific analysis is needed.
Operation: The system consists of a gas-flow detector, supporting electronics, and an optional guard detector for reducing background count rate. A thin window can be placed between the gas-flow detector and sample to protect the detector from contamination, or the sample can be placed directly into the detector. Systems with guard detectors operate sample and guard detectors in anticoincidence mode to reduce the background and MDC. The detector high voltage and discriminator are set to count alpha radiation, beta radiation, or both simultaneously. The alpha and beta operating voltages are determined for each system by placing an alpha source, like ^{230}Th or ^{241}Am, in the detector and increasing the high voltage incrementally until the count rate becomes constant, then repeating with a beta source, like ^{90}Sr. The alpha plateau, or region of constant count rate, should have a slope <2%/100V and be >800V long. The beta plateau should have a slope of <2.5%/100V and be >200V long. Operation on the beta plateau will also allow detection of some gamma radiation and bremsstrahlung (x-rays), but the efficiency is very low. Crosstalk between the α-to-β channels is typically around 10% while β-to-α channels should be <1%. The activity in soil samples is chemically extracted, separated if necessary, deposited in a thin layer in a planchet to minimize self absorption, and heated to dryness. Liquids are deposited and dried, while air filters and swipes are placed directly in the planchet. After each sample is placed under the detector, P-10 counting gas constantly flows through the detector. Systems with automatic sample changers can analyze tens to hundreds of planchet samples in a single run.
Specificity/Sensitivity: Natural radionuclides present in soil samples can interfere with the detection of other contaminants. Unless the nature of the contaminant and any naturally-occurring radionuclides is well known, this system is better used for screening samples. Although it is possible to use a proportional counter to roughly determine the energies of alpha and beta radiation, the normal mode of operation is to detect all alpha events or all alpha and beta events. Some systems use a discriminator to separate alpha and beta events, allowing simultaneous determination of both the alpha and beta activity in a sample. These systems do not identify the alpha or beta energies detected and cannot be used to identify specific radionuclides. The alpha channel background is very low, <0.2 cpm (<0.04 cpm guarded), depending on detector size. Typical, 4-pi, efficiencies for very thin alpha sources are 35-45% (window) and 40-50% (windowless). Efficiency depends on window thickness, particle energy, source-detector geometry, backscatter from the sample and holder, and detector size. The beta channel background ranges from 2 to 15 cpm (<0.5 cpm guarded). The 4-pi efficiency for a thin ^{90}Sr/^{90}Y source is >50% (window) to >60% (windowless), but can reduce to <5% for a thick source. MDA's for guarded gas-flow proportional counters are somewhat lower for beta emitters than for internal proportional counters because of the lower backgrounds. Analyzing a high radioactivity sample or flushing the detector with P10 gas at too high a flow rate can suspend fine particles and contaminate the detector.
Cost of Equipment: $4K-$5K (manual), $25K-$30K (automatic)
Cost per Measurement: $30 to $50 plus radiochemistry

System: LIQUID SCINTILLATION SPECTROMETER
Lab/Field: Lab (primarily), field (secondarily)
Radiation Detected: **Primary:** Alpha, beta **Secondary:** Gamma
Applicability to Site Surveys: Liquid Scintillation can be a very effective tool for measuring the concentration of radionuclides in soil, water, air filters, and swipes. Liquid scintillation has historically been applied more to beta emitters, particularly the low energy beta emitters ^{3}H and ^{14}C, but it can also apply to other radionuclides. More recently it has been used for measuring radon in air and water. Initial scoping surveys may be done (particularly for loose surface contamination) with surface swipes or air particulate filters. They may be counted directly in liquid scintillation cocktails with no paper dissolution or other sample preparation.
Operation: The liquid scintillation process involves detection of light pulses (usually in the near visible range) by photo-multiplier tubes (or conceptually similar devices). The detected light pulses originate from the re-structuring of previously excited molecular electron structures. The molecular species that first absorb and then re-admit the visible light are called "liquid scintillators" and the solutions in which they reside are called "liquid scintillation cocktails." For gross counting, samples may be placed directly into a LSC vial of cocktail, and counted with no preparation. Inaccuracies result when the sample itself absorbs the radiation before it can reach the LSC cocktail, or when the sample absorbs the light produced by the cocktail. For accurate results, these interferences are minimized. Interferences in liquid scintillation counting due to the inability of the solution to deliver the full energy pulse to the photo-multiplier detector, for a variety of reasons, are called "pulse quenching." Raw samples that cloud or color the LSC cocktail so the resulting scintillations are absorbed will "quench" the sample and result in underestimates of the activity. Such samples are first processed by ashing, radiochemical or solvent extraction, or pulverizing to place the sample in intimate contact with the LSC cocktail. Actions like bleaching the sample may also be necessary to make the cocktail solution transparent to the wavelength of light it emits. The analyst has several reliable computational or experimental procedures to account for "quenching." One is by exposing the sample and pure cocktail to an external radioactive standard and measuring the difference in response.
Specificity/Sensitivity: The method is extremely flexible and accurate when used with proper calibration and compensation for quenching effects. Energy spectra are 10 to 100 times broader than gamma spectrum photopeaks so that quantitative determination of complex multi-energy beta spectra is impossible. Sample preparation can range from none to complex chemical reactions. In some cases, liquid scintillation offers many unique advantages such as no sample preparation before counting in contrast to conventional sample preparation for gas proportional counting. Recent advances in electronic stability and energy pulse shape discrimination has greatly expanded uses. Liquid scintillation counters are ideal instruments for moderate to high energy beta as well as alpha emitters, where the use of pulse shape discrimination has allowed dramatic increases in sensitivity by electronic discrimination against beta and gamma emitters. Additionally, very high energy beta emitters (above 1.5 MeV) may be counted using liquid scintillation equipment without "liquid scintillation cocktails" by use of the Cerenkov light pulse emitted as high energy charged particles move through water or similar substances.
Cost of Equipment: $20,000 to $70,000 based on the specific features and degree of automation
Cost per Measurement: $50 -200 plus cost of chemical separation, if required

H.3 LABORATORY INSTRUMENTS

H.3.3 Gamma Ray Analysis

System: GERMANIUM DETECTOR WITH MULTICHANNEL ANALYZER (MCA)
Lab/Field: Lab
Radiation Detected: **Primary:** Gamma **Secondary:** None
Applicability to Site: This system accurately measures the activity of gamma-emitting radionuclides in a variety of materials like soil, water, air filters, etc. with little preparation. Germanium is especially powerful in dealing with multiple radionuclides and complicated spectra.
Operation: This system consists of a germanium detector connected to a dewar of liquid nitrogen, high voltage power supply, spectroscopy grade amplifier, analog to digital converter, and a multichannel analyzer. P-type germanium detectors typically operate from +2000 to +5000 volts. N-type germanium detectors operate from -2000 to -5000 volts. Germanium is a semiconductor material. When a gamma ray interacts with a germanium crystal, it produces electron-hole pairs. An electric field is applied which causes the electrons to move in the conduction band and the holes to pass the charge from atom to neighboring atom. The charge is collected rapidly and is proportional to the deposited energy. The count rate/energy spectrum is displayed on the MCA screen with the full energy photopeaks providing more useful information than the general smear of Compton scattering events shown in between. The system is energy calibrated using isotopes that emit at least two known gamma ray energies, so the MCA data channels are given an energy equivalence. The MCA's display then becomes a display of intensity versus energy. Efficiency calibration is performed using known concentrations of mixed isotopes. A curve of gamma ray energy versus counting efficiency is generated, and it shows that P-type germanium is most sensitive at 120 keV and trails off to either side. Since the counting efficiency depends on the distance from the sample to the detector, each geometry must be given a separate efficiency calibration curve. From that point the center of each gaussian-shaped peak tells the gamma ray energy that produced it, the combination of peaks identifies each isotope, and the area under selected peaks is a measure of the amount of that isotope in the sample. Samples are placed in containers and tare weighed. Plastic petri dishes sit atop the detector and are useful for small volumes or low energies, while Marinelli beakers fit around the detector and provide exceptional counting efficiency for volume samples. Counting times of 1000 seconds to 1000 minutes are typical. Each peak is identified manually or by gamma spectrometry analysis software. The counts in each peak or energy band, the sample weight, the efficiency calibration curve, and the isotope's decay scheme are factored together to give the sample concentration.
Specificity/Sensitivity: The system accurately identifies and quantifies the concentrations of multiple gamma-emitting radionuclides in samples like soil, water, and air filters with minimum preparation. A P-type detector is good for energies over 50 keV. An N-type or P-type planar (thin crystal) detector with beryllium-end window is good for 5-80 keV energies using a thinner sample placed over the window.
Cost of Equipment: $35,000 to $150,000 based on detector efficiency and sophistication of MCA/computer/software system
Cost per Measurement: $ 100 to $200 (rush requests can double or triple costs)

System: SODIUM IODIDE DETECTOR WITH MULTICHANNEL ANALYZER
Lab/Field: Lab
Radiation Detected: **Primary:** Gamma **Secondary:** None
Applicability to Site Surveys: This system accurately measures the activity of gamma-emitting radionuclides in a variety of materials like soil, water, air filters, etc. with little preparation. Sodium iodide is inherently more efficient for detecting gamma rays but has lower resolution than germanium, particularly if multiple radionuclides and complicated spectra are involved.
Operation: This system consists of a sodium iodide detector, a high voltage power supply, an amplifier, an analog to digital converter, and a multichannel analyzer. The detector is a sodium iodide crystal connected to a photomultiplier tube (PMT). Crystal shapes can vary extensively and typical detector high voltage are 900-1,000 V. Sodium iodide is a scintillation material. A gamma ray interacting with a sodium iodide crystal produces light which is passed to the PMT. This light ejects electrons which the PMT multiplies into a pulse that is proportional to the energy the gamma ray imparted to the crystal. The MCA assesses the pulse size and places a count in the corresponding channel. The count rate and energy spectrum is displayed on the MCA screen with the full energy photopeaks providing more useful information than the general smear of Compton scattering events shown in between. The system is energy calibrated using isotopes that emit at least two gamma ray energies, so the MCA data channels are given an energy equivalence. The MCA's CRT then becomes a display of intensity versus energy. A non-linear energy response and lower resolution make isotopic identification less precise than with a germanium detector. Efficiency calibration is performed using known concentrations of single or mixed isotopes. The single isotope method develops a count rate to activity factor. The mixed isotope method produces a gamma ray energy versus counting efficiency curve that shows that sodium iodide is most sensitive around 100-120 keV and trails off to either side. Counting efficiency is a function of sample to detector distance, so each geometry must have a separate efficiency calibration curve. The center of each peak tells the gamma ray energy that produced it and the combination of peaks identifies each isotope. Although the area under a peak relates to that isotope's activity in the sample, integrating a band of channels often provides better sensitivity. Samples are placed in containers and tare weighed. Plastic petri dishes sit atop the detector and are useful for small volumes or low energies, while Marinelli beakers fit around the detector and provide exceptional counting efficiency for volume samples. Counting times of 60 seconds to 1,000 minutes are typical. The CRT display is scanned and each peak is identified by isotope. The counts in each peak or energy band, the sample weight, the efficiency calibration curve, and the isotope's decay scheme are factored together to give the sample concentration.
Specificity/Sensitivity: This system analyzes gamma-emitting isotopes with minimum preparation, better efficiency, but lower resolution compared to most germanium detectors. Germanium detectors do reach efficiencies of 150% compared with a 3 in. by 3 in. sodium iodide detector, but the cost is around $100,000 each compared with $3,000. Sodium iodide measures energies over 80 keV. The instrument response is energy dependent, the resolution is not superb, and the energy calibration is not totally linear, so care should be taken when identifying or quantifying multiple isotopes. Computer software can help interpret complicated spectra. Sodium iodide is fragile and should be protected from shock and sudden temperature changes.
Cost of Equipment: $6K-$20K
Cost per Measurement: $100-$200 per sample.

EQUIPMENT SUMMARY TABLES

Table H.1 - Radiation Detectors with Applications to Alpha Surveys

Table H.2 - Radiation Detectors with Applications to Beta Surveys

Table H.3 - Radiation Detectors with Applications to Gamma Surveys

Table H.4 - Radiation Detectors with Applications to Radon Surveys

Table H.5 - Systems that Measure Atomic Mass or Emissions

Table H.1 Radiation Detectors with Applications to Alpha Surveys

System	Description	Application	Remarks	Equipment Cost	Measurement Cost
Alpha spectroscopy	A system using silicon diode surface barrier detectors for alpha energy identification and quantification	Accurately identifies and measures the activity of multiple alpha radionuclides in a thin extracted sample of soil, water, or air filters.	Sample requires radiochemical separation or other preparation before counting	$10K-$100K	$250-$400
Alpha scintillation survey meter	<1 mg/cm^2 window, probe face area 50 to 100 cm^2.	Field measurement of presence or absence of alpha contamination on nonporous surfaces, swipes, and air filters, or on irregular surfaces if the degree of surface shielding is known.	Minimum sensitivity is 10 cpm, or 1 cpm with headphones	$1000	$5
Alpha Track Detector	Polycarbonate plastic sheet is placed in contact with a contaminated surface and kept in place	Measures gross alpha surface contamination, soil activity level, or the depth profile of contamination	Alpha radiation produces holes that are enlarged chemically. Density of holes gives a measure of the radioactivity level.		$5-$25
Electret ion chamber	A charged Teflon disk in an open-faced ion chamber	Measures alpha or beta contamination on surfaces and in soils, plus gamma radiation dose or radon concentration	The type of radiation is determined by how the electret is employed, *e.g.*, the unit is kept closed and bagged in plastic to measure gammas	$4,000-$5,000	$8-$25
Long range alpha detector (LRAD)	1m x 1m detector measures ionization inside the box. Attached to tractor for movement. Has location finder and plots graph of contamination.	Measures surface contamination or soil concentration at grid points and plots curves of constant contamination. Intended for large areas.	Alpha detection limit is 20-50 dpm/100 cm^2 or 0.4 Bq/g (10 pCi/g).	$25,000	$80

Table H.1 Radiation Detectors with Applications to Alpha Surveys

System	Description	Application	Remarks	Equipment Cost	Measurement Cost
Gas-flow proportional counter (field)	A detector through which P10 gas flows and which measures alpha and beta radiation. < 1-10 mg/cm^2 window, probe face area 50 to 100 cm^2 for hand held detectors; up to 600 cm^2 if cart mounted	Surface scanning, surface activity measurement, or field evaluation of swipes. Serves as a screen to determine if more nuclide-specific analyses are needed.	Natural radionuclides in samples can interfere with the detection of other contaminants. Requires P10 gas	$2K-$4K	$2-$10/m^2
Gas-flow proportional counter (lab)	Windowless (internal proportional) or window <0.1 mg/cm^2, probe face area 10 to 20 cm^2. May have a second or guard detector to reduce background and MDA.	Laboratory measurement of water, air, and swipe samples	Requires P10 gas. Windowless detectors can be contaminated.	$4K-$30K	$50
Liquid scintillation counter (LSC)	Samples are mixed with LSC cocktail and the radiation emitted causes light pulses with proportional intensity.	Laboratory analysis of alpha or beta emitters, including spectrometry capabilities.	Highly selective for alpha or beta radiation by pulse shape discrimination. Requires LSC cocktail.	$20K-$70K	$50-$200

Table H.2 Radiation Detectors with Applications to Beta Surveys

System	Description	Application	Remarks	Equipment Cost	Measurement Cost
GM survey meter with beta pancake probe	Thin 1.4 mg/cm^2 window detector, probe area 10 to 100 cm^2	Surface scanning of personnel, working areas, equipment, and swipes for beta contamination. Laboratory measurement of swipes when connected to a scaler.	Relatively high detection limit making it of limited value in final status surveys.	$400-$1,500	$5-$10
Gas-flow proportional counter (field)	A detector through which P10 gas flows and which measures alpha and beta radiation. < 1-10 mg/cm^2 window, probe face area 50 to 100 cm^2	Surface scanning, surface activity measurement, or field evaluation of swipes. Serves as a screen to determine if more nuclide-specific analyses are needed.	Natural radionuclides in samples can interfere with the detection of other contaminants. Requires P10 gas, but can be disconnected for hours.	$2K-$4K	$2-$10/m^2
Gas-flow proportional counter (lab)	Windowless (internal proportional) or window <0.1 mg/cm^2, probe face area 10 to 20 cm^2. May have a second or guard detector to reduce background and MDA.	Laboratory measurement of water, air, and swipe samples	Requires P10 gas. Windowless detectors can be contaminated.	$4K-$30K	$50
Liquid scintillation counter (LSC)	Samples are mixed with LSC cocktail and the radiation emitted causes light pulses with proportional intensity.	Laboratory analysis of alpha and beta emitters, including spectrometry capabilities.	Highly selective for alpha and beta radiation by pulse shape discrimination. Requires LSC cocktail.	$20K-$70K	$100-$200

Table H.3 Radiation Detectors with Applications to Gamma and X-Ray Surveys

System	Description	Application	Remarks	Cost of Equipment	Cost per Measurement
GM survey meter with gamma probe	Thick-walled 30 mg/cm^2 detector	Measure radiation levels above 0.1 mR/hr.	Its non-linear energy response can be corrected by using an energy compensated probe.	$400-$1,000	$5
Pressurized ion chamber (PIC)	A highly accurate ionization chamber that is rugged and stable.	Excellent for measuring gamma exposure rate during site remediation.	Is used in conjunction with radionuclide identification equipment.	$15K - $50K	$50 - $500
Electret ion chamber	Electrostatically charged disk inside an ion chamber	Gamma exposure rate	N/A, rented	included in rental price	$8 - $25
Hand-held ion chamber survey meter	Ion chamber for measuring higher radiation levels than typical background.	Measures true gamma exposure rate.	Not very useful for site surveys because of high detection limit above background levels.	$800-$1,200	$5
Hand-held pressurized ion chamber survey meter	Ion chamber for measuring higher radiation levels than typical background.	Measures true gamma exposure rate with more sensitivity than the unpressurized ion chamber.	Not very useful for site surveys because of high detection limit above background levels.	$1,000-$1,500	$5
Sodium Iodide survey meter	Detectors sizes up to 8"x8". Used in micro R-meter in smaller sizes.	Measures low levels of environmental radiation.	Its energy response is not linear, so it should be calibrated for the energy field it will measure or have calibration factors developed by comparison with a PIC for a specific site.	$2K	$5
FIDLER (Field Instrument for Detection of Low Energy Radiation)	Thin crystals of NaI or CsI.	Scanning of gamma/X radiation from plutonium and americium.		$6K-$7K	$10-$20

Table H.3 Radiation Detectors with Applications to Gamma and X-Ray Surveys

System	Description	Application	Remarks	Cost of Equipment	Cost per Measurement
Sodium iodide detector with multichannel analyzer (MCA)	Sodium iodide crystal with a large range of sizes and shapes, connected to a photomultiplier tube and MCA.	Laboratory gamma spectroscopy to determine the identity and concentration of gamma emitting radionuclides in a sample.	Sensitive for surface soil or groundwater contamination. Analysis programs have difficulty if sample contains more than a few isotopes.	$6K-$20K	$100 to $200
Germanium detector with multichannel analyzer (MCA)	Intrinsic germanium semiconductor in p- or n-type configuration and without a beryllium window.	Laboratory gamma spectroscopy to determine the identity and concentration of gamma emitting radionuclides in a sample.	Very sensitive for surface soil or groundwater contamination. Is especially powerful when more than one radionuclide is present in a sample.	$35K-$150K	$100 to $200
Portable Germanium Multichannel Analyzer (MCA) System	A portable version of a laboratory based germanium detector and multichannel analyzer.	Excellent during characterization through final status survey to identify and quantify the concentration of gamma ray emitting radionuclides and in situ concentrations of soil and other media	Requires a supply of liquid nitrogen or a mechanical cooling system, as well as highly trained operators.	$40K	$100
Field x-ray fluorescence spectrometer	Uses silicon or germanium semiconductor	Determining fractional abundance of low percentage metal atoms.		$15K-$75K	$200
Thermoluminescence dosimeters (TLDs)	Crystals that are sensitive to gamma radiation	Measure cumulative radiation dose over a period of days to months.	Requires special calibration to achieve high accuracy and reproducibility of results.	$5K-$50K for reader + $25-$40 per TLD	$25-$125

Table H.4 Radiation Detectors with Applications to Radon Surveys

System	Description	Application	Remarks	Equipment Cost	Measurement Cost
Large area activated charcoal collector	A canister containing activated charcoal is twisted into the surface and left for 24 hours.	Short term radon flux measurements	The LLD is 0.007 Bq $m^{-2}s^{-1}$ (0.2 pCi $m^{-2}s^{-1}$).	N/A, rented	$20-$50 including canister
Continuous radon monitor	Air pump and scintillation cell or ionization chamber	Track the real time concentration of radon	Takes 1 to 4 hours for system to equilibrate before starting. The LLD is 0.004-0.04 Bq/L (0.1-1.0 pCi/L).	$1K-$5K	$80
Activated charcoal adsorption	Activated charcoal is opened to the ambient air, then gamma counted on a gamma scintillator or in a liquid scintillation counter.	Measure radon concentration in indoor air	Detector is deployed for 2 to 7 days. The LLD is 0.007-0.04 Bq/L (0.2 to 1.0 pCi/L).	$10K-$30K	$5-$30 including canister if outsourced.
Electret ion chamber	This is a charged plastic vessel that can be opened for air to pass into.	Measure short-term or long-term radon concentration in indoor air.	Must correct reading for gamma background concentration. Electret is sensitive to extremes of temperature and humidity. LLD is 0.007-0.02 Bq/L (0.2-0.5 pCi/L).	N/A, rented	$8-$25 for rental
Alpha track detection	A small piece of special plastic or film inside a small container. Damage tracks from alpha particles are chemically etched and tracks counted.	Measure indoor or outdoor radon concentration in air.	LLD is 0.04 Bq $L^{-1}d^{-1}$ (1 pCi $L^{-1}d^{-1}$).		$5-$25

Table H.5 Systems that Measure Atomic Mass or Emissions

System	Description	Application	Remarks	Cost of Equipment	Cost per Measurement
LA-ICP-AES (Laser Ablation Inductively Coupled Plasma Atomic Emissions Spectrometer)	Vaporizes and ionizes the surface material, and measures emissions from the resulting atoms.	Live time analysis of radioactive U and Th contamination in the field.	Requires expensive equipment and skilled operators. LLD is 0.004 Bq/g (0.1 pCi/g) for ^{232}Th and 0.01 Bq/g (0.3 pCi/g) for ^{238}U.	>$1,000,000	$4,000
LA-ICP-MS (Laser Ablation Inductively Coupled Plasma Mass Spectrometer)	Vaporizes and ionizes the surface material, then measures the mass of the resulting atoms.	Live time analysis of radioactive U and Th contamination in the field.	Requires expensive equipment and skilled operators. More sensitive than LA-ICP-AES. LLD is 0.6 Bq/g (15 pCi/g) for ^{230}Th.	>$1,000,000	>$4,000
Chemical speciation laser ablation/mass spectrometer	A laser changes the sample into an aerosol that it analyzed with a mass spectrometer.	Analyze organic and inorganic species with high sensitivity and specificity.	Volatilized samples can be carried hundreds of feet to the analysis area.	>$1,000,000	>$4,000

APPENDIX I

STATISTICAL TABLES AND PROCEDURES

I.1 Normal Distribution

Table I.1 Cumulative Normal Distribution Function Φ(z)

z	*0.00*	*0.01*	*0.02*	*0.03*	*0.04*	*0.05*	*0.06*	*0.07*	*0.08*	*0.09*
0.00	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.10	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5674	0.5714	0.5753
0.20	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.30	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.40	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.50	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.60	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.70	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.80	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.90	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.6315	0.8340	0.8365	0.8389
1.00	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.10	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.20	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.30	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.40	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.50	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.60	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.70	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.80	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.90	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.00	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.10	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.20	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.30	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.40	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.50	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.60	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.70	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.80	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.90	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.00	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.10	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.20	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.30	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.40	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

Negative values of z can be obtained from the relationship $\Phi(-z) = 1 - \Phi(z)$.

I.2 Sample Sizes for Statistical Tests

Table I.2a Sample Sizes for Sign Test

(Number of measurements to be performed in each survey unit)

	(α,β) **or** (β,α)														
Δ/σ	**0.01 0.01**	**0.01 0.025**	**0.01 0.05**	**0.01 0.1**	**0.01 0.25**	**0.025 0.025**	**0.025 0.05**	**0.025 0.1**	**0.025 0.25**	**0.05 0.05**	**0.05 0.1**	**0.05 0.25**	**0.1 0.1**	**0.1 0.25**	**0.25 0.25**
0.1	4095	3476	2984	2463	1704	2907	2459	1989	1313	2048	1620	1018	1244	725	345
0.2	1035	879	754	623	431	735	622	503	333	518	410	258	315	184	88
0.3	468	398	341	282	195	333	281	227	150	234	185	117	143	83	40
0.4	270	230	197	162	113	192	162	131	87	136	107	68	82	48	23
0.5	178	152	130	107	75	126	107	87	58	89	71	45	54	33	16
0.6	129	110	94	77	54	92	77	63	42	65	52	33	40	23	11
0.7	99	83	72	59	41	70	59	48	33	50	40	26	30	18	9
0.8	80	68	58	48	34	57	48	39	26	40	32	21	24	15	8
0.9	66	57	48	40	28	47	40	33	22	34	27	17	21	12	6
1.0	57	48	41	34	24	40	34	28	18	29	23	15	18	11	5
1.1	50	42	36	30	21	35	30	24	17	26	21	14	16	10	5
1.2	45	38	33	27	20	32	27	22	15	23	18	12	15	9	5
1.3	41	35	30	26	17	29	24	21	14	21	17	11	14	8	4
1.4	38	33	28	23	16	27	23	18	12	20	16	10	12	8	4
1.5	35	30	27	22	15	26	22	17	12	18	15	10	11	8	4
1.6	34	29	24	21	15	24	21	17	11	17	14	9	11	6	4
1.7	33	28	24	20	14	23	20	16	11	17	14	9	10	6	4
1.8	32	27	23	20	14	22	20	16	11	16	12	9	10	6	4
1.9	30	26	22	18	14	22	18	15	10	16	12	9	10	6	4
2.0	29	26	22	18	12	21	18	15	10	15	12	8	10	6	3
2.5	28	23	21	17	12	20	17	14	10	15	11	8	9	5	3
3.0	27	23	20	17	12	20	17	14	9	14	11	8	9	5	3

Table I.2b Sample Sizes for Wilcoxon Rank Sum Test

(Number of measurements to be performed in the reference area and in each survey unit)

(α,β) **or** (β,α)

Δ/σ	0.01 0.01	0.01 0.025	0.01 0.05	0.01 0.1	0.01 0.25	0.025 0.025	0.025 0.05	0.025 0.1	0.025 0.25	0.05 0.05	0.05 0.1	0.05 0.25	0.1 0.1	0.1 0.25	0.25 0.25
0.1	5452	4627	3972	3278	2268	3870	3273	2646	1748	2726	2157	1355	1655	964	459
0.2	1370	1163	998	824	570	973	823	665	440	685	542	341	416	243	116
0.3	614	521	448	370	256	436	369	298	197	307	243	153	187	109	52
0.4	350	297	255	211	146	248	210	170	112	175	139	87	106	62	30
0.5	227	193	166	137	95	162	137	111	73	114	90	57	69	41	20
0.6	161	137	117	97	67	114	97	78	52	81	64	40	49	29	14
0.7	121	103	88	73	51	86	73	59	39	61	48	30	37	22	11
0.8	95	81	69	57	40	68	57	46	31	48	38	24	29	17	8
0.9	77	66	56	47	32	55	46	38	25	39	31	20	24	14	7
1.0	64	55	47	39	27	46	39	32	21	32	26	16	20	12	6
1.1	55	47	40	33	23	39	33	27	18	28	22	14	17	10	5
1.2	48	41	35	29	20	34	29	24	16	24	19	12	15	9	4
1.3	43	36	31	26	18	30	26	21	14	22	17	11	13	8	4
1.4	38	32	28	23	16	27	23	19	13	19	15	10	12	7	4
1.5	35	30	25	21	15	25	21	17	11	18	14	9	11	7	3
1.6	32	27	23	19	14	23	19	16	11	16	13	8	10	6	3
1.7	30	25	22	18	13	21	18	15	10	15	12	8	9	6	3
1.8	28	24	20	17	12	20	17	14	9	14	11	7	9	5	3
1.9	26	22	19	16	11	19	16	13	9	13	11	7	8	5	3
2.0	25	21	18	15	11	18	15	12	8	13	10	7	8	5	3
2.25	22	19	16	14	10	16	14	11	8	11	9	6	7	4	2
2.5	21	18	15	13	9	15	13	10	7	11	9	6	7	4	2
2.75	20	17	15	12	9	14	12	10	7	10	8	5	6	4	2
3.0	19	16	14	12	8	14	12	10	6	10	8	5	6	4	2
3.5	18	16	13	11	8	13	11	9	6	9	8	5	6	4	2
4.0	18	15	13	11	8	13	11	9	6	9	7	5	6	4	2

I.3 Critical Values for the SignTest

Table I.3 Critical Values for the Sign Test Statistic S+

	Alpha								
N	***0.005***	***0.01***	***0.025***	***0.05***	***0.1***	***0.2***	***0.3***	***0.4***	***0.5***
4	4	4	4	4	3	3	3	2	2
5	5	5	5	4	4	3	3	3	2
6	6	6	5	5	5	4	4	3	3
7	7	6	6	6	5	5	4	4	3
8	7	7	7	6	6	5	5	4	4
9	8	8	7	7	6	6	5	5	4
10	9	9	8	8	7	6	6	5	5
11	10	9	9	8	8	7	6	6	5
12	10	10	9	9	8	7	7	6	6
13	11	11	10	9	9	8	7	7	6
14	12	11	11	10	9	9	8	7	7
15	12	12	11	11	10	9	9	8	7
16	13	13	12	11	11	10	9	9	8
17	14	13	12	12	11	10	10	9	8
18	14	14	13	12	12	11	10	10	9
19	15	14	14	13	12	11	11	10	9
20	16	15	14	14	13	12	11	11	10
21	16	16	15	14	13	12	12	11	10
22	17	16	16	15	14	13	12	12	11
23	18	17	16	15	15	14	13	12	11
24	18	18	17	16	15	14	13	13	12
25	19	18	17	17	16	15	14	13	12
26	19	19	18	17	16	15	14	14	13
27	20	19	19	18	17	16	15	14	13
28	21	20	19	18	17	16	15	15	14
29	21	21	20	19	18	17	16	15	14
30	22	21	20	19	19	17	16	16	15

Table I.3 Critical Values for the Sign Test Statistic S+ (continued)

	Alpha								
N	***0.005***	***0.01***	***0.025***	***0.05***	***0.1***	***0.2***	***0.3***	***0.4***	***0.5***
31	23	22	21	20	19	18	17	16	15
32	23	23	22	21	20	18	17	17	16
33	24	23	22	21	20	19	18	17	16
34	24	24	23	22	21	19	19	18	17
35	25	24	23	22	21	20	19	18	17
36	26	25	24	23	22	21	20	19	18
37	26	26	24	23	22	21	20	19	18
38	27	26	25	24	23	22	21	20	19
39	27	27	26	25	23	22	21	20	19
40	28	27	26	25	24	23	22	21	20
41	29	28	27	26	25	23	22	21	20
42	29	28	27	26	25	24	23	22	21
43	30	29	28	27	26	24	23	22	21
44	30	30	28	27	26	25	24	23	22
45	31	30	29	28	27	25	24	23	22
46	32	31	30	29	27	26	25	24	23
47	32	31	30	29	28	26	25	24	23
48	33	32	31	30	28	27	26	25	24
49	33	33	31	30	29	27	26	25	24
50	34	33	32	31	30	28	27	26	25

For N greater than 50, the table (critical) value can be calculated from:

$$\frac{N}{2} + \frac{z}{2}\sqrt{N}$$

z is the (1-α) percentile of a standard normal distribution, which can be found on page I-10 or on page 5-28 in Table 5.2.

I.4 Critical Values for the WRS Test

Table I.4 Critical Values for the WRS test

m is the number of reference area samples and n is the number of survey unit samples.

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 2	α=0.001	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43
	α=0.005	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	40	42
	α=0.01	7	9	11	13	15	17	19	21	23	25	27	28	30	32	34	36	38	39	41
	α=0.025	7	9	11	13	15	17	18	20	22	23	25	27	29	31	33	34	36	38	40
	α=0.05	7	9	11	12	14	16	17	19	21	23	24	26	27	29	31	33	34	36	38
	α=0.1	7	8	10	11	13	15	16	18	19	21	22	24	26	27	29	30	32	33	35

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 3	α=0.001	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	56	59	62	65
	α=0.005	12	15	18	21	24	27	30	32	35	38	40	43	46	48	51	54	57	59	62
	α=0.01	12	15	18	21	24	26	29	31	34	37	39	42	45	47	50	52	55	58	60
	α=0.025	12	15	18	20	22	25	27	30	32	35	37	40	42	45	47	50	52	55	57
	α=0.05	12	14	17	19	21	24	26	28	31	33	36	38	40	43	45	47	50	52	54
	α=0.1	11	13	16	18	20	22	24	27	29	31	33	35	37	40	42	44	46	48	50

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 4	α=0.001	18	22	26	30	34	38	42	46	49	53	57	60	64	68	71	75	78	82	86
	α=0.005	18	22	26	30	33	37	40	44	47	51	54	58	61	64	68	71	75	78	81
	α=0.01	18	22	26	29	32	36	39	42	46	49	52	56	59	62	66	69	72	76	79
	α=0.025	18	22	25	28	31	34	37	41	44	47	50	53	56	59	62	66	69	72	75
	α=0.05	18	21	24	27	30	33	36	39	42	45	48	51	54	57	59	62	65	68	71
	α=0.1	17	20	22	25	28	31	34	36	39	42	45	48	50	53	56	59	61	64	67

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 5	α=0.001	25	30	35	40	45	50	54	58	63	67	72	76	81	85	89	94	98	102	107
	α=0.005	25	30	35	39	43	48	52	56	60	64	68	72	77	81	85	89	93	97	101
	α=0.01	25	30	34	38	42	46	50	54	58	62	66	70	74	78	82	86	90	94	98
	α=0.025	25	29	33	37	41	44	48	52	56	60	63	67	71	75	79	82	86	90	94
	α=0.05	24	28	32	35	39	43	46	50	53	57	61	64	68	71	75	79	82	86	89
	α=0.1	23	27	30	34	37	41	44	47	51	54	57	61	64	67	71	74	77	81	84

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 6	α=0.001	33	39	45	51	57	63	67	72	77	82	88	93	98	103	108	113	118	123	128
	α=0.005	33	39	44	49	54	59	64	69	74	79	83	88	93	98	103	107	112	117	122
	α=0.01	33	39	43	48	53	58	62	67	72	77	81	86	91	95	100	104	109	114	118
	α=0.025	33	37	42	47	51	56	60	64	69	73	78	82	87	91	95	100	104	109	113
	α=0.05	32	36	41	45	49	54	58	62	66	70	75	79	83	87	91	96	100	104	108
	α=0.1	31	35	39	43	47	51	55	59	63	67	71	75	79	83	87	91	94	98	102

Table I.4 Critical Values for the WRS Test (continued)

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 7	α=0.001	42	49	56	63	69	75	81	87	92	98	104	110	116	122	128	133	139	145	151
	α=0.005	42	49	55	61	66	72	77	83	88	94	99	105	110	116	121	127	132	138	143
	α=0.01	42	48	54	59	65	70	76	81	86	92	97	102	108	113	118	123	129	134	139
	α=0.025	42	47	52	57	63	68	73	78	83	88	93	98	103	108	113	118	123	128	133
	α=0.05	41	46	51	56	61	65	70	75	80	85	90	94	99	104	109	113	118	123	128
	α=0.1	40	44	49	54	58	63	67	72	76	81	85	90	94	99	103	108	112	117	121

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 8	α=0.001	52	60	68	75	82	89	95	102	109	115	122	128	135	141	148	154	161	167	174
	α=0.005	52	60	66	73	79	85	92	98	104	110	116	122	129	135	141	147	153	159	165
	α=0.01	52	59	65	71	77	84	90	96	102	108	114	120	125	131	137	143	149	155	161
	α=0.025	51	57	63	69	75	81	86	92	98	104	109	115	121	126	132	137	143	149	154
	α=0.05	50	56	62	67	73	78	84	89	95	100	105	111	116	122	127	132	138	143	148
	α=0.1	49	54	60	65	70	75	80	85	91	96	101	106	111	116	121	126	131	136	141

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 9	α=0.001	63	72	81	88	96	104	111	118	126	133	140	147	155	162	169	176	183	190	198
	α=0.005	63	71	79	86	93	100	107	114	121	127	134	141	148	155	161	168	175	182	188
	α=0.01	63	70	77	84	91	98	105	111	118	125	131	138	144	151	157	164	170	177	184
	α=0.025	62	69	76	82	88	95	101	108	114	120	126	133	139	145	151	158	164	170	176
	α=0.05	61	67	74	80	86	92	98	104	110	116	122	128	134	140	146	152	158	164	170
	α=0.1	60	66	71	77	83	89	94	100	106	112	117	123	129	134	140	145	151	157	162

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 10	α=0.001	75	85	94	103	111	119	128	136	144	152	160	167	175	183	191	199	207	215	222
	α=0.005	75	84	92	100	108	115	123	131	138	146	153	160	168	175	183	190	197	205	212
	α=0.01	75	83	91	98	106	113	121	128	135	142	150	157	164	171	178	186	193	200	207
	α=0.025	74	81	89	96	103	110	117	124	131	138	145	151	158	165	172	179	186	192	199
	α=0.05	73	80	87	93	100	107	114	120	127	133	140	147	153	160	166	173	179	186	192
	α=0.1	71	78	84	91	97	103	110	116	122	128	135	141	147	153	160	166	172	178	184

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 11	α=0.001	88	99	109	118	127	136	145	154	163	171	180	188	197	206	214	223	231	240	248
	α=0.005	88	98	107	115	124	132	140	148	157	165	173	181	189	197	205	213	221	229	237
	α=0.01	88	97	105	113	122	130	138	146	153	161	169	177	185	193	200	208	216	224	232
	α=0.025	87	95	103	111	118	126	134	141	149	156	164	171	179	186	194	201	208	216	223
	α=0.05	86	93	101	108	115	123	130	137	144	152	159	166	173	180	187	195	202	209	216
	α=0.1	84	91	98	105	112	119	126	133	139	146	153	160	167	173	180	187	194	201	207

Table I.4 Critical Values for the WRS Test (continued)

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 12	α=0.001	102	114	125	135	145	154	164	173	183	192	202	210	220	230	238	247	256	266	275
	α=0.005	102	112	122	131	140	149	158	167	176	185	194	202	211	220	228	237	246	254	263
	α=0.01	102	111	120	129	138	147	156	164	173	181	190	198	207	215	223	232	240	249	257
	α=0.025	100	109	118	126	135	143	151	159	168	176	184	192	200	208	216	224	232	240	248
	α=0.05	99	108	116	124	132	140	147	155	165	171	179	186	194	202	209	217	225	233	240
	α=0.1	97	105	113	120	128	135	143	150	158	165	172	180	187	194	202	209	216	224	231

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 13	α=0.001	117	130	141	152	163	173	183	193	203	213	223	233	243	253	263	273	282	292	302
	α=0.005	117	128	139	148	158	168	177	187	196	206	215	225	234	243	253	262	271	280	290
	α=0.01	116	127	137	146	156	165	174	184	193	202	211	220	229	238	247	256	265	274	283
	α=0.025	115	125	134	143	152	161	170	179	187	196	205	214	222	231	239	248	257	265	274
	α=0.05	114	123	132	140	149	157	166	174	183	191	199	208	216	224	233	241	249	257	266
	α=0.1	112	120	129	137	145	153	161	169	177	185	193	201	209	217	224	232	240	248	256

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 14	α=0.001	133	147	159	171	182	193	204	215	225	236	247	257	268	278	289	299	310	320	330
	α=0.005	133	145	156	167	177	187	198	208	218	228	238	248	258	268	278	288	298	307	317
	α=0.01	132	144	154	164	175	185	194	204	214	224	234	243	253	263	272	282	291	301	311
	α=0.025	131	141	151	161	171	180	190	199	208	218	227	236	245	255	264	273	282	292	301
	α=0.05	129	139	149	158	167	176	185	194	203	212	221	230	239	248	257	265	274	283	292
	α=0.1	128	136	145	154	163	171	180	189	197	206	214	223	231	240	248	257	265	273	282

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 15	α=0.001	150	165	178	190	202	212	225	237	248	260	271	282	293	304	316	327	338	349	360
	α=0.005	150	162	174	186	197	208	219	230	240	251	262	272	283	293	304	314	325	335	346
	α=0.01	149	161	172	183	194	205	215	226	236	247	257	267	278	288	298	308	319	329	339
	α=0.025	148	159	169	180	190	200	210	220	230	240	250	260	270	280	289	299	309	319	329
	α=0.05	146	157	167	176	186	196	206	215	225	234	244	253	263	272	282	291	301	310	319
	α=0.1	144	154	163	172	182	191	200	209	218	227	236	246	255	264	273	282	291	300	309

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 16	α=0.001	168	184	197	210	223	236	248	260	272	284	296	308	320	332	343	355	367	379	390
	α=0.005	168	181	194	206	218	229	241	252	264	275	286	298	309	320	331	342	353	365	376
	α=0.01	167	180	192	203	215	226	237	248	259	270	281	292	303	314	325	336	347	357	368
	α=0.025	166	177	188	200	210	221	232	242	253	264	274	284	295	305	316	326	337	347	357
	α=0.05	164	175	185	196	206	217	227	237	247	257	267	278	288	298	308	318	328	338	348
	α=0.1	162	172	182	192	202	211	221	231	241	250	260	269	279	289	298	308	317	327	336

Table I.4 Critical Values for the WRS Test (continued)

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 17	α=0.001	187	203	218	232	245	258	271	284	297	310	322	335	347	360	372	384	397	409	422
	α=0.005	187	201	214	227	239	252	264	276	288	300	312	324	336	347	359	371	383	394	406
	α=0.01	186	199	212	224	236	248	260	272	284	295	307	318	330	341	353	364	376	387	399
	α=0.025	184	197	209	220	232	243	254	266	277	288	299	310	321	332	343	354	365	376	387
	α=0.05	183	194	205	217	228	238	249	260	271	282	292	303	313	324	335	345	356	366	377
	α=0.1	180	191	202	212	223	233	243	253	264	274	284	294	305	315	325	335	345	355	365

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 18	α=0.001	207	224	239	254	268	282	296	309	323	336	349	362	376	389	402	415	428	441	454
	α=0.005	207	222	236	249	262	275	288	301	313	326	339	351	364	376	388	401	413	425	438
	α=0.01	206	220	233	246	259	272	284	296	309	321	333	345	357	370	382	394	406	418	430
	α=0.025	204	217	230	242	254	266	278	290	302	313	325	337	348	360	372	383	395	406	418
	α=0.05	202	215	226	238	250	261	273	284	295	307	318	329	340	352	363	374	385	396	407
	α=0.1	200	211	222	233	244	255	266	277	288	299	309	320	331	342	352	363	374	384	395

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 19	α=0.001	228	246	262	277	292	307	321	335	350	364	377	391	405	419	433	446	460	473	487
	α=0.005	227	243	258	272	286	300	313	327	340	353	366	379	392	405	419	431	444	457	470
	α=0.01	226	242	256	269	283	296	309	322	335	348	361	373	386	399	411	424	437	449	462
	α=0.025	225	239	252	265	278	290	303	315	327	340	352	364	377	389	401	413	425	437	450
	α=0.05	223	236	248	261	273	285	297	309	321	333	345	356	368	380	392	403	415	427	439
	α=0.1	220	232	244	256	267	279	290	302	313	325	336	347	358	370	381	392	403	415	426

	n =	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
m = 20	α=0.001	250	269	286	302	317	333	348	363	377	392	407	421	435	450	464	479	493	507	521
	α=0.005	249	266	281	296	311	325	339	353	367	381	395	409	422	436	450	463	477	490	504
	α=0.01	248	264	279	293	307	321	335	349	362	376	389	402	416	429	442	456	469	482	495
	α=0.025	247	261	275	289	302	315	329	341	354	367	380	393	406	419	431	444	457	470	482
	α=0.05	245	258	271	284	297	310	322	335	347	360	372	385	397	409	422	434	446	459	471
	α=0.1	242	254	267	279	291	303	315	327	339	351	363	375	387	399	410	422	434	446	458

Reject the null hypothesis if the test statistic (W_r) is greater than the table (critical) value. For n or m greater than 20, the table (critical) value can be calculated from:

$$m(n+m+1)/2 \; + \; z\sqrt{nm(n+m+1)/12} \qquad \text{(I.1)}$$

if there are few or no ties, and from

$$m(n+m+1)/2 \; + \; z\sqrt{\frac{nm}{12}[(n+m+1) - \sum_{j=1}^{g} \frac{t_j(t_j^2-1)}{(n+m)(n+m-1)}]} \qquad \text{(I.2)}$$

if there are many ties, where g is the number of groups of tied measurements and t_j is the number of tied measurements in the jth group. z is the (1-α) percentile of a standard normal distribution, which can be found in the following table:

α	**z**
0.001	3.09
0.005	2.575
0.01	2.326
0.025	1.960
0.05	1.645
0.1	1.282

Other values can be found in Table I-1.

I.5 Probability of Detecting an Elevated Area

Table I.5 Risk that an Elevated Area with Length L/G and Shape S will not be Detected and the Area (%) of the Elevated Area Relative to a Triangular Sample Grid Area of 0.866 G^2

	Shape Parameter, S																			
	0.10		0.20		0.30		0.40		0.50		0.60		0.70		0.80		0.90		1.00	
L/G	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area
0.01	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%
0.02	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%
0.03	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%
0.04	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	0.99	1%	0.99	1%
0.05	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	1.00	<1%	0.99	1%	0.99	1%	0.99	1%	0.99	1%	0.99	1%
0.06	1.00	<1%	1.00	<1%	1.00	<1%	0.99	<1%	0.99	1%	0.99	1%	0.99	1%	0.99	1%	0.99	1%	0.99	1%
0.07	1.00	<1%	1.00	<1%	0.99	1%	0.99	<1%	0.99	1%	0.99	1%	0.99	1%	0.99	1%	0.98	2%	0.98	2%
0.08	1.00	<1%	1.00	<1%	0.99	1%	0.99	<1%	0.99	1%	0.99	1%	0.98	2%	0.98	2%	0.98	2%	0.98	2%
0.09	1.00	<1%	0.99	1%	0.99	1%	0.99	1%	0.99	1%	0.98	2%	0.98	2%	0.98	2%	0.97	3%	0.97	3%
0.10	1.00	<1%	0.99	1%	0.99	1%	0.99	1%	0.98	2%	0.98	2%	0.97	3%	0.97	3%	0.97	3%	0.96	4%
0.11	1.00	<1%	0.99	1%	0.99	1%	0.98	2%	0.98	2%	0.97	3%	0.97	3%	0.96	4%	0.96	4%	0.96	4%
0.12	0.99	1%	0.99	1%	0.98	2%	0.98	2%	0.97	3%	0.97	3%	0.96	4%	0.96	4%	0.95	5%	0.95	5%
0.13	0.99	1%	0.99	1%	0.98	2%	0.98	2%	0.97	3%	0.96	4%	0.96	4%	0.95	5%	0.94	6%	0.94	6%
0.14	0.99	1%	0.99	1%	0.98	2%	0.97	3%	0.96	4%	0.96	4%	0.95	5%	0.94	6%	0.94	6%	0.93	7%
0.15	0.99	1%	0.98	2%	0.98	2%	0.97	3%	0.96	4%	0.95	5%	0.94	6%	0.93	7%	0.93	7%	0.92	8%
0.16	0.99	1%	0.98	2%	0.97	3%	0.96	4%	0.95	5%	0.94	6%	0.94	7%	0.93	7%	0.92	8%	0.91	9%
0.17	0.99	1%	0.98	2%	0.97	3%	0.96	4%	0.95	5%	0.94	6%	0.93	7%	0.92	8%	0.91	9%	0.90	10%
0.18	0.99	1%	0.98	2%	0.96	4%	0.95	5%	0.94	6%	0.93	7%	0.92	8%	0.91	9%	0.89	11%	0.88	12%
0.19	0.99	1%	0.97	3%	0.96	4%	0.95	5%	0.93	7%	0.92	8%	0.91	9%	0.90	10%	0.88	12%	0.87	13%
0.20	0.99	1%	0.97	3%	0.96	4%	0.94	6%	0.93	7%	0.91	9%	0.90	10%	0.88	12%	0.87	13%	0.85	15%
0.21	0.98	2%	0.97	3%	0.95	5%	0.94	6%	0.92	8%	0.90	10%	0.89	11%	0.87	13%	0.86	14%	0.84	16%
0.22	0.98	2%	0.96	4%	0.95	5%	0.93	7%	0.91	9%	0.89	11%	0.88	12%	0.86	14%	0.84	16%	0.82	18%
0.23	0.98	2%	0.96	4%	0.94	6%	0.92	8%	0.90	10%	0.88	12%	0.87	13%	0.85	15%	0.83	17%	0.81	19%
0.24	0.98	2%	0.96	4%	0.94	6%	0.92	8%	0.90	10%	0.87	13%	0.85	15%	0.83	17%	0.81	19%	0.79	21%
0.25	0.98	2%	0.95	5%	0.93	7%	0.91	9%	0.89	11%	0.86	14%	0.84	16%	0.82	18%	0.80	20%	0.77	23%
0.26	0.98	2%	0.95	5%	0.93	7%	0.90	10%	0.88	12%	0.85	15%	0.83	17%	0.80	20%	0.78	22%	0.75	25%
0.27	0.97	3%	0.95	5%	0.92	8%	0.89	11%	0.87	13%	0.84	16%	0.81	19%	0.79	21%	0.76	24%	0.74	26%
0.28	0.97	3%	0.94	6%	0.91	9%	0.89	11%	0.86	14%	0.83	17%	0.80	20%	0.77	23%	0.74	26%	0.72	28%
0.29	0.97	3%	0.94	6%	0.91	9%	0.88	12%	0.85	15%	0.82	18%	0.79	21%	0.76	24%	0.73	27%	0.69	31%
0.30	0.97	3%	0.93	7%	0.90	10%	0.87	13%	0.84	16%	0.80	20%	0.77	23%	0.74	26%	0.71	29%	0.67	33%

Guidance for using Table I.5 can be found in Gilbert 1987 and EPA 1989a.

Table I.5 Risk that an Elevated Area with Length L/G and Shape S will not be Detected and the Area (%) of the Elevated Area Relative to a Triangular Sample Grid Area of 0.866 G^2 (continued)

	Shape Parameter, S																			
	0.10		0.20		0.30		0.40		0.50		0.60		0.70		0.80		0.90		1.00	
L/G	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area
0.31	0.97	3%	0.93	7%	0.90	10%	0.86	14%	0.83	17%	0.79	21%	0.76	24%	0.72	28%	0.69	31%	0.65	35%
0.32	0.96	4%	0.93	7%	0.89	11%	0.85	15%	0.81	19%	0.78	22%	0.74	26%	0.70	30%	0.67	33%	0.63	37%
0.33	0.96	4%	0.92	8%	0.88	12%	0.84	16%	0.80	20%	0.76	24%	0.72	28%	0.68	32%	0.64	36%	0.61	40%
0.34	0.96	4%	0.92	8%	0.87	13%	0.83	17%	0.79	21%	0.75	25%	0.71	29%	0.66	34%	0.62	38%	0.58	42%
0.35	0.96	4%	0.91	9%	0.87	13%	0.82	18%	0.78	22%	0.73	27%	0.69	31%	0.64	36%	0.60	40%	0.56	44%
0.36	0.95	5%	0.91	9%	0.86	14%	0.81	19%	0.76	24%	0.72	28%	0.67	33%	0.62	38%	0.58	42%	0.53	47%
0.37	0.95	5%	0.90	10%	0.85	15%	0.80	20%	0.75	25%	0.70	30%	0.65	35%	0.60	40%	0.55	45%	0.50	50%
0.38	0.95	5%	0.90	10%	0.84	16%	0.79	21%	0.74	26%	0.69	31%	0.63	37%	0.58	42%	0.53	47%	0.48	52%
0.39	0.94	6%	0.89	11%	0.83	17%	0.78	22%	0.72	28%	0.67	33%	0.61	39%	0.56	44%	0.50	50%	0.45	55%
0.40	0.94	6%	0.88	12%	0.83	17%	0.77	23%	0.71	29%	0.65	35%	0.59	41%	0.54	46%	0.48	52%	0.42	58%
0.41	0.94	6%	0.88	12%	0.82	18%	0.76	24%	0.70	30%	0.63	37%	0.57	43%	0.51	49%	0.45	55%	0.39	61%
0.42	0.94	6%	0.87	13%	0.81	19%	0.74	26%	0.68	32%	0.62	38%	0.55	45%	0.49	51%	0.42	58%	0.36	64%
0.43	0.93	7%	0.87	13%	0.80	20%	0.73	27%	0.66	34%	0.60	40%	0.53	47%	0.46	54%	0.40	60%	0.33	67%
0.44	0.93	7%	0.86	14%	0.79	21%	0.72	28%	0.65	35%	0.58	42%	0.51	49%	0.44	56%	0.37	63%	0.30	70%
0.45	0.93	7%	0.85	15%	0.78	22%	0.71	29%	0.63	37%	0.56	44%	0.49	51%	0.41	59%	0.34	66%	0.27	73%
0.46	0.92	8%	0.85	15%	0.77	23%	0.69	31%	0.62	38%	0.54	46%	0.46	54%	0.39	61%	0.31	69%	0.23	77%
0.47	0.92	8%	0.84	16%	0.76	24%	0.68	32%	0.60	40%	0.52	48%	0.44	56%	0.36	64%	0.28	72%	0.20	80%
0.48	0.92	8%	0.83	17%	0.75	25%	0.67	33%	0.58	42%	0.50	50%	0.41	59%	0.33	67%	0.25	75%	0.16	84%
0.49	0.91	9%	0.83	17%	0.74	26%	0.65	35%	0.56	44%	0.48	52%	0.39	61%	0.30	70%	0.22	78%	0.13	87%
0.50	0.91	9%	0.82	18%	0.73	27%	0.64	36%	0.55	45%	0.46	54%	0.37	63%	0.27	73%	0.18	82%	0.09	91%
0.51	0.91	9%	0.81	19%	0.72	28%	0.62	38%	0.53	47%	0.43	57%	0.34	66%	0.25	75%	0.15	85%	0.07	94%
0.52	0.90	10%	0.80	20%	0.71	29%	0.61	39%	0.51	49%	0.41	59%	0.32	69%	0.22	78%	0.13	88%	0.05	98%
0.53	0.90	10%	0.80	20%	0.70	31%	0.59	41%	0.49	51%	0.39	61%	0.29	71%	0.19	82%	0.10	92%	0.03	102%
0.54	0.89	11%	0.79	21%	0.68	32%	0.58	42%	0.47	53%	0.37	63%	0.27	74%	0.17	85%	0.08	95%	0.02	106%
0.55	0.89	11%	0.78	22%	0.67	33%	0.56	44%	0.46	55%	0.35	66%	0.24	77%	0.14	88%	0.06	99%	0.01	110%
0.56	0.89	11%	0.77	23%	0.66	34%	0.55	46%	0.44	57%	0.33	68%	0.22	80%	0.12	91%	0.04	102%	0.00	114%
0.57	0.88	12%	0.77	24%	0.65	35%	0.54	47%	0.42	59%	0.31	71%	0.20	83%	0.10	94%	0.02	106%	0.00	118%
0.58	0.88	12%	0.76	24%	0.64	37%	0.52	49%	0.40	61%	0.29	73%	0.18	85%	0.08	98%	0.01	110%	0.00	122%
0.59	0.87	13%	0.75	25%	0.63	38%	0.51	51%	0.39	63%	0.27	76%	0.16	88%	0.06	101%	0.00	114%	0.00	126%
0.60	0.87	13%	0.74	26%	0.62	39%	0.49	52%	0.37	65%	0.25	78%	0.14	91%	0.04	104%	0.00	118%	0.00	131%
0.61	0.87	13%	0.73	27%	0.60	40%	0.48	54%	0.35	67%	0.23	81%	0.12	94%	0.03	108%	0.00	121%	0.00	135%
0.62	0.86	14%	0.73	28%	0.59	42%	0.46	56%	0.34	70%	0.21	84%	0.10	98%	0.02	112%	0.00	126%	0.00	139%
0.63	0.86	14%	0.72	29%	0.58	43%	0.45	58%	0.32	72%	0.20	86%	0.09	101%	0.01	115%	0.00	130%	0.00	144%
0.64	0.85	15%	0.71	30%	0.57	45%	0.43	59%	0.30	74%	0.18	89%	0.07	104%	0.00	119%	0.00	134%	0.00	149%
0.65	0.85	15%	0.70	31%	0.56	46%	0.42	61%	0.29	77%	0.16	92%	0.06	107%	0.00	123%	0.00	138%	0.00	153%

Table I.5 Risk that an Elevated Area with Length L/G and Shape S will not be Detected and the Area (%) of the Elevated Area Relative to a Triangular Sample Grid Area of $0.866G^2$ (continued)

	Shape Parameter, S																			
	0.10		0.20		0.30		0.40		0.50		0.60		0.70		0.80		0.90		1.00	
L/G	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area	Risk	Area
0.66	0.84	16%	0.69	32%	0.55	47%	0.40	63%	0.27	79%	0.15	95%	0.05	111%	0.00	126%	0.00	142%	0.00	158%
0.67	0.84	16%	0.68	33%	0.53	49%	0.39	65%	0.25	81%	0.13	98%	0.03	114%	0.00	130%	0.00	147%	0.00	163%
0.68	0.84	17%	0.68	34%	0.52	50%	0.38	67%	0.24	84%	0.12	101%	0.02	117%	0.00	134%	0.00	151%	0.00	168%
0.69	0.83	17%	0.67	35%	0.51	52%	0.36	69%	0.22	86%	0.10	104%	0.01	121%	0.00	138%	0.00	155%	0.00	173%
0.70	0.83	18%	0.66	36%	0.50	53%	0.35	71%	0.21	89%	0.09	107%	0.01	124%	0.00	142%	0.00	160%	0.00	178%
0.71	0.82	18%	0.65	37%	0.49	55%	0.33	73%	0.20	91%	0.08	110%	0.00	128%	0.00	146%	0.00	165%	0.00	183%
0.72	0.82	19%	0.64	38%	0.48	56%	0.32	75%	0.18	94%	0.07	113%	0.00	132%	0.00	150%	0.00	169%	0.00	188%
0.73	0.81	19%	0.63	39%	0.46	58%	0.31	77%	0.17	97%	0.05	116%	0.00	135%	0.00	155%	0.00	174%	0.00	193%
0.74	0.81	20%	0.62	40%	0.45	60%	0.29	79%	0.15	99%	0.04	119%	0.00	139%	0.00	159%	0.00	179%	0.00	199%
0.75	0.80	20%	0.61	41%	0.44	61%	0.28	82%	0.14	102%	0.04	122%	0.00	143%	0.00	163%	0.00	184%	0.00	204%
0.76	0.80	21%	0.61	42%	0.43	63%	0.27	84%	0.13	105%	0.03	126%	0.00	147%	0.00	168%	0.00	189%	0.00	210%
0.77	0.79	22%	0.60	43%	0.42	65%	0.25	86%	0.12	108%	0.02	129%	0.00	151%	0.00	172%	0.00	194%	0.00	215%
0.78	0.79	22%	0.59	44%	0.40	66%	0.24	88%	0.10	110%	0.01	132%	0.00	154%	0.00	177%	0.00	199%	0.00	221%
0.79	0.78	23%	0.58	45%	0.39	68%	0.23	91%	0.09	113%	0.01	136%	0.00	158%	0.00	181%	0.00	204%	0.00	226%
0.80	0.78	23%	0.57	46%	0.38	70%	0.22	93%	0.08	116%	0.00	139%	0.00	163%	0.00	186%	0.00	209%	0.00	232%
0.81	0.77	24%	0.56	48%	0.37	71%	0.20	95%	0.07	119%	0.00	143%	0.00	167%	0.00	190%	0.00	214%	0.00	238%
0.82	0.77	24%	0.55	49%	0.36	73%	0.19	98%	0.06	122%	0.00	146%	0.00	171%	0.00	195%	0.00	220%	0.00	244%
0.83	0.76	25%	0.54	50%	0.35	75%	0.18	100%	0.05	125%	0.00	150%	0.00	175%	0.00	200%	0.00	225%	0.00	250%
0.84	0.76	26%	0.53	51%	0.33	77%	0.17	102%	0.05	128%	0.00	154%	0.00	179%	0.00	205%	0.00	230%	0.00	256%
0.85	0.75	26%	0.52	52%	0.32	79%	0.16	105%	0.04	131%	0.00	157%	0.00	183%	0.00	210%	0.00	236%	0.00	262%
0.86	0.74	27%	0.51	54%	0.31	80%	0.14	107%	0.03	134%	0.00	161%	0.00	188%	0.00	215%	0.00	241%	0.00	268%
0.87	0.74	27%	0.50	55%	0.30	82%	0.13	110%	0.02	137%	0.00	165%	0.00	192%	0.00	220%	0.00	247%	0.00	275%
0.88	0.73	28%	0.50	56%	0.29	84%	0.12	112%	0.02	140%	0.00	169%	0.00	197%	0.00	225%	0.00	253%	0.00	281%
0.89	0.73	29%	0.49	57%	0.28	86%	0.11	115%	0.01	144%	0.00	172%	0.00	201%	0.00	230%	0.00	259%	0.00	287%
0.90	0.72	29%	0.48	59%	0.27	88%	0.10	118%	0.01	147%	0.00	176%	0.00	206%	0.00	235%	0.00	264%	0.00	294%
0.91	0.72	30%	0.47	60%	0.26	90%	0.10	120%	0.01	150%	0.00	180%	0.00	210%	0.00	240%	0.00	270%	0.00	300%
0.92	0.71	31%	0.46	61%	0.25	92%	0.09	123%	0.00	154%	0.00	184%	0.00	215%	0.00	246%	0.00	276%	0.00	307%
0.93	0.71	31%	0.45	63%	0.24	94%	0.08	126%	0.00	157%	0.00	188%	0.00	220%	0.00	251%	0.00	282%	0.00	314%
0.94	0.70	32%	0.44	64%	0.23	96%	0.07	128%	0.00	160%	0.00	192%	0.00	224%	0.00	256%	0.00	288%	0.00	321%
0.95	0.69	33%	0.43	65%	0.22	98%	0.07	131%	0.00	164%	0.00	196%	0.00	229%	0.00	262%	0.00	295%	0.00	327%
0.96	0.69	33%	0.42	67%	0.21	100%	0.06	134%	0.00	167%	0.00	201%	0.00	234%	0.00	267%	0.00	301%	0.00	334%
0.97	0.68	34%	0.41	68%	0.20	102%	0.05	137%	0.00	171%	0.00	205%	0.00	239%	0.00	273%	0.00	307%	0.00	341%
0.98	0.68	35%	0.40	70%	0.19	105%	0.05	139%	0.00	174%	0.00	209%	0.00	244%	0.00	279%	0.00	314%	0.00	348%
0.99	0.67	36%	0.40	71%	0.18	107%	0.04	142%	0.00	178%	0.00	213%	0.00	249%	0.00	284%	0.00	320%	0.00	356%
1.00	0.67	36%	0.39	73%	0.17	109%	0.04	145%	0.00	181%	0.00	218%	0.00	254%	0.00	290%	0.00	326%	0.00	363%

I.6 Random Numbers

Table I.6 1,000 Random Numbers Uniformly Distributed between Zero and One

0.163601	0.647423	0.555548	0.248859	0.259801	0.718368	0.305020	0.812482	0.601951	0.973160
0.934196	0.951102	0.979831	0.132364	0.157808	0.040605	0.997626	0.896462	0.360578	0.443218
0.054552	0.965257	0.999181	0.172627	0.583713	0.852958	0.116336	0.748483	0.058602	0.738495
0.972409	0.241889	0.799991	0.926726	0.585505	0.453993	0.877990	0.947022	0.910821	0.388081
0.556401	0.621126	0.293328	0.984335	0.366531	0.912588	0.733824	0.092405	0.717362	0.423421
0.625153	0.838711	0.196153	0.630553	0.867808	0.957094	0.830218	0.783518	0.141557	0.444997
0.527330	0.124034	0.351792	0.161947	0.688925	0.140346	0.553577	0.890058	0.470457	0.566196
0.826643	0.673286	0.550827	0.885295	0.690781	0.371540	0.108632	0.090765	0.618443	0.937184
0.296068	0.891272	0.392367	0.649633	0.261410	0.523221	0.769081	0.358794	0.924341	0.167665
0.848882	0.083603	0.274621	0.268003	0.272254	0.017727	0.309463	0.445986	0.244653	0.944564
0.779276	0.484461	0.101393	0.995100	0.085164	0.611426	0.030270	0.494982	0.426236	0.270225
0.095038	0.577943	0.186239	0.267852	0.786070	0.208937	0.184565	0.826397	0.256825	0.489034
0.011672	0.844846	0.443407	0.915087	0.275906	0.883009	0.243728	0.865552	0.796671	0.314429
0.215993	0.476035	0.354717	0.883172	0.840666	0.393867	0.374810	0.222167	0.114691	0.596046
0.982374	0.101973	0.683995	0.730612	0.548200	0.084302	0.145212	0.337680	0.566173	0.592776
0.860868	0.794380	0.819422	0.752871	0.158956	0.317468	0.062387	0.909843	0.779089	0.648967
0.718917	0.696798	0.463655	0.762408	0.823097	0.843209	0.368678	0.996266	0.542048	0.663842
0.800735	0.225556	0.398048	0.437067	0.642698	0.144068	0.104212	0.675095	0.318953	0.648478
0.915538	0.711742	0.232159	0.242961	0.327863	0.156608	0.260175	0.385141	0.681475	0.978186
0.975506	0.652654	0.928348	0.513444	0.744095	0.972031	0.527368	0.494287	0.602829	0.592834
0.435196	0.272807	0.452254	0.793464	0.817291	0.828245	0.407518	0.441518	0.358966	0.619741
0.692512	0.368151	0.821543	0.583707	0.802354	0.133831	0.569521	0.474516	0.437608	0.961559
0.678823	0.930602	0.657348	0.025057	0.294093	0.499623	0.006423	0.290613	0.325204	0.044439
0.642075	0.029842	0.289042	0.891009	0.813844	0.973093	0.952871	0.361623	0.709933	0.466955
0.174285	0.863244	0.133649	0.773819	0.891664	0.246417	0.272407	0.517658	0.132225	0.795514
0.951401	0.921291	0.210993	0.369411	0.196909	0.054389	0.364475	0.716718	0.096843	0.308418
0.186824	0.005407	0.310843	0.998118	0.725887	0.143171	0.293721	0.841304	0.661969	0.409622
0.105673	0.026338	0.878006	0.105936	0.612556	0.124601	0.922558	0.648985	0.896805	0.737256
0.801080	0.619461	0.933720	0.275881	0.637352	0.644996	0.713379	0.302687	0.904515	0.457172
0.101214	0.236405	0.945199	0.005975	0.893786	0.082317	0.648743	0.511871	0.298942	0.121573
0.177754	0.930066	0.390527	0.575622	0.390428	0.600575	0.460949	0.191600	0.910079	0.099444
0.846157	0.322467	0.156607	0.253388	0.739021	0.133498	0.293141	0.144834	0.626600	0.045169
0.812147	0.306383	0.201517	0.306651	0.827112	0.277716	0.660224	0.268538	0.518416	0.579216
0.691055	0.059046	0.104390	0.427038	0.148688	0.480788	0.026511	0.572705	0.745522	0.986078
0.483819	0.797573	0.174899	0.892670	0.118990	0.813221	0.857964	0.279164	0.883509	0.154562
0.165133	0.985134	0.214681	0.595309	0.741697	0.418602	0.301917	0.338913	0.680062	0.097350
0.281668	0.476899	0.839512	0.057760	0.474156	0.898409	0.482638	0.198725	0.888281	0.018872
0.554337	0.350955	0.942401	0.526759	0.509846	0.408165	0.800079	0.789263	0.564192	0.140684

Table I.6 1,000 Random Numbers Uniformly Distributed between Zero and One (continued)

0.873143	0.349662	0.238282	0.383195	0.568383	0.298471	0.490431	0.731405	0.339906	0.431645
0.401675	0.061151	0.771468	0.795760	0.365952	0.221234	0.947374	0.375686	0.828215	0.113060
0.574987	0.154831	0.808117	0.723544	0.134014	0.360957	0.166572	0.112314	0.242857	0.309290
0.745415	0.929459	0.425406	0.118845	0.386382	0.867386	0.808757	0.009573	0.229879	0.849242
0.613554	0.926550	0.857632	0.014438	0.004214	0.592513	0.280223	0.283447	0.943793	0.205750
0.880368	0.303741	0.247850	0.341580	0.867155	0.542130	0.473418	0.650251	0.326222	0.036285
0.567556	0.183534	0.696381	0.373333	0.716762	0.526636	0.306862	0.904790	0.151931	0.328792
0.280015	0.237361	0.336240	0.424191	0.192603	0.770194	0.284572	0.992475	0.308979	0.698329
0.502862	0.818555	0.238758	0.057148	0.461531	0.904929	0.521982	0.599127	0.239509	0.424858
0.738375	0.794328	0.305231	0.887161	0.021104	0.469779	0.913966	0.266514	0.647901	0.246223
0.366209	0.749763	0.634971	0.261038	0.869115	0.787951	0.678287	0.667142	0.216531	0.763214
0.739267	0.554299	0.979969	0.489597	0.545130	0.931869	0.096443	0.374089	0.140070	0.840563
0.375690	0.866922	0.256930	0.518074	0.217373	0.027043	0.801938	0.040364	0.624283	0.292810
0.894101	0.178824	0.443631	0.110614	0.556232	0.969563	0.291364	0.695764	0.306903	0.303885
0.668169	0.296926	0.324041	0.616290	0.799426	0.372555	0.070954	0.045748	0.505327	0.027722
0.470107	0.135634	0.271284	0.494071	0.485610	0.382772	0.418470	0.004082	0.298068	0.539847
0.047906	0.694949	0.309033	0.223989	0.008978	0.383695	0.479858	0.894958	0.597796	0.162072
0.917713	0.072793	0.107402	0.007328	0.176598	0.576809	0.052969	0.421803	0.737514	0.340966
0.839439	0.338565	0.254833	0.924413	0.871833	0.480599	0.172846	0.736102	0.471802	0.783451
0.488244	0.260352	0.129716	0.153558	0.305933	0.777100	0.111924	0.412930	0.601453	0.083217
0.488369	0.485094	0.322236	0.894264	0.781546	0.770237	0.707400	0.587451	0.571609	0.981580
0.311380	0.270400	0.807264	0.348433	0.172763	0.914856	0.011893	0.014317	0.820797	0.261767
0.028802	0.072165	0.944160	0.804761	0.770481	0.104256	0.112919	0.184068	0.940946	0.238087
0.466082	0.603884	0.959713	0.547834	0.487552	0.455150	0.240324	0.428921	0.648821	0.277620
0.720229	0.575779	0.939622	0.234554	0.767389	0.735335	0.941002	0.794021	0.291615	0.165732
0.861579	0.778039	0.331677	0.608231	0.646094	0.498720	0.140520	0.259197	0.782477	0.922273
0.849884	0.917789	0.816247	0.572502	0.753757	0.857324	0.988330	0.597085	0.186087	0.771997
0.989999	0.994007	0.349735	0.954437	0.741124	0.791852	0.986074	0.444554	0.177531	0.743725
0.337214	0.987184	0.344245	0.039033	0.549585	0.688526	0.225470	0.556251	0.157058	0.681447
0.706330	0.082994	0.299909	0.613361	0.031334	0.941102	0.772731	0.198070	0.460602	0.778659
0.417239	0.916556	0.707773	0.249767	0.169301	0.914420	0.732687	0.934912	0.985594	0.726957
0.653326	0.529996	0.305465	0.181747	0.153359	0.353168	0.673377	0.448970	0.546347	0.885438
0.099373	0.156385	0.067157	0.755573	0.689979	0.494021	0.996216	0.051811	0.049321	0.595525
0.860299	0.210143	0.026232	0.838499	0.108975	0.455260	0.320633	0.150619	0.445073	0.275619
0.067160	0.791992	0.363875	0.825052	0.047561	0.311194	0.447486	0.971659	0.876616	0.455018
0.944317	0.348844	0.210015	0.769274	0.253032	0.239894	0.208165	0.600014	0.945046	0.505316
0.917419	0.185575	0.743859	0.655124	0.185320	0.237660	0.271534	0.949825	0.441666	0.811135
0.365705	0.800723	0.116707	0.386073	0.837800	0.244896	0.337304	0.869528	0.845737	0.194553
0.911453	0.591254	0.920222	0.707522	0.782902	0.092884	0.426444	0.320336	0.226369	0.377845

Table I.6 1,000 Random Numbers Uniformly Distributed between Zero and One (continued)

0.027171	0.058193	0.726183	0.057705	0.935493	0.688071	0.752543	0.932781	0.048914	0.591035
0.768066	0.387888	0.655990	0.690208	0.746739	0.936409	0.685458	0.090931	0.242120	0.067899
0.052305	0.899285	0.092643	0.058916	0.826653	0.772790	0.785028	0.967761	0.588503	0.896590
0.623285	0.492051	0.644294	0.821341	0.600824	0.901289	0.774379	0.391874	0.810022	0.437879
0.624284	0.308522	0.208541	0.297156	0.576129	0.373705	0.370345	0.372748	0.965550	0.874416
0.853117	0.671602	0.018316	0.095780	0.871263	0.885420	0.919787	0.439594	0.460586	0.629443
0.967796	0.933631	0.397054	0.682343	0.505977	0.406611	0.539543	0.066152	0.885414	0.857606
0.759450	0.768853	0.115419	0.744466	0.607572	0.179839	0.413809	0.228607	0.362857	0.826932
0.514703	0.108915	0.864053	0.076280	0.352557	0.674917	0.572689	0.588574	0.596215	0.639101
0.826296	0.264540	0.255775	0.180449	0.405715	0.740170	0.423514	0.537793	0.877436	0.512284
0.354198	0.792775	0.051583	0.806962	0.385851	0.655314	0.046701	0.860466	0.848112	0.515684
0.744807	0.960789	0.123099	0.163569	0.621969	0.571558	0.482449	0.346358	0.795845	0.207558
0.642312	0.356643	0.797708	0.505570	0.418534	0.634642	0.033111	0.393330	0.105093	0.328848
0.824625	0.855876	0.770743	0.678619	0.927298	0.204828	0.831460	0.979875	0.566627	0.056160
0.755877	0.679791	0.442388	0.899944	0.563383	0.197074	0.679568	0.244433	0.786084	0.337991
0.625370	0.967123	0.321605	0.697578	0.122418	0.475395	0.068207	0.070374	0.353248	0.461960
0.124012	0.133851	0.761154	0.501578	0.204221	0.866481	0.925783	0.329001	0.327832	0.844681
0.825392	0.382001	0.847909	0.520741	0.404959	0.308849	0.418976	0.972838	0.452438	0.600528
0.999194	0.297058	0.617183	0.570478	0.875712	0.581618	0.284410	0.405575	0.362205	0.427077
0.536855	0.667083	0.636883	0.043774	0.113509	0.980045	0.237797	0.618925	0.670767	0.814902
0.361632	0.797162	0.136063	0.487575	0.682796	0.952708	0.759989	0.058556	0.292400	0.871674
0.923253	0.479871	0.022855	0.673915	0.733795	0.811955	0.417970	0.095675	0.831670	0.043950
0.845432	0.202336	0.348421	0.050704	0.171916	0.600557	0.284838	0.606715	0.758190	0.394811

I.7 Stem and Leaf Display

The construction of a **stem and leaf display** is a simple way to generate a crude histogram of the data quickly. The "stems" of such a display are the most significant digits of the data. Consider the sample data of Section 8.2.2.2:

90.7, 83.5, 86.4, 88.5, 84.4, 74.2, 84.1, 87.6, 78.2, 77.6,
86.4, 76.3, 86.5, 77.4, 90.3, 90.1, 79.1, 92.4, 75.5, 80.5.

Here the data span three decades, so one might consider using the stems 70, 80 and 90. However, three is too few stems to be informative, just as three intervals would be too few for constructing a histogram. Therefore, for this example, each decade is divided into two parts. This results in the six stems 70, 75, 80, 85, 90, 95. The leaves are the least significant digits, so 90.7 has the stem 90 and the leaf 0.7. 77.4 has the stem 75 and the leaf 7.4. Note that even though the stem is 75, the leaf is *not* 2.4. The leaf is kept as 7.4 so that the data can be read directly from the display without any calculations.

As shown in the top part of Figure I.1, simply arrange the leaves of the data into rows, one stem per row. The result is a quick histogram of the data. In order to ensure this, the same number of digits should be used for each leaf, so that each occupies the same amount of horizontal space.

If the stems are arranged in increasing order, as shown in the bottom half of Figure I.1, it is easy to pick out the minimum (74.2), the maximum (92.4), and the median (between 84.1 and 84.4).

A stem and leaf display (or histogram) with two peaks may indicate that residual radioactivity is distributed over only a portion of the survey unit. Further information on the construction and interpretation of data plots is given in EPA QA/G-9 (EPA 1996a).

Stem Leaves
70 4.2
75 8.2, 7.6, 6.3, 7.4, 9.1, 5.5
80 3.5, 4.4, 4.1, 0.5
85 6.4, 8.5, 7.6, 6.4, 6.5
90 0.7, 0.3, 0.1, 2.4
95

Stem Sorted Leaves
70 4.2
75 5.5, 6.3, 7.4, 7.6, 8.2, 9.1
80 0.5, 3.5, 4.1, 4.4
85 6.4, 6.4, 6.5, 7.6, 8.5
90 0.1, 0.3, 0.7, 2.4
95

Figure I.1 Example of a Stem and Leaf Display

I.8 Quantile Plots

A **Quantile plot** is constructed by first ranking the data from smallest to largest. Sorting the data is easy once the stem and leaf display has been constructed. Then, each data value is simply plotted against the percentage of the samples with that value or less. This percentage is computed from:

$$Percent = \frac{100\,(rank - 0.5)}{(number\ \ of\ \ data\ \ points)} \qquad \text{(I-3)}$$

The results for the example data of Section I.7 are shown in Table I.7. The Quantile plot for this example is shown in Figure I.2.

The slope of the curve in the Quantile plot is an indication of the amount of data in a given range of values. A small amount of data in a range will result in a large slope. A large amount of data in a range of values will result in a more horizonal slope. A sharp rise near the bottom or the top is an indication of asymmetry. Sudden changes in slope, or notably flat or notably steep areas may indicate peculiarities in the survey unit data needing further investigation.

Table I.7 Data for Quantile Plot

Data:	74.2	75.5	76.3	77.4	77.6	78.2	79.1	80.5	83.5	84.1
Rank:	1	2	3	4	5	6	7	8	9	10
Percent:	2.5	7.5	12.5	17.5	22.5	27.5	32.5	37.5	42.5	47.5
Data:	84.4	86.4	86.4	86.5	87.6	88.5	90.1	90.3	90.7	92.4
Rank:	11	12.5	12.5	14	15	16	17	18	19	20
Percent:	52.5	60.0	60.0	67.5	72.5	77.5	82.5	87.5	92.5	97.5

A useful aid to interpreting the quantile plot is the addition of boxes containing the middle 50% and middle 75% of the data. These are shown as the dashed lines in Figure I.2. The 50% box has its upper right corner at the 75th percentile and its lower left corner at the 25th percentile. These points are also called the Quartiles. These are ~78 and ~88, respectively, as indicated by the dashed lines. They bracket the middle half of the data values. The 75% box has its upper right corner at the 87.5th percentile and its lower left corner at the 12.5th percentile. A sharp increase within the 50% box can indicate two or more modes in the data. Outside the 75% box, sharp increases can indicate outliers. The median (50th percentile) is indicated by the heavy solid line at the value ~84, and can be used as an aid to judging the symmetry of the data distribution. There are no especially unusual features in the example Quantile plot shown in Figure I.2, other than the possibility of slight asymmetry around the median.

Another Quantile plot, for the example data of Section 8.3.3, is shown in Figure I.3.

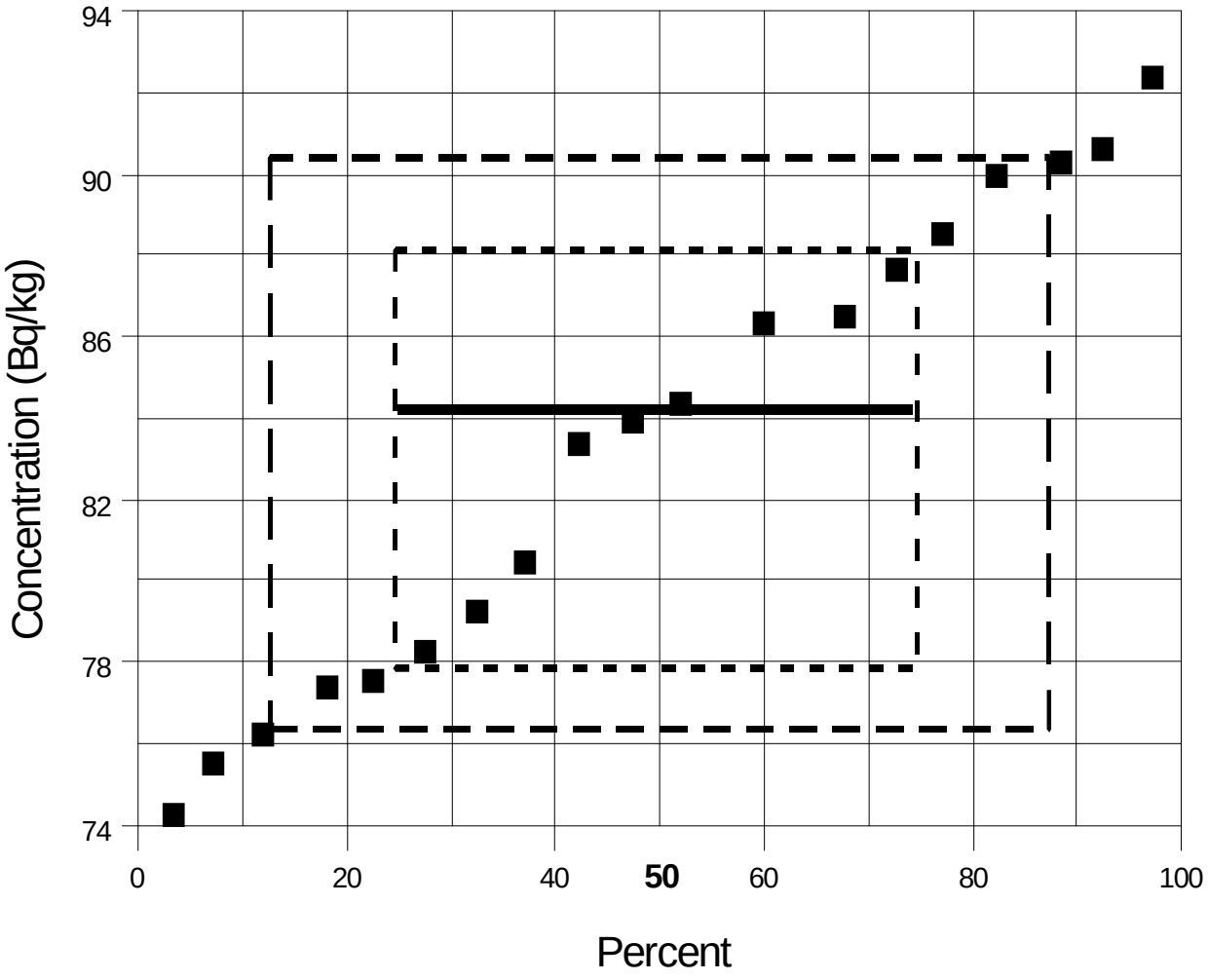

Figure I.2 Example of a Quantile Plot

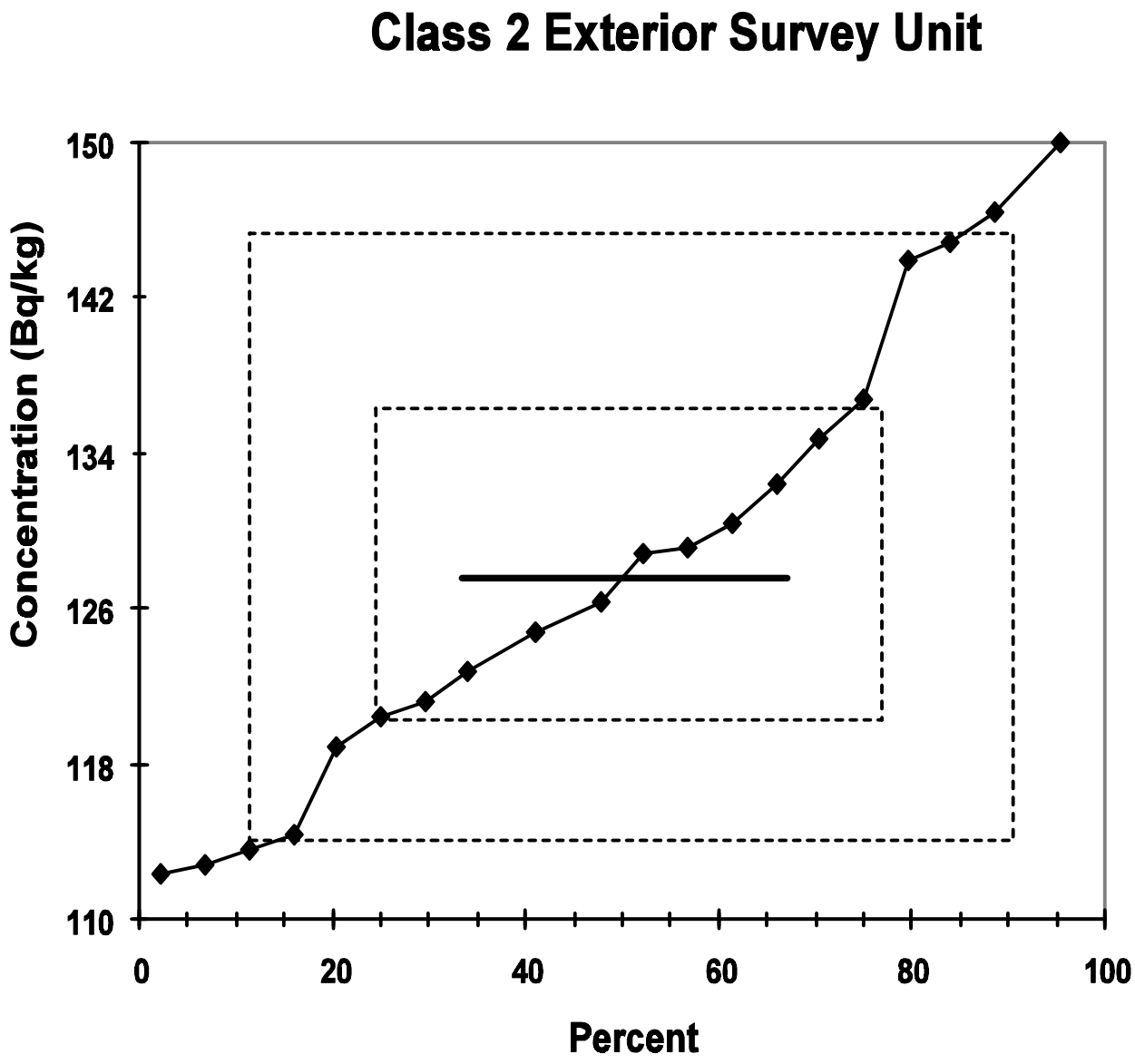

Figure I.3 Quantile Plot for Example Class 2 Exterior Survey Unit of Section 8.3.3.

A **Quantile-Quantile plot** is extremely useful for comparing two sets of data. Suppose the following 17 concentration values were obtained in a reference area corresponding to the example survey unit data of Section I.7:

92.1, 83.2, 81.7, 81.8, 88.5, 82.4, 81.5, 69.7, 82.4, 89.7,
81.4, 79.4, 82.0, 79.9, 81.1, 59.4, 75.3.

A Quantile-Quantile plot can be constructed to compare the distribution of the survey unit data, Y_j, j=1,...n, with the distribution of the reference area data X_i , i=1,... m. (If the reference area data set were the larger, the roles of X and Y would be reversed.) The data from each set are ranked separately from smallest to largest. This has already been done for the survey unit data in Table I.7. For the reference area data, we obtain the results in Table I.8.

Table I.8 Ranked Reference Area Concentrations

Data:	59.4	69.7	75.3	79.4	79.9	81.1	81.4	81.5	81.7	81.8
Rank:	1	2	3	4	5	6	7	8	9	10
Data:	82.0	82.4	82.4	83.2	88.5	89.7	92.1			
Rank:	11	12.5	12.5	14	15	16	17			

The median for the reference area data is 81.7, the sample mean is 80.7, and the sample standard deviation is 7.5.

For the larger data set, the data must be interpolated to match the number of points in the smaller data set. This is done by computing

$$\nu_1 = 0.5(n/m) + 0.5 \quad \textit{and} \quad \nu_{i+1} = \nu_i + (n/m) \quad \textit{for } i = 1,...m-1, \tag{I-4}$$

where m is the number of points in the smaller data set and n is the number of points in the larger data set. For each of the ranks, i, in the smaller data set, a corresponding value in the larger data set is found by first decomposing v_i into its integer part, j, and its fractional part, g.

Then the interpolated values are computed from the relationship:

$$Z_i = (1\text{-}g)\, Y_j + g\, Y_{j+1} . \qquad \text{(I-5)}$$

The results of these calculations are shown in Table I.9.

Table I.9 Interpolated Ranks for Survey Unit Concentrations

Rank	1	2	3	4	5	6	7	8	9	10
v_i	1.09	2.26	3.44	4.62	5.79	6.97	8.15	9.33	10.50	11.68
Z_i	74.3	75.7	76.8	77.5	78.1	79.1	80.9	83.7	84.3	85.8
X_i	59.4	69.7	75.3	79.4	79.7	81.1	81.4	81.5	81.7	81.8

Rank	11	12.5	12.5	14	15	16	17
v_i	12.85	14.03	15.21	16.38	17.56	18.74	19.91
Z_i	86.4	86.5	87.8	89.1	90.2	90.6	92.3
X_i	82.0	82.4	82.4	83.2	88.5	89.7	92.1

Finally, Z_i is plotted against X_i to obtain the Quantile-Quantile plot. This example is shown in Figure I.4.

The Quantile-Quantile Plot is valuable because it provides a direct visual comparison of the two data sets. If the two data distributions differ only in location (*e.g.* mean) or scale (*e.g.* standard deviation), the points will lie on a straight line. If the two data distributions being compared are identical, all of the plotted points will lie on the line $Y=X$. Any deviations from this would point to possible differences in these distributions. The middle data point plots the median of Y against the median of X. That this point lies above the line $Y=X$, in the example of Figure 8.4, shows that the median of Y is larger than the median of X. Indeed, the cluster of points above the line $Y = X$ in the region of the plot where the data points are dense, is an indication that the central portion of the survey unit distribution is shifted toward higher values than the reference area distribution. This could imply that there is residual radioactivity in the survey unit. This should be tested using the nonparametric statistical tests described in Chapter 8.

Another Quantile-Quantile plot, for the Class 1 Interior Survey Unit example data, is shown in Figure A.8.

Further information on the interpretation of Quantile and Quantile-Quantile plots are given in EPA QA/G-9 (EPA 1996a).

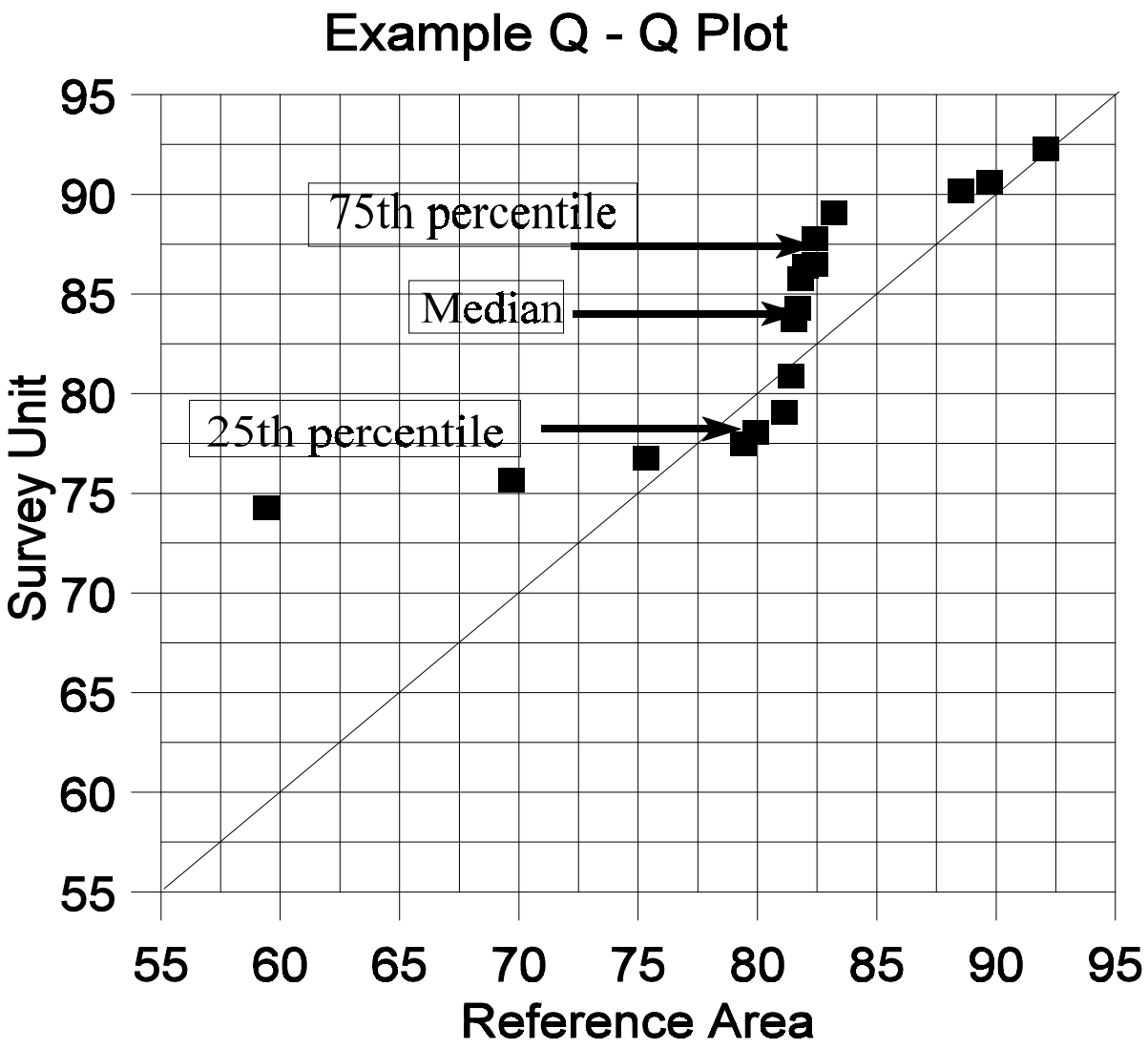

Figure I.4 Example Quantile-Quantile Plot

I.9 Power Calculations for the Statistical Tests

I.9.1 Power of the Sign Test

The power of the Sign test for detecting residual radioactivity at the concentration level LBGR = DGCL - Δ, may be found using equation I-6.

$$1 - \beta = 1 - \sum_{i=0}^{k} \binom{N}{i} [q^*]^i \cdot [1-q^*]^{N-i} \approx 1 - \Phi\left(\frac{k - Nq^*}{\sqrt{Nq^*(1-q^*)}}\right) \qquad \text{(I-6)}$$

with

$$q^* = \Phi(\Delta/\sigma) \qquad \text{(I-7)}$$

The function Φ(z) is the standard normal cumulative distribution function tabulated in Table I.1. Note that if Δ/σ is large, q^* approaches one, and the power also approaches one. This calculation can be performed for other values, Δ*, in order to construct a power curve for the test. These calculations can also be performed using the standard deviation of the actual measurement data, *s*, in order to construct a retrospective power curve for the test. This is an important step when the null hypothesis is not rejected, since it demonstrates whether the DQOs have been met.

The retrospective power curve for the Sign test can be constructed using Equations I-6 and I-7, together with the actual number of concentration measurements obtained, N. The power as a function of Δ/σ is calculated. The values of Δ/σ are converted to concentration using:

Concentration = $DCGL_W$ - (Δ/σ)(observed standard deviation).

The results for the Class 3 Exterior Survey Unit example of Section 8.3.4 are plotted in Figure I.5. This figure shows the probability that the survey unit would have passed the release criterion using the Sign test versus concentration of residual radioactivity. This curve shows that the data quality objectives were met, despite the fact that the actual standard deviation was larger than that used in designing the survey. This is primarily due to the additional 20% that was added to the sample size, and also that sample sizes were always rounded up. The curve shows that a survey unit with less than 135 Bq/kg would almost always pass, and that a survey unit with more than 145 Bq/kg would almost always fail.

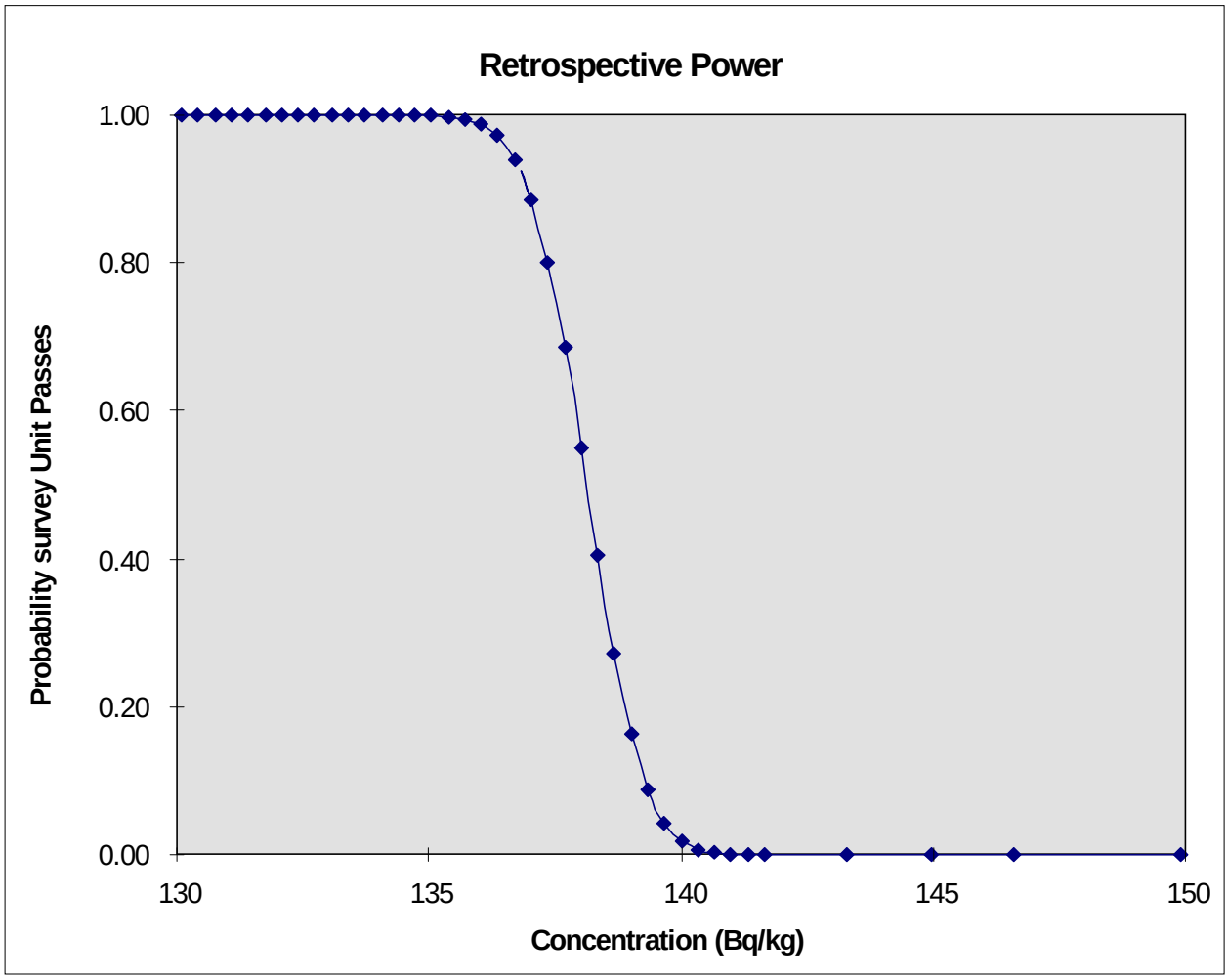

Figure I.5 Retrospective Power Curve for Class 3 Exterior Survey Unit

I.9.2 Power of the Wilcoxon Rank Sum Test

The power of the WRS test is computed from

$$Power = 1 - \Phi\left[\frac{W_c - 0.5 - 0.5m(m+1) - E(W_{MW})}{\sqrt{Var(W_{MW})}}\right] \quad \text{(I-8)}$$

where W_c is the critical value found in Table I.4 for the appropriate vales of α, n and m. Values of $\Phi(z)$, the standard normal cumulative distribution function, are given in Table I.1.

$W_{MW} = W_r - 0.5m(m+1)$ is the Mann-Whitney form of the WRS test statistic. Its mean is

$$E(W_{MW}) = mnP_r \quad \text{(I-9)}$$

and its variance is

$$\text{Var}(W_{MW}) = mnP_r(1-P_r) + mn(n+m-2)(p_2 - P_r^2) \quad \text{(I-10)}$$

Values of P_r and p_2 as a function of Δ/σ are given in Table I.10.

The power calculated in Equation I-8 is an approximation, but the results are generally accurate enough to be used to determine if the sample design achieves the DQOs.

The retrospective power curve for the WRS test can be constructed using Equations I-8, I-9, and I-10, together with the actual number of concentration measurements obtained, N. The power as a function of Δ/σ is calculated. The values of Δ/σ are converted to dpm/100 cm^2 using:

dpm/100 cm^2 = DCGL - (Δ/σ)(observed standard deviation).

The results for this example are plotted in Figure I.6, showing the probability that the survey unit would have passed the release criterion using the WRS test versus dpm of residual radioactivity. This curve shows that the data quality objectives were easily achieved. The curve shows that a survey unit with less than 4,500 dpm/100 cm^2 above background would almost always pass, and that one with more than 5,100 dpm/100 cm^2 above background would almost always fail.

Table I.10 Values of P_r and p_2 for Computing the Mean and Variance of W_{MW}

Δ/σ	P_r	p_2	Δ/σ	P_r	p_2
-6.0	1.11E-05	1.16E-07	0.7	0.689691	0.544073
-5.0	0.000204	6.14E-06	0.8	0.714196	0.574469
-4.0	0.002339	0.000174	0.9	0.737741	0.604402
-3.5	0.006664	0.000738	1.0	0.760250	0.633702
-3.0	0.016947	0.002690	1.1	0.781662	0.662216
-2.5	0.038550	0.008465	1.2	0.801928	0.689800
-2.0	0.078650	0.023066	1.3	0.821015	0.716331
-1.9	0.089555	0.027714	1.4	0.838901	0.741698
-1.8	0.101546	0.033114	1.5	0.855578	0.765812
-1.7	0.114666	0.039348	1.6	0.871050	0.788602
-1.6	0.128950	0.046501	1.7	0.885334	0.810016
-1.5	0.144422	0.054656	1.8	0.898454	0.830022
-1.4	0.161099	0.063897	1.9	0.910445	0.848605
-1.3	0.178985	0.074301	2.0	0.921350	0.865767
-1.2	0.198072	0.085944	2.1	0.931218	0.881527
-1.1	0.218338	0.098892	2.2	0.940103	0.895917
-1.0	0.239750	0.113202	2.3	0.948062	0.908982
-0.9	0.262259	0.128920	2.4	0.955157	0.920777
-0.8	0.285804	0.146077	2.5	0.961450	0.931365
-0.7	0.310309	0.164691	2.6	0.967004	0.940817
-0.6	0.335687	0.184760	2.7	0.971881	0.949208
-0.5	0.361837	0.206266	2.8	0.976143	0.956616
-0.4	0.388649	0.229172	2.9	0.979848	0.963118
-0.3	0.416002	0.253419	3.0	0.983053	0.968795
-0.2	0.443769	0.278930	3.1	0.985811	0.973725
-0.1	0.471814	0.305606	3.2	0.988174	0.977981
0.0	0.500000	0.333333	3.3	0.990188	0.981636
0.1	0.528186	0.361978	3.4	0.991895	0.984758
0.2	0.556231	0.391392	3.5	0.993336	0.987410
0.3	0.583998	0.421415	4.0	0.997661	0.995497
0.4	0.611351	0.451875	5.0	0.999796	0.999599
0.5	0.638163	0.482593	6.0	0.999989	0.999978
0.6	0.664313	0.513387			

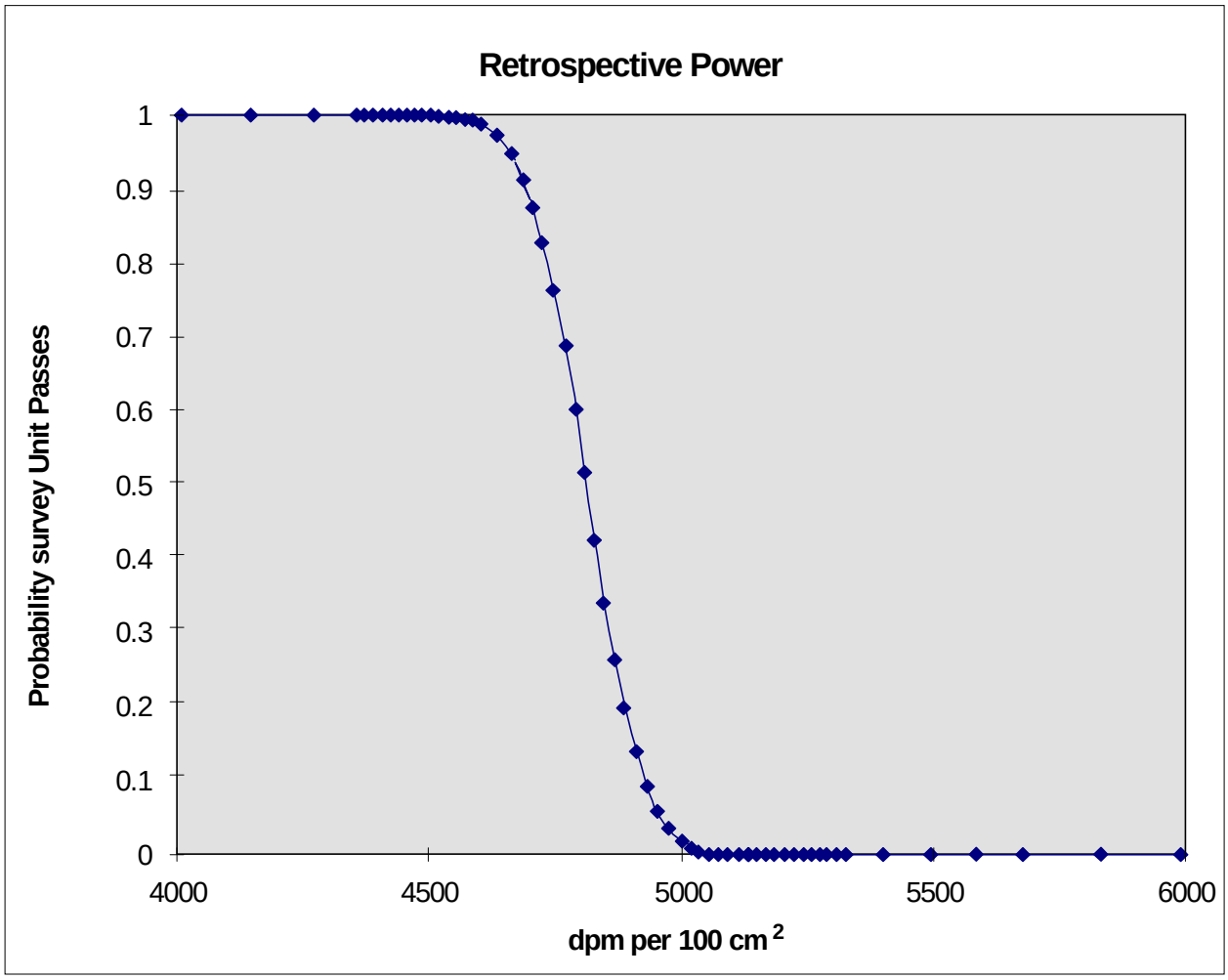

Figure I.6 Retrospective Power Curve for Class 2 Interior Drywall Survey Unit

I.10 Spreadsheet Formulas for the Wilcoxon Rank Sum Test

The analysis for the WRS test is very well suited for calculation on a spreadsheet. This is how the analysis discussed above was done. This particular example was constructed using Excel 5.0™. The formula sheet corresponding to Table 8.6 is given in Table I.11. The function in Column D of Table I.11 calculates the ranks of the data. The RANK function in Excel™ does not return tied ranks in the way needed for the WRS. The COUNTIF function is used to correct for this. Column E simply picks out the reference area ranks from Column D.

Table I.11 Spreadsheet Formulas Used in Table 8.6

	A	B	C	D	E
1	**Data**	**Area**	**Adjusted Data**	**Ranks**	**Reference Area Ranks**
2	49	R	=IF(B2="R",A2+160,A2)	=RANK(C2,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C2) - 1) / 2	=IF(B2="R",D2,0)
3	35	R	=IF(B3="R",A3+160,A3)	=RANK(C3,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C3) - 1) / 2	=IF(B3="R",D3,0)
4	45	R	=IF(B4="R",A4+160,A4)	=RANK(C4,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C4) - 1) / 2	=IF(B4="R",D4,0)
5	45	R	=IF(B5="R",A5+160,A5)	=RANK(C5,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C5) - 1) / 2	=IF(B5="R",D5,0)
6	41	R	=IF(B6="R",A6+160,A6)	=RANK(C6,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C6) - 1) / 2	=IF(B6="R",D6,0)
7	44	R	=IF(B7="R",A7+160,A7)	=RANK(C7,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C7) - 1) / 2	=IF(B7="R",D7,0)
8	48	R	=IF(B8="R",A8+160,A8)	=RANK(C8,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C8) - 1) / 2	=IF(B8="R",D8,0)
9	37	R	=IF(B9="R",A9+160,A9)	=RANK(C9,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C9) - 1) / 2	=IF(B9="R",D9,0)
10	46	R	=IF(B10="R",A10+160,A10)	=RANK(C10,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C10) - 1) / 2	=IF(B10="R",D10,0)
11	42	R	=IF(B11="R",A11+160,A11)	=RANK(C11,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C11) - 1) / 2	=IF(B11="R",D11,0)
12	47	R	=IF(B12="R",A12+160,A12)	=RANK(C12,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C12) - 1) / 2	=IF(B12="R",D12,0)
13	104	S	=IF(B13="R",A13+160,A13)	=RANK(C13,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C13) - 1) / 2	=IF(B13="R",D13,0)
14	94	S	=IF(B14="R",A14+160,A14)	=RANK(C14,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C14) - 1) / 2	=IF(B14="R",D14,0)
15	98	S	=IF(B15="R",A15+160,A15)	=RANK(C15,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C15) - 1) / 2	=IF(B15="R",D15,0)
16	99	S	=IF(B16="R",A16+160,A16)	=RANK(C16,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C16) - 1) / 2	=IF(B16="R",D16,0)
17	90	S	=IF(B17="R",A17+160,A17)	=RANK(C17,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C17) - 1) / 2	=IF(B17="R",D17,0)
18	104	S	=IF(B18="R",A18+160,A18)	=RANK(C18,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C18) - 1) / 2	=IF(B18="R",D18,0)
19	95	S	=IF(B19="R",A19+160,A19)	=RANK(C19,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C19) - 1) / 2	=IF(B19="R",D19,0)
20	105	S	=IF(B20="R",A20+160,A20)	=RANK(C20,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C20) - 1) / 2	=IF(B20="R",D20,0)
21	93	S	=IF(B21="R",A21+160,A21)	=RANK(C21,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C21) - 1) / 2	=IF(B21="R",D21,0)
22	101	S	=IF(B22="R",A22+160,A22)	=RANK(C22,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C22) - 1) / 2	=IF(B22="R",D22,0)
23	92	S	=IF(B23="R",A23+160,A23)	=RANK(C23,$C$2:$C$23,1)+(COUNTIF($C$2:$C$23,C23) - 1) / 2	=IF(B23="R",D23,0)
24			Sum=	=SUM(D2:D23)	=SUM(E2:E23)

I.11 Multiple Radionuclides

There are two cases to be considered when dealing with multiple radionuclides, namely 1) the radionuclide concentrations have a fairly constant ratio throughout the survey unit, or 2) the concentrations of the different radionuclides appear to be unrelated in the survey unit. In statistical terms, we are concerned about whether the concentrations of the different radionuclides are correlated or not. A simple way to judge this would be to make a scatter plot of the concentrations against each other, and see if the points appear to have an underlying linear pattern. The correlation coefficient can also be computed to see if it lies nearer to zero than to one. One could also perform a curve fit and test the significance of the result. Ultimately, however, sound judgement must be used in interpreting the results of such calculations. If there is no physical reason for the concentrations to be related, they probably are not. Conversely, if there is sound evidence that the radionuclide concentrations should be related because of how they were treated, processed or released, this information should be used.

I.11.1 Using the Unity Rule

In either of the two above cases, the unity rule described in Section 4.3.3 is applied. The difference is in how it is applied. Suppose there are *n* radionuclides. If the concentration of radionuclide *i* is denoted by C_i, and its $DCGL_W$ is denoted by D_i, then the unity rule for the *n* radionuclides states that:

$$C_1 / D_1 + C_2 / D_2 + C_3 / D_3 + \cdots + C_n / D_n \leq 1 \qquad \text{(I-11)}$$

This will ensure that the total dose or risk due to the sum of all the radionuclides does not exceed the release criterion. Note that if D_{min} is the smallest of the DCGLs, then

$$(C_1 + C_2 + C_3 + \cdots + C_n)/D_{min} \leq C_1 / D_1 + C_2 / D_2 + C_3 / D_3 + \cdots + C_n / D_n \qquad \text{(I-12)}$$

so that the smallest DCGL may be applied to the total activity concentration, rather than using the unity rule. While this option may be considered, in many cases it will be too conservative to be useful.

I.11.2 Radionuclide Concentrations with Fixed Ratios

If there is an established ratio among the concentrations of the *n* radionuclides in a survey unit, then the concentration of every radionuclide can be expressed in terms of any one of them, e.g., radionuclide #1. The measured radionuclide is often called a *surrogate* radionuclide for the others.

If $C_2 = R_2 C_1, C_3 = R_3 C_1, \ldots, C_i = R_i C_1, \ldots, C_n = R_n C_1$

then

$$\begin{aligned} & C_1 / D_1 + C_2 / D_2 + C_3 / D_3 + \cdots + C_n / D_n \\ & = C_1 / D_1 + R_2 C_1 / D_2 + R_3 C_1 / D_3 + \cdots + R_n C_1 / D_n \\ & = C_1 [1/ D_1 + R_2 / D_2 + R_3 / D_3 + \cdots + R_n / D_n] \\ & = C_1 / D_{total} \end{aligned} \quad \text{(I-13)}$$

where

$$D_{total} = 1/ [1/ D_1 + R_2 / D_2 + R_3 / D_3 + \cdots + R_n / D_n] \quad \text{(I-14)}$$

Thus, D_{total} is the $DCGL_W$ for the surrogate radionuclide when the concentration of that radionuclide represents all radionuclides that are present in the survey unit. Clearly, this scheme is applicable only when radionuclide specific measurements of the surrogate radionuclide are made. It is unlikely to apply in situations where the surrogate radionuclide appears in background, since background variations would tend to obscure the relationships between it and the other radionuclides.

Thus, in the case where there are constant ratios among radionuclide concentrations, the statistical tests are applied as if only the surrogate radionuclide were contributing to the residual radioactivity, with the $DCGL_W$ for that radionuclide replaced by D_{total}. For example, in planning the final status survey, only the expected standard deviation of the concentration measurements for the surrogate radionuclide is needed to calculate the sample size.

For the elevated measurement comparison, the $DCGL_{EMC}$ for the surrogate radionuclide is replaced by

$$E_{total} = 1/ [1/ E_1 + R_2 / E_2 + R_3 / E_3 + \cdots + R_n / E_n] \quad \text{(I-15)}$$

where E_i is the $DCGL_{EMC}$ for radionuclide *i*.

I.11.3 Unrelated Radionuclide Concentrations

If the concentrations of the different radionuclides appear to be unrelated in the survey unit, there is little alternative but to measure the concentration of each radionuclide and use the unity rule. The exception would be in applying the most restrictive $DCGL_W$ to all of the radionuclides, as mentioned later in this section.

Since the release criterion is

$$C_1 / D_1 + C_2 / D_2 + C_3 / D_3 + \cdots + C_n / D_n \leq 1 \quad \text{(I-16)}$$

the quantity to be measured is the *weighted sum*, $T = C_1 / D_1 + C_2 / D_2 + C_3 / D_3 + \cdots + C_n / D_n$. The $DCGL_W$ for T is one. In planning the final status survey, the measurement standard deviation of the weighted sum, T, is estimated by

$$\sigma^2(T) = [\sigma(C_1)/ D_1]^2 + [\sigma(C_2)/ D_2]^2 + [\sigma(C_3)/ D_3]^2 + \cdots + [\sigma(C_n)/ D_n]^2 \qquad \text{(I-17)}$$

since the measured concentrations of the various radionuclides are assumed to be uncorrelated.

For the elevated measurement comparison, the inequality

$$C_1 / E_1 + C_2 / E_2 + C_3 / E_3 + \cdots + C_n / E_n \leq 1 \qquad \text{(I-18)}$$

is used, where E_i is the $DCGL_{EMC}$ for radionuclide i. For scanning, the most restrictive $DCGL_{EMC}$ should generally be used.

When some of the radionuclides also appear in background, the quantity $T = C_1 / D_1 + C_2 / D_2 + C_3 / D_3 + \cdots + C_n / D_n$ must also be measured in an appropriate reference area. If radionuclide i does not appear in background, set $C_i = 0$ in the calculation of T for the reference area.

Note that if there is a fixed ratio between the concentrations of some radionuclides, but not others, a combination of the method of this section with that of the previous section may be used. The appropriate value of D_{total} with the concentration of the measured surrogate radionuclide should replace the corresponding terms in equation I-17.

I.11.4 Example Application of WRS Test to multiple radionuclides

This section contains an example application of the nonparametric statistical methods in this report to sites that have residual radioactivity from more than one radionuclide. Consider a site with both ^{60}Co and ^{137}Cs contamination. ^{137}Cs appears in background from global atmospheric weapons tests at a typical concentration of about 1 pCi/g. Assume that the $DCGL_W$ for ^{60}Co is 2 pCi/g and for ^{137}Cs is 1.4 pCi/g. In disturbed areas, the background concentration of ^{137}Cs can vary considerably. An estimated spatial standard deviation of 0.5 pCi/g for ^{137}Cs will be assumed. During remediation, it was found that the concentrations of the two radionuclides were not well correlated in the survey unit. ^{60}Co concentrations were more variable than the ^{137}Cs concentrations, and 0.7 pCi/g is estimated for its standard deviation. Measurement errors for both ^{60}Co and ^{137}Cs using gamma spectrometry will be small compared to this. For the comparison to the release criteria, the weighted sum of the concentrations of these radionuclides is computed from:

Weighted sum = (^{60}Co concentration)/(^{60}Co $DCGL_W$) + (^{137}Cs Concentration)/(^{137}Cs $DCGL_W$)
= (^{60}Co concentration)/(2) + (^{137}Cs Concentration)/(1.4)

The variance of the weighted sum, assuming that the ^{60}Co and ^{137}Cs concentrations are spatially unrelated is

$\sigma^2 = [(^{60}Co \text{ Standard deviation})/(^{60}Co \text{ DCGL}_W)]^2 + [(^{137}Cs \text{ Standard Deviation})/(^{137}Cs \text{ DCGL}_W)]^2$
$= [(0.7)/(2)]^2 + [(0.5)/(1.4)]^2 = 0.25.$

Thus $\sigma = 0.5$. The $DCGL_W$ for the weighted sum is one. The null hypothesis is that the survey unit exceeds the release criterion. During the DQO process, the LBGR was set at 0.5 for the weighted sum, so that $\Delta = DCGL_W$ - LBGR =1.0 -0.5 = 0.5, and $\Delta/\sigma = 0.5/0.5 = 1.0$. The acceptable error rates chosen were $\alpha = \beta = 0.05$. To achieve this, 32 samples each are required in the survey unit and the reference area.

The weighted sums are computed for each measurement location in both the reference area and the survey unit. The WRS test is then performed on the weighted sum. The calculations for this example are shown in Table I.12. The $DCGL_W$ (i.e., 1.0) is added to the weighted sum for each location in the reference area. The ranks of the combined survey unit and adjusted reference area weighted sums are then computed. The sum of the ranks of the adjusted reference area weighted sums is then compared to the critical value for $n = m = 32$, $\alpha = 0.05$, which is 1162 (see formula following Table I.4). In Table I.12, the sum of the ranks of the adjusted reference area weighted sums is 1281. This exceeds the critical value, so the null hypothesis is rejected. The survey unit meets the release criterion. The difference between the mean of the weighted sums in the survey unit and the reference area is 1.86 - 1.16 = 0.7. Thus, the estimated dose or risk due to residual radioactivity in the survey unit is 70% of the release criterion.

Table I.12 Example WRS Test for Two Radionuclides

	Reference Area		Survey Unit		Weighted Sum			Ranks	
	^{137}Cs	^{60}Co	^{137}Cs	^{60}Co	*Ref*	*Survey*	*Adj Ref*	*Survey*	*Adj Ref*
1	2.00	0	1.12	0.06	1.43	0.83	2.43	1	56
2	1.23	0	1.66	1.99	0.88	2.18	1.88	43	21
3	0.99	0	3.02	0.56	0.71	2.44	1.71	57	14
4	1.98	0	2.47	0.26	1.41	1.89	2.41	23	55
5	1.78	0	2.08	0.21	1.27	1.59	2.27	9	50
6	1.93	0	2.96	0.00	1.38	2.11	2.38	37	54
7	1.73	0	2.05	0.20	1.23	1.56	2.23	7	46
8	1.83	0	2.41	0.00	1.30	1.72	2.30	16	52
9	1.27	0	1.74	0.00	0.91	1.24	1.91	2	24
10	0.74	0	2.65	0.16	0.53	1.97	1.53	27	6
11	1.17	0	1.92	0.63	0.83	1.68	1.83	13	18
12	1.51	0	1.91	0.69	1.08	1.71	2.08	15	32
13	2.25	0	3.06	0.13	1.61	2.25	2.61	47	63
14	1.36	0	2.18	0.98	0.97	2.05	1.97	30	28
15	2.05	0	2.08	1.26	1.46	2.12	2.46	39	58
16	1.61	0	2.30	1.16	1.15	2.22	2.15	45	41
17	1.29	0	2.20	0.00	0.92	1.57	1.92	8	25
18	1.55	0	3.11	0.50	1.11	2.47	2.11	59	35
19	1.82	0	2.31	0.00	1.30	1.65	2.30	11	51
20	1.17	0	2.82	0.41	0.84	2.22	1.84	44	19
21	1.76	0	1.81	1.18	1.26	1.88	2.26	22	48
22	2.21	0	2.71	0.17	1.58	2.02	2.58	29	62
23	2.35	0	1.89	0.00	1.68	1.35	2.68	3	64
24	1.51	0	2.12	0.34	1.08	1.68	2.08	12	33
25	0.66	0	2.59	0.14	0.47	1.92	1.47	26	5
26	1.56	0	1.75	0.71	1.12	1.60	2.12	10	38
27	1.93	0	2.35	0.85	1.38	2.10	2.38	34	53
28	2.15	0	2.28	0.87	1.54	2.06	2.54	31	61
29	2.07	0	2.56	0.56	1.48	2.11	2.48	36	60
30	1.77	0	2.50	0.00	1.27	1.78	2.27	17	49
31	1.19	0	1.79	0.30	0.85	1.43	1.85	4	20
32	1.57	0	2.55	0.70	1.12	2.17	2.12	42	40
Avg	1.62	0	2.28	0.47	1.16	1.86	2.16	sum = 799	sum = 1281
Std Dev	0.43	0	0.46	0.48	0.31	0.36	0.31		

APPENDIX J

DERIVATION OF ALPHA SCANNING EQUATIONS PRESENTED IN SECTION 6.7.2.2

For alpha survey instrumentation with a background around one to three counts per minute, a single count will give a surveyor sufficient cause to stop and investigate further. Assuming this to be true, the probability of detecting given levels of alpha emitting radionuclides can be calculated by use of Poisson summation statistics.

Discussion

Experiments yielding numerical values for a random variable X, where X represents the number of events occurring during a given time interval or a specified region in space, are often called Poisson experiments (Walpole and Myers 1985). The probability distribution of the Poisson random variable X, representing the number of events occurring in a given time interval t, is given by:

$$P(x;\lambda t) = \frac{e^{-\lambda t}(\lambda t)^x}{x!}, \quad x = 0, 1, 2, ... \qquad \text{(J-1)}$$

where:

$P(x; \lambda t)$ =		probability of x events in time interval t
λ	=	Average number of events per unit time
λt	=	Average value expected

To define this distribution for an alpha scanning system, substitutions may be made giving:

$$P(n;m) = \frac{e^{-m} m^n}{n!} \qquad \text{(J-2)}$$

where:

P(n; m) =		probability of getting n counts when the average number expected is m
m	=	λt , average number of counts expected
n	=	x, number of counts actually detected

For a given detector size, source activity, and scanning rate, the probability of getting *n* counts while passing over the source activity with the detector can be written as:

$$P(n;m) = \frac{e^{\frac{-GEd}{60v}}\left[\frac{GEd}{60v}\right]^n}{n!} = \frac{e^{\frac{-GEt}{60}}\left[\frac{GEt}{60}\right]^n}{n!} \quad \text{(J-3)}$$

where:

G	=	source activity (dpm)
E	=	detector efficiency (4π)
d	=	width of the detector in the direction of scan (cm)
v	=	scan speed (cm/s)
t	=	d/v, dwell time over source (s)

If it is assumed that the detector background is equal to zero, then the probability of observing greater than or equal to 1 count, P(n≥1), within a time interval t is:

$$P(n \geq 1) = 1 - P(n = 0) \quad \text{(J-4)}$$

If it is also assumed that a single count is sufficient to cause a surveyor to stop and investigate further, then:

$$P(n \geq 1) = 1 - P(n = 0) = 1 - e^{-\frac{GEd}{60v}} \quad \text{(J-5)}$$

Figures J.1 through J.3 show this function plotted for three different detector sizes and four different source activity levels. Note that the source activity levels are given in terms of areal activity values (dpm per 100 cm^2), the probe sizes are the dimensions of the probes in line with the direction of scanning, and the detection efficiency has been assumed to be 15%. The assumption is made that the areal activity is contained within a 100 cm^2 area and that the detector completely passes over the area either in one or multiple passes.

Once a count has been recorded and the surveyor stops, the surveyor should wait a sufficient period of time such that if the guideline level of contamination is present, the probability of getting another count is at least 90%. This minimum time interval can be calculated for given contamination guideline values by substituting the following parameters into Equation J-5 and solving:

$P(\geq 1) = 0.9$

$d/v = t$

$G = \frac{CA}{100}$

where:

C = contamination guideline (dpm/100 cm^2)

A = Detector area (cm^2)

Giving:

$$t = \frac{13800}{CAE} \qquad \text{(J-6)}$$

Equation J-3 can be solved to give the probability of getting any number of counts while passing over the source area, although the solutions can become long and complex. Many portable proportional counters have background count rates on the order of 5 to 10 counts per minute and a single count will not give a surveyor cause to stop and investigate further. If a surveyor did stop for every count, and subsequently waited a sufficiently long period to make sure that the previous count either was or wasn't caused by an elevated contamination level, little or no progress would be made. For these types of instruments, the surveyor usually will need to get at least 2 counts while passing over the source area before stopping for further investigation. Assuming this to be a valid assumption, Equation J-3 can be solved for $n \geq 2$ as follows:

$$\begin{aligned} P(n \geq 2) &= 1 - P(n = 0) - P(n = 1) \\ &= 1 - e^{-\frac{(GE+B)t}{60}} - \frac{(GE+B)t}{60} e^{-\frac{(GE+B)t}{60}} \\ &= 1 - e^{-\frac{(GE+B)t}{60}} \left(1 + \frac{(GE+B)t}{60}\right) \end{aligned} \qquad \text{(J-7)}$$

Where:

P(n≥2) = probability of getting 2 or more counts during the time interval t

P(n=0) = probability of not getting any counts during the time interval t

P(n=1) = probability of getting 1 count during the time interval t

B = background count rate (cpm)

All other variables are the same as in Equation J-3.

Figures J-4 through J-7 show this function plotted for three different probe sizes and three different source activity levels. The same assumptions were made when calculating these curves as were made for Figures J-1 through J-3 except that the background was assumed to be 7 counts per minute.

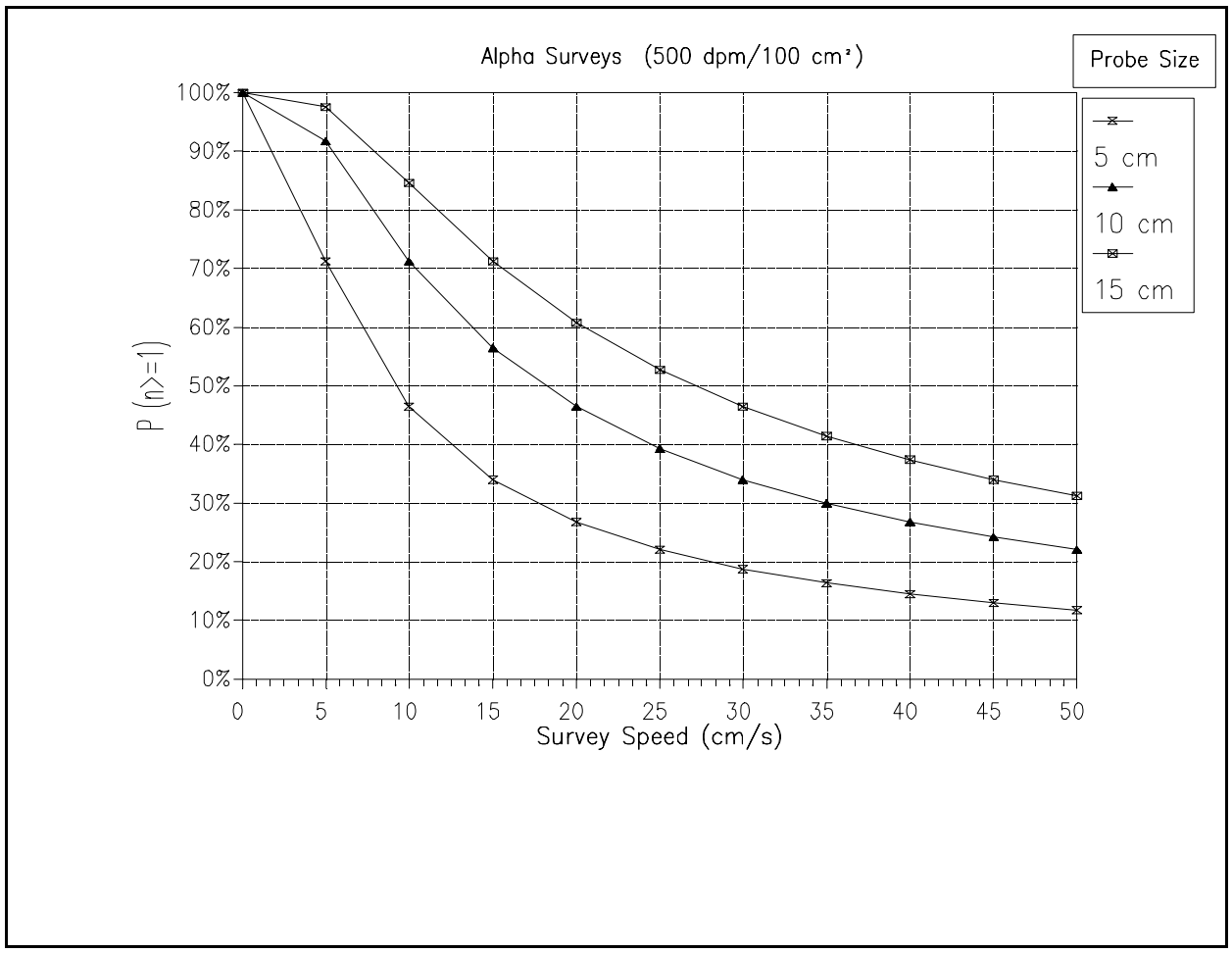

Figure J.1 Probability (P) of getting one or more counts when passing over a 100 cm^2 area contaminated at 500 dpm/100 cm^2 alpha. The chart shows the probability versus scanning speed for three different probe sizes. The probe size denotes the dimensions of the probes which are in line with the direction of scanning. A detection efficiency of 15% (4π) is assumed.

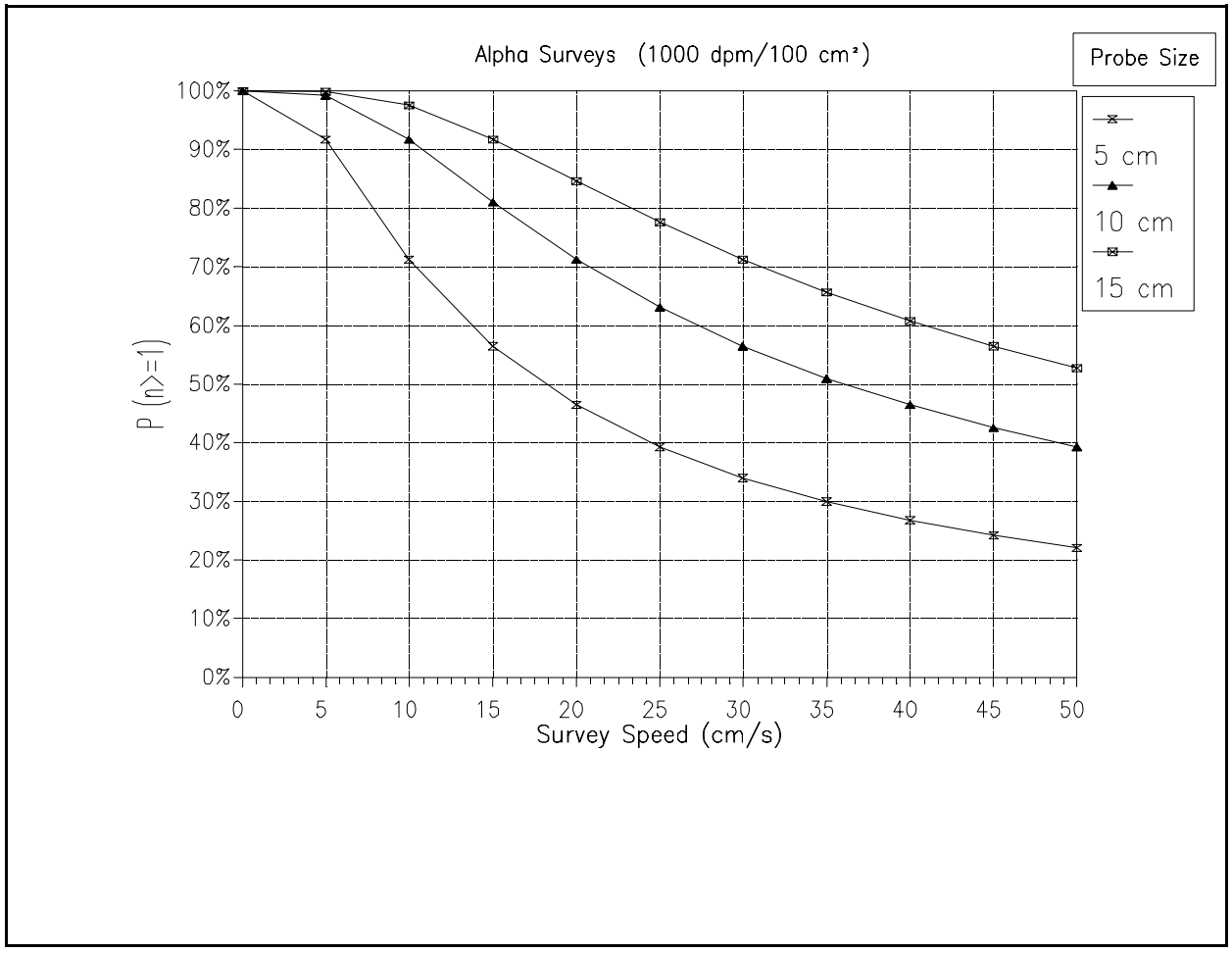

Figure J.2 Probability (P) of getting one or more counts when passing over a 100 cm^2 area contaminated at 1,000 dpm/100 cm^2 alpha. The chart shows the probability versus scanning speed for three different probe sizes. The probe size denotes the dimensions of the probes which are in line with the direction of scanning. A detection efficiency of 15% (4π) is assumed.

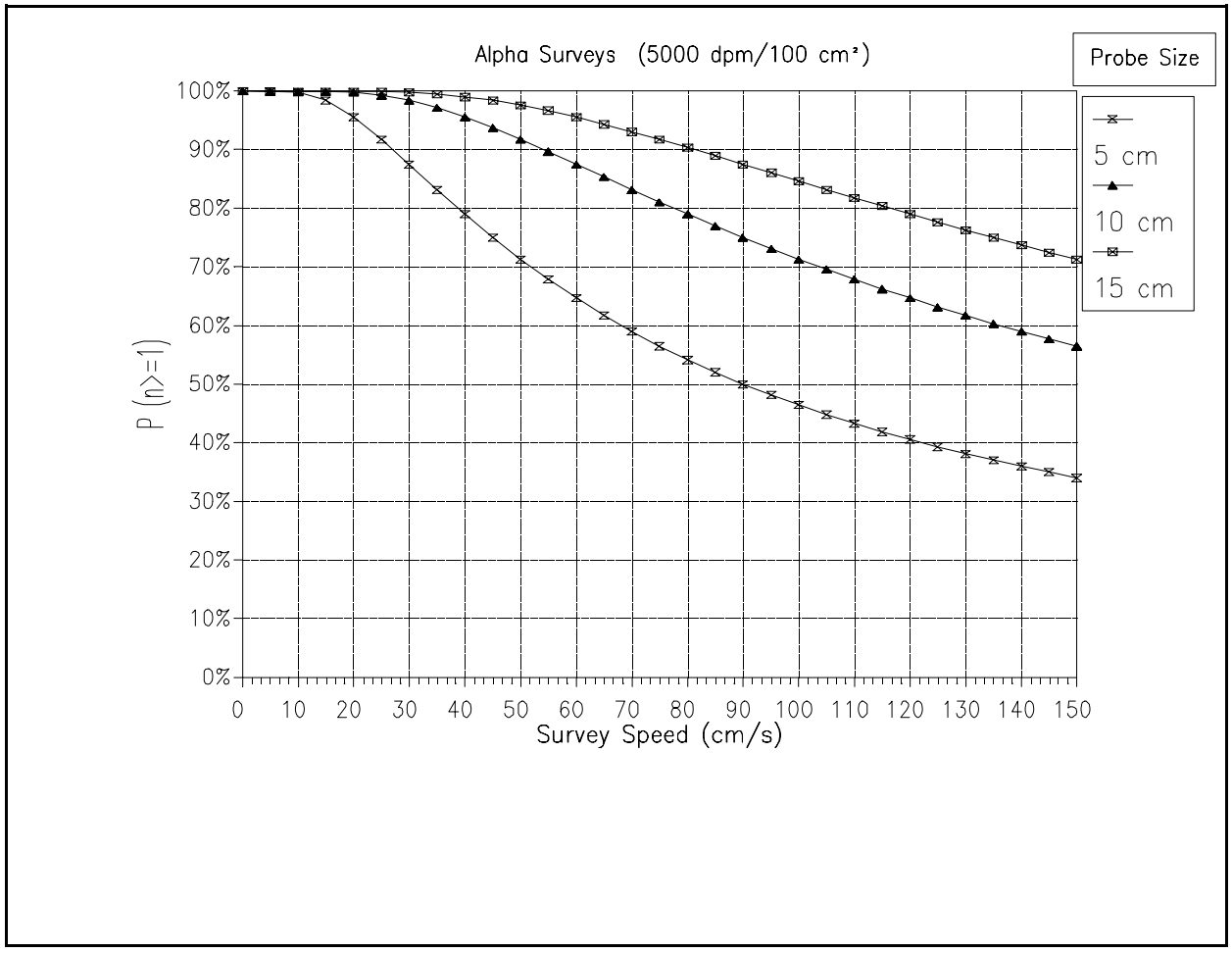

Figure J.3 Probability (P) of getting one or more counts when passing over a 100 cm^2 area contaminated at 5,000 dpm/100 cm^2 alpha. The chart shows the probability versus scanning speed for three different probe sizes. The probe size denotes the dimensions of the probes which are in line with the direction of scanning. A detection efficiency of 15% (4π) is assumed.

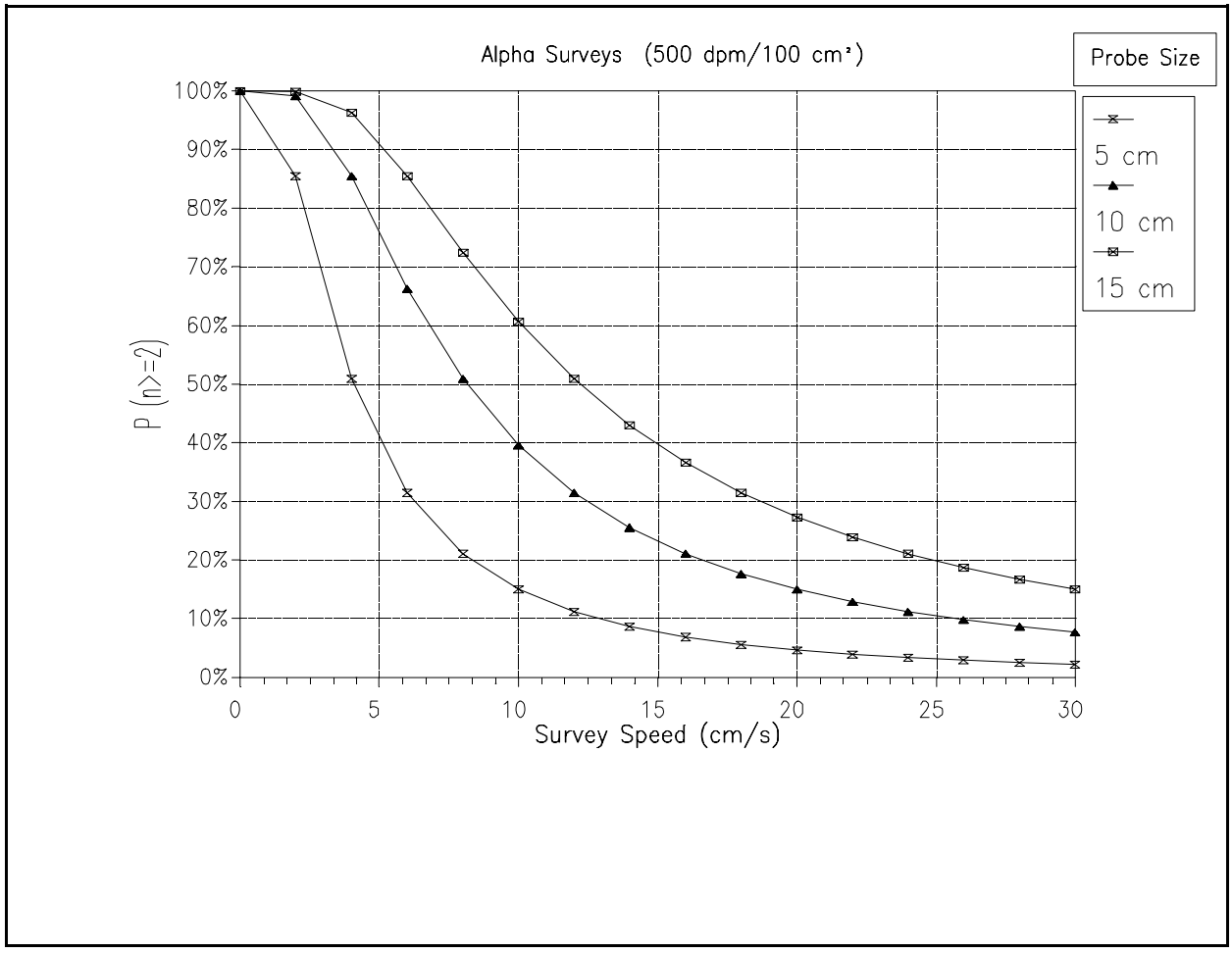

Figure J.4 Probability (P) of getting two or more counts when passing over a 100 cm^2 area contaminated at 500 dpm/100 cm^2 alpha. The chart shows the probability versus scanning speed for three different probe sizes. The probe size denotes the dimensions of the probes which are in line with the direction of scanning. A detection efficiency of 15% (4π) is assumed.

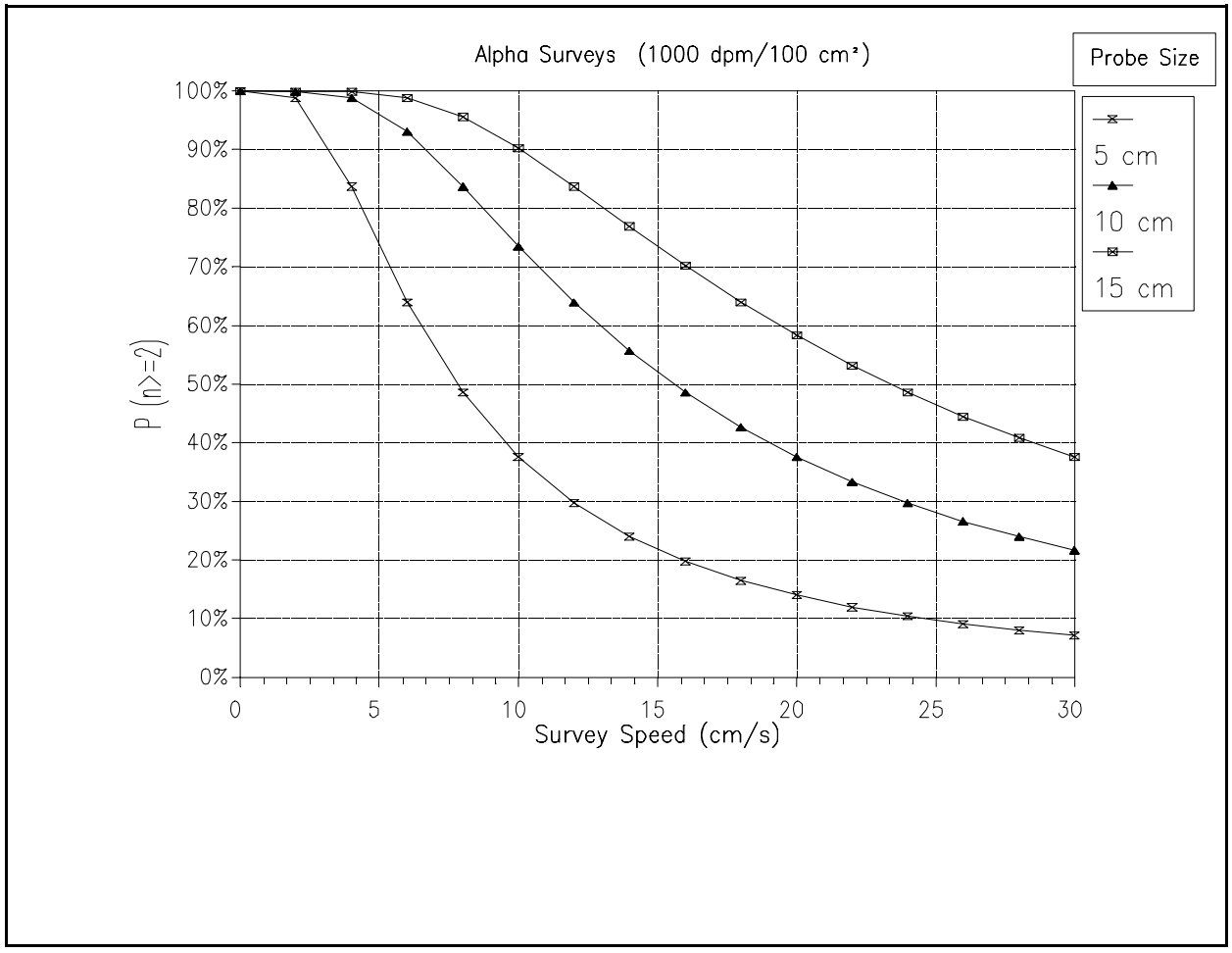

Figure J.5 Probability (P) of getting two or more counts when passing over a 100 cm^2 area contaminated at 1,000 dpm/100 cm^2 alpha. The chart shows the probability versus scanning speed for three different probe sizes. The probe size denotes the dimensions of the probes which are in line with the direction of scanning. A detection efficiency of 15% (4π) is assumed.

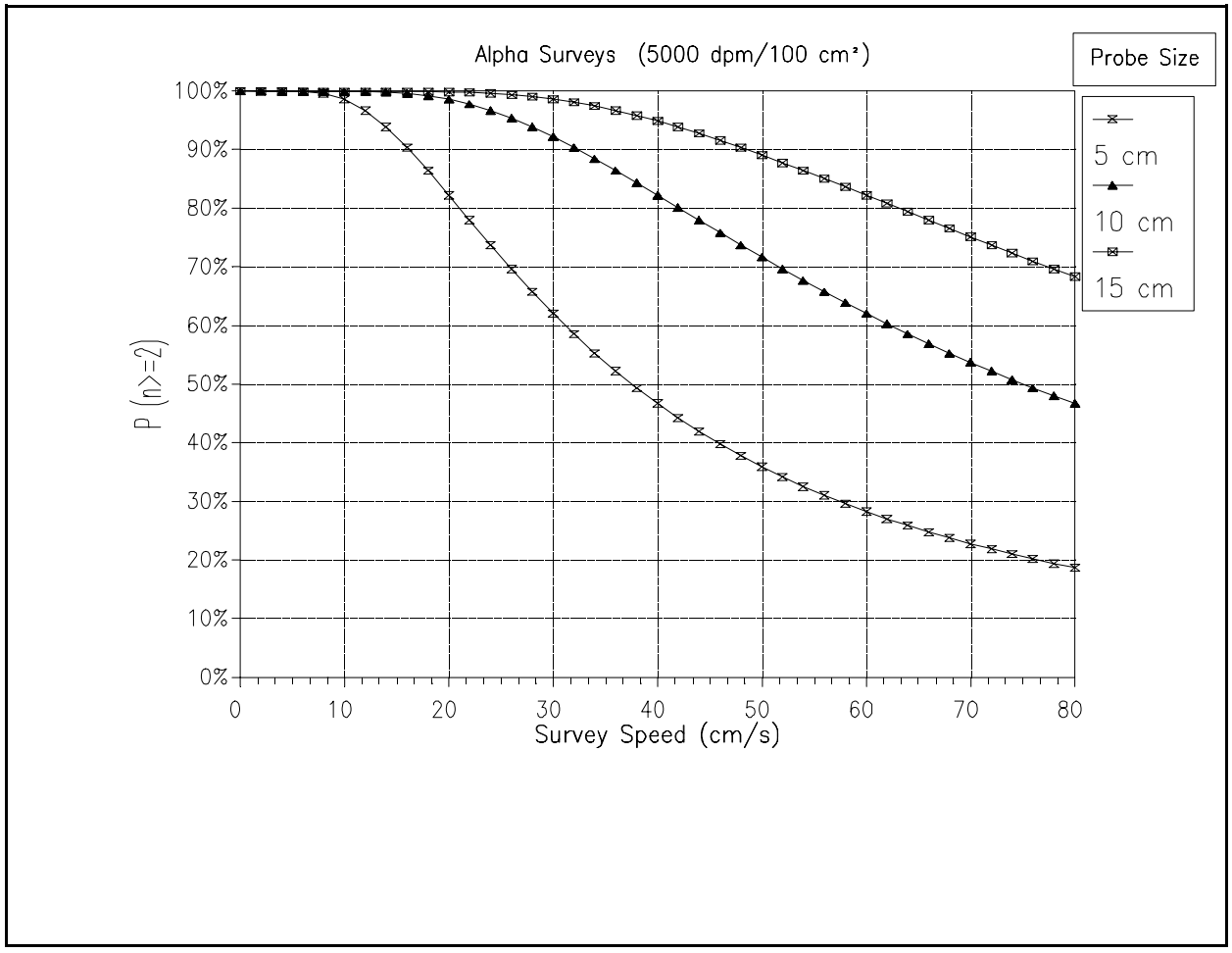

Figure J.6 Probability (P) of getting two or more counts when passing over a 100 cm^2 area contaminated at 5,000 dpm/100 cm^2 alpha. The chart shows the probability versus scanning speed for three different probe sizes. The probe size denotes the dimensions of the probes which are in line with the direction of scanning. A detection efficiency of 15% (4π) is assumed.

APPENDIX K

COMPARISON TABLES BETWEEN QUALITY ASSURANCE DOCUMENTS

The comparison tables in this appendix provide a reference for the MARSSIM user who may not be familiar with developing a QAPP based on EPA QA/R-5 (EPA 1994c). The tables relate the basic recommendations and requirements of EPA QA/R-5 and other quality assurance documents the reader may be more familiar with.

Each of the quality assurance documents compared in these tables was developed for a specific industry and scope. For this reason, there is not a direct comparison from one document to another. Rather, the tables are designed to show similarities between different quality assurance documents. In addition, there are topics specific to certain quality assurance documents that do not have a counterpart in these comparison tables.

If there is no section listed as being comparable with a section of EPA QA/R-5, this does not necessarily mean that the topic is not covered by the quality assurance document. In some cases the topic may have been divided up into several subtopics that are distributed between other sections of the particular document.

This appendix is not meant to provide a thorough cross-reference between different quality assurance documents. The purpose of these comparison tables is to demonstrate how the content of QAPPs might be arranged differently and show a user the location of important information concerning radiation surveys and site investigations. This might occur if the QAPP is developed using guidance the reviewer is unfamiliar with.

EPA QA/R-5 is compared with five quality assurance documents in the following tables:

- EPA QAMS-005/80 (EPA 1980d)
- ASME NQA-1 (ASME 1989)
- DOE Order 5700.6c (DOE 1991c)
- MIL-Q-9858A (DOD 1963)
- ISO 9000 (ISO 1987)

Table K.1 Comparison of EPA QA/R-5 and EPA QAMS-005/80

EPA QA/R-5 Elements		EPA QAMS-005/80	
A1	Title and Approval Sheet	1.0	Title Page with Provision for Approval Signatures
A2	Table of Contents	2.0	Table of Contents
A3	Distribution List		
A4	Project/Task Organization	4.0	Project Organization and Responsibility
A5	Problem Definition/Background	3.0	Project Description
A6	Project/Task Description	3.0	Project Description
A7	Quality Objectives and Criteria for Measurement Data	5.0	Quality Assurance Objectives for Measurement Data
A8	Project Narrative		
A9	Special Training Requirements/Certification		
A10	Documentation and Records		
B1	Sampling Process Design	6.0	Sampling Procedures
B2	Sampling Methods Requirements	6.0	Sampling Procedures
B3	Sample Handling and Custody Requirements	7.0	Sample Custody
B4	Analytical Methods Requirements	9.0	Analytical Methods
B5	Quality Control Requirements	11.0	Internal Quality Control Checks and Frequency
B6	Instrument/Equipment Testing, Inspection, and Maintenance Requirements	13.0	Preventive Maintenance Procedures and Schedules
B7	Instrument Calibration and Frequency	8.0	Calibration Procedures and Frequency
B8	Inspection/Acceptance Requirements for Supplies and Consumables		
B9	Data Acquisition Requirements		
B10	Data Quality Management		
C1	Assessments and Response Actions	12.0 15.0	Assessment and Response Actions Corrective Actions
C2	Reports to Management	16.0	Quality Assurance Reports to Management
D1	Data Review, Validation, and Verification Requirements	10.0	Data Reduction, Validation, and Reporting
D2	Validation and Verification Methods	10.0	Data Reduction, Validation, and Reporting
D3	Reconciliation with User Requirements		

Table K.2 Comparison of EPA QA/R-5 and ASME NQA-1

EPA QA/R-5 Elements		ASME NQA-1 Elements	
A1	Title and Approval Sheet		
A2	Table of Contents		
A3	Distribution List		
A4	Project/Task Organization	1.	Organization
A5	Problem Definition/Background		
A6	Project/Task Description	3.	Design Control
A7	Quality Objectives and Criteria for Measurement Data	2.	Quality Assurance Program
A8	Project Narrative	8.	Identification and Control of Items
A9	Special Training Requirements/Certification		
A10	Documentation and Records	4. 6.	Procurement Document Control Document Control
B1	Sampling Process Design	3.	Design Control
B2	Sampling Methods Requirements	5.	Instructions, Procedures, and Drawings
B3	Sample Handling and Custody Requirements	13.	Handling, Storage, and Shipping
B4	Analytical Methods Requirements	5.	Instructions, Procedures, and Drawings
B5	Quality Control Requirements	9. 11.	Control of Processes Test Control
B6	Instrument/Equipment Testing, Inspection, and Maintenance Requirements	10. 12.	Inspection Control of Measuring and Test Equipment
B7	Instrument Calibration and Frequency	14.	Inspection, Test, and Operating Status
B8	Inspection/Acceptance Requirements for Supplies and Consumables	7. 8.	Control of Purchased Items and Services Identification and Control of Items
B9	Data Acquisition Requirements		
B10	Data Quality Management		
C1	Assessments and Response Actions	15. 16. 18.	Control of Nonconforming Items Corrective Action Audits
C2	Reports to Management	17.	Quality Assurance Records
D1	Data Review, Validation, and Verification Requirements		
D2	Validation and Verification Methods		
D3	Reconciliation with User Requirements		

Table K.3 Comparison of EPA QA/R-5 and DOE Order 5700.6c

EPA QA/R-5 Elements		DOE Order 5700.6C Elements	
A1	Title and Approval Sheet		
A2	Table of Contents		
A3	Distribution List		
A4	Project/Task Organization	2	Personnel Training and Qualification
A5	Problem Definition/Background	1	Program
A6	Project/Task Description		
A7	Quality Objectives and Criteria for Measurement Data	1	Program
A8	Project Narrative		
A9	Special Training Requirements/Certification	2	Personnel Training and Qualification
A10	Documentation and Records	4	Documents and Records
B1	Sampling Process Design	6	Design
B2	Sampling Methods Requirements	5	Work Processes
B3	Sample Handling and Custody Requirements		
B4	Analytical Methods Requirements	5	Work Processes
B5	Quality Control Requirements		
B6	Instrument/Equipment Testing, Inspection, and Maintenance Requirements	8	Inspection and Acceptance Testing
B7	Instrument Calibration and Frequency		
B8	Inspection/Acceptance Requirements for Supplies and Consumables	7 8	Procurement Inspection and Acceptance Testing
B9	Data Acquisition Requirements		
B10	Data Quality Management		
C1	Assessments and Response Actions	10	Independent Assessment
C2	Reports to Management	9	Management Assessment
D1	Data Review, Validation, and Verification Requirements		
D2	Validation and Verification Methods		
D3	Reconciliation with User Requirements	3	Quality Improvement

Table K.4 Comparison of EPA QA/R-5 and MIL-Q-9858A

EPA QA/R-5 Elements		MIL-Q-9858A Elements	
A1	Title and Approval Sheet		
A2	Table of Contents		
A3	Distribution List		
A4	Project/Task Organization	3.1	Organization
A5	Problem Definition/Background		
A6	Project/Task Description		
A7	Quality Objectives and Criteria for Measurement Data	3.2	Initial Quality Planning
A8	Project Narrative		
A9	Special Training Requirements/Certification		
A10	Documentation and Records	3.4 4.1	Records Drawings, Documentation, and Changes
B1	Sampling Process Design		
B2	Sampling Methods Requirements	3.3	Work Instructions
B3	Sample Handling and Custody Requirements	6.4	Handling, Storage, and Delivery
B4	Analytical Methods Requirements	3.3	Work Instructions
B5	Quality Control Requirements	6.7	Identification of Inspection Status
B6	Instrument/Equipment Testing, Inspection, and Maintenance Requirements	4.2	Measuring and Test Equipment
B7	Instrument Calibration and Frequency	4.2	Measuring and Test Equipment
B8	Inspection/Acceptance Requirements for Supplies and Consumables	5.0 6.1	Control of Purchases Materials and Material Control
B9	Data Acquisition Requirements		
B10	Data Quality Management	3.4	Records
C1	Assessments and Response Actions	3.5 6.5	Corrective Action Nonconforming Material
C2	Reports to Management	3.6	Costs Related to Quality
D1	Data Review, Validation, and Verification Requirements		
D2	Validation and Verification Methods	6.6	Statistical Quality Control
D3	Reconciliation with User Requirements		
		6.2	Production Processing and Fabrication
		6.3	Completed Item Inspection and Test

Table K.5 Comparison of EPA QA/R-5 and ISO 9000

EPA QA/R-5 Elements		ISO 9000 Elements	
A1	Title and Approval Sheet		
A2	Table of Contents		
A3	Distribution List		
A4	Project/Task Organization	4	Management Responsibility
A5	Problem Definition/Background		
A6	Project/Task Description		
A7	Quality Objectives and Criteria for Measurement Data	5 5.2	Quality System Principles Structure of the Quality System
A8	Project Narrative		
A9	Special Training Requirements/Certification		
A10	Documentation and Records		
B1	Sampling Process Design	8	Quality in Specification and Design
B2	Sampling Methods Requirements	10	Quality in Production
B3	Sample Handling and Custody Requirements	16	Handling and Post Production Functions
B4	Analytical Methods Requirements	10	Quality in Production
B5	Quality Control Requirements	11	Control of Production
B6	Instrument/Equipment Testing, Inspection, and Maintenance Requirements	13	Control of Measuring and Test Equipment
B7	Instrument Calibration and Frequency		
B8	Inspection/Acceptance Requirements for Supplies and Consumables	9 11.2	Quality in Procurement Material Control and Traceability
B9	Data Acquisition Requirements		
B10	Data Quality Management		
C1	Assessments and Response Actions	5.4 14 15	Auditing the Quality System Nonconformity Corrective Action
C2	Reports to Management	5.3 6	Documentation of the Quality System Economics—Quality Related Costs
D1	Data Review, Validation, and Verification Requirements	11.7	Control of Verification Status
D2	Validation and Verification Methods	12	Verification Status
D3	Reconciliation with User Requirements		
		7	Quality in Marketing

APPENDIX L

REGIONAL RADIATION PROGRAM MANAGERS

The following is a directory list of regional program managers in Federal agencies who administer radiation control activities and have responsibility for certain radiation protection activities. The telephone numbers and addresses in this appendix are subject to change without notice. A more complete directory list of professional personnel in state and local government agencies is available from the Conference of Radiation Control Program Directors, Inc. (CRCPD). This directory is updated and distributed yearly. To obtain a copy of this annual publication please contact:

CRCPD
205 Capital Avenue
Frankfort, KY 40601
(502) 227-4543
http://www.crcpd.org
staff@crcpd.org

L.1 Department of Energy (DOE)

DOE Home Page http://www.doe.gov

Oak Ridge Operations Office
ORO Public Affairs Office
Post Office Box 2001
Oak Ridge, Tennessee 37831
Telephone: (865) 576-1005
http://www.oakridge.doe.gov/

Savannah River Operations Office
Department of Energy
Post Office Box A
Aiken, South Carolina 29808
Telephone: (803) 725-2889
http://www.srs.gov/

Albuquerque Operations Office
Department of Energy
Post Office Box 5400
Albuquerque, New Mexico 87185-5400
Telephone: (505) 845-6202
http://www.doeal.gov/

Chicago Operations Office
Department of Energy
9700 South Cass Avenue
Argonne, Illinois 60439
Telephone: (630) 252-2000
http://www.ch.doe.gov/

Idaho Operations Office
Department of Energy
Post Office Box 1625
Idaho Falls, Idaho 83401
Telephone: (208) 526-0833
http://www.id.doe.gov/doeid/index.html

Oakland Operations Office
Department of Energy
1301 Clay Street
Oakland, California 94612
Telephone: (510) 637-1762
http://www.oak.doe.gov/

Richland Operations Office
Department of Energy
Post Office Box 550, A7-75
Richland, Washington 99352
Telephone: (509) 376-7501
http://www.hanford.gov/

Nevada Operations Office
Department of Energy
PO Box 98518
Las Vegas, NV 89193-8518
Telephone: (702) 295-3521
http://www.nv.doe.gov/

L.2 Environmental Protection Agency (EPA)

EPA Home Page http://www.epa.gov

Region 1	(CT, MA, ME, NH, RI, VT)	
	U.S. Environmental Protection Agency	Telephone: (888) 372-7341
	Region 1	(617) 918-1111
	1 Congress Street	http://www.epa.gov/region01/
	Boston, Massachusetts 02114-2023	
Region 2	(NJ, NY, PR, VI)	
	U.S. Environmental Protection Agency	Telephone: (212) 637-3000
	Region 2	http://www.epa.gov/Region2/
	290 Broadway	
	New York, New York 10007-1866	
Region 3	(DC, DE, MD, PA, VA, WV)	
	U.S. Environmental Protection Agency	Telephone: (215) 597-9800
	Region 3 (3CG00)	(215) 814-5000
	1650 Arch Street	(800) 438-2474
	Philadelphia, Pennsylvania 19103-2029	http://www.epa.gov/region03/
Region 4	(AL, FL, GA, KY, MS, NC, SC, TN)	
	U.S. Environmental Protection Agency	Telephone: (404) 562-9900
	Region 4	(800) 241-1754
	Atlanta Federal Center	http://www.epa.gov/region4/
	61 Forsyth Street, SW	
	Atlanta, Georgia 30303-3104	
Region 5	(IL, IN, MI, MN, OH, WI)	
	U.S. Environmental Protection Agency	Telephone: (312) 353-2000
	Region 5	(800) 621-8431
	77 West Jackson Boulevard	http://www.epa.gov/region5/
	Chicago, Illinois 60604	

Region 6	(AR, LA, NM, OK, TX)	
	U.S. Environmental Protection Agency	Telephone: (214) 665-2200
	Region 6	(800) 887-6063
	1445 Ross Avenue, Suite 1200	http://www.epa.gov/earth1r6/index.htm
	Dallas, Texas 75202	
Region 7	(IA, KS, MO, NE)	
	U.S. Environmental Protection Agency	Telephone: (913) 551-7003
	Region 7	(800) 223-0425
	901 North 5th Street	http://www.epa.gov/rgytgrnj/
	Kansas City, Kansas 66101	
Region 8	(CO, MT, ND, SD, UT, WY)	
	U.S. Environmental Protection Agency	Telephone:(303) 312-6312
	Region 8	(800) 227-8917
	999 18th Street, Suite 500	http://www.epa.gov/unix0008/
	Denver, Colorado 80202-2466	
Region 9	(AZ, CA, HI, NV, American Samoa, and Guam)	
	U.S. Environmental Protection Agency	Telephone: (415) 947-8700
	Region 9	http://www.epa.gov/region09/
	75 Hawthorne Street	
	San Francisco, California 94105	
Region 10	(AK, ID, OR, WA)	
	U.S. Environmental Protection Agency	Telephone: (206) 553-1200
	Region 10	(800) 424-4372
	1200 Sixth Avenue	http://www.epa.gov/r10earth/
	Seattle, Washington 98101	

L.3 Nuclear Regulatory Commission (NRC)

NRC Home Page http://www.nrc.gov

Region I (CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT)
Administrator Telephone: (610) 337-5000
U.S. Nuclear Regulatory Commission (800) 432-1156
475 Allendale Road
King of Prussia, Pennsylvania 19406-1415

Region II (AL, FL, GA, KY, MS, NC, PR, SC, TN, VA, VI, WV, Panama Canal)
Administrator Telephone: (404) 562-4400
U.S. Nuclear Regulatory Commission (800) 577-8510
Sam Nunn Atlanta Federal Center, 23 T85
61 Forsyth Street, SW
Atlanta, Georgia 30303-8931

Region III (IA, IL, IN, MI, MN, MO, OH, WI)
Administrator Telephone: (630) 829-9500
U.S. Nuclear Regulatory Commission (800) 522-3025
801 Warrenville Road
Lisle, Illinois 60532-4351

Region IV (AR, CO, ID, KS, LA, MT, NE, ND, NM, OK, SD, TX, UT, WY, AK, AZ, CA, HI, NV, OR, WA, Pacific Trust Territories)
Administrator Telephone: (817) 860-8100
U.S. Nuclear Regulatory Commission (800) 952-9677
Texas Health Resources Tower
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

L.4 Department of the Army

The following is a list of key personnel within the Department of the Army who administer radiation control activities and have responsibilities for certain radiation protection activities.

Deputy for Environmental Safety & Occupational Health
Office of the Assistant Secretary of the Army
(Installations, Logistics, & Environment)
110 Army Pentagon
Washington, DC 20310-0110
Telephone: (703) 695-7824

Director of Army Radiation Safety
Army Safety Office
DACS-SF
Chief of Staff
200 Army Pentagon
Washington, DC 20310-0200
Telephone: (703) 695-7291

Radiological Hygiene Consultant
Office of The Surgeon General
Walter Reed Army Medical Center
Attn: MCHL-HP
Washington, DC 20307-5001
Telephone: (301) 295-0267

L.5 Department of the Navy

The following is a list of key personnel within the Department of the Navy who administer radiation control activities and have responsibilities for certain radiation protection activities.

Naval Radiation Safety Committee
Chief of Naval Operations (N455)
2211 S. Clark Place
Crystal Plaza #5, Room 680
Arlington, VA 22202-3735
Telephone: (703) 602-2582

Commander (SEA-07R)
Radiological Controls Program
Naval Sea Systems Command
2531 Jefferson Davis Highway
Arlington, VA 22242-5160
Telephone: (703) 602-1252

Officer in Charge
Radiological Affairs Support Office
P.O. Drawer 260
Yorktown, VA 23691-0260
Telephone: (757) 887-4692

L.6 Department of the Air Force

The following is a list of key personnel within the Department of the Air Force who administer radiation control activities and have responsibilities for certain radiation protection activities.

Chief, Materials Licensing
USAF Radioisotope Committee
AFMOA/SGOR
110 Luke Avenue, Room 405
Bolling AFB, DC 20332-7050
Telephone: (202) 767-4313

Chief, Consultant Branch
Radiation Services Division, Armstrong Laboratory
IERA/SDRH
2402 E Street
Brooks AFB, TX 78235-5114
Telephone: (210) 536-3486

APPENDIX M

SAMPLING METHODS: A LIST OF SOURCES

M.1 Introduction

Planning activities associated with field survey work include developing new and compiling or adopting existing sampling methods. The following listing includes documents that represent examples for the types of information one encounters when searching for sampling methods. This listing initially presents references that appear with brief annotations that characterize the information found in each document.

Journal articles and books may list references that lead to still other types of useful information. Depending on survey needs, media being sampled, or site-specific requirements, one may follow these references to resources that describe other types of methods found in original papers or documents that appeared even as specific sampling techniques were first introduced.

The present listing is not exhaustive. Other titles or resources for sampling methods are available through online literature databases; Federal, State, and university libraries; the internet; and other sources.

M.2 List of Sources

Department of Energy (DOE). 1987. *The Environmental Survey Manual*. DOE/EH-0053, Vol. 1 of 4. DOE, Office of the Assistant Secretary for Environment, Safety, and Health, Office of Environmental Audit, Washington, D.C.

- *General Description of Document*: Size: Approximately 188 pages (single sided)—This is the first of a four volume set that amounts to over 4 ins. (total thickness) of documentation related to environmental surveys. The first volume represents the main document, with the remaining three volumes contain eleven appendices.

- *Key Features of This Document*: Unlike a number of other references listed here, this document *does* include information related to radionuclides and considers biota (animal, plant, and related sample types). Flow charts, checklists, planning diagrams, and figures help the reader to visualize a number of topics described in the text of all four volumes. Section 2 of this volume entertains topics related to a survey team's activities and survey reports. Section 3 considers the use of existing data, followed by technical checklists in Section 4 and health and safety issues described in Section 5.

A quick review of this first volume reveals a limited amount of depth to the information presented. There is little descriptive *How To Sample* information given here. However, as an overview, the document is quite comprehensive and this may encourage a survey team to consider obtaining additional information relevant to a particular project need.

Department of Energy (DOE). 1987. *The Environmental Survey Manual: Appendices A, B, and C*. DOE/EH-0053, Vol. 2 of 4. DOE, Office of the Assistant Secretary for Environment, Safety, and Health, Office of Environmental Audit, Washington, D.C.

- *General Description of Document*: Size: Approximately 188 pages (double sided)—This second volume contains three of eleven appendices.

- *Key Features of This Document*: The appendices include: A) Criteria for Data Evaluation, B) Checklists and Lines of Inquiry, and C) Health and Safety Plan for On-Site Survey Activities.

Department of Energy (DOE). 1987. *The Environmental Survey Manual: Appendix D*. DOE/EH-0053, Vol. 3 of 4. DOE, Office of the Assistant Secretary for Environment, Safety, and Health, Office of Environmental Audit, Washington, D.C.

- *General Description of Document*: Size: Approximately 438 pages (double sided)—This single volume is the largest part of the four part set and contains only one appendix: Appendix D - Analytical Methods.

- *Key Features of This Document*: The topics presented here have little to do with sample collection and are mostly concerned with the types of compounds or constituents within a sample. A radiological section covers a number of radionuclides that one may encounter in a number of sample matrices—including in water, air, soil, and sediments. Again, this is an appendix dedicated to sample analysis.

Department of Energy (DOE). 1987. *The Environmental Survey Manual: Appendices E, F, G, H, I, J, and K*. DOE/EH-0053, Vol. 4 of 4. DOE, Office of the Assistant Secretary for Environment, Safety, and Health, Office of Environmental Audit, Washington, D.C.

- *General Description of Document*: Size: Approximately 312 pages (double sided)—This fourth and final volume includes seven appendices.

- *Key Features of This Document*: Appendix E is entitled *Field Sampling Protocols and Guidance*—which offers a number of site scenarios to describe an approach to sampling under varied conditions. Each scenario is followed by a set of sampling procedures appropriate for a particular sample matrix. This appendix is 216 pages in length making this the largest part of Volume 4. Diagrams are included to illustrate scenarios and the appearance of sampling equipment.

  The remaining appendices cover: F) guidelines for preparation of quality assurance plans, G) decontamination guidance, H) data management and analysis, I) sample and document management guidance, J) health and safety guidance for sampling and analysis teams, and K) documents for sampling and analysis program.

Department of Energy (DOE). 1991. *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*. DOE/EH-0173T, DOE, Assistant Secretary for Environment, Safety, and Health, Washington, D.C. (DE91-013607)

- *General Description of Document*: Size: approximately 90 pages— This guide covers a number of topics related to radiation and environmental surveillance.

- *Key Features of This Document*: To accomplish environmental surveillance, various sample types—from biotic (animal and plant) to abiotic (air, water, soil, *etc.*)—are considered in Chapter 5 (title: Environmental Surveillance). The basis for taking certain samples appears along with information on sample location and frequency. A brief statement on sampling methods completes each section but procedures or techniques are not given in detail. References to other guidance documents on sampling are cited. The reader is directed to other sources to obtain additional regulatory information or descriptions of specific procedures.

  Chapter 6 provides information on laboratory procedures. Other chapters cover: liquid effluent monitoring, airborne effluent monitoring, meteorological monitoring, data analysis and statistical treatment, dose calculations, records and reports, quality assurance (QA), and reports.

Department of Energy (DOE). 1994. *Decommissioning Handbook.* DOE/EM-0142P. DOE, Office of Environmental Restoration, Germantown, MD

- *General Description of Document*: Size: Approximately 312 pages—The manual is essentially written for those involved in decommissioning a nuclear power facility. While not specifically focused on radiation sampling methods, this document may play a role in

identifying activities or sampling needs related to survey work before or during remediation at some Federal facilities.

- *Key Features of This Document*: Chapter 6 presents information on final project configuration based on planning and as such speaks of site boundaries. Chapter 7 presents topics related to characterization including on-site measurements.

  This document includes discussion and illustrations of robotic devices used in sampling operations. Perhaps only appropriate in extreme situations, the use of a robot for obtaining a sample may apply where radiation levels are high, dust or air quality pose problems, or where technical staff cannot physically reach a sample location due to structural limitations.

Environmental Protection Agency (EPA). 1980. *Samplers and Sampling Procedures for Hazardous Waste Streams*. EPA-600/2-80-018, EPA, Municipal Environmental Research Laboratory, Cincinnati, OH.

- *General Description of Document*: Size: 67 pages—the procedures listed here cover different types of media and include helpful diagrams of sampling devices.

- *Key Features of This Document*: While not specifically geared to radioactive samples, this short manual outlines and presents information in a logical sequence—starting with descriptions of sampling devices, followed by discussion of selecting an appropriate device for various media (including samples taken from various sources; *e.g.*, drum, barrel, waste pile), container types, labels, seals, use of a log book, chain of custody, sample receipt and logging, preservation and storage of samples, and references. The document includes five appendices, covering development of the composite liquid waste sampler, parts for constructing the sampler, checklist of items required in the field for sampling hazardous waste, random sampling, and systematic errors in using the composite liquid waste sampler.

Environmental Protection Agency (EPA). 1982. *Test Methods For Evaluating Solid Waste, Physical / Chemical Methods, 2nd Edition.* EPA, Office of Solid Waste, Washington, D.C. (PB87-120291)

- *General Description of Document*: Size: Approximately 375 pages—composed of chapters and methods that update the first edition of this volume.

- *Key Features of This Document*: Chapter 1 of this manual pulls together information from the first three chapters of the first edition. This includes a Sampling Methodology section that addresses statistics, sampling strategies and examples, implementing a sampling plan, plus tables and figures of sampling devices, *etc.* The main focus is on solid waste including metals and organics. Methods are described with the same format as indicated above in reference 1. As above, the methods include some information relevant to the field component of sampling work, but the remainder of each method essentially is most useful to laboratory personnel.

Environmental Protection Agency (EPA). 1982. *Handbook for Sampling and Sample Preservation of Water and Wastewater.* EPA-600/4-82-029, EPA, Environmental Monitoring and Support Laboratory, Cincinnati, OH. (PB83-124503)

- *General Description of Document*: Size: Approximately 500 pages—composed of information specifically focused on sample collection and preservation. While the document concerns only water sampling, this volume is comprehensive and even includes a chapter on *Sampling Radioactive Materials*.

- *Key Features of This Document*: The handbook is geared to address sampling issues. The scope of the document covers all types or sources of water, including: municipal, industrial, surface, agricultural, ground, and drinking waters. Types of samples are defined and discussed, including grab and composite samples. Diagrams, tables, and forms are provided to illustrate key points raised in the text. Statistical methods and related tables are provided. Each topic is accompanied by references. The chapter on radioactive samples is brief but touches on: background, radioactive decay, detection capability, frequency of sampling, sampling location, sample volume, containers, filtration, preservation, general procedures, radiation safety, and references.

Environmental Protection Agency (EPA). 1984. *Soil Sampling Quality Assurance User's Guide*. EPA 600/4-84-043, EPA, Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, NV.

- *General Description of Document*: Size: 102 pages—The introduction to this document starts with: "An adequate quality assurance/quality control (QA/QC) program requires the identification and quantification of all sources of error associated with each step of a monitoring program so that the resulting data will be of known quality. the components of error, or variance, include those associated with sampling, sample preparation, extraction, analysis, and residual error."

- *Key Features of This Document*: Because of potential inhomogeneity in soil samples, the authors state this QA/QC document is specifically concerned with soil sampling. The general outline of the document includes: objectives of QA/QC, statistics, exploratory studies, sample number and sample sites, sample collection, sample handling and documentation, analysis and interpretation of QA/QC data, and systems audits and training. References are provided followed by two appendices covering sample number precision and confidence plus tables for use in calculating confidence tolerance limits and judging validity of measurements.

  The sample collection chapter is very brief and does not specifically outline methods or types of equipment. This and the following chapter on sample handling and documentation mention relevant topics in light of QA/QC.

Environmental Protection Agency (EPA). 1986. *Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual*. EPA, Region IV, Environmental Services Division, Athens, GA. (Sections 3 to 5 reviewed)

- *General Description of Document*: Size: approximately 90 pages (single sided)—The introduction states: "The objectives of this section are to present the Branch standard operating procedures for sample identification, sample control and chain of custody, maintenance of field records, and document control.

- *Key Features of This Document*: The basic format of the document is that of a compendium of standard operating procedures bound in one volume. Each Standard Operating Procedure (SOP) is several pages and is dedicated to a specific topic. A five page outline pertaining to sampling procedures presents a brief overview that is a relatively typical treatment of this topic. Sample preservation, for example, is summarized with five bullet points. The next section offers a three page listing of definitions covering grab, composite, split, duplicate, reference or control, and background samples, plus a very brief definition for sample aliquot.

  The document lacks figures but does include descriptive notes for equipment and methods related to taking samples of waste water, surface water (fresh and salt water), ground water, potable water supply, soil, samples from landfills and hazardous waste sites, followed by references. The last part of the guide include information on making flow measurements.

  The document does not appear to focus on radioactive materials, but as with other documents the information can in part be used in conjunction with obtaining radioactive samples.

Environmental Protection Agency (EPA). 1987. *A Compendium of Superfund Field Operations Methods*. EPA/540/P-87/001, EPA, Office of Emergency and Remedial Response, Washington, D.C.

- *General Description of Document*: Size: Approximately 375 pages—the size and title of this document is a clue to the comprehensive nature of this volume. In brief, the text of this document provides a potentially valuable resource to field workers involved with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) surveys. While relatively complete—in that the document covers a broad range of topics—some readers may desire additional depth to the information provided here. Conversely, planners and field personnel might gain added insight by considering the broad range of topics included here before approaching the survey process.

- *Key Features of This Document*: Perhaps the best summary of this compendium is provided by a listing of sections, as follows: 1) Use of the Compendium, 2) Preparation of Project Description and Statement of Objectives, 3) Implementing Field Objectives, 4) Sample Control, Including Chain of Custody, 5) Laboratory Interface, 6) Sample Containers, Preservation, and Shipping, 7) Field Methods for Screening Hazardous Material, 8) Earth Sciences (*i.e.*, drilling, excavations, reconnaissance, geophysics, and ground water), 9) Earth Sciences Laboratory Procedures, 10) Surface Hydrology, 11) Meteorology and Air Quality, 12) Specialized Sampling Techniques (*e.g.*, wipes, human habitation sampling, TCDD, and container sampling), 14) Land Surveying, Aerial Photography, and Mapping, 15) Field Instrumentation (a comprehensive treatment including radiation monitors), 16) data handling, 17) Document Control, 18) Corrective Action, 19) QA Audit Procedures, and 20) QA Reporting.

  That this document serves objectives set forth by Superfund—and is not specifically focused on radionuclide sampling—in no way diminishes the importance of the compendium's complete overview of field sampling equipment and activities.

Environmental Protection Agency (EPA). 1989. *Test Methods For Evaluating Solid Waste Physical / Chemical Methods - Third Edition Proposed Update Package*. EPA, Office of Solid Waste, Washington, D.C. (PB89-148076)

- *General Description of Document*: Size Approximately 500 pages—composed of several updated chapters and 46 methods that are described by text and graphics. Only methods that are updated from 2nd Edition appear in this volume.

- *Key Features of This Document*: Chapters 1, 2, 4, and 7 describe QC, Choosing the Correct Procedure, Organic Analytes, and Regulatory Definitions, respectively. Of primary interest are the 46 methods that are described in what constitutes the bulk of this document. However, as is evident from some of the first methods listed for organics, sample collection techniques are only briefly touched on by a section of Chapter Four. This essentially makes the methods laboratory oriented protocols and the only reference to field methods appears in the text of a short chapter as opposed to part of each method. Some methods do list *Sample Collection, Preservation, and Handling* information with emphasis on use of containers, acidification or refrigeration, or a brief set of points to consider when preparing to go out to the field.

  Each method includes a method number and a title, plus the following information: 1) Scope and Application, 2) Summary of Method, 3) Interferences, 4) Apparatus and Materials, 5) Reagents, 6) Sample Collection, Preservation, and Handling, 7) Procedure, 8) QC, 9) Method Performance, and 10) References. Diagrams, flow charts, and tables follow the initial sequence of sections.

  The listing of methods include Method 9320 for Radium-228, Method 9310 for Gross Alpha & Gross Beta, and Method 9315 for Alpha-Emitting Radium Isotopes. These methods do not appear in the bound volume used for this review and thus no further comment is offered here.

Environmental Protection Agency (EPA). 1991. *Compendium of ERT Surface Water and Sediment Sampling Procedures*. OSWER Directive 9360.4-03, EPA, Office of Emergency and Remedial Response, Washington, D.C. (PB91-921274)

- *General Description of Document*: Size: 31 pages—this document includes three standard operating procedures (SOPs), the first of which is the same as the first SOP listed in the document described below.

- *Key Features of This Document*: The three SOPs included in this document include: 1) Sampling Equipment Decontamination, 2) Surface Water Sampling, and 3) Sediment Sampling. Each SOP is similar in content with sections that cover: scope, method summary, preservation, containers, equipment, apparatus, *etc*.

Environmental Protection Agency (EPA). 1991. *Compendium of ERT Ground water Sampling Procedures*. OSWER Directive 9360.4-06, EPA, Office of Emergency and Remedial Response, Washington, D.C. (PB91-921275)

- *General Description of Document*: Size: 71 pages—this document embodies eight standard operating procedures (SOPs) with a similar format as that described above.

- *Key Features of This Document*: The SOPs covered in this document include sampling equipment decontamination, ground water well sampling, soil gas samples, installing monitor wells, water level measurements, and other topics related to ground water and wells.

Environmental Protection Agency (EPA). 1991. *Compendium of ERT Soil Sampling and Surface Geophysics Procedures*. OSWER Directive 9360.4-02, EPA, Office of Emergency and Remedial Response, Washington, D.C. (PB91-921273)

- *General Description of Document*: Size: 39 pages—this document lists four standard operating procedures (SOPs) for soil sampling—with a similar format as that described above.

- *Key Features of This Document*: The SOPs covered in this document include sampling equipment decontamination, soil sampling, soil gas sampling, and soil sampling and surface geophysics. The SOP for soil sampling is five pages in length. This treatment essentially covers samples collected from the soil surface, to use of augers and tube samplers, a trier, split-spoon (barrel) sampler, and excavation techniques.

Environmental Protection Agency (EPA). 1991. *Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual*. EPA, Region IV, Environmental Services Division, Athens, GA.

- *General Description of Document*: Size: Approximately 500 pages (single sided)—This document is presented with seven sections and eleven appendices. The main sections cover standard operating polices and procedures which relates to the Region IV laboratory's administrative functions to SOPs that are specifically focused on sampling activities.

- *Key Features of This Document*: Sections 3 and 4 are of primary importance when thinking of sample control, field record keeping, document control and sampling procedures. Section 4 on sampling procedures is descriptive—without diagrams or figures—and quite comprehensive in that this section touches on a multitude of topics not mentioned in a number of other guides, including: selection of parameters to be measured, holding time, cross contamination, and Data Quality Objectives (DQOs) (described as Level I to V). The sampling of soil, water, and air are covered in this

section with many of the subsections covering topics that are common to other documents reviewed here. A number of example forms are presented, including several that relate to State programs. Section 6 covers field analytical methods and Section 7 describes field physical measurements.

The appendices include helpful information relevant to sampling, including: A) sample containers, preservation, holding times, and permissible sample type, B) standard cleaning procedures, C) shipping procedures, D) standard field analytical methods, E) monitoring wells, F) pump operation procedures, G) air monitoring, H) wastewater field methods, I) saturation monitoring, and K) safety protocols.

Environmental Protection Agency (EPA). 1992. *Characterizing Heterogeneous Waste: Methods and Recommendations*. EPA/600/R92/033, EPA, Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, NV. (PB92-216894)

- *General Description of Document*: Size: 144 pages—the focus of this document is on all types of waste materials that one might encounter. The base scenario appears to be one where a drum is encountered and the objective is to work to a point when the drum contents are understood. Because a drum may include more than one type of waste, this document provides a review of a wide variety of materials one might expect when surveying a site.

- *Key Features of This Document*: The table of contents reveals that the text attempts to provide a complete picture, from definitions of terms, to planning studies, QA/QC and data assessment, to sample acquisition, and steps that follow to the lab and what makes the characterization process a success. Radioactive waste materials, along with organics, solids, liquids, *etc*., are covered, but in a relatively brief fashion. The model scenario of dealing with wastes in a drum is incorporated into a hypothetical example in an appendix.

Environmental Protection Agency (EPA). 1992. *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies*. EPA/600/R92/128, EPA, Office of Research and Development, Washington, DC. (PB92-220532)

- *General Description of Document*: Size: 174 pages—this document summarizes various statistical and geostatistical concepts and procedures pertaining to the design, implementation, and data interpretation of appropriate sampling designs.

- *Key Features of This Document*: This document focuses on applying the concept of the Data Life Cycle to soil sampling. The document describes statistical concepts that apply to soil sampling, including particulate sampling theory. Types of samples, numbers of samples, and size of samples as well as methods for sampling soils from conveyor belts and stockpiles are also discussed. A bibliography is provided.

APPENDIX N

Data Validation Using Data Descriptors

Data validation is often defined by six data descriptors:

1) reports to decision maker
2) documentation
3) data sources
4) analytical method and detection limit
5) data review
6) data quality indicators

The decision maker or reviewer examines the data, documentation, and reports for each of the six data descriptors to determine if performance is within the limits specified in the DQOs developed during survey planning. The data validation process should be conducted according to procedures documented in the QAPP.

N.1 Reports to Decision Maker

Data and documentation supplied to the decision maker should be evaluated for completeness and appropriateness and to determine if any changes were made to the survey plan during the course of work. The survey plan discusses the surveying, sampling, and analytical design and contains the QAPP and DQOs. The decision maker should receive all data as collected plus preliminary and final data reports. The final decision on qualifying or rejecting data will be made during the assessment of environmental data. All data, including qualified or rejected data, should be documented and recorded even if the data are not included in the final report.

Preliminary analytical data reports allow the decision maker to begin the assessment process as soon as the surveying effort has begun. These initial reports have three functions.

1) For scoping or characterization survey data, they allow the decision maker to begin to characterize the site on the basis of actual data. Radionuclides of interest will be identified and the variability in concentration can be estimated.

2) They allow potential measurement problems to be identified and the need for corrective action can be assessed.

3) Schedules are more likely to be met if the planning of subsequent survey activities can begin before the final data reports are produced.

N.2 Documentation

Three types of documentation should be assessed: (1) field operation records; (2) laboratory records; and (3) data handling records (EPA 1997a).

N.2.1 Field Operation Records

The information contained in these records documents overall field operations and generally consists of the following:

- *Field measurement records*. These records show that the proper measurement protocol was performed in the field. At a minimum, this documentation should include the names of the persons conducting the activity, measurement identification, measurement locations, measurement results, maps and diagrams, equipment and SOP used, and unusual observations. Bound field notebooks are generally used to record raw data and make references to prescribed procedures and changes in planned activities. Data recording forms might also be used. A document control system should be used for these records to control attributes such as formatting to include pre-numbered pages with date and signature lines.

- *Sample tracking records*. Sample tracking records (*e.g.*, chain-of-custody) document the progression of samples as they travel from the original sampling location to the laboratory and finally to disposal (see Section 7.7).

- *QC measurement records*. QC measurement records document the performance of QC measurements in the field. These records should include calibration and standards' traceability documentation that can be used to provide a reproducible reference point to which all similar measurements can be correlated. QC measurement records should contain information on the frequency, conditions, level of standards, and instrument calibration history.

- *Personnel files*. Personnel files record the names and training certificates of the staff collecting the data.

- *General field procedures*. General field procedures (*e.g.*, SOPs) record the procedures used in the field to collect data and outline potential areas of difficulty in performing measurements.

- *Deficiency and problem identification reports*. These reports document problems and deficiencies encountered as well as suggestions for process improvement.

- *Corrective action reports*. Corrective action reports show what methods were used in cases where general field practices or other standard procedures were violated and include the methods used to resolve noncompliance.

N.2.2 Laboratory Records

The following list describes some of the laboratory-specific records that should be compiled if available and appropriate:

- *Laboratory measurement results and sample data.* These records contain information on the sample analysis used to verify that prescribed analytical methods were followed. The overall number of samples, sample identification, sample measurement results, any deviations from the SOPs, time of day, and date should be included. Sample location information might also be provided.

- *Sample management records*. Sample management records should document sample receipt, handling and storage, and scheduling of analyses. The records will verify that sample tracking requirements were maintained, reflect any anomalies in the samples (*e.g.*, receipt of damaged samples), and note proper log-in of samples into the laboratory.

- *Test methods*. Unless analyses were performed exactly as prescribed by SOPs, this documentation will describe how the analyses were carried out in the laboratory. This documentation includes sample preparation and analysis, instrument standardization, detection and reporting limits, and method-specific QC requirements. Documentation demonstrating laboratory proficiency with each method used could also be a part of the data reporting package, particularly for subcontracted work.

- *QC measurement records*. These include the general QC records, such as initial demonstration of capability, instrument calibration, routine monitoring of analytical performance, calibration verification, *etc.*, considered in Section 7.3 for selecting a radioanalytical laboratory. Project-specific information from the QC checks such as blanks, spikes, calibration check samples, replicates, splits, and so on should be included in these reports to facilitate data quality analysis.

- *Deficiency and problem identification reports*. These reports document problems and deficiencies encountered as well as suggestions for process improvement.

- *Corrective action reports*. Corrective action reports show what methods were used in cases where general laboratory practices or other standard procedures were violated and include the methods used to resolve noncompliance. Corrective action procedures to replace samples violating the SOP also should be noted.

N.2.3 Data Handling Records

Data handling records document protocols used in data reduction, verification, and validation. Data reduction addresses data transformation operations such as converting raw data into reportable quantities and units, using significant figures, calculating measurement uncertainties, *etc.* The records document procedures for handling data corrections.

N.3 Data Sources

Data source assessment involves the evaluation and use of historical analytical data. Historical analytical data should be evaluated according to data quality indicators and not the source of the data (*e.g.*, analytical protocols may have changed significantly over time). Data quality indicators are qualitative and quantitative descriptors used in interpreting the degree of acceptability or utility of data. Historical data sources are addressed during the Historical Site Assessment, and are discussed in Section 3.4.1.

N.4 Analytical Method and Detection Limit

The selection of appropriate analytical methods based on detection limits is important to survey planning. The detection limit of the method directly affects the usability of the data because results near the detection limit have a greater possibility of false negatives and false positives. Results near the detection limit have increased measurement uncertainty. When the measurement uncertainty becomes large compared to the variability in the radionuclide concentration, it becomes more difficult to demonstrate compliance using the guidance provided in MARSSIM.

The decision maker compares detection limits (*i.e.*, minimum detectable concentrations; MDCs) with radionuclide-specific results to determine their effectiveness in relation to the DCGL. Assessment of preliminary data reports provides an opportunity to review the detection limits early and resolve any detection sensitivity problems. When a radionuclide is reported as not detected, the result can only be used with confidence if the MDCs reported are lower than the DCGL.

If the DCGL is less than or equal to the MDC, and the radionuclide is not detected, report the actual result of the analysis. Do not report data as “less than the detection limit.” Even negative results and results with large uncertainties can be used in the statistical tests described in Chapter 8. Results reported as “<MDC” cannot be fully used and, for example, complicate even such simple analyses as calculating an average. When the MDC reported for a radionuclide is near the DCGL, the confidence in both identification and quantitation may be low. Information

concerning non-detects or detections at or near MDCs should be qualified according to the degree of acceptable uncertainty.

N.5 Data Review

Data review begins with an assessment of the quality of analytical results and is performed by a professional with knowledge of the analytical procedures. Only data that are reviewed according to a specified level or plan should be used in the quantitative site investigation. Any analytical errors, or limitations in the data that are identified by the review, should be noted. An explanation of data qualifiers should be included with the review report.

All data should receive some level of review. Data that have not been reviewed should be identified, because the lack of review increases the uncertainty in the data. Unreviewed data may lead to Type I and Type II decision errors, and may also contain transcription errors and calculation errors. Data may be used in the preliminary assessment before review, but should be reviewed at a predetermined level before use in the final survey report.

Depending on the survey objectives, the level and depth of the data review varies. The level and depth of the data review may be determined during the planning process and should include an examination of laboratory and method performance for the measurements and radionuclides involved. This examination includes

- evaluation of data completeness
- verification of instrument calibration
- measurement of precision using duplicates, replicates, or split samples
- measurement of bias using reference materials or spikes
- examination of blanks for contamination
- assessment of adherence to method specifications and QC limits
- evaluation of method performance in the sample matrix
- applicability and validation of analytical procedures for site-specific measurements
- assessment of external QC measurement results and QA assessments

A different level or depth of data review may be indicated by the results of this evaluation. Specific data review procedures are dependent upon the survey objectives and should be documented in the QAPP.

N.6 Data Quality Indicators

The assessment of data quality indicators presented in this section is significant to determine data usability. The principal data quality indicators are precision, bias, representativeness, comparability, and completeness (EPA 1997a). Other data quality indicators affecting the RSSI process include the selection and classification of survey units, Type I and Type II decision error rates, the variability in the radionuclide concentration measured within the survey unit, and the lower bound of the gray region (see Section 2.3.1).

Of the six principal data quality indicators, precision and bias are quantitative measures, representativeness and comparability are qualitative, completeness is a combination of both qualitative and quantitative measures, and accuracy is a combination of precision and bias. The selection and classification of survey units is qualitative, while decision error rates, variability, and the lower bound of the gray region are quantitative measures.

The major activity in determining the usability of data based on survey activities is assessing the effectiveness of measurements. Scanning and direct measurements taken during survey activities and samples collected for analysis should meet site-specific objectives based on scoping and planning decisions.

Determining the usability of analytical results begins with the review of QC measurements and qualifiers to assess the measurement result and the performance of the analytical method. If an error in the data is discovered, it is more important to evaluate the effect of the error on the data than to determine the source of the error. The documentation described in Section N.2 is reviewed as a whole for some criteria. Data are reviewed at the measurement level for other criteria.

Factors affecting the accuracy of identification and the precision and bias of quantitation of individual radionuclides, such as calibration and recoveries, should be examined radionuclide by radionuclide. Table N.1 presents a summary of the QC measurements and the data use implications.

N.6.1 Precision

Precision is a measure of agreement among replicate measurements of the same property under prescribed similar conditions. This agreement is calculated as either the range or the standard deviation. It may also be expressed as a percentage of the mean of the measurements such as relative range (for duplicates) or coefficient of variation.

Table N.1 Use of Quality Control Data

Quality Control Criterion	Effect on Identification When Criterion is Not Met	Quantitative Bias	Use
Spikes (Higher than expected result)	Potential for incorrectly deciding a survey unit does not meet the release criterion (Type II decision error)	High	Use data as upper limit
Spikes (Lower than expected result)	Potential for incorrectly deciding a survey unit does meet the release criterion[a] (Type I decision error)	Low	Use data as lower limit
Replicates (Inconsistent)	None, unless analyte found in one duplicate and not the other—then either Type I or Type II decision error	High or Low[b]	Use data as estimate—poor precision
Blanks (Contaminated)	Potential for incorrectly deciding a survey unit does not meet the release criterion (Type II decision error)	High	Check for gross contamination or instrument malfunction
Calibration (Bias)	Potential for Type I or Type II decision errors	High or Low[b]	Use data as estimate unless problem is extreme

[a] Only likely if recovery is near zero.
[b] Effect on bias determined by examination of data for each radionuclide.

For scanning and direct measurements, precision may be specified for a single person performing the measurement or as a comparison between people performing the same measurement. For laboratory analyses, precision may be specified as either intralaboratory (within a laboratory) or interlaboratory (between laboratories). Precision estimates based on a single surveyor or laboratory represent the agreement expected when the same person or laboratory uses the same method to perform multiple measurements of the same location. Precision estimates based on two or more surveyors or laboratories refer to the agreement expected when different people or laboratories perform the same measurement using the same method.

The two basic activities performed in the assessment of precision are estimating the radionuclide concentration variability from the measurement locations and estimating the measurement error attributable to the data collection process. The level for each of these performance measures

should be specified during development of DQOs. If the statistical performance objectives are not met, additional measurements should be taken or one (or more) of the performance parameters changed.

Measurement error is estimated using the results of replicate measurements, as discussed in Chapter 6 for field measurements and Chapter 7 for laboratory measurements. When collocated measurements are performed (in the field or in the laboratory) an estimate of total precision is obtained. When collocated samples are not available for laboratory analysis, a sample subdivided in the field and preserved separately can be used to assess the variability of sample handling, preservation, and storage along with the variability in the analytical process, but variability in sample acquisition is not included. When only variability in the analytical process is desired, a sample can be subdivided in the laboratory prior to analysis.

Summary statistics such as sample mean and sample variance can provide as assessment of the precision of a measurement system or component thereof for a project. These statistics may be used to estimate precision at discrete concentration levels, average estimated precision over applicable concentration ranges, or provide the basis for a continual assessment of precision for future measurements. Methods for calculating and reporting precision are provided in *EPA Guidance for Quality Assurance Project Plans* (EPA 1997a).

Table N.2 presents the minimum considerations, impacts if the considerations are not met, and corrective actions for precision.

N.6.2 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Bias assessments for radioanalytical measurements should be made using personnel, equipment, and spiking materials or reference materials as independent as possible from those used in the calibration of the measurement system. When possible, bias assessments should be based on certified reference materials rather than matrix spikes or water spikes so that the effect of the matrix and the chemical composition of the contamination is incorporated into the assessment. While matrix spikes include matrix effects, the addition of a small amount of liquid spike does not always reflect the chemical composition of the contamination in the sample matrix. Water spikes do not account for either matrix effects or chemical composition of the contamination. When spikes are used to assess bias, a documented spiking protocol and consistency in following that protocol are important to obtaining meaningful data quality estimates.

Table N.2 Minimum Considerations for Precision, Impact if Not Met, and Corrective Actions

Minimum Considerations for Precision	Impact When Minimum Considerations Are Not Met	Corrective Action
Confidence level as specified in DQOs. Power as specified in DQOs. Minimum detectable relative differences specified in the survey design and modified after analysis of background measurements if necessary One set of field duplicates or more as specified in the survey design. Analytical duplicates and splits as specified in the survey design. Measurement error specified.	Errors in decisions to act or not to act based on analytical data. Unacceptable level of uncertainty. Increased variability of quantitative results. Potential for incorrectly deciding a survey unit does meet the release criterion for measurements near the detection limits (Type I decision error).	For Surveying and Sampling: Add survey or sample locations based on information from available data that are known to be representative. Adjust performance objectives. For Analysis: Analysis of new duplicate samples. Review laboratory protocols to ensure comparability. Use precision measurements to determine confidence limits for the effects on the data. The investigator can use the maximum measurement results to set an upper bound on the uncertainty if there is too much variability in the analyses.

Activity levels for bias assessment measurements should cover the range of expected contaminant concentrations, although the minimum activity is usually at least five times the MDC. For many final status surveys, the expected contaminant concentration is zero or background, so the highest activity will be associated with the bias assessment measurements. The minimum and maximum concentrations allowable in bias assessment samples should be agreed on during survey planning activities to prevent accidental contamination of the environment or an environmental level radioanalytical laboratory.

For scanning and direct measurements there are a limited number of options available for performing bias assessment measurements. Perhaps the best estimate of bias for scanning and direct measurements is to collect samples from locations where scans or direct measurements were performed, analyze the samples in a laboratory, and compare the results. Problems associated with this method include the time required to obtain the results and the difficulty in

obtaining samples that are representative of the field measurement to provide comparable results. A simple method of demonstrating that analytical bias is not a significant problem for scanning or direct measurements is to use the instrument performance checks to demonstrate the lack of analytical bias. A control chart can be used to determine the variability of a specific instrument and track the instrument performance throughout the course of the survey. Field background measurements can also be plotted on a control chart to estimate bias caused by contamination of the instrument.

There are several types of bias assessment samples available for laboratory analyses as discussed in Chapter 7. Field blanks can be evaluated to estimate the potential bias caused by contamination from sample collection, preparation, shipping, and storage.

Table N.3 presents the minimum considerations, impacts if the considerations are not met, and corrective actions for bias.

Table N.3 Minimum Considerations for Bias, Impact if Not Met, and Corrective Actions

Minimum Considerations for Bias	Impact When Minimum Considerations Are Not Met	Corrective Action
Matrix spikes to assess bias of non-detects and positive sample results if specified in the survey design. Analytical spikes as specified in the survey design. Use analytical methods (routine methods whenever possible) that specify expected or required recovery ranges using spikes or other QC measures. No radionuclides of potential concern detected in the blanks.	Potential for incorrectly deciding a survey unit does meet the release criterion (Type I decision error): if spike recovery is low, it is probable that the method or analysis is biased low for that radionuclide and values of all related samples may underestimate the actual concentration. Potential for incorrectly deciding a survey unit does not meet the release criterion (Type II decision error): if spike recovery exceeds 100%, interferences may be present, and it is probable that the method or analysis is biased high. Analytical results overestimate the true concentration of the spiked radionuclide.	Consider resampling at affected locations. If recoveries are extremely low or extremely high, the investigator should consult with a radiochemist or health physicist to identify a more appropriate method for reanalysis of the samples.

N.6.3 Accuracy

Accuracy is a measure of the closeness of an individual measurement or the average of a number of measurements to the true value (EPA 1997a). Accuracy includes a combination of random error (precision) and systematic error (bias) components that result from performing measurements. Systematic and random uncertainties (or errors) are discussed in more detail in Section 6.8.1.

Accuracy is determined by analyzing a reference material of known contaminant concentration or by reanalyzing material to which a known concentration of contaminant has been added. To be accurate, data must be both precise and unbiased. Using the analogy of archery, to be accurate one's arrows must land close together and, on average, at the spot where they are aimed. That is, the arrows must all land near the bull's eye (see Figure N.1).

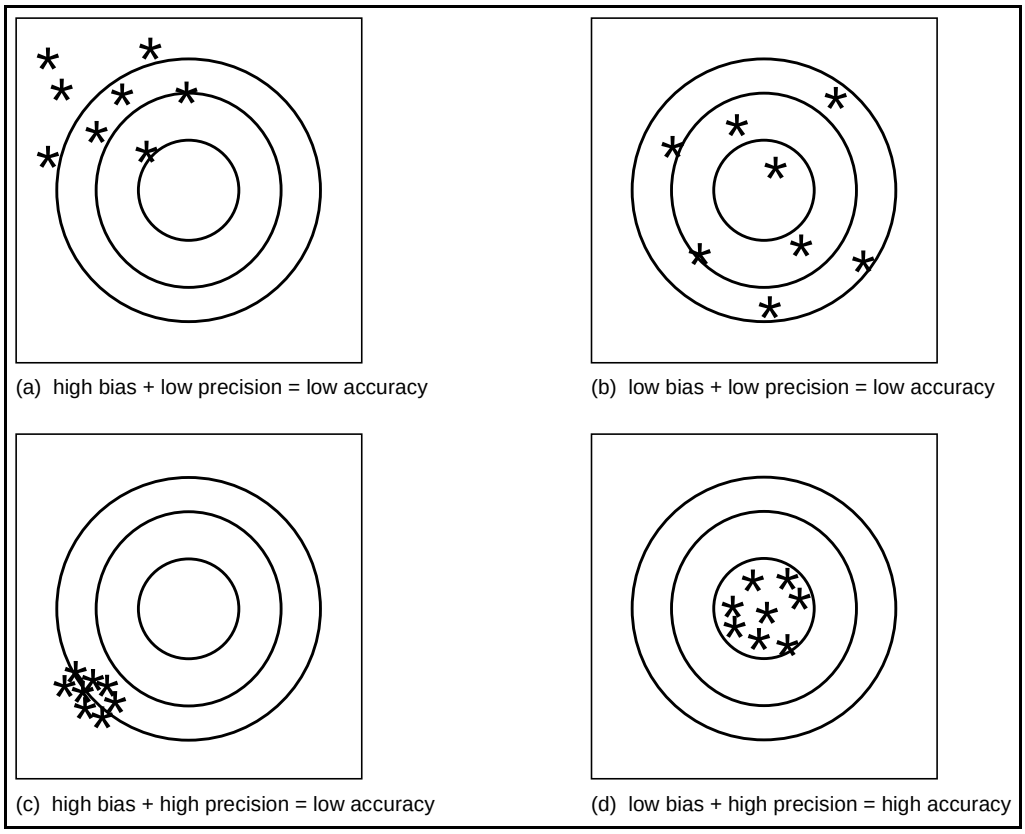

Figure N.1 Measurement Bias and Random Measurement Uncertainty

Accuracy is usually expressed either as a percent recovery or as a percent bias. Determination of accuracy always includes the effects of variability (precision); therefore, accuracy is used as a combination of bias and precision. The combination is known statistically as mean square error. Mean square error is the quantitative term for overall quality of individual measurements or estimators.

Mean square error is the sum of the variance plus the square of the bias. (The bias is squared to eliminate concern over whether the bias is positive or negative.) Frequently it is impossible to quantify all of the components of the mean square error—especially the biases—but it is important to attempt to quantify the magnitude of such potential biases, often by comparison with auxiliary data.

N.6.4 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point or for a process condition or environmental condition. Representativeness is a qualitative term that should be evaluated to determine whether *in situ* and other measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the media and contamination measured or studied.

Representativeness of data is critical to data usability assessments. The results of the environmental radiological survey will be biased to the degree that the data do not reflect the radionuclides and concentrations present at the site. Non-representative radionuclide identification may result in false negatives. Non-representative estimates of concentrations may be higher or lower than the true concentration. With few exceptions, non-representative measurements are only resolved by additional measurements.

Representativeness is primarily a planning concern. The solution to enhancing representativeness is in the design of the survey plan. Representativeness is determined by examining the survey plan. Analytical data quality affects representativeness since data of low quality may be rejected for use.

Table N.4 presents the minimum considerations, impacts if the considerations are not met, and corrective actions for representativeness.

N.6.5 Comparability

Comparability is the qualitative term that expresses the confidence that two data sets can contribute to a common analysis and interpolation. Comparability should be carefully evaluated to establish whether two data sets can be considered equivalent in regard to the measurement of a specific variable or groups of variables.

Table N.4 Minimum Considerations for Representativeness, Impact if Not Met, and Corrective Actions

Minimum Considerations for Representativeness	Impact When Minimum Considerations Are Not Met	Corrective Action
Survey data representative of survey unit. Documented sample preparation procedures. Filtering, compositing, and sample preservation may affect representativeness. Documented analytical data as specified in the survey design.	Bias high or low in estimate of extent and quantity of contaminated material. Potential for incorrectly deciding a survey unit does meet the release criterion (Type I decision error). Inaccurate identification or estimate of concentration of a radionuclide. Remaining data may no longer sufficiently represent the site if a large portion of the data are rejected, or if all data from measurements at a specific location are rejected.	Additional surveying or sampling. Examination of effects of sample preparation procedures. Reanalysis of samples, or resurveying or resampling of the affected site areas. If the resurveying, resampling, or reanalyses cannot be performed, document in the site environmental radiological survey report what areas of the site are not represented due to poor quality of analytical data.

Comparability is not compromised provided that the survey design is unbiased, and the survey design or analytical methods are not changed over time. Comparability is a very important qualitative data indicator for analytical assessment and is a critical parameter when considering the combination of data sets from different analyses for the same radionuclides. The assessment of data quality indicators determines if analytical results being reported are equivalent to data obtained from similar analyses. Only comparable data sets can be readily combined.

The use of routine methods (as defined in Section 7.6) simplifies the determination of comparability because all laboratories use the same standardized procedures and reporting parameters. In other cases, the decision maker may have to consult with a health physicist and/or radiochemist to evaluate whether different methods are sufficiently comparable to combine data sets.

There are a number of issues that can make two data sets comparable, and the presence of each of the following items enhances their comparability (EPA 1997a).

- two data sets should contain the same set of variables of interest.
- units in which these variables were measured should be convertible to a common metric.
- similar analytic procedures and quality assurance should be used to collect data for both data sets
- time of measurements of certain characteristics (variables) should be similar for both data sets
- measuring devices used for both data sets should have approximately similar detection levels
- rules for excluding certain types of observations from both samples should be similar
- samples within data sets should be selected in a similar manner
- sampling frames from which the samples were selected should be similar
- number of observations in both data sets should be of the same order of magnitude

These characteristics vary in importance depending on the final use of the data. The closer two data sets are with regard to these characteristics, the more appropriate it will be to compare them. Large differences between characteristics may be of only minor importance depending on the decision that is to be made from the data.

Table N.5 presents the minimum considerations, impacts if they are not met, and corrective actions for comparability.

N.6.6 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system, expressed as a percentage of the number of valid measurements that should have been collected (*i.e.*, measurements that were planned to be collected).

Completeness for measurements is calculated by the following formula:

$$\%Completeness = \frac{(Number\ of\ Valid\ Measurements)\ x\ 100}{Total\ Number\ of\ Measurements\ Planned}$$

Completeness is not intended to be a measure of representativeness; that is, it does not describe how closely the measured results reflect the actual concentration or distribution of the contaminant in the media being measured. A project could produce 100% data completeness (*i.e.*, all planned measurements were actually performed and found valid), but the results may not be representative of the actual contaminant concentration.

Table N.5 Minimum Considerations for Comparability, Impact if Not Met, and Corrective Actions

Minimum Considerations for Comparability	Impact When Minimum Considerations Are Not Met	Corrective Action
Unbiased survey design or documented reasons for selecting another survey design. The analytical methods used should have common analytical parameters. Same units of measure used in reporting. Similar detection limits. Equivalent sample preparation techniques. Analytical equipment with similar efficiencies or the efficiencies should be factored into the results.	Non-additivity of survey results. Reduced confidence, power, and ability to detect differences, given the number of measurements available. Increased overall error.	For Surveying and Sampling: Statistical analysis of effects of bias. For Analytical Data: Preferentially use those data that provide the most definitive identification and quantitation of the radionuclides of potential concern. For quantitation, examine the precision and accuracy data along with the reported detection limits. Reanalysis using comparable methods.

Alternatively, there could be only 70% data completeness (30% lost or found invalid), but, due to the nature of the survey design, the results could still be representative of the target population and yield valid estimates. The degree to which lack of completeness affects the outcome of the survey is a function of many variables ranging from deficiencies in the number of measurements to failure to analyze as many replications as deemed necessary by the QAPP and DQOs. The intensity of effect due to incompleteness of data is sometimes best expressed as a qualitative measure and not just as a quantitative percentage.

Completeness can have an effect on the DQO parameters. Lack of completeness may require reconsideration of the limits for decision error rates because insufficient completeness will decrease the power of the statistical tests described in Chapter 8.

For most final status surveys, the issue of completeness only arises when the survey unit demonstrates compliance with the release criterion and less than 100% of the measurements are determined to be acceptable. The question now becomes whether the number of measurements is sufficient to support the decision to release the survey unit. This question can be answered by constructing a power curve as described in Appendix I and evaluating the results. An alternative

method is to consider that the number of measurements estimated to demonstrate compliance in Chapter 5 was increased by 20% to account for lost or rejected data and uncertainty in the calculation of the number of measurements. This means a survey with 80% completeness may still have sufficient power to support a decision to release the survey unit.

Table N.6 presents the minimum considerations, impacts if the considerations are not met, and corrective actions for completeness.

Table N.6 Minimum Considerations for Completeness, Impact if Not Met, and Corrective Actions

Minimum Considerations for Completeness	Impact When Minimum Considerations Are Not Met	Corrective Action
Percentage of measurement completeness determined during planning to meet specified performance measures.	Higher potential for incorrectly deciding a survey unit does not meet the release criterion (Type II decision error). Reduction in power. A reduction in the number of measurements reduces site coverage and may affect representativeness. Reduced ability to differentiate site levels from background. Impact of incompleteness generally decreases as the number of measurements increases.	Resurveying, resampling, or reanalysis to fill data gaps. Additional analysis of samples already in laboratory. Determine whether the missing data are crucial to the survey.

N.6.7 Selection and Classification of Survey Units

Selection and classification of survey units is a qualitative measure of the assumptions used to develop the survey plan. The level of survey effort, measurement locations (*i.e.*, random vs. systematic and density of measurements), and the integrated survey design are based on the survey unit classification. The results of the survey should be reviewed to determine whether the classification used to plan the survey is supported by the results of the survey.

If a Class 3 survey unit is found to contain areas of contamination (even if the survey unit passes the statistical tests), the survey unit may be divided into several survey units with appropriate classifications, and additional surveys planned as necessary for these new survey units.

Class 3 areas may only require additional randomly located measurements to provide sufficient power to release the new survey units. Class 2 and Class 1 areas will usually require a new survey design based on systematic measurement locations, and Class 1 areas may require remediation before a new final status survey is performed.

If a Class 2 survey unit is determined to be a Class 1 survey unit following the final status survey and remediation is not required, it may not be necessary to plan a new survey. The scan MDC should be compared to the $DCGL_{EMC}$ to determine if the measurement spacing is adequate to meet the survey objectives. If the scan MDC is too high, a new scan survey using a more sensitive measurement technique may be available. Alternatively, a new survey may be planned using a new measurement spacing or a stratified survey design may be implemented to use as much of the existing data as possible.

N.6.8 Decision Error Rates

The decision error rates developed during survey planning are related to completeness. A low level of completeness will affect the power of the statistical test. It is recommended that a power curve be constructed as described in Appendix I, and the expected decision error rates compared to the actual decision error rates to determine if the survey objectives have been accomplished.

N.6.9 Variability in Contaminant Concentration

The variability in the contaminant concentration (both in the survey unit and the reference area) is a key parameter in survey planning, and is related to the precision of the measurements. Statistical simulations show that underestimating the value of σ (the standard deviation of the survey unit measurements) can greatly increase the probability that a survey unit will fail to demonstrate compliance with the release criterion.

If a survey unit fails to demonstrate compliance and the actual σ is greater than the σ used during survey planning, there are several options available to the project manager. If the major component of variability is measurement uncertainty, a new survey can be designed using a measurement technique with higher precision or a lower MDC to reduce variability. If samples were collected as part of the survey design, it may only be necessary to reanalyze the samples using a method with higher precision rather than collect additional samples. Alternatively, the number of measurements can be increased to reduce the variability.

If the variability is due to actual variations in the contaminant concentration, there are still options available. If there is a high variability in the reference area, it may be appropriate to demonstrate the survey unit is indistinguishable from background. NUREG 1505 (NRC 1997b) provides guidance on determining whether this test is appropriate and performing the statistical tests. If the variability is caused by different contaminant distributions in different parts of the site (*i.e.*, changing soil types influences contaminant concentrations), it may be appropriate to redefine the survey unit boundaries to provide a more homogeneous set of survey units.

N.6.10 Lower Bound of the Gray Region

The lower bound of the gray region (LBGR) is used to calculate the relative shift, which in turn is used to estimate the number of measurements required to demonstrate compliance. The LBGR is initially set arbitrarily to one half the $DCGL_W$. If this initial selection is used to design the survey, there is no technical basis for the selection of this value. This becomes important because the Type II decision error rate (β) is calculated at the LBGR.

For survey units that pass the statistical tests, the value selected for the LBGR is generally not a concern. If the survey unit fails to demonstrate compliance, it may be caused by improper selection of the LBGR. Because the number of measurements estimated during survey planning is based on the relative shift (which includes both σ and the LBGR), MARSSIM recommends that a power curve be constructed as described in Appendix I. If the survey unit failed to demonstrate compliance because of a lack of statistical power, an adjustment of the LBGR may be necessary when planning subsequent surveys.

GLOSSARY

91b material: Any material identified under Section 91b of the Atomic Energy Act of 1954 (42 U.S.C. Section 2121).

A_{min}: The smallest *area of elevated activity* identified using the DQO Process that is important to identify.

action level: The numerical value that will cause the *decision maker* to choose one of the alternative actions. It may be a regulatory threshold standard (*e.g.*, Maximum Contaminant Level for drinking water), a dose- or risk-based concentration level (*e.g.*, *DCGL*), or a reference-based standard. See *investigation level*.

activity: See *radioactivity*.

ALARA (acronym for As Low As Reasonably Achievable): A basic concept of radiation protection which specifies that exposure to ionizing radiation and releases of radioactive materials should be managed to reduce collective doses as far below regulatory limits as is reasonably achievable considering economic, technological, and societal factors, among others. Reducing exposure at a site to *ALARA* strikes a balance between what is possible through additional planning and management, remediation, and the use of additional resources to achieve a lower collective dose level. A determination of *ALARA* is a site-specific analysis that is open to interpretation, because it depends on approaches or circumstances that may differ between regulatory agencies. An *ALARA* recommendation should not be interpreted as a set limit or level.

alpha (α): The specified maximum probability of a *Type I error*. In other words, the maximum probability of rejecting the *null hypothesis* when it is true. *Alpha* is also referred to as the *size of the test*. *Alpha* reflects the amount of evidence the *decision maker* would like to see before abandoning the *null hypothesis*.

alpha particle: A positively charged particle emitted by some radioactive materials undergoing *radioactive decay*.

alternative hypothesis (H_a): See *hypothesis*.

area: A general term referring to any portion of a *site*, up to and including the entire *site*.

area of elevated activity: An *area* over which *residual radioactivity* exceeds a specified value $DCGL_{EMC}$.

area factor (A_m): A factor used to adjust $DCGL_W$ to estimate $DCGL_{EMC}$ and the *minimum detectable concentration* for scanning surveys in *Class 1* survey units—$DCGL_{EMC} = DCGL_W \bullet A_m$. A_m is the magnitude by which the *residual radioactivity* in a small *area of elevated activity* can exceed the $DCGL_W$ while maintaining compliance with the *release criterion*. Examples of *area factors* are provided in Chapter 5 of this manual.

arithmetic mean: The average value obtained when the sum of individual values is divided by the number of values.

arithmetic standard deviation: A statistic used to quantify the variability of a set of data. It is calculated in the following manner: 1) subtracting the arithmetic mean from each data value individually, 2) squaring the differences, 3) summing the squares of the differences, 4) dividing the sum of the squared differences by the total number of data values less one, and 5) taking the square root of the quotient. The calculation process produces the Root Mean Square Deviation (RMSD).

assessment: The evaluation process used to measure the performance or effectiveness of a system and its elements. As used in MARSSIM, assessment is an all-inclusive term used to denote any of the following: audit, performance evaluation, management systems review, peer review, inspection, or surveillance.

attainment objectives: Objectives that specify the design and scope of the sampling study including the radionuclides to be tested, the cleanup standards to be attained, the measure or parameter to be compared to the cleanup standard, and the *Type I* and *Type II* error rates for the selected statistical tests.

audit (quality): A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

background reference area: See *reference area*.

background radiation: Radiation from cosmic sources, *naturally occurring radioactive material*, including radon (except as a decay product of *source* or *special nuclear material*), and global fallout as it exists in the environment from the testing of nuclear explosive devices or from nuclear accidents like Chernobyl which contribute to *background radiation* and are not under the control of the cognizant organization. *Background radiation* does not include radiation from *source*, *byproduct*, or *special nuclear materials* regulated by the cognizant Federal or State agency. Different definitions may exist for this term. The definition provided in regulations or regulatory program being used for a site release should always be used if it differs from the definition provided here.

Becquerel (Bq): The International System (SI) unit of activity equal to one nuclear transformation (disintegration) per second. 1 *Bq* = 2.7×10^{-11} *Curies (Ci)* = 27.03 picocuries (pCi).

beta (β): The probability of a *Type II error, i.e.*, the probability of accepting the null hypothesis when it is false. The complement of *beta* (1-β) is referred to as the *power* of the test.

beta particle: An electron emitted from the nucleus during *radioactive decay*.

bias: The systematic or persistent distortion of a measurement process which causes errors in one direction (*i.e.*, the expected sample measurement is different from the sample's true value).

biased sample or measurement: See *judgement measurement*.

byproduct material: Any radioactive material (except *special nuclear material*) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing *special nuclear material*.

calibration: Comparison of a measurement standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustments.

CDE (committed dose equivalent): The *dose equivalent* calculated to be received by a tissue or organ over a 50-year period after the intake into the body. It dose not include contributions from radiation sources external to the body. CDE is expressed in units of Sv or rem.

CEDE (committed effective dose equivalent): The sum of the committed *dose equivalent* to various tissues in the body, each multiplied by the appropriate weighting factor (W_t). CEDE is expressed in units of Sv or rem. See *TEDE*.

chain of custody: An unbroken trail of accountability that ensures the physical security of samples, data, and records.

characterization survey: A type of *survey* that includes facility or *site* sampling, monitoring, and analysis activities to determine the extent and nature of contamination. *Characterization surveys* provide the basis for acquiring necessary technical information to develop, analyze, and select appropriate *cleanup* techniques.

Class 1 area: An *area* that is projected to require a *Class 1 final status survey*.

Class 1 survey: A type of *final status survey* that applies to *areas* with the highest potential for contamination, and meet the following criteria: (1) *impacted*; (2) potential for delivering a dose above the *release criterion*; (3) potential for small *areas of elevated activity*; and (4) insufficient evidence to support reclassification as *Class 2* or *Class 3*.

Class 2 area: An *area* that is projected to require a *Class 2 final status survey*.

Class 2 survey: A type of *final status survey* that applies to *areas* that meet the following criteria: (1) *impacted*; (2) low potential for delivering a dose above the *release criterion*; and (3) little or no potential for small *areas of elevated activity.*

Class 3 area: An *area* that is projected to require a *Class 3 final status survey*.

Class 3 survey: A type of *final status survey* that applies to *areas* that meet the following criteria: (1) *impacted*; (2) little or no potential for delivering a dose above the *release criterion*; and (3) little or no potential for small *areas of elevated activity.*

classification: The act or result of separating *areas* or *survey units* into one of three designated classes: *Class 1 area, Class 2 area,* or *Class 3 area*.

cleanup: Actions taken to deal with a release or threatened release of hazardous substances that could affect public health or the environment. The term is often used broadly to describe various Superfund response actions or phases of remedial responses, such as remedial investigation/ feasibility study. Cleanup is sometimes used interchangeably with the terms *remedial action,* response action, or *corrective action.*

cleanup standard: A numerical limit set by a regulatory agency as a requirement for releasing a *site* after *cleanup*. See *release criterion.*

cleanup (survey) unit: A geographical *area* of specified size and shape defined for the purpose of survey design and compliance testing.

coefficient of variation: A unitless measure that allows the comparison of dispersion across several sets of data. It is often used in environmental applications because variability (expressed as a standard deviation) is often proportional to the mean. See *relative standard deviation.*

comparability: A measure of the confidence with which one data set can be compared to another.

completeness: A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions.

composite sample: A sample formed by collecting several samples and combining them (or selected portions of them) into a new sample which is then thoroughly mixed.

conceptual site model: A description of a site and its environs and presentation of hypotheses regarding the contaminants present, their routes of migration, and their potential impact on sensitive receptors.

confidence interval: A range of values for which there is a specified probability (*e.g.*, 80%, 90%, 95%) that this set contains the true value of an estimated parameter.

confirmatory survey: A type of *survey* that includes limited independent (third-party) measurements, sampling, and analyses to verify the findings of a *final status survey*.

consensus standard: A standard established by a group representing a cross section of a particular industry or trade, or a part thereof.

contamination: The presence of *residual radioactivity* in excess of levels which are acceptable for release of a *site* or facility for *unrestricted use*.

control chart: A graphic representation of a process, showing plotted values of some statistic gathered from that characteristic, and one or two control limits. It has two basic uses: 1) as a judgement to determine if a process was in control, and 2) as an aid in achieving and maintaining statistical control.

core sample: A soil sample taken by core drilling.

corrective action: An action taken to eliminate the causes of an existing nonconformance, deficiency, or other undesirable situation in order to prevent recurrence.

criterion: See *release criterion*.

critical group: The group of individuals reasonably expected to receive the greatest exposure to *residual radioactivity* for any applicable set of circumstances.

critical level (L_c): A fixed value of the *test statistic* corresponding to a given probability level, as determined from the sampling distribution of the *test statistic*. L_c is the level at which there is a statistical probability (with a predetermined confidence) of correctly identifying a background value as "greater than background."

critical value: The value of a statistic (t) corresponding to a given significance level as determined from its sampling distribution; e.g., if Pr ($t > t_o$) = 0.05, t_o is the critical value of t at the 5 percent level.

curie (Ci): The customary unit of radioactivity. One *curie* (Ci) is equal to 37 billion disintegrations per second (3.7×10^{10} dps = 3.7×10^{10} *Bq*), which is approximately equal to the decay rate of one gram of ^{226}Ra. Fractions of a *curie, e.g.* picocurie (pCi) or 10^{-12} Ci and microcurie (μCi) or 10^{-6} Ci, are levels typically encountered in *decommissioning*.

cyclotron: A device used to impart high energy to charged particles, of atomic weight one or greater, which can be used to initiate nuclear transformations upon collision with a suitable target.

D: The true, but unknown, value of the difference between the mean concentration of *residual radioactivity* in the *survey unit* and the *reference area*.

DQA (Data Quality Assessment): The scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support their intended use.

DQOs (Data Quality Objectives): Qualitative and quantitative statements derived from the DQO process that clarify study technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Data Quality Objectives Process: A systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use. The key elements of the process include:

- concisely defining the problem
- identifying the decision to be made
- identifying the inputs to that decision
- defining the boundaries of the study
- developing the decision rule
- specifying tolerate limits on potential decision errors
- selecting the most resource efficient data collection design

DQOs are the qualitative and quantitative outputs from the DQO process. The DQO process was developed originally by the U.S. Environmental Protection Agency, but has been adapted for use by other organizations to meet their specific planning requirement. See also *graded approach*.

data quality indicators: Measurable attributes of the attainment of the necessary quality for a particular decision. *Data quality indicators* include *precision, bias, completeness, representativeness, reproducibility, comparability,* and statistical confidence.

data usability: The process of ensuring or determining whether the quality of the data produced meets the intended use of the data.

DCGL (derived concentration guideline level): A derived, radionuclide-specific activity concentration within a *survey unit* corresponding to the *release criterion*. The *DCGL* is based on the spatial distribution of the contaminant and hence is derived differently for the *nonparametric* statistical test ($DCGL_W$) and the *Elevated Measurement Comparison* ($DCGL_{EMC}$). *DCGLs* are derived from activity/dose relationships through various *exposure pathway* scenarios.

decay: See *radioactive decay*.

decision maker: The person, team, board, or committee responsible for the final decision regarding disposition of the *survey unit*.

decision rule: A statement that describes a logical basis for choosing among alternative actions.

decommission: To remove a facility or *site* safely from service and reduce *residual radioactivity* to a level that permits release of the property and termination of the *license* and other authorization for site operation.

decommissioning: The process of removing a facility or *site* from operation, followed by *decontamination*, and license termination (or termination of authorization for operation) if appropriate. The objective of *decommissioning* is to reduce the *residual radioactivity* in structures, materials, soils, groundwater, and other media at the *site* so that the concentration of each radionuclide contaminant that contributes to *residual radioactivity* is indistinguishable from the *background radiation* concentration for that radionuclide.

decontamination: The removal of radiological contaminants from, or their neutralization on, a person, object or area to within levels established by governing regulatory agencies. *Decontamination* is sometimes used interchangeably with *remediation*, remedial action, and *cleanup*.

delta (δ): The amount that the distribution of measurements for a *survey unit* is shifted to the right of the distribution of measurements of the *reference area*.

delta (Δ): The width of the *gray region*. **Δ** divided by σ, the *arithmetic standard deviation* of the measurements, is the *relative shift* expressed in multiples of standard deviations. See *relative shift, gray region*.

derived concentration guideline level: See *DCGL*.

design specification process: The process of determining the sampling and analysis procedures that are needed to demonstrate that the attainment objectives are achieved.

detection limit: The net response level that can be expected to be seen with a detector with a fixed level of certainty.

detection sensitivity: The minimum level of ability to identify the presence of radiation or *radioactivity*.

direct measurement: Radioactivity measurement obtained by placing the detector near the surface or media being surveyed. An indication of the resulting radioactivity level is read out directly.

distribution coefficient (K_d): The ratio of elemental (*i.e.*, radionuclide) concentration in soil to that in water in a soil-water system at equilibrium. K_d is generally measured in terms of gram weights of soil and volumes of water (g/cm^3 or g/ml).

dose commitment: The dose that an organ or tissue would receive during a specified period of time (*e.g.*, 50 or 70 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a given release.

dose equivalent (dose): A quantity that expresses all radiations on a common scale for calculating the effective absorbed dose. This quantity is the product of absorbed dose (rads) multiplied by a quality factor and any other modifying factors. Dose is measured in *Sv* or *rem*.

double-blind measurement: Measurements that cannot be distinguished from routine measurements by the individual performing the measurement. See *non-blind measurement* and *single-blind measurement*.

effective probe area: The *physical probe area* corrected for the amount of the probe area covered by a protective screen.

elevated area: See *area of elevated activity*.

elevated measurement: A measurement that exceeds a specified value $DCGL_{EMC}$.

Elevated Measurement Comparison (EMC): This comparison is used in conjunction with the Wilcoxon test to determine if there are any measurements that exceed a specified value $DCGL_{EMC}$.

exposure pathway: The route by which radioactivity travels through the environment to eventually cause radiation exposure to a person or group.

exposure rate: The amount of ionization produced per unit time in air by X-rays or gamma rays. The unit of exposure rate is Roentgens/hour (R/h); for decommissioning activities the typical units are microRoentgens per hour (µR/h), *i.e.*, 10^{-6} R/h.

external radiation: Radiation from a source outside the body.

false negative decision error: The error that occurs when the null hypothesis (H_0) is not rejected when it is false. For example, the false negative decision error occurs when the decision maker concludes that the waste is hazardous when it truly is not hazardous. A statistician usually refers to a false negative error as a *Type II decision error*. The measure of the size of this error is called *beta*, and is also known as the complement of the power of a hypothesis test.

false positive decision error: A false positive decision error occurs when the null hypothesis (H_0) is rejected when it is true. Consider an example where the decision maker presumes that a certain waste is hazardous (*i.e.*, the null hypothesis or baseline condition is "the waste is hazardous"). If the decision maker concludes that there is insufficient evidence to classify the waste as hazardous when it truly is hazardous, the decision maker would make a false positive decision error. A statistician usually refers to the false positive error as a *Type I decision error*. The measure of the size of this error is called *alpha*, the level of significance, or the size of the critical region.

Field Sampling Plan: As defined for Superfund in the Code of Federal Regulations 40 CFR 300.430, a document which describes the number, type, and location of samples and the type of analyses to be performed. It is part of the *Sampling and Analysis Plan*.

final status survey: Measurements and sampling to describe the radiological conditions of a site, following completion of decontamination activities (if any) in preparation for release.

fluence rate: A fundamental parameter for assessing the level of radiation at a measurement site. In the case of *in situ* spectrometric measurements, a calibrated detector provides a measure of the *fluence rate* of primary photons at specific energies that are characteristic of a particular radionuclide.

gamma (γ) radiation: Penetrating high-energy, short-wavelength electromagnetic radiation (similar to X-rays) emitted during *radioactive decay*. Gamma rays are very penetrating and require dense materials (such as lead or steel) for shielding.

graded approach: The process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and the degree of confidence needed in the quality of the results. See *data quality objectives process*.

gray region: A range of values of the parameter of interest for a *survey unit* where the consequences of making a decision error are relatively minor. The upper bound of the gray region in MARSSIM is set equal to the $DCGL_W$, and the *lower bound of the gray region (LBGR)* is a site-specific variable.

grid: A network of parallel horizontal and vertical lines forming squares on a map that may be overlaid on a property parcel for the purpose of identification of exact locations. See *reference coordinate system*.

grid block: A square defined by two adjacent vertical and two adjacent horizontal reference grid lines.

half-life ($t_{1/2}$): The time required for one-half of the atoms of a particular radionuclide present to disintegrate.

Historical Site Assessment (HSA): A detailed investigation to collect existing information, primarily historical, on a *site* and its surroundings.

hot measurement: See *elevated measurement*.

hot spot: See *area of elevated activity*.

hypothesis: An assumption about a property or characteristic of a set of data under study. The goal of statistical inference is to decide which of two complementary hypotheses is likely to be true. The *null hypothesis* (H_0) describes what is assumed to be the true state of nature and the *alternative hypothesis* (H_a) describes the opposite situation.

impacted area: Any *area* that is not *classified* as *non-impacted*. Areas with a reasonable possibility of containing *residual radioactivity* in excess of natural background or fallout levels.

independent assessment: An assessment performed by a qualified individual, group, or organization that is not part of the organization directly performing and accountable for the work being assessed.

indistinguishable from background: The term indistinguishable from background means that the detectable concentration distribution of a radionuclide is not statistically different from the background concentration distribution of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques.

infiltration rate: The rate at which a quantity of a hazardous substance moves from one environmental medium to another—*e.g.*, the rate at which a quantity of a radionuclide moves from a source into and through a volume of soil or solution.

inspection: An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic.

inventory: Total residual quantity of formerly licensed radioactive material at a site.

investigation level: A derived media-specific, radionuclide-specific concentration or activity level of radioactivity that: 1) is based on the release criterion, and 2) triggers a response, such as further investigation or cleanup, if exceeded. See *action level*.

isopleth: A line drawn through points on a graph or plot at which a given quantity has the same numerical value or occurs with the same frequency.

judgment measurement: Measurements performed at locations selected using professional judgment based on unusual appearance, location relative to known contaminated areas, high potential for residual radioactivity, general supplemental information, *etc*. Judgment measurements are not included in the statistical evaluation of the survey unit data because they violate the assumption of randomly selected, independent measurements. Instead, judgment measurements are individually compared to the $DCGL_W$.

karst terrain: A kind of terrain with characteristics of relief and drainage arising from a high degree of rock solubility. The majority of karst conditions occur in limestone areas, but karst may also occur in areas of dolomite, gypsum, or salt deposits. Features associated with karst terrain may include irregular topography, abrupt ridges, sink holes, caverns, abundant springs, and disappearing streams. Well developed or well integrated drainage systems of streams and tributaries are generally not present.

klystron: An electron tube used in television, *etc*., for converting a stream of electrons into ultra high-frequency waves that are transmitted as a pencil-like radio beam.

less-than data: Measurements that are less than the *minimum detectable concentration*.

license: A license issued under the regulations in parts 30 through 35, 39, 40, 60, 61, 70 or part 72 of 10 CFR Chapter I.

licensee: The holder of a *license*.

license termination: Discontinuation of a *license*, the eventual conclusion to *decommissioning*.

lower bound of the gray region (LBGR): The minimum value of the gray region. The width of the *gray region* (*DCGL-LBGR*) is also referred to as the shift, Δ.

lower limit of detection (L_D): The smallest amount of radiation or radioactivity that statistically yields a net result above the method background. The critical detection level, L_C, is the lower bound of the 95% detection interval defined for L_D and is the level at which there is a 5% chance of calling a background value "greater than background." This value should be used when actually counting samples or making direct radiation measurements. Any response above this level should be considered as above background; *i.e.*, a net positive result. This will ensure 95% detection capability for L_D. A 95% confidence interval should be calculated for all responses greater than L_C.

m: The number of measurements from the reference area used to conduct a statistical test.

magnetron: A vacuum tube in which the flow of ions from the heated cathode to the anode is controlled by a magnetic field externally applied and perpendicular to the electric field by which they are propelled. Magnetrons are used to produce very short radio waves.

measurement: For the purpose of MARSSIM, it is used interchangeably to mean: 1) the act of using a detector to determine the level or quantity of radioactivity on a surface or in a sample of material removed from a media being evaluated, or 2) the quantity obtained by the act of measuring.

micrometeorology: The study of weather conditions in a local or very small area, such as immediately around a tree or building, that can affect meteorological conditions.

minimum detectable concentration (MDC): The minimum detectable concentration (MDC) is the *a priori* activity level that a specific instrument and technique can be expected to detect 95% of the time. When stating the detection capability of an instrument, this value should be used. The *MDC* is the detection limit, L_D, multiplied by an appropriate conversion factor to give units of activity.

minimum detectable count rate (MDCR): The minimum detectable count rate (MDCR) is the *a priori* count rate that a specific instrument and technique can be expected to detect.

missing or unusable data: Data (measurements) that are mislabeled, lost, or do not meet quality control standards. *Less-than data* are not considered to be missing or unusable data. See *R*.

munitions: Military supplies, especially weapons and ammunition.

N: $N = m + n$, is the total number of measurements required from the reference area and a *survey unit*. See *m* and *n*.

n: Number of measurements from a survey unit used to conduct a statistical test.

n_f: The number of samples that should be collected in an *area* to assure that the required number of measurements from that area for conducting statistical tests is obtained. $n_f = n/(1-R)$.

NARM: Naturally occurring or accelerator-produced radioactive material, such as radium, and not classified as *source material*.

naturally occurring radionuclides: Radionuclides and their associated progeny produced during the formation of the earth or by interactions of terrestrial matter with cosmic rays.

non-blind measurement: Non-blind measurements are measurements that have a concentration and origin that are known to the individual performing the measurement. See *single-blind measurement* and *double-blind measurement*.

nonconformance: A deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate; nonfulfillment of a specified requirements.

non-impacted area: Areas where there is no reasonable possibility (extremely low probability) of residual contamination. Non-impacted areas are typically located off-site and may be used as background *reference areas*.

nonparametric test: A test based on relatively few assumptions about the exact form of the underlying probability distributions of the measurements. As a consequence, nonparametric tests are generally valid for a fairly broad class of distributions. The *Wilcoxon Rank Sum test* and the *Sign test* are examples of nonparametric tests.

normal (gaussian) distribution: A family of bell shaped distributions described by the mean and variance.

organization: a company, corporation, firm, government unit, enterprise, facility, or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration.

outlier: Measurements that are unusually large or small relative to the rest and therefore are suspected of misrepresenting the population from which they were collected.

p: The probability that a random measurement from the *survey unit* is less than Δ.

p′: The probability that the sum of two independent random measurements from the *survey unit* is less than 2Δ.

P_r: The probability that a measurement performed at a random location in the *survey unit* is greater than a measurement performed at a random location in the *reference area*.

peer review: A documented critical review of work generally beyond the state of the art or characterized by the existence of potential uncertainty. The peer review is conducted by qualified individuals (or organization) who are independent of those who performed the work, but are collectively equivalent in technical expertise (*i.e.*, peers) to those who performed the original work. The peer review is conducted to ensure that activities are technically adequate, competently performed, properly documented, and satisfy established technical and quality requirements. The peer review is an in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, acceptance criteria, and conclusions pertaining to specific work and of the documentation that supports them. Peer reviews provide an evaluation of a subject where quantitative methods of analysis or measures of success are unavailable or undefined, such as in research and development.

performance evaluation: A type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of an analyst or laboratory.

physical probe area: The physical surface area assessed by a detector. The physical probe area is used to make probe area corrections in the activity calculations.

Pitman efficiency: A measure of performance for statistical tests. It is equal to the reciprocal of the ratio of the sample sizes required by each of two tests to achieve the same power, as these sample sizes become large.

power (1-β): The probability of rejecting the *null hypothesis* when it is false. The power is equal to one minus the *Type II* error rate, *i.e.* (1-β).

precision: A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions, expressed generally in terms of the *standard deviation*.

process: A combination of people, machine and equipment, methods, and the environment in which they operate to produce a given product or service.

professional judgement: An expression of opinion, based on technical knowledge and professional experience, assumptions, algorithms, and definitions, as stated by an expert in response to technical problems.

qualified data: Any data that have been modified or adjusted as part of statistical or mathematical evaluation, data *validation*, or data *verification* operations.

quality: The totality of features and characteristics of a product or service that bear on its ability to meet the stated or implied needs and expectations of the user.

quality assurance (QA): An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer.

Quality Assurance Project Plan (QAPP): A formal document describing in comprehensive detail the necessary *QA*, *QC*, and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria. As defined for Superfund in the Code of Federal Regulations 40 CFR 300.430, the Quality Assurance Project Plan describes policy, organization, and functional activities and the Data Quality Objectives and measures necessary to achieve adequate data for use in selecting the appropriate remedy. The

QAPP is a plan that provides a process for obtaining data of sufficient quality and quantity to satisfy data needs. It is a part of the *Sampling and Analysis Plan*.

quality control (QC): The overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer, operational techniques and activities that are used to fulfill requirements for *quality*.

quality indicators: Measurable attributes of the attainment of the necessary quality for a particular environmental decision. Indicators of quality include precision, bias, completeness, representativeness, reproducibility, comparability, and statistical confidence.

Quality Management Plan (QMP): A formal document that describes the quality system in terms of the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, and assessing all activities conducted.

quality system: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC.

R: The rate of missing or unusable measurements expected to occur for samples collected in *reference areas* or *survey units*. See *missing or unusable data*. See n_f. (Not to be confused with the symbol for the radiation exposure unit Roentgen.)

R_A: The acceptable level of risk associated with not detecting an *area of elevated activity* of area A_{min}.

radiation survey: Measurements of radiation levels associated with a *site* together with appropriate documentation and data evaluation.

radioactive decay: The spontaneous transformation of an unstable atom into one or more different nuclides accompanied by either the emission of energy and/or particles from the nucleus, nuclear capture or ejection of orbital electrons, or fission. Unstable atoms decay into a more stable state, eventually reaching a form that does not decay further or has a very long *half-life*.

radioactivity: The mean number of nuclear transformations occurring in a given quantity of radioactive material per unit time. The International System (SI) unit of radioactivity is the *Becquerel (Bq)*. The customary unit is the *Curie (Ci)*.

radiological survey: Measurements of radiation levels and radioactivity associated with a *site* together with appropriate documentation and data evaluation.

radioluminescence: Light produced by the absorption of energy from ionizing radiation.

radionuclide: An unstable nuclide that undergoes *radioactive decay*.

random error: The deviation of an observed value from the true value is called the error of observation. If the error of observation behaves like a random variable (*i.e.*, its value occurs as though chosen at random from a probability distribution of such errors) it is called a *random error*. See *systematic error*.

readily removable: A qualitative statement of the extent to which a radionuclide can be removed from a surface or medium using non-destructive, common, housekeeping techniques (*e.g.*, washing with moderate amounts of detergent and water) that do not generate large volumes of radioactive waste requiring subsequent disposal or produce chemical wastes that are expected to adversely affect public health or the environment.

reference area: Geographical *area* from which representative reference measurements are performed for comparison with measurements performed in specific *survey units* at remediation site. A site radiological *reference area* (background area) is defined as an area that has similar physical, chemical, radiological, and biological characteristics as the site area being remediated, but which has not been contaminated by site activities. The distribution and concentration of *background radiation* in the *reference area* should be the same as that which would be expected on the *site* if that *site* had never been contaminated. More than one *reference area* may be necessary for valid comparisons if a *site* exhibits considerable physical, chemical, radiological, or biological variability.

reference coordinate system: A *grid* of intersecting lines referenced to a fixed site location or benchmark. Typically the lines are arranged in a perpendicular pattern dividing the survey location into squares or blocks of equal areas. Other patterns include three-dimensional and polar coordinate systems.

reference region: The geographical region from which *reference areas* will be selected for comparison with *survey units*.

regulation: A rule, law, order, or direction from federal or state governments regulating action or conduct. Regulations concerning radioisotopes in the environment in the United States are shared by the Environmental Protection Agency (EPA), the U.S. Nuclear Regulatory Commission (NRC), the U.S. Department of Energy (DOE), and many State governments. Federal regulations and certain directives issued by the U.S. Department of Defense(DOD) are enforced within the DOD.

relative shift (Δ/σ): Δ divided by σ, the *standard deviation* of the measurements. See *delta*.

relative standard deviation: See *coefficient of variation*.

release criterion: A regulatory limit expressed in terms of dose or risk.

rem (radiation equivalent man): The conventional unit of *dose equivalent*. The corresponding International System (SI) unit is the *Sievert (Sv)*: 1 Sv = 100 rem.

remedial action: Those actions that are consistent with a permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment. See *remedy*.

remediation: Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a Superfund site.

remediation control survey: A type of survey that includes monitoring the progress of remedial action by real time measurement of areas being decontaminated to determine whether or not efforts are effective and to guide further *decontamination* activities.

remedy: See *remedial action*.

removable activity: Surface activity that is *readily removable* by wiping the surface with moderate pressure and can be assessed with standard radiation detectors. It is usually expressed in units of dpm/100 cm^2.

removal: The cleanup or removal of released hazardous substances, or pollutants or contaminants which may present an imminent and substantial danger; such actions as may be necessary taken in the event of the threat of release of hazardous substances into the environment; such actions as may be necessary to monitor, assess, and evaluate the threat of release of hazardous substances; the removal and disposal of material, or the taking of other such actions as may be necessary to prevent, minimize or mitigate damage to the public health or welfare or the environment.

replicate: A repeated analysis of the same sample or repeated measurement at the same location.

representative measurement: A measurement that is selected using a procedure in such a way that it, in combination with other representative measurements, will give an accurate representation of the phenomenon being studied.

representativeness: A measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

reproducibility: The precision, usually expressed as a standard deviation, that measures the variability among the results of measurement of the same sample at different laboratories.

residual radioactivity: Radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the cognizant organization's control. This includes radioactivity from all sources used by the cognizant organization, but excludes background radioactivity as specified by the applicable regulation or standard. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR Part 20.

restoration: Actions to return a remediated area to a usable state following decontamination.

restricted use: A designation following *remediation* requiring radiological controls.

robust: A statistical test or method that is approximately valid under a wide range of conditions.

run chart: A chart used to visually represent data. Run charts are used to monitor a process to see whether or not the long range average is changing. Run charts are points plotted on a graph in the order in which they become available, such as parameters plotted versus time.

s: The *arithmetic standard deviation* of the mean.

S+: The *test statistic* used for the *Sign test*.

sample: (As used in MARSSIM) A part or selection from a medium located in a *survey unit* or *reference area* that represents the quality or quantity of a given parameter or nature of the whole area or unit; a portion serving as a specimen.

sample: (As used in statistics) A set of individual samples or measurements drawn from a population whose properties are studied to gain information about the entire population.

Sampling and Analysis Plan (SAP): As defined for Superfund in the Code of Federal Regulations 40 CFR 300.430, a plan that provide a process for obtaining data of sufficient quality and quantity to satisfy data needs. The sampling and analysis plans consists of two parts: 1) the *Field Sampling Plan*, which describes the number, type, and location of samples and the type of analyses; and 2) the *Quality Assurance Project Plan*, which describes policy, organization, functional activities, the Data Quality Objectives, and measures necessary to achieve adequate data for use in selecting the appropriate remedy.

scanning: An evaluation technique performed by moving a detection device over a surface at a specified speed and distance above the surface to detect radiation.

scoping survey: A type of *survey* that is conducted to identify: 1) radionuclide contaminants, 2) relative radionuclide ratios, and 3) general levels and extent of contamination.

self-assessment: Assessments of work conducted by individuals, groups, or organizations directly responsible for overseeing and/or performing the work.

shape parameter (S): For an elliptical area of elevated activity, the ratio of the semi-minor axis length to the semi-major axis length. For a circle, the shape parameter is one. A small shape parameter corresponds to a flat ellipse.

shift: See *delta (Δ)*.

Sievert (Sv): The special name for the International System (SI) unit of *dose equivalent*. 1 Sv = 100 *rem* = 1 Joule per kilogram.

Sign test: A *nonparametric* statistical test used to demonstrate compliance with the release criterion when the radionuclide of interest is not present in background and the distribution of data is not symmetric. See also *Wilcoxon Rank Sum test*.

single-blind measurement: A measurement that can be distinguished from routine measurements but are of unknown concentration. See *non-blind measurement* and *double-blind measurement*.

site: Any installation, facility, or discrete, physically separate parcel of land, or any building or structure or portion thereof, that is being considered for survey and investigation.

site reconnaissance: A visit to the *site* to gather sufficient information to support a site decision regarding the need for further action, or to verify existing site data. Site reconnaissance is not a study of the full extent of contamination at a facility or site, or a risk assessment.

size (of a test): See *alpha*.

soil: The top layer of the earth's surface, consisting of rock and mineral particles mixed with organic matter. A particular kind of earth or ground—*e.g.*, sandy soil.

soil activity (soil concentration): The level of radioactivity present in soil and expressed in units of activity per soil mass (typically Bq/kg or pCi/g).

source material: Uranium and/or Thorium other than that classified as *special nuclear material*.

source term: All residual radioactivity remaining at the *site*, including material released during normal operations, inadvertent releases, or accidents, and that which may have been buried at the site in accordance with 10 CFR Part 20.

special nuclear material: Plutonium, ^{233}U, and Uranium enriched in ^{235}U; material capable of undergoing a fission reaction.

split: A sample that has been homogenized and divided into two or more aliquots for subsequent analysis.

standard normal distribution: A *normal (Gaussian) distribution* with mean zero and variance one.

standard operating procedure (SOP): A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and that is officially approved as the method for performing certain routine or repetitive tasks.

statistical control: The condition describing a process from which all special causes have been removed, evidenced on control chart by the absence of points beyond the control limits and by the absence of non-random patterns or trends within the control limits. A special cause is a source of variation that is intermittent, unpredictable, or unstable.

stratification: The act or result of separating an area into two or more sub-areas so as each sub-area has relatively homogeneous characteristics such as contamination level, topology, surface soil type, vegetation cover, *etc*.

subsurface soil sample: A soil sample that reflects the modeling assumptions used to develop the *DCGL* for subsurface soil activity. An example would be soil taken deeper than 15 cm below the soil surface to support surveys performed to demonstrate compliance with 40 CFR 192.

surface contamination: *Residual radioactivity* found on building or equipment surfaces and expressed in units of activity per surface area (Bq/m^2 or $dpm/100\ cm^2$).

surface soil sample: A soil sample that reflects the modeling assumptions used to develop the *DCGL* for surface soil activity. An example would be soil taken from the first 15 cm of surface soil to support surveys performed to demonstrate compliance with 40 CFR 192.

surveillance (quality): Continual or frequent monitoring and verification of the status of an entity and the analysis of records to ensure that specified requirements are being fulfilled.

survey: A systematic evaluation and documentation of radiological measurements with a correctly calibrated instrument or instruments that meet the sensitivity required by the objective of the evaluation.

survey plan: A plan for determining the radiological characteristics of a *site*.

survey unit: A geographical area consisting of structures or land areas of specified size and shape at a remediated site for which a separate decision will be made whether the unit attains the site-specific reference-based cleanup standard for the designated pollution parameter. *Survey units* are generally formed by grouping contiguous site areas with a similar use history and the same classification of contamination potential. Survey units are established to facilitate the survey process and the statistical analysis of survey data.

systematic error: An error of observation based on system faults which are biased in one or more ways, *e.g.*, tending to be on one side of the true value more than the other.

T+: The *test statistic* for the *Wilcoxon Signed Rank test*.

tandem testing: Two or more statistical tests conducted using the same data set.

technical review: A documented critical review of work that has been performed within the state of the art. The review is accomplished by one or more qualified reviewers who are independent of those who performed the work, but are collectively equivalent in technical expertise to those who performed the original work. The review is an in-depth analysis and evaluation of documents, activities, material, data, or items that require technical verification or validation for applicability, correctness, adequacy, completeness, and assurance that established requirements are satisfied.

technical systems audit (TSA): A thorough, systematic, on-site, qualitative audit of facilities, equipment, personnel, training, procedures, recordkeeping, data validation, data management, and reporting aspects of a system.

TEDE (total effective dose equivalent): The sum of the effective dose equivalent (for external exposure) and the committed effective dose equivalent (for internal exposure). TEDE is expressed in units of Sv or rem. See *CEDE*.

test statistic: A function of the measurements (or their ranks) that has a known distribution if the *null hypothesis* is true. This is compared to the *critical level* to determine if the *null hypothesis* should be accepted or rejected. See $S+$, $T+$, and W_r.

tied measurements: Two or more measurements that have the same value.

traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughput the project back to the requirements for quality for the project.

triangular sampling grid: A grid of sampling locations that is arranged in a triangular pattern. See *grid*.

two-sample t test: A parametric statistical test used in place of the *Wilcoxon Rank Sum (WRS) test* if the *reference area* and *survey unit* measurements are known to be *normally (Gaussian) distributed* and there are no *less-than measurements* in either data set.

Type I decision error: A decision error that occurs when the *null hypothesis* is rejected when it is true. The probability of making a *Type I decision error* is called *alpha* (α).

Type II decision error: A decision error that occurs when the *null hypothesis* is accepted when it is false. The probability of making a *Type II decision error* is called *beta* (β).

unity rule (mixture rule): A rule applied when more than one radionuclide is present at a concentration that is distinguishable from background and where a single concentration comparison does not apply. In this case, the mixture of radionuclides is compared against default concentrations by applying the unity rule. This is accomplished by determining: 1) the ratio between the concentration of each radionuclide in the mixture, and 2) the concentration for that radionuclide in an appropriate listing of default values. The sum of the ratios for all radionuclides in the mixture should not exceed 1.

unrestricted area: Any *area* where access is not controlled by a *licensee* for purposes of protection of individuals from exposure to radiation and radioactive materials—including areas used for residential purposes.

unrestricted release: Release of a *site* from regulatory control without requirements for future radiological restrictions. Also known as unrestricted use.

validation: Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. In design and development, validation concerns the process of examining a product or result to determine conformance to user needs.

verification: Confirmation by examination and provision of objective evidence that the specified requirements have been fulfilled. In design and development, verification concerns the process of examining a result of given activity to determine conformance to the stated requirements for that activity.

W_r: The sum of the ranks of the adjusted measurements from the reference area, used as the *test statistic* for the *Wilcoxon Rank Sum test*.

W_s: The sum of the ranks of the measurements from the survey unit, used with the *Wilcoxon Rank Sum test*.

weighting factor (W_t): The fraction of the overall health risk, resulting from uniform, whole-body radiation, attributable to specific tissue. The dose equivalent to tissue is multiplied by the appropriate weighting factor to obtain the effective dose equivalent to the tissue.

Wilcoxon Rank Sum (WRS) test: A *nonparametric* statistical test used to determine compliance with the *release criterion* when the radionuclide of concern is present in background. See also *Sign test*.

working level: A special unit of radon exposure defined as any combination of short-lived radon daughters in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy. This value is approximately equal to the alpha energy released from the decay of progeny in equilibrium with 100 pCi of ^{222}Ra.

$Z_{1-\varphi}$: The value from the standard normal distribution that cuts off 100 φ % of the upper tail of the standard normal distribution. See *standard normal distribution.*

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11. ABSTRACT *(200 words or less)*

The MARSSIM provides information on planning, conducting, evaluating, and documenting building and surface soil final status radiological surveys for demonstrating compliance with dose or risk-based regulations or standards. The MARSSIM is a multi-agency consensus document that was developed collaboratively by four Federal agencies having authority and control over radioactive materials: Department of Defense (DOD), Department of Energy (DOE), Environmental Protection Agency (EPA), and Nuclear Regulatory Commission (NRC). The MARSSIM's objective is to describe a consistent approach for building and surface soil final status surveys to meet established dose or risk-based release criteria, while at the same time encouraging an effective use of resources.

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PRELIMINARY ASSESSMENT/ SITE INSPECTION OF NAVAL STATION TREASURE ISLAND, CA.

VOLUME I

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NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY

Port Hueneme, California 93043

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April 1988

EXECUTIVE SUMMARY

This report presents the results of the Preliminary Assessment/Site Inspection (PA/SI) conducted at Naval Station (NAVSTA) Treasure Island, California which includes Treasure Island (TI) and a portion of Yerba Buena Island (YBI). The purpose of the PA/SI is to identify and assess sites posing a potential threat to human health or the environment due to contamination from past hazardous materials operations.

At TI and YBI, contaminants could potentially migrate by two pathways: infiltration through the soil until reaching the ground water and surface runoff. The ultimate receptor of any soluble contamination at TI will be the surrounding San Francisco Bay waters and the Bay fauna and flora. At YBI, due to its different geologic conditions, soluble contaminants could either be transported to the Bay waters or could infiltrate into the Franciscan sandstone and shales. However, there is limited potential for harm to humans because ground water is not utilized at either TI or YBI. The ground water is also not anticipated to provide a problem for wildlife on TI and YBI because it is not a significant water source to the wildlife. Contaminated ground water and surface runoff entering San Francisco Bay could potentially affect marine fauna and flora.

Based on information from historical records, aerial photographs, agency contacts, field inspection, and personnel interviews, a total of 26 potentially contaminated sites were identified at NAVSTA TI.

Each site was evaluated with regard to contaminant characteristics, migration pathways, and pollutant receptors. The study concludes that 20 of the 26 potentially contaminated sites warrant further investigation under the Navy Installation Restoration (IR) Program. Remedial Investigation/Feasibility Study (RI/FS) involving sampling and monitoring of the 21 sites are recommended to confirm or deny the presence of suspected contaminants at the sites. The 20 sites are:

Site No. 1 - Medical Clinic
Site No. 3 - PCB Equipment Storage Area
Site No. 4 - Hydraulic Training School
Site No. 5 - Old Boiler Plant
Site No. 7 - Pesticide Storage
Site No. 9 - Foundry
Site No. 10 - Bus Painting Shop
Site No. 11 - YBI Landfill
Site No. 12 - Old Bunker Area
Site No. 13 - Stormwater Outfalls (TI)/(YBI)
Site No. 15 - Old Fuel Farm
Site No. 16 - Clipper Cove Tank Farm
Site No. 17 - Tanks 103/104
Site No. 19 - Refuse Transfer Area
Site No. 20 - Auto Hobby Shop/Transportation Center
Site No. 21 - Vessel Waste Oil Recovery
Site No. 22 - Navy Exchange Service Station
Site No. 24 - 5th Street Fuel Releases
Site No. 25 - Seaplane Maintenance
Site No. 26 - Underground Tanks

The sampling and analysis of the sites will assess whether a threat to human health or the environment exists, the extent of contamination, and the potential for migration. These RI/FS study results will then be used to evaluate the necessity of conducting remedial action or cleanup operations.

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CHAPTER 1. INTRODUCTION

1.1 PROGRAM BACKGROUND. Past hazardous waste disposal methods, although acceptable at the time, have often caused unexpected long-term problems through release of hazardous substances into the soil and ground water. In response to a growing recognition of these problems, Congress directed the U.S. Environmental Protection Agency (EPA) to develop a comprehensive national program to manage past disposal sites. The program is outlined in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of December 1980 and the Superfund Amendments and Reauthorization Act (SARA) of October 1986.

1.1.1 DOD Program. Department of Defense (DOD) efforts in this area preceded the nationwide CERCLA program. In 1975, the U.S. Army developed for DOD a pilot program to investigate past disposal sites at military installations. DOD defined the program as the Installation Restoration Program in 1980 and instructed the services to comply with program guidelines.

1.1.2 Navy Program. The Navy manages its part of the program, the Navy Installation Restoration (IR), in three phases. Phase One, the Preliminary Assessment/Site Inspection (PA/SI), identifies potential threats to human health or to the environment caused by past hazardous substance storage, handling, or disposal practices at naval activities. Phase Two, the Remedial Investigation/Feasibility Study (RI/FS), verifies and if necessary characterizes the extent of contamination present through additional sampling, provides additional information regarding migration pathways, characterizes the extent of contamination present and evaluates the most feasible type of remedial measure to implement. Phase Three, the Remedial Action, provides the required corrective measures to mitigate or eliminate confirmed problems.

1.2 AUTHORITY. The Chief of Naval Operations (CNO) initiated the Navy IR Program in OPNAVNOTE 6240 of 11 September 1980, superseded by OPNAVINST 5090.1 of 26 May 1983. The Naval Facilities Engineering Command (NAVFACENGCOM) manages the program within the existing structure of the Naval Environmental Protection Support Service (NEPSS), which is administered by the Naval Energy and Environmental Support Activity (NEESA). NEESA conducts the program's first phase, the PA/SIs, in coordination with NAVFACENGCOM Engineering Field Divisions (EFDs).

1.3 SCOPE.

1.3.1 Past Operations. The Navy IR Program focuses attention on past hazardous substance storage, use, and disposal practices on Navy property. Current practices are regularly surveyed for conformity to State and Federal regulations and, therefore, are not included in the scope of the Navy IR Program. The PA/SI report addresses operational hazardous and nonhazardous disposal and storage areas on Treasure Island (TI) and Yerba Buena Island (YBI) in the past. Current operations are investigated solely to assess what types and quantities of chemicals or other materials were used and what disposal methods were practiced.

1.3.2 Results. If necessary, a PA/SI recommends Remedial Measures to be performed by the activity or EFD, or recommends a Remedial Investigation (RI)

to be administered by the EFD under the Navy IR Program. Based on these recommendations, NAVFACENGCOM schedules an RI for those sites determined by scientific and engineering judgment to be potential hazards to human health or to the environment.

1.4 PRELIMINARY ASSESSMENT/SITE INSPECTION

1.4.1 Records Searches. The PA/SI begins with a records search at various government agencies, including EFDs, national and regional archives and records centers, and U.S. Geological Survey offices. In this integral step, study team members review records to assimilate information about the activity's past missions, industrial processes, waste disposal records, and known environmental contamination. Examples of records include activity master plans and histories, environmental impact statements, cadastral records, and aerial photographs.

1.4.2 On-Site Survey. After the records search, the study team conducts an on-site survey to complete documentation of past operations and to identify potentially contaminated areas. With the assistance of an activity point of contact, the team inspects the activity during the survey, and interviews long-term employees and retirees. The on-site survey for NAVSTA TI, which includes both TI and part of YBI, was conducted 5-9 October 1987; information in this report is current as of those dates. Figure 1-1 shows the regional location of NAVSTA TI.

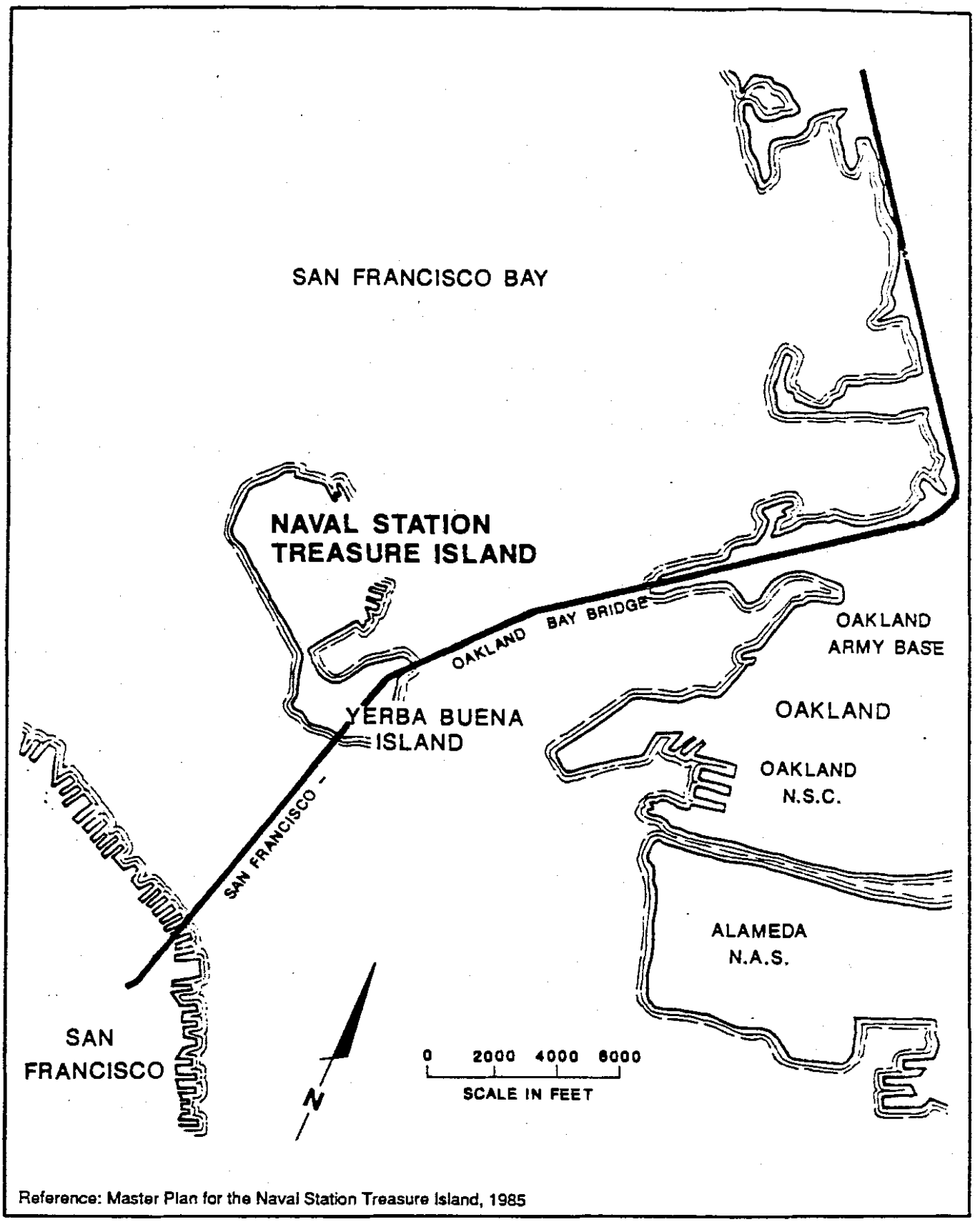
Information obtained from interviews is verified by data from other sources or from corroborating interviews. If information for certain sites is conflicting or inadequate, the team collects samples for clarification.

1.4.3 Hazard Ranking System. Sufficient information is collected during the PA/SI to provide the documentation necessary to evaluate each site using the Hazard Ranking System (HRS). The HRS, developed by EPA, is used to systematically evaluate (score) the relative severity of potential problems.

1.4.4 Remedial Investigation. A Remedial Investigation is recommended for sites at which sufficient evidence exists to indicate the presence of contamination.

1.5 REMEDIAL INVESTIGATION/FEASIBILITY STUDY. Generally the EFD conducts the RI in two steps: verification and characterization. In the verification step, short-term monitoring, sampling, and chemical analyses are performed to assess whether specific toxic and hazardous materials identified in the PA/SI are present in concentrations considered to be hazardous. The PA/SI recommends a verification step sampling and monitoring program. If appropriate, a characterization step provides more detailed information concerning contaminant migration and site hydrogeology via long-term testing and monitoring, sampling, and chemical analyses. The scope of the RI/FS usually depends on the results of the verification phase. If sites require remedial action or additional monitoring programs, a Feasibility Study is conducted to evaluate the effectiveness of various remedial action alternatives.

1.6 PA/SI REPORT CONTENTS. The significant findings and conclusions from the PA/SI at NAVSTA TI are presented in Chapter 2. Recommendations for further



Reference: Master Plan for the Naval Station Treasure Island, 1985

PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	REGIONAL LOCATION	FIGURE 1-1

studies are presented in Chapter 3. Chapter 4 describes general activity information, history, biological features, and physical features. Chapters 5 through 8 trace the use of chemicals and hazardous materials, from storage and transfer, through manufacturing and operations, to waste processing and disposal. The latter chapters provide documentation to support the findings and conclusions in Chapter 2.

CHAPTER 2. SIGNIFICANT FINDINGS AND CONCLUSIONS

2.1 INTRODUCTION. Naval Station (NAVSTA) Treasure Island was chosen for a PA/SI to comply with the Federal Agency Hazardous Waste Compliance Docket as published in the Federal Register on February 12, 1988. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended requires a Preliminary Assessment by April 17, 1988 for facilities listed on the Federal Agency Hazardous Waste Compliance Docket. The Federal Agency Hazardous Waste Compliance Docket indicated that the NAVSTA Treasure Island was placed on the docket because of the information submitted under the following acts: the Resource, Conservation, and Recovery Act (RCRA), Sections 3005 and 3010, and CERCLA Section 103C.

This chapter summarizes the significant findings and conclusions made by the PA/SI Team concerning characteristics of the disposal sites and potentially contaminated areas identified at NAVSTA Treasure Island which is comprised of Treasure Island (TI) and a portion of Yerba Buena Island (YBI) (Figure 2-1).

Table 2-1 summarizes the history of operations at all 26 potential sites identified. Site usage, years of operation, and potential contaminants are indicated.

With few exceptions, contamination at the sites on both TI and YBI is the result of petroleum hydrocarbons originating from fueling operations. Numerous storage tanks and underground fuel lines exist, many of which have been gradually abandoned since about the 1950s. Due to the undocumented nature of leaks and spills from these sources, the volumes released generally cannot be quantified.

This chapter begins with a summary discussion of hydrogeology and migration potential. The following sections present brief discussions of each of 20 sites recommended for subsequent RIs, 2 sites at which Remedial Measures are judged necessary, and 4 sites which require no further investigations at this time. All 26 sites are shown on Figures 2-2 and 2-3.

2.1.1 Hydrogeology and Migration Potential. TI and YBI are surrounded by the waters of San Francisco Bay (Figure 2-1). TI is a man-made island composed of dredged materials consisting of poorly graded fine sand placed over Yerba Buena Shoals. The fill materials appear to have medium permeability, 1.0×10^{-3} to 1.0×10^{-4} cm/sec (Harding Lawson Associates, 1985). Ground water at TI is generally encountered at 30-72 inches below ground surface. The direction of flow for both ground water and surface runoff at TI is towards the Bay. Soluble contaminants would tend to migrate vertically through the sand to the water table or migrate overland in surface runoff. Less soluble contaminants, however, may tend to bind with the soils and become relatively immobile. For example, hydrocarbons, a major contaminant at TI, may migrate down to the water table where the less soluble hydrocarbons may become relatively immobile in the capillary fringe, while the soluble fraction dissolves in the ground water.

YBI is a natural rock island with minimal soil cover. Surface soils are sandy loam to gravelly loam and subsoils are gravelly loam to sandy clay loam (WESTDIV, 1986b). Bedrock on YBI consists of sandstone and shale. Although there is limited information concerning ground water at YBI, the ground water

in similar sites in the San Francisco Bay area is commonly present in sandstone or fractured shale due to infiltration. In the filled areas at YBI on the eastern side, soluble contaminants would potentially migrate to the Bay waters. At other areas on the Island, the surface runoff would either transport potential contaminants to the Bay or runoff would infiltrate into the Franciscan sandstone and shale. Less soluble contaminants would tend to bind with the soils and bedrock becoming relatively immobile or leaching small quantities to the surface runoff and ground water.

For both TI and YBI, there is limited potential for human contact with or consumption of ground water. Drinking water wells are not used on TI or YBI; instead, water used by the facilities is conveyed by pipeline from San Francisco or Emeryville via the Bay Bridge. No information was available on utilization of ground water by wildlife, but it is not anticipated to provide a significant source of water.

2.1.2 Potential Contaminant Receptors. The potential receptor of soluble contamination at TI and YBI would include flora and fauna using or inhabiting the surrounding waters of San Francisco Bay. Contaminants entering San Francisco Bay from TI and YBI could affect open water bay habitat used by two federal and state listed endangered species (California least tern and California brown pelican). Both species feed in the open water habitat of San Francisco Bay within the vicinity of TI and YBI. Feeding by these species near TI and YBI could result in the consumption of fish in which contaminants could potentially concentrate. Another species of concern that may use the shores of YBI is the harbor seal. The harbor seal is protected under the Marine Mammal Protection Act. In addition, San Francisco Bay is also subject to moderate to heavy sport and game fishing pressure. Therefore, some fish used for human consumption could contain concentrations of contaminants originating from TI or YBI.

2.2 SITES RECOMMENDED FOR REMEDIAL INVESTIGATION.

2.2.1 Site 1: Medical Clinic. Site 1, an area of soil below a portion of the Medical Clinic (Building 257; Figure 2-2) is contaminated as the result of leaks from abandoned x-ray equipment. At the south end of the middle wing of Building 257, corrosive developer and/or fixer solutions leaked from the equipment, eroded the wooden floor and then dripped directly to the soil under the building. The exact time, quantity, and duration of the release was not established. The affected area may cover up to 100 square feet to an unknown depth. No immediate receptors were identified in the area of release under the building. Surface sampling by NEESA confirmed the presence of silver in concentrations as high as 7,740 mg/kg and acidic soil conditions with pH as low as 4.0. Chemical results are shown in Table B-1, located in Appendix B.

The predominant migration pathway is vertically through soils to the ground water table, and then laterally to the Bay. Because sample analysis indicate contamination is present, Site 1 is recommended for an RI to assess the degree of contamination with depth and to evaluate if contaminants have migrated to ground water.

2.2.2 Site 3: PCB Equipment Storage Area. A paved PCB equipment storage area is located on the south side of Building 3 on TI, about 150 ft from the shore (Figure 2-2). Spills have occurred, one as recently as two to three

TABLE 2-1

SUMMARY OF SITE OPERATIONAL HISTORY

SITE	DESCRIPTION	YEARS	OPERATION	POTENTIAL CONTAMINANTS
1	Medical Clinic (Bldg. 257)	1940s-late 1970s	X-ray development	Developer and/or fixer solutions metals such as silver
2	Radiation Training Area	mid 1950s-1969	Radioactive water containment	Radioactive sources such as K-42, Na-24, Ra-226, Cs-137, Br-80, Br-82, and Pu-239
3	PCB Storage Area (Bldg. 3)	pre-1953-present	Outside Storage Area	PCBs
4	Hydraulic Training School (Bldg. 342)	1970s-present	Outside Storage Area	Waste hydraulic oil (mainly transmission oil)
5	Old Boiler Plant (Bldg. 102)	1964-1968 1968-1987	Boiler Plant Debris from demolished boiler plant	Mercuric nitrate Asbestos
6	Fire Training Area	1946-1987	Fire training school	Petroleum hydrocarbons, magnesium and fire extinguishing chemicals
7	Pesticide Storage (Bldg. 62)	1943-late 1950s 1955-early 1960s 1968-?	Mixed and stored paints Mixed and stored pesticides and herbicides Treatment plant spread area for wastewater sludge	Paints containing linseed oil and lead Pesticides and herbicides Organics and metals
8	Army Point (YBI) Sludge Disposal Area	1968-?	Treatment plant spread area for wastewater sludge	Organics and metals
9	Foundry (Bldg. 41)	1943-1947 1953-1968 1981-1987	Forge/foundry Paint shop Welding school	---- Paints containing lead or zinc-chromium based pigments, paint thinners and solvents ----
10	Bus Painting Shop (Bldg. 335)	1947-1953 1953-1955 ?-present	Bus paint shop Storage and mixing area for pest control shop Steam rack	Waste paints, thinners, solvents pesticides, and herbicides Oils, grease, and petroleum hydrocarbons

TABLE 2-1

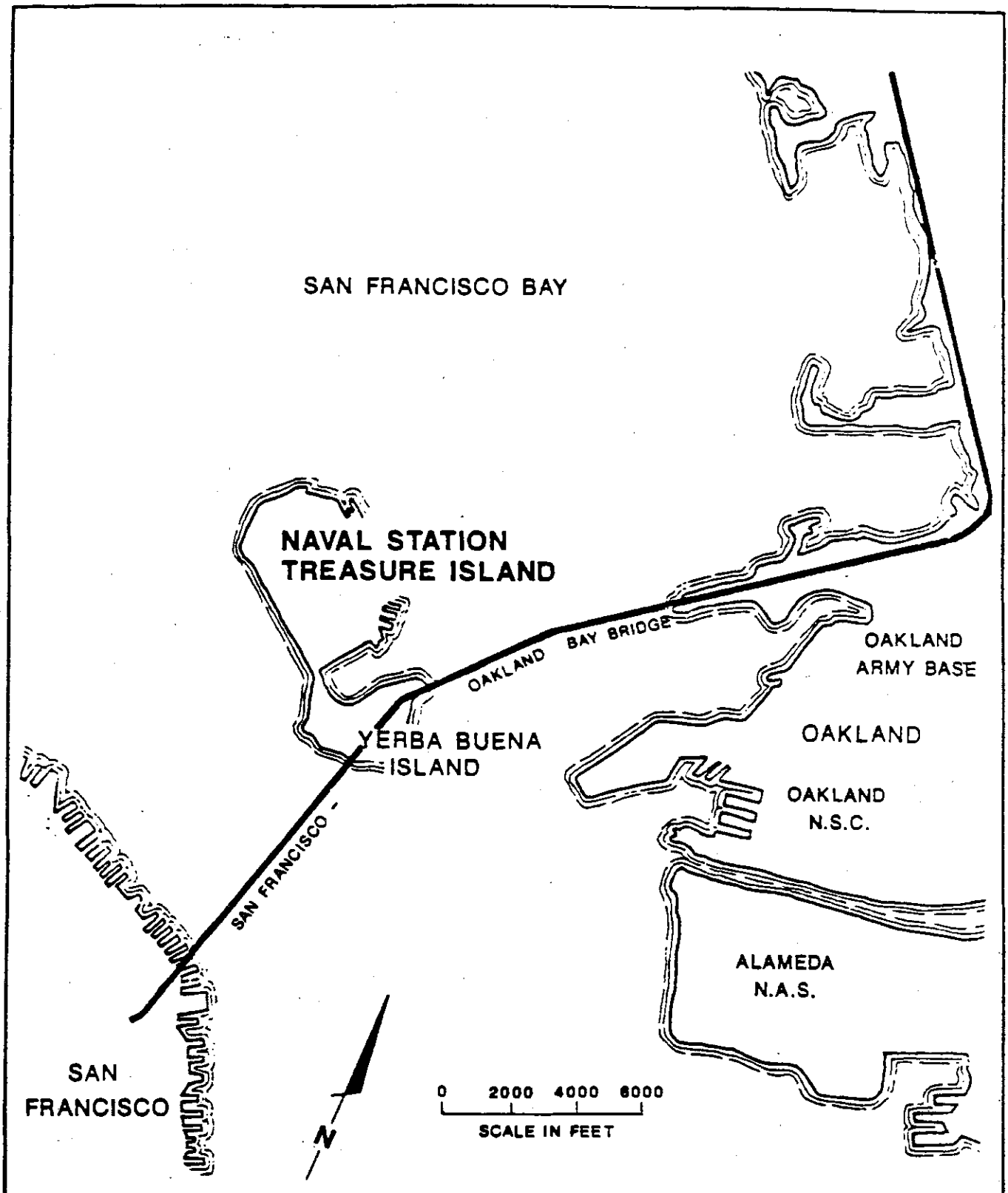
SUMMARY OF SITE OPERATIONAL HISTORY

SITE	DESCRIPTION	YEARS	OPERATION	POTENTIAL CONTAMINANTS
11	YBI Landfill	1935-present	Unsanctioned disposal area	----
12	Old Bunker Area	1940s-1969	Ammunition bunkers, disposal area	----
13	Stormwater outfalls	1936-present	Stormwater discharge; vessel discharge	Storm and wastewater effluent mercuric nitrate, vessel waste; oils
14	New Fuel Farm	1943-present	Fuel storage	Petroleum hydrocarbons
15	Old Fuel Farm	pre-1943-present	Undrained abandoned underground pipelines	Petroleum hydrocarbons
16	Clipper Cove Tank Farm	1940s-1960s	10 storage tanks	Lead, oil, and other petroleum hydrocarbons
		1960s	Spread area for sludge from dismantled tanks	Lead, oil, and other petroleum hydrocarbons
17	Tanks 103/104	1943-present	Storage tanks	Petroleum hydrocarbons (diesel) (accidental release in 1983)
18	Pier 21 Fuel Release	1985	Pipelines to Pier 21	Petroleum hydrocarbons (accidental release in 1985)
19	Refuse Transfer Area	1953-present	Refuse holding and disposal area	Unidentified fluids
20	Auto Hobby Shop/Transportation Center (Bldgs. 194, 224, 225, 230 and 267)	1943-1950	TI Transportation Center	Degreasing substances, solvents, oils, grease, hydrocarbons
	(Bldg 225)	1947-present	Auto Hobby Shop with drum storage area	Hydraulic fluid, recycled oil, grease, vehicle fluid, and metals such as chromium, nickel and zinc
21	Vessel Waste Oil Recovery	1946-present	Vessel waste oil recovery	Waste oils
22	Naval Exchange Service Station	1946-present	Gas Station	Petroleum hydrocarbons and accumulated vehicle fluids
23	Y8I Line Break	Early 1980s	Pipeline	Hydrocarbons (black oil)
24	Fifth Street	1986-1987	Abandoned pipelines	Petroleum hydrocarbons

TABLE 2-1

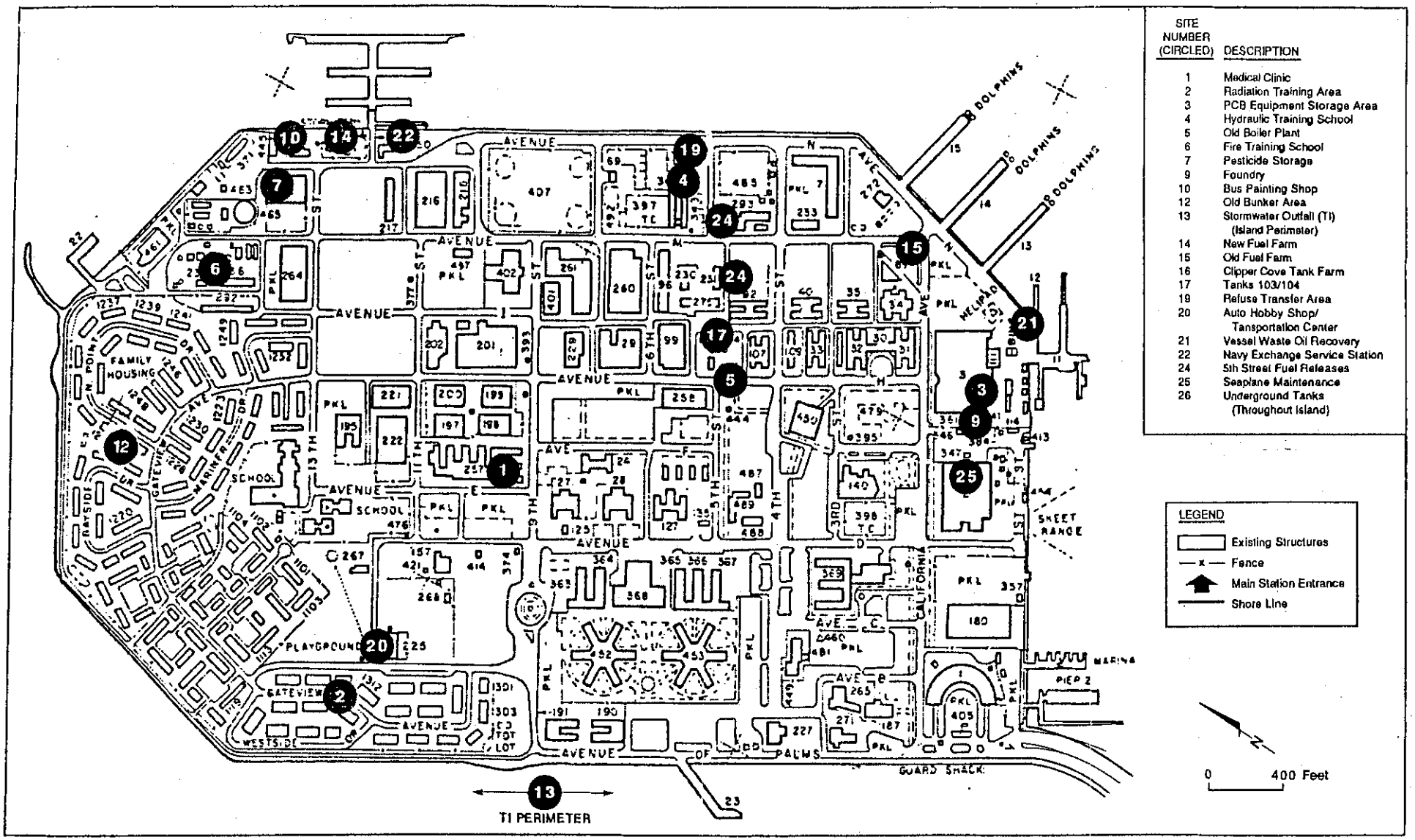
SUMMARY OF SITE OPERATIONAL HISTORY

SITE	DESCRIPTION	YEARS	OPERATION	POTENTIAL CONTAMINANTS
25	Seaplane Maintenance (Bldgs. 2,3, and 180)	1943-1958	Seaplane maintenance	Waste liquids and solvents for engine cleaning
	(Bldg. 2)	-----	Gasoline tanks	Gasoline
26	Asbestos Covered Piping (YBI)	early 1980s	Pipelines	Asbestos
27	Underground Tanks	pre-1935-present	Storage of petroleum products	Petroleum products



Reference: Master Plan for the Naval Station Treasure Island, 1985

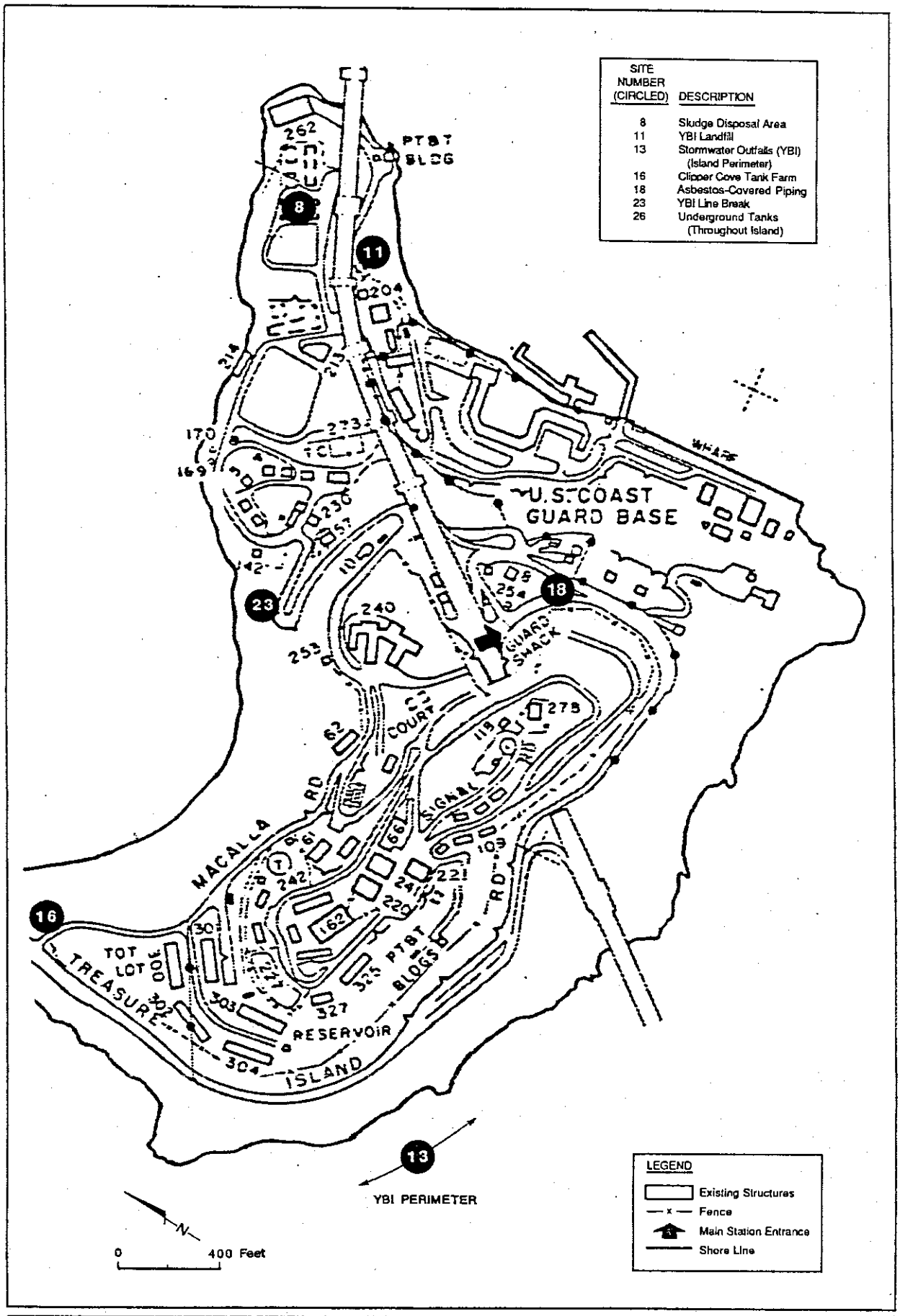
PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	REGIONAL LOCATION	FIGURE 2-1



PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.

LOCATION OF IDENTIFIED SITES-TREASURE ISLAND (TI)

FIGURE 2-2



PRELIMINARY ASSESSMENT/ SITE INSPECTION
NAVSTA Treasure Island, Ca.

LOCATION OF IDENTIFIED SITES
YERBA BUENA ISLAND (YBI)

FIGURE 2-3

years ago. The quantity of material released was not identified and an area up to 100 square feet may be involved. The material was reported to have been cleaned up, but records of the cleanup were not located. Of several samples taken in the storage area by NEESA during October, 1987, only one wipe sample contained PCB, at a concentration of 3.5 µg/100 cm^2 (Appendix B). 2 samples had detections However, it is likely that past spills were not remediated and, further, PCBs can migrate through asphaltic materials. Therefore, the potential for soil and ground water contamination is possible.

Pathways for contaminant migration are vertical, through the asphalt paving into subsurface soils, or through stormwater runoff into the storm sewer system and then into the Bay. Contaminant receptors are both organisms in the Bay and the soils and pavement underlying the site. Because PCBs may be present in the subsurface soils and the ground water may be affected, this site is recommended for an RI.

2.2.3 Site 4: Hydraulic Training School. In the area behind the Hydraulic Training School (Building 342, Figure 2-2), waste oil has been released from drums and has stained the underlying concrete pavement and an adjacent earthen area. The site is approximately 200 ft north of 5th Street, midway between Avenues M and N. Several hundred square feet have been affected. The quantity and duration of the release is not known and the depth of contamination is uncertain. The Hydraulic Training School, according to TI personnel, has been located at building 342 since the early 1970s. Samples obtained by NEESA personnel at the surface and at about a 6-inch depth did confirm contamination with oil and grease and petroleum hydrocarbons at maximum concentrations of 88,800 mg/kg and 53,000 µg/g, respectively (Appendix B).

The contaminant migration pathway is primarily vertical in the unpaved area, through the surface soils towards ground water. In the paved area (concrete pad), the migration pathway is via surface water flow to the unpaved areas or to a storm drain located about 30 ft from the pad between the Hydraulic Training School (Building 342) and the adjacent Building 343. The storm system drains into San Francisco Bay.

Due to the analytical results which confirmed oil and grease and petroleum hydrocarbons at this area, Site 4 is recommended for an RI.

2.2.4 Site 5: Old Boiler Plant. During the period from about 1943 to its demolition in 1968, Building 102 was used as a boiler plant on TI (Figure 2-2). In early 1987 during construction of a pipeline trench in the asphalt paved area near the intersection of Fifth Street and Avenue H where the boiler plant had been located, building debris was uncovered which reportedly included asbestos insulation. The quantity and other constituents of the debris were not established. The pipeline trench was backfilled and the asphalt pavement patched.

The asbestos, if present, is currently in a "contained" state posing no threat of airborne contamination. However, the area presumably may again unknowingly be excavated as part of routine street and pipeline maintenance, releasing asbestos fibers into the atmosphere, potentially threatening human health; therefore, Site 5 is recommended for for an RI to evaluate if the debris does

in fact contain asbestos and if necessary, to plan subsequent remedial measures.

2.2.5 Site 7: Pesticide Storage. Building 62, as shown on Figure 2-2, is located in the northeastern section of TI and lies about 250 ft from the shore. The building has been used for storage and handling of a variety of liquid substances in the past including pesticides, herbicides, paint, and other unidentified fluids. These materials were stored in small, 1 to 5 gallon containers. Pesticides and herbicides were mixed and prepared for use beginning about 1955 until at least the early 1960s. Paints containing linseed oil and lead were apparently mixed on-site near Pier 11 from 1943 to the late 1950s. Excess fluids were disposed by pouring directly onto the ground or stormwater drains outside Building 62 to the east and into San Francisco Bay. This practice occurred for approximately 20 years, from 1943 to at least the early 1960s. Relatively small volumes were involved; usually 5-10 gallons per disposal, every 1 to 40 weeks.

In addition, it was reported that sludge from the adjacent wastewater treatment plant (WWT) was spread on the ground in an area bounded by Building 62, the WWT, Avenue M, and 13th Street, about 250 ft by 100 ft in plan dimension. The volume spread was estimated to be up to 10-15 cubic yards per month, total, at this site and at Site 8, potentially spreading 960 to 1440 cubic yards of sludge from 1968 to 1976. The potential exists for organics and metals in the wet sludge to have migrated into the subsurface. Sludge contaminants may be similar to those discharged by the WWT in 1984 which included cyanide, arsenic, cadmium, chromium, copper, lead, nickel, silver, zinc, phenolics, and mercury.

The area surrounding Building 62 is almost entirely paved. However, a portion of the possible sludge spreading area is not paved. Contaminant migration pathways would generally be expected to be vertical to the ground water table, carried by percolating surface water, and then horizontal, carried in the ground water to San Francisco Bay. Because the potential exists for contamination from the spread of sludge or the various liquids which were disposed of in the area, Site 7 is recommended for an RI.

2.2.6 Site 9: Foundry. Building 41 on TI has been used for at least three operations since the early 1940s. On building indexes for 1943 and 1947, Building 41 is listed as a forge and foundry. Details regarding this use were not located. From at least 1953 to 1968, Building 41 is listed as a paint shop although a 1985 index continues to erroneously list it as a paint shop. The paint booth emission abatement equipment is reported to still be installed. Between 1968 and 1981, building usage is indeterminate. Most recently, from 1981 to 1987, the building was used as a welding training school by NTTC. The area around the building is currently paved.

While being used as a paint booth, it was reported that paint mixing operations took place. Discharge of waste paints, thinners, and solvents to the Bay adjacent to the building and spillage of some materials is speculated by TI personnel to have occurred. Paints used at this facility are known to have contained lead or zinc-chromium-based pigments.

This area of TI was the site of seaplane maintenance operations and therefore the area surrounding the building may have been paved for much of its

existence. Paving would serve to reduce water infiltration and contaminant transport into the subsurface. Rather, the migration pathway would be via surface water flow, carrying contaminants to the storm sewer system and then to San Francisco Bay. Because the potential for soil or ground water contamination cannot be excluded due to the varied long-term use of the site, Site 9 is recommended for an RI to evaluate what contaminants may be present in the subsurface soils.

2.2.7 Site 10: Bus Painting Shop. Building 335 on TI was constructed during the mid-1940s and is located about 100 ft from the shoreline, between Site 7, Pesticide Storage, and the Bay. During the 1940s and 1950s, the building was operated as a bus paint shop and for an unspecified period of time, paints may have also been mixed at this building. Based on handling practices reported at similar facilities on TI, waste paints, thinners, and solvents may have been released onto the ground near the building, spread on the adjacent riprap, or discharged to the Bay. Building 335 was also reported to have been used for storage, mixing and handling of pest control solutions (pesticides and herbicides) during an unspecified time period. Solution residues were reported to have been washed from containers and spraying equipment. It was also reported that Building 335 housed a do-it-yourself steam rack which was used to clean vehicles, drums, garbage cans, etc.

Based on this varied usage, a wide range of contaminants were present at this site. A floor drain is present in the building, connected to the storm sewer system, which would convey potential contaminants directly to the Bay. The building is currently surrounded mainly by gravel surface, and contaminant migration pathway in this area would be vertical to the ground water table, then to the Bay. Due to the potential contamination of the soil and ground water, Site 10 is recommended for an RI.

2.2.8 Site 11: YBI Landfill. The southern edge of the eastern port of YBI is a former marsh area about 100 ft by 400 ft in plan dimension which was identified as a dump in a 1935 topographic map. The exact dates of sanctioned operation were not established. Unsanctioned disposal occurs currently although there are signs in the area to discourage additional dumping. The volume and type of material disposed in the area could not be identified. The potential for ground water contamination originating from the buried materials is possible. An RI is recommended to be performed at this site to characterize the fill materials and evaluate if contamination is present in the fill, the underlying native soils, or ground water.

2.2.9 Site 12: Old Bunker Area. From the early 1940s until about 1968, the northern one-quarter of TI contained ammunition bunkers. Surrounding the bunkers, both trench-type disposal units and general debris disposal areas were constructed. Although we have found no information detailing these operations, the disposal areas were identified in a series of trenches and borings performed during foundation excavations for the 1200-series housing units constructed in 1968. Materials were identified as "loose rubbish, bottles, wire rope, paper, steel drum, incinerator ash, etc." (MKE-Abrams-Keller & Grannon, 1968). In some areas, rubbish was found to the depths excavated, about elevation -2 feet MSL. Because site preparation recommendations included removing the debris only to elevation +2 feet MSL, rubbish probably remains buried in this area. The area is still the site of military housing with housing units, paved streets, and grassy lawns.

Contaminant migration pathways are expected to be vertical to the ground water table and then into the Bay. Due to the presence of the housing units and because the potential for soil and ground water contamination is possible if the refuse was not completely removed during construction, Site 12 is recommended for an RI.

2.2.10 Site 13: Stormwater Outfalls. TI has two distinct sewer systems: a wastewater system and a stormwater sewer system. Water conveyed by the stormwater system is collected from surface drains and some building drains and is discharged to the Bay without treatment. According to facility drawings, there are numerous discharge outfalls which convey water collected from different parts of the station. During the years of NAVSTA TI operations, it is likely that contaminants such as paints, paint thinners, hydrocarbons, solvents, and pesticides may have been deposited in the Bay waters through the storm and wastewater system effluents (e.g., Sites 3, 4, 7, 10, 20, and 22). In addition, these types of contaminants would also have deposited in the Bay through direct discharge (from vessels and from the Station) and through ground water migration. An RI is recommended to identify the potential contaminants. A systematic sediment sampling plan for both TI and YBI is proposed for the RI.

2.2.11 Site 15: Old Fuel Farm. Prior to 1943, the NAVSTA TI fuel farm was located east of Building 89 near the intersection of Avenue M and 2nd Street. The farm consisted of the two above ground 210,000 gallon fuel storage tanks (4 and 5) later transferred to Site 14, the New Fuel Farm. The location of the farm is not precisely known because its relocation predates the earliest air photos and plans available for review. Based on available information, there is no history of spills associated with these tanks but associated underground pipelines may have been abandoned without first draining the remaining fuel in the lines. Many line breaks have already occurred (e.g., Site 24: Fifth Street Fuel Releases, Section 2.2.1.9), draining segments of the lines and resulting in contamination. In 1985, excavations in this area at the nearby commissary and also for the new pier facility both revealed soil suspected of containing oil and/or hydrocarbons. The volume of oil, if any, remaining in abandoned lines cannot be quantified due to the line breaks.

Migration of released fuels is vertical, carried by surface infiltration to the ground water table and then via ground water to the Bay. The area is currently paved, however, inhibiting migration. To evaluate the degree and extent of soil contamination and assess if ground water has been affected, this site is recommended for an RI.

2.2.12 Site 16: Clipper Cove Tank Farm. Ten above ground storage tanks were located on the east side of the isthmus joining YBI and TI from about the 1940s until they were dismantled in the 1960s. These storage tanks contained aviation gasoline and automotive diesel. Unknown quantities of sludge were removed from the bottom of each of these tanks at the time they were dismantled and were reportedly deposited on bare ground east at an unspecified distance from the tanks. No record exists documenting the sludge removal and disposal or any tank or piping releases. The sludge would either erode and wash away into the Bay and/or would be absorbed into the underlying soil over a period of years. Surface soil samples revealed lead and total petroleum hydrocarbons ranging in concentration from 89 to 160 mg/k for lead and 240 to 540 µg/g for total petroleum hydrocarbons (Appendix B). Due to the

potential contamination of the soil and ground water, a more extensive soil sampling program is recommended in an RI to evaluate the extent of subsurface contamination. The area is currently unpaved and is the site of a picnic area.

2.2.13 Site 17: Tanks 103/104. Contamination at this site on TI also may result from hydrocarbon contamination. An estimated 20,000 gallons of diesel fuel were reportedly released from the above ground Tanks 103 and 104 onto the unpaved ground surface. No exact date for the release was available, but it was reported to have occurred in 1983. The area (about 130 ft by 220 ft) has since been paved and bermed. It was also reported that waste oil was spread at least once around the base of Tanks 103 and 104 for weed and dust control. The date, quantity, and source of oil used were not identified and the waste oil may potentially have contained PCB.

The predominant migration pathway is vertical to the ground water table and then to the Bay. This vertical migration path is expected to be inhibited by the surface pavement. Because residual contamination may exist either resulting from the spill or from standard operations and to assess whether ground water is contaminated, an RI is recommended for Site 17.

2.2.14 Site 19: Refuse Transfer Area. The area northeast of Building 342 adjacent to Avenue N has been used for refuse staging (holding/disposal) since about 1953. Currently, trash is transferred from various small containers to large bins for subsequent disposal off-station. A paved ramp constructed in 1970 is present, from which trucks can end-dump trash into the bins. Small quantities of loose trash are spread throughout the site and soils are stained along the fence adjacent to Site 4. Currently, the facility has signs prohibiting the disposal of acids, paints, oils, batteries, or any kind of hazardous waste. Soil, ground water, and surface runoff may be potentially contaminated as a result of past operations. Due to the age of the site and the potential for a variety of contaminants, an RI is recommended for this site.

2.2.15 Site 20: Auto Hobby Shop/Transportation Center. During the period from approximately 1943 to 1950, Buildings 194, 224, 225, and 267 were used as the TI transportation center where steam cleaning and/or degreasing of vehicles took place. A gas station was also located in Building 370 until at least 1976. Some waste fluids drained from the vehicles were reportedly allowed to run into the storm sewer system and ultimately into San Francisco Bay. It is uncertain whether the fluids were in general recycled, released into the Bay, or disposed of (buried or deposited) in other areas of the station. The quantities of fluids may have been substantial, based on the level of operations at TI during this time.

At an unspecified time, Building 225 was converted to the Auto Hobby Shop. Drums of hydraulic fluid, recycled oil, and other vehicle fluids have commonly been stored on pallets in the rear yard and the ground and concrete beneath the drums is stained (darkened). Soil surrounding the drums was sampled by NEESA personnel in October 1987. The analyses revealed the presence of chromium, lead, nickel, zinc, oil and grease, and total petroleum hydrocarbons. In the three soil samples analyzed, chromium ranged from 33 to 67 mg/kg, lead ranged from 270 to 2,000 mg/kg, nickel ranged from 27 to 35 mg/kg, and zinc ranged from 160 to 500 mg/kg. The oil and grease and total

petroleum hydrocarbons concentration from two soil samples ranged from 13,300 to 38,200 mg/kg and 9,700 to 25,000 µg/g, respectively (Appendix B).

Several underground tanks were located in this area and may have been abandoned in place. Locations include three known tanks east of Building 225, where the service station was located, and possibly others east and northeast of Building 225.

The areas where Transportation Center buildings stood are now unpaved and it is not known if they were paved in the 1940s. The Auto Hobby Shop is paved on the northwest side fronting 12th Street.

Considering the contaminants detected in the surface sampling and the extent and magnitude of the transportation center operations, Site 20 is recommended for an RI. Currently, the contaminant migration pathway in unpaved areas is vertical, to the ground water table, through which contaminants would be transported to the Bay. In paved areas, transport is via surface water flow into the storm sewer system.

2.2.16 Site 21: Vessel Waste Oil Recovery. Waste oil from vessels is unloaded into cylindrical steel shells (DONUTs) which are maintained partly above and partly below the water surface. Current DONUTs have bottoms which prevent the oil from contacting the water but older models did not have bottoms and allowed contact. The DONUT is maneuvered to shore and pumped through an oil/water separation system. The separator and DONUTs are in a paved area which is heavily stained. Volumes of waste oils were anticipated at 271,900 gallons per year for 1975 in a 1972 document (NAVSHIPS/NAVSEC). Because of the quantities involved and the direct contact, contamination of sediments and onshore soils is possible, and Site 21 is recommended for an RI.

2.2.17 Site 22: Navy Exchange Service Station. Building 330 has been used as a service station since about 1946 and is therefore expected to involve automobile fuels and fluids. Some filter and vehicle fluids have been deposited in the storm drain near the service bay and the build-up of materials in the storm drain indicates that the practice has been occurring for several years. Although the volumes of fluids and materials released is unknown, a 1972 report anticipated that by 1975, 12,000 gallons per year of fluids and materials would be generated (NAVSHIPS/NAVSEC). The ultimate receptors of fluids in the storm sewer system are organisms in San Francisco Bay (Site 13).

Underground fuel tanks and a pump island are located at the station. Although no leaks were detected in the tanks at the service station in 1986 (ERM-West, 1987), spills at tank fill pipes, pinhole leaks in tanks previously located at the station, or other pipeline leaks are likely to have occurred in the 42 years of operation. Contamination of subsurface soils and ground water may be likely due to such leaks as well as service bay operations. This site is recommended for an RI to assess if soil contamination has occurred and whether product is present on the ground water table. The contaminant migration pathway through soils is vertical to the ground water table and then to the San Francisco Bay. Due to the potential for contamination, this site is recommended for an RI to assess if soil contamination has occurred and whether product is present on the ground water table.

2.2.18 Site 24: Fifth Street Fuel Releases. An abandoned underground pipeline has recently leaked unknown volumes of product at three locations along Fifth Street. The leaks were discovered in 1986 and 1987 and excavated soil was sampled in October 1987. Analyses of samples near Buildings 293 and 40 (where package boilers may have been located) reveal the presence of oil and grease and total petroleum hydrocarbons. The oil and grease and total petroleum hydrocarbons detected in four samples collected by NEESA personnel ranged from 470 to 7,450 mg/k and 180 to 5,100 µg/g, respectively (Appendix B). The excavated spoil materials were stockpiled about 5 ft wide, 10 ft long, and 4-5 ft high, about 125 cubic ft.

The pipeline network which was formerly used to transport oil and fuel on TI and, to a lesser extent, YBI, has in many cases been abandoned in place without first draining the line. The actual volume of in place oil may have been up to 10,000 gallons on TI, but the locations of the abandoned segments are unknown as are the volumes which may already have leaked. This practice of in-place abandonment has presumably occurred from 1950 to present, paralleling the abandonment of fuel storage tanks, fueling piers, fueling stations, and buildings which required fuel deliveries.

The pathway for contaminant migration will be vertical to the ground water table via percolating surface water, and then horizontal via ground water to the Bay. The existence of contamination at the known Fifth Street release sites warrants further study during an RI to assess the degree of contamination and assess if ground water has been affected.

2.2.19 Site 25: Seaplane Maintenance. During the period from about 1943 to 1958 seaplanes were maintained in Buildings 2, 3, and 180. Little information exists regarding operations, but reportedly engineering work and cleaning occurred. Based on other operations on TI during the same time period, waste liquids or solvents from engine cleaning may have been deposited in the Bay via the storm drain system or directly to the ground surface or the Bay (Site 13).

Several underground gasoline tanks may be abandoned in place in this area. Ten aviation gasoline tanks adjacent to Building 2 have not been located precisely nor is there a record of their abandonment. Tanks may have also been located west and south of Building 2.

Although there is no specific record of leakage associated with these tanks or the maintenance activities, considering the potential for contamination, it is advisable to verify their existence and the extent of possible contamination in an RI.

2.2.20 Site 26: Underground Tanks. Locations of a possible sixteen underground petroleum storage tanks were identified during this study. Table 2-2 summarizes available information regarding the tanks. Some of these tanks may have been abandoned in place, possibly containing product, whereas others may have been removed but not recorded as no longer existing. For the former, the likelihood of contamination as the tanks have corroded and released product is high. Contaminant migration pathway is vertical, carried by percolating surface water, to the ground water table and then via ground water to the Bay.

TABLE 2-2

SITE 27: UNDERGROUND TANKS

NUMBER TANKS	LOCATION	AGE	MATERIAL	SIZE	CONTENTS	COMMENTS
2	Approximately 100' each of NE corner of former gas station 370-TI near former Building 224-TI	Building 224 used from pre-1943 until demolition prior to 1981	Steel	Unknown	Diesel?	Found two vertical pipes in open field near former site of Building 224-TI -- possibly associated with package boilers.
1	Approximately 300' east of NE corner of Building 92-TI	Building 234 used from pre-1943 until demolition prior to 1981	Steel	Estimated 500 Gallons	Diesel?	Found vertical pipe in open field near former site of Building 234-TI.
10	Adjacent to (south of) SE corner of Building 2-TI	Used from pre-1935 to	Steel	4,000(?) Gallons Each	Aviation Fuel	Found vertical pipe approximately 50' west and 4' south of SE corner of Building 2-TI -- possibly associated with the aviation tanks.
7	Buildings 1 through 7-YBI with one tank per building	Buildings operational from pre-1935 to present	Steel	Estimated 500 Gallons Each	Diesel	Indicated as possible tanks associated with package boilers for each building (quarters) -- from personnel interview.
1	Adjacent to (NW of) Building 66-YBI	Buildings operational from pre-1935 to present	Steel	Unknown	Unknown	Indicated during personnel interview. Uncertain use. Possible tank for package boiler.
1	Approximately 75' SE of Building 213-YBI	Building in use from pre-1935 until at least 1953	Steel	Estimated 500 to 1,000	Diesel	Indicated during personnel interview. Uncertain use, possible tank for package boiler.
1	Adjacent (?) to Building 204-YBI	Gas station from pre-1935 until conversion to fire station on or before 1947	Steel	Estimated 1,000 to 4,000 Gallons(?)	Diesel and/or Gasoline	Indicated during personnel interview -- tank associated with former gas station location-YBI.
1	Adjacent to Building 8-YBI	Building in use from pre-1935 to present	Steel	Estimated 500 Gallons	Diesel(?)	Indicated during personnel interview -- tank associated with possible package boiler for quarters-YBI.
1	Adjacent to Building 9-YBI	Building in use from pre-1935 to present	Steel	Estimated 500 Gallons	Diesel(?)	Indicated during personnel interview -- tank associated with possible package boiler for quarters-YBI.

According to Title 23, Chapter 2, Subchapter 16 of the California Administrative Code (CAC), closure plans must be developed and implemented for all underground storage tanks. As a first step, the presence of tanks should be verified using geophysical methods. Navy personnel can then ascertain whether the tanks are abandoned or in service, and can proceed according to the appropriate state requirements.

In addition, these underground tanks will be investigated under the Navy Underground Tank Program. If significant contamination is discovered, the tanks may be included in a RI.

2.3 REMEDIAL MEASURE SITE RECOMMENDATIONS. Remedial investigations have been performed at the following two sites and remedial measures either are being developed (Site 6) or have been formulated (Site 14).

2.3.1 Site 6: Fire Training Area. The fire training area, part of the NTTC, has been used to conduct fire training since 1946 on TI. Several consultant reports document leaking underground storage tanks and severely contaminated soil and ground water in this area. Contamination is due to the presence of petroleum hydrocarbons, such as gasoline and diesel, which are most likely present as a result of the school's operations. In the past, fire training operations may have been conducted on an earthen area prior to construction of a concrete pad. As a result, the soil in this area has the potential to be contaminated with both hydrocarbons and fire extinguishing chemicals. Prior to construction of the wastewater treatment plant in the 1960s, wastewater from this activity was discharged directly into the Bay. A remedial investigation is ongoing at this site under the direction of NAVFAC WESTDIV personnel.

2.3.2 Site 14: New Fuel Farm. Contamination at this TI site results from various tank and pipeline leaks and sludge disposal practices during the farm's existence (1943 to present). Water has been also historically bled from the fuel farm tanks and allowed to infiltrate the soil surrounding the tanks. The fuel farm area was paved in about 1980 and the bleeding operation was stopped.

Monitoring wells and borings placed around the tanks in a 1986 investigation (WESTDIV, 1986) revealed concentrations of hydrocarbons, particularly in the vadose zone. This study effectively formed the basis for and presented remediation alternatives.

2.4 NON-REMEDIAL INVESTIGATION RECOMMENDATIONS. For the four sites presented below, we do not recommend that RIs be performed at this time.

2.4.1 Site 2: Radiation Training Area. As shown on Figure 2-2, this site is located near the intersection of 12th Street and Avenue A where mockups were used for radiation training. Radioactive water was involved with this activity and was collected in two subgrade concrete tanks. At the time of the training, several hundred square feet of area could have been affected. Operations in this area began in the early 1950s and ceased in 1969 when the school moved to its current location in Building 371.

Because the half life of the radioactive material used (Bromine-82) was on the order of 24-36 hours, any remaining radiation level is expected to be below

significant levels. Reference to the area was made in a 1971 report (Lowry & Associates) which stated that testing at the ground surface for residual contamination was negative. Further tests at depth during housing construction in the area were to be performed and the soil was to have been decontaminated if necessary. Based on the radioactive half life of the source and prior studies, Site 2 is not recommended for an RI.

RI DEPENDS ON SITE T RESULTS

2.4.2 Site 8: Army Point Sludge Disposal Area, YBI. It was reported that during an unspecified time period, sludge from the wastewater treatment plant on TI was trucked to Army Point on YBI and spread on the ground in an area formerly occupied by quarters. The volume potentially spread was up to 10-15 cubic yards per month, total, at this site and Site 7, Pesticide Storage, potentially spreading 960 to 1,440 cubic yards of sludge from 1968 to 1976. Depending on the time and duration of the operation, there is a potential for organics and metals (such as cyanide, arsenic, cadmium, chromium, copper, nickel, lead, silver, zinc, phenolics, and mercury) in the wet sludge to have migrated into the subsurface. However, insofar as this practice was the same as that described near Site 7 (Section 2.2.5), consideration of this site for an RI should be deferred pending the results of the Site 7 study.

2.4.3 Site 18: Asbestos-Covered Piping, YBI. It was reported that as a result of a landslide on YBI in the early 1980s, abandoned steam piping insulated with asbestos was exposed. No other information was found to confirm this report, nor were plans located which suggested the presence of such lines. No further studies are suggested to verify the lines' existence or the presence of asbestos. Any asbestos is currently buried with the lines and therefore is contained. The possibility of the lines being uncovered as a result of routine maintenance is low given the nature of Naval operations on YBI.

2.4.4 Site 23: YBI Line Break. A landslide in early 1980s reportedly caused a rupture in a pipeline on YBI releasing black oil. The line carried the product from the fueling Piers 3 and 4 uphill to storage Tank 117 located on top of YBI. Although the volume of production released is not known, the capacity of the length of line between the refueling pier and Tank 117 is on the order of 400 gallons. Due to the steep topography and the mechanism of landslide movement, the areal distribution of product is presumed high and concentration of released product low. Therefore, Site 23 is not recommended for a confirmation study.

CHAPTER 3. RECOMMENDATIONS

3.1 INTRODUCTION. This chapter presents recommendations for the remedial investigations suggested in Chapter 2 at the potentially contaminated areas identified at NAVSTA Treasure Island.

The sampling recommendations are designed to first verify the presence of contamination. The location of these sites on TI and YBI is provided on Figures 3-1 and 3-2, respectively. Ground water samples from monitoring wells are recommended to be collected on a one-time basis. Depending on results of this verification step, a further characterization of the extent of the contamination at the sites may be required. Design of the Characterization Study would depend on results from the verification work.

3.2 REMEDIAL INVESTIGATIONS. The PA/SI team concludes that Remedial Investigations (RI) are appropriate and warranted for 20 sites. Operations at some sites are located on YBI. Operations at some sites in close proximity to one another are believed to result in overlapping areas of contamination. These sites have been grouped together for the verification field effort, resulting in a total of 18 RI areas (Figures 3-3 through 3-21).

We recommend a geophysical survey first be performed at each site on TI and YBI to determine the locations of possible underground utility lines and pipelines in the immediate vicinity. This must be done prior to drilling so that all underground tanks, pipelines, and other hazards are located first.

Because of the relatively uniform water table and minimal relief on TI, all borings and monitoring wells planned for TI may be uniformly installed. Except as noted below, at both TI and YBI we recommend that soil borings extend to the ground water table, anticipated at about 5 feet below ground surface. Further, monitoring wells should be screened about 2 feet above the water table to 8 feet below; i.e., should extend about 13 feet deep with a 10-foot screened length of PVC topped by a 5-foot blank length of PVC. Approximately 2 ft stick-up is expected at each well location on TI. The well should be installed with an appropriate filter pack and slot size in accordance with monitoring well design standards for the subsurface materials encountered. This general well construction plan may be modified depending upon the range of tidal fluctuation and specific site conditions. We recommend that the top of each well be encased in a locking steel, traffic resistant box to prevent damage or unauthorized access. After well construction, it is recommended that the location and elevation of the new wells be surveyed. Hollow-stem auger methods are also recommended for drilling.

Soil sampling, water sampling, handling, and shipment should be consistent with EPA protocol.

Monitoring wells must be developed fully by bailing, pumping, and surging, following installation. Water samples collected with a Teflon or stainless steel bailer should be obtained after developing and purging the wells. During the initial well development, a minimum of five casing volumes should be removed. Prior to sampling, a minimum of three casing volumes should be removed.

3.2.1 Site 1: Medical Clinic (Figure 3-3)

Type of Sampling: Soil
Number of Soil Borings: 1, approximately, 5 feet deep
Number of Ground Water Monitoring Wells: None
Soil Sampling: 5 samples
Number of Samples: 5
Parameters: pH, silver
Remarks: Hand-auger methods may be used to advance this boring from within Building 257. The boring should be positioned along the center-line of the eroded floor area. Samples should be obtained near the ground surface, and at about 1 ft intervals to the ground water table.

3.2.2 Site 3: PCB Equipment Storage Area (Figure 3-4)

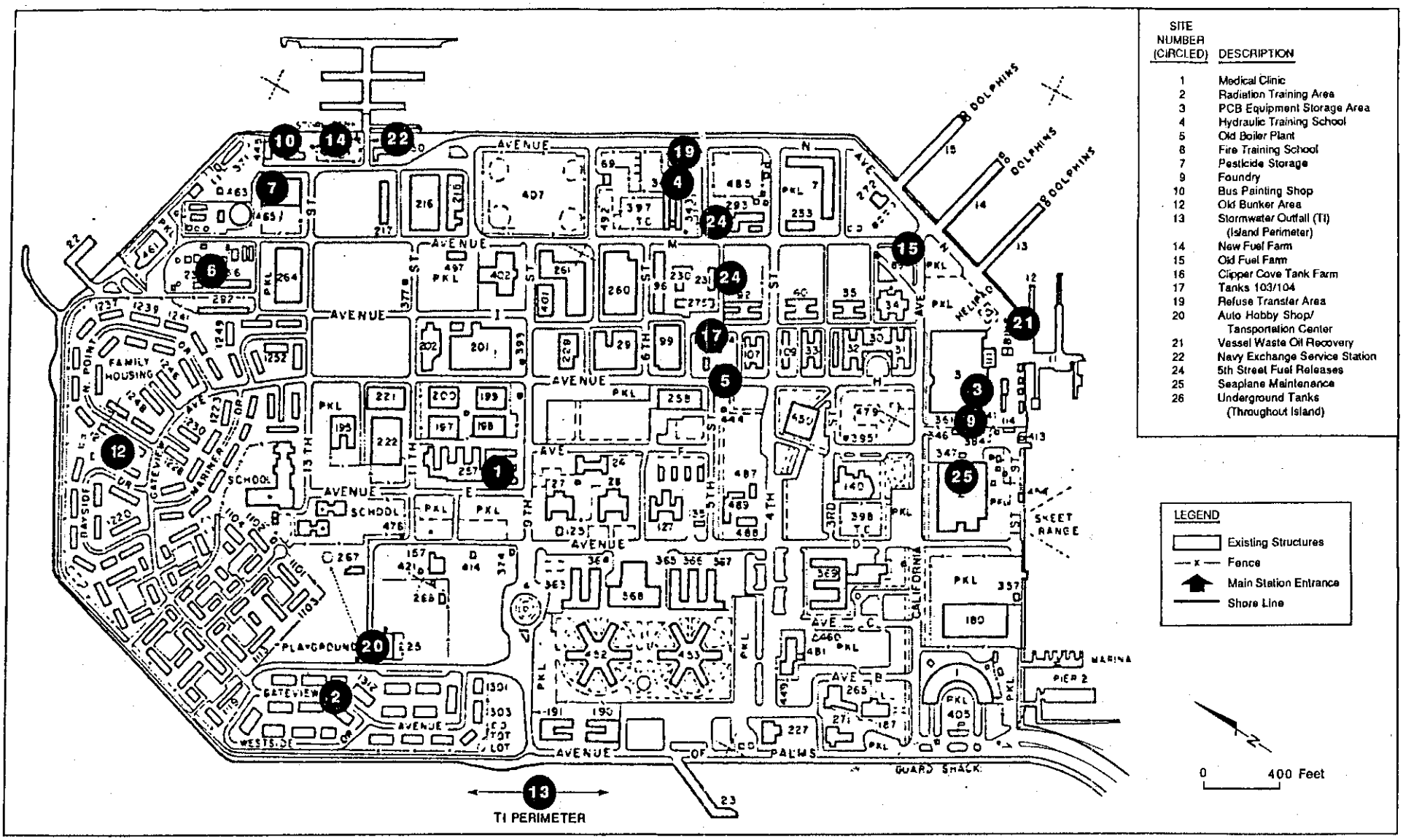
Type of Sampling: Soil, ground water
Number of Soil Borings: 1
Number of Ground Water Monitoring Wells: 1
Soil Sampling: 3 samples
Number of Samples: 3 soil, 1 water
Test Parameters: PCBs (EPA Methods 8080 for soil and 608 for water), total petroleum hydrocarbons (EPA Method 418.1)
Remarks: The uppermost soil sample should be obtained at the ground surface from beneath the pavement, with other samples at 2 feet depth and ground water (about 5 feet depth). All soil samples and water sample are to be evaluated for PCBs and the surface soil sample and water sample for hydrocarbons.

3.2.3 Site 4: Hydraulic Training School/Site 19: Refuse Transfer Area (Figure 3-5)

Type of Sampling: Soil, ground water
Number of Soil Borings: 3
Number of Ground Water Monitoring Wells: 3
Soil Sampling: 3 samples at each well
Number of Samples: 9 soil, 3 water
Test Parameters: Priority pollutant metals, PCBs (EPA Methods 8080 for soil and 608 for water), lead, total petroleum hydrocarbons (EPA Method 418.1)
Remarks: Obtain first soil samples at ground surface, second at about 2.5 feet depth, last at ground water (about 5 feet depth). Analyze upper two samples in each well for lead and water samples from each well for lead. Analyze all soil and water samples for hydrocarbons. Analyze upper two samples in well nearest Building 342 for PCBs. Analyze mid-level soil sample in boring nearest Building 342 for Priority Pollutants.

3.2.4 Site 5: Old Boiler Plant (Figure 3-6)

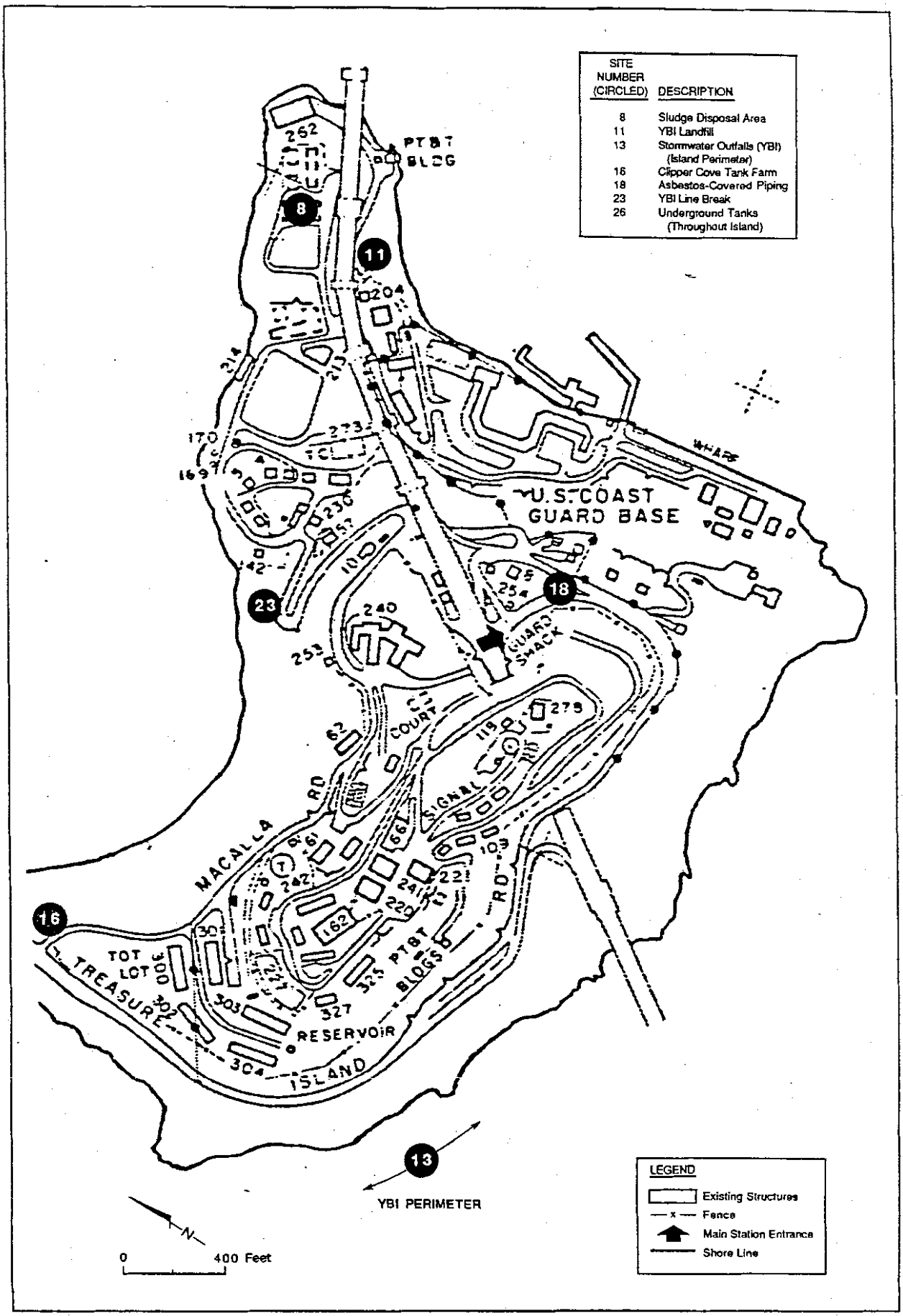
Type of Sampling: Soil
Number of Soil Borings: None
Number of Ground Water Monitoring Wells: None
Number of Sampling Pits: 2
Soil Sampling: 3 samples per pit



PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.

LOCATION OF IDENTIFIED SITES–TREASURE ISLAND (TI)

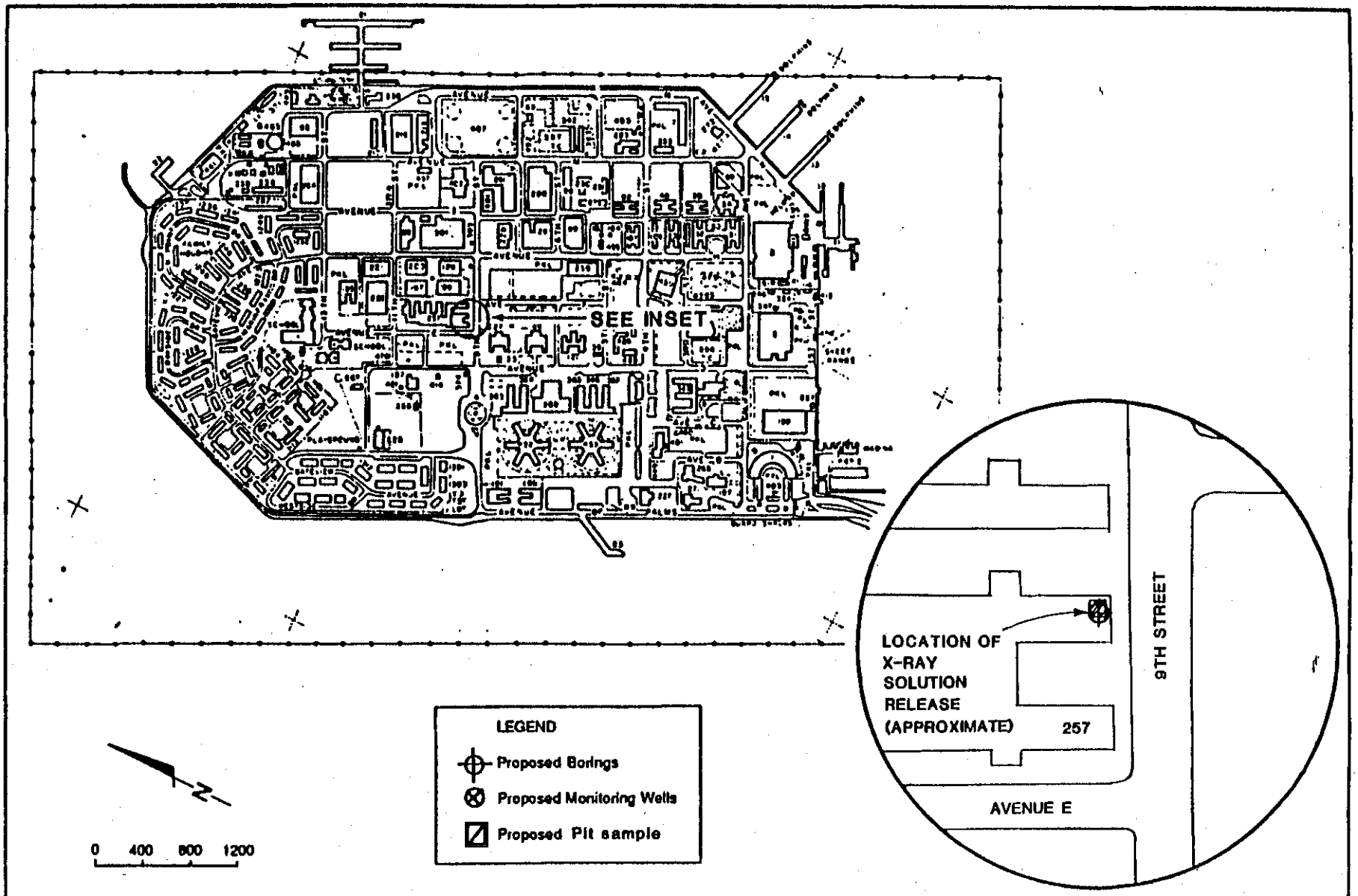
FIGURE 3-1



PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.

LOCATION OF IDENTIFIED SITES YERBA BUENA ISLAND (YBI)

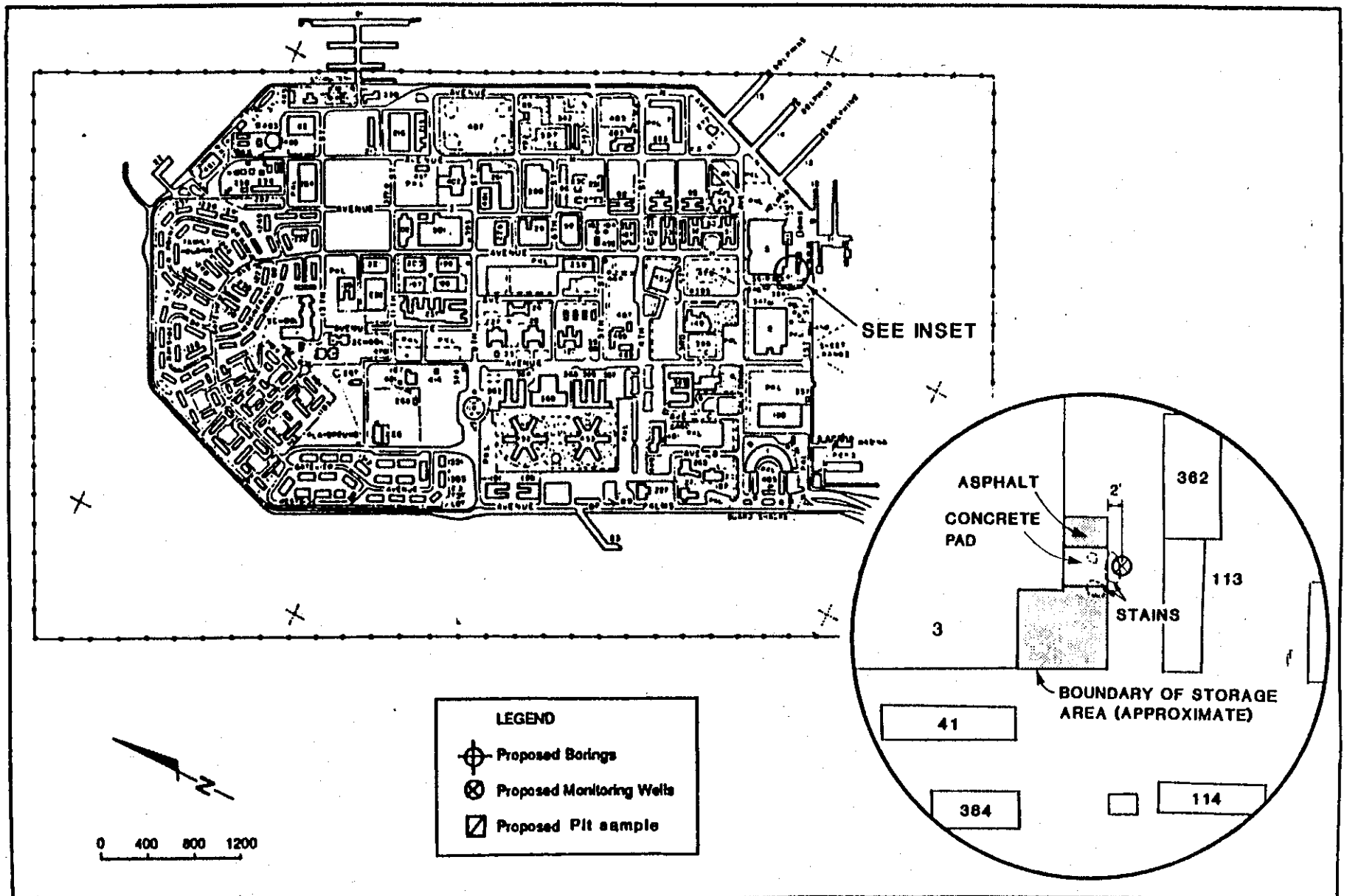
FIGURE 3-2



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 1
MEDICAL CLINIC
REMEDIAL INVESTIGATION

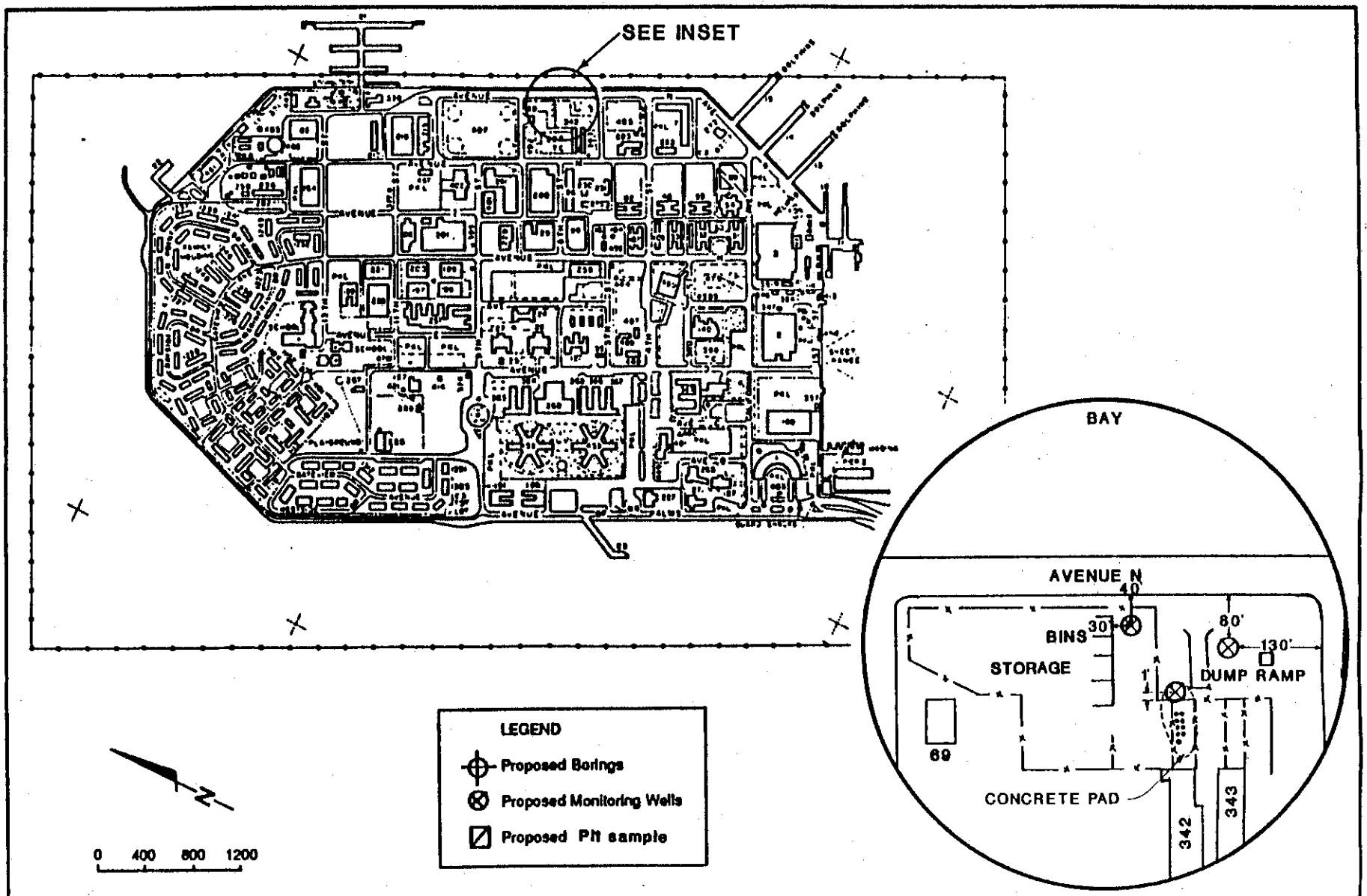
FIGURE
3-3



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 3
PCB EQUIPMENT STORAGE AREA
REMEDIAL INVESTIGATION

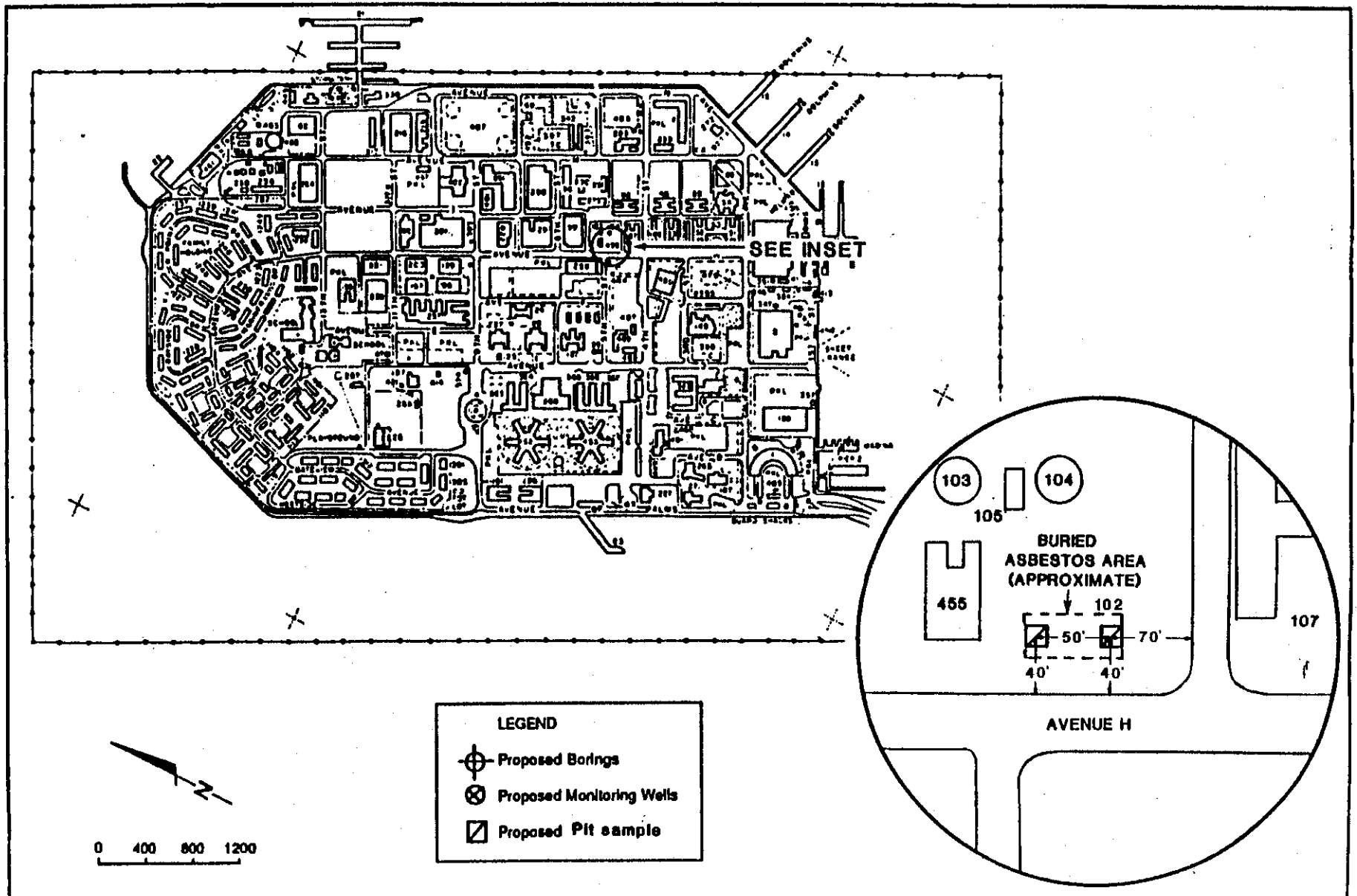
FIGURE
3-4



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 4: HYDRAULIC TRAINING SCHOOL
SITE 19: REFUSE TRANSFER AREA
REMEDIAL INVESTIGATION

FIGURE
3-5



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 5
OLD BOILER PLANT
REMEDIAL INVESTIGATION

FIGURE
3-6

Number of Samples: 6
Test Parameters: Asbestos
Remarks: Sample in two areas by excavating a pit approximately 2 feet x 4 feet in plan dimension and 3 feet deep. Obtain samples from pit walls at the ground surface, at about 1.5 feet deep and at about 3 feet deep or where asbestos contamination seems likely by visual inspection.

3.2.5 Site 7: Pesticide Storage (Figure 3-7)

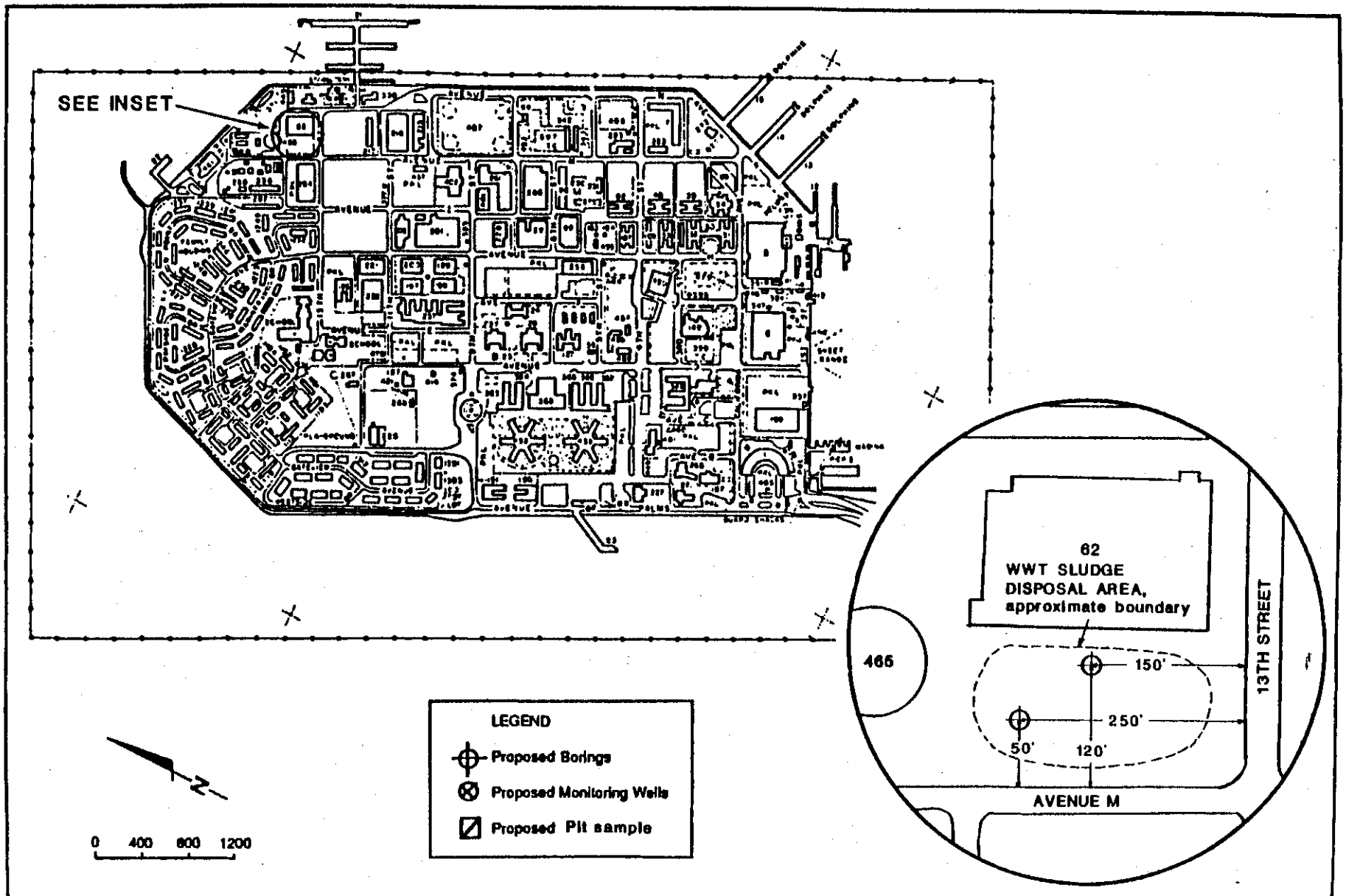
Type of Sampling: Soil
Number of Soil Borings: 2
Number of Ground Water Monitoring Wells: None
Soil Sampling: 3 samples at each boring
Number of Samples: 6
Test Parameters: Priority Pollutant metals, organochlorine pesticides and PCBs (EPA Method 8080), organophosphorous pesticides (EPA Method 8140), chlorinated herbicides (EPA Method 8150).
Remarks: Obtain samples near the ground surface, at about 2.5 feet depth, and the ground water table (about 5 feet depth). Test all samples in boring nearest Building 62 and the surface sample in the remaining boring for pesticides and herbicides. Analyze all six samples for Priority Pollutant metals.

3.2.6 Site 9: Foundry (Figure 3-8)

Type of Sampling: Soil
Number of Soil Borings: None
Number of Ground Water Monitoring Wells: None
Number of Sampling Pits: 4
Soil Sampling: 3 samples at each pit
Number of Samples: 12
Test Parameters: Priority Pollutant metals, volatiles/semi-volatiles (EPA Method 8240 and EPA Method 8270)
Remarks: Excavate four pits, approximately 2 feet x 4 feet in plan dimension and 3 feet deep. Obtain samples at 3 levels in each immediately below paving, at about 2 feet depth, and at about 3 feet depth. Composite all three samples at each pit to obtain four samples, total, and analyze each for Priority Pollutant metals, volatiles and semi-volatiles.

3.2.7 Site 10: Bus Painting Shop (Figure 3-9)

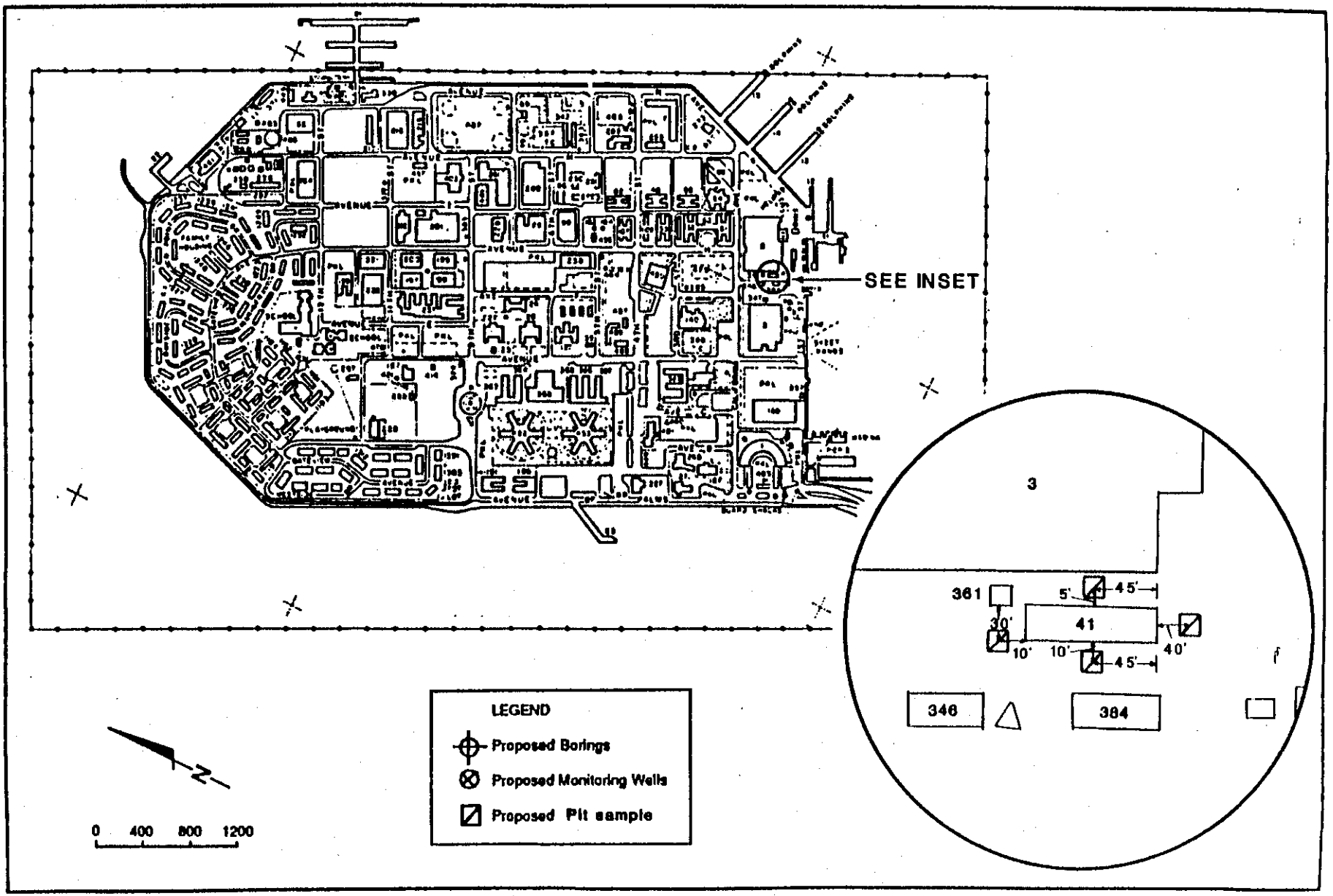
Type of Sampling: Soil, water
Number of Soil Borings: 4
Number of Ground Water Monitoring Wells: 1
Soil Sampling: 3 at each boring
Number of Samples: 12 soil, 1 water
Test Parameters: Volatile organics (EPA Methods 8240 for soil and 624 for water), semi-volatile organics (EPA Methods 8270 for soil and 625 for water), Priority Pollutant metals, organochlorine and organophosphorous pesticides (EPA Methods 8080 for soil, 608 for water, 8140 for soil, 614 for water), total hydrocarbons (EPA Method 418.1).
Remarks: Sample near the ground surface (or below paving) at about 2.5 feet depth, and the ground water table (about 5 feet depth). Analyze



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 7
PESTICIDE STORAGE
REMEDIAL INVESTIGATION

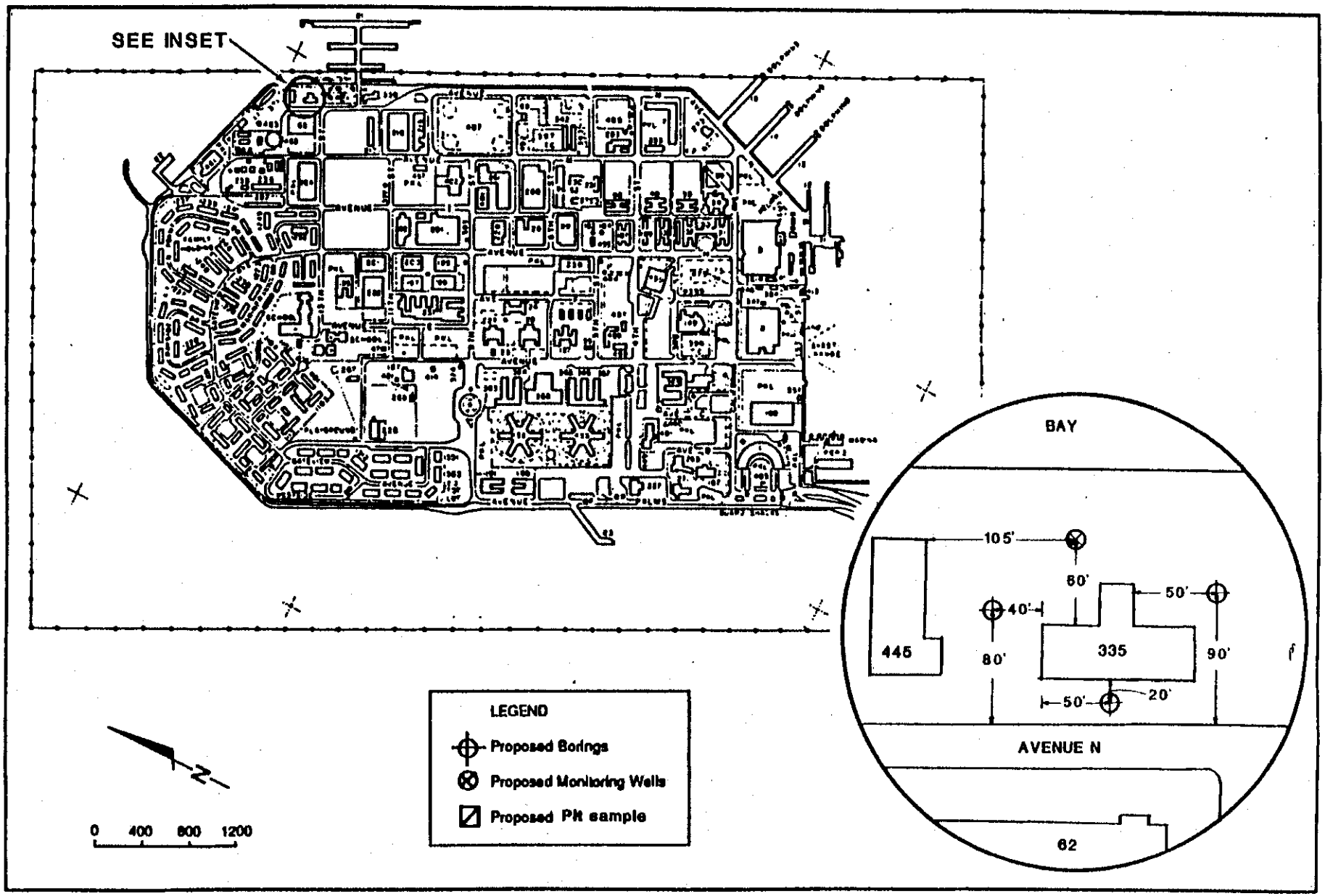
FIGURE
3-7



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 9
FOUNDRY
REMEDIAL INVESTIGATION

FIGURE
3-8



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 10
BUS PAINTING SHOP
REMEDIAL INVESTIGATION

FIGURE
3-9

upper two samples at each location for priority pollutant metals. Analyze uppermost sample at each location and water sample for pesticides. Analyze mid-level samples and water for hydrocarbons and volatile and semi-volatile organics. Analyze lower level samples for hydrocarbons if staining or odors are evident.

3.2.8 Site 11: YBI Landfill (Figure 3-10)

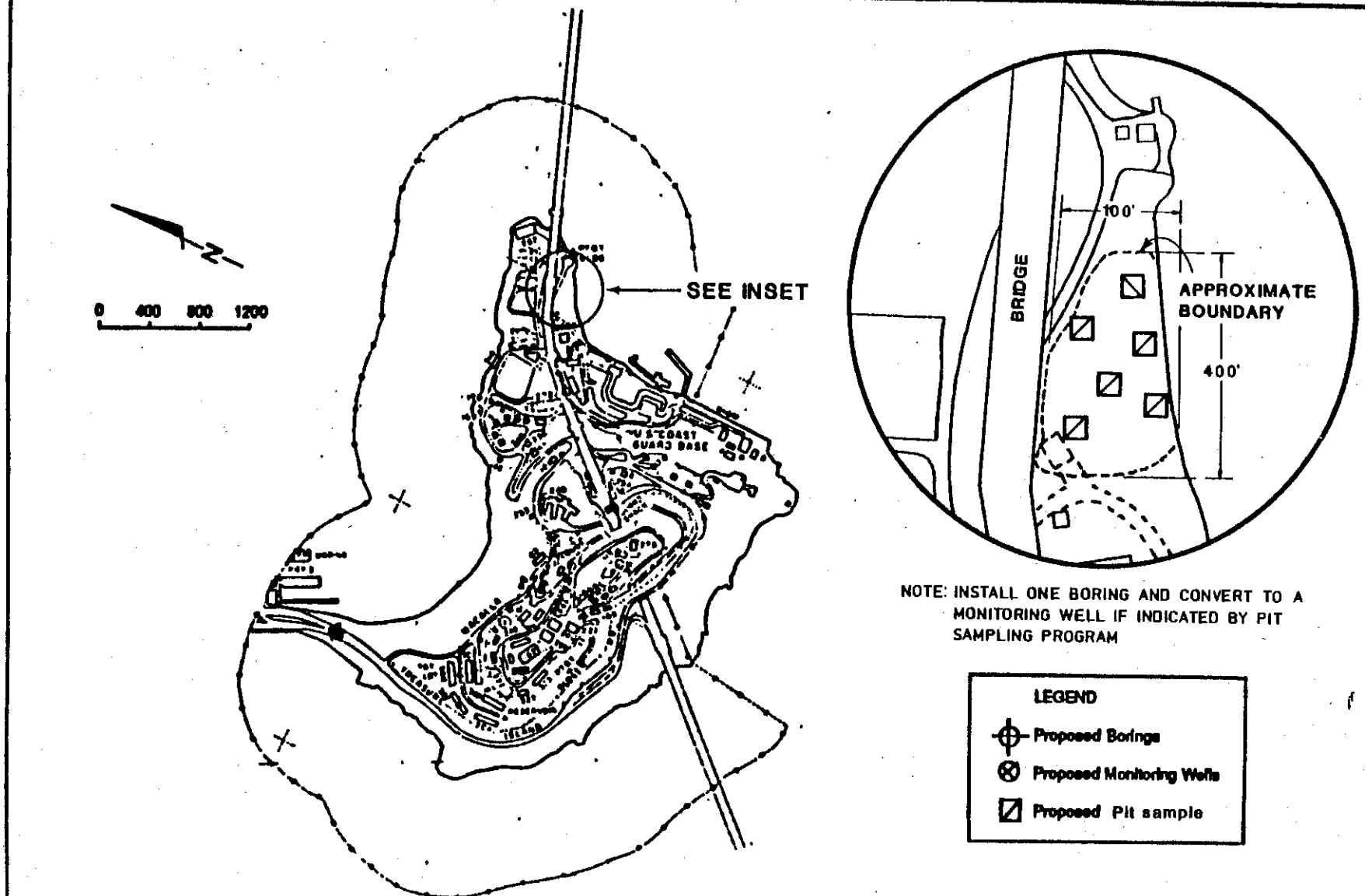
Type of Sampling: Soil, water
Number of Soil Borings: 1, to native soils underlying debris
Number of Ground Water Monitoring Wells: 1
Number of Sampling Pits: 6
Soil Sampling: 1 sample maximum at each pit; 3 samples at each boring
Number of Samples: 9 soil, 1 water
Test Parameters: Volatile and semi-volatile organics (EPA Methods 624 and 625 for water), Priority Pollutant metals, organochlorine pesticides (EPA Method 8080 for soil), total hydrocarbons (EPA Method 418.1).
Remarks: Perform pit sampling and sample organic debris encountered in each pit, if any, i.e., do not sample inert material such as concrete rubble. If rubbish is located, install boring and convert to monitoring well. Sample at about 1 foot depth, at ground water table and at native soil horizon. (If debris inhibits ability to advance boring, relocate boring in line towards shore.) Analyze all soil debris samples and water sample for priority pollutants. In addition, analyze water sample for volatile and semi-volatile organics, pesticides, and hydrocarbons.

3.2.9 Site 12: Old Bunker Area (Figure 3-11)

Type of Sampling: Soil, water
Number of Soil Borings: 9
Number of Ground Water Monitoring Wells: 7
Number of Sampling Pits: None
Soil Sampling: 2 samples at each boring
Number of Samples: 18 soil, 7 water
Test Parameters: Volatile and semi-volatile organics (EPA Methods 8240 and 8270 for soil, 624 and 625 for water), Priority Pollutant metals, organochlorine and organophosphate pesticides (EPA Methods 8080 and 8140 for soil, 608 and 614 for water), total hydrocarbons (EPA Method 418.1).
Remarks: Sample at about 1-foot depth and at ground water table (about 5 foot depth). Sample in rubbish layers, if encountered. Advance borings to a total depth of about 15 feet and log for rubbish. Analyze all water samples for volatile and semi-volatile organics, Priority Pollutant metals, pesticides, and hydrocarbons. Analyze all soil samples for Priority Pollutant metals. Analyze lower level soil samples for Priority Pollutant metals, volatiles, semi-volatiles, and hydrocarbons if samples appear to be composed of rubbish fill.

3.2.10 Site 13: Offshore Sampling/Stormwater Outfalls (Figures 3-12 and 3-13)

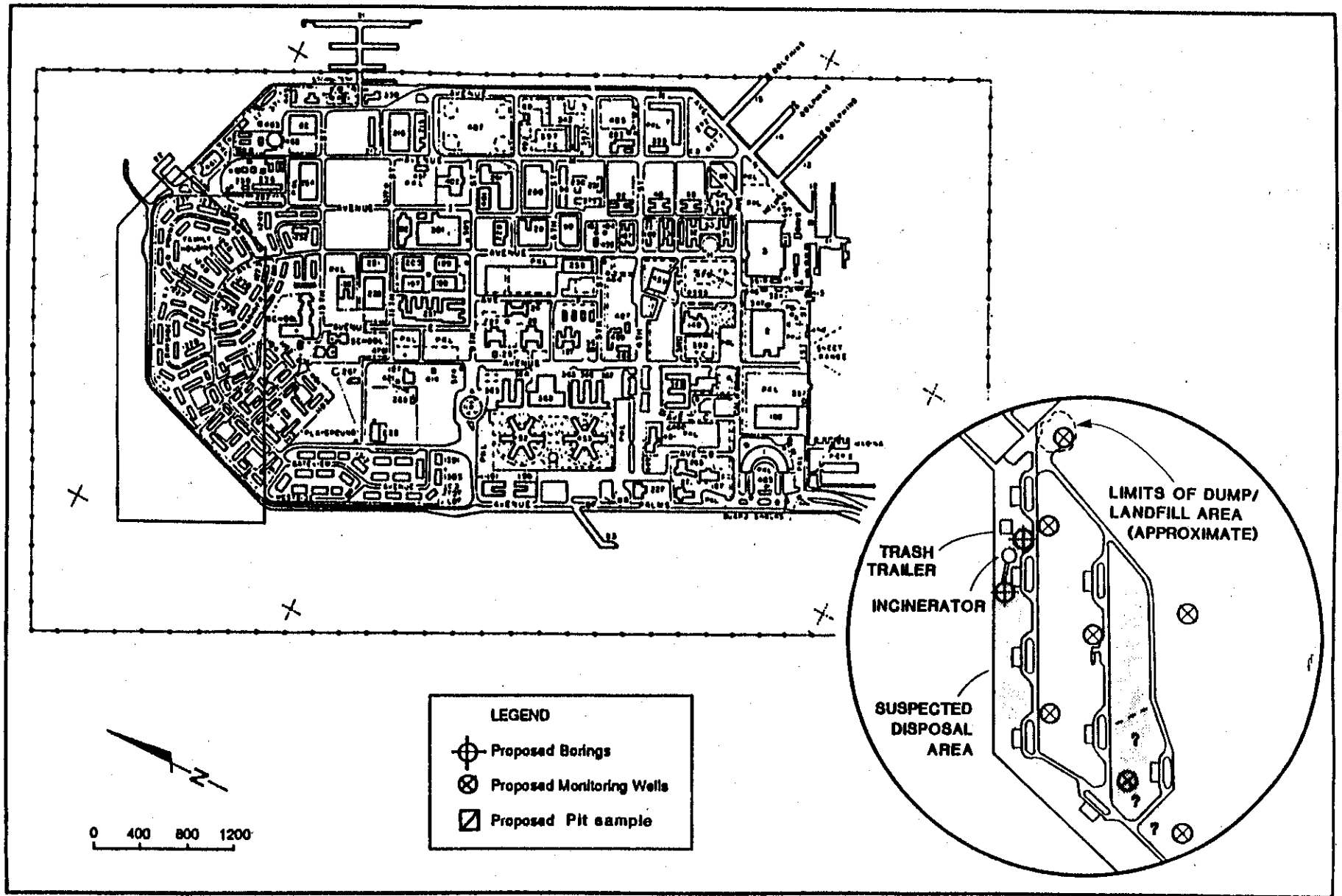
Type of Sampling: Soil
Number of Soil Borings: None
Number of Ground Water Monitoring Wells: None
Number of Sediment Sampling Locations: 21



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 11
YBI LANDFILL
REMEDIAL INVESTIGATION

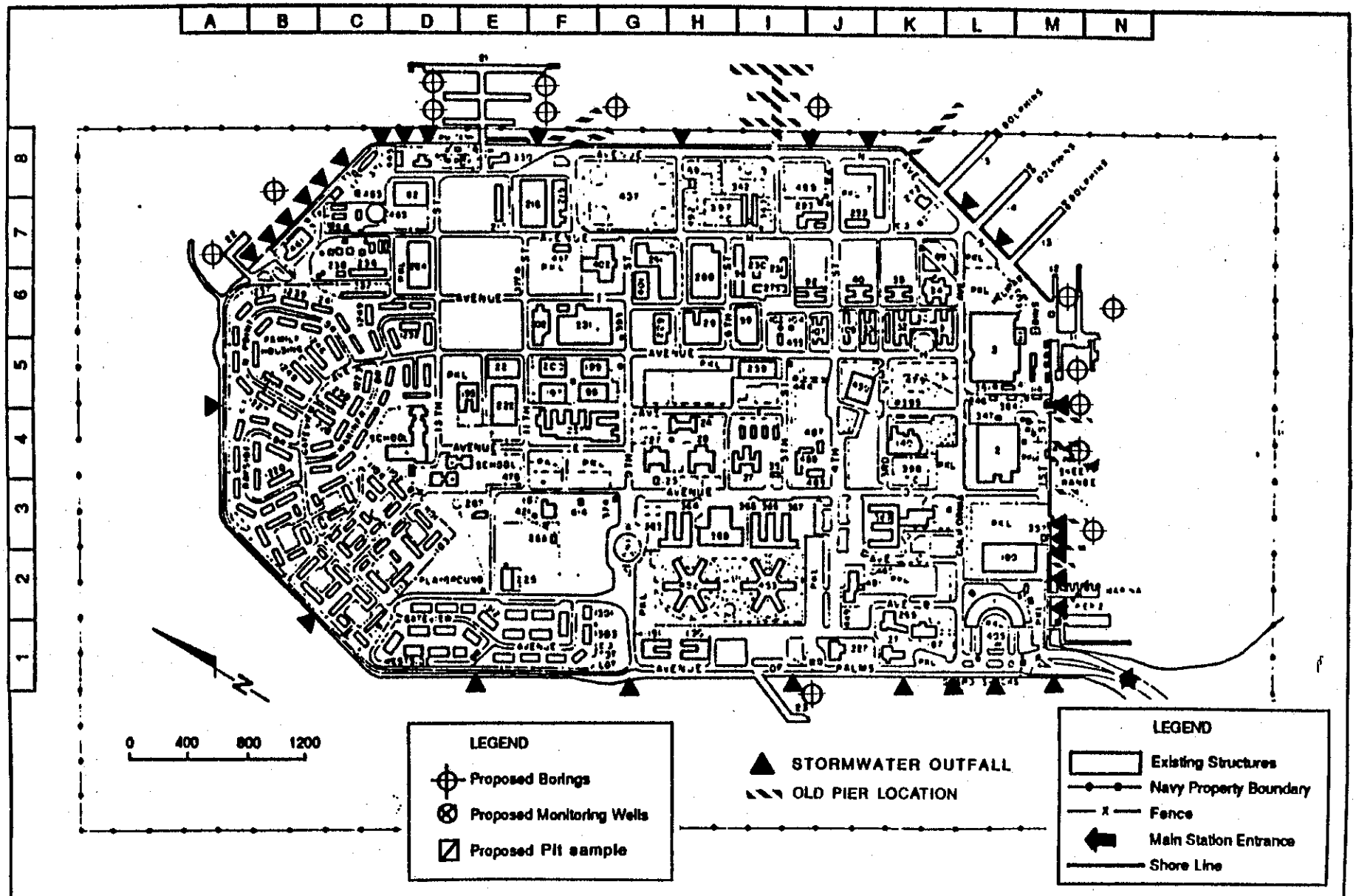
FIGURE
3-10



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 12
OLD BUNKER AREA
REMEDIAL INVESTIGATION

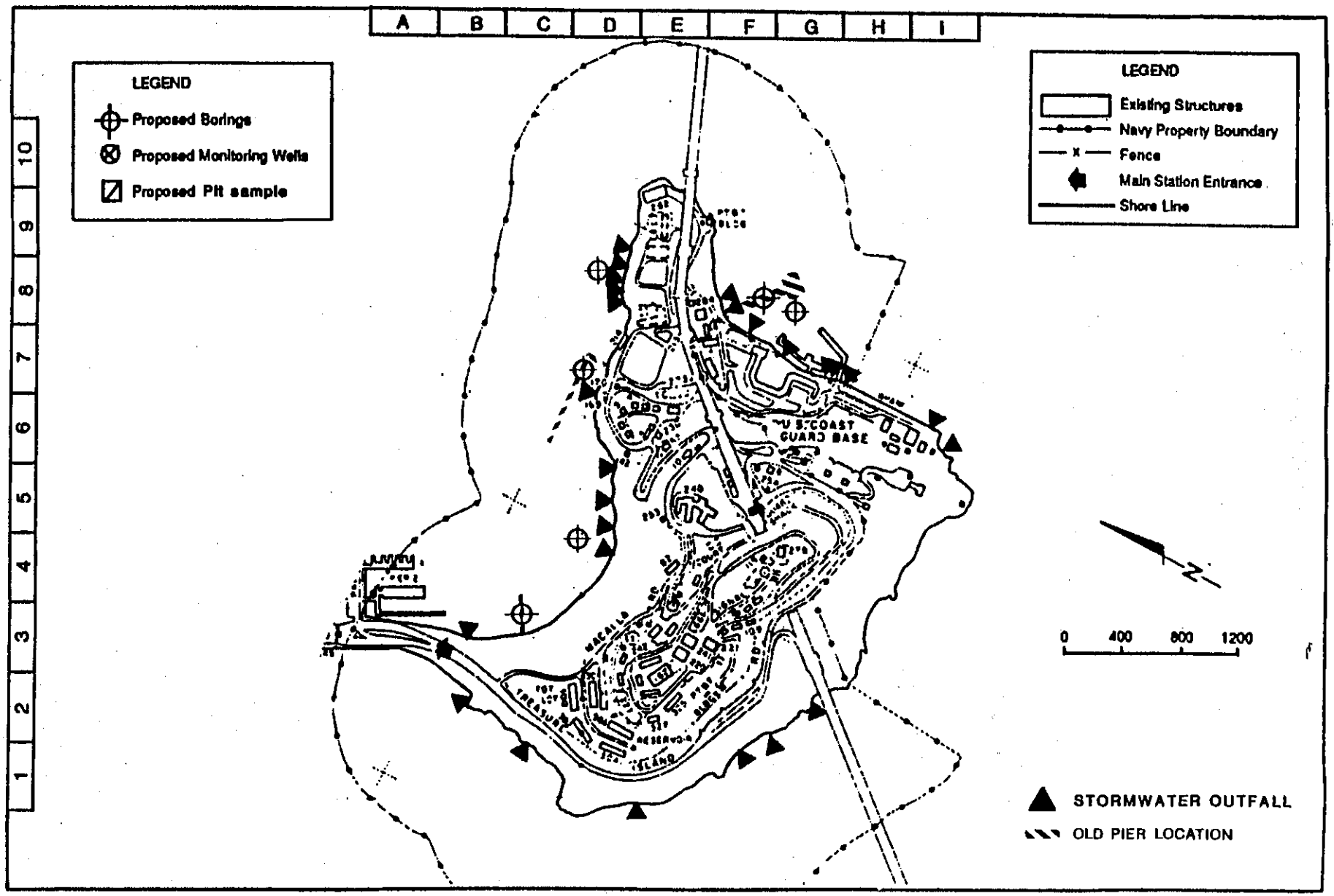
FIGURE
3-11



PRELIMINARY ASSESSMENT/
SITE INSPECTION -
NAVSTA Treasure Island, Ca.

SITE 13: OFFSHORE SAMPLING (TI)
REMEDIAL INVESTIGATION

FIGURE
3-12



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 13: OFFSHORE SAMPLING (YBI)
REMEDIAL INVESTIGATION

FIGURE
3-13

Soil Sampling: Continuous for upper 3 feet
Number of Samples: 42
Test Parameters: Priority Pollutant metals, total hydrocarbons (EPA Method 418.1).
Remarks: Obtain sediment samples using two 1.5-foot piston tubes from barge-mounted rig. Tubes must be teflon coated or stainless steel. Analyze samples from each end of each tube for hydrocarbons. Composite sediment samples from tubes at each location in the laboratory and analyze for metals.

3.2.11 Site 15: Old Fuel Farm (Figure 3-14)

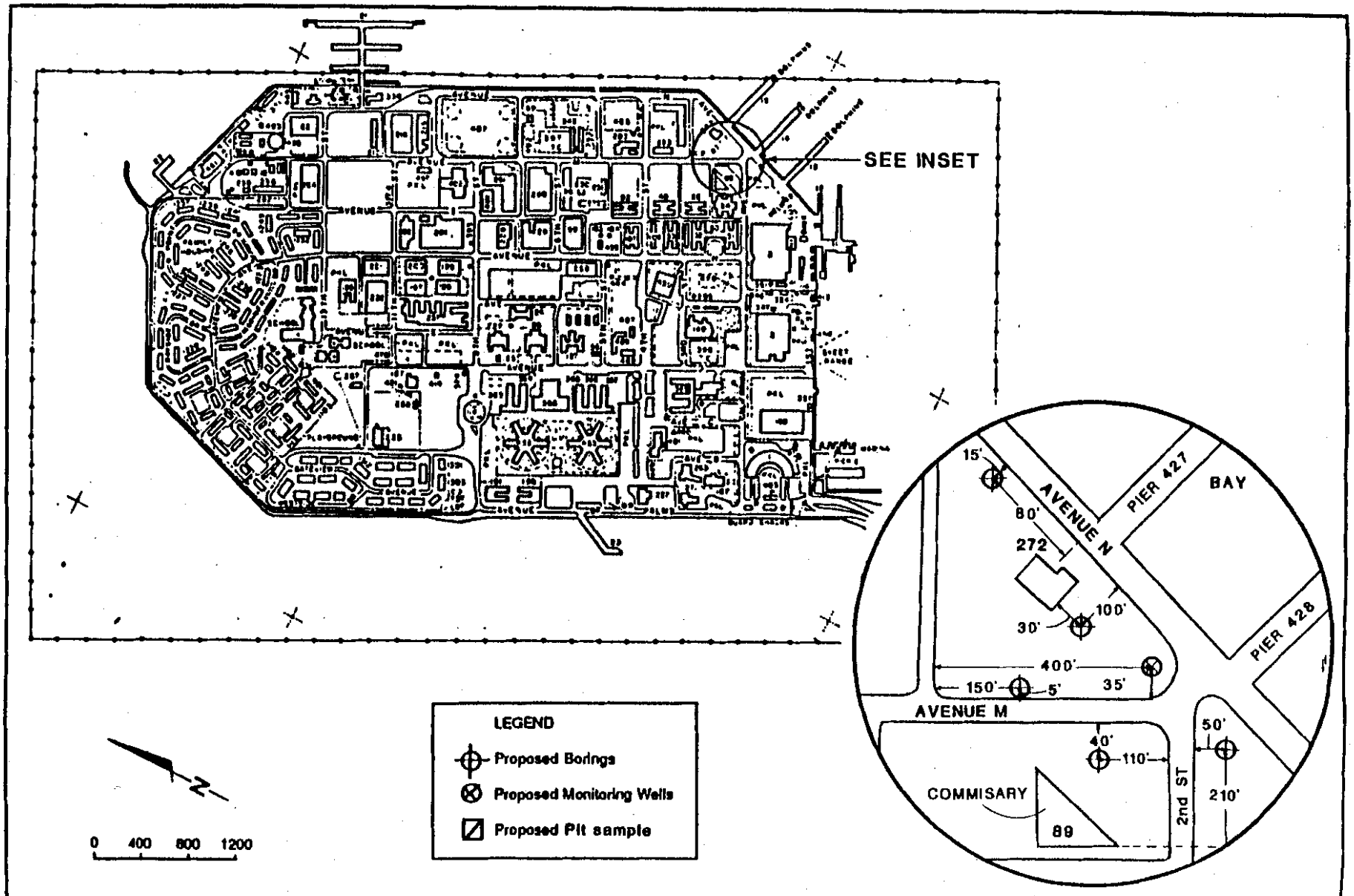
Type of Sampling: Soil, water
Number of Soil Borings: 6
Number of Ground Water Monitoring Wells: 1
Soil Sampling: 2 samples at each boring
Number of Samples: 12 soil, 1 water
Test Parameters: Volatile and semi-volatile organics (EPA Methods 8240 for soil, 624 for water, 8270 for soil, and 625 for water), lead, total hydrocarbons (EPA Method 418.1).
Remarks: Sample immediately below pavement and above the ground water table (about 5 feet depth). Analyze all soil and water samples for hydrocarbons and lead. Analyze the lower soil samples and water sample for volatiles and semi-volatiles.

3.2.12 Site 16: Clipper Cove Tank Farm (Figure 3-15)

Type of Sampling: Soil
Number of Soil Borings: 3
Number of Ground Water Monitoring Wells: None
Soil Sampling: 2 samples at each boring
Number of Samples: 6
Test Parameters: Volatile and semi-volatile organics (EPA Methods 8240 and 8270 for soil), lead, total hydrocarbons (EPA Method 418.1).
Remarks: Sample about 6 inches below ground surface and near the ground water table (about 5 feet depth). Analyze all soil samples for volatiles, semi-volatiles, lead, and total hydrocarbons. Extend the two borings nearest the cove to elevation -5 feet. If tarry materials are present, sample and analyze using the same suite of tests.

3.2.13 Site 17: Tanks 103/104 (Figure 3-16)

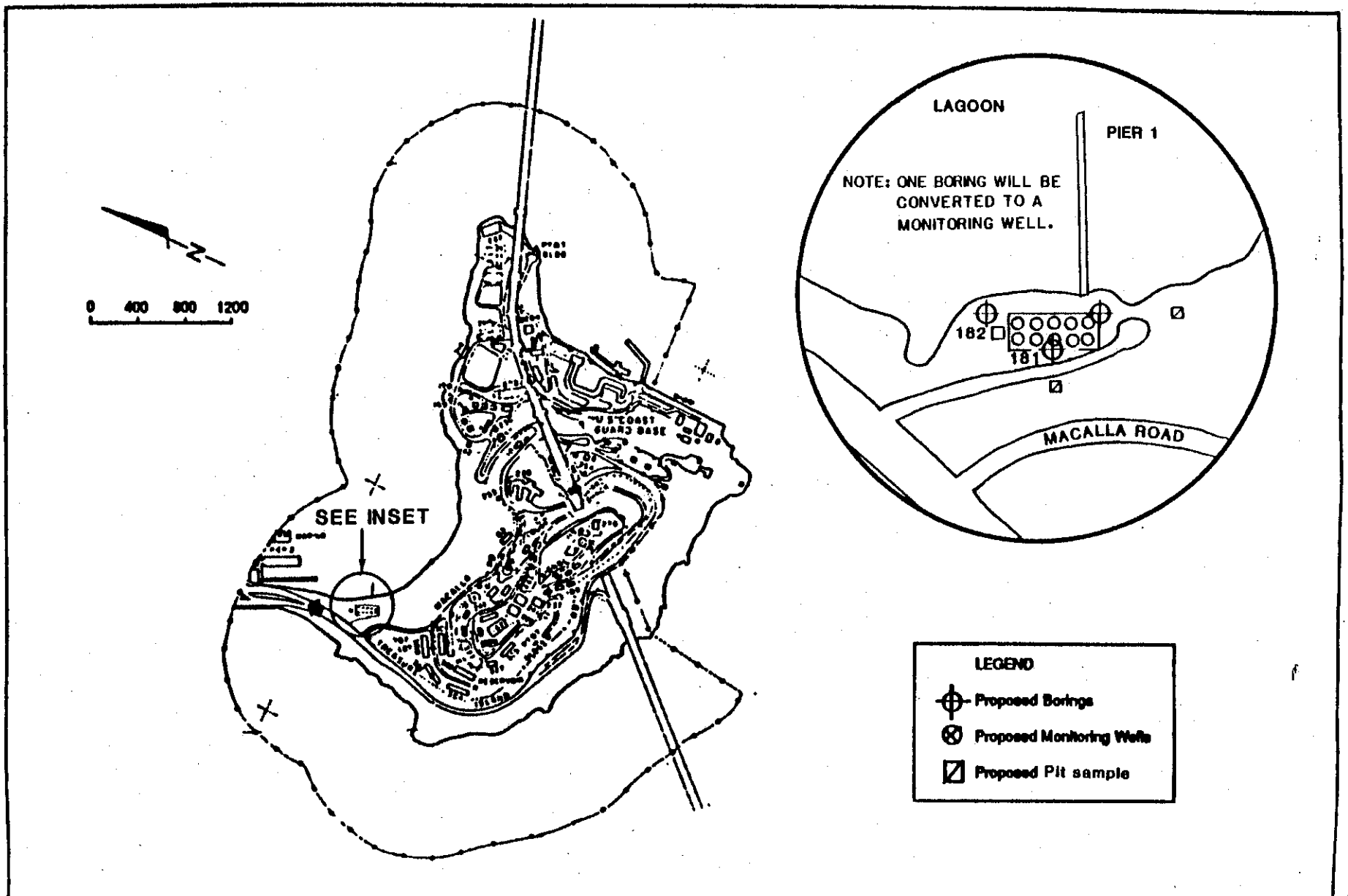
Type of Sampling: Soil, water
Number of Soil Borings: 2
Number of Ground Water Monitoring Wells: 1
Soil Sampling: 2 samples at each boring
Number of Samples: 4 soil, 1 water
Test Parameters: Volatile and semi-volatile organics (EPA Methods 8240 for soil, 624 for water, 8270 for soil and 625 for water), lead, total hydrocarbons (EPA Method 418.1), PCBs.
Remarks: Core through concrete slab. Sample immediately below slab and also near the ground water table (about 5 feet depth). If samples from one boring appear visually more contaminated than from the other, convert the first to a sampling well. Otherwise, convert the boring nearer Tank



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 15
OLD FUEL FARM
REMEDIAL INVESTIGATION

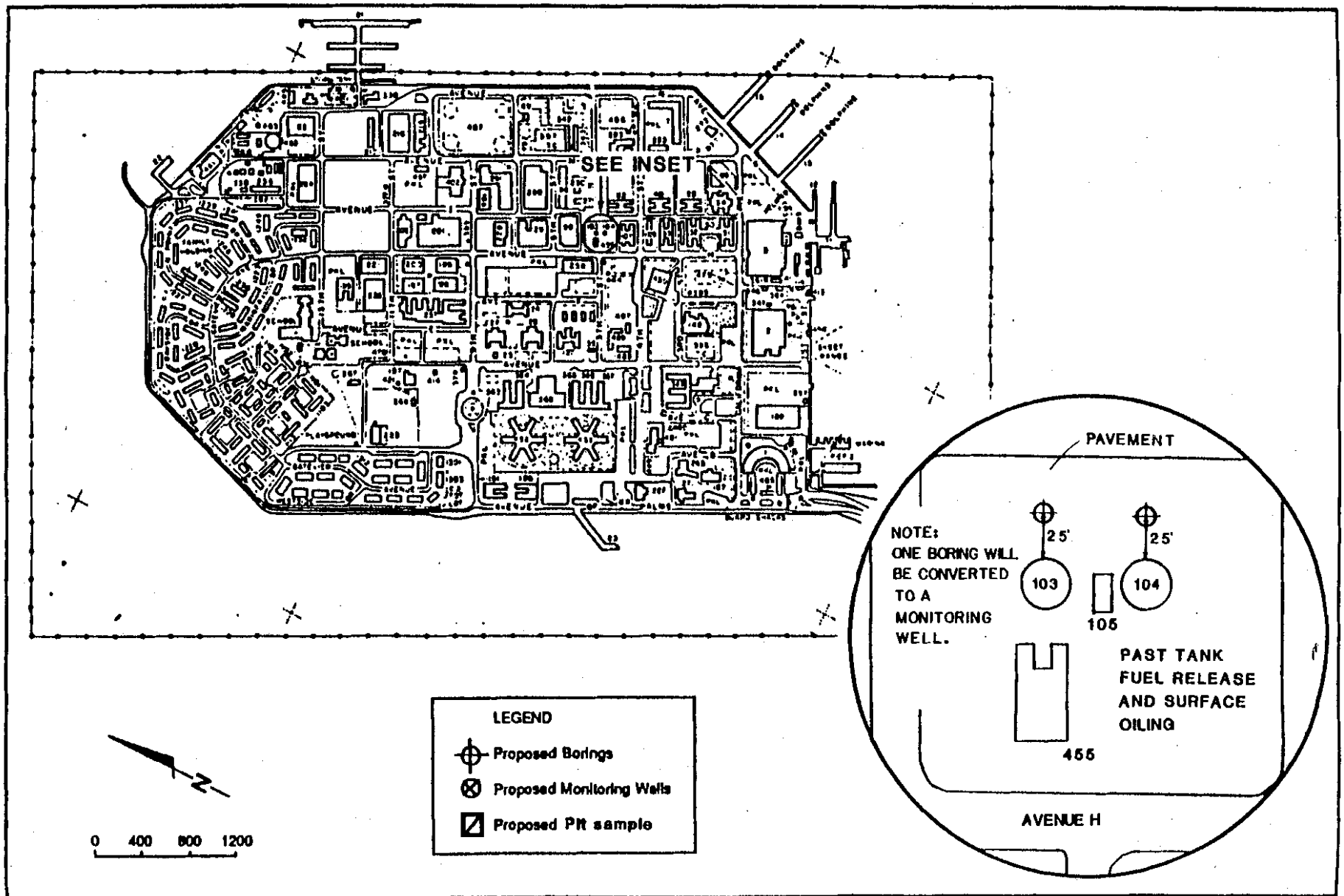
FIGURE
3-14



PRELIMINARY ASSESSMENT/ SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 16
CLIPPER COVE TANK FARM
REMEDIAL INVESTIGATION

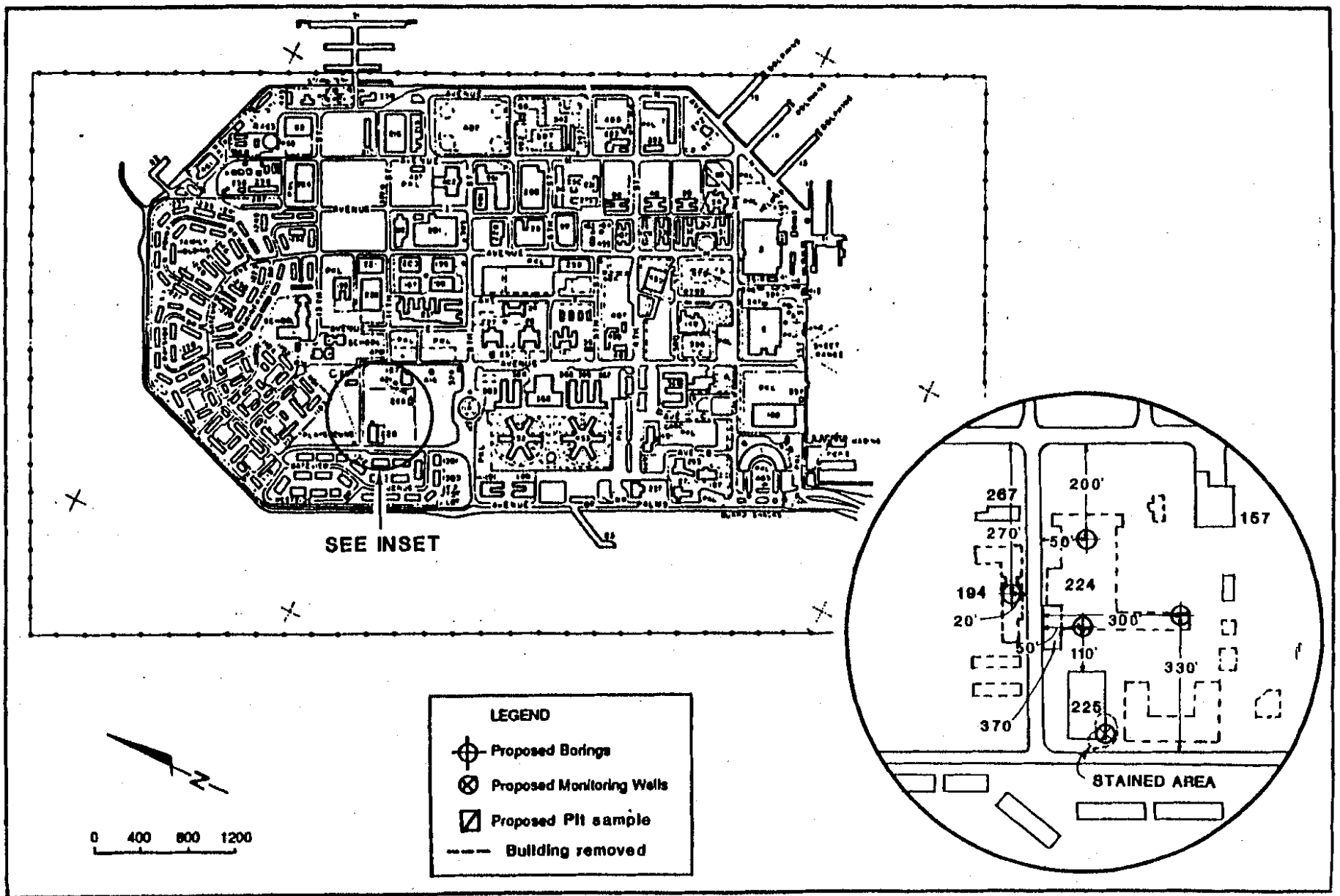
FIGURE
3-15



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 17
TANKS 103/104
REMEDIAL INVESTIGATION

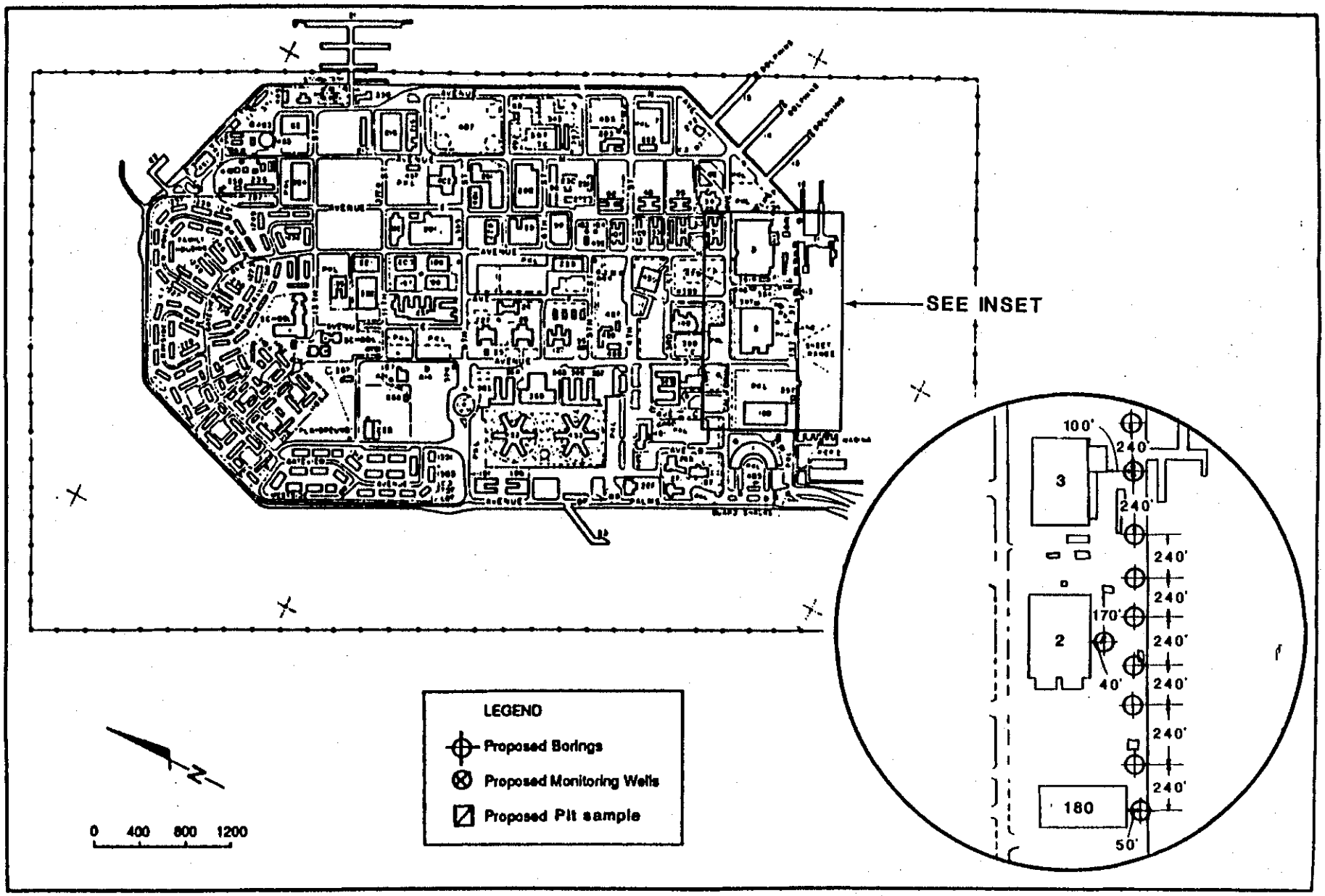
FIGURE
3-16



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 20
AUTO HOBBY SHOP/TRANSPORTATION CENTER
REMEDIAL INVESTIGATION

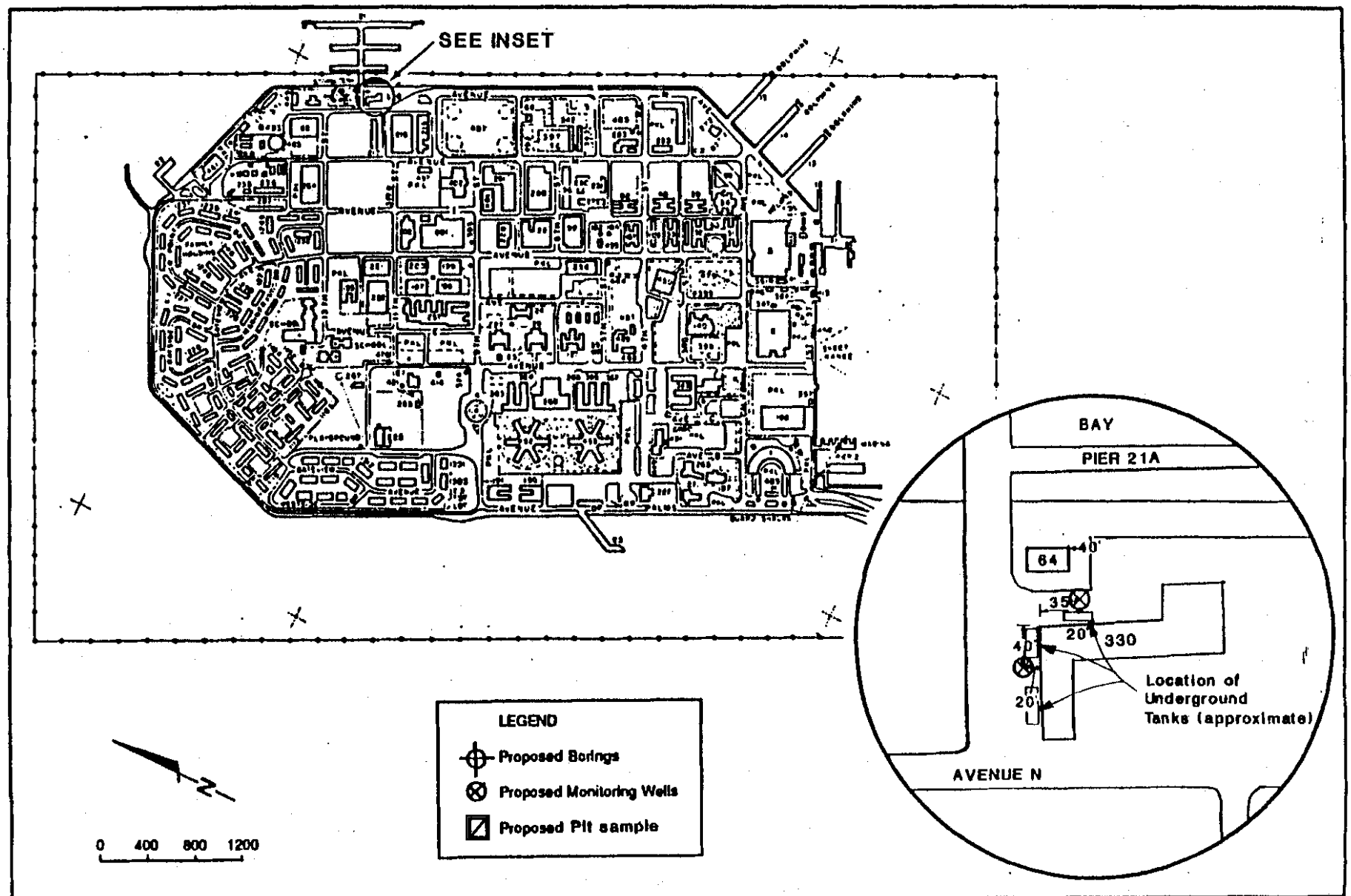
FIGURE
3-17



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 21: VESSEL WASTE OIL RECOVERY
SITE 25: SEAPLANE MAINTENANCE
REMEDIAL INVESTIGATION

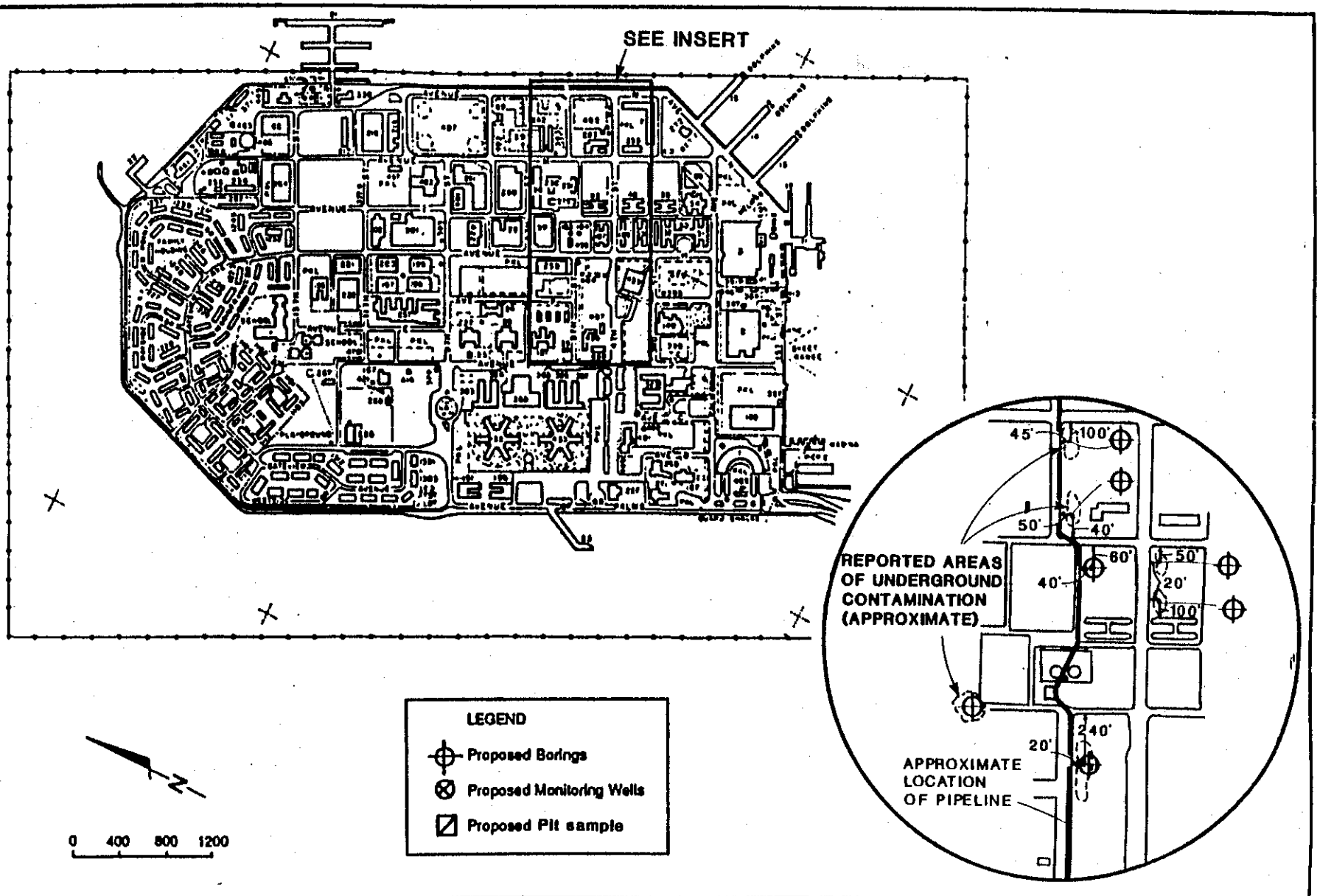
FIGURE
3-18



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 22
NAVY EXCHANGE SERVICE STATION
REMEDIAL INVESTIGATION

FIGURE
3-19



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 24
5TH STREET FUEL RELEASES
REMEDIAL INVESTIGATION

FIGURE
3-20

Number of Samples: 28 soil
Test Parameters: Lead, total hydrocarbons (EPA Method 418.1), and BTX
Remarks: Borings should be advanced with an auger rig and samples will be obtained near ground surface and at the water table. Where borings are advanced through asphalt or concrete, the asphalt and concrete will be patched after the borings are backgrouted.

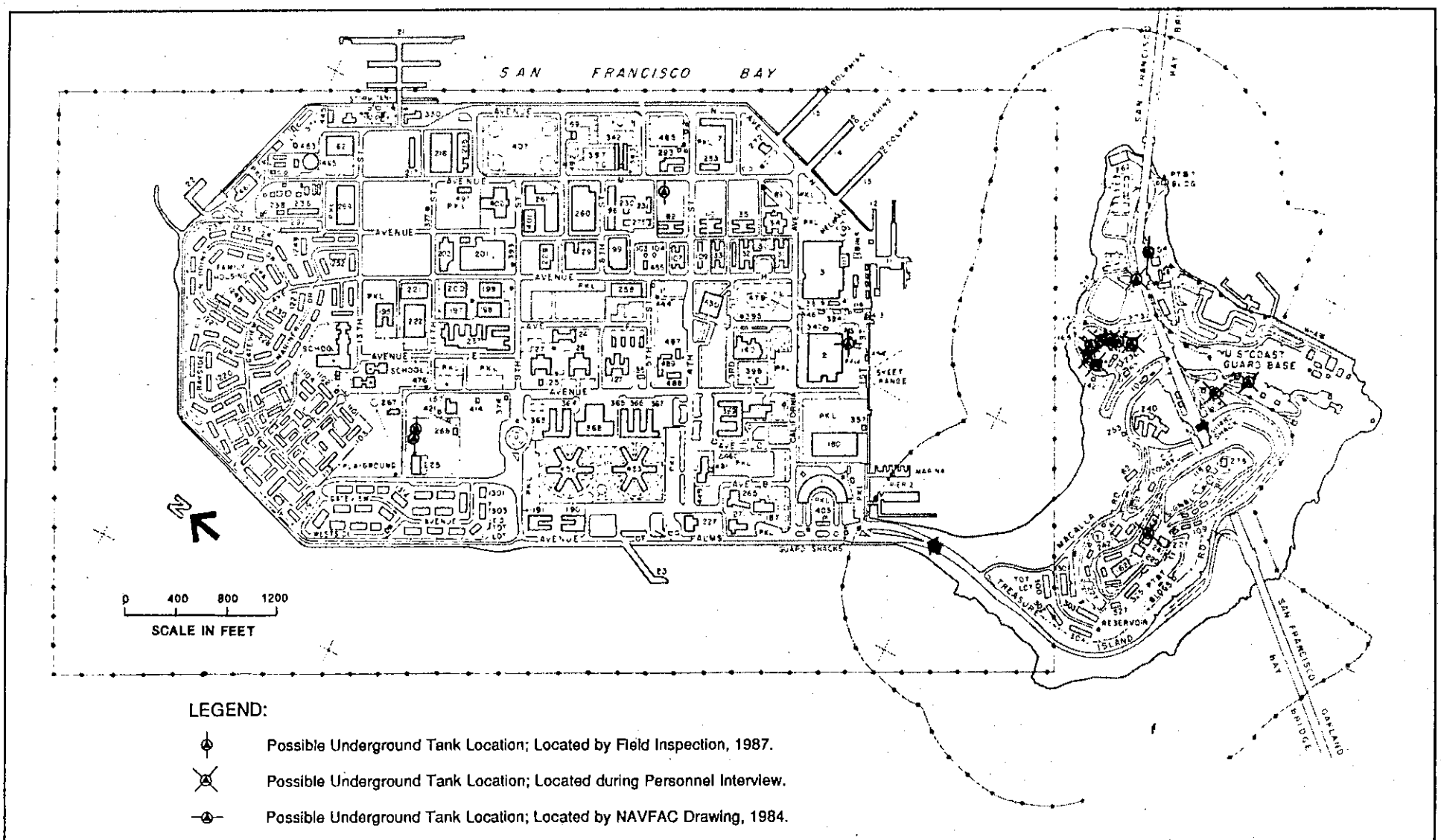
3.2.18 Site 26: Underground Tanks (Figure 3-21)

Type of Sampling: None
Number of Soil Borings: None
Number of Ground Water Monitoring Wells: None
Number of Sampling Pits: None
Soil Sampling: None
Test Parameters: Not applicable
Remarks: The RI at this site involves surface geophysical surveys to determine the presence of underground tanks at 16 locations.

3.3 REMEDIAL MEASURE RECOMMENDATIONS. The following sites warrant Remedial Measures due to the known levels of contamination.

3.3.1 Site 6: Fire Training Area (Figure 3-22). The Fire Training School is scheduled to relocate to a new center on TI by about 1989. Ongoing studies by NAVFAC WESTDIV will be completed to characterize the extent and degree of contamination at the School.

3.3.2 Site 14: New Fuel Farm (Figure 3-23). Contamination at this site has been investigated by NAVFAC WESTDIV (1986). The WESTDIV study effectively formed the basis for and presented remedial action alternatives.



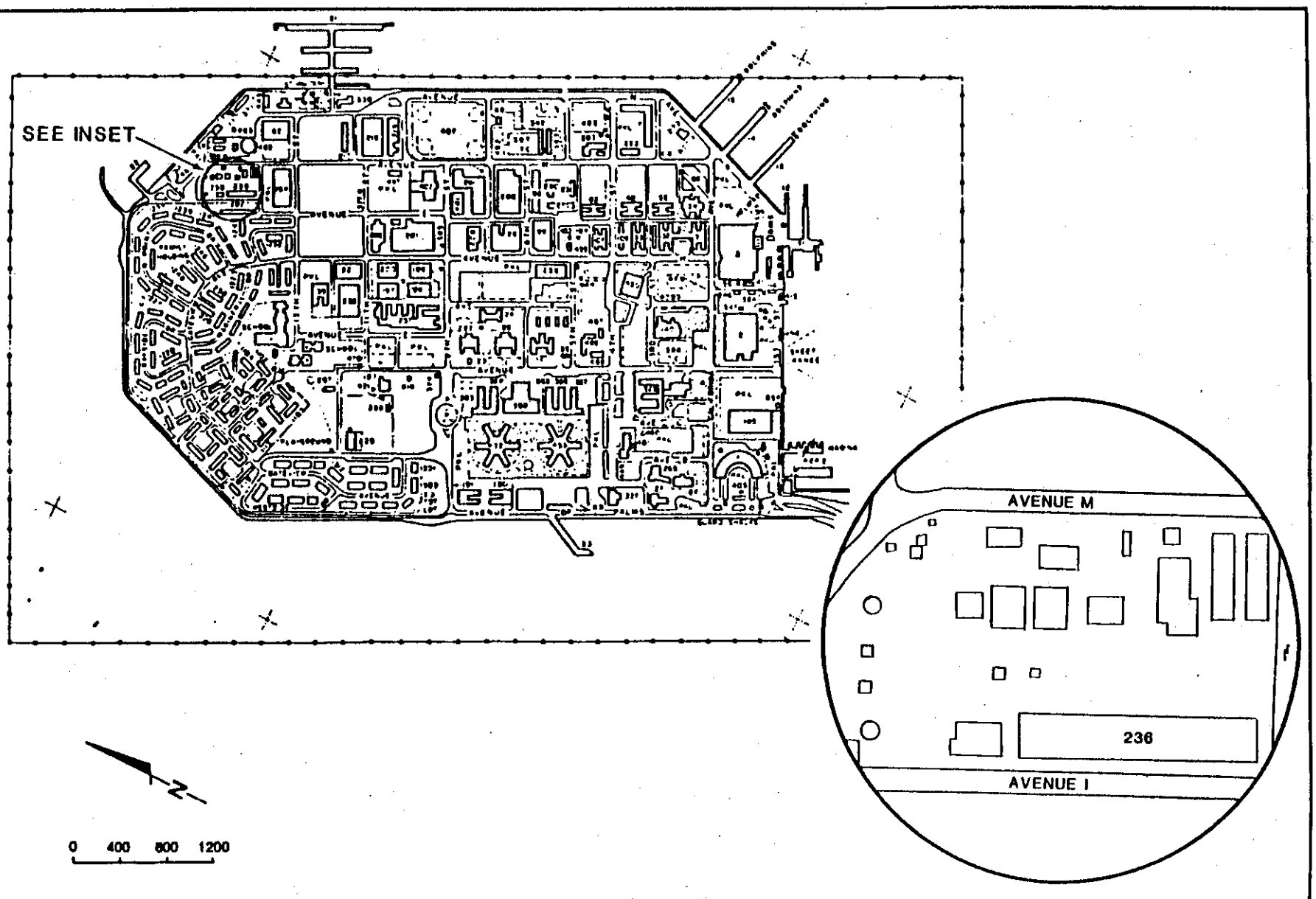
LEGEND:

- Possible Underground Tank Location; Located by Field Inspection, 1987.
- Possible Underground Tank Location; Located during Personnel Interview.
- Possible Underground Tank Location; Located by NAVFAC Drawing, 1984.

PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 26: UNDERGROUND TANKS

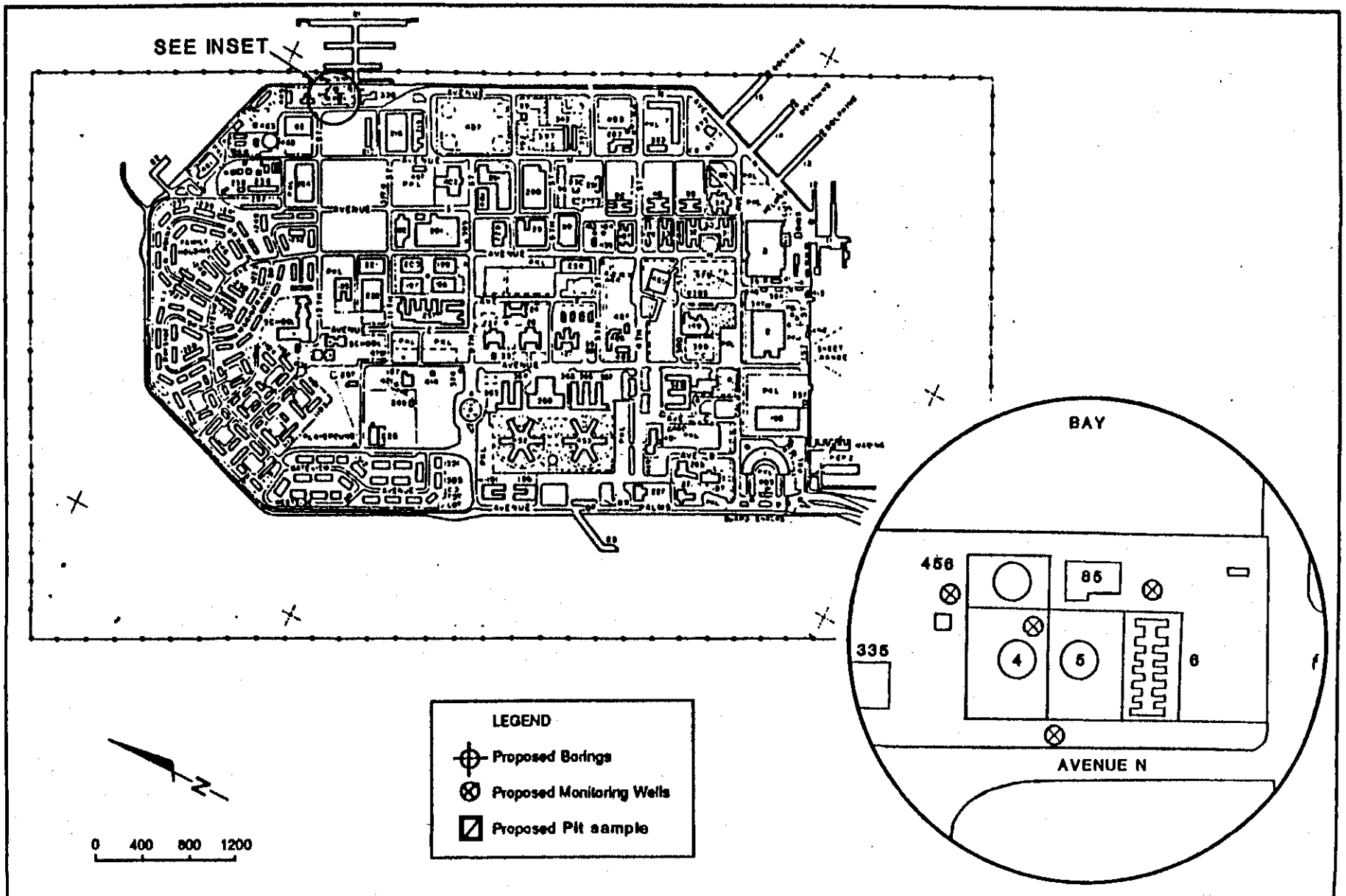
FIGURE
3-21



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 6
FIRE TRAINING AREA

FIGURE
3-22



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 14
NEW FUEL FARM

FIGURE
3-23

CHAPTER 4. BACKGROUND

4.1 INTRODUCTION

4.1.1 Location and Mission. Naval Station Treasure Island is located in San Francisco Bay, midway between San Francisco and Oakland, California (Figure 4-1). The station consists of two islands: Treasure Island (TI) which is approximately 450 acres in size, and Yerba Buena Island (YBI) which is about 130 acres.

Major functions on the station are the Naval Technical Training Center; waterfront facilities; troop and family housing; personnel support, Naval Readiness Command Region Twenty; a Navy brig; and Navy and Marine Corps Museum. YBI serves as a residential suburb, with 107 units of officer family housing and a major Coast Guard Station.

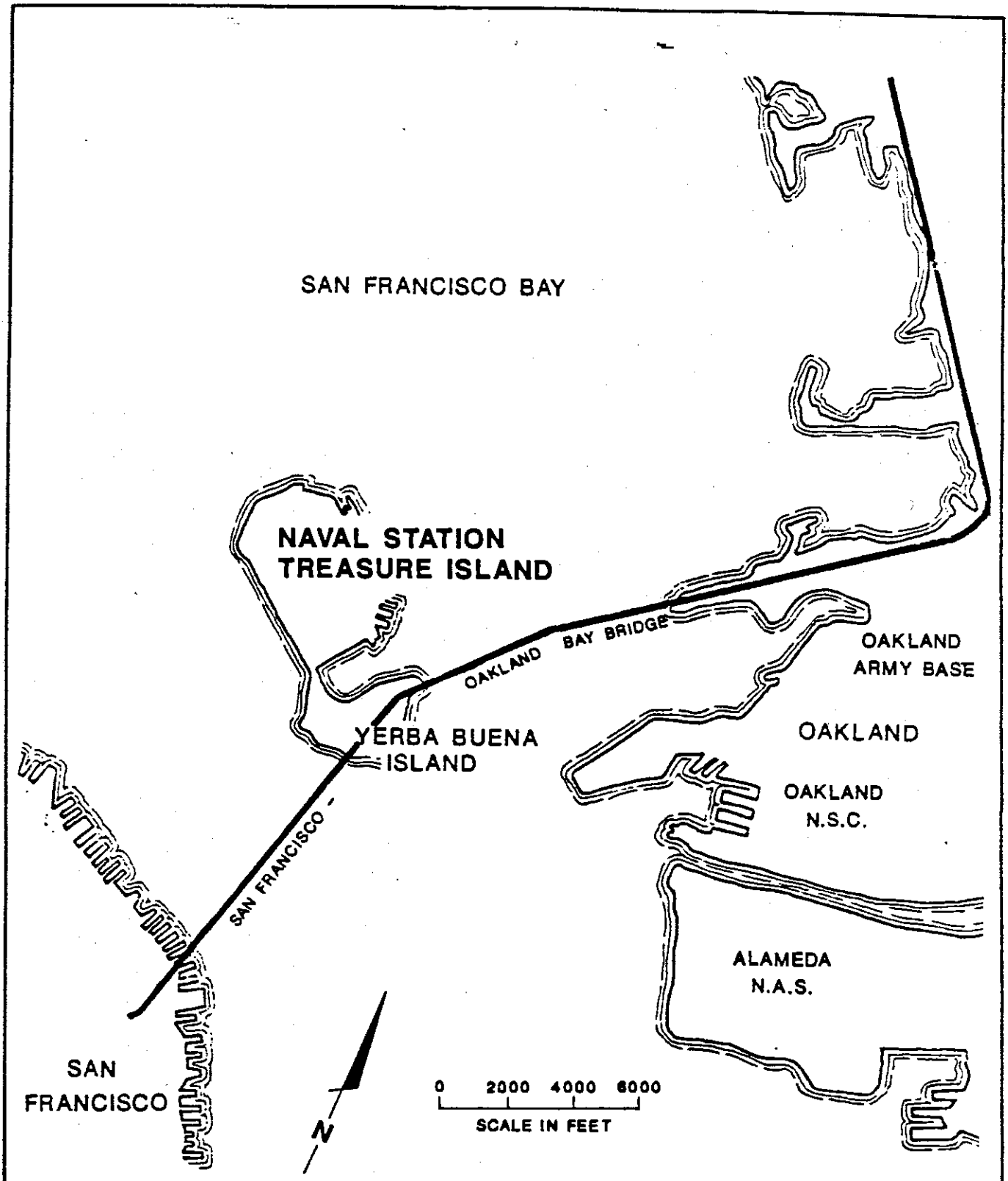
The major claimant of Naval Station TI is the Commander Naval Surface Force of the U.S. Pacific Fleet (COMNAVSURFPAC). The mission of Naval Station TI is to maintain and operate facilities; to provide services and materials in support of units of the operating forces of the U.S. Navy and designated shore functions; and to perform other tasks and functions as may be directed by higher authority.

The following tasks and functions are performed in the accomplishment of the assigned mission:

- Operations and Training
- Administration
- General Engineering Support and Mission Operations
- Personnel Support
- Medical/Dental
- Maintenance of Material
- Maintenance of Real Property and Utility Operations
- Supply Operations

4.1.2 Tenant/Host Relationships. Naval Station TI is owned by the United States Navy. The Navy has been conducting operations on YBI since 1896. The Navy began leasing TI in 1941 and traded for the deed to the Island with the City of San Francisco after World War II. It has owned and operated both islands (TI and YBI) since then. Current tenant operations are listed below:

- Air Force Office of Special Investigations Detachment
- Air Force Reserve
- American Federation of Government Employees
- American Red Cross
- Army Corps of Engineers, San Francisco
- California Conservation Corps
- Circuit Military Judge Navy-Marine Corps Trial Judiciary Northwest Circuit
- Commissary Store
- COMNAVBASE San Francisco
- DOD Housing
- Environmental Protection Agency
- Fifth Reserve Naval Construction



Reference: Master Plan for the Naval Station Treasure Island, 1985

PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	VICINITY MAP	FIGURE 4-1

- Headquarters, 12th Marine Corps District
- Inspector-Instructor Staff, 5th Battalion, 14th Marines
- Joint Military Postal Activity - Pacific
- Marine Corps Absentee Collection
- Military Sealift Command Fire Fighting and Damage Control School
- Mobile Technical Unit Nine
- National Maritime Union Job Corps
- Naval and Marine Corps Reserve Center
- Naval Civilian Personnel Command - Western Field Division
- Naval Hospital Branch Clinic, T.I.
- Naval Investigative Service Regional Office San Francisco
- Naval Investigative Service Resident Agency San Francisco
- Naval Legal Service Office, San Francisco
- Naval Regional Dental Clinic, Treasure Island
- Naval Reserve Intelligence Program
- Naval Reserve Readiness Command Region Twenty
- Naval Reserve Security Group Training
- Naval Technical Training Center, Treasure Island
- Naval Telecommunications Center, Oakland
- Navy Absentee Collection Unit, San Francisco
- Navy Band, San Francisco
- Navy Campus
- Navy Passenger Transportation Office
- Navy Recruiting Area Eight
- Navy Relief Office
- Office of Naval Research Patent Council
- Personnel Support Activity San Francisco
- Personnel Support Activity Detachment Treasure Island
- Post Office/U.S. Postal Service
- Recreational Services Regional Office, Naval Military Personnel Command
- Reserve Naval Mobile Construction Battalion Two
- Resident Officer-in-Charge of Construction
- Scheduled Airline Ticket Office
- Selective Service
- Shore Intermediate Maintenance Activity
- Telephone Office
- Treasure Island School, San Francisco Unified School District
- Treasure Island Yacht Club
- USO

4.1.3 Leases and Agreements. Several buildings and parcels of land on TI and YBI are leased to other government agencies or organizations. The Bureau of Alcohol, Tobacco and Firearms has operated an investigative testing laboratory in Building 233 since about 1976. The United States Coast Guard owns approximately 30 acres on YBI for a Coast Guard base to support their operations in San Francisco Bay and coastal California. The California Conservation Corps leases Building 109 to support their operations on station and in the Bay Area.

4.1.4 Adjacent Land Use. Naval Station TI is located within San Francisco County, in the middle of San Francisco Bay about three miles east of the City of San Francisco. It is surrounded on all sides by the waters of San

Francisco Bay. The station is included in a proposal to homeport a battleship battlegroup, including the U.S.S. MISSOURI.

The station is surrounded by extensively developed mixed use lands of the San Francisco Bay Area including the cities of San Francisco and Oakland. The San Francisco Bay Area is a major metropolitan center of business, industry and government. The Bay Area encompasses over 6,000 square miles with about 280 miles of shoreline. The population of the Bay Area exceeds 3 million people.

All vehicular transportation to and from TI must use the San Francisco-Oakland Bay Bridge (Highway 80) which passes through YBI by way of a tunnel. The bridge provides access and egress to San Francisco to the west and Oakland to the east. Other major transportation links in the region include San Francisco International Airport and Oakland International Airport.

4.2 HISTORY. Military activity on YBI dates back to 1866 when the U.S. government took possession of the Island for defensive fortifications. It was occupied by the U.S. Army until 1896 when the Navy assumed operations. The Navy operated a training center on YBI until 1923 when the center was moved to San Diego. YBI continued to function as a Naval Receiving Station until World War II, when Naval operations were transferred to TI.

TI was built on Yerba Buena Shoals with construction beginning in 1936 and continuing for a 14-month period. Initially built for the 1939-1940 Golden Gate International Exposition, TI was leased to the Navy in 1941 from the City of San Francisco. The Island became a major Naval facility processing and training approximately 12,000 military personnel during World War II. After the war, the City of San Francisco traded the deed to TI for government land south of San Francisco which is now San Francisco International Airport.

Today Naval Station TI is a shore activity in an active, fully operational status. The station processes Pacific-bound and homecoming personnel and provides training schools for Naval personnel. Approximately 3,000 military and 1,000 civilian personnel work on TI. There are 704 housing units on TI. YBI serves as a residential suburb with 107 units of family housing.

Because TI is man-made there is no potential for existence of prehistoric cultural resources on the Island. A cultural resources survey was prepared in 1982 to determine the eligibility of the Island and remaining exposition structures for testing in the National Register of Historic Places. Three buildings were considered eligible for the National Register. However, one building considered eligible, the former Exposition Administration (now Naval Station Headquarters), was not recommended by the National Park System Advisory Board. It was later recommended that the building be considered for nomination (WESTDIV, 1987). The other two buildings have not been proposed for nomination since the buildings have no particular architectural merit and their architectural integrity has been compromised.

4.3 LEGAL ACTIONS. On 21 October 1954, the Regional Water Pollution Control Board passed Resolution No. 161 entitled "Finding a Condition of Pollution and Nuisance to Exist as a Result of Untreated Sewage Discharges in San Francisco Bay from Shore Facilities of the United States Navy at Treasure Island and Yerba Buena Island." The resolution was passed as a result of the ongoing disposal of raw sewage into San Francisco Bay. The resolution required that

funds be provided for construction of sewage treatment and disposal facilities by no later than fiscal year 1960. This would enable the Naval Station to comply with programs formulated under state law (Executive Order No. 10014) to protect the waters of the state. An amendment to Resolution No. 161 was passed in January 1966 requiring the Navy to have disinfection facilities installed and operational by 31 October 1967.

In 1986, the Navy received a Notice of Violation from the Bay Area Air Quality Management District for asbestos removal and related handling procedures. The removal and violation were related to asbestos abatement procedures that took place on 13th Street between G and H Streets on TI.

4.4 BIOLOGICAL FEATURES. Information on the biological features of the Bay Area and on Naval Station TI was developed from the on-site Preliminary Assessment/Site Inspection (PA/SI) survey conducted on 5-9 October 1987, contacts with personnel on TI and at WESTDIV and previous reports and publications. Relatively little published information exists on the biological features of TI and YBI. Most available information focuses on the biological features of the Bay Area.

Naval Station TI is located in San Francisco County in the middle of San Francisco Bay. The Station consists of two islands: Treasure Island (TI), and Yerba Buena Island (YBI) which are approximately three miles east of San Francisco. The Bay covers a total area approximately 900 square miles extending from TI about 30 miles to the southeast and 20 miles to the north; and reaches eastward from San Pablo Bay about 30 miles through Carquinez Strait. The Bay varies from 3 to 13 miles in width, with the main channel from 20 to 60 feet deep south of the Bay Bridge; from 30 to 130 feet deep between TI and Angel Island; and from 300 to about 350 feet deep beneath the Golden Gate Bridge (Smith, 1959).

The San Francisco Bay region is characterized by a wide variety of physical habitats, each of which contains a characteristic assemblage of flora and fauna. Table 4-1 provides a summary of the 16 habitat or community types that occur in the Bay Area, as defined by Smith (1959). The table also lists some of the characteristic plant and animal species associated with each habitat type. Of the 16 habitat types listed in Table 4-1, there are at least four which occur on TI and/or YBI. These are indicated by asterisks in the table.

The Bay Area supports a variety of fish, birds and mammals. The fishery resource includes anadromous fish which migrate through the Bay to spawn; native fish that remain in the area for life and shellfish such as crab and shrimp. The Bay is also an important resting, feeding and wintering area for thousands of birds migrating along the Pacific Flyway which extends from South America to the Arctic Circle. Seventy-five different species of waterfowl visit San Francisco Bay and the waterfowl population fluctuates between 600,000 and 800,000 individuals (WESTDIV, 1986). There is also a wide variety of mammals in the region including both marine and terrestrial species.

4.4.1 Ecosystems. Terrestrial and aquatic ecosystems occur on or near TI and YBI. Wetland ecosystems are present throughout the Bay Area, but are not located on or near TI or YBI. However, both islands are highly influenced by the surrounding marine habitat of San Francisco Bay.

TABLE 4-1

BIOTIC COMMUNITIES OF THE SAN FRANCISCO BAY REGION

Community	Characteristic Plants	Characteristic Animals
1. Rocky Shore	Surf grasses (*Phyllospadix Torreyi* and *P. Scouleri*), numerous marine plants.	Black Turnstone (*Arenaria melanocephala*) Surfbird (*Aphriza virgata*), Wandering Tattler (*Heteroscelus incanum*).
2. Costal Strand	Tree Lupine (*Lupinus arboreus*), Sea Rocket (*Cakile edentula*), a blue grass (*Poa douglasi*), sand verbena (*Abronia* spp.), Beach Grass (*Ammophila arenaria*).	Sanderling (*Crocethia alba*), Snowy Plover (*Charadrius alexandrinus*), a sand crab (*Emerita analoga*), beach amphipods or "fleas" (*Orchestia traskiana*, *Orchestoidea* spp.).
3. Coastal Salt Marsh	Pickle-weed (*Salicornia ambigua*), Sea Blite (*Suaeda california*), Marsh Rosemary (*Limonium commune*), Marsh Grindelia (*Grindelia cuneifolia*), California Cord Grass (*Spartina foliosa*).	Clapper Rail (*Rallus longirostris*), Marsh Hawk (*Circus cyaneus*), Short-eared Owl (*Asio flammeus*), Salt-marsh harvest Mouse (*Reithrodontomys raviventris*), Vagrant Shrew (*Sorex vagrans*).
4. Freshwater Marsh	Common Tule (*Scirpus acutus*), California Bulrush (*Scirpus californicus*), Common Cat-tail (*Typha latifolia*), sedge (*Carex* and other spp.,).	Long-billed Marsh Wren (*Telmatodytes palustris*), Red-winged Blackbird (*Agelaisu phoeniceus*), Yellowthroat (*Geothlypis trichas*), garter snakes (*Thamnophis* spp.), Pacific Tree Frog (*Hyla regilla*).
5. Coastal Scrub*	California Sage Brush (*Artemisia californica*), Black Sage (*Salvia mellifera*), Coyote Bush (*Baccharis pilularis*), Bush Monkey-flower (*Diplacus aurantiacus*).	Rufous-crowned Sparrow (*Aimophila ruficeps*), Rock Wren (*Salpinctes obsoletus*), Wrentit (*Chamaea fasciata*), Brush Rabbit (*Sylvilagus* bachmani), Western Fence Lizard (*Sceloporus occidentalis*).

AMB/0330A

TABLE 4-1 (continued)

Community	Characteristic Plants	Characteristic Animals
6. Closed-cone Pine Florest	Bishop Pine (Pinus muricata), Monterey Pine (P. radiata).	Pygmy Nuthatch (Sitta pygmaea).
7. Redwood Forest	Coast Redwood (Sequoia sempervirens), Douglas Fir (Pseudotsuga taxifolia), Wax Myrtle (Myrica californica), Redwood Sorrel (Oxalis oregona), Thimble Berry (Rubus parviflora), California Sword Fern (Polystichum munitum).	Winter Wren (Troglodytes troglodytes), Mountain Beaver (Aplodontia rufa) (north of bay), Trowbridge Shrew (Sorex trowbridgei), Pacific Giant Salamander (Dicamptodon ensatus), Ensatina (Ensatina eschscholtzi).
8. Douglas Fir Forest	Douglas Fir (P. taxifolia), Tanoak (Lithocarpus densiflora), Madrone (Arbutus menziesi), California Laurel (Umbellularia californica).	Brown Creeper (Certhia familiaris), Golden-crowned Kinglet (Regulus satrapa), Western Gray Squirrel (Sciurus griseus), Dusky-footed Wood Rat (Neotoma fuscipes).
9. Ponderosa Pine Forest	Ponderosa Pine (Pinus ponderosa), California Black Oak (Quercus kelloggi).	Pileated Woodpecker (Dryocopus pileatus).
10. Broadleaf Evergreen	Tanoak (Lithocarpus densiflora), California Laurel (Umbellularia california), Madrone (Arbutus menziesi), California Buckeye (Aesculus californica), Golden Chinquapin (Castanopsis chrysophylla minor), Coast Live Oak (Quercus agrifolia), Douglas Fir (Pseudotsuga taxifolia).	Black-headed Grosbeak (Pheucticus melanocephalus), Hutton's Vireo (Vireo huttoni), Western Gray Squirrel (Sciurus griseus), Dusky-footed Wood Rat (Neotoma fuscipes), California Slender Salamander (Batrachoseps attenuatus), Arboreal Salamander (Aneides lugubris).

104. Analyze all samples for volatile and semi-volatile organics. Analyze all soil samples for lead, PCBs, and total hydrocarbon content as well. Patch concrete.

3.2.14 Site 20: Auto Hobby Shop/Transportation Center (Figure 3-17)

Type of Sampling: Soil, water
Number of Soil Borings: 5
Number of Ground Water Monitoring Wells: 1
Soil Sampling: 2 samples at each boring
Number of Samples: 10 soil, 1 water
Test Parameters: Volatile and semi-volatile organics (EPA Methods 8240 for soil, 624 for water, 8270 for soil and 625 for water) PCBs, lead, total hydrocarbons (EPA Method 418.1).
Remarks: Sample approximately 6 inches below ground surface, and near the ground water table (about 5 feet depth). Analyze all soil and water samples for lead and total hydrocarbon content. Analyze the lower soil samples and water sample for volatile and semi-volatile organics.

3.2.15 Site 21: Vessel Waste Oil Recovery/Site 25: Seaplane Maintenance (Figure 3-18)

Type of Sampling: Soil
Number of Soil Borings: 10, each approximately 5 to 10 feet deep
Number of Ground Water Monitoring Wells: None
Soil Sampling: 2 samples at each boring
Number of Samples: 20
Test Parameters: Priority Pollutant metals, volatile organic analysis (EPA Method 8240 for soil), and semi-volatile analysis (EPA Method 8270 for soil)
Remarks: The borings will be advanced with an auger rig and samples will be obtained near ground surface in fill soils and at the water table (about 5 feet). The boring locations will need to be backgrouted and patched with asphalt or concrete.

3.2.16 Site 22: Navy Exchange Service Station (Figure 3-19)

Type of Sampling: Soil, water
Number of Soil Borings: 2
Number of Ground Water Monitoring Wells: 2
Soil Sampling: 2 samples at each location
Number of Samples: 4 soil, 2 water
Test Parameters: Volatile and semi-volatile organics (EPA Methods 8240 for soil, 624 for water, 8270 for soil, 625 for water), lead, total hydrocarbons (EPA Method 418.1).
Remarks: The well borings will be advanced with an auger rig. Soil samples will be taken near the ground surface and at the water table.

3.2.17 Site 24: Fifth Street Fuel Releases (Figure 3-20)

Type of Sampling: Soil
Number of Soil Borings: 7
Number of Ground Water Monitoring Wells: None
Soil Sampling: 4 samples at each location

TABLE 4-1 (continued)

Community	Characteristic Plants	Characteristic Animals
11. Oak Woodland*	At lower elevations: Valley Oak (Quercus lobata), Coast Live oak (Q. agrifolia). At higher elevations: Blue Oak (Q. douglasi), Digger Pine (Pinus sabiniana). Throughout: Holly-leaf Cherry (Prunus ilicifolia), California Coffee Berry (Rhamnus californica), Poison Oak (rhusdiversiloba).	Acorn woodpecker (Melanerpes formicivorus), White-breasted Nuthatch (Sitta carolinensis), Brush Mouse (Peromyscus boylei), California Ground Squirrel (Citellus beecheyi).
12. Chaparral	Chamis (Adenostoma fasciculatum), Scrub Oak (Q. dumosa), Holly-leaf Cherry (P. ilicifolia), Buckbrush (Ceanothus cuneatus), California Coffee Berry (R. californica), manzanita (Arctostaphylos spp.), wild lilac (Ceanothus spp.).	Bewick's Wren (Thryomanes bewicki), Wrentit (Chamaea fasciata), California Thrasher (Toxostoma redivivum), North of Bay - Sonoma Chipmunk (Eutamias sonomae), South of Bay - Merriam Chipmunk (E. merriami), Striped Racer (Masticophis lateralis).
13. Grassland*	Blue Bunch Grass (Festuca idahoensis), California Oat Grass (Danthonia californica), Foothill Sedge (Carex tumulicola), brome grass (Bromus spp.), wild oats (Avena spp.)	Western Meadowlark (Sturnella neglecta), Horned Lark (Eremophila alpestris), California Ground Squirrel (Citellus beecheyi), Black-tailed Jack Rabbit (Lepus californicus) California Vole (Microtus californicus), Gopher Snake (Pituophis catenifer).
14. Riparian Woodland	[A] Western Sycamore (Platanus racemosa), Fremont Cottonwood (Populus fremonti), Red Willow (Salix laevigata), Arroyo Willow (S. lasiolepis). [B] Box elder (Acer negundo), Big Leaf Maple (A. macrophyllum), White Alder (Alnus rhombifolia/), Red Alder (A. rubra) (restricted to within 30 miles of the coast).	Downy Woodpecker (Dendrocopos pubescens), Yellow Warbler (Dendroica petechia), Yellow-breasted Chat (Icteria virens), Raccoon (Procyon lotor), Western Pond Turtle (Clemmys marmorata), California Newt (Taricha torosa).

TABLE 4-1 (continued)

Community	Characteristic Plants	Characteristic Animals
15. Rural	Alfalfa, truck crops, prune, apricot, pear, grape vines, eucalyptus, willows, and poplars.	Barn Owl (Tyto alba), Sparrow Hawk (Falco sparverius), Brewer's Blackbird (Euphagus cyanocephalus), Botta Pocket Gopher; (Thomomys bottae), California Vole (M. californicus), Gopher Snake (P. catenifer).
16. Urban*	Great variety of introduced trees, shrubs, and garden flowers.	House Finch (Carpodacus mexicanus), English Sparrow (Passer domesticus), Norway Rat (Rattus norvegicus), House House (Mus musculus).

* Community occurring within the boundaries of Treasure Island and/or Yerba Buena Island.

Source: Smith (1959)

4.4.1.1 Terrestrial ecosystems. TI is a flat man-made island created from dredgings of the Bay bottom river sands and silts (WESTDIV, 1986). The Island is intensively developed, maintained and landscaped with trees, shrubs, and lawns. There are approximately 445 acres of urban terrestrial habitat on TI consisting of buildings, roads and parking lots, landscaping and maintained areas. The vegetation consists of grasses, shrubs, herbaceous perennials, and trees; most of which have been cultivated in landscaped areas as the Island was developed. Some of the more dominant species include perennial ryegrass, Kentucky bluegrass, star acacia, bottle brush, boxwood, oleander, English ivy, ice plant, blue gum, Monterey pine, coast live oak, bishop pine, sycamore and white fir. Tables 4-2, 4-3 and 4-4 contain a listing of the known vegetation on Naval Station TI.

YBI is a rugged, steeply sloping heavily wooded island which contrasts greatly with the flat urban industrial character of the man-made TI. The majority of the approximately 130-acre island is undeveloped. However, there are approximately 55 acres of developed urban terrestrial habitat consisting mostly of residential housing areas. Vegetation in these areas is similar to the cultivated landscaping described for TI. Tables 4-2, 4-3 and 4-4 provide a listing of these species.

The majority of YBI consists of undeveloped land (approximately 75 acres). The undeveloped areas consist of grasslands, woodlands, brushlands and a proposed wildlife area for Army Point. The proposed wildlife area for Army Point is an area that can be greatly enhanced by a minimum of restoration effort. There is approximately 1 acre of grassland, 30 acres of eucalyptus woodland, 10 acres of mixed woodland, 20 acres of brushland, 10 acres of the proposed wildlife area and four acres of parkland (Clipper Cove picnic area) (WESTDIV, 1986). Some of the typical species include, brome, California oatgrass, blue gum eucalyptus, coyote bush, coastal sage, poison oak, California buckeye and blackberry. The wildlife area is located on Army Point on the eastern tip of YBI. Tables 4-2, 4-3, and 4-4 contains a complete listing of the vegetation on Naval Station TI.

Wildlife known and expected to occur on TI and YBI consist mostly of species adapted to urban environments and landscape plantings. Birds typically associated with urban or residential environments and adapted to human disturbance are found on TI and YBI. These include house finch, stellar jay, English sparrow, savannah sparrow, and robin. Large areas of shrubs interspersed with grasslands and extensive eucalyptus woodlands occur on YBI. These areas provide cover for birds such as quail, woodpecker, horned lark, cedar waxwing and white-breasted nuthatch. The shoreline areas of YBI are used by terns and pelicans for foraging and by herring gulls for roosting. A listing of the birds known to occur on TI and YBI is provided on Table 4-5.

The mammals of both TI and YBI consist primarily of California ground squirrel and pocket mice. A small group of harbor seals uses the southwest shoreline of YBI (WESTDIV, 1986). Information on the frequency of use of this area by harbor seals was not available. The harbor seal is protected from hunting, capture, killing or harassment under the Marine Mammal Protection Act.

4.4.1.2 Marine ecosystem. The San Francisco Bay-Delta is the largest estuary on the Pacific Coast of the United States. The bay has been exposed to massive anthropogenic influence over the last 200 years (Nichols, et al.,

Table 4-3

Vegetation of Naval Station Treasure Island[1]

Shrubs and Herbaceous Perennials

Common Names	Scientific Names
Sydney golden wattle	Acacia longifolia
Star acacia	Acacia verticillata
California buckeye	Aesculus californica
English ivy	Algerian hedera helix canariensis
Coyote bush	Baccahris Pilularis
Boxwood	Buxus
Bottle brush	Callistemon citrinus
Ice plant	Carpolrotus edules
Flowering quicne	Chaenonekes lagenaria
Cotoneaster	Cotoneaster
Heather	Erica
Escallonia	Escallonia
Wild strawberry	Fragaria chiloensis
Gazania perennial	Gazania
Kupuka tree	Griselinia littoralis
Veronica	Hebe sp.
Ilex holly	Ilex
Burfordii holly	Ilex cornuta
Australian tea tree	Leptosperum laevigatum
Privit	Ligustrum texanum
Melaleuca	Melaleuca
Myoporum	Myoporum laetum
Oleander	Nerium oleander
Poison oak	Phus diversiloba
Rockrose cistus	Purpureus orchid
India hawthorne	Raphiolepis indica
Rosemary	Rosmarinus officinalis
Blackberry	Rubus spp.
Sage	Salvia
Elderberry	Sambucus
Periwinkle	Vinca minor

1. Includes both TI and YBI
Source: WESTDIV, 1986.

Table 4-2

Vegetation of Naval Station Treasure Island[1]

Grass Species

Common Names	Scientific Names
Perennial grain	Agrotricum W-21
Brome	Bromus sp.
Blando brome	Bromus mollis
Pacific reedgrass	Calamagrostis mutkaensis
California oatgrass	Danthonia californica
Zorro annual fescue	Festuca megalura
Common velvetgrass	Holcus lanatus
Perennial ryegrass	Lolium perenne
Kentucky bluegrass	Poa pratensis
Hardinggrass	Phalaris Kuberosa stenoptera
Lana vetch	Vicia asycarpa

1. Includes both TI and YBI
Source: WESTDIV, 1986.

Table 4-4

Vegetation of Naval Station Treasure Island[1]

Tree Species

Common Names	Scientific Names
White fir	Abies concolar
Green wattle	Acacia decurrens
Black acacia	Acacia melanoxylon
Bigleaf maple	Acer macrophyllum
California buckeye	Aesculus californica
White alder	Alnus rhomfibolia
Red alder	Alnus rubra
Port Oxford cedar	Chamaecyparis lawsonia
Pacific dogwood	Cornus nuttallii
Monterey cypress	Cupressus macrocarpa
Eucalyptus	Eucalyptus
Yate tree	Eucalyptus cornuta
Blue gum	Eucalyptus globulus
Incence cedar	Libocedrus decurrens
New Zealand Christmas tree	Metrosideros excelsa
European olive	Olea europaea
Canary Island date palm	Phoenix canariensis
Bishop pine	Pinus muricata
Monterey pine	Pinus radiata
Torrey pine	Pinus torreyana
Sycamore	Platanus acerifolia
Douglas fir	Pseudotsuga mensiesii
Coast live oak	Quercus agrifolia
Willow	Salix
California pepper	Schinus molle
Redwood	Sequoia sempervirens
California bay	Umbellularia californica
California fan palm	Washingtonia filifera

1. Includes both TI and YBI
Source: WESTDIV, 1986.

Table 4-5

Wildlife of Naval Station Treasure Island[1]

Common Names	Scientific Names
Red-winged balckbird	Agelaius phoeniceus
Lewis woodpecker	Asyndesmus lewis
Cedar waxwing	Bombycilla cedrorum
House finch	Carpodacus mexicanus
Common crow	Corvus brachyrhynchos
Steller jay	Cyanocitta stelleri
Horned lark	Ermophila alpestris
Peregrine falcon	Falconiformes
California quail	Laphortyx california
Least tern	Laridae
Herring gull	Larus argentatus
Mockingbird	Mimus polyglottos
English sparrow	Passer domesticus
Sparrow	Passerculus sandwichensis
Savannah sparrow	Passerculus sandwichensis
Brown pelican	Pelecanidae
White-breasted nuthatch	Sitta carolinensis
American robin	Turdus migratorius
Robin	Turdus migratorius
White-crowned sparrow	Zonotrichia Leucophyrs
California ground squirrel	Citellus beeheyi
Harbor seal	Otariidae
Pocket mice	Perognathus

1. Includes both TI and YBI
Source: WESTDIV, 1986.

1987). These changes to the Bay have resulted in somewhat equal changes to its biological resources. As an example, great losses of wetland areas have occurred since the mid-1800s. In addition, benthic communities have been totally altered from historical populations and the fishery resources have undergone long-term changes. Some fish populations appear to be continuing to decline (Phillips, 1987).

A widely held belief is that pollution of the Bay has contributed and is currently contributing to changes in the biological resources of San Francisco Bay. However, incontrovertible evidence of such effects is rare for any ecosystem and San Francisco Bay is no exception (Phillips, 1987). The Bay is still heavily utilized for both sport and commercial fishing; however, commercial fishing is uncommon near TI and YBI. Marine fauna which occur in the Bay and near TI and YBI include anadromous fish such as striped bass, king salmon, and sturgeon. Other commonly occurring fish include sole, flounder, shark, rays, rockfish and perch. Bait and forage fish such as sardines, anchovies, herring and smelt are also common. Common shellfish include shrimp and crab. Many of the species listed above are common near TI and YBI. The sport fishing pier located on the western shore of TI is frequently used as a local fishing area.

The predominant marine habitat around TI and YBI is subtidal with unconsolidated mud bottom substrate. A limited intertidal habitat consisting of riprap and dock and pier pilings is also present (WESTDIV, 1987). There is some rocky intertidal shoreline with mudflats extending north between YBI and TI. The most numerous benthic species include amphipods, several species of clams and polychete worms (WESTDIV, 1987).

Marine flora also occur throughout the Bay, but are more commonly found on rocky shores, tidepools and reefs. These include the green, brown and red algae. No information is readily available on the species occurring on or immediately adjacent to the shores of TI and YBI. Apparently there is little interest in the biological resources of TI and YBI by the local scientific and academic community. However, common species on Bay shorelines that may occur on the shores of TI and YBI include Zostera sp., Ulva sp., Enteromorpha sp., Ralfsia sp. and perhaps several red alga (Rhodophyta). Eelgrass beds (Zostera sp.) are reported to occur on the eastern shore of YBI (WESTDIV, 1987).

4.4.2 Rare, Threatened and Endangered Species. The Endangered Species Act of 1973 (Public Law 93-0205), as amended, provides that all federal agencies shall carry out programs for the conservation of listed endangered and threatened species. Federal agencies must ensure that actions authorized, funded, or carried out by them will not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitats as determined by the Secretary of the Interior (OPNAVINST 5090.1, 1983).

The list of endangered and threatened animal and plant species is published in the Federal Register 50 CFR 17.11-17.12. The official State of California listing of endangered and rare animals is contained in California Administrative Code, Title 14, Section 670.2 (State of California, 1987). The California Native Plant Protection Act of 1978 assigns primary responsibility to the state Department of Fish and Game for determining California plants to

be listed as endangered or rare. As of 20 November 1979, the State of California had listed 75 endangered and 40 rare plants. The Department of Fish and Game uses the California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California as their species-of-concern list (Smith and York, 1984).

A species is endangered when its prospects of survival and reproduction are in immediate jeopardy. A species is threatened or rare when, although not immediately facing extinction, it is in such small numbers throughout its range that it may become endangered if its present environmental conditions deteriorate.

4.4.2.1 Plants. No rare, threatened or endangered plants designated by the California Department of Fish and Game or the U.S. Fish and Wildlife Service have been observed or are expected to occur on Naval Station TI (TI and YBI). Likewise, there are no habitats of special biological interest on TI or YBI.

4.4.2.2 Wildlife. Three species of wildlife classified as endangered by both the state and federal governments are known to occur in the region and have been reported to occasionally use Naval Station TI for hunting and foraging (WESTDIV, 1986). These include peregrine falcon (Falco peregrinus anatum), California least tern (Sterna albifrons brownii) and California brown pelican (Pelicanus occidentalis californicus). These species are not expected to nest on TI or YBI. It is unlikely that the species could be adversely affected by contaminants on or from TI or YBI. These species feed throughout the Bay Area and are not specifically dependent on TI or YBI for food. In addition, other than potential direct discharge of contaminants to the Bay from TI or YBI, no method of contaminants entering the food chain from TI or YBI has been identified. All three species are carnivorous; with the least tern and brown pelican feeding on fish and the peregrine falcon feeding primarily on small birds. Additional information on all three endangered species is provided below.

The peregrine falcon (Falco peregrinus anatum) is listed as an endangered species by both the state and federal governments. The peregrine falcon is a very rare transient or winter visitor along the coast, foraging and resting in open country, river mouths, and near shore waters such as San Francisco Bay. Due to the absence of any reported suitable nesting habitat, the peregrine falcon would be considered only a rare transient or migrant at TI or YBI.

The California least tern (Sterna albifrons brownii) is listed as an endangered species by the U.S. Fish and Wildlife Service and the California Department of Fish and Game. In California, it can be found from April to September nesting on sandy beaches and salt flats. The California least tern migrates along the coast to wintering areas in Central and South America. Least terns primarily feed on small fish in near shore waters, including marshes, estuaries, bays and the surf line; it has been occasionally observed near TI and YBI. It is expected to be an infrequent visitor to near shore waters off TI and YBI.

The California brown pelican (Pelicanus occidentalis californicus) is listed as endangered by the U.S. Fish and Wildlife Service and the California Department of Fish and Game. It is the endangered species expected most frequently near TI and YBI. The brown pelican occurs year-round along the

California coastline and feeds in or rests on open water areas just outside the surf line along the coast and near shore waters like San Francisco Bay. It has a diet consisting primarily of fish.

4.5 PHYSICAL FEATURES.

4.5.1 Climate. The climate at TI and YBI, like the remainder of the Bay Area, is dominated by the Pacific Ocean, producing a maritime climate that is characterized by little variation in temperature. The average annual air temperature is 56°F to 58°F with an average frost-free period of 300 to 330 days.

The average annual precipitation is about 25 to 30 inches. Almost 90 percent of this precipitation occurs during November through April. Mean annual evaporation is 48 inches. The greatest evaporation occurs during July (WESTDIV, 1987).

During the winter the relative humidity is about 80 to 90 percent at night and 60 to 80 percent during the day. Humidity decreases in spring, but by summer it increases especially at night or morning when frequent fogs occur. In the fall the humidity is lowest, ranging from 50 percent during the day to 70 percent at night.

The wind direction for the Bay Area throughout most of the year is northwest. For more than 50 percent of the time, wind speed is less than 6 miles per hour; only 10 percent of the time does it exceed 12 miles per hour. The strongest winds are usually associated with winter storms. In winter and spring cold temperatures will sometimes accompany the winds from the north and east. In the summer westerly winds result from cool marine air flowing to the warmer interior (WESTDIV, 1987).

4.5.2 Topography.

4.5.2.1 Treasure Island. TI is essentially a flat (0 to 2 percent slopes) man-made island with little relief. Based on a 1977 topographic map, the elevation ranges from approximately 5 to 15 feet (MSL) (WESTDIV, 1986). Topographic contours indicate that the eastern side of the Island contains the highest elevations, while the lowest elevations tend to be on the northwest part of the Island. The average elevation for TI is approximately 11 feet (MSL).

4.5.2.2 Yerba Buena Island. YBI is a natural island with gently rolling to very steep slopes (5 to 95 percent slopes) (WESTDIV, 1986). The elevation range extends from sea level (0 feet at MSL) to the highest point, at elevation approximately 440 feet (MSL) which is located in the middle of the Island (Radbruch, 1957).

4.5.3 Geology.

4.5.3.1 Regional Geology. San Francisco Bay is a drowned river valley which developed within a northwest trending structural trough formed in Franciscan bedrock. In the Late Pliocene, approximately 2 million years ago, the San Francisco-Marin block tilted towards the east along the Hayward Fault. The uplifted western edge of the block formed the hills of Marin while the

downdropped eastern edge created the elongated depression which is now occupied by San Francisco Bay. Following the downdropping of the bedrock block, material eroded from the Berkeley/Oakland Hills was deposited in alluvial fans which gradually coalesced to form the broad, gently sloping plain which borders the eastern shoreline of the bay.

During the mid-Pleistocene, a river system eroded deep channels into these areas of downdropped bedrock, creating an irregular bedrock topography and forming the Carquinez Straits and the Golden Gate. The river valleys were then flooded through the Golden Gate as sea level rose in response to Pleistocene continental glaciation melting cycles. Throughout the Pleistocene, there were cycles of sea level rise and fall. Even minor fluctuations in the bay water level would have resulted in extensive interfingering of alluvial and estuarine sediments as the Bay area underwent episodic flooding.

During the Quaternary the San Francisco Bay Region became a tectonically active region. It is located near the contact between the North American and Pacific crustal plates. This seismic regime is characterized by northwest trending faults. These faults exhibit mainly right lateral strike-slip movement, which means that the movement is predominantly horizontal, and when viewed from one side of a fault the zone on the opposite side of the fault has moved to the right.

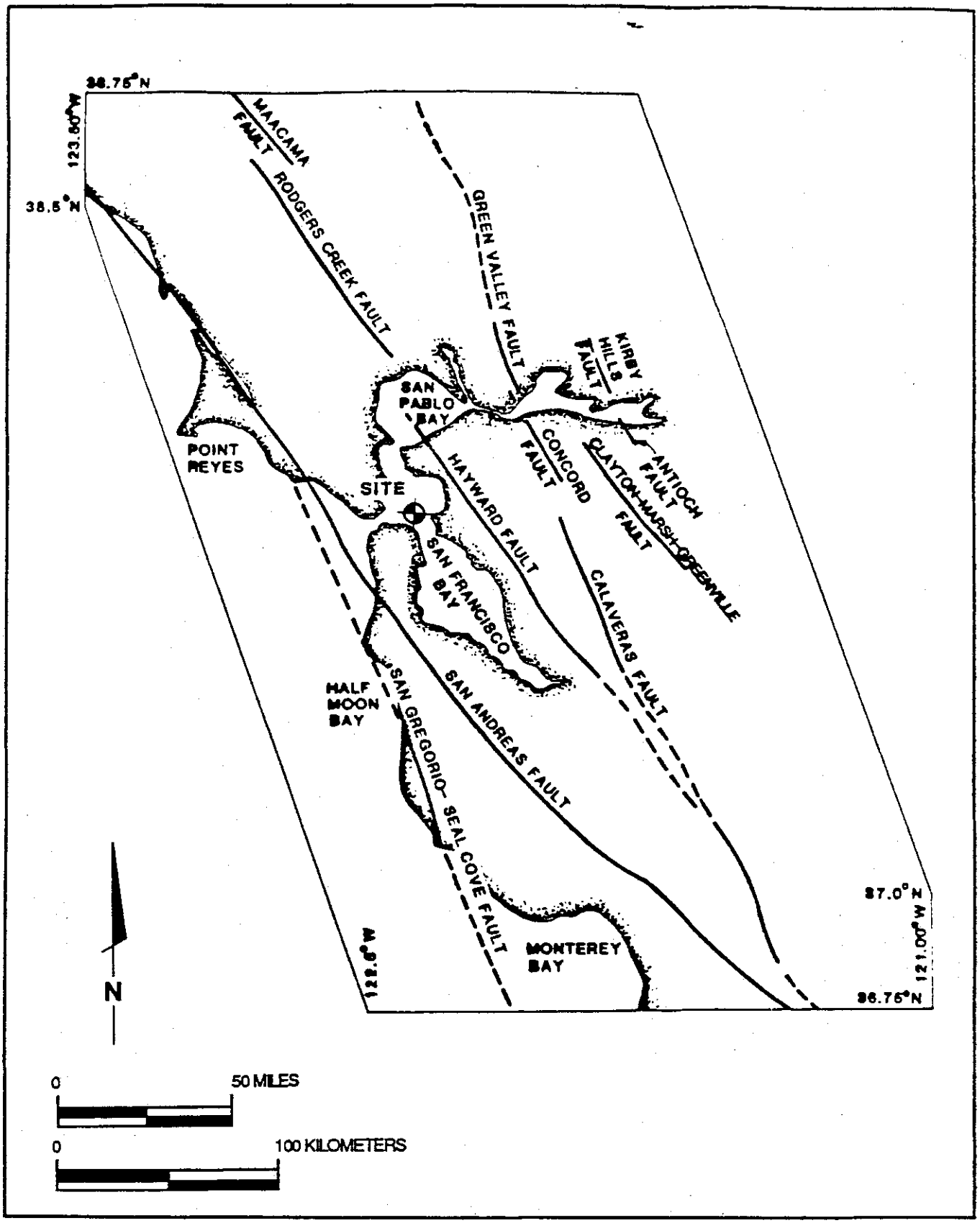
The major active faults in the site vicinity are all part of the San Andreas fault system. A schematic map of the regional faults and the site location map are presented on Figure 4-2. These faults include the Hayward fault approximately 5 kilometers to the east, the San Andreas fault approximately 15 kilometers to the west of the site, the Calaveras fault approximately 85 kilometers to the southeast, and the San Gregorio-Seal Cove fault zone 40 kilometers to the west.

Other significant faults in the site region are the Rodgers Creek fault approximately 70 kilometers north of the site and the Maacama fault approximately 175 kilometers to the north. In addition, there are several smaller, less active faults in the site region which also contribute to the regional seismicity. These faults include the Concord fault 28 kilometers to the east, the Green Valley fault about 70 kilometers to the northeast, the Antioch fault about 110 kilometers to the northeast, the Kirby Hills-Vacaville fault system about 110 kilometers to the northeast, and the Greenville-Mt. Diablo fault system about 100 kilometers to the east.

4.5.3.2 Local Geology.

4.5.3.2.1 Treasure Island. TI is a man-made island constructed of artificial fill (Qaf) dredged from the Bay (Blake and others, 1974; Radbruch, 1957) as shown on Figure 4-3. Before fill emplacement this area originally consisted of Yerba Buena Shoals and a sand spit extending from the northwest point of YBI.

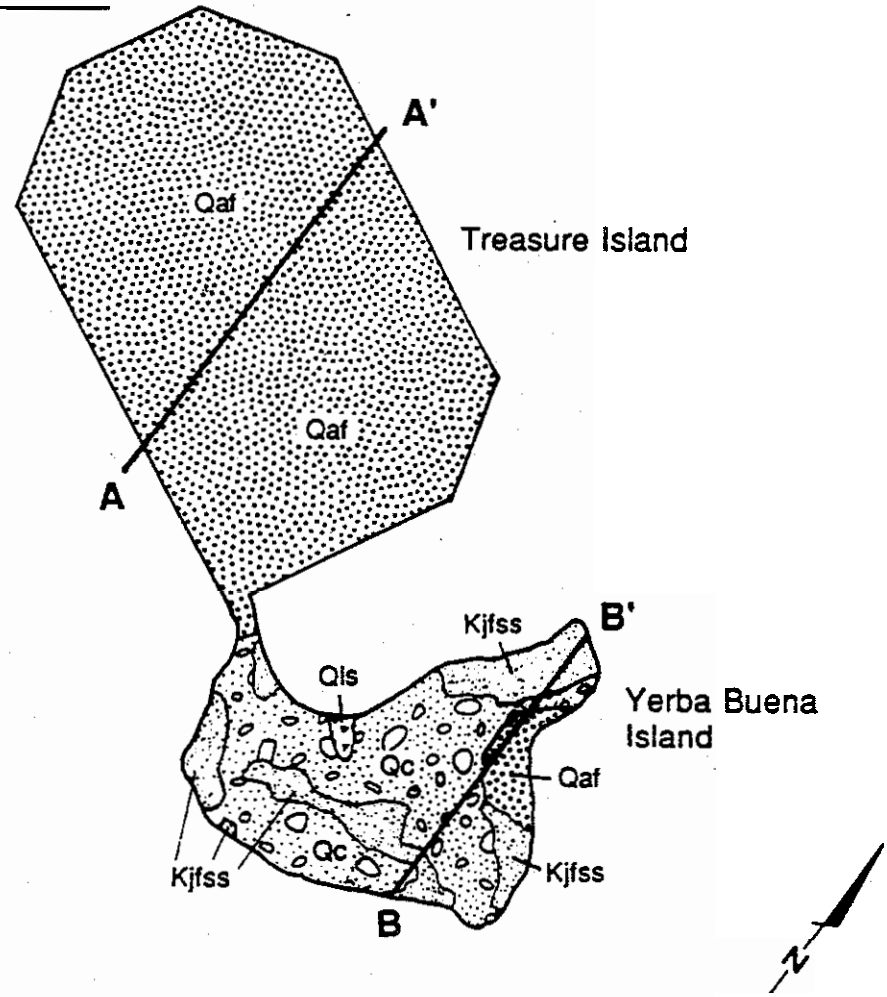
Dredging and construction of the Island began in 1936 and was completed in 1937 (Lee, 1966). The artificial fill used for construction consisted primarily of sand with lesser amounts of silt, clay, and gravel. It has been



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

LOCATION MAP
(FAULTS WITHIN STUDY AREA)

FIGURE
4-2



KEY:

- Qls — Landslide Debris
- Qaf — Artificial Fill (sand, clay, or miscellaneous refuse)
- Qc — Colma Formation (sand with minor sandy silt, clay, and gravel interbeds)
- Kjfss — Franciscan Group (sandstone and shale)

0 1/2 1 MILE

SCALE

Adapted from: Blake, M.C. and others, 1974, Preliminary Geologic Map of Marin and San Francisco Counties and Ports of Alameda, Contra Costa and Sonoma Counties, California, U.S. Geological Survey, Miscellaneous Field Studies. Map MF 574.

Radbruch, D.H. 1957, Areal and Engineering Geology of the Oakland West Quadrangle, California, U.S. Geological Survey, Miscellaneous Geologic Investigations, Map I-239.

PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

GEOLOGIC MAP

FIGURE
4-3

reported that the fill thickness throughout the site is 50 feet (WESTDIV, 1987).

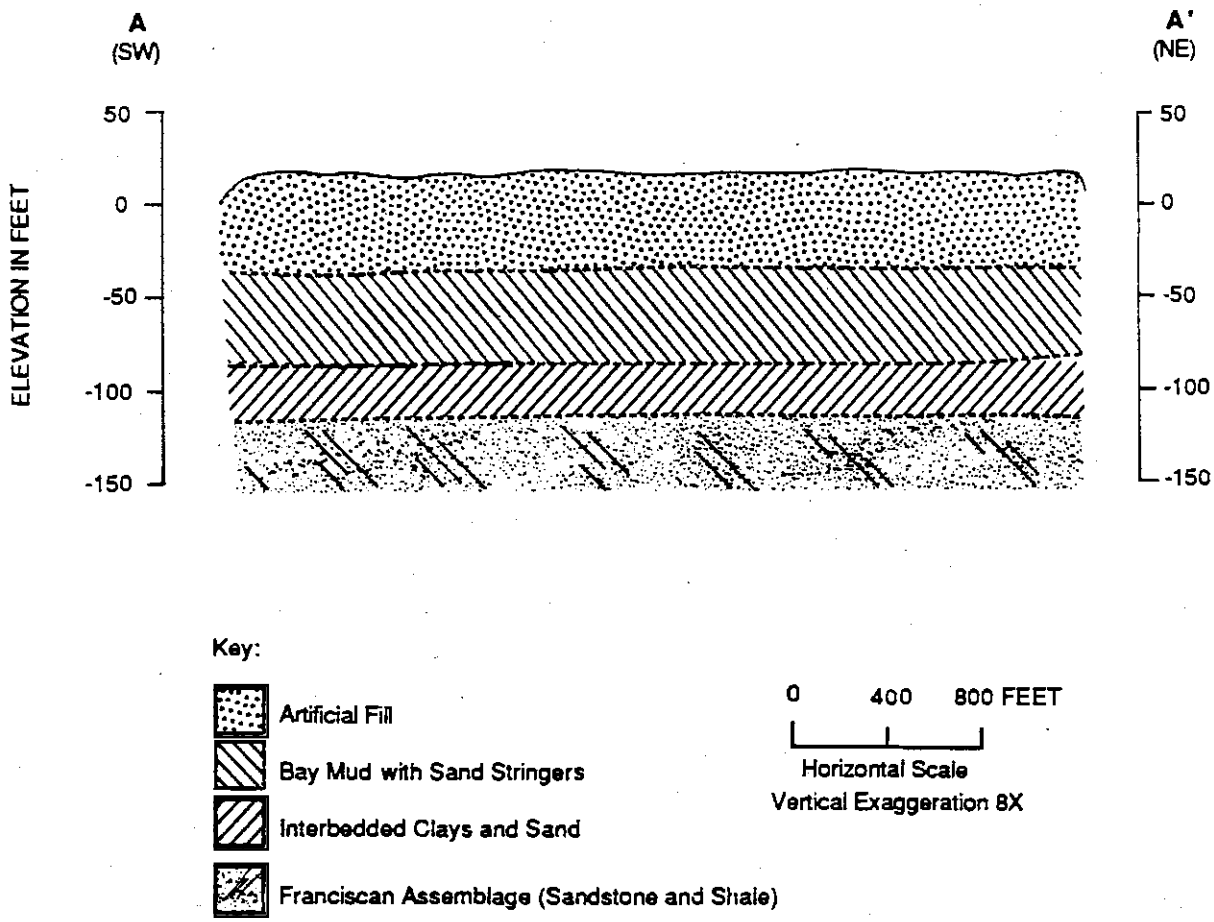
Below the hydraulically placed fill is a thick body of clayey silt known as Bay Mud. The clayey Bay Mud contains some fine-grained sand stringers and extends to a depth of 100 to 120 feet below ground surface. Underlying this are relatively consolidated interbedded clays and sands that extend 30 feet to the sandstone and shale bedrock (Lee, 1966). The cross section A-A' on Figure 4-4 shows a schematic representation of the strata underlying the placed fill.

4.5.3.2.2 Yerba Buena Island. YBI is a natural island that has been mapped by Blake and others (1974) to consist of four geologic units: landslide debris (Qls); artificial fill (Qaf); sand of the Colma Formation (Qc); and sandstone and shale bedrock of the Franciscan assemblage (Kjfss). Figure 4-3 shows the geologic units for YBI as well as TI. A description of the geologic units and their properties is listed on Table 4-6. Figure 4-5, Schematic Geologic Cross Section B-B', depicts the subsurface stratigraphy on YBI.

The most recent geologic unit at YBI is the landslide debris (Qls) which results from clayey silty sand that has moved downslope. An area of significant landslide debris is located on the north side of the Island although smaller areas of landslide debris are found at other locations. The next unit, the artificial fill (Qaf), has been placed along the eastern shoreline of the Island. The Colma Formation (Qc), a fine- to medium-grained sand with minor amounts of sandy silt, clay, and gravel interbeds, is exposed over approximately 70 percent of the island. It unconformably overlies the bedrock below and is variable in thickness, extending from a few inches to several feet. It blankets the ravines and slopes and in places even forms relatively flat benches. Underlying the Quaternary deposits (i.e., Qls, Qaf, and Qc) are the resistant sandstone and shale of the Franciscan assemblage (Kjfss). The Franciscan Assemblage is the oldest geologic unit on the island. It tends to be highly variable in composition and structure in the Bay region; however, surficially at YBI it appears very consistent in structure and composition. The Franciscan units exposed on YBI generally dip to the northeast and have a northwest to southeast trend.

4.5.4 Soils. A U.S. Department of Agriculture (USDA) soil survey of this area has recently been completed, but the publication is still in process. Therefore, there is limited information available on water capacity, shrink-swell potential, etc. Soil survey information has been obtained from the Natural Resource Management Plan Document (WESTDIV, 1986) and from communication with the USDA Soil Conservation Service in Half Moon Bay, California (1987).

According to the recent survey, TI is mapped as Urban Lands and Orthents, as shown by the symbol, 245, on Figure 4-6. A limited description provided by the USDA Soil Conservation Service of these soil properties is summarized by symbol on Table 4-7. Urban Lands are defined as those areas which are more than 85 percent covered with buildings, asphalt, concrete, and other impervious materials. Orthents are reclaimed soils that are very heterogeneous and consist of variable amounts of soils, gravel, broken rock, asphalt, concrete, Bay Mud, and other solid materials. In general, the soils found on TI are poorly graded, fine sand with occasional discontinuous lenses of silt and clay.

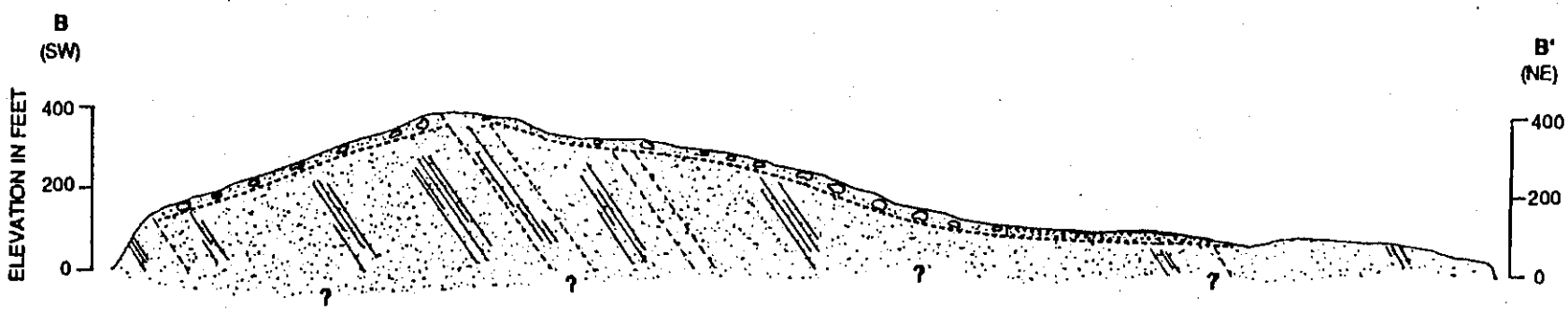


REFERENCE:

Blake, M.C. and others, 1974, Preliminary Geologic Map of Marin and San Francisco Counties and Ports of Alameda, Contra Costa and Sonoma Counties, California, U.S. Geological Survey, Miscellaneous Field Studies, Map MF 574.

Radbruch, D.H. 1957, Areal and Engineering Geology of the Oakland West Quadrangle, California, U.S. Geological Survey, Miscellaneous Geologic Investigations, Map 1-239.

PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	**SCHEMATIC SUBSURFACE CROSS SECTION A-A' TREASURE ISLAND**	FIGURE 4-4



KEY:

- Artificial Fill
- Colma Formation (Fine to medium grained sand, with minor amounts of sandy silt, clay and gravel as interbeds)
- Franciscan Assemblage (sandstone and shale)

0 200 400 FEET

Horizontal Scale

No Vertical Exaggeration

REFERENCE:

Blake, M.C. and others, 1974, Preliminary Geologic Map of Marin and San Francisco Counties and Ports of Alameda, Contra Costa and Sonoma Counties, California, U.S. Geological Survey, Miscellaneous Field Studies, Map MF 574.

Radbruch, D.H. 1957, Areal and Engineering Geology of the Oakland West Quadrangle, California, U.S. Geological Survey, Miscellaneous Geologic Investigations, Map I-239.

PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SCHEMATIC SUBSURFACE CROSS SECTION B-B'
YERBA BUENA ISLAND

FIGURE
4-5

Table 4-6

DESCRIPTION OF GEOLOGIC UNITS
Naval Station Treasure Island, CA

GEOLOGIC* UNIT	GEOLOGIC AGE	LITHOLOGY	DISTRIBUTION AND THICKNESS	TOPOGRAPHIC FORM	ORIGIN OF DEPOSIT	PERMEABILITY	SLOPE STABILITY	EARTHQUAKE STABILITY	DRY DENSITY (AVERAGE FOR UNIT)	MOISTURE CONTENT (AVERAGE FOR UNIT)
Artificial fill (Qaf)	Quarternary	Consists of miscellaneous refuse, bay mud, or sand dredged from bay; composition varies from place to place; may be difficult to distinguish from natural bay mud or Merritt sand. In most places overlies bay mud.	Along shore of bay and on Treasure Island. Maximum known thickness 25 feet.	Flat, level areas a few feet above sea level.	Manmade.	Varies with composition.	Varies with composition; wet clay or loose sand must be supported in cuts.	Poor; unstable bay mud underlies most fill.	Varies with composition.	Varies with composition.
Colma Formation (Qc)	Quarternary	Sand, fine-grained. Moderate yellowish-brown. Predominantly quartz and feldspar, mostly highly altered; some magnetite and biotite, minor amounts of other minerals; contains fragments of sandstone up to three-eights inch in diameter; slightly cemented within silt and clay. Grains subangular to subrounded, frosted. Well-sorted. Varies from loose windblown sand to slightly coherent clayey, silty sand, which can be crumbled between the fingers. Lies unconformably oon sandstone of the Franciscan group.	Fills ravines, mantles slopes and hilltops on Yerba Buena Island. Maximum known thickness 90 feet.	Ravine filling, follows contours of hills; forms flat benches in places.	Residual, derived from underlying sandstone of the Franciscan group; reworked by gravity, water, and wind.	High; medium where clayey.	Cuts steeper than the angle of repose of loose sand must be supported. Slopes cribbed or planted to prevent erosion; slides on steep slopes when wet; slides numerous in ravines.	Fair.	Unknown.	Unknown.
Franciscan Assemblage (Kjfss)	Cretaceous and Jurassic	Sandstone, arkosic to graywacke; fine to very coarse grained, with some shale beds. Sand grains consist largely of quartz, feldspar, and shale, with some chert and biotite and minor amounts of epidote, chlorite, clay, and carbonaceous material. Fresh rock is medium gray; weathered or altered rock is light brown or very pale orange. Fresh rock dense, hard; altered rock may be scratched with finger nail. Sandstone varies from massive to thin bedded, is cut by veins of quartz or calcite. Rock jointed, fractured; contorted in some places; many fracture surfaces coated with iron, manganese, and clay minerals.	In northeastern corner and east-central part of quadrangle; on Yerba Buena Island; probably underlies alluvium throughout quadrangle. Total thickness unknown.	Forms rather steep, rounded hills.	Marine deposit in geosyncline; source of sediments thought to be land mass west of present coastline.	Low.	Stable in vertical crust except for contorted or sheared sandstone and shale, which may slide on steep faces.	Good.	138 (127-149)	7 (3-11)

Note: Table 4-6 is based on table in "Areal and Engineering Geology of the Oakland West Quadrangle, California" by Dorothy W. Radbruch, 1957, U.S.G.S. Miscellaneous Geologic Investigations Map I-239 and has been altered with updated information from "Preliminary Geologic Map of Marin and San Francisco Counties and Parts of Alameda, Contra Costa and Sonoma Counties, California" by H. C. Blake and others, 1974, U.S.G.S. Miscellaneous Field Studies Map MF574.

AMB/0331A

TABLE 4-7

SOIL MAP SUMMARY

Location: Yerba Buena Island

Date: 1/27/86

Land Capability	Symbol On Map	Soil Name	Slope	Effective Rooting Depth	Soil/Profile Texture		A.W.C.	Erosion Hazard	Limiting Factors
					Surface	Subsoil			
VIII	432	Orthents, Cut & Fill - Urban Land Complex	5-75%						Slope
		Consists of: 50% Orthents, Cut & Fill		Highly variable	Highly variable		Highly variable	Moderate to very high	Steep slopes. Shallow depth to rock in some areas. Highly variable soil properties.
		35% Urban Land		Most of the soil surface is covered with asphalt, buildings, etc.				None	Rapid runoff.
VIIe	550	Candlestick Kron-Buriburi complex	30-75%						
		Consists of: 40% Candlestick		20-40"	Fine sandy loam	Loam over sandy clay loam	Low to moderate	High to very high	Steep slopes. Slippage.
		25% Kron		10-20"	Sandy loam	Loam	Very low to low	Very high to high	Steep slopes. Shallow depth to rock.
		20% Buriburi		20-40"	Gravelly loam	Gravelly loam	low to moderate	high to very high	Steep slopes.
	100	Urban land	0-2%	Most of the soil surface is covered with asphalt, buildings, etc.				None	Rapid runoff.

TABLE 4-7 (Continued)

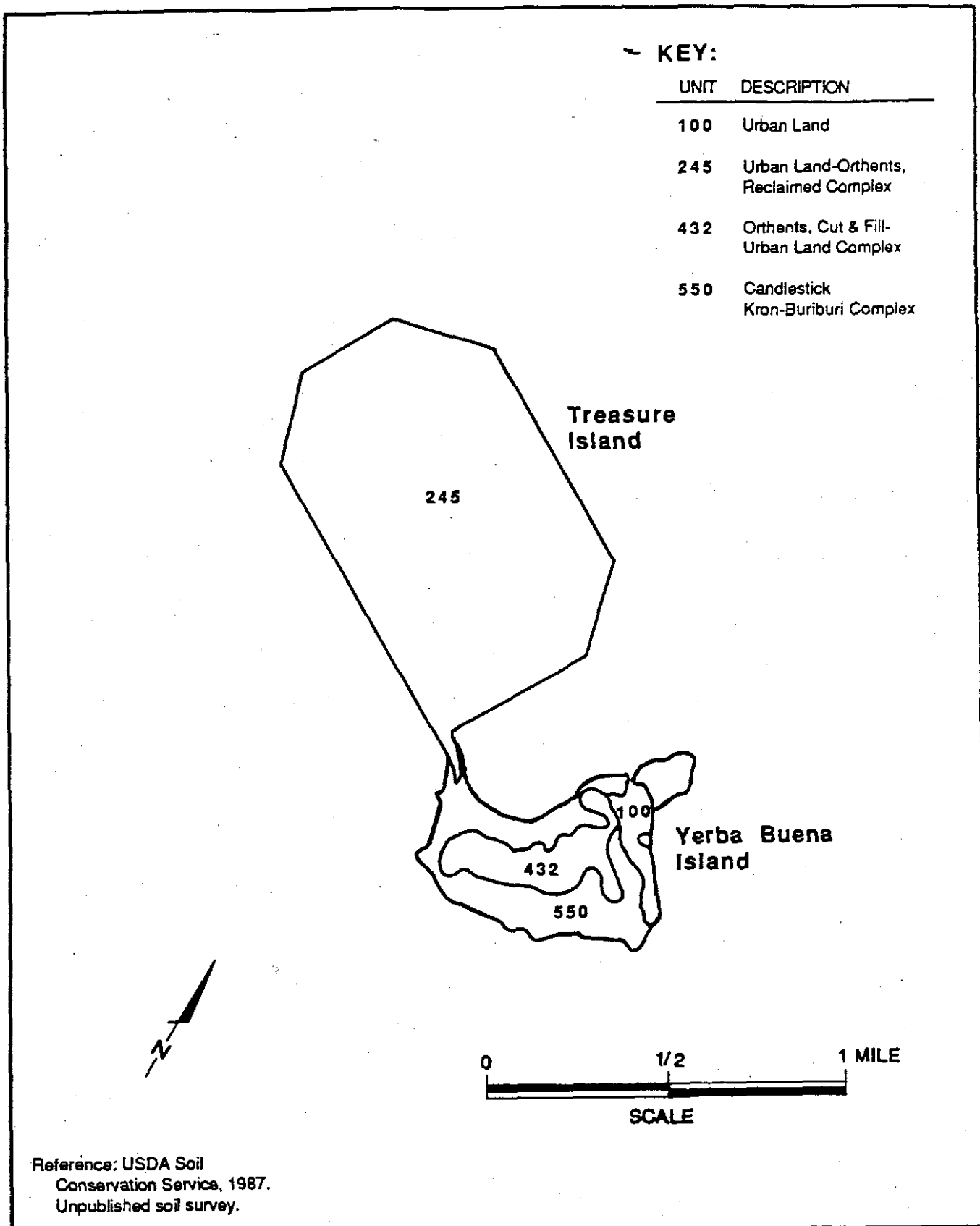
SOIL MAP SUMMARY

Location: Treasure Island

Date: 1/27/86

Land Capability	Symbol On Map	Soil Name	Slope	Effective Rooting Depth	Soil/Profile Texture Surface	Soil/Profile Texture Subsoil	A.W.C.	Erosion Hazard	Limiting Factors
VIII	245	Urban land-Orthents, Reclaimed complex	0-2%	Most of the soil surface is covered with asphalt, buildings, etc.				None	Rapid runoff.
		Consists of: 65% Urban Land	0-2%	Most of the soil surface is covered with asphalt, buildings, etc.				None	Rapid runoff.
		30% Orthents, reclaimed		Limited at 30-60" by water table	Highly variable		Highly variable	Low	Subsidence. Highly variable soil properties. High water table. Corrosivity, salinity
		5% minor soils							

Note: Table obtained from U.S.D.A. Soil Conservation Service (1987).



Reference: USDA Soil Conservation Service, 1987. Unpublished soil survey.

PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	YERBA BUENA ISLAND/ TREASURE ISLAND SCHEMATIC SOIL MAP	FIGURE 4-6

At YBI the soils are classified as Candlestick, Kron, and Buriburi soils. These three soil types are found on 30 to 75 percent slopes. In addition, on YBI there are areas of Urban Land and Orthents found on 5 to 75 percent slopes. Figure 4-3 shows the USDA symbols of soils on YBI. Table 4-7, provided by the USDA Soil Conservation Service, describes the soil types for each symbol. The soils on YBI are 10 to 40 inches deep over the sandstone and shales of the Franciscan formation (McCreary-Koretsky Engineers, 1965). The soils at the surface range from fine sandy loam to gravelly loam. The subsoil ranges from gravelly loam to sandy clay loam.

4.5.5 Hydrology.

4.5.5.1 Surface water. TI and YBI are surrounded by the waters of San Francisco Bay. Any surface drainage off the two islands flows into the Bay.

San Francisco Bay has water quality problems resulting from past and present practices. One source of contamination has been the disposal of waste from urban areas into the Bay. Discharge into the Bay has declined but still occurs. Another source of release to the Bay is from surface runoff which carries pollutants into surface drainage where they are eventually carried into the Bay. A third source of pollution is accidental spills or deliberate discharge from ships. The California Water Quality Control Board which establishes local water quality standards, classifies the water quality status in the Bay Area as critical (WESTDIV, 1986).

4.5.5.2 Ground water.

4.5.5.2.1 Treasure Island. The subsurface water at TI is under water table condition. Generally the ground water is present at depths of 30 to 72 inches below ground surface. The one available report on tidal variation on TI indicated a tidal difference of approximately 0.3 foot (McCreary-Koretsky Engineers, 1965). Recharge occurs from infiltrations resulting from precipitation, landscape irrigation and leaking storm drains, and from Bay waters. Because of the presence of relatively impermeable silt and clay lenses, there may be some perched conditions above the shallow water table.

The subsurface water at the site is not used. As a source of water it proves impotable due to the contact with the saline to brackish Bay waters.

Although there is limited ground water data from TI, a crude approximation of the ground water velocity can be estimated using Darcy's flow law and some assumptions. The average linear ground water equation is $\bar{v} = Ki/n$ where $\bar{v}$ = average linear velocity (ft/day)

K = hydraulic conductivity or permeability (ft/day)
i = hydraulic gradient
n = porosity.

Based on slug tests conducted by Harding Lawson Associates (1985), the hydraulic conductivity of the sands at 10 to 20 feet below ground surface range from 1×10^{-3} to 1×10^{-4} cm/sec (2.8 to 2.8×10^{-1} ft/day). A value for the hydraulic gradient can be estimated from the average ground elevation of +11 (MSL) and average depth to ground water on the Island which is 5 feet below ground surface, resulting in a ground water elevation of +6 ft

(MSL). An average hydraulic gradient from the Island interior to sea level could be estimated as 0.0038. With the values of hydraulic conductivity, the hydraulic gradient of 0.0038, and an assumed porosity of 0.30, which is within the range of porosities listed for sands by Freeze and Cherry (1979), the average linear velocity is estimated to range from 3.6×10^{-2}ft/day to 3.6×10^{-3}ft/day.

4.5.5.2.2 Yerba Buena Island. Due to the absence of information on any wells at YBI, specifics on ground water are unavailable. However, in the Bay Area ground water is normally found in outcrops of the Franciscan sandstones and shale, if the shale is fractured. The ground water would be recharged by water infiltrating from precipitation, landscape irrigation, and from the Bay waters. The quality of the ground water is unknown but is probably of poor quality due to salt water intrusion.

From a theoretical standpoint the hydraulic conductivity or permeability of the sandstone should be higher than that of the shale, except if secondary porosity such as fracturing is significant. From Freeze and Cherry (1979) the hydraulic conductivity of the sandstone would probably range from 1×10^{-3} to 1×10^{-8} cm/sec and the hydraulic conductivity of the shale would range from 1×10^{-7} to 1×10^{-11} cm/sec if there were limited secondary porosity. An estimate of average linear velocity was not attempted because there were too many unknown variables.

A U.S. Geological Survey study by Webster (1972) contains a map showing ranges in probable maximum well yield from water-bearing rocks in the San Francisco Region. YBI on this map is designated as an "A" area, where the yield of any wells would have limited storage capacity and would likely go dry or have reduced yields during the summer and autumn months. "A" areas are considered to have marginal to adequate water for stock or single family domestic use. There is a 68 percent chance that wells in areas designated "A" will yield from 0.5 to 5 gallons per minute (gpm) and a 95 percent chance that they will yield 0.1 to 10 gpm.

4.5.5.3 Water supplies. The primary source of drinking water, industrial water, and landscape irrigation at TI and YBI is the water provided by the San Francisco Water Department. This water is conveyed from San Francisco across the Bay Bridge by a 10-inch pipeline. In addition, the East Bay Municipal Utility District supplies a secondary water source via a pipeline which begins at Emeryville and extends across the Bay Bridge. From these two pipelines the water is transported and stored in several large capacity concrete tanks on TI and YBI (WESTDIV, 1985).

4.5.6 Migration Potential. There are basically two pathways for contaminant migration at TI and YBI. The first is through subsurface flow into the ground water and the second is by surface runoff.

The ultimate receptor of any soluble contamination at TI will be to the surrounding Bay waters. The direction of flow for the ground water and surface runoff is towards the Bay. In general, surface runoff would flow from east to the north side of TI.

Less soluble contaminants, however, may tend to bind with the soils and become relatively immobile. For example, hydrocarbons, a major contaminant at TI,

may migrate downward to the water table where the less soluble hydrocarbon components will become relatively immobile in the capillary fringe, while the soluble fraction dissolves into the ground water.

At YBI, the geologic conditions differ. In the filled areas on the eastern side, soluble contaminants would migrate to the Bay waters. At other areas on the Island, the surface runoff would either transport potential contaminants to the Bay or the runoff would infiltrate into the sandstone. Once in the sandstone, the waterborne contaminants will be transported in the direction of lower hydraulic potential. If there is limited secondary porosity in the shale, it may potentially act as an impermeable barrier to contaminant migration.

Because the ground water at both YBI and TI are not used, there is limited potential for human contact. No information was available on utilization of ground water (springs, etc.) by wildlife. However, ground water is not anticipated to provide a significant source of water to YBI's wildlife. Contaminated ground water entering San Francisco Bay could potentially affect marine fauna and flora, particularly sessile organisms such as benthic invertebrates and algae in nearshore waters of TI and YBI. Contaminants could potentially accumulate in the tissues of invertebrates and be introduced into the food chain of predators such as waterfowl and fish. A detailed water quality and sediment sampling program, and extensive bioassay analyses would be necessary to determine the extent of contamination (if any) and potential effects on the food chain of nearshore marine fauna and flora.

CHAPTER 5. ACTIVITY WASTE GENERATION

5.1 INTRODUCTION. This chapter describes major waste generators at NAVSTA TI. Past operations are described as completely as possible, whereas current operations are discussed only as they relate to a better understanding of past waste practices. Section 5.2 describes Industrial Operations, Section 5.3 describes Ordnance Operations, and Section 5.4 describes Radiological Operations. Figures 5-1 and 5-2 can be used to locate the sites discussed. Table 5-1 includes information on routine work generated from activities for which data were available.

5.2 INDUSTRIAL OPERATIONS.

These sections describe waste generation from various industrial operations.

5.2.1 Bureau of Alcohol, Tobacco, and Firearms (BATF) Laboratory (J7, TI). The laboratory conducts routine testing on alcoholic beverages and investigative testing on articles associated with criminal activities. The lab has been located in Building 233 since about 1976 and is scheduled to cease operation in 1988. Approximately 1,000 gallons per year of alcoholic beverages are washed down the drain system with water to the wastewater treatment system. Small quantities of various waste solvents, especially chlorinated hydrocarbons, are collected and disposed of off-station through the TI fire department. Chemicals and solvents used in the laboratory which are reported to have been disposed of in this manner include: carbon tetrachloride, methylene chloride, acetone, ethers, toluene, pentanes, pyridine, tetrahydrofuran, trichloroethane, hexane, various acids/caustics/alcohols, silver nitrate, and brucine sulfate. Spent photographic chemicals were also disposed of in the drain system during the period 1979 to 1984. The volume of chemicals disposed of is unknown. A water filled tank is used for ballistics testing during which weapons are fired into the tank. The water is used to slow the bullet without altering its shape or markings. The tank is drained (about 500 gals) to the ground outside approximately every six months when the water stagnates. Based on the observed operation of the tank, no surface contamination is expected. Table 5-1 provides a summary of routine wastes generated from the laboratory.

5.2.2 Medical Clinic (G4, TI). The Medical Clinic is located in Building 257 and has been providing medical services to station personnel since the early 1940s. Other medical activities including surgery and recovery wards were conducted in several additional buildings during the 1940s, but no information was located on these activities. Two major types of waste generated from Building 257 activities are infectious wastes and x-ray wastes.

5.2.2.1 Infectious wastes. Infectious wastes are collected in plastic bags or containers and stored in large trash-type containers with lids. The wastes are transported off-station where they are autoclaved prior to disposal or incineration. Infectious wastes may have once been processed through the trash incinerator at Treasure Island.

5.2.2.2 X-ray wastes. The x-ray department has been located in different parts of Building 257 since the 1940s. About ten years ago it was located at the south end of the middle wing of the building (Site 1). While in this location, fixer and/or developer leaked from the equipment, produced a hole

TABLE 5-1

ROUTINE WASTE GENERATION

OPERATION	WASTE	QUANTITIES	DESTINATION	CURRENT ACTIVITY?
Bureau of Alcohol, Tobacco and Firearms				
Alcohol Testing Lab	Alcoholic Beverages	1,000 gal/yr	San Francisco Bay	Yes
Photo Lab	Spent Developers & Fixers	---	San Francisco Bay	Yes
Criminal Investigation Lab	Miscellaneous Chemicals	Small Amounts	San Francisco Bay	Yes
Naval Station, Piers 13-16	Bilge Water (1% Oil)	3,979,000 gal/yr	Hunters Point or Contractor	Yes
	Ballast Water (1% Oil)	1,350,000 gal/yr	Hunters Point or Contractor	Yes
	Oil (From Bilge in Port)	4,000 gal/yr	Hunters Point or Contractor	Yes
	Oil (From Bilge at Sea)	266,500 gal/yr	Hunters Point or Contractor	Yes
	Oil (From Ballast)	1,400 gal/yr	Hunters Point or Contractor	Yes
Wastewater Treatment Plants				
Treasure Island	Sludge	10-15 cu yds/mo	Ground	No
Treasure Island	Domestic Wastewater	1,000,000 gal/day	San Francisco Bay	Yes
Yerba Buena Island	Domestic Wastewater	20,000 gal/day	San Francisco Bay	No
Auto Hobby Shop, Naval Exchange Service Station	Waste Lube & Hydraulic Oils	21,000 gal/yr	Recycled off-station (PWC, DRMO)	Yes
Navy Technical Training Center Fire Training School	Oil Residues	14,000 gal/yr	Disposed of through PWC contract with IT Corporation	Yes
	Oxygen Breathing Apparatus Cannisters (Potassium Super Oxide)	34,700 lbs/yr	Neutralization, then disposal through DRMO	Yes
Boiler Water/Feed Water Training	Dilute Mercuric Nitrate Solution	220 gal/yr	Disposed of through PWC contract with IT Corporation	Yes
Public Works Center Shop	Waste Paint	---	PWC	Yes
PCB Transformers	PCB Transformers	---	Disposed of through PWC contract with IT Corporation	Yes
Radiac Test Center	Radioactive Sources (e.g., Br-82, Na-84, and non-repairable equipment)		Radiac Repair Facility at Mare Island Shipyard, Vallejo, California	Yes

through the wood floor, and flowed into the soil beneath the raised building. The duration and quantity of released material were not established. Two soil samples obtained from beneath the building in October 1987 contained 7,740 and 3,050 mg/kg of silver and had a pH of 4.2 and 4.0 respectively (see Appendix B). In the late 1970s the x-ray department was relocated to the east end of the north wing. Later in 1982, it was moved to its present location in the northeast corner of the middle wing. Currently, x-ray equipment solutions are managed off-station for disposal or silver recovery.

5.2.3 Dental Clinic (G4, TI). The dental clinic, like the medical clinic, is located in Building 257 and provides dental care to station personnel. The three principal wastes generated are mercury amalgam, infectious, and x-ray wastes.

5.2.3.1 Mercury amalgam. Mercury amalgam is used in dental fillings. Pre-1980, mercury was obtained in glass bottles and mixed prior to use in the fillings. No reports of spills were obtained. If spills had occurred, it was a standard naval practice to clean the spill by using a mercury vacuum. Waste mercury and mercury amalgam are reported to have been sent off-station to DRMO Alameda. The quantities of material disposed of were not identified.

5.2.3.2 Infectious wastes. Infectious wastes are collected in plastic bags or containers and stored in trash-type containers with lids. The wastes are transported off-station to be autoclaved prior to disposal or incineration. In the past infectious wastes may have been processed through the trash incinerator.

5.2.3.3 X-ray wastes. Waste developer and fixer are sent off-station for management by DRMO Alameda. Since approximately 1970, materials have been handled in this manner but prior to that they were disposed of in the sanitary drain system. Volumes of materials managed were not quantified.

5.2.4 Boiler Plants. There are currently five boiler plants (Pier Plant (K6, TI), Building 455 (I5-I6, TI), and Zones 1 (L4-M4, TI), 4 (F4-F5, TI), and 5 (C7, TI)) on TI and one (Building 66 (E3-F3, YBI)) on YBI used to provide steam. Chemicals used in most boilers include acids, caustics, and morpholine. Boiler plant blowdown is either sent to the wastewater or stormwater systems. The waters from all 5 boiler rooms on TI drain into the storm drain system; however, the storm drain from Building 455 ties into a lift station where the water is eventually processed through the sewer treatment plant. Water from the storm drains sent by the remaining 4 boiler plants of TI is discharged to the Bay (Site 13).

Moreover, in the early 1940s boiler plants were constructed at Buildings 14, 26, and 102 on TI and Building 214 on YBI. Boiler plant 102 was demolished in about 1968 and it was reported that building debris, including asbestos, is buried in the location where the building stood (Site 15). TI personnel speculated that asbestos may be buried where Buildings 26 and possibly Building 14 were demolished. Asbestos from demolition of Building 214 is reported to have been taken off-station.

5.2.5 Government Printing Office (I5-I6, TI). The GPO is located in Building 99 and has been in operation since 1984. Wastes generated at this facility

are reported to be managed according to current regulations. Based on other printing operations, the wastes would include waste inks and cleaning solvents.

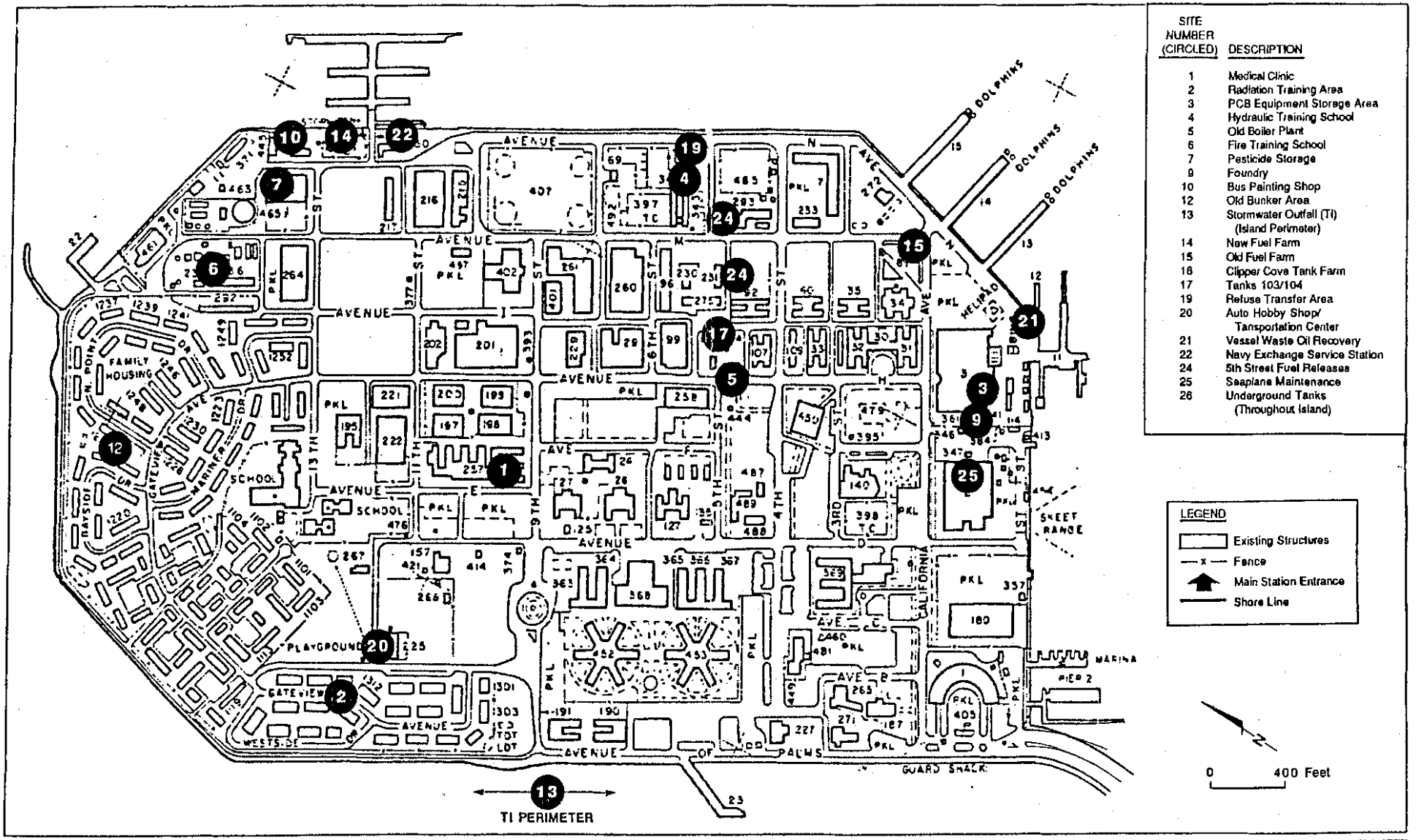
5.2.6 Dry Cleaning (I5-I6, TI). Uniforms, clothing, draperies, and household fabrics and cloths are currently taken off-station to be dry cleaned. Prior to about 1970-1975, dry cleaning was conducted in Building 99. Specific information regarding solvent use and handling was not located. Types of solvents typically used in dry cleaning were tetrachloroethylene (perchloroethylene) and benzene.

5.2.7 Incinerators. Several incinerators have operated on the station since the early 1940s. Building 58 (C8, TI) was an incinerator in 1943, but is listed as a paint shop in 1947. Building 87 (L6-L7, TI) was an incinerator from at least 1943 to 1953. Building 345 (A5-A6, TI) was an incinerator from at least 1953 to 1968 and was later demolished between 1968 and 1969. Building 231 (E8, YBI) on YBI was an incinerator in 1953. Specific information was not available on the type and volumes of material burned in these units or where the ash was disposed. Building 345 had an associated trash pit approximately 43 x 12 x 10 feet deep. Information was not available as to which pit was filled in or with what type of material. Building 481 (I7, TI) is currently listed as an incinerator. These is also an incinerator located on-station which reportedly is used to burn classified documents. Details on the operation or location of this unit were not accessible.

5.2.8 Acid Dip Tanks (M5, TI). Until about 1982, acid dip tanks were located on the south side of Building 3. The acid solution in the tanks was used to remove corrosion from metal. Information was not obtained to identify how often the acid tanks were emptied or to where they were discharged. Generally both acid and caustic solutions are used in the corrosion cleaning process. An acid such as sulfuric acid may be used to remove rust and corrosion. Later the material is dipped in a weak caustic solution to neutralize the effect of the acid before the material receives a final rinse with water.

5.2.9 Paint Shops. Several paint shops have operated on station since the 1940s. Based on drawings reviewed, paint was used or stored on TI in Buildings 41 (Site 9) (L5), 58 (C8), 126 (I3), 142 (M2-M3), 151 (G3-H3), 223 (E3), 270 (B7), 334 (C7-D7), 335 (D8) (Site 10) and 379. Paint mixing activities were reported to have been conducted in Building 41 from 1953 to 1968 and in Building 335 from 1947-1953. No information was located to identify the quantities of paint used. One of the methods of disposing of waste paint, thinner, and solvents was to drain them over the riprap at the edge of the island. Paints containing lead and zinc-chromium were known to have been used in the past. Building 41 is still listed as the public works paint booth, but was reported to have not been used for painting activities since 1968. Building 379 is presently listed as a paint locker.

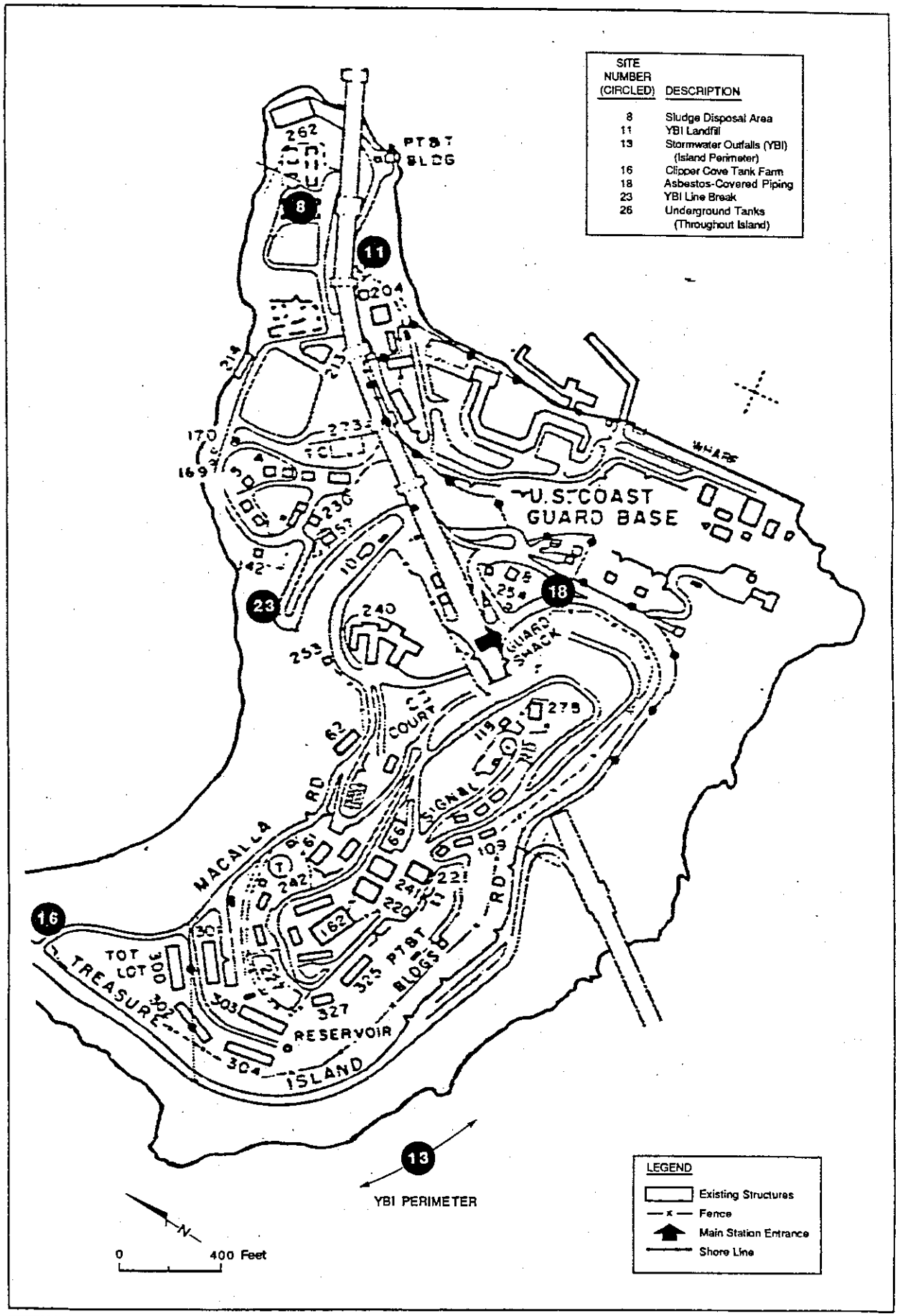
5.2.10 Sandblasting Area. Sandblasting was reported to have been conducted outside Building 3 (5, TI) from an unspecified time up until the early 1970s. Building 355 (M5, TI) is still listed as being a sandblasting shop, but information concerning current sandblasting activities was not obtained. The disposal location of the used sand is not known, but was reported to be the bunker area at the north end of the island, Site 12. No information was obtained to estimate the volume of sand that may have been disposed. Typical



PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.

LOCATION OF IDENTIFIED SITES–TREASURE ISLAND (TI)

FIGURE 5-1



PRELIMINARY ASSESSMENT/ SITE INSPECTION
NAVSTA Treasure Island, Ca.

LOCATION OF IDENTIFIED SITES
YERBA BUENA ISLAND (YBI)

FIGURE 5-2

sandblasting operations probably generate waste sand and paint; lead and zinc-chromium paints were used in the past.

5.2.11 Foundry (L5, TI). Building 41 (Site 9) was used as a foundry during at least 1943-1947. No information was located to describe the operation of this facility or to identify the types of wastes which may have been generated or how they may have been disposed. However, typically at foundries slag metals would be the anticipated generated waste.

5.2.12 Wastewater Treatment Plant (C7-D7, TI). The wastewater treatment plant was constructed in 1967 to 1968 and became operational in 1969. Previously, primary treatment of wastes had been performed beginning in 1961. Untreated wastes were discharged from TI previous to 1961. It was reported that sludge from the plant was spread on the ground on the west side of Building 62 (Site 7) and on Army Point at YBI (Site 8). The volume spread was estimated to be 10-15 cubic yards per month from approximately 1968 to 1976. In more recent times, as necessary, sludge is removed from the unit by vacuum truck and hauled off-station as a hazardous waste by the DRMO Alameda for additional processing or disposal. Prior to construction of the plant, a circular Imhoff tank and a chlorinator were used to process YBI domestic wastes. The effluent discharged directly into the San Francisco Bay. Table 5-1 provides a summary of routine wastes generated from the wastewater treatment plants.

5.2.13 Pesticide Operations. Pesticides have been stored on TI in Buildings 335 (D8), 62 (D7), 112 (M6), and 292 (C6). It is reported that pesticides were stored in Building 335 (Site 10) until approximately 1955 when they were stored in Building 112 and Building 62 (Site 7). Pesticides were stored in Building 62 from 1955 to the early 1960s. After 1980 or 1981, the pesticides were removed to their present storage location in Building 292. Two of those buildings, 335 and 112, are located adjacent to the water and it has been speculated that residues may have been discharged to the Bay (Site 13). Pesticides currently used are boric acid, diazinon, malathion, Decon, rat bait, and endosulfan. In 1974 and 1975, 35-Burgo insecticide was also applied on TI and YBI. Present practices use approximately 10 gallons/yr of all pesticides.

5.2.14 Electric Rewind Shop (L5-L6, TI). A part of Building 3 was used as an electric rewind shop. It was speculated that solvents, such as carbon tetrachloride, may have been used to degrease motors prior to rewind activities. The period of operation of this shop was not determined.

5.2.15 Boiler Training Center (L4, TI). A boiler training center was located by Building 2 at an unspecified time. Training may have involved the use of acids, caustics, or other chemicals. A summary of the routine wastes generated from the boiler training center is provided on Table 5-1.

5.2.16 Fire Training School (B6-C7, TI) (Site 6). This operation, part of the NTTC, is located at the northeast corner of TI. The complex was built in 1946 and is bounded by Buildings 264, 292, 461, and the wastewater treatment plant. We understand that, although some additions and modifications to the area have been made, operating procedures now are very similar to those followed since the center was established.

The central training yard is a paved area surrounded by a concrete trench collector (installed about 1949). Diesel and gasoline, magnesium, and wood-fueled fires are set in various mockups in the yard and are extinguished with a water, biodegradable soap and industrial talc mixture. Approximately 18,700 gallons of gasoline and 31,200 gallons of diesel are used each year. Wastewater and unburned diesel and gasoline are collected in the trench and pass through a series of oil/water separators. Ultimately, the wastewater flows to the wastewater treatment plant and waste diesel and gasoline fuels are disposed of off-site. Approximately 14,000 gallons/yr of gasoline and oil residue are generated (Table 5-1). Wood ash is periodically cleared to waste bins and dumpsters. The paved yard and sumps have been cleaned twice yearly since about 1981 with water and biodegradable soap; rinsate flows through the same trench collector system to the WWT. Information describing how wastes were disposed of prior to construction of the perimeter trench and also the WWT was not located, but discharge to the Bay is probable via the storm sewer system. Several pavement patches are evident in the yard which suggest that underground piping has been replaced although information regarding leaks was not obtained.

At an undetermined time, four concrete-lined burn pits were located at the north edge of the center, at least one of which was termed a "napalm pit." No napalm had reportedly been used as a fuel source. These pits may have been surrounded by a gravel yard, not a paved surface, and any fuel spills in this area would not have been contained.

Four underground fuel storage tanks are located at the center, two at the north edge and two at the east. The tanks apparently have always been truck-filled.

The eastern portion of the school, outside the paved training yard, is partially paved and partially a gravel surface. Above and below ground piping, underground fuel storage tanks, and the underground separator tank system are located in this area.

5.2.17 Gasoline Stations. Six gasoline stations have been located on the island in the past to provide fuels for civilian and government motor vehicles. Only two stations are currently in operation: Naval Exchange Service Station (Site 19) and dispensing pumps adjacent to Building 180. Underground tanks associated with the current and former gasoline stations are discussed in Section 6.1.5. A summary of the routine wastes generated from the Naval Exchange Service Station is provided on Table 5-1.

5.2.18 Garages and Vehicle Maintenance (See Figures 5-1 and 5-2). The vehicle maintenance operations conducted on-site included routine changing of fluids such as oil and lubricants; parts replacement including filters, brakes, tires, engines, and transmissions; body work, and vehicle (steam) cleaning and degreasing. Numerous garages and vehicle maintenance areas have been in operation on TI and YBI at various times and the dates of operation are highly variable. The majority of the vehicle maintenance operations on TI have occurred in Buildings 2 (L4-M4), 3 (L5-M6), 69 (H8), 115 (L5), 125 (H3), 129 (I4), 180 (L2-M2), 193 (D1), 194 (E3), 223 (E3-F3), 224 (E3), 225 (E2), 267 (E3), 330 (E8), and 335 (D8). Of these, only 180, 225, 330, and 335 are still active. Little information exists as to the type and intensity of usage

of the YBI maintenance areas although the service station 204/208 (H5, YBI) seems to have been in existence for the longest period of time.

Buildings 129, 194, 223, 224, and 267 have been identified as potential areas of vehicle cleaning, degreasing, and transmission repair in the past. Activities within these buildings would commonly produce oil, grease, metal shavings, and unknown cleaning solvents which have been released into San Francisco Bay by the storm sewer system. These buildings were most intensively used from 1943 to 1948. Only Building 129 currently remains today, and it is used for storage.

Disposal methods for the waste streams associated with the maintenance shops have been variable. Waste fluids, for example, from the Auto Hobby Shop 225 (Site 20) are now recycled by a certified agent via contract with PWC (Table 5-1). However, in the past wastes were routinely emptied into the storm sewer system. Waste filters and parts were disposed of in trash bins and ultimately shipped to nonhazardous landfills for disposal. This method of disposal is still used in current operations.

5.2.18.1 Auto Hobby Shop (E2, TI). The Auto Hobby Shop (Site 20) is located in Building 225 and is used by station personnel to work on motor vehicles. Wastes generated at the shop include oils, lubricants, antifreeze, and solvents from degreasing operations. A 1972 report (NAVSHIPS/NAVSEC) aniticipated that by 1975 the Auto Hobby Shop would generate 6,000 gallons of waste lube and hydraulic oils (Table 5-1). Wastes are stored in 55 gallon drums before being transported by and disposed of by contracts via PWC. However, waste fluids in the past were reported to have been routinely emptied into the storm sewer system. Waste fillers and parts were disposed of in trash bins and ultimately shipped to nonhazardous landfills for disposal. This method of disposal is still used in current operations. At two locations outside the Auto Hobby Shop, soil samples were collected and analyzed in October 1987. These samples contained 13,300 and 28,200 mg/kg of oil and grease and 9,700 and 25,000 µg/g of total petroleum hydrocarbons, as summarized in Appendix B.

5.2.19 Transformer Maintenance. Electrical transformers are used on-station to supply electricity to the various facilities. Periodic servicing of these transformers, capacitors, switches, etc. has been required and a quarterly monitoring program was instituted about 1984. Some of the units are known to have contained Polychlorinated Biphenyls (PCBs). These units have been taken out of service and stored by Building 3 or by the USS Pandemonium. IT Corporation under contract with PWC then drained the PCB fluid and disposed of the fluid and transformers (Table 5-1). Prior to 1984 maintenance consisted of checking fluid levels in the transformers and refilling the transformers when appropriate.

Since the 1984 program was implemented, PCB transformer locations have been appropriately decontaminated. For example, a transformer which had leaked was removed from inside Building 3's substation in mid-1987. Subsequent wipe-sample testing of the area by NEESA revealed residual low PCB concentrations of 2.6 µg/100cm^2 and less than 1 µg/100 cm^2 (Appendix B), confirming that any contamination was cleaned up adequately.

5.2.20 Shipping Repair. Ship repair operations were reportedly conducted on TI at Piers 11 (N6) and 12 (M6) and in Buildings 2 (L4) and 69 (H8) from at least 1943 until prior to 1983. Information regarding the nature of the ship repair operations and the associated waste volumes and management practices was not available.

5.2.21 Pier Building Shop. Routine pier operations including some wharf building operations were reported to occur during the 1950s and possibly in years before or after the 1950s. Information regarding the nature of these procedures and the associated waste volumes and management practices was not located. Whether wood treatment chemicals may have been used was not identified.

5.2.22 Aircraft Servicing. Filing information reviewed indicates routine aircraft servicing was conducted on-station in the past. It is known servicing and maintenance on the Pan Am Clipper was conducted from the late 1930s to 1958. Some servicing of naval aircraft is expected to have occurred during the period when airstrips were located on-station. Because operations ceased in 1958, detailed information regarding the nature of these procedures and the associated waste volumes and management practice was not available for review. The wastes generated probably included lube oils, fuels, fuel additives, engine fluids, paints, thinners, and cleaning solvents.

5.2.23 Welding School (L5, TI). The NTTC operated a welding school in Building 41 from about 1981 until February 1987. Information from prior instructors or operation files concerning waste generated were not located. Typical wastes generated by welding operations include metals and polishing agents.

5.3 ORDNANCE OPERATIONS. This section describes waste generation from Ordnance Operations at NAVSTA TI.

5.3.1 Ordnance Production/Loading. A review of historic facility records indicates ordnance production/loading operations were conducted on-station in the past. Detailed information regarding the nature of these operations and the associated waste volumes and management practices was not located.

5.3.2 Ordnance Storage. In the past, ordnance bunkers and storage buildings were located at the northern end of TI (Site 12). This included Buildings 43 through 54 and 277 through 287 (A2-C6). These facilities were removed during 1968 and were replaced by housing units.

5.4 RADIOLOGICAL OPERATIONS. Several operations were identified as using radioactive materials. Some are past operations and some are still conducted.

5.4.1 Radiological Instrument Calibration (I7, TI). The Radiac Test Center, part of the NTTC, is located in Building 343 and is used to train personnel on the use and calibration of radiation detection equipment. Sealed radioactive sources with long half-lives are used for the training. When spent, the sources are processed through NSC Oakland where they are later transferred to Radiac Repair Facility at Mare Island Naval Shipyard for disposal. Radioactive materials used during facility operation have included Potassium-42, Sodium-24, Radium-226, Cesium-137, Bromine-80 and 82, and Plutonium-239 compounds (Table 5-1). Use of Radium-226 was discontinued by

the Navy in 1984. Radioactive materials currently are stored in Building 344 adjacent to Building 343.

5.4.2 Radiation Decontamination Training. During the period from approximately 1964 to 1969, radiation decontamination training by NTTC was conducted near the intersection of 12th Street and Avenue A (E1, TI) using a ship and aircraft mockup (Site 2). A radioactive solution containing Bromine-82 was spread over the mockup and personnel were trained on procedures to decontaminate the equipment. Wash water from the operation was collected in concrete tanks and held approximately 21 days prior to discharge to the bay. The reported half-life of Bromine-82 is 24-36 hours. The ship mockup was moved to its current location, Building 371 (C8, TI), in 1969. Information was not located to indicate what was done with the aircraft mockup and the concrete tanks. After the move, radiation training was conducted using sealed sources.

CHAPTER 6. MATERIAL HANDLING: STORAGE AND TRANSPORTATION

This chapter describes the methods used to store and handle hazardous materials. Information for the materials handled includes locations, amounts, how stored, incidents in handling or storage, and years of operation.

The majority of operations on TI and YBI began in the early 1940s immediately after the property was transferred to Naval ownership, although YBI was the site of Army activity in the 1930s. Little information exists for the period prior to 1943 and for this reason 1943 is used as a baseline for the beginning of operations. Specific site locations can be identified using the grid reference symbols provided to the right of the operation title and the grid system located on Figure 6-1 for TI and Figure 6-2 for YBI.

6.1 PETROLEUM, OILS, AND LUBRICANTS (POL).

6.1.1 Waste Hydraulic Oil Storage (C7, TI). Building 342 is the Hydraulic Training Center (Site 4), a part of the NTTC. At the rear of the building, there is an unbermed, paved area containing generally twelve to eighteen 55-gallon drums of waste oil (mainly transmission oil). Leaks or spills have occurred resulting in staining of the pallets and asphalt surface. Some oil has flowed off of the paved area into a dirt and gravel area at the eastern and northern edges of the storage area. The drums of waste oil are temporarily stored adjacent to Building 342, before removal by the PWC or via a contractor for PWC.

6.1.2 Waste Vessel Oil (M6, TI). Waste oil from vessels is unloaded into cylindrical steel shells (DONUTs) which are maintained partly above and partly below the water surface. The number of fuel spills reported through Port Services is listed on Table 6-1. Current DONUTs have bottoms which prevent the oil from contacting the water. Older models did not have bottoms and the oil directly contacted the water. The DONUT is maneuvered to shore and pumped through an oil/water separation system (Site 21). The recovered oil is recycled by the DRMO. Volumes of waste oils for 1975 were estimated at 271,900 gallons per year in a 1972 document (NAVSHIPS/NAVSEC, 1972) which discussed shipboard oily waste generation. The volume of waste oil generated in 1985 is given on Table 6-2.

6.1.3 Fuel Farm (D8-E8, TI). The fuel farm is the primary source of storage and distribution of gasoline, oils, and fuel oils on-site. The farm office is located in Building 64. The fuel farm includes 11 above ground storage tanks, a pump and clarifier house in Building 85, Pier 21A north for offloading fuel from barges, a network of underground pipelines for distribution, and a tank truck for distribution. The fuel farm associated with the World's Fair and Pan Am clipper operations was located in the southeastern portion of TI, slightly southeast of Building 89. The fuel farm was moved to the present location in 1943 to support naval operations. Fuel is offloaded from barges at Pier 21A north and is piped onshore to the appropriate tank for storage. Fuel is distributed in several ways including tank truck delivery to underground tanks and via pipeline to the Naval Exchange Service Station (Site 22). The storage tanks include two 210,000 gallon uprights (Tanks 4 and 5), one 50,000 gallon upright (Tank 456), and eight 10,000 gallon horizontals (Tank Row 6). One source of waste from these tanks is bleed water. In the past, this stream was run onto the bare ground beside each tank, but is now

TABLE 6-1

OIL SPILLS REPORTED THROUGH PORT SERVICES

DATE	NUMBER OF SPILLS
July 1971 to December 1972	53
1973	52
1974	21
1975 through 1979	Missing Data
1980	3
1981	3
1982	Missing Data
1983	8
1984	2

Ref: Command History of U.S. Naval Station, Treasure Island, 1971 to 1984.

AMB/1212a

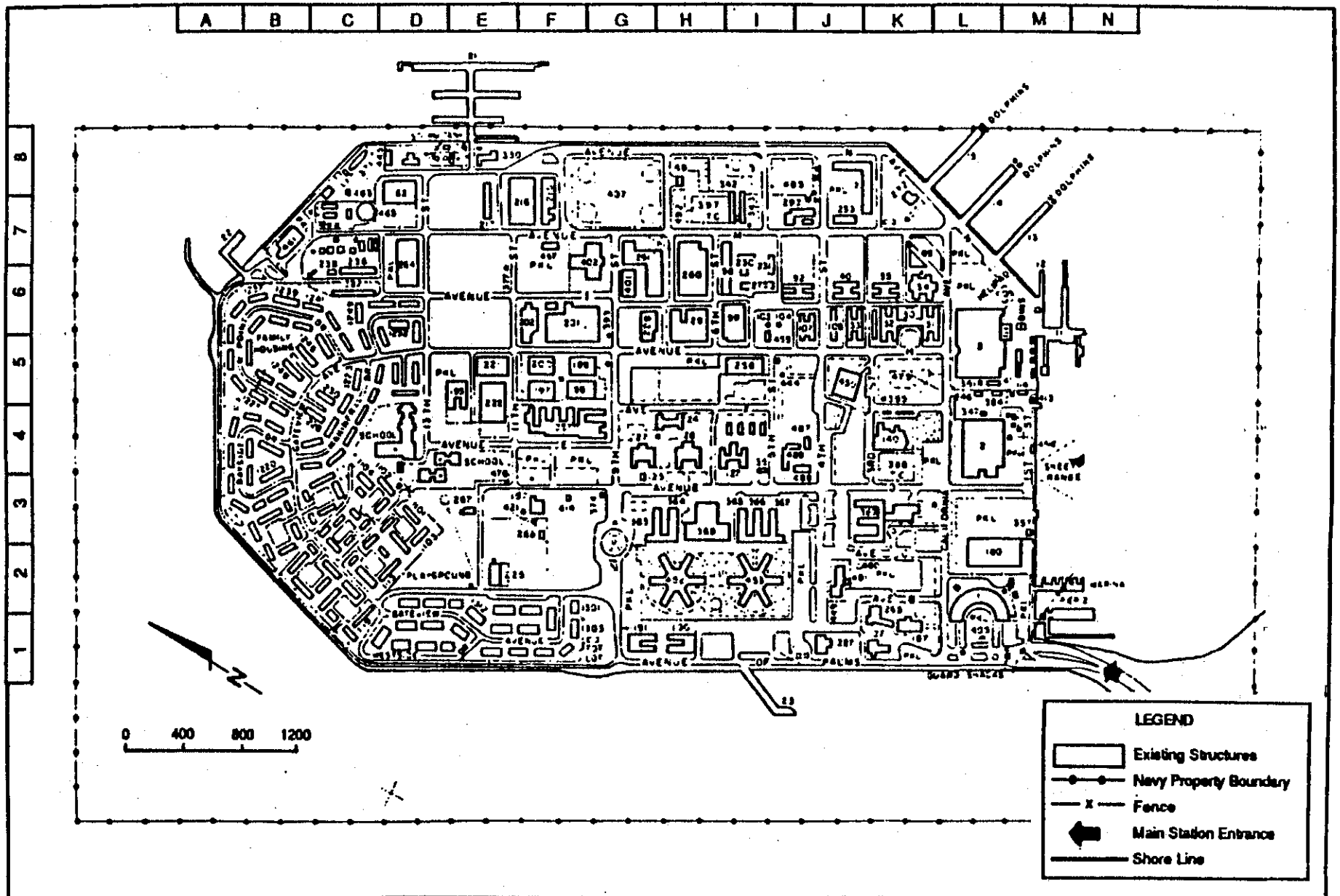
TABLE 6-2

HAZARDOUS WASTE VOLUMES REPORTED AT TREASURE ISLAND NAVAL STATION FOR 1985

GENERATOR	U.S. DOT WASTE TYPE	WASTE NUMBER	QUANTITY
Naval Station Operations	Waste Oils	221	30,093 gallons
	Trichloroethane	4226	5 gallons
	Waste Paint	—	84 gallons
	Flammable Hazardous Waste Solid	222	400 pounds
	Flammable Hazardous Waste Liquid	221	34 gallons
Naval Technical Training Center Operations	Waste Oils	221	20,000 gallons
	Oxygen Breathing Apparatus Cannisters	—	34,700 pounds
	Mercuric Nitrate	151	110 gallons
	Flammable Hazardous Waste Solid	222	450 pounds
	Flammable Hazardous Waste Liquid	221	52 gallons
U.S.S. GALLANT	Corrosive Waste Solid	D002	9,915 pounds
	Corrosive Waste Liquid	D002	20 gallons
	Flammable Hazardous Waste Solid	221	150 pounds
U.S.S. EXCEL	Flammable Hazardous Waste Solid	222	9,151 pounds
	Flammable Hazardous Waste Liquid	221	900 gallons

Ref: CY 1985 Hazardous Waste Annual Report, NEESA.

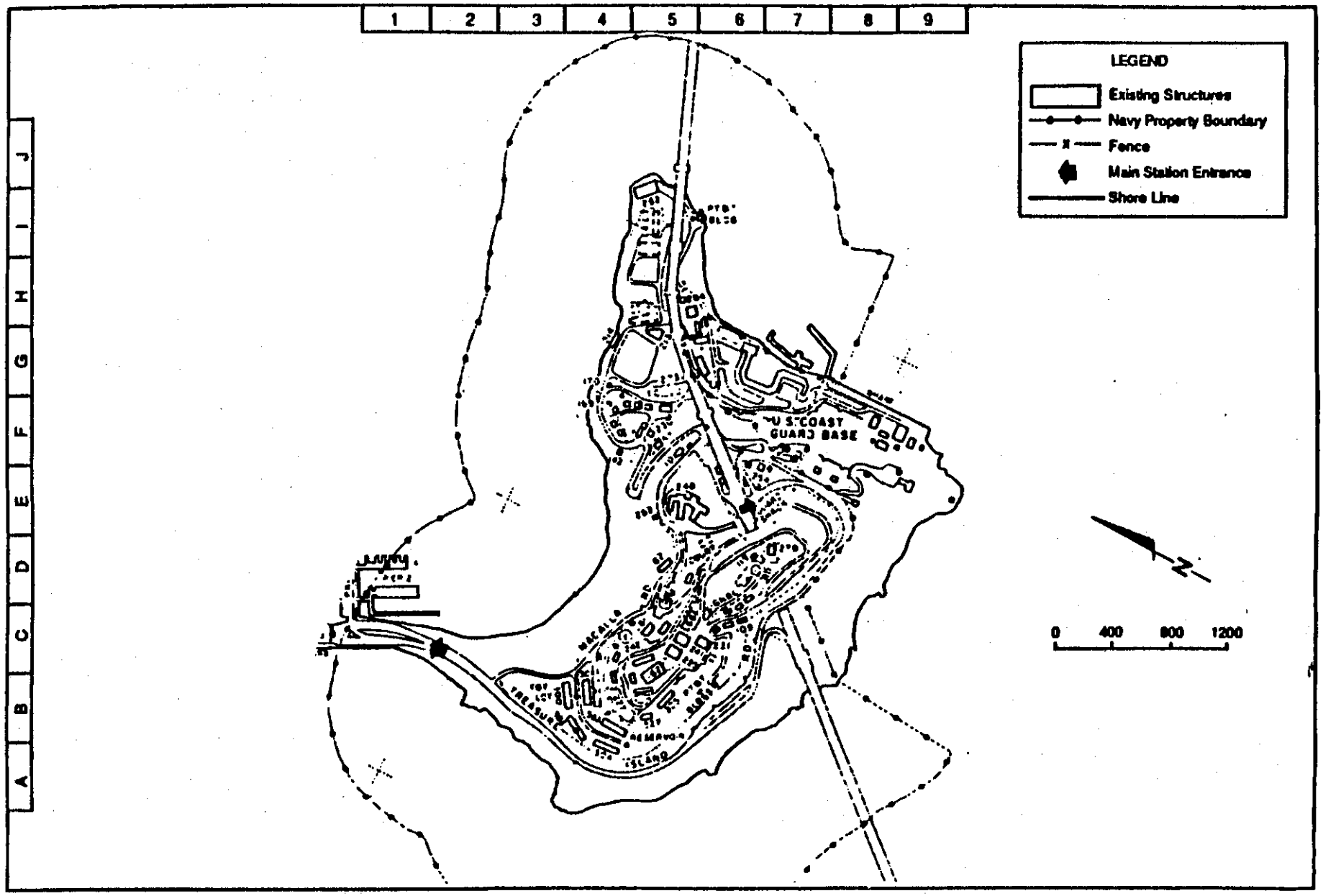
AMB/1209a



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

TREASURE ISLAND LOCATION MAP

FIGURE
6-1



PRELIMINARY ASSESSMENT/
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NAVSTA Treasure Island, Ca.

YERBA BUENA LOCATION MAP

FIGURE
6-2

processed through a series of filters located inside the clarifier, Building 85. Another source of waste associated with the fuel farm is spillage from storage and distribution operations.

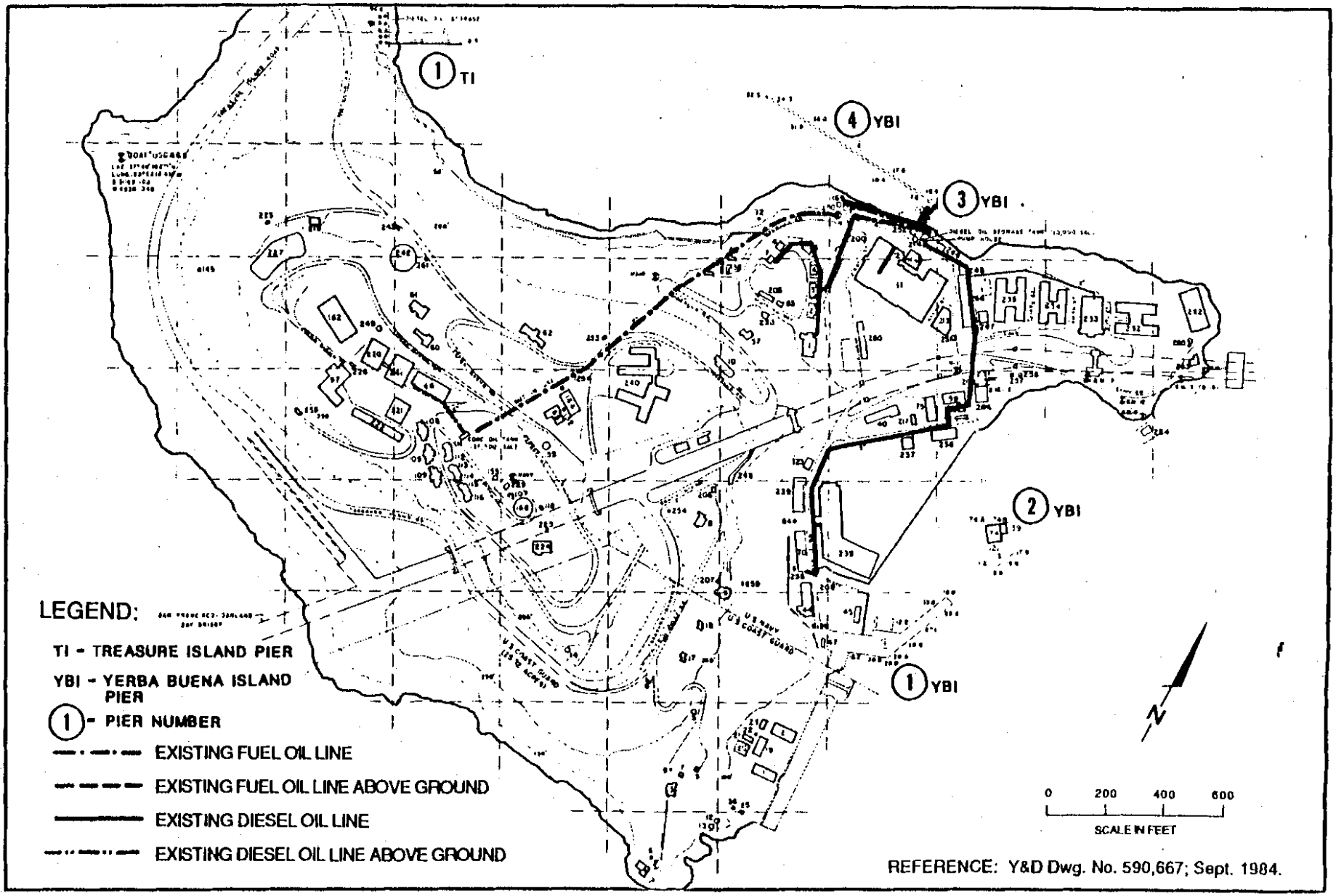
Diesel fuel and leaded and unleaded gasoline are stored and handled at the fuel farm while the tank farm housing Tanks 103 and 104 (I5-I6, TI) (Site 17) store grade 6 fuel oil. Tanks 103 and 104 are upright tanks and have been operational since 1943; each have an approximated 200,000 gallon capacity and distribution is accomplished by underground pipeline to several locations on-site. There are two oil pumping stations (Buildings 101 and 105) and one heating plant (Building 102/455) associated with Tanks 103 and 104. Plant 102 (Site 5) was demolished and replaced by Plant 455 in 1968. Figure 6-3 and 6-4 show the most recent locations of underground pipelines associated with the tank farms on TI and YBI.

A tank farm, Clipper Cove Tank Farm (Site 16), existed on the finger of fill connecting TI and YBI (C2-C3, YBI) from approximately 1943 to sometime between 1959 and 1966. The farm contained 10 upright above ground automotive diesel and aviation gasoline storage tanks of about 50,000 gallon capacity each. These tanks were filled via pipeline from the offloading point at Pier 1. Fuel was then drawn from these tanks by the pump station 182 and used for site vehicles. Between 1959 and 1966 the tanks were removed by a private contractor.

6.1.4 Storage Tanks. Above ground storage tank locations for TI and YBI are shown on Figure 6-5. The majority of the tanks on YBI which were used for fresh water, saltwater, and fuel storage are no longer in use and have been demolished or inactivated. The majority of tanks on TI are still in use. The above ground tanks on TI are mentioned in the previous and following sections.

All above ground fuel tanks on YBI are no longer used and include Tanks 117, 169, 170, and 214, all of which received offloaded fuel from Pier 3/4. Tank 117 had a volume of 37,500 gallons and was used to store black oil. Tanks 169 and 214 were used to hold 26,670 and 10,000 gallons of diesel fuel, respectively. The tank located at 214 was part of the heating plant. Tank 170 had a working capacity of 26,670 gallons and stored grade 6 oil. These four fuel tanks were in operation from 1943 until the late 1970s with the exception of Tank 117 which is reported to have been taken out of service in approximately 1950. There are numerous above ground water tanks located on YBI, several of which may have been used for oil storage at some point as well.

6.1.5 Underground Tanks. Underground tanks, shown on Figure 6-6, have been used on-site to store fuels and oils for package heaters or boilers at individual buildings, for backup power generators, for gas station fuels, for firefighter training, and for aviation fuel. These tanks are filled either by underground pipeline or by tank truck. Two underground tank surveys completed by ERM-West (1987) assessed a total of 38 locations where underground tanks were thought to exist, 31 of which were confirmed as tank locations. Of the 26 known tanks outside of the NTTC area, 5 were leak tested, 1 was detected as leaking and is scheduled for closure. Tank closure plans were filed for 21 of the 26 non-NTTC tanks in existence on Treasure Island and Yerba Buena Island. Investigation of the 6 tank locations in the NTTC area confirmed the existence of 5 such tanks. Figure 6-6 gives the locations of the known and possible underground tank locations.



PRELIMINARY ASSESSMENT/
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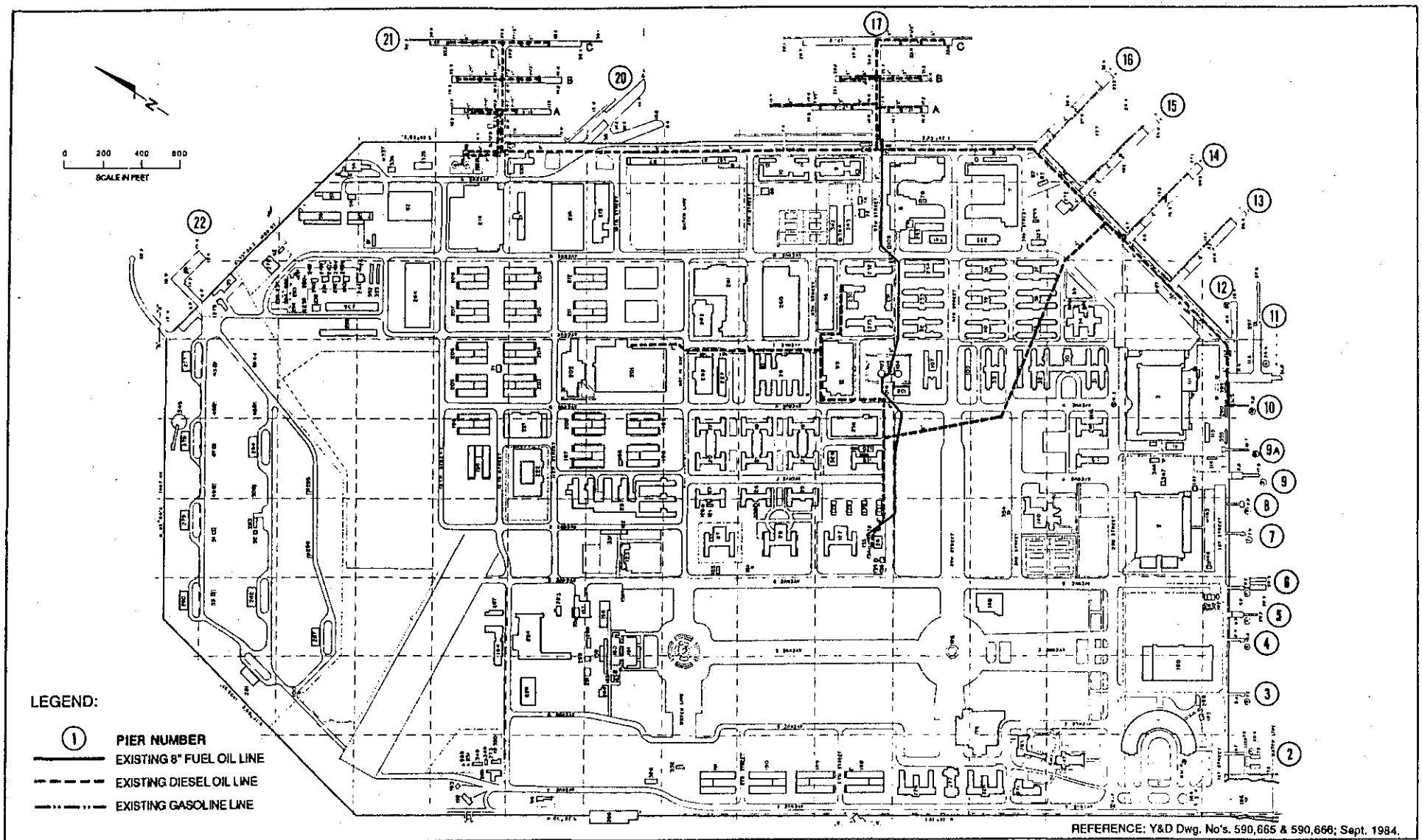
UNDERGROUND PETROLEUM PIPELINES AND REFUELING PIER LOCATIONS-YBI

FIGURE 6-4



REFERENCE: Y&D Dwg. No's. 590,665 & 590,666; Sept. 1984.

PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

UNDERGROUND PETROLEUM PIPELINES AND REFUELING PIER LOCATIONS - TI

FIGURE
6-3

An additional 16 potential underground tank locations have been identified during this site assessment. These locations are shown on Figure 6-7. As with the fuel farm, above ground tanks, and fueling piers, the primary sources of potential contamination are spillage during filling and leaking pipelines or tanks.

6.1.6 Fueling Piers (See Figures 6-3 and 6-4). TI and YBI housed several fueling piers which were used for offloading fuel from barges or for fueling docked vessels. Pipelines commonly ran from each pier to a pumping station onshore. Pier 3/4 on YBI and Piers 1, 10, 17, and 21 on TI have each been involved in fueling operations since 1943. From 1943 to 1953 all piers were operating as fueling and offloading sites. However, at some time between 1968 and 1977, Pier 3/4 on YBI and Pier 1 on TI had been completely removed. Pier 10 discontinued operation as a fueling and offloading point at an unidentified time and Pier 17 was removed sometime between 1968 and 1977 leaving Pier 21A north as the sole remaining fueling pier. The main source of potential contamination associated with fueling vessels and fuel offloading is spillage of fuel and oil during these operations. Spill quantities are difficult to estimate since records of spills were not located. The majority of the spills would have been into the waters of San Francisco Bay.

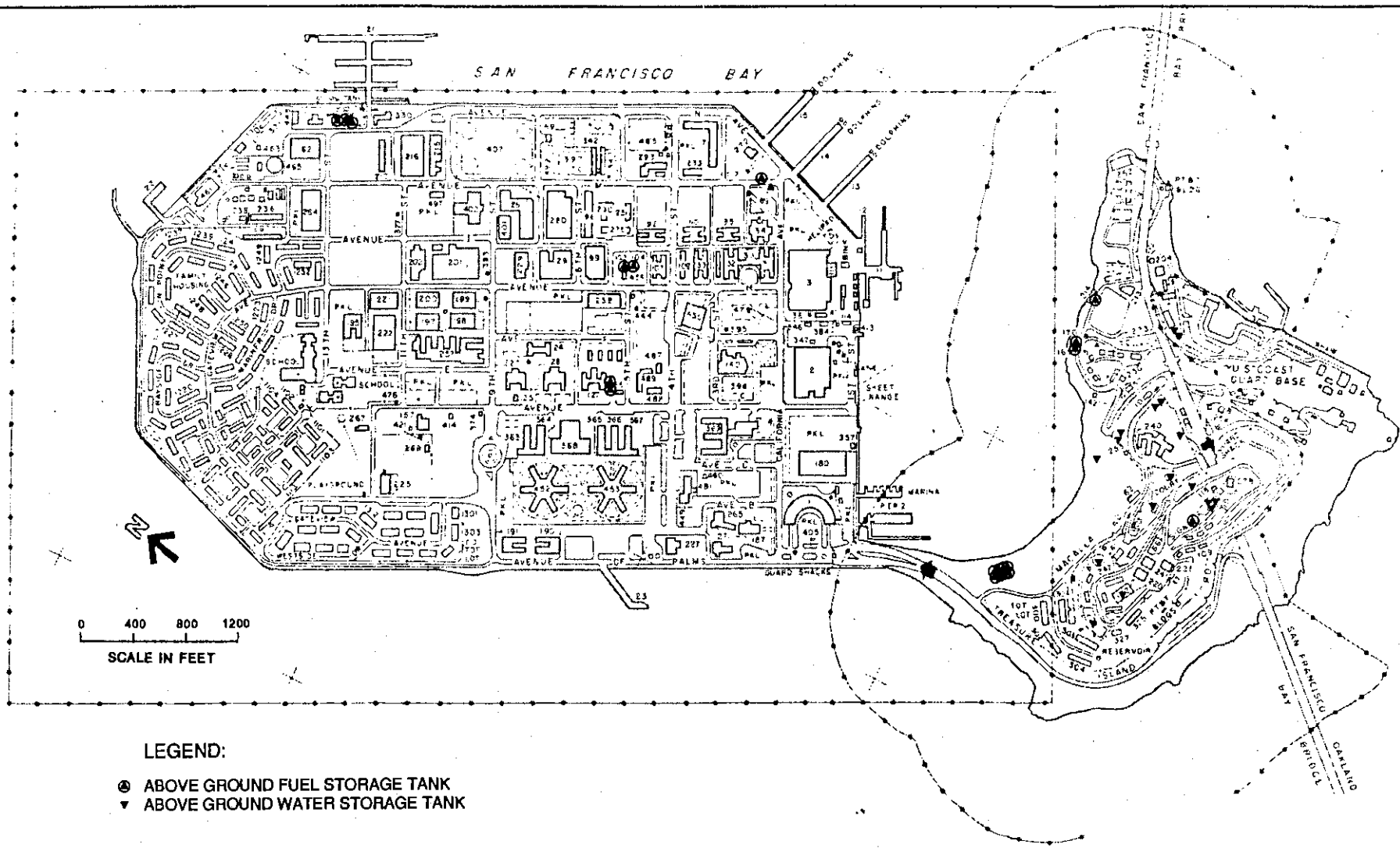
Pier 3/4 on YBI was used in offloading diesel fuel and grade 6 fuel to several destinations. Diesel fuel was routed to above ground Tanks 169 and 214 or to Buildings 1-7, 59, 70, 233, and 238 via underground and above ground piping. Grade 6 fuel oil was offloaded and delivered to Tank 170 and to Building 66, also via pipeline. The pier was partially demolished between 1959 and 1969 and completely removed sometime between 1969 and 1977.

Pier 1 on TI was located in the Clipper Cove area and operated from 1943 until its destruction between 1958 and 1959. Diesel fuel was offloaded at the pier from barges and stored in ten upright tanks (Site 16), each with approximately 50,000 gallons capacity (Tank Farm 181, YBI) located immediately west of the pier. A pumping station (Building 182, YBI) was used to fuel trucks and other vehicles from these tanks.

Pier 10 on TI was used to fuel and offload ships and barges with diesel and grade 6 fuel via an underground pipeline. Fueling operations were discontinued at Pier 10 at an unspecified time.

Pier 17 was a major offloading and fueling pier from 1943 until its demolition sometime between 1968 and 1977. Upon demolition of Pier 17, Pier 21 became the primary offloading and fueling point. Diesel fuel was offloaded at Piers 17A, 17B, and 17C and delivered to various locations on-station via pipeline. Grade 6 fuel was offloaded on 17B and routed to Tanks 103, 104, and 133 for storage. Steam lines were commonly buried immediately adjacent to grade 6 and black oil lines in order to heat the viscous oil to facilitate flow within the pipeline. An underground pipeline running parallel to Avenue N carried the offloaded fuels and oils from Pier 17 north to the fuel farm, and west and south to various storage tanks. Flow was reversed to southward from the fuel farm after demolition of Pier 17.

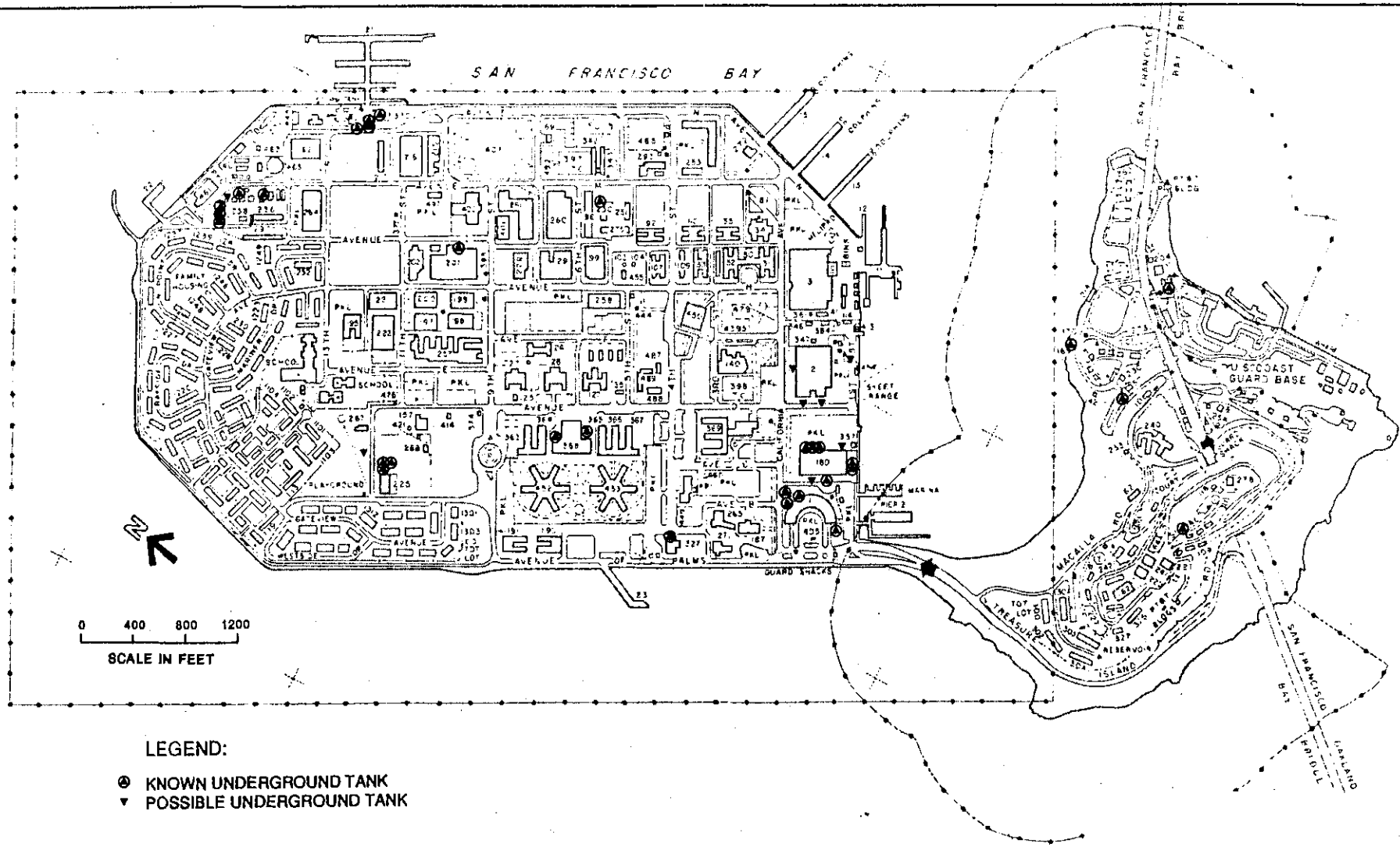
Diesel was offloaded on Piers 21A, 21B, and 21C and routed to the fuel farm storage tanks or to other locations on-site. Gasoline and diesel were offloaded on Pier 21A north and routed to storage tanks at the fuel farm or to



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

LOCATION OF PRESENT AND FORMER ABOVE GROUND FUEL & WATER STORAGE TANKS

FIGURE
6-5



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

KNOWN AND POSSIBLE UNDERGROUND TANKS

FIGURE
6-6

other tanks on-site via an underground pipeline. Pier 21A north has been operational from 1943 until the present time as an offloading site. Piers 21B and 21C were operational from 1943 until an unspecified time.

6.1.7 Service Stations (See Figures 6-1 and 6-2). During the period from 1943 to 1953, up to 5 service stations were operating on TI and YBI including Buildings 81 (K8, TI), 82 (K8, TI), 225 (E2, TI) (Site 20), and 330 (E8, TI) (Site 22), and 204/208 (H5, YBI), respectively. A sixth fueling station (Building 182) was associated with the diesel storage (Tanks 181) near Clipper Cove (C2-C3, YBI). Two service stations are currently in operation on TI including the Naval Exchange Service Station (Building 330, Site 22) and the station located south of Building 180 (M2, TI). Station 81 was in use from 1943 until its conversion to a storage area in about 1947. Station 82 appears to have operated from 1943 until at least 1953, while the service station east of the Auto Hobby Shop (Site 20, Building 225) operated from 1943 until it was destroyed by fire in about 1958. The Clipper Cove station (Building 182) was removed during the demolition of the upright storage tanks (Building 181) sometime between 1959 and 1966. Station 204/208 was operational as Building 204 from 1943 to 1947 and was moved to Building 208 during 1947 where it existed until closure at an unknown time.

Stations 81 and 82 received fuel from underground piping which may have been connected to underground tanks of unknown volume. Station 225 contains three underground tanks with surface fill lines, two of which are 1,000 gallon capacity, and one of which is 5,000 gallon capacity. These tanks are still in place although the service station has been closed. No information was located regarding tanks associated with the YBI gas station (Buildings 204/208). There is reason to suspect at least one tank existed near Building 204 at one time based on conversations with a former employee. Station 330 has been connected to the storage tanks at the fuel farm via underground piping, although three underground tanks were previously used as day tanks for the station. The station south of Building 180 is served by a tank truck from the fuel farm and contains two underground storage tanks. Waste associated with the gas stations includes spilled gasoline and diesel which is difficult to quantify. This spilled product was periodically washed from the ground surface into storm drains or carried by runoff to the storm drains which discharged into San Francisco Bay (Site 13). Other waste products associated with the gas stations are included in the following section titled Garages and Vehicle Maintenance.

6.1.8 Garages and Vehicle Maintenance (See Figures 6-1 and 6-2). Numerous garages and vehicle maintenance areas have been in operation on TI and YBI at various times and the dates of operation are highly variable. The majority of the vehicle maintenance operations on TI have occurred in Buildings 2 (L4-M4), 3 (L5-M6), 69 (H8), 115 (L5), 125 (H3), 129 (I4), 180 (L2-M2), 193 (D1), 194 (E3), 223 (E3-F3), 224 (E3), 225 (E2), 267 (E3), 330 (E8), and 335 (D8). Of these, only 180, 225, 330, and 335 are still active. Little information exists as to the type and intensity of usage of the YBI maintenance areas although the service station 204/208 (H5, YBI) seems to have been in existence for the longest period of time. The garage and vehicle maintenance operations conducted on-site included routine changing of fluids such as oil and lubricants; parts replacement including filters, brakes, tires, engines, and transmissions; body work; and vehicle (steam) cleaning and degreasing.

Disposal methods for the waste streams associated with the maintenance shops have been variable. Waste fluids from the Auto Hobby Shop (Building 225) are now recycled by a certified agent under contract with the DRMO. However, they were reported to have been routinely emptied into the storm sewer system in the past. Waste filters and parts were disposed of in trash bins and ultimately shipped to nonhazardous landfills for disposal. This method of disposal is still used in current operations.

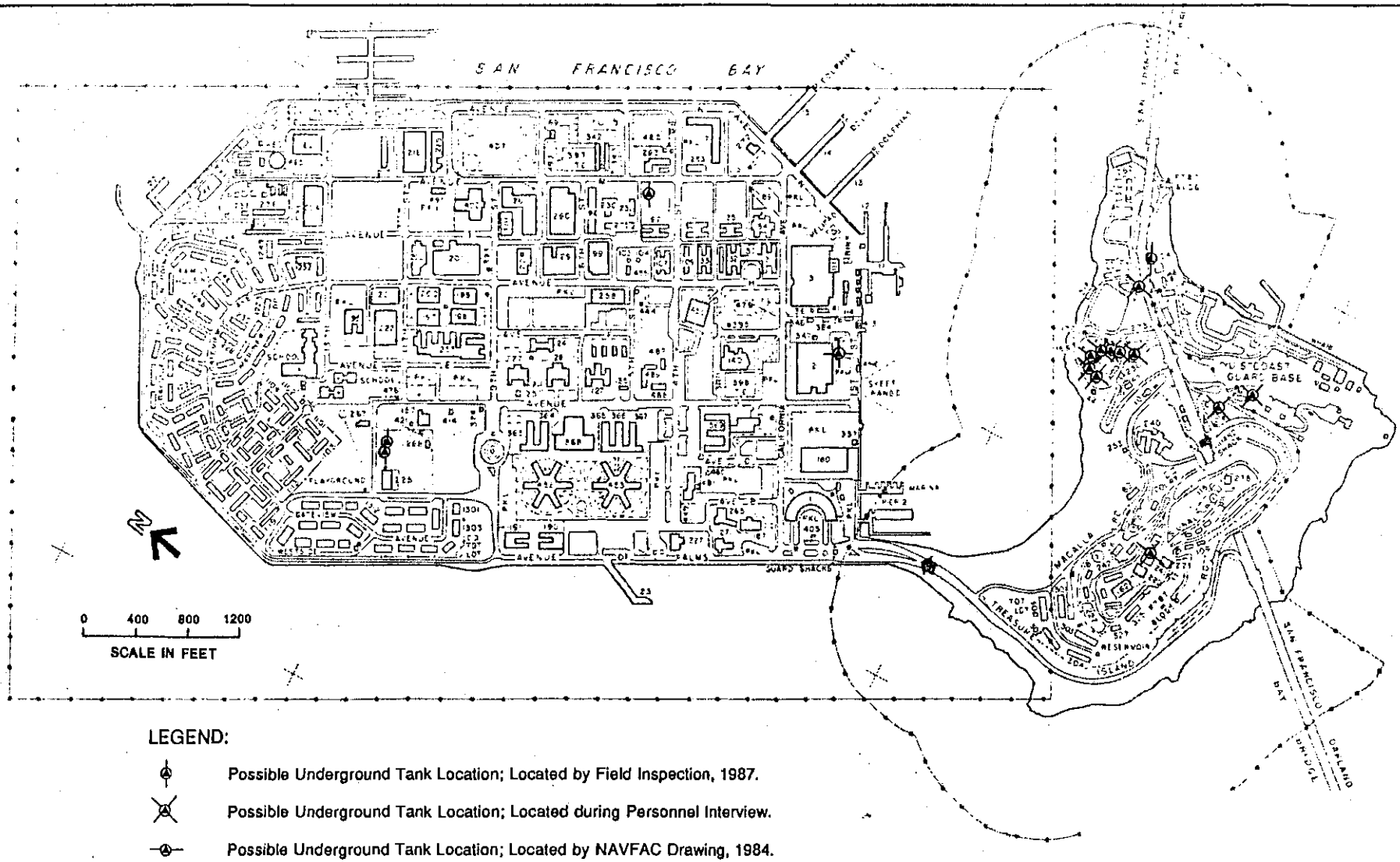
Degreasing and vehicle cleaning operations commonly produced oil, grease, metal shavings, and unknown cleaning agents which may have been released into San Francisco Bay by the storm sewer system. Buildings 129, 194, 223, 224, and 267 have been identified as potential areas of vehicle cleaning, degreasing, and transmission repair in the past. Activities within these buildings were probably most intensive from 1943 to 1948. Only Building 129 currently remains and it is used for storage.

A 1972 report (NAVSHIPS/NAVSEC) anticipated that by 1975 the transportation shop would generate 3,000 gallons of waste lube and hydraulic oils while the Auto Hobby Shop and Naval Exchange would generate 6,000 and 12,000 gallons of these fluids, respectively. While such fluids are currently recycled, there is reason to believe that this was not always the case. The quantities have certainly varied in the past depending upon the volume of vehicle maintenance. No further information regarding actual quantities managed was located.

Seaplanes commonly landed near Clipper Cove from 1943 to approximately 1958. The planes were pulled from the water at Piers 13 through 16. The planes were fueled with aviation fuel supplied from the 10 underground tanks located south of Building 2, and were serviced in Buildings 2, 3, and 180 (Site 25). Little is known of the types of service and maintenance provided for the planes although there are indications that engine repair and cleaning were a common practice. Information regarding the disposal methods of the wastes generated was not located.

6.1.9 Transformer Storage (N5, TI). A storage area for electrical transformers is presently located on the south side of Building 3 (Site 4). The area is covered by asphalt or concrete. Some but not all of the transformer units stored are marked as hazardous materials. Treasure Island personnel indicated that a spill had occurred in the storage area within the past two to three years. The transformers are transported to NSC Oakland for management and disposal. In addition, it has been reported that in the past transformers were also stockpiled by the U.S.S. PANDEMONIUM behind Building 445.

It has been suggested that the approximate number of transformers on Yerba Buena Island and Treasure Island has been 15. The major transformer on YBI has been located near the old boiler plant, Building 214. It was reported to have been removed over two years ago. On TI transformers are believed to have been located in the Star Barracks (Buildings 452 and 453), Building 1, U.S.S. PANDEMONIUM (currently Building 371), and in the buildings opposite the Chiefs Barracks. Transformers were also reported to exist below the wooden piers; however, when the vault boxes were opened, the transformers were missing. Personnel have stated that all potentially contaminated PCB transformers have been removed and replaced from TI and YBI.



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

POSSIBLE UNDERGROUND TANKS

FIGURE
6-7

6.2 PHOTO CHEMICALS. Chemicals used in photograph and x-ray processes are purchased in commercial containers. Waste chemicals are either recycled though DRMO Alameda or disposed of in the wastewater system.

6.3 TRASH, RUBBISH, AND SCRAP (H8-I8, TI). Debris storage yards have been located at several sites on TI. Currently, trash is collected from around the station and transported to a handling area east of Building 342 (Site 19). The trash is consolidated in large containers prior to being taken off-station for disposal by the PWC. Loose debris and soil staining were visible in the area around the transfer area. A scrap/salvage storage area is also located north of this handling area.

Formerly, a salvage yard was located in the 1940s and 1950s at the northeast corner of the island in the area of the present-day Buildings 371 and 445. A trash disposal trailer was located immediately north of family housing unit 1235 and appears on a general development map dated 1953. Presumably, the trailer was removed when the family housing was constructed in the late 1960s. An area indicated as a dump is also noted on a 1977 map, located approximately midway between family housing unit 1237 and Building 461. The northern end of TI, where the 1200 series family housing units stand, was used as a disposal area as well, presumably during the 1950s and is discussed further in Section 8.12. The exact dates of use of all facilities, the materials disposed of, and the quantities involved are not known.

6.4 INFECTIOUS WASTES. Infectious wastes from the medical and dental clinic are collected in special bags and placed in metal trash containers at the facility. The containers are transferred off-station for further handling. In the past infectious wastes may have been processed through the trash incinerator.

6.5 RADIOLOGICAL MATERIALS (I7, TI). Sealed radioactive sources are transported to and from the facility in motor vehicles in compliance with Department of Transportation requirements. Spent sealed sources are disposed of through NSC Oakland where they are later transferred to the Radiac Repair Facility at Mare Island Naval Shipyard for disposal. The radioactive sources are stored in Building 344.

6.6 DRMO OPERATIONS.

The Defense Reutilization and Marketing Office (DRMO) in Alameda and Public Works Center (PWC) in Oakland handle the disposal of hazardous wastes generated on Treasure Island. This is done either directly by PWC and DRMO personnel or indirectly by PWC via contracts with certified waste haulers. Radioactive wastes are handled through Radiac Repair Facility at Mare Island.

PWC arranges, generally through subcontractors, for the disposal of its wastes generated in PWC shop and PWC operations onsite.

DRMO handles approximately 90 percent of the hazardous wastes generated on Treasure Island. Naval Station operations and the Naval Technical Training Center operations are the primary generators although docked vessels, the U.S.S. Gallant and U.S.S. Excel, are also large generators (see Table 6-2). During 1985, over 50,000 gallons of waste oil were manifested off-station. Almost half of this volume was generated by the Naval Technical Training

Center (NTTC) at the Fire Training School. NTTC also generated 34,700 pounds of canisters from oxygen breathing apparatus (OBA) and over 100 gallons of mercuric nitrate from the Boiler Water/Feeder School. The U.S.S. Excel generated over 9,100 pounds of flammable hazardous waste solids, and the U.S.S. Gallant generated almost 10,000 pounds of corrosive wastes.

The wastes manifested by DRMO off-station are transported either directly to a disposal facility or to Alameda where subsequent disposal arrangements are made. Wastes are usually transferred to Alameda when storage time is about to exceed the 90-day limit at Treasure Island and/or volumes are not sufficient for cost-effective disposal. In the latter case, they are consolidated and held by DRMO in Alameda until disposal at a later date. Total hazardous waste volumes transported off Treasure Island, either directly to a disposal facility or to Alameda, are shown in Table 6-3.

TABLE 6-3

HAZARDOUS WASTE VOLUMES MANIFESTED OFF-STATION IN 1985

U.S. DOT WASTE TYPE	WASTE NUMBER	QUANTITY
Waste Oils N.O.S.	221	50,093 gallons
Flammable Hazardous Waste Solid	222	10,151 pounds
Trichloroethane	4226	5 gallons
Waste Paint	--	144 gallons
Flammable Hazardous Waste Liquid	221	986 gallons
Oxygen Breathing Apparatus Cannisters	--	34,700 pounds
Mercuric Nitrate	151	110 gallons
Corrosive Waste Solid	D002	9,915 pounds
Corrosive Waste Liquid	D002	20 gallons
TRANSFERRED TO DRMO, ALAMEDA:		
Waste Paint	D001	930 pounds
Coating Compound	D001	45 pounds
Duplicating Fluid	D001	336 pounds
Removal Fluid	D001	45 pounds
Polychlorinated Biphenyls (PCBs)	261	90 pounds

Ref: EPA Generator Biennial Hazardous Waste Report for 1985, U.S. Naval Station, Treasure Island.

AMB/1210a

CHAPTER 7. WASTE PROCESSING OPERATIONS

This chapter provides information on the chemical, physical, and biological waste processing operations including a description of the process, quantities processed (where available), and characterization of the effluent streams. In the following sections, grid locations of various TI facilities are referenced to Figure 7-1 and YBI facilities are referenced to Figure 7-2. Specific site locations can be identified using the grid system located on the figure.

7.1 SEWAGE PLANT (C7,8 - D7,8, TI). The current wastewater treatment plant (WWT) became operational in 1969 with secondary treatment and receives wastewater streams from TI and YBI. From 1961 to 1969, only primary treatment was performed, and prior to 1961, no treatment facility existed for TI wastewater. A small waste treatment system which included an Imhoff tank (used to separate soild wastes from liquid wastes) was operated on YBI as early as 1966 according to maps and aerial photos of the area. The YBI system processed only YBI wastes. The exact time period of operation of this facility is unspecified

Where necessary, oil/water separators are used to separate oil and water. The TI WWT system consists of grit (solids) separators, digestors, a trickling filter, and a chlorination basin. Sludge and solids are periodically removed for off-station management. The WWT effluent water is discharged to the Bay under an NPDES permit. Maximum flow through the system is currently about 2 million gallons per day. Tables 7-1 and 7-2 summarize facility capacity and volume treated.

Reportedly, for a brief period of time from 1968 to 1976, the sludge was spread in open areas adjacent to the WWT (near Building 62) and on YBI (Sections 8.7 and 8.8, Sites 7 and 8). Spread volumes were estimated at about 10 to 15 cubic yards per month total for both sites, potentially spreading 960 to 1440 cubic yards of sludge from 1968 to 1976. Table 7-3 presents pollutants discharged by the WWT in 1984. Similar compounds may have been present in the sludge in 1969 and therefore may be expected to exist in two spreading areas.

7.2 DOCUMENT INCINERATOR (J2, TI). An incinerator, Building 481, is used to burn classified documents. Because of the nature of the operation, specific details of the quantity of material burned, the time period during which it has operated, and the disposal and volume of the ash were not provided. Several small incinerators have been located on TI for brief periods of time. Other locations on TI include Buildings 58 (C8), 87 (M6), and 345 (A5) (see Section 7.5).

7.3 RUBBISH TRANSFER AREA (H8-I8, TI). A rubbish transfer area is located to the east of Building 342. Trash is transferred from small containers to large bins which are transported off-station for disposal.

7.4 WASTE OIL RECOVERY SYSTEM (M6, TI). Waste oil unloaded from ships is transferred to an on-shore oil/water separation facility consisting of five above ground tanks each with a 2,000-gallon capacity. The oil recovered from the system is disposed of off-site through contracts at PWC by a certified waste hauler and through DRMO Alameda. The water from the system is processed through the wastewater treatment system. A 1972 report estimated 271,900

TABLE 7-1

WASTEWATER VOLUMES TREATED ANNUALLY

YEAR	VOLUMES (Million Gallons)
1974	511.0
1975	474.5
1976	485.5
1977	220.0
1978	Unknown*
1979	365 (Estimate)*

Ref: "Questionnaire on Waste Water Treatment and Reuse in California," State of California, Department of Water Resources, Sacramento, California, 1980.

AMB/1213a

TABLE 7-2

WASTEWATER TREATMENT PLANT DAILY FLOW RATES

	TREASURE ISLAND (Million Gallons Per Day)	YERBA BUENA ISLAND (Million Gallons Per Day)
1969:		
Average Daily Flow	1.0	0.02 (Estimate)
Peak Daily Flow	1.9	Not Metered
Design Capacity	1.3	0.09
1980:		
Average Daily Flow	1.0	Not Operating
Average Dry-Weather Design Flow	2.0	Not Operating
Peak Wet-Weather Design Flow	4.4	Not Operating

References:

Report on Waste Disposal Practices at Naval Station, Treasure Island, Pacific Southwest Region, California-Nevada Basins Office, Alameda, June 13, 1969.

Report on Waste Disposal Practices, Yerba Buena Island, Pacific Southwest Region, California-Nevada Basins Office, Alameda, June 13, 1969.

California Regional Water Quality Control Board, San Francisco Bay Region, Resolution No. 69-_____, July 31, 1969.

California Regional Water Quality Control Board, San Francisco Bay Region, Order No. 80-23, May 20, 1980.

AMB/1214a

TABLE 7-3

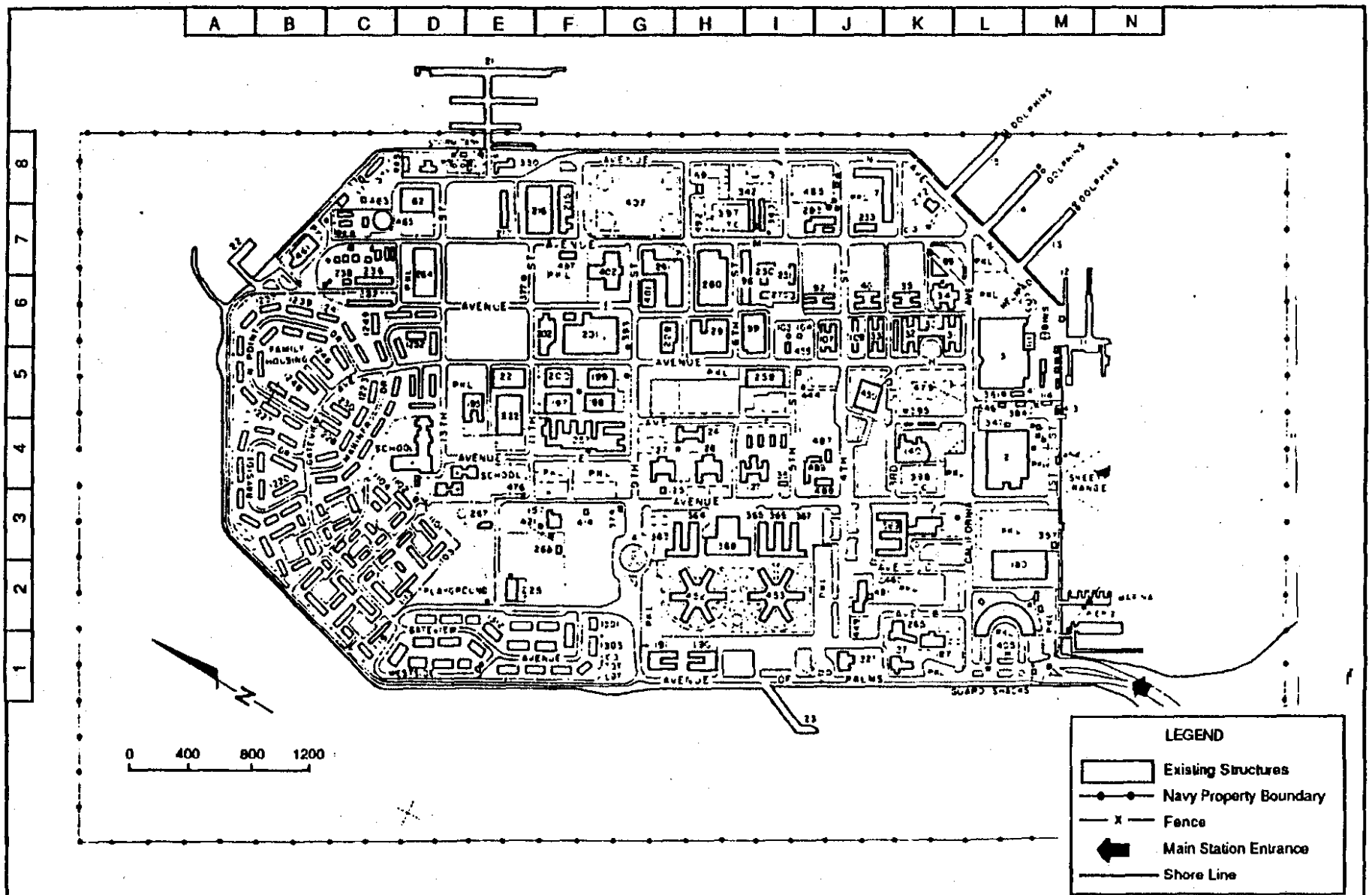
POLLUTANTS DISCHARGED BY TREASURE ISLAND WASTEWATER TREATMENT PLANT

PARAMETER	AVERAGE LOADING (kg/day)	NPDES* PERMIT REQUIREMENT (kg/day, 6 mo. med.)
Cyanide, Total	<0.07	0.76
Arsenic, Total	<0.129	0.076
Cadmium, Total	<0.13	0.15
Chromium, Total	0.017	0.038
Copper, Total	0.07	1.5
Lead, Total	0.07	0.76
Nickel, Total	<0.07	0.76
Silver, Total	<0.07	0.15
Zinc, Total	0.15	2.3
Phenolics, Total Recoverable	0.02	3.8
Mercury, Total	<0.004	0.0076
Chlorinated Hydro-Carbons, General	Not Detected	0.015

* National Pollutant Discharge Elimination System.

Ref: NPDES Permit No. CA0110116 Discharge Monitoring Report for 1984, dated December 14, 1984.

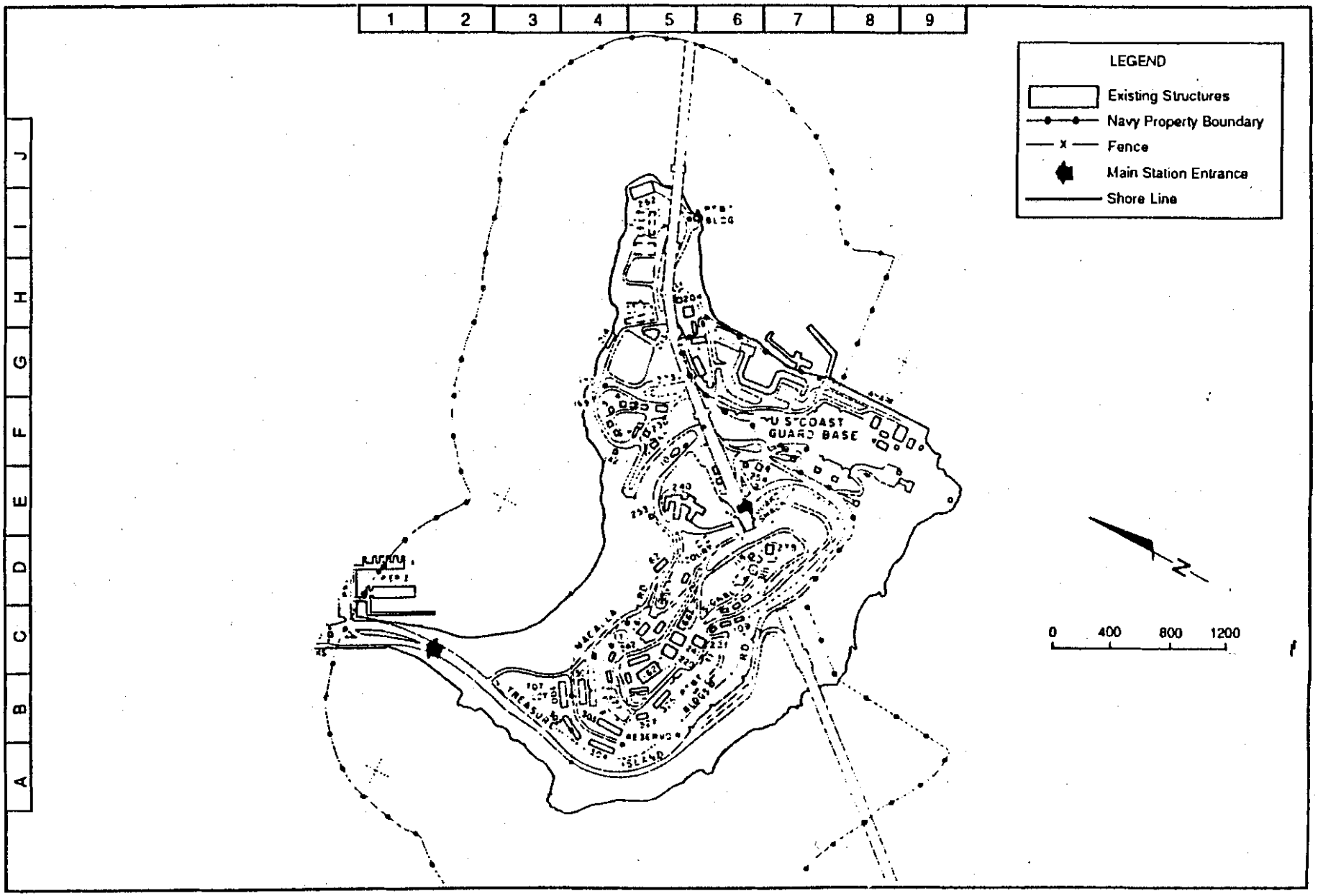
AMB/1215a



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

TREASURE ISLAND LOCATION MAP

FIGURE
7-1



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

YERBA BUENA LOCATION MAP

FIGURE
7-2

gallons per year of oil would be recovered by 1975; however, this is dependent upon the number of ships which are serviced.

7.5 TRASH INCINERATOR (A5, TI). A large trash incinerator (Building 345) was located at the northern edge of TI in the ammunition bunker area between at least 1953 and the mid-1960s. Based on a 1951 design plan, a conveyor belt system was used to transport materials from a trash pit located southwest of the incinerator to the top of the 84-foot incinerator. A trash trailer was also located in this area on a 1955 general development map. Both are discussed further in Section 8.12. Information regarding the volume and types of materials incinerated and the disposition of ash and unburned waste was not found.

CHAPTER 8. DISPOSAL SITES AND POTENTIALLY CONTAMINATED AREAS

This Chapter describes potentially contaminated areas identified during this study. Specific site locations for TI can be identified using the grid system located on Figure 8-1, while locations for YBI can be identified using Figure 8-2. A summary of operations at each site is shown in Table 8-1.

8.1 SITE 1: MEDICAL CLINIC. (G4, TI) At the south end of the middle wing of Building 257 (Figure 8-3), the wood flooring was eroded by leaks from x-ray equipment. Corrosive developer and/or fixer solution leaked from the equipment and then dripped onto the soils under the building, which is raised on pedestals. The affected area may cover up to 100 square feet to an unknown depth. The exact time, quantity, and duration of the release material was not established. The eroded flooring section is now carpeted and has been either repaired or replaced. This portion of the building was temporarily used as a day care facility. Surface sampling by NEESA confirmed the presence of silver in concentrations of 3,050 and 7,740 mg/kg and acidic soil (pH of 4.0 and 4.2, Appendix B).

8.2 SITE 2: RADIATION TRAINING AREA. (D1,2-E1,2, TI) The area near the intersection of 12th Street and Avenue A contained ship and aircraft mockups used for radiation training (Figure 8-4). Radioactive water was involved with this activity and was collected in two subgrade concrete tanks. Records reviewed did not indicate whether the training area and water conveying devices were coated or were bare earth. At the time of the training, several hundred square feet of area could have been affected. The training operations in this area began in the mid-1950s and ceased in 1969 when the school moved to its current location in Building 371. Because the half life of the radioactive material used (Bromine-82) was on the order of 24-36 hours, any remaining radiation level is expected to be below significant levels. Reference to the area was made in a 1971 foundation study for housing units (Lowry & Associates) which stated that testing at the ground surface for residual contamination was negative. The area is currently the site of military housing.

8.3 SITE 3: PCB EQUIPMENT STORAGE AREA. (N5, TI) It was reported that PCB containing oil was accidentally released in the PCB equipment storage area on the south side of Building 3 (Figure 8-5) about two to three years ago. The quantity of material released was not identified and an area up to 100 square feet may be involved. The material was reported to have been cleaned up, but records of the cleanup were not located. Based on the location of the storage area, any oil which may have floated on rain water may be expected to flow into the Bay where it would be rapidly diluted to insignificant levels. Of several samples taken by NEESA personnel in the storage area, only one wipe sample contained PCB, at a concentration of 3.5 µg/100 cm^2 (Appendix B).

8.4 SITE 4: HYDRAULIC TRAINING SCHOOL. (H7-I7, TI) The concrete pad immediately behind the Hydraulic Training School, Building 342, is used as a drum storage area (Figure 8-6). Drums of hydraulic oil, motor oil, and unidentified fluids in unknown quantities are stored on pallets which are leaking and appear to have leaked in the past. The concrete beneath the pallets is stained (darkened) as is the bare ground immediately surrounding the pad. An area about 40 ft by 100 ft in plan dimension has been affected. The quantity and duration of the release is not known and so the depth of

TABLE 8-1

SUMMARY OF SITE OPERATIONAL HISTORY

SITE	DESCRIPTION	YEARS	OPERATION	POTENTIAL CONTAMINANTS
1	Medical Clinic (Bldg. 257)	1940s-late 1970s	X-ray development	Developer and/or fixer solutions metals such as silver
2	Radiation Training Area	mid 1950s-1969	Radioactive water containment	Radioactive sources such as K-42, Na-24, Ra-226, Cs-137, Br-80, Br-82, and Pu-239
3	PCB Storage Area (Bldg. 3)	pre-1953-present	Outside Storage Area	PCBs
4	Hydraulic Training School (Bldg. 342)	1970s-present	Outside Storage Area	Waste hydraulic oil (mainly transmission oil)
5	Old Boiler Plant (Bldg. 102)	1964-1968 1968-1987	Boiler Plant Debris from demolished boiler plant	Asbestos
6	Fire Training Area	1946-1987	Fire training school	Petroleum hydrocarbons, magnesium and fire extinguishing chemicals
7	Pesticide Storage (Bldg. 62)	1943-late 1950s 1955-early 1960s 1968-1976	Mixed and stored paints Mixed and stored pesticides and herbicides Treatment plant spread area for wastewater sludge	Paints containing linseed oil and lead Pesticides and herbicides Organics and metals
8	Army Point (YBI) Sludge Disposal Area	1968-1976	Treatment plant spread area for wastewater sludge	Organics and metals
9	Foundry (Bldg. 41)	1943-1947 1953-1968 1981-1987	Forge/foundry Paint shop Welding school	---- Paints containing lead or zinc-chromium based pigments, paint thinners and solvents ----
10	Bus Painting Shop (Bldg. 335)	1947-1953 1953-1955 ?-present	Bus paint shop Storage and mixing area for pest control shop Steam rack	Waste paints, thinners, solvents pesticides, and herbicides Oils, grease, and petroleum hydrocarbons

TABLE 8-1

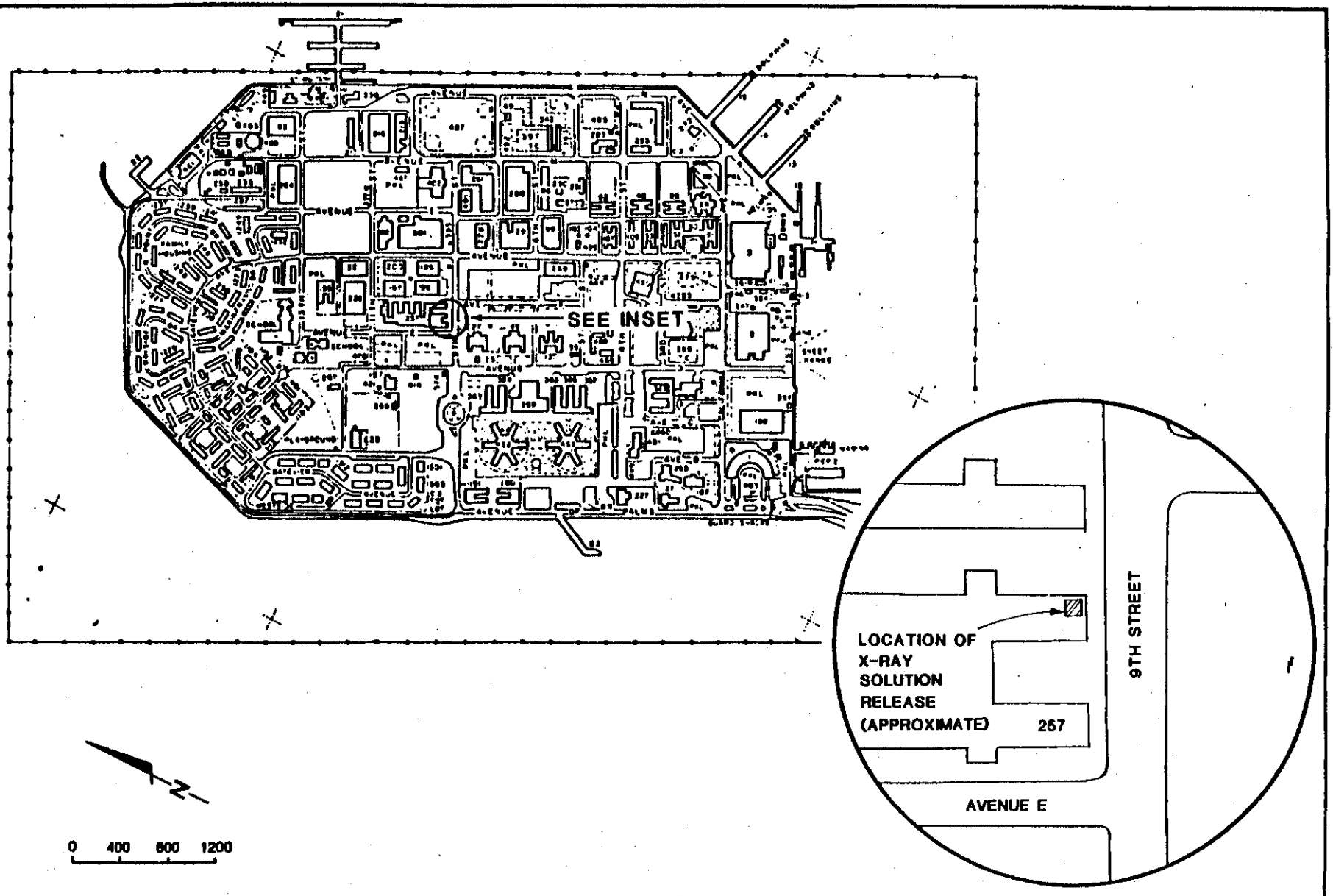
SUMMARY OF SITE OPERATIONAL HISTORY

SITE	DESCRIPTION	YEARS	OPERATION	POTENTIAL CONTAMINANTS
11	YBI Landfill	1935-present	Sanctioned and unsanctioned disposal area	----
12	Old Bunker Area	1940s-1969	Ammunition bunkers, disposal area	----
13	Stormwater outfalls	1936-present	Stormwater discharge; vessel discharge	Storm and wastewater effluent mercuric nitrate, vessel waste; oils
14	New Fuel Farm	1943-present	Fuel storage	Petroleum hydrocarbons
15	Old Fuel Farm	pre-1943-present	Undrained abandoned underground pipelines	Petroleum hydrocarbons
16	Clipper Cove Tank Farm	1940s-1960s	10 storage tanks	Lead, oil, and other petroleum hydrocarbons
		1960s	Spread area for sludge from dismantled tanks	Lead, oil, and other petroleum hydrocarbons
17	Tanks 103/104	1943-present	Storage tanks	Petroleum hydrocarbons (diesel) (accidental release in 1983)
18	Asbestos Covered Piping (YBI)	early 1980s	Pipelines	Asbestos
19	Refuse Transfer Area	1953-present	Refuse holding and disposal area	Unidentified fluids
20	Auto Hobby Shop/Transportation Center (Bldgs. 194, 224, 225, 230 and 267)	1943-1950	TI Transportation Center	Degreasing substances, solvents, oils, grease, hydrocarbons
	(Bldg 225)	1947-present	Auto Hobby Shop with drum storage area	Hydraulic fluid, recycled oil, grease, vehicle fluid, and metals such as chromium, nickel and zinc
21	Vessel Waste Oil Recovery	1946-present	Vessel waste oil recovery	Waste oils
22	Naval Exchange Service Station	1946-present	Gas Station	Petroleum hydrocarbons and accumulated vehicle fluids
23	YBI Line Break	Early 1980s	Pipeline	Hydrocarbons (black oil)

TABLE 8-1

SUMMARY OF SITE OPERATIONAL HISTORY

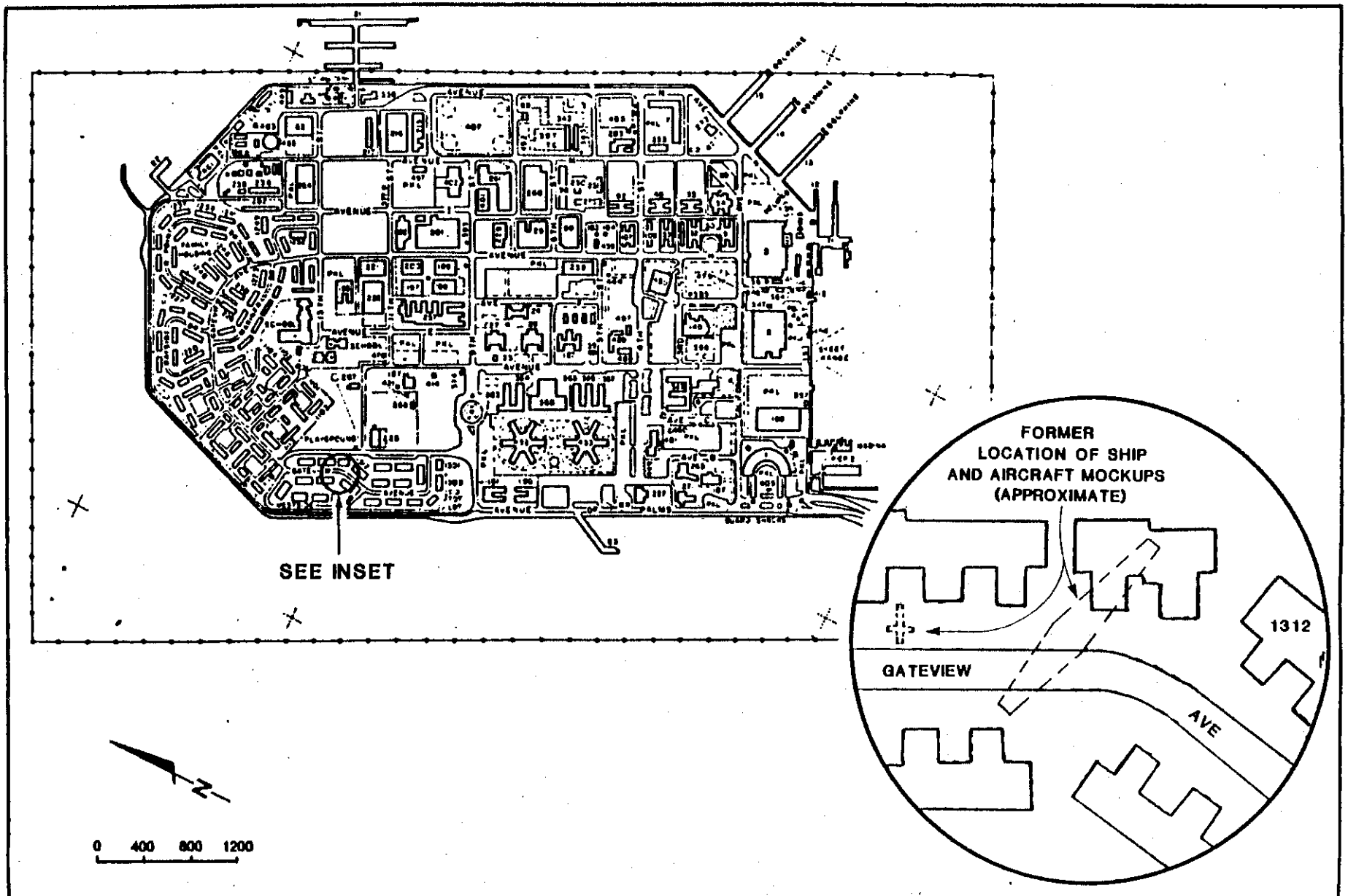
SITE	DESCRIPTION	YEARS	OPERATION	POTENTIAL CONTAMINANTS
24	Fifth Street Fuel Releases	1986-1987	Abandoned pipelines	Petroleum hydrocarbons
25	Seaplane Maintenance (Bldgs. 2, 3, and 180)	1943-1958	Seaplane maintenance	Waste liquids and solvents for engine cleaning
	(Bldg. 2)	----	Gasoline tanks	Gasoline
26	Underground Tanks	pre-1935-present	Storage of petroleum products	Petroleum products



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 1
MEDICAL CLINIC

FIGURE
8-3



PRELIMINARY ASSESSMENT/
SITE INSPECTION
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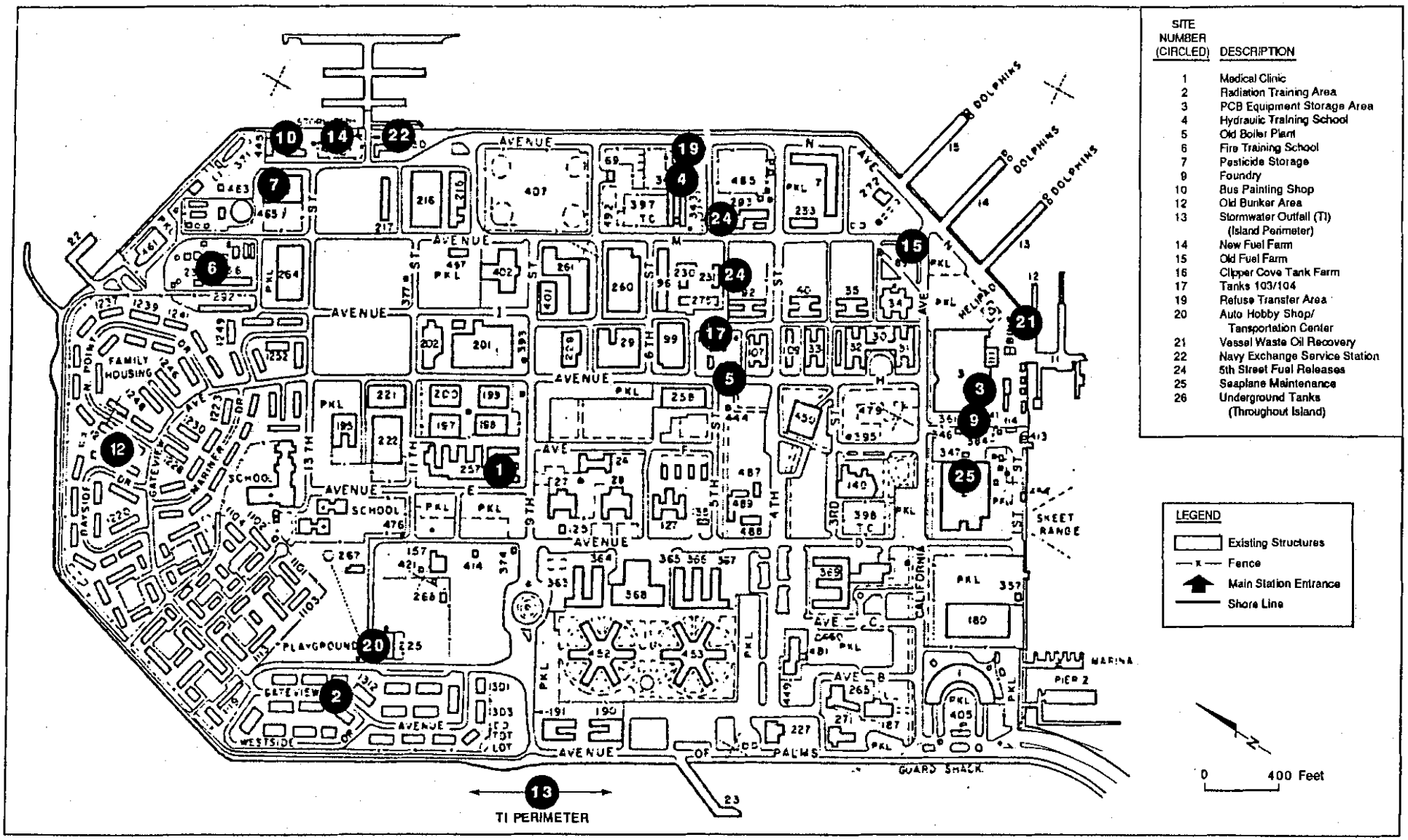
SITE 2
RADIATION TRAINING AREA

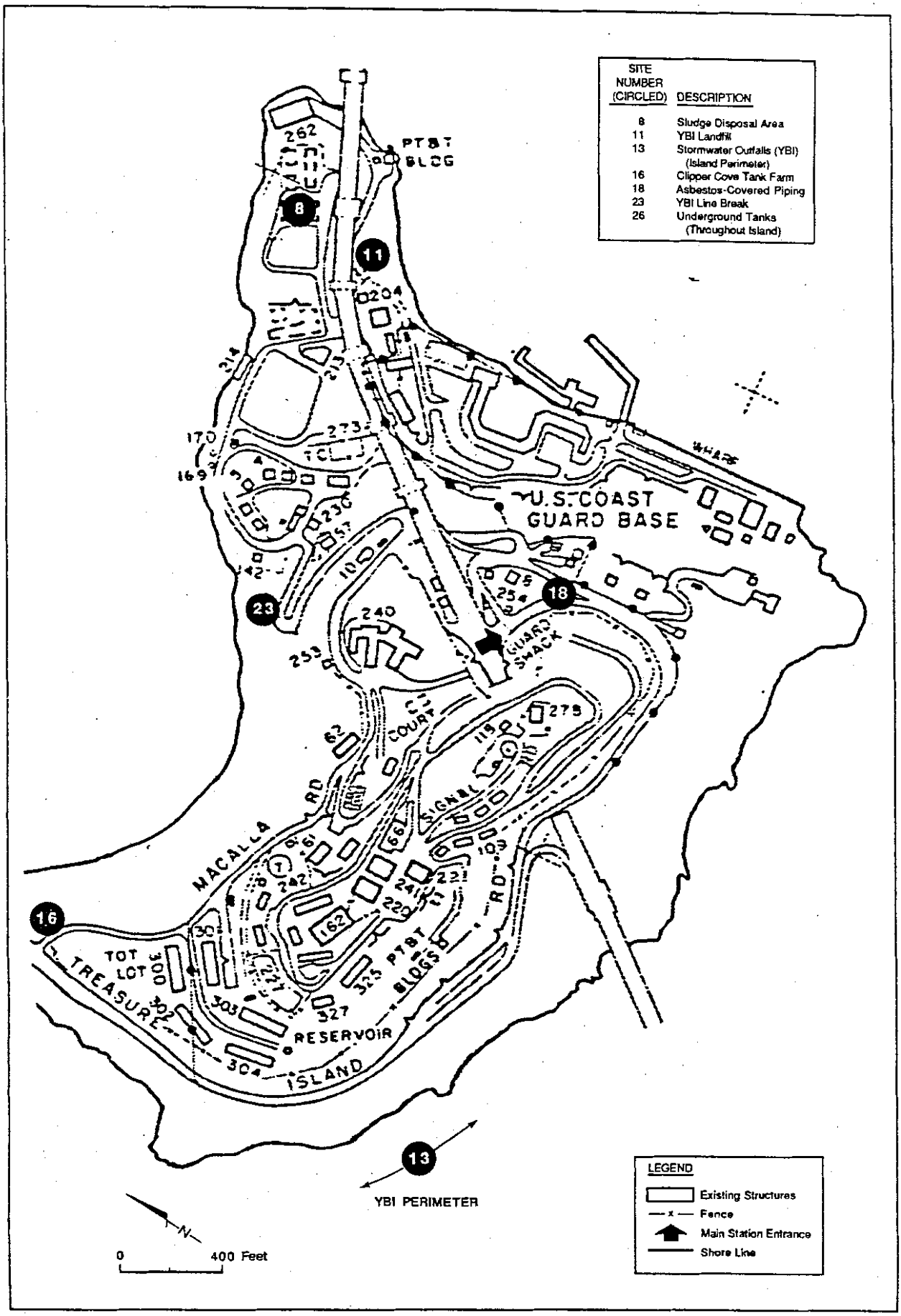
FIGURE
8-4



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

LOCATION OF IDENTIFIED SITES–TREASURE ISLAND (TI)

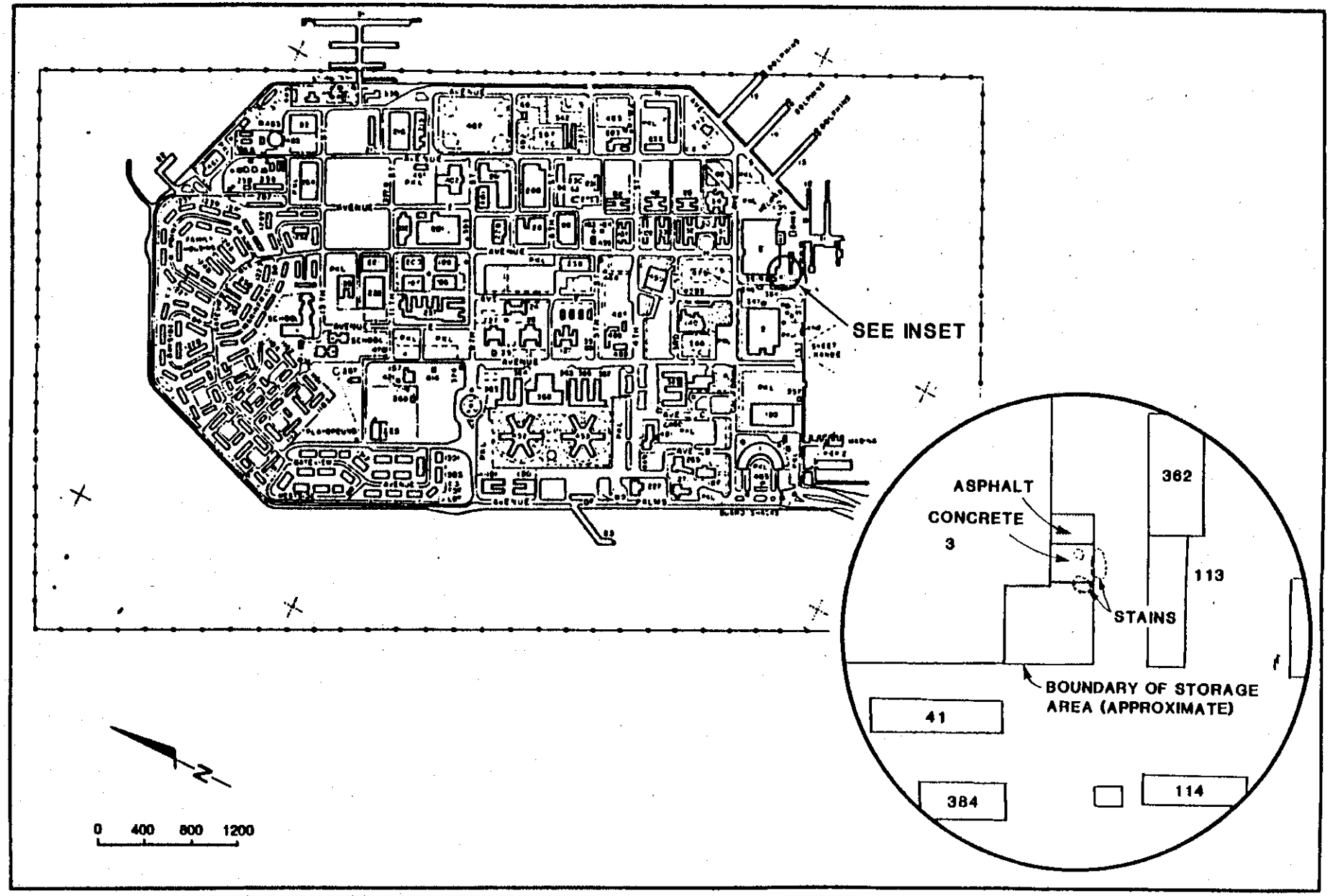
FIGURE 8-1



PRELIMINARY ASSESSMENT/ SITE INSPECTION
NAVSTA Treasure Island, Ca.

LOCATION OF IDENTIFIED SITES
YERBA BUENA ISLAND (YBI)

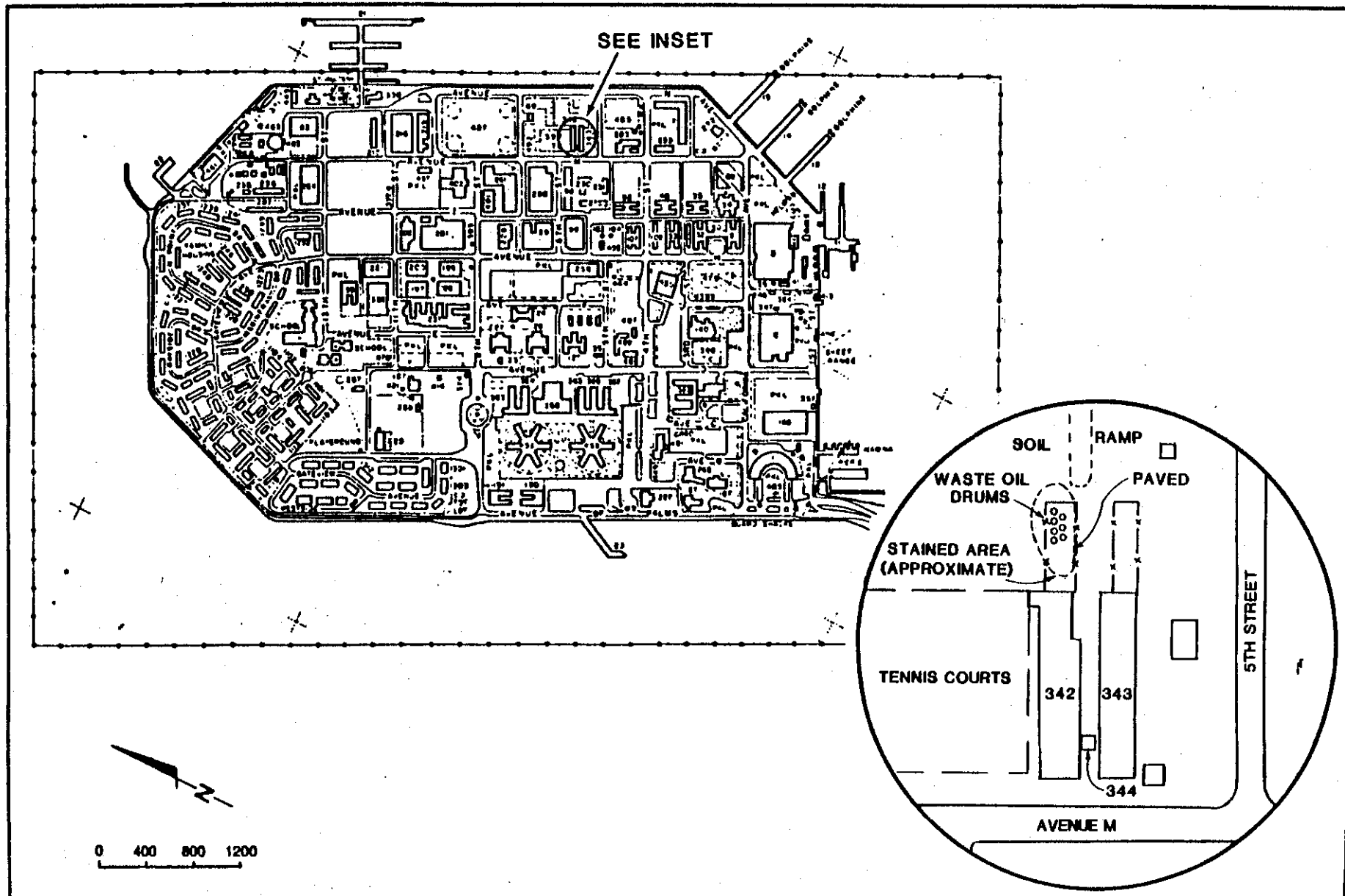
FIGURE 8-2



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 3
PCB EQUIPMENT STORAGE AREA

FIGURE
8-5



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 4
HYDRAULIC TRAINING SCHOOL

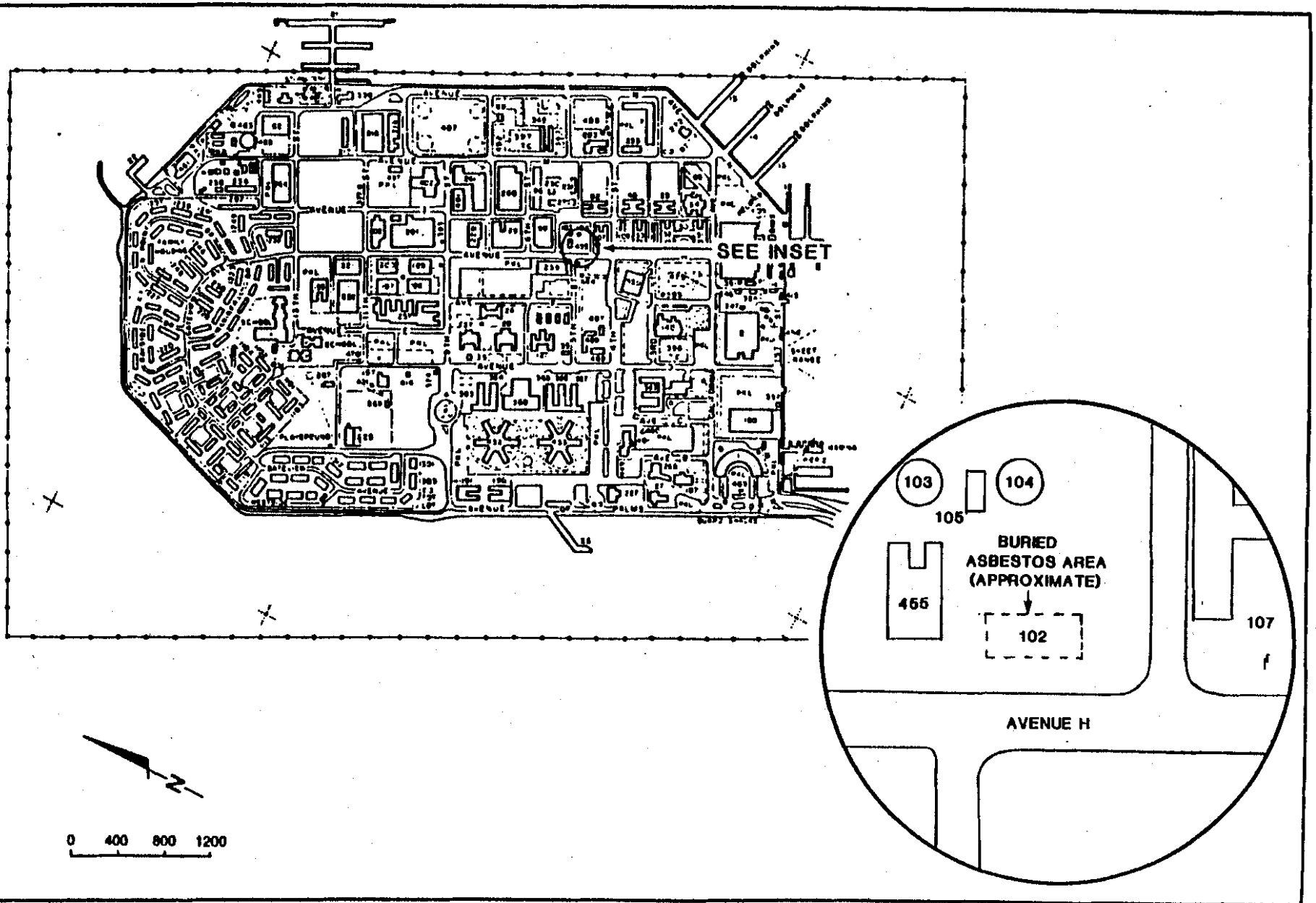
FIGURE
8-6

contamination is uncertain. Samples obtained by NEESA personnel at the surface and at about a 6-inch depth adjacent to the paved area were contaminated with oil and grease (7,030 to 88,800 mg/kg) and hydrocarbons (5,800 to 53,000 µg/g). No PCBs were detected (Appendix B).

8.5 SITE 5: OLD BOILER PLANT. (I5,6-J5,6, TI) During the period from approximately 1943 to 1968, Building 102, located near the intersection of 5th Street and Avenue H as shown in Figure 8-7, was used as a boiler plant. In 1968, Building 455 was constructed to replace boiler plant 102 which was then demolished. It was reported that in early 1987, excavation for a pipeline trench in the asphalt paved area where boiler plant Building 102 had been located uncovered building debris including asbestos insulation. The pipeline was rerouted, the trench backfilled, and the asphalt pavement was patched. Consequently, asbestos-containing debris is reported to be buried in the former location of boiler plant Building 102. The quantity and constituency of the debris was not established.

8.6 SITE 6: FIRE TRAINING AREA. (C6-C7, TI) The fire fighter training area is part of the Naval Technical Training Center (Figure 8-8) and has been used to conduct fire training since 1946. The ERM-West underground tanks investigation conducted in 1987 and a follow-up study performed by Harding Lawson Associates identified leaking underground storage tanks and severely contaminated soil and groundwater in this area. Contamination is due to the presence of petroleum hydrocarbons, such as gasoline and diesel, which are most likely present as a result of the tank leaks, underground piping leaks, above ground uncontained fuel spills and pipe leaks in paved and gravel areas, etc., originating from the school's activities. Prior to construction of the WWT in the late 1960s, wastewater from this activity is reported to have been discharged directly to the Bay. It was also reported that in the past, fire training operations were conducted on an earthen area prior to the construction of the concrete pad which now covers the area. Based in the reported operation of the facility, the soil in this area is potentially contaminated with hydrocarbons and fire extinguishing chemicals which may have migrated into the subsurface. A remedial investigation of this site is currently being conducted by NAVFAC WESTDIV.

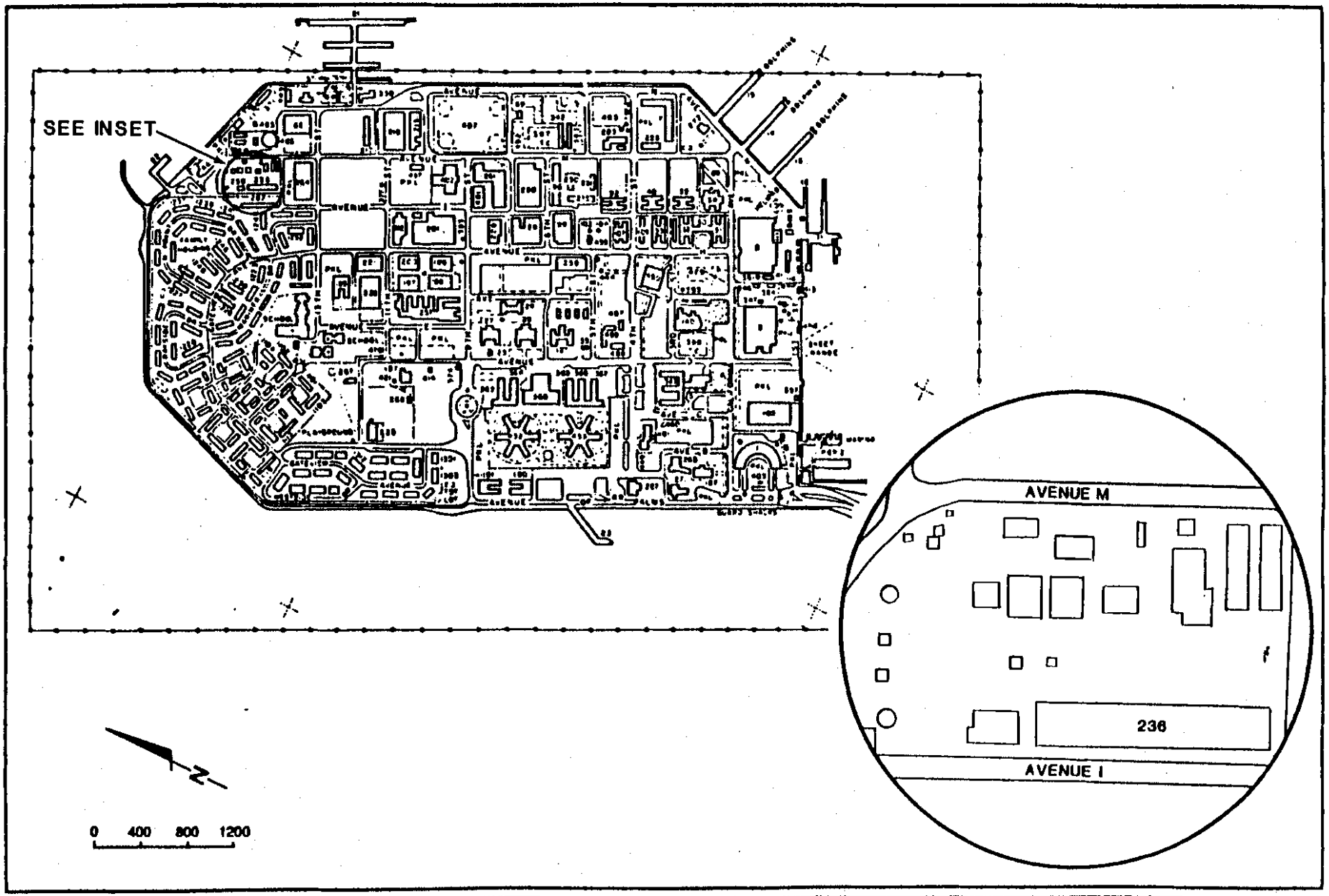
8.7 SITE 7: PESTICIDE STORAGE. (D7, TI) Building 62 (Figure 8-9) was used for storage and handling of a variety of liquid substances in the past including paint, pesticides, herbicides, and other unidentified fluids. Currently, pesticides and herbicides are distributed by Alameda personnel. The volumes handled were apparently in the 1 to 5 gallon range. Paints were reportedly mixed on-site near Pier 11 from 1943 to the late 1950s and contained linseed oil and lead. Pesticides and herbicides were mixed and prepared for use beginning in about 1955 until at least the early 1960s. Type and mixtures of pesticides and herbicides used on TI and YBI at the time are not known; however, currently used pesticides include boric acid, diazinon, malathion, Decon, rat bait, and endosulfan. 35-Burgo insecticide is also known to have been applied in 1975 and 1976. Excess fluids were disposed by pouring directly onto the ground outside Building 62 to the east and into San Francisco Bay. This practice occurred for approximately 20 years from 1943 to at least the early 1960s. Relatively small volumes were involved; usually 5-10 gallons per disposal, every 1 to 40 weeks.



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 5
OLD BOILER PLANT

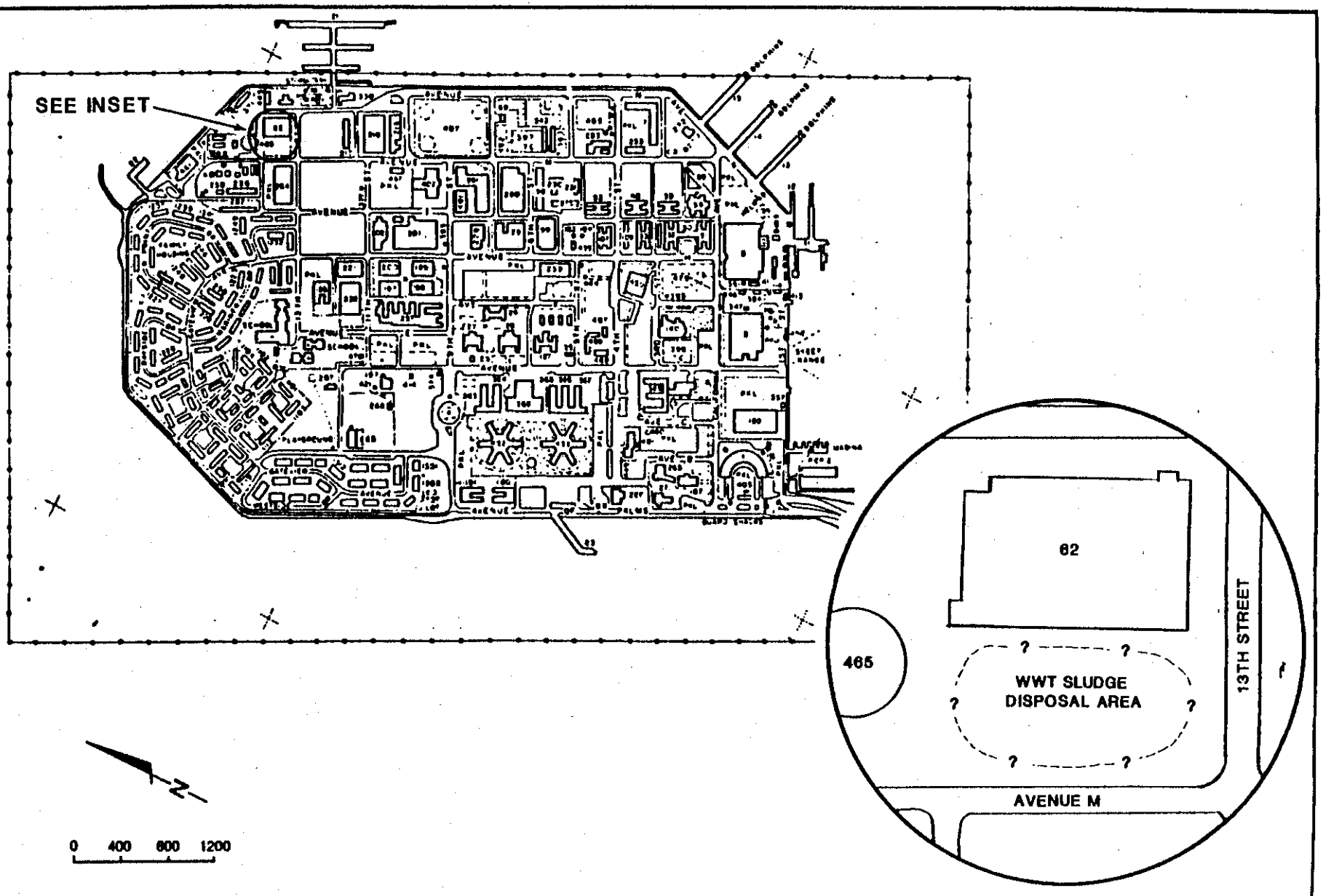
FIGURE
8-7



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 6
FIRE TRAINING AREA

FIGURE
8-8



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 7
PESTICIDE STORAGE

FIGURE
8-9

In addition, it was reported that sludge from the TI wastewater treatment plant (WWT), constructed in 1968, was spread on the ground west of Building 62. The volume spread was estimated to be up to 10-15 cubic yards per month total, at this location and at Site 8, potentially having spread 960 to 1440 cubic yards from 1968 to 1976. There is a potential for organics and metals in the wet sludge to have migrated into the subsurface. Although possible contaminants cannot be specifically identified, they may be similar to those discharged through the WWT in 1984 discussed in Section 7.1.

8.8 SITE 8: ARMY POINT SLUDGE DISPOSAL AREA, YBI. (E9, YBI) Army Point is located at the east end of YBI. It was reported that sludge from the WWT on TI was trucked to Army Point and spread on the ground in an area formerly occupied by quarters (Figure 8-10). The sludge was reportedly spread between housing foundations which still exist. The volume potentially spread at this site and at Site 7 totaled up to 10-15 cubic yards per month, potentially spreading 960 to 1440 cubic yards from approximately 1968 to 1976. There is a potential for organics and metals in the wet sludge to have migrated into the subsurface. Contaminants may be similar to those identified in WWT effluent (Section 7.1).

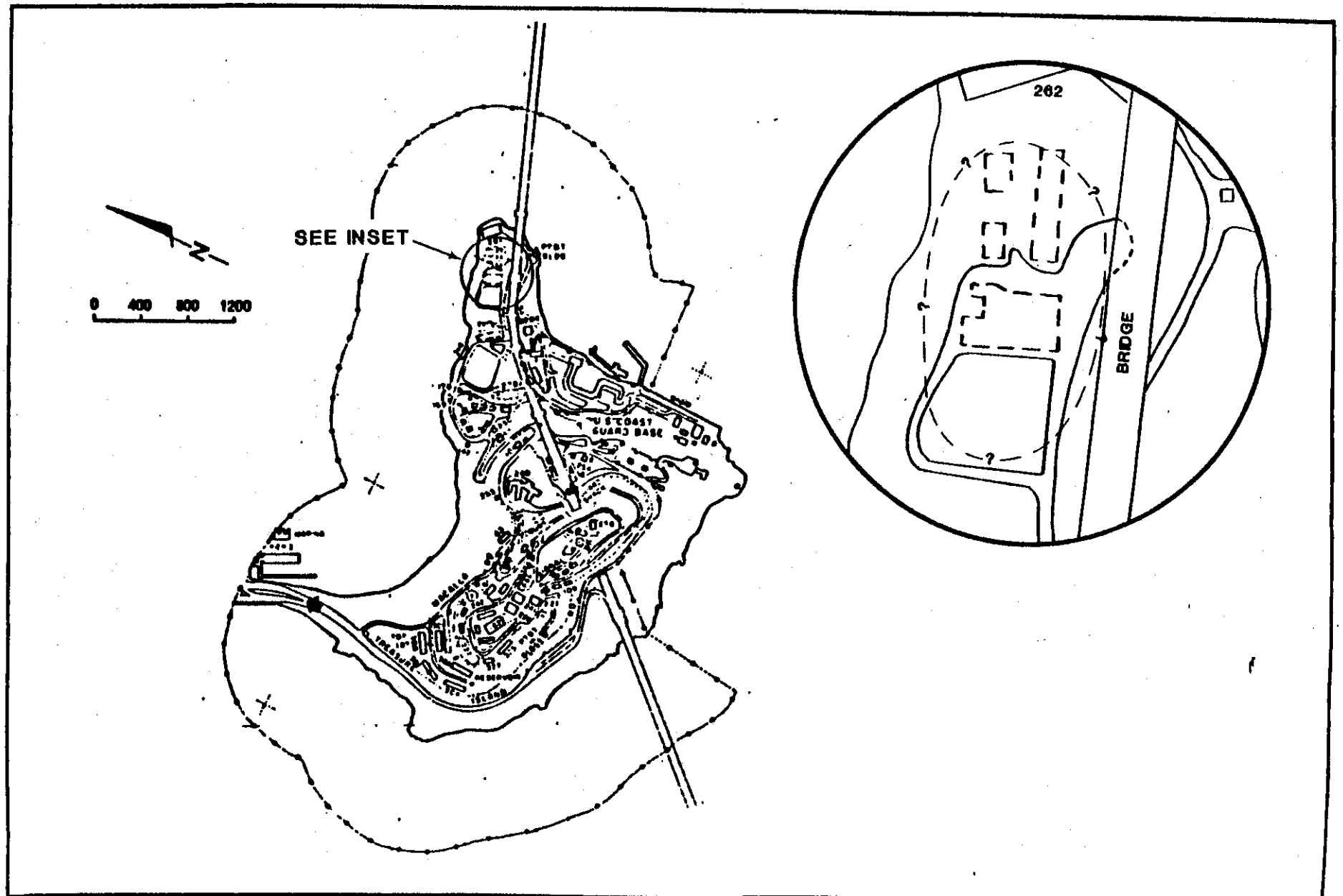
8.9 SITE 9: FOUNDRY. (L5, TI) Building 41 (Figure 8-11) has been used for at least three operations since the early 1940s. On building indexes for 1943 and 1947, Building 41 is listed as a forge/foundry. Beginning at least in 1953, the building was reported to have been used as a paint shop until 1968 when it was converted to storage. A 1985 index still incorrectly lists the building as a paint shop and the paint booth emission abatement equipment is reported to be still in place. The NTTC operated a welding school in Building 41 from roughly 1981 until early 1987. Details regarding this use were not located.

While being used as a paint booth, it was reported that paint mixing operations took place. It was reported that waste paints, thinners, and solvents may have been discharged to the Bay adjacent to the building. Spillage of some materials may have also occurred. Paints used at this facility are known to have contained lead or zinc-chromium-based pigments.

Because this area was developed as part of the World's Fair and Pan Am Clipper operations, the area may have been asphalt or concrete paved; the area currently is paved. If the area has continuously been paved, contaminant migration into subsurface soils may not have occurred or contaminants may not be present in substantial concentrations. Alternatively, contaminants may have been carried via surface water into the storm sewer system and then into the Bay.

8.10 SITE 10: BUS PAINTING SHOP. (D8, TI) Building 335 (Figure 8-12) was constructed during the mid-1940s and has been used for various purposes. On the building indexes for 1947 and 1953, the building was operated as a bus paint shop. It was reported that for an unspecified period of time, paints were mixed at this building. There are reports that waste paints, thinners, and solvents were spread on the adjacent riprap, discharged to the Bay, and released onto the ground near the building.

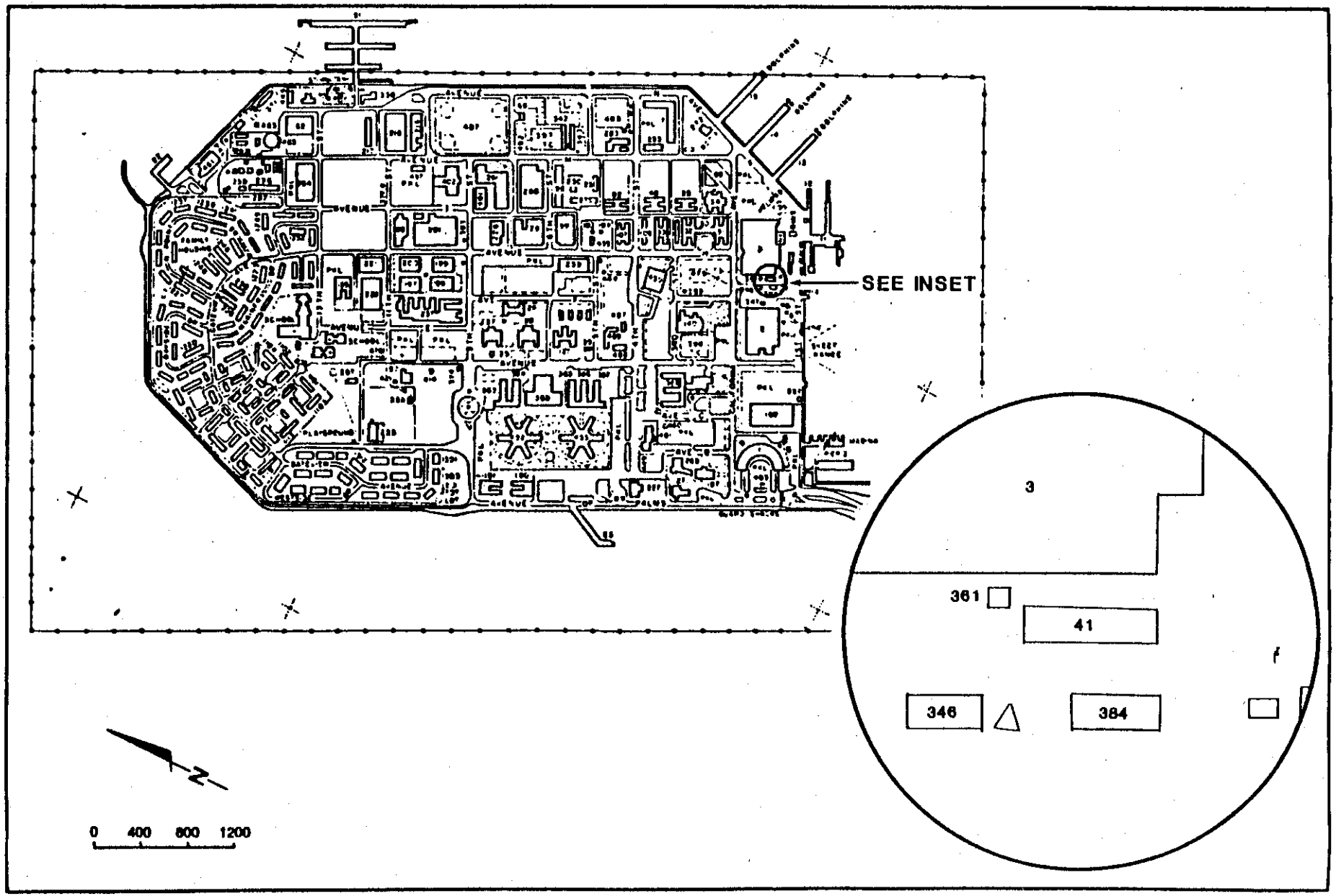
Building 335 was also reportedly used for storage and mixing of pest control solutions (pesticides and herbicides) during an unspecified time period.



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 8
ARMY POINT SLUDGE DISPOSAL AREA, YBI

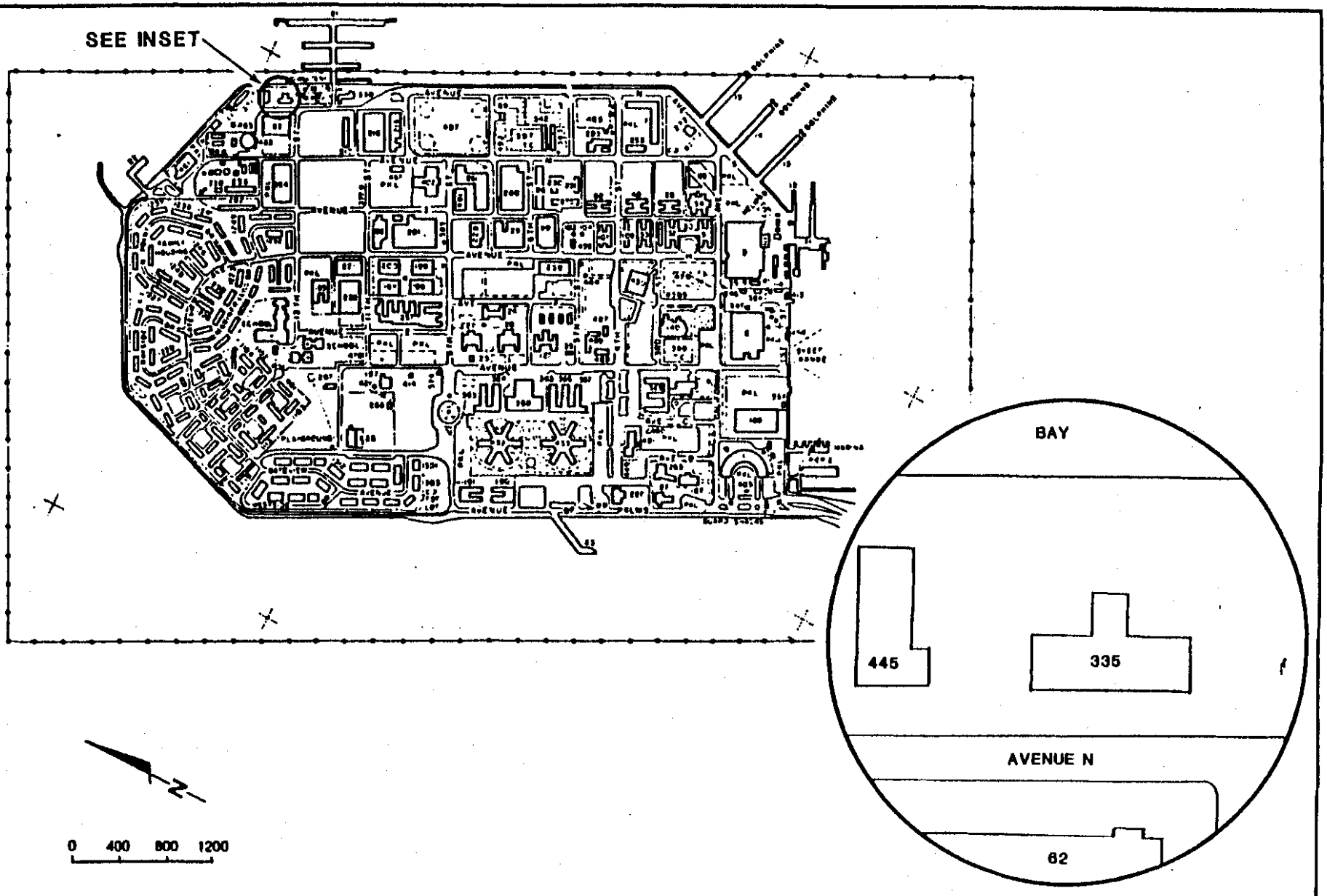
FIGURE
8-10



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 9
FOUNDRY

FIGURE
8-11



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 10
BUS PAINTING SHOP

FIGURE
8-12

Solution residues were reported to have been washed from containers and spraying equipment. It was also reported that Building 335 housed a do-it-yourself steam rack used to clean vehicles, drums, garbage cans, etc.

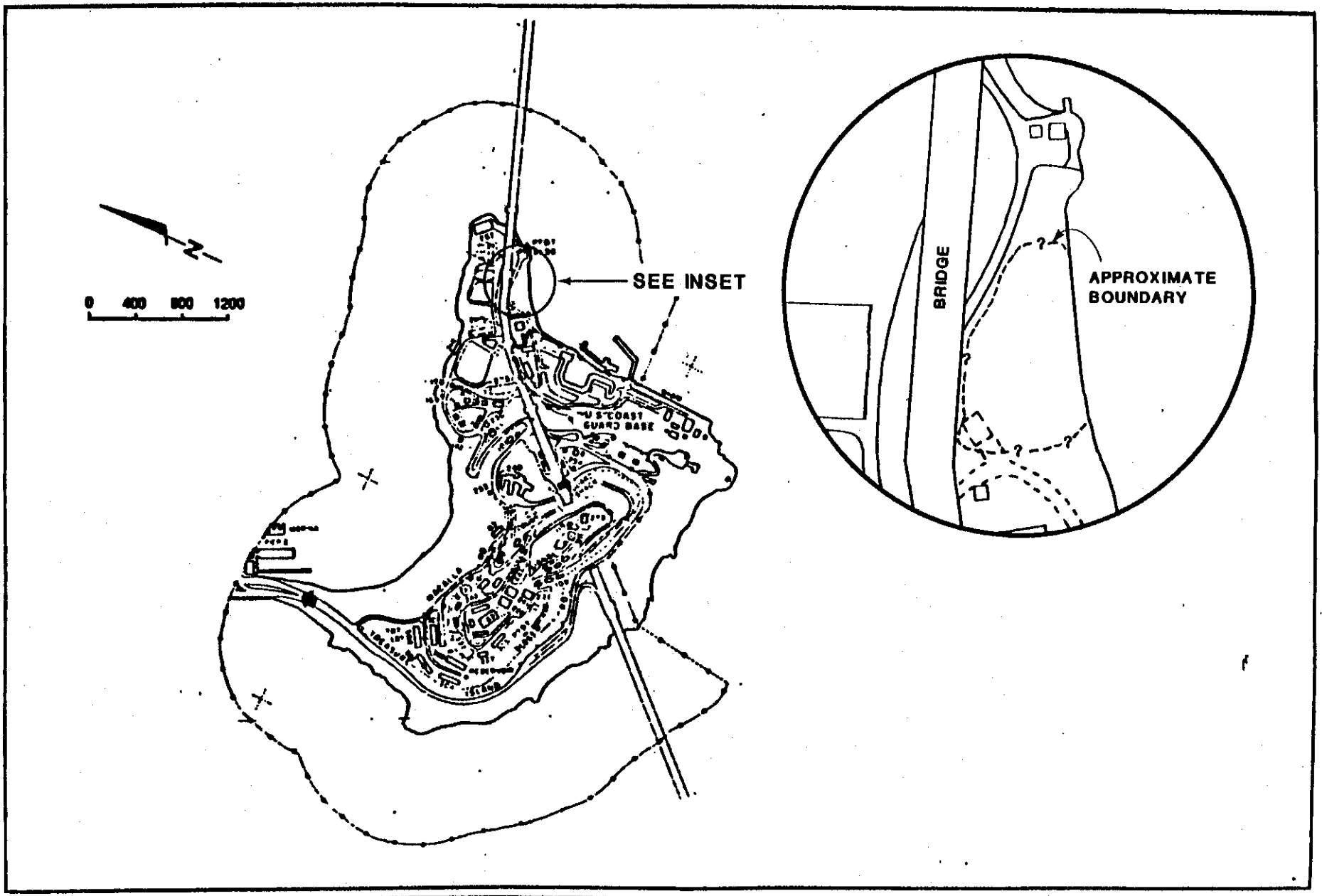
A floor drain is present in the shop, connected to the storm sewer system. Storm drains are also located near the building; the storm system discharges directly into the Bay. However, no information was found indicating whether the area surrounding the shop was ever paved, and it is conceivable that possible contaminants may have migrated into the subsurface soils. The potential for current contamination of the soils around tbe building and sediments at the storm outfalls does exist.

8.11 SITE 11: YBI LANDFILL. (E11, YBI) The southern edge of the eastern tip of YBI is a former marsh area which was identified as a dump in a 1935 topographic map (Figure 8-13). The area is roughly 100 ft by 400 ft in plan dimension. The volume and type of material disposed in the area were not identified. The area is somewhat overgrown at this time, and signs are posted to discourage additional disposal.

8.12 SITE 12: OLD BUNKER AREA. (A2-6, B2-6, TI) From the early 1940s until 1968, ammunition bunkers were located at the north end of TI. Surrounding the bunkers, both cell-type disposal units and general debris disposal areas were constructed (Figure 8-14). Although we have found no information detailing these operations, the disposal areas were identified in a series of trenches and borings performed during foundation excavations for the 1200-series housing units. Locations of the trenches and typical trench logs are shown in Figures 8-15 and 8-16. Figure 8-15 also shows the limits of the disposal area, as identified in the 1968 report, and the location of the incinerator discussed in Section 2.5. Extrapolating from the trench logs, it is estimated that originally 6,200 cubic yards of rubbish may have been disposed of in cell-disposal units and 24,400 cubic yards as loose debris. On the order of 3,800 cubic yards may still exist in former cell units and 12,200 cubic yards of loose debris, assuming rubbish was excavated to elevation +2 ft MSL. The debris is described in the trench logs as comprised of "loose rubbish, bottles, wire rope, paper, steel drum, incinerator ash, etc." (MKE-Abrams-Keller & Gannon, 1968).

In some trenched areas, rubbish was found from the ground surface, approximately elevation +5.5 feet MSL, to the depths excavated, about elevation -2 feet MSL. Site preparation recommendations included removing rubbish only to elevation +2 feet MSL. Assuming these recommendations were adhered to, rubbish probably remains buried in this area beneath the housing units and the potential for both soil and ground water contamination is likely.

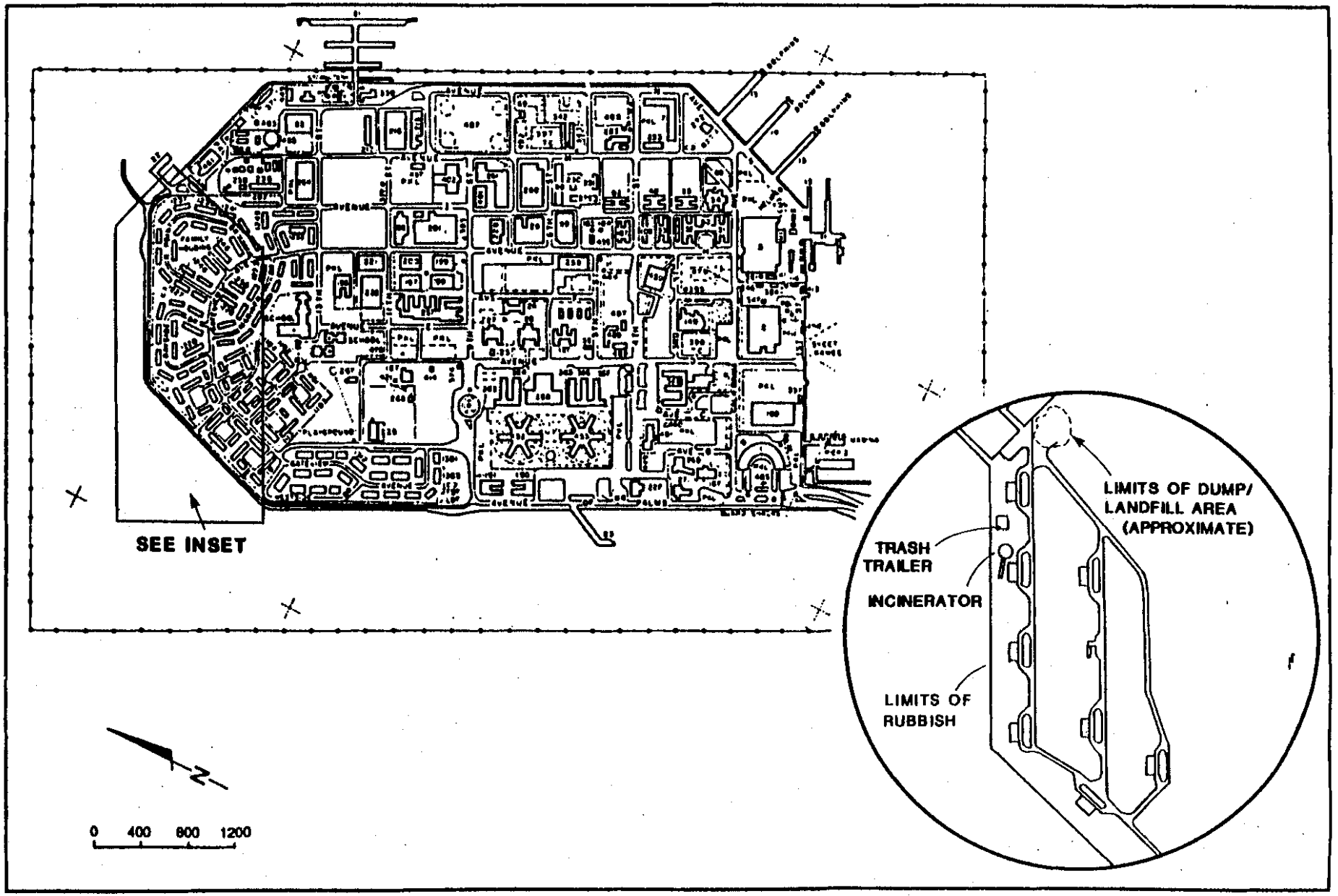
8.13 SITE 13: (TI AND YBI PERIMETER) STORMWATER OUTFALLS. Treasure Island has two distinct sewer systems: a wastewater system and a stormwater sewer system. Water conveyed by the stormwater system is collected from surface drains and some building drains. Stormwater system effluent is discharged to the Bay without treatment. According to facility drawings, there are numerous discharge outfalls which convey water collected from different parts of the station. The outfall locations for TI are indicated on Figure 8-17 and for YBI on Figure 8-18.



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 11
YBI LANDFILL

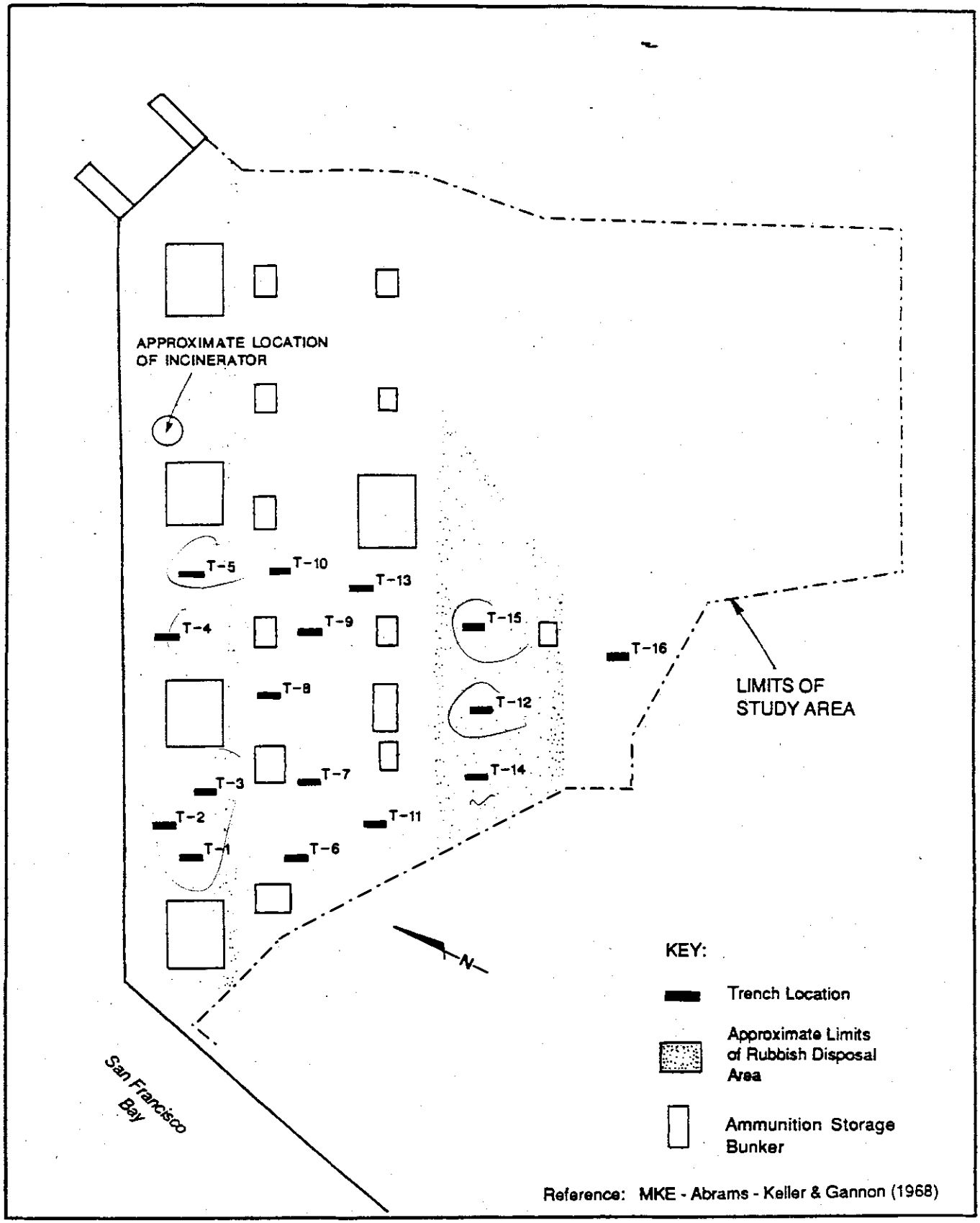
FIGURE
8-13



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 12
OLD BUNKER AREA

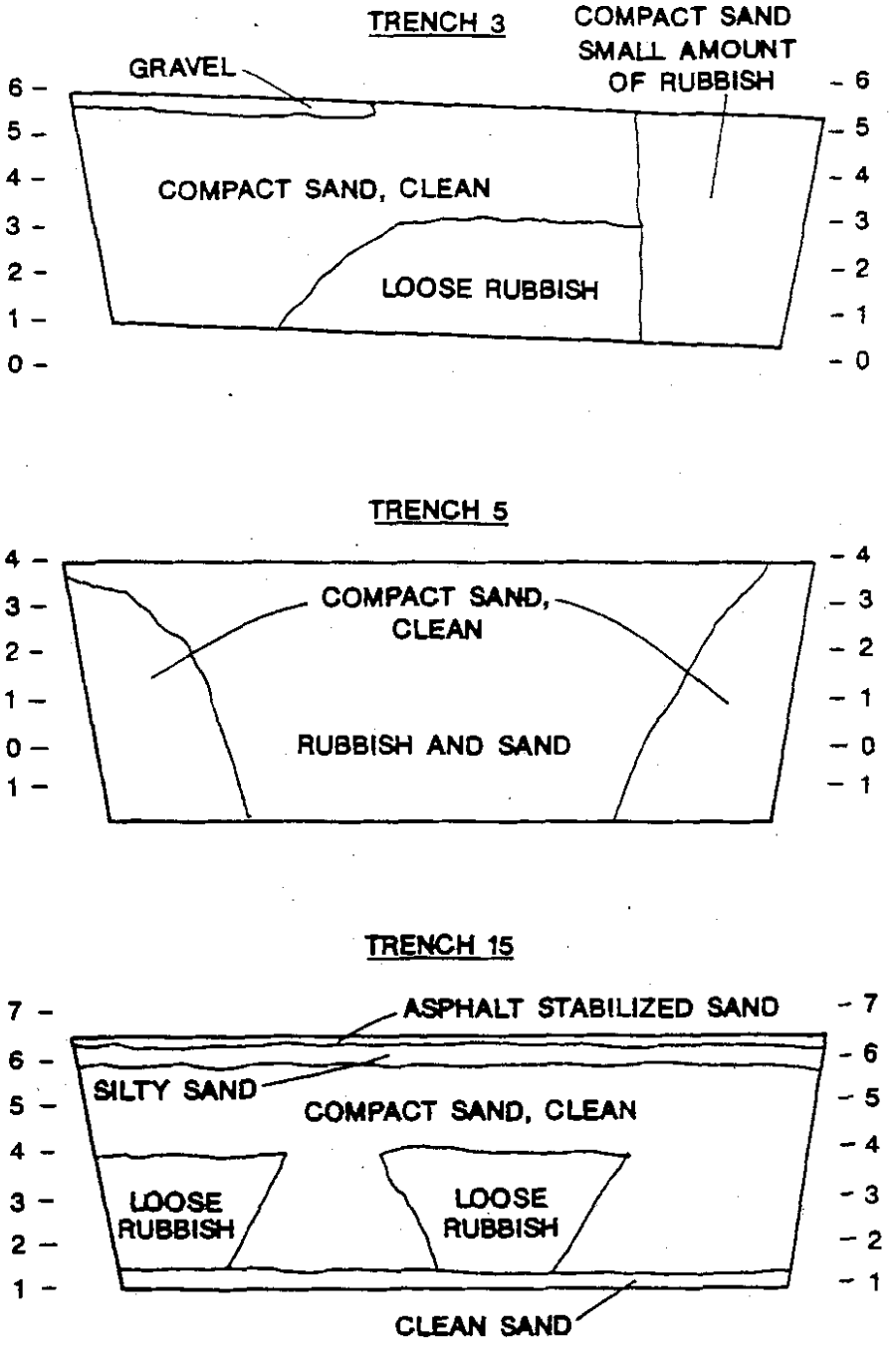
FIGURE
8-14



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

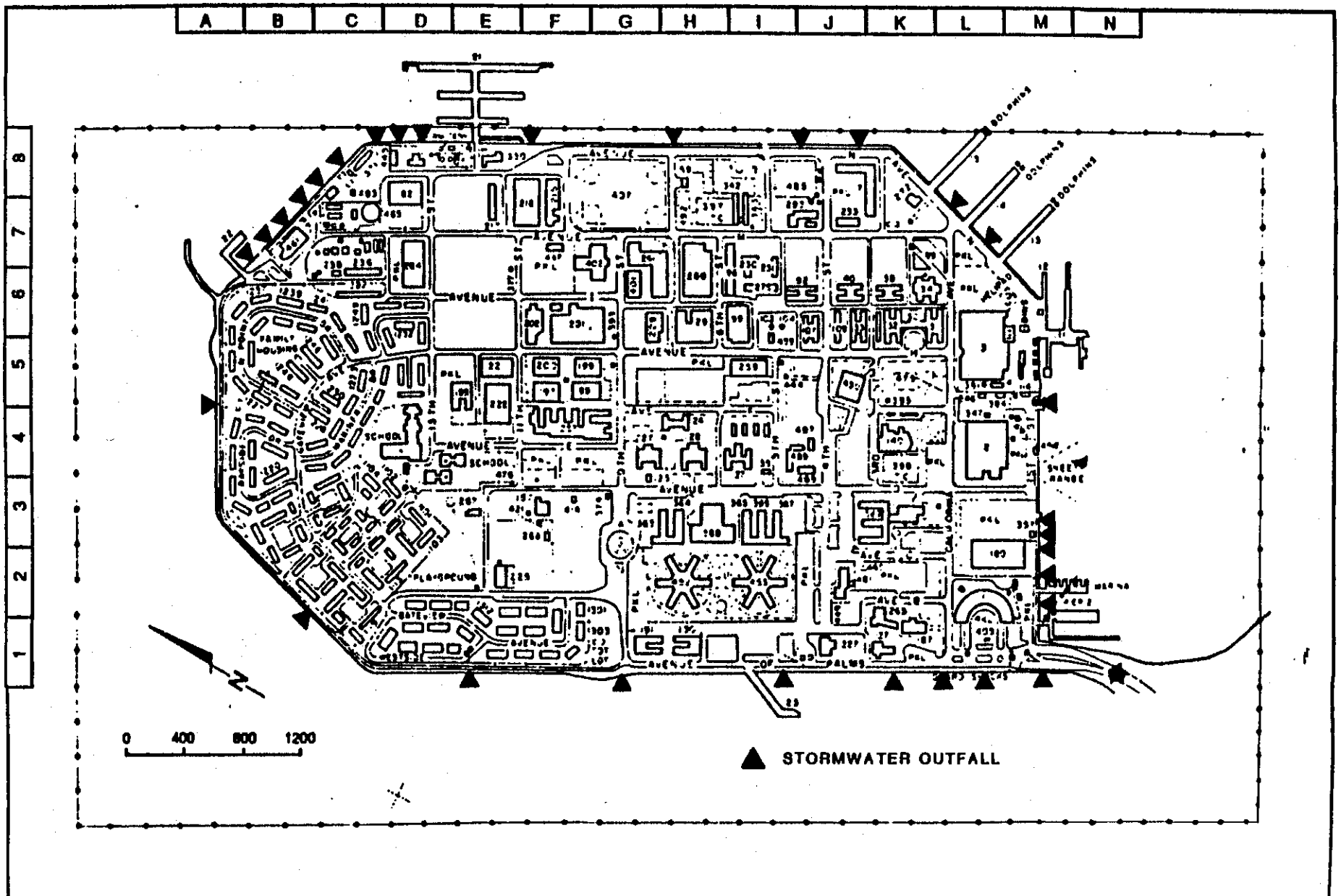
**SITE 12 TRENCH LOCATIONS-
1968 FOUNDATION INVESTIGATION**

FIGURE
8-15



Reference: MKE - Abrams - Keller & Gannon (1968)

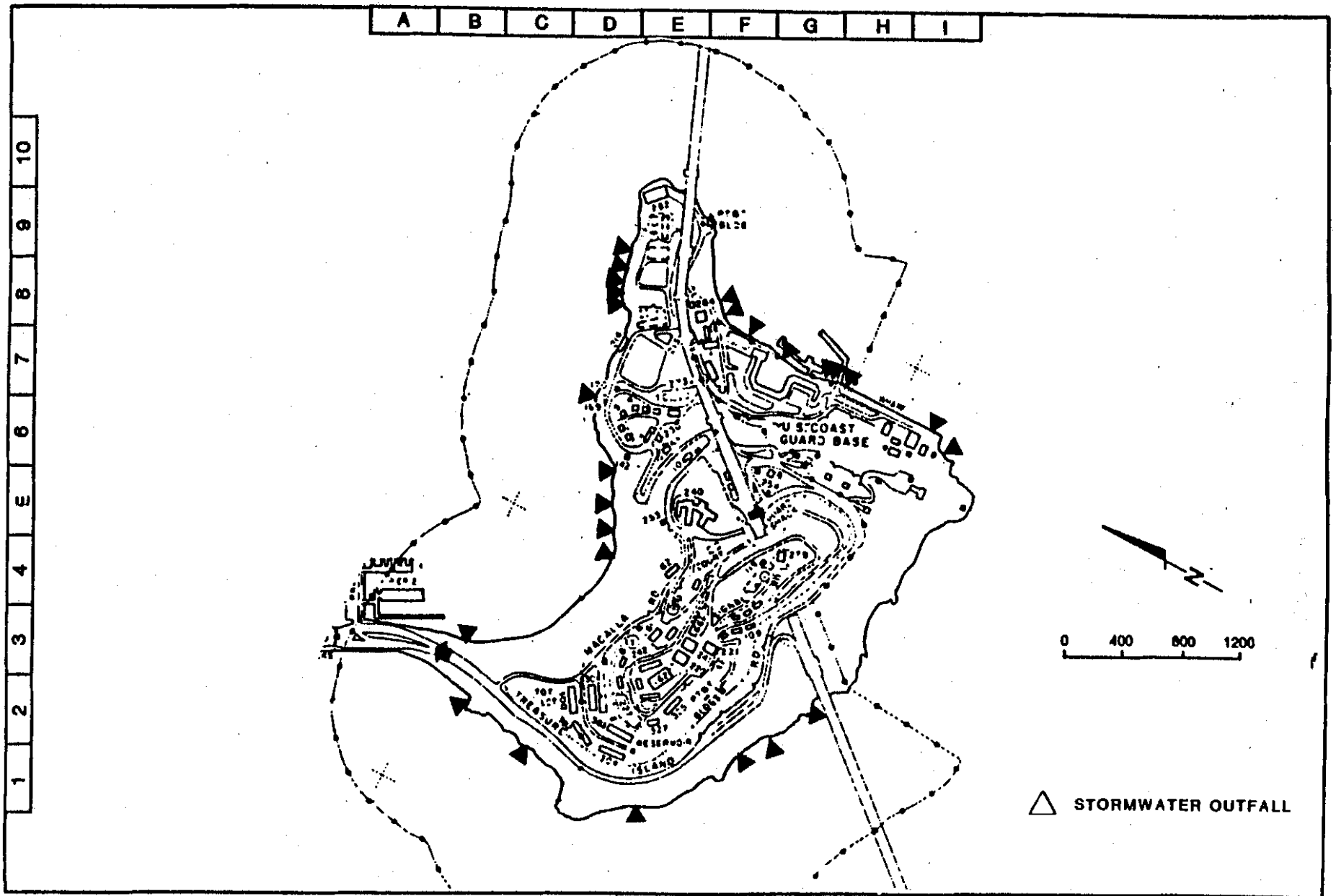
PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	SITE 12 TYPICAL TRENCH LOGS	FIGURE 8-16



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 13
STORMWATER OUTFALLS, TI

FIGURE
8-17



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 13
STORMWATER OUTFALLS, YBI

FIGURE
8-18

Contaminants carried in the WWT effluent were characterized for the 1984 NPDES permit and are discussed in Section 7.1. These contaminants are illustrative of those discharged since secondary treatment at the WWT began in 1969, at the outfall adjacent to the plant. For reference, Table 8-2 summarizes various chemical concentrations of Bay sediments.

The storm sewer system has discharged contaminants deposited in it by surface water flow from all areas of TI and YBI. Contaminants could include:

- pesticides, herbicides, and insecticides (e.g. Site 7);
- paint-related compounds (solvents, lead, zinc, and chromium) (e.g. Site 7 and Site 10);
- hydrocarbons generated at service stations, the Transportation Center, the Auto Hobby Shop (degreasers, oils, fuels, solvents, and grease) (e.g. Site 22);
- hydrocarbons generated during refueling operations (black oil, and diesel fuels);
- hydrocarbons generated during spill incidents on land (gasoline, and diesel fuel) (e.g. Site 17 and and Site 25);
- wastes generated by tenant activities: NTTC Fire Fighter School - oil, fuel, and fire fighting chemicals (e.g. Site 6); NTTC Boiler Water/Feeder Water School - mercuric nitrate; and Hydraulic Shop - waste oil (e.g. Site 4);
- PCBs from leaking transformers and spill incidents (e.g. Site 3).

Contaminants collected in the stormwater system have been discharged through outfalls surrounding TI and YBI. However, because of current action and tidal scour, the buildup of sediments is greatest along the northern and eastern coast of TI, Clipper Cove, and the eastern and southern coast of YBI.

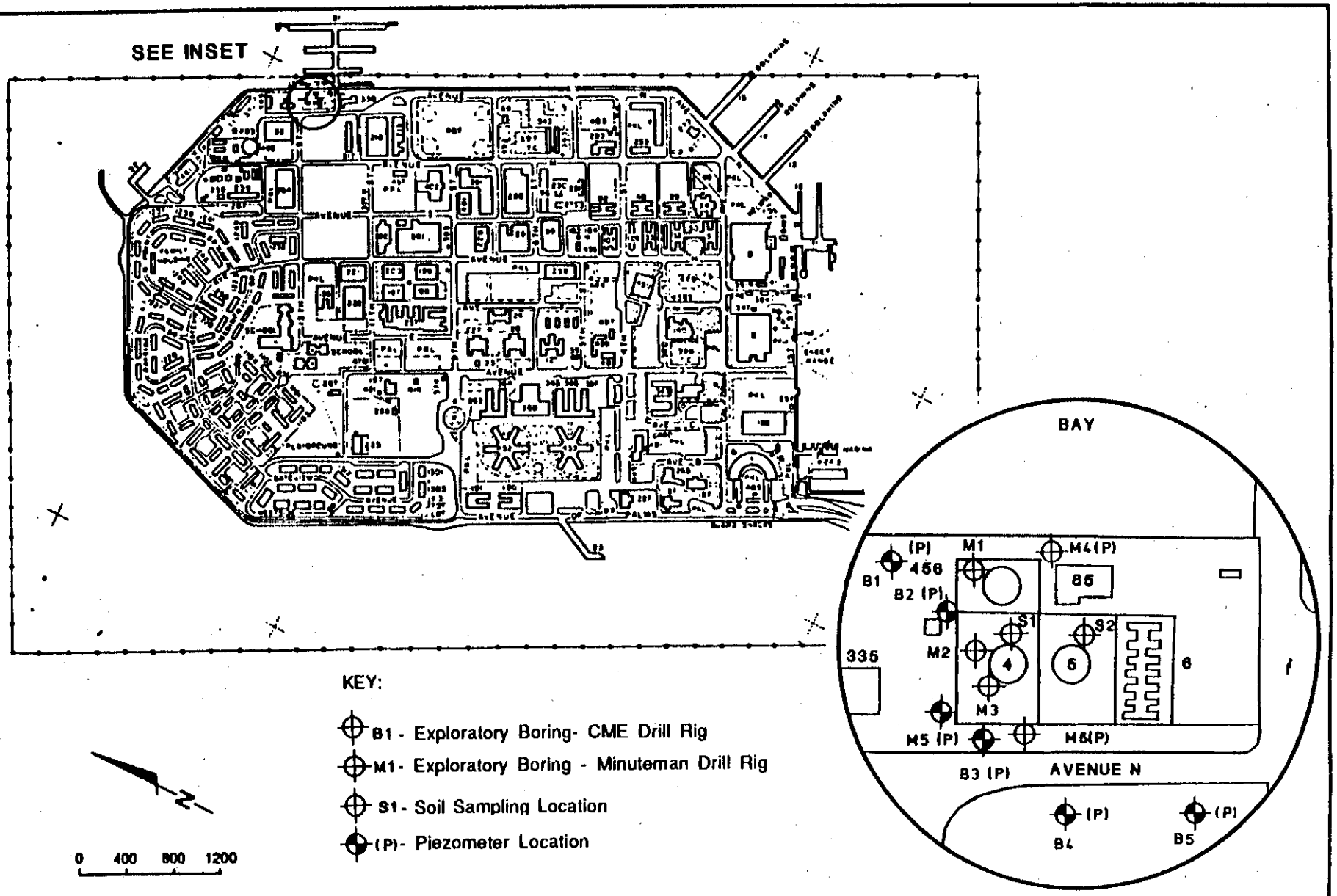
8.14 SITE 14: NEW FUEL FARM. (D8-E8, TI) Approximately 20,000 gallons of fuel were released from Tank 4 at the New Fuel Farm (Figure 8-19) during the period from November 1984 to February 1985. A subsequent investigation by Smith and Denison (1985) revealed cracked and corroded tank walls and floors. Analyses of samples from monitoring wells and borings placed around the tanks (WESTDIV, 1986; Figure 8-19) revealed detectable hydrocarbons but in concentrations incompatible with a leak of such magnitude. Concentrations of volatile hydrocarbons found in soil samples taken from borings M1 through M5, S1 and S2 ranged from 7.3 to 150 mg/kg (milligrams per kilogram). Concentrations of volatile hydrocarbons detected in water samples taken from borings and wells B1 through B5, M1 through M6, S1 and S2 ranged from less than 0.005 milligrams per liter (mg/l) to 1.84 mg/l. The greatest concentrations of hydrocarbons were found in wells M1 through M5 which were placed around the northern half of the fuel farm as shown on Figure 8-19. Water from two of the monitoring wells also contained hydrocarbons in excess of California State Drinking Water Standards.

TABLE 8-2 SUMMARY OF BAY SEDIMENT CHEMICAL PROPERTIES

Location	Date Sampled	Constituents				
		Mercury (mg/kg)	Cadmium (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)	Oil & Grease (mg/kg)
Alameda NAS	7/72	0.2–0.7	0.5–1.7	27–87	82–180	420–1700
	5/73	0.08–1.4	0.8–3.4	5–150	16–380	120–5500
	10/74	0.2–1.0	0.9–4.5	37–134	62–185	380–3000
Concord NWS	6/74	0.2–0.4	0.3–2.0	14–87	68–500	300–1500
Mare Island	8/72	0.4–0.7	0.7–6.7	30–120	160–291	300–1400
	2/72	0.2–0.7	2.0	25–35	80–125	500–34,000
Motba E.	8/73	0.1–2.2	---	14–136	41–274	300–1100
Motba N.	11/74	0.3–1.0	0.9–1.9	34–90	85–186	820–2200
Motba S.	11/74	0.5–0.8	1.2–1.8	44–83	118–172	940–1500
Pt. Molate	7/74	0.2–1.0	0.7–2.2	6–26	80–160	200–1600

Reference:

Adapted from International Engineering Co., Inc., 1975. Final Report Engineering Concept Study Dredge Spoils Disposal Facility, Skaggs Island, California.



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 14
NEW FUEL FARM

FIGURE
8-19

Previous reports (WESTDIV, 1986) also state that sludge from the tank bottoms has been historically disposal of into pits excavated adjacent to the tanks. In addition, water has been historically bled from the fuel farm tanks and this bleed water was allowed to infiltrate into the soil surrounding the tanks. The bleeding would continue until product was visible in the water. Hence, the water released contained some small percentage of hydrocarbons which may have accumulated in the soil over a period of years. The fuel farm area was paved about 1981 and the bleeding operation was stopped.

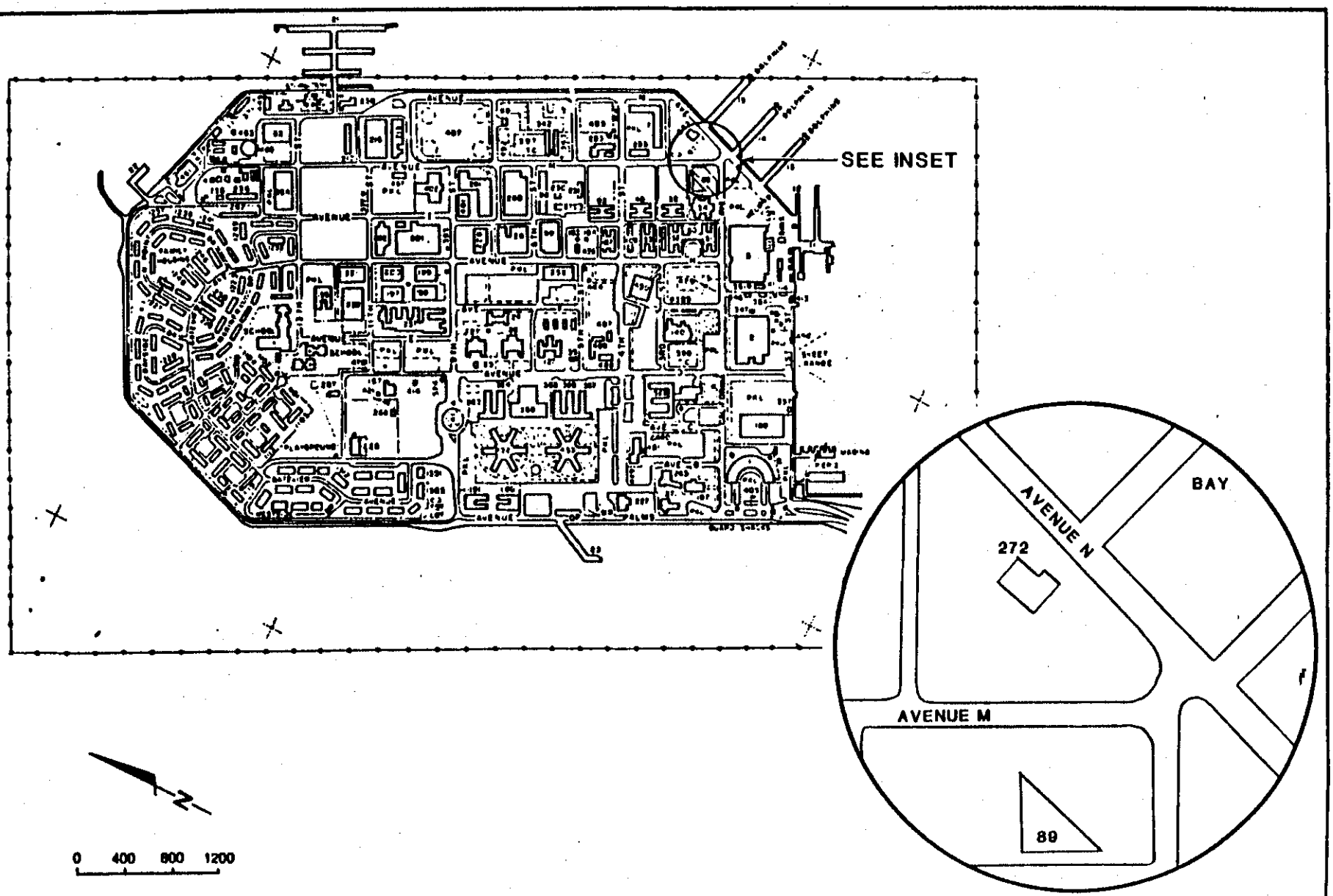
The WESTDIV (1986) report concluded that the contamination present is due to tank leakage and other sources such as surface spills and sludge disposal. The contamination is now concentrated in the vadose zone beneath the concrete-paved tank pad. Because infiltration of percolating water is effectively prohibited by the concrete, the contaminants are now relatively immobilized.

Deeper contamination, below the water table, was not explored by the report. Recommendations included continued ground water monitoring and sampling, installation of additional monitoring wells along the shore east of the fuel farm, additional soil and water sampling around Tank 5 and around the horizontal tank area, and further evaluation of the possibility of adding an extraction and recovery system.

8.15 SITE 15: OLD FUEL FARM. (K7-L7, TI) Two above ground 210,000 gallon diesel fuel storage tanks (4 and 5) were located east of Building 89 (Figure 8-20) before about 1943 when they were moved to the current fuel farm, Site 14. The tank locations are not precisely known as no air photos or plans were found which pre-date 1943. Based on available information, there is no history of spills associated with the former tank locations. However, it was reported that associated underground pipelines were abandoned without first draining fuel from the lines. Excavations at the nearby commissary in 1985 and for the new pier facility (also in 1985) both revealed soil suspected of containing oil and/or hydrocarbons.

8.16 SITE 16: CLIPPER COVE TANK FARM. (B3, YBI) Ten above ground storage tanks of 50,000 gallon capacity each, were located on YBI from at least 1943 until they were dismantled by a private contractor in the 1960s (Figure 8-21). The tanks were reported to have stored aviation gasoline and automotive diesel. Unknown quantities of sludge were removed from the bottom of the tanks at that time. The sludge was reportedly deposited on bare ground on the cliff ledge northeast of the tanks. No record exists documenting the sludge removal and disposal. The sludge was apparently left to erode and wash away into the Bay and/or be absorbed into the underlying soil over a period of years. Surface soil samples taken by NEESA in the vicinity of the tanks revealed lead (in concentrations of 89 to 160 mg/kg) and total petroleum hydrocarbons (240 to 540 µg/g) (see Appendix B). The lead concentrations are below total threshold limit concentrations, but the hydrocarbons exceed the 100 µg/g California limit. A more thorough soil sampling program may help pinpoint the disposal location, although it is likely that little trace of the sludge remains. The site is currently a picnic area, including a barbecue pit.

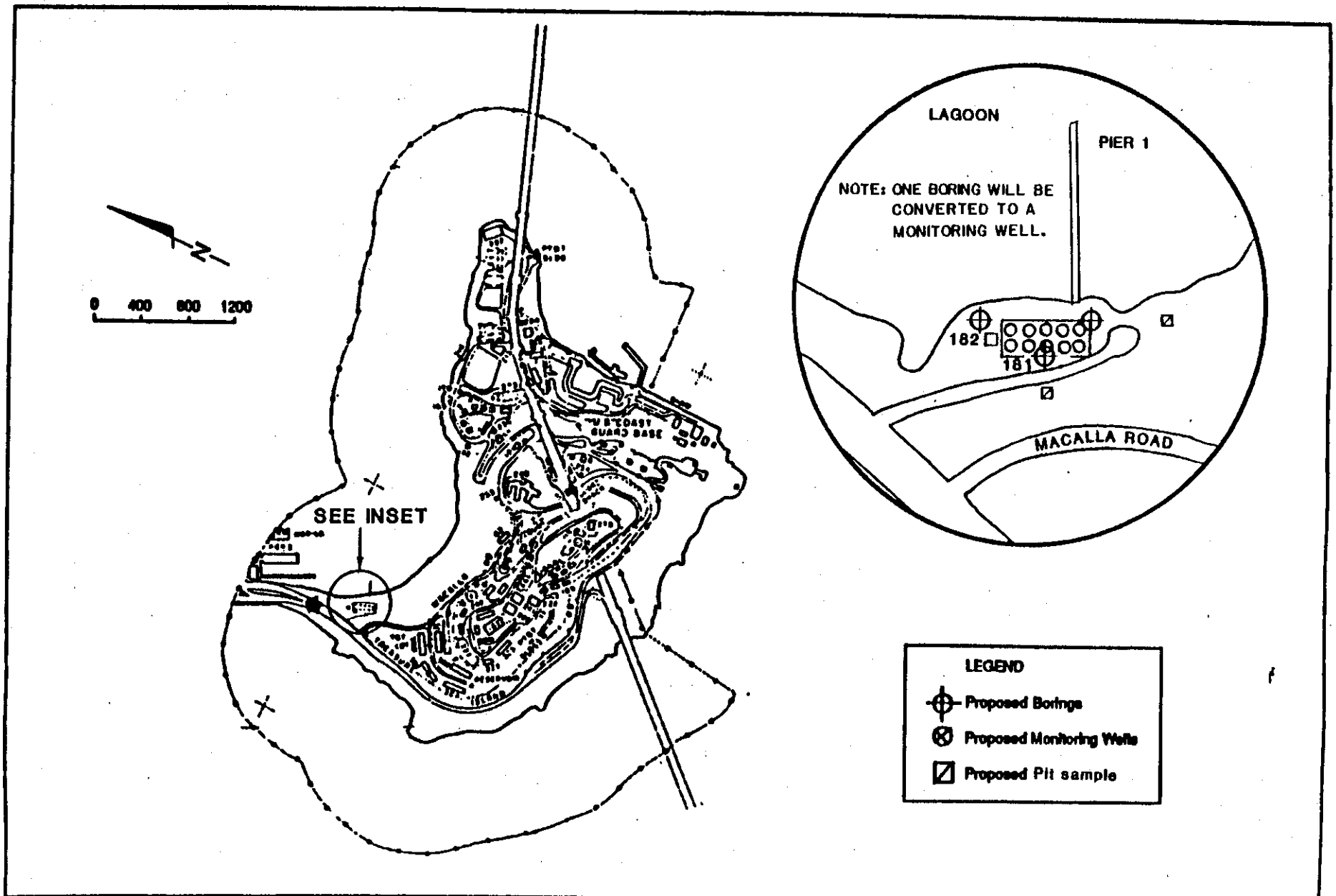
8.17 SITE 17: TANKS 103/104. (I6, TI) An estimated 20,000 gallons of fuel oil were reportedly spilled from Tank(s) 103 and 104 (200,000 gallon capacity,



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 15
OLD FUEL FARM

FIGURE
8-20



PRELIMINARY ASSESSMENT/ SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 16
CLIPPER COVE TANK FARM

FIGURE 8-21

each; Figure 8-22). No exact date for the release was available, but it was reported to have occurred about 1983. A specific cause for the incident was not available. At the time of the release, the tanks stood on bare ground; the area around these tanks about 130 ft by 220 ft has since been bermed and paved.

It was also reported that at least once waste oil was spread around the base of Tanks 103 and 104 for weed and dust control, an area of several hundred square feet. The date, quantity, and source of oil for the incident were not identified. The waste oil may have contained PCB.

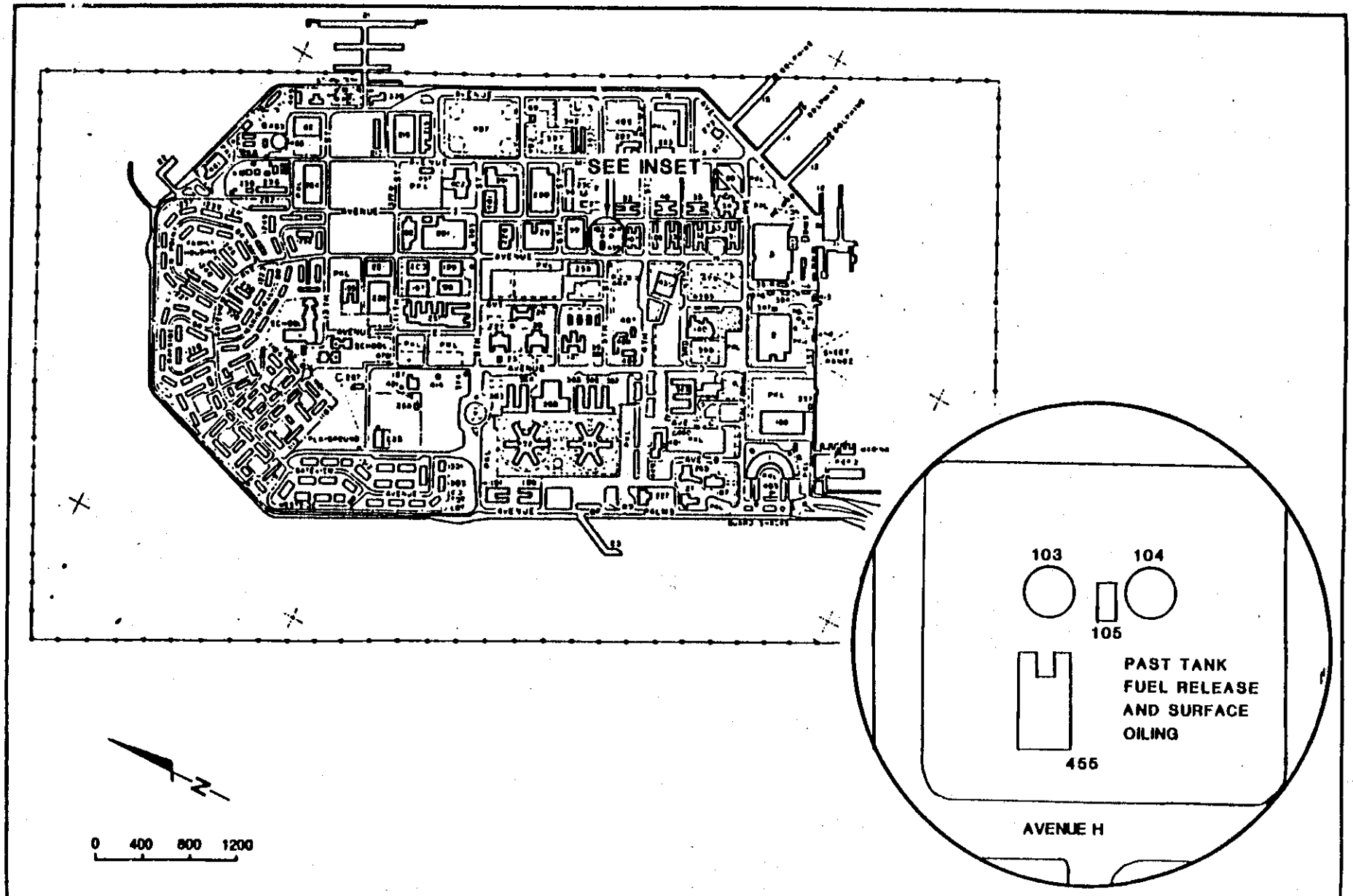
8.18 SITE 18: ASBESTOS-COVERED PIPING, YBI. (G5, YBI) It was reported that as a result of a landslide in the early 1980s on YBI, abandoned steam piping was exposed which was insulated with asbestos (Figure 8-23). No other information was found to confirm this report nor were plans located which suggested the presence of such lines. Because any asbestos coating on other lines is buried with the lines, the asbestos may be considered to be contained. The possibility of such lines becoming exposed (e.g., through maintenance operations) and thus presenting a hazard is low given the nature of operations on YBI.

8.19 SITE 19: REFUSE TRANSFER AREA. (H8-I8, TI) A rubbish transfer area has been located to the east of Building 342 along Avenue M since about 1953 (Figure 8-24). Trash is transferred from small containers to large bins which are transported off-station for disposal. The area contains a paved disposal ramp for trucks to back up and deposit their contents in large containers. Several large containers are stored on the site. Small quantities of miscellaneous trash were spread around the area. There were several small areas of oil contaminated soil associated with leaking engine fluids. The transfer area is approximately 200 ft by 130 ft in plan dimension.

8.20 SITE 20: AUTO HOBBY SHOP/TRANSPORTATION CENTER. (E2, TI) During the period from approximately 1943 to 1950 Buildings 194, 224, 225, and 267 were used as a transportation center where steam cleaning and/or degreasing of vehicles took place (Figure 8-25). Only Building 225 remains. The waste fluid drained from the vehicles was apparently allowed to run off into the storm sewer system and ultimately into San Francisco Bay. It is uncertain whether or not any of the fluids were alternatively routed to the wastewater treatment plant or recycled.

At an unspecified time, Building 225 was converted to the Auto Hobby Shop. Drums of hydraulic fluid, recycled oil, and other vehicle fluids are stored on pallets in the rear yard of the Shop. This practice was common through the history of the shop. The ground and concrete beneath the drums is stained (darkened), apparently by fluid from the drums. The stain extends to the gutter and storm drain as shown on Figure 8-25. Soil surrounding the drums was sampled and revealed the presence of chromium at concentrations of 44 and 67 mg/kg, lead at 270 and 700 mg/kg, nickel at 28 and 35 mg/kg, zinc at 160 and 470 mg/kg, oil and grease at 13,300 and 28,200 mg/kg, and total petroleum hydrocarbons at 9700 and 25,000 µg/g (Appendix B).

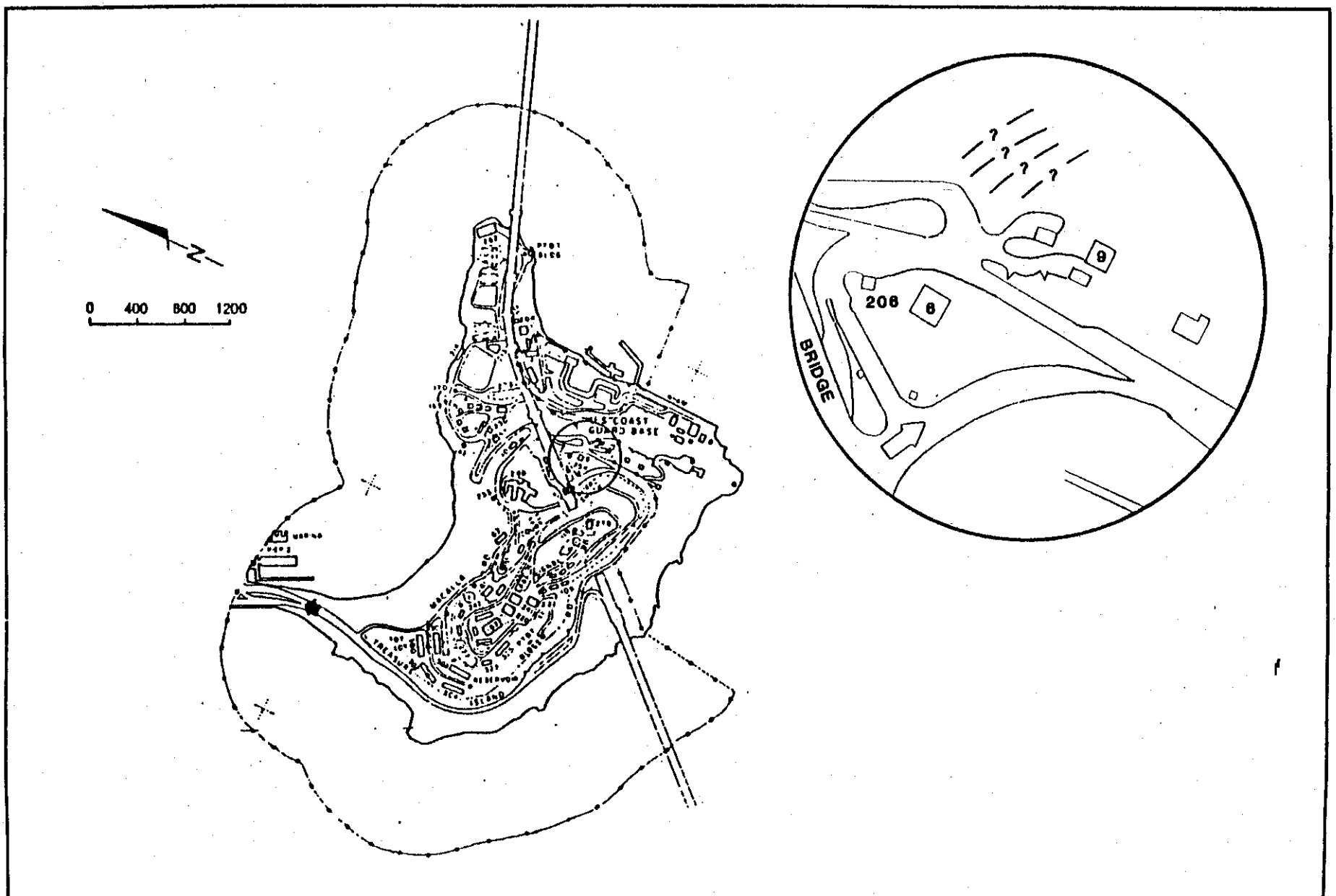
An investigation performed by BSK Associates (1987) of the area surrounding Building 225 included advancing 10 borings, 3 of which were converted to monitoring wells as shown on Figure 8-25. Soil samples from 6 of the borings



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 17
TANKS 103/104

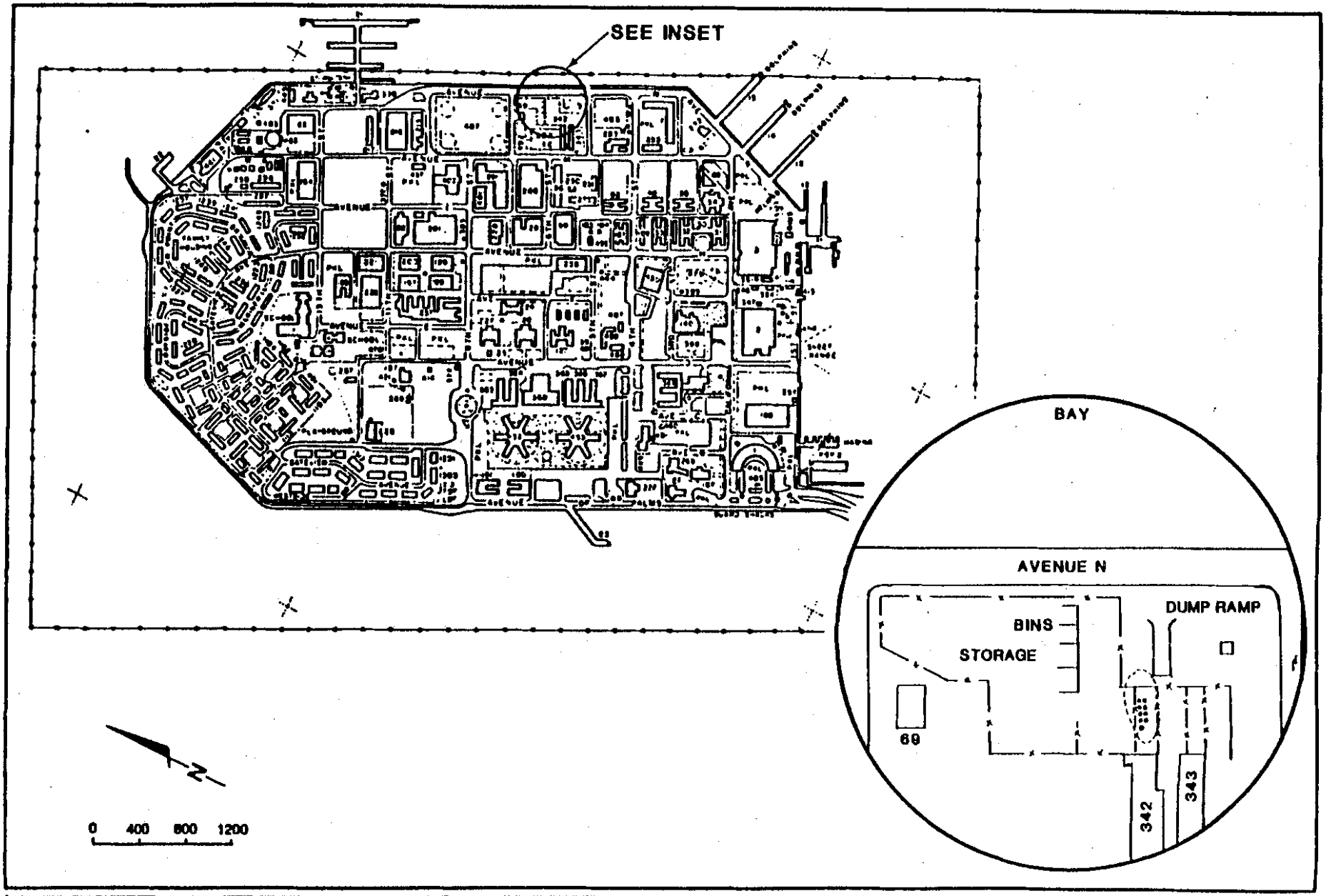
FIGURE
8-22



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 18
ASBESTOS COVERED PIPING, YBI

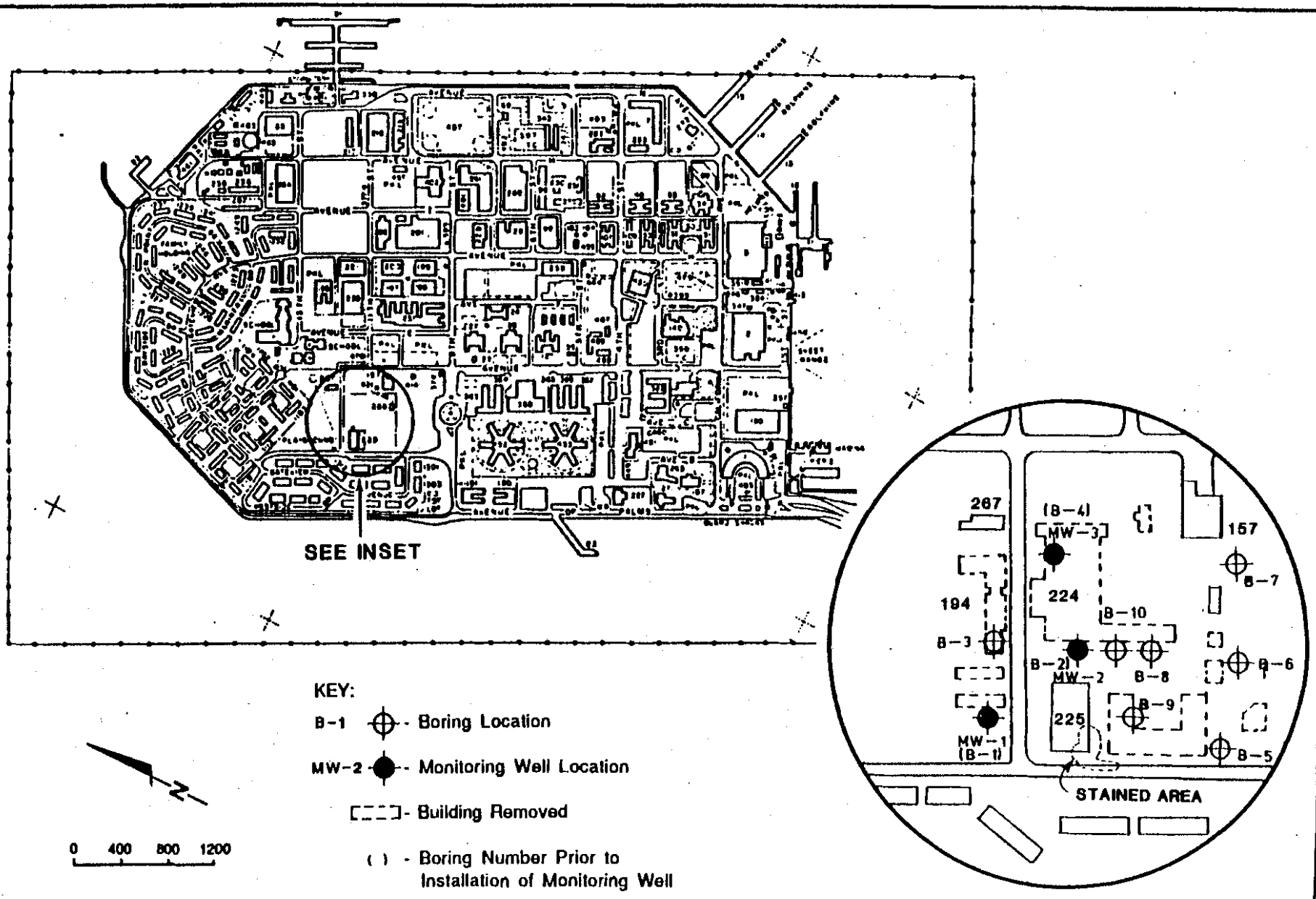
FIGURE
8-23



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 19
REFUSE TRANSFER AREA

FIGURE
8-24



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 20
AUTO HOBBY SHOP / TRANSPORTATION CENTER

FIGURE
8-25

were analyzed for total volatile hydrocarbons and total extractable hydrocarbons. Soil from boring B-2 contained concentrations of volatile hydrocarbons at 241 mg/kg and extractable hydrocarbons at 104 and 2 mg/kg. A soil sample from boring B-1 contained 30 mg/kg of extractable hydrocarbons. Water from boring B-2 contained volatile hydrocarbons of 195 mg/l (milligrams per liter) and extractable hydrocarbons of 320 mg/l.

Analyses of soil and water samples from boring B-2 for Organochlorine Pesticides and PCBs did not detect any contaminants; analyses of soil and water samples from boring B-2 for EPA metals revealed the presence of arsenic, chromium (+6), copper, lead, mercury, nickel, and zinc all at levels far below Total Threshold Limit Concentrations (TTLC) and Soluble Threshold Limit Concentrations (STLC).

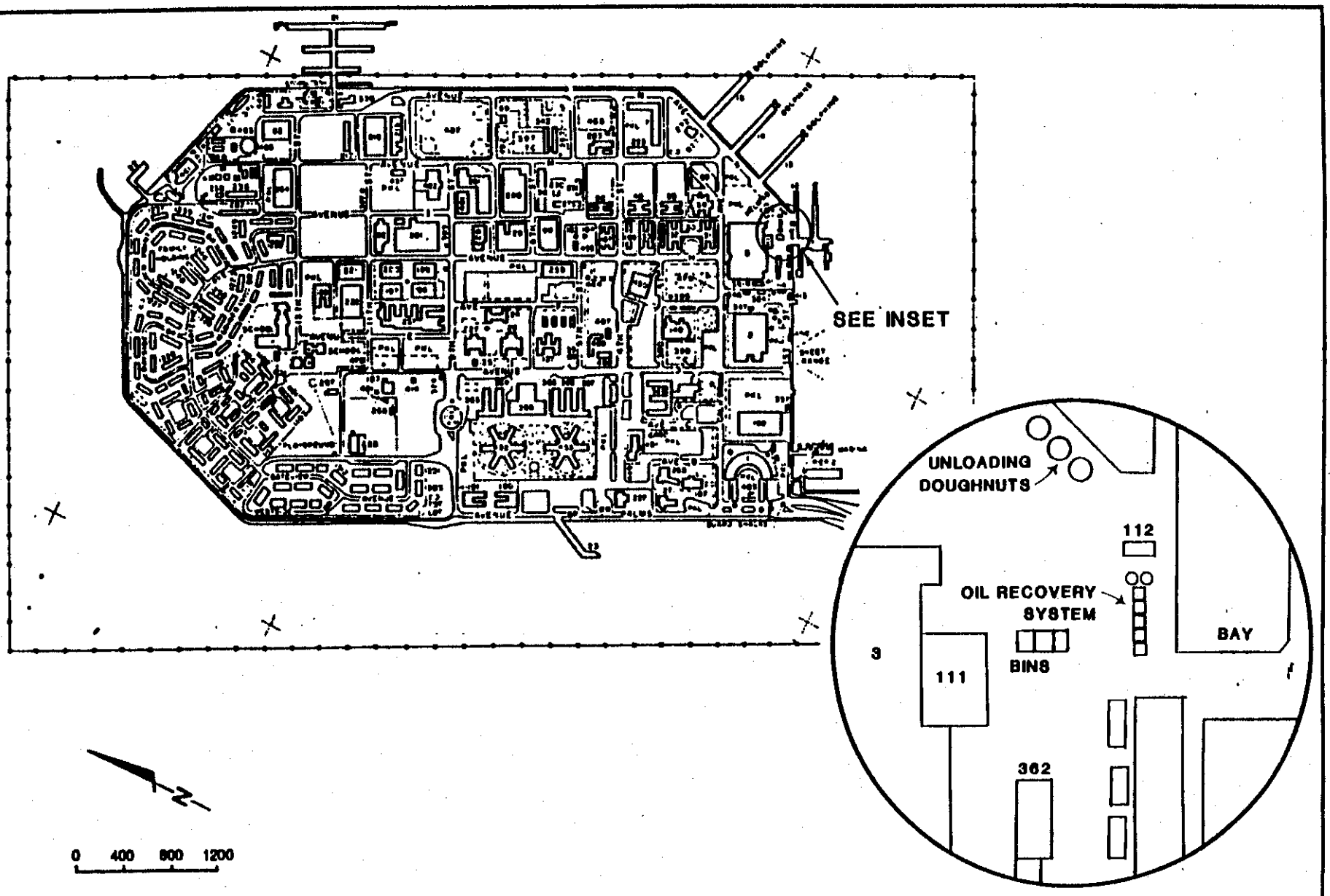
Several underground tanks may have been located in this area which have been abandoned in place. Locations include three known tanks east of Building 225 near boring B-2 and possibly others east and northeast of Building 225. The location of underground tanks associated with the former gas station (Building 370), transportation centers, and vehicle cleaning area may account for the presence of the contaminants detected as described above.

8.21 SITE 21: VESSEL WASTE OIL RECOVERY. (M5-M6) Waste oil from vessels is unloaded into cylindrical steel shells (DONUTs) which are maintained partly above and partly below the water surface. Current DONUTs have bottoms which prevent the oil from contacting the water. Older models did not have bottoms and the oil directly contacted the water. The DONUT is maneuvered to shore and pumped through an oil/water separation system (Figure 8-26). The separator and DONUTs stand on a paved area which is heavily stained. The recovered oil is recycled. Volumes of waste oils anticipated for 1975 were at 271,900 gallons per year according to a NAVSHIPS/NAVSEC (1972) document. Contamination at this site may involve sediments, due to spills and contact in older DONUTs, and onshore soils, due to spills associated with the separator.

Sediments in this area may also be contaminated with mercury as a result of vessel boiler operations. Mercuric nitrate is introduced to the vessel boiler lines to inhibit scale. The systems are occasionally purged and liquids are dumped at sea or in dock.

8.22 SITE 22: NAVY EXCHANGE SERVICE STATION. (E8, TI) Recent examination of the storm drain at the service bay of the Naval Exchange Service Station (Figure 8-27) has revealed that filters and vehicle fluids have been deposited in the storm drain. The ultimate receptors of the waste fluids are organisms in San Francisco Bay. The condition of the materials found in the storm drain indicates that the practice has been occurring for some time although the volumes of fluids and materials released is unknown. A 1972 NAVSHIPS/NAVSEC report estimated that by 1975 12,000 gallons of waste oils and fluids would be generated from service station activities.

Three underground storage tanks are located at the service station, as shown in Figure 8-27. Because the service station has been in operation since 1946, it is likely that fuels have leaked from the tanks or tank fill pipes and have also spilled in the area.



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 21
VESSEL WASTE OIL RECOVERY

FIGURE
8-26

8.23 SITE 23: YBI LINE BREAK. (D5, YBI) A landslide in early 1980s reportedly ruptured a pipeline on YBI (Figure 8-28). The line carried black oil from fueling Pier 3/4 uphill to storage Tank 117 located on top of YBI. Although the volume of product released is not known, the capacity of the line was about 400 gallons between the Pier and Tank 117. The landslide occurred at a steep, rocky cliff face with minimal soil cover and the spilled product is assumed to have been carried via surface water flow to the Bay.

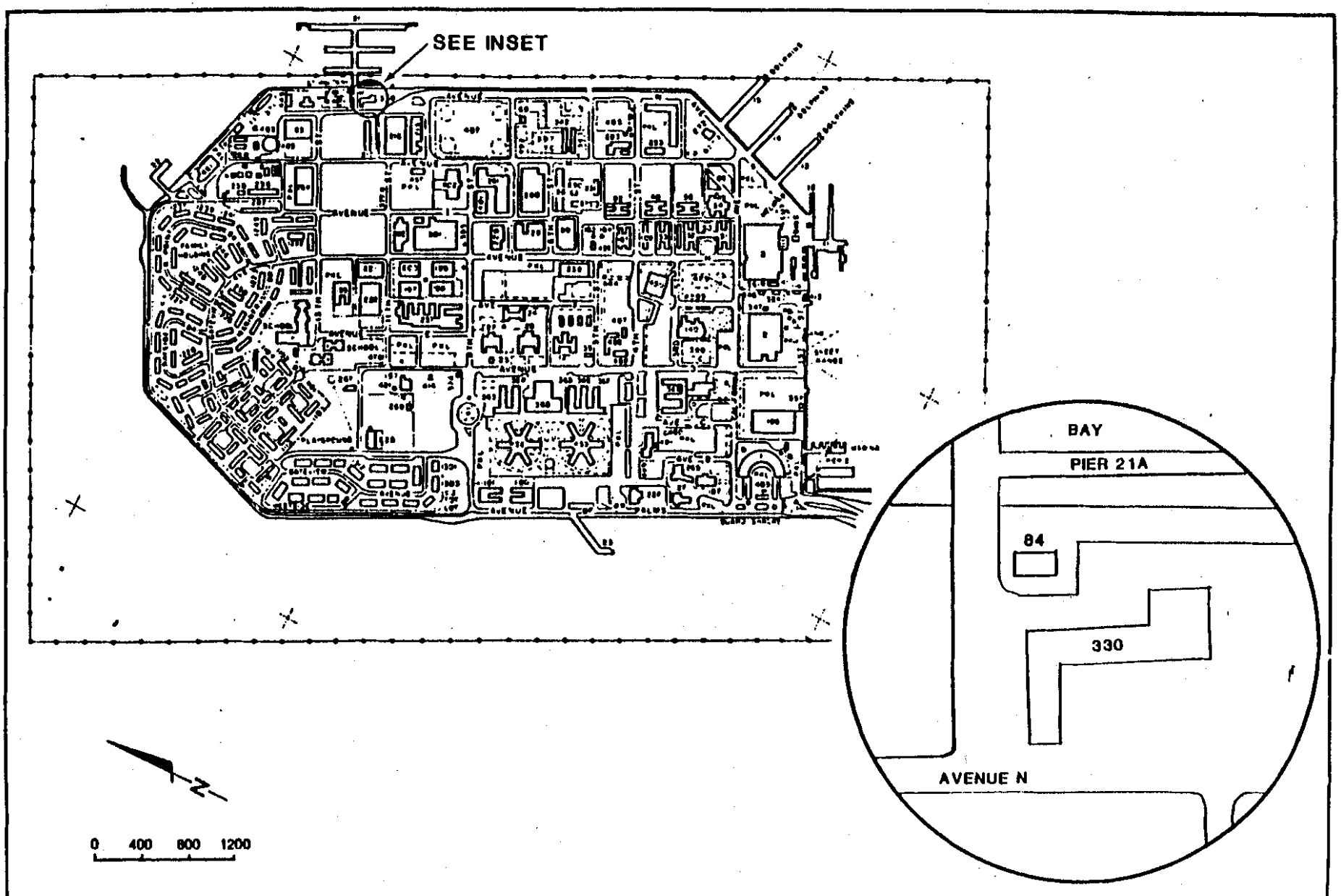
8.24 SITE 24: 5TH STREET FUEL RELEASES. (I6-I8, TI) Abandoned underground pipelines on TI have reportedly leaked recently in three locations along 5th Street in the vicinity of Buildings 293 and both 40 or 92 (Figure 8-29). The leaks were discovered in 1986 and 1987 and excavated soil was sampled in October 1987. Analyses of samples north of Building 293 reveal the presence of oil and grease from 470 to 7,450 mg/kg and total petroleum hydrocarbons at 180 to 5,100 µg/g. A sample northeast of Building 40 had oil and grease at 680 mg/kg and total hydrocarbons at 500 µg/g. The pipelines were once used to transport grade 6 fuel oil but were abandoned in place about 1985. A cathodic protection system was installed between 1980 and 1985 to help protect the existing pipelines from corrosion. The system was installed incorrectly and may have actually enhanced the corrosion of the pipeline system. The actual quantity of leaked fuel or oil has not been estimated.

The pipeline network which was formerly used to transport oil and fuel has in many cases been abandoned in place without first draining the pipeline. The actual volume of in place oil may have been up to 10,000 gallons, but the locations of the abandoned pipeline segments are unknown. This practice of in-place abandonment has presumably occurred from 1950 to present, paralleling the abandonment of fuel storage tanks, fueling piers, fueling stations, and buildings which required fuel deliveries. Abandoned pipelines may be located both on TI and YBI.

8.25 SITE 25: SEAPLANE MAINTENANCE. (L2-L6, TI) During the period from about 1943 to 1958 seaplanes were maintained in Buildings 2, 3, and 180 (Figure 8-30). Little information exists regarding operations, but apparently engineering work and cleaning occurred. Given the method of waste handling with regard to other similar operations (i.e. Auto Hobby Shop), further investigations may determine if contamination is present. Based on other operations on TI during the same time period, waste liquids or solvents from engine cleaning may have been deposited in the Bay via the storm drain system or directly to the ground surface.

The ten aviation gasoline tanks adjacent to Building 2 have not been located precisely nor is there a record of their abandonment. Tanks may have also been located west and south of Building 2. No records of leakage associated with these tanks were found.

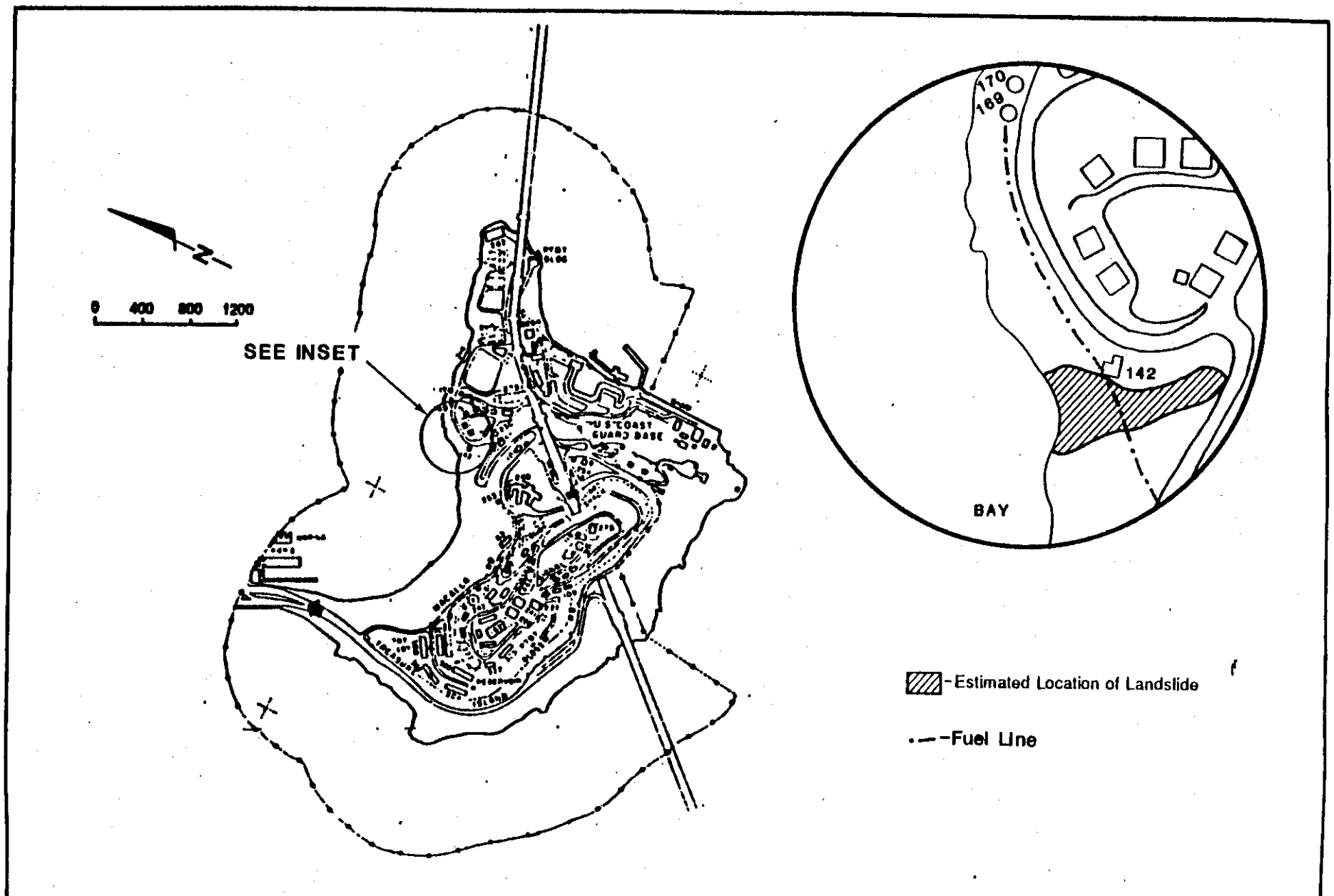
8.26 SITE 26: UNDERGROUND TANKS. The locations of suspected underground tanks on TI (excluding Site 6: Fire Training Area tanks) and YBI are shown on Figure 8-31. ERM-West (1987) located 28 underground tanks and filed closure plans for 21 underground tanks. An additional 16 potential underground tank locations remain. These suspected tank locations were identified by field inspection, during discussions with station personnel, and by NAVFAC Drawing 6085580P (November 16, 1984). Information regarding each tank is given in Table 8-3.



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 22
NAVY EXCHANGE SERVICE STATION

FIGURE
8-27



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

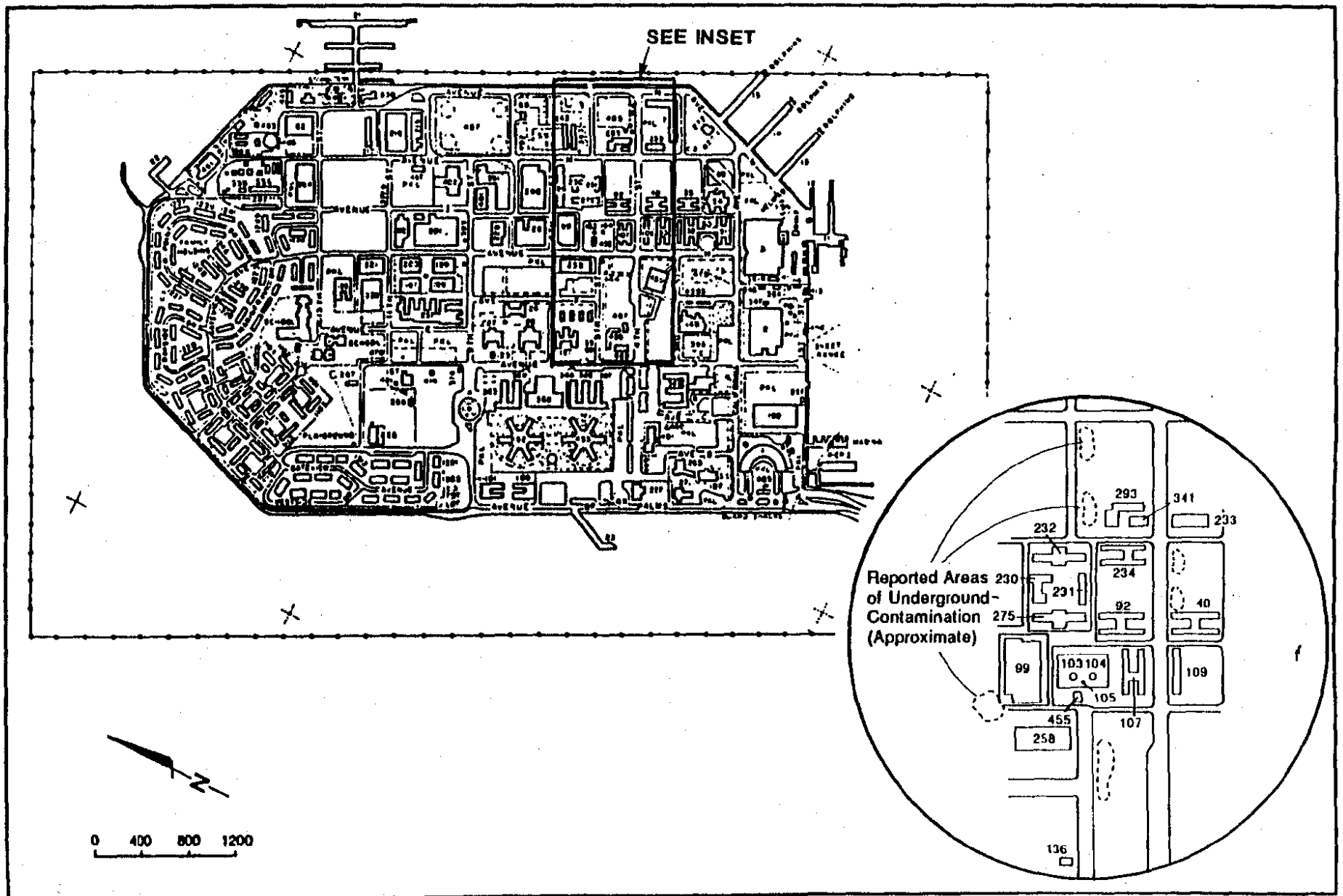
SITE 23
YBI LINE BREAK

FIGURE
8-28

TABLE 8-3

SITE 26: UNDERGROUND TANKS

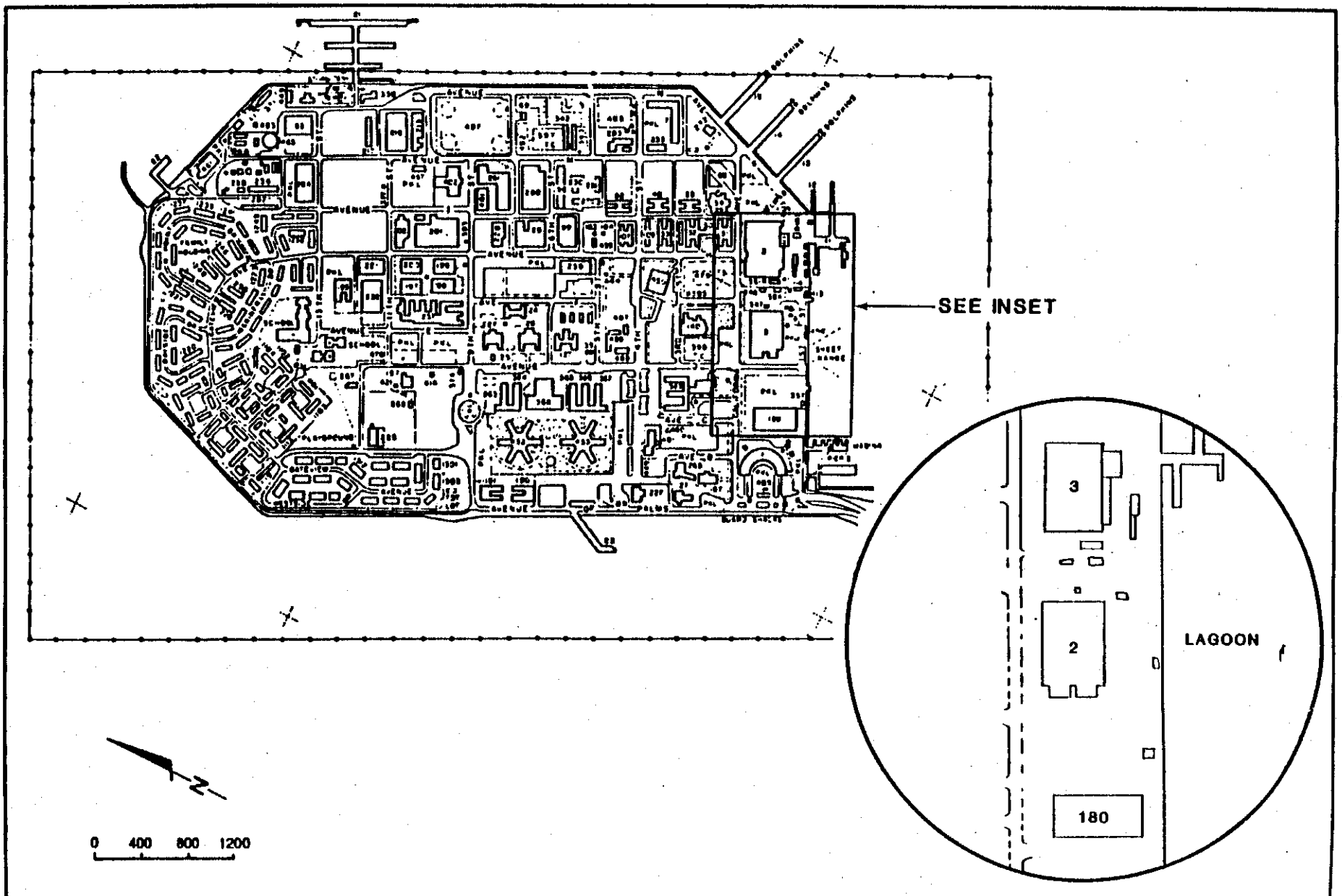
NUMBER TANKS	LOCATION	AGE	MATERIAL	SIZE	CONTENTS	COMMENTS
2	Approximately 100' each of NE corner of former gas station 370-TI near former Building 224-TI	Building 224 used from pre-1943 until demolition prior to 1981	Steel	Unknown	Diesel?	Found two vertical pipes in open field near former site of Building 224-TI -- possibly associated with package boilers.
1	Approximately 300' east of NE corner of Building 92-TI	Building 234 used from pre-1943 until demolition prior to 1981	Steel	Estimated 500 Gallons	Diesel?	Found vertical pipe in open field near former site of Building 234-TI.
10	Adjacent to (south of) SE corner of Building 2-TI	Used from pre-1935 to	Steel	4,000(?) Gallons Each	Aviation Fuel	Found vertical pipe approximately 50' west and 4' south of SE corner of Building 2-TI -- possibly associated with the aviation tanks.
7	Buildings 1 through 7-YBI with one tank per building	Buildings operational from pre-1935 to present	Steel	Estimated 500 Gallons Each	Diesel	Indicated as possible tanks associated with package boilers for each building (quarters) -- from personnel interview.
1	Adjacent to (NW of) Building 66-YBI	Buildings operational from pre-1935 to present	Steel	Unknown	Unknown	Indicated during personnel interview. Uncertain use. Possible tank for package boiler.
1	Approximately 75' SE of Building 213-YBI	Building in use from pre-1935 until at least 1953	Steel	Estimated 500 to 1,000	Diesel	Indicated during personnel interview. Uncertain use, possible tank for package boiler.
1	Adjacent (?) to Building 204-YBI	Gas station from pre-1935 until conversion to fire station on or before 1947	Steel	Estimated 1,000 to 4,000 Gallons(?)	Diesel and/or Gasoline	Indicated during personnel interview -- tank associated with former gas station location-YBI.
1	Adjacent to Building 8-YBI	Building in use from pre-1935 to present	Steel	Estimated 500 Gallons	Diesel(?)	Indicated during personnel interview -- tank associated with possible package boiler for quarters-YBI.
1	Adjacent to Building 9-YBI	Building in use from pre-1935 to present	Steel	Estimated 500 Gallons	Diesel(?)	Indicated during personnel interview -- tank associated with possible package boiler for quarters-YBI.



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 24
5th STREET FUEL RELEASES

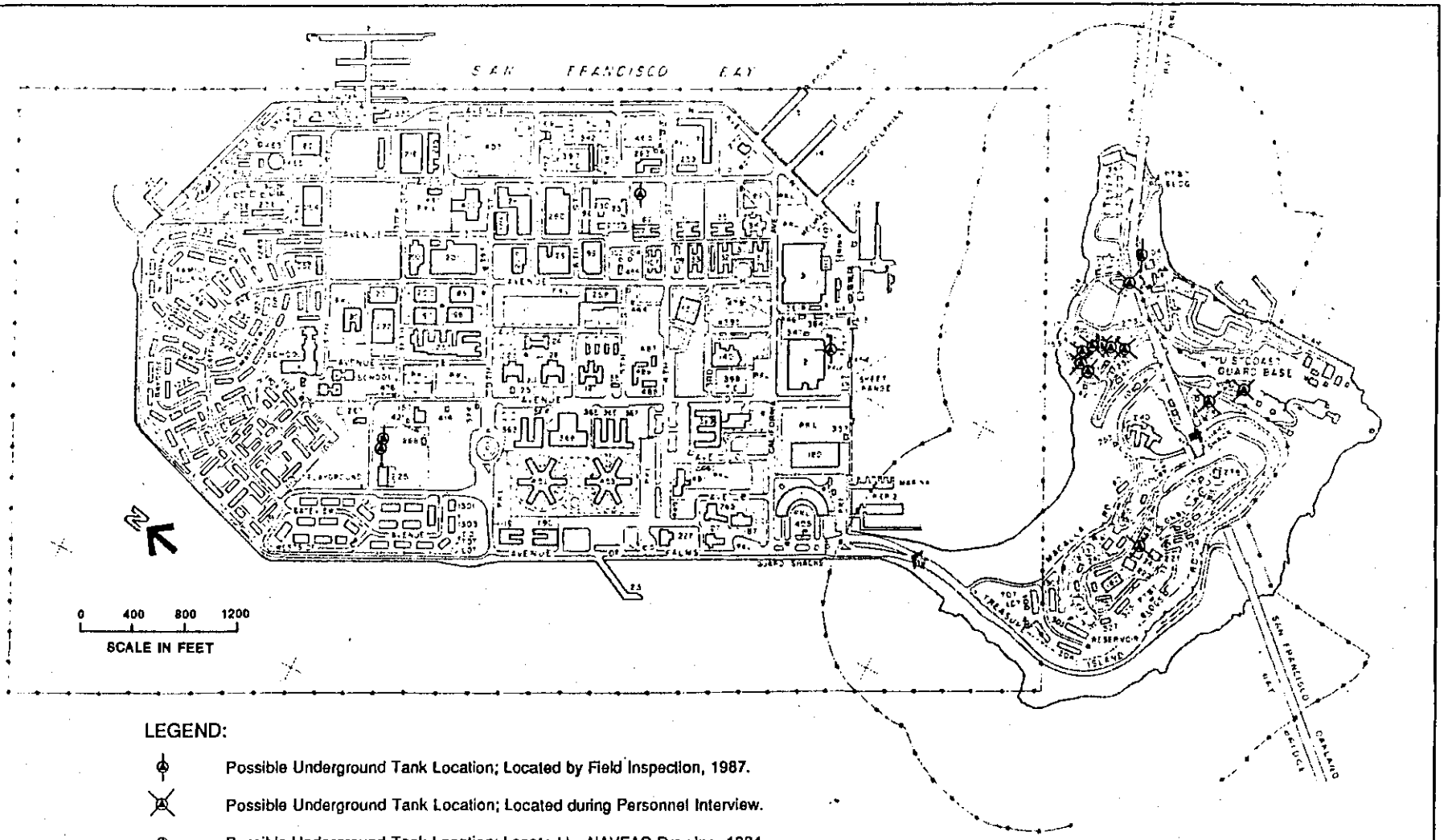
FIGURE
8-29



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 25
SEAPLANE MAINTENANCE

FIGURE
8-30



PRELIMINARY ASSESSMENT/
SITE INSPECTION
NAVSTA Treasure Island, Ca.

SITE 26: UNDERGROUND TANKS

FIGURE
8-31

Four potential locations were identified during field inspection due to unexplained vertical pipes, possibly fill pipes, protruding from the ground east of Building 225, in the field east of Building 92 and against the south side of Building 2 on TI (also identified by NAVFAC Drawing, 1984).

Station personnel indicated that as many as 11 underground tanks associated with package boilers may still exist on YBI.

The last potential underground tank site is located near Building 204 on YBI, the former site of a gas station. No records were found indicating the closure of this tank.

Of these 16 potential tank locations, those associated with the package boilers and gas station on YBI appear to be the most likely locations while those sites identified by protruding pipes are the least certain. A thorough survey by geophysical methods is the most definitive technique, besides excavation, for locating these possible tanks.

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APPENDIX A

Glossary

Table A-1

Glossary: Acronyms

BATF	Bureau of Alcohol, Tobacco, and Firearms
BTX	Benzene, Toluene, and Xylenes
CAC	California Administrative Code
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CNO	Chief of Naval Operations
COMNAVSURFPAC	Commander Naval Surface Force U.S. Pacific Fleet
DOD	Department of Defense
DOT	Department of Transportation
DPDO	Defense Property Disposal Office
DRMO	Defense Reutilization and Marketing Office (Alameda)
EFD	Engineering Field Division
EPA	Environmental Protection Agency
FS	Feasibility Study
HRS	Hazard Ranking System
HW	Hazardous Waste
IR	Installation Restoration
Kjfss	Sandstone and shale (Franciscan)
MSL	Mean Sea Level
NACIP	Navy Assessment and Control of Installation Pollutants
NAVFAC	Naval Facility
NAVFACENGCOM	Naval Facilities Engineering Command
NAVSTA TI	Naval Station Treasure Island (Treasure Island and a portion of Yerba Buena Island)
NEESA	Naval Energy and Environmental Support Activity
NEPSS	Naval Environmental Protection Support Service
NPDES	National Pollutant Discharge Elimination System
NSC	Naval Supply Center (Oakland)
NTTC	Naval Technical Training Center
OBA	Oxygen Breathing Apparatus
PA/SI	Preliminary Assessment/Site Inspection
PCB	Polychlorinated biphenyl
PWC	Public Works Center (Oakland)
Qaf	Artificial fill
Qls	Landslide debris
Qc	Colma Formation
Radiac	Radiation training activity
RCRA	Resource, Conservation, and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act
TI	Treasure Island
TTLC	Total Threshold Limit Concentration
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WESTDIV	Western Division
WWT	Wastewater Treatment, Wastewater Treatment Plant
YBI	Yerba Buena Island

APPENDIX B

Summary of NEESA Sampling and Analyses

A total of 30 samples were collected by Dames & Moore and NEESA personnel from 10 sites at Naval Station Treasure Island on October 28 and 29 and in mid-November, 1987. The samples taken included soil, wipe samples from asphalt or concrete surfaces, and asphalt chunks. The samples were analyzed for petroleum, PCBs, pH, and various metals. The analytical results are shown on Tables B-1 and B-2 while Plates B-1 through B-4 show the sampling locations.

TABLE B-1

METALS AND SOIL ACIDITY ANALYSES

SITE NO.	SITE DESCRIPTION	SAMPLE NUMBER	PLATE REF.	SAMPLE TYPE	DEPTH	pH	LEAD (mg/K)	CHROMIUM (mg/K)	NICKEL (mg/K)	ZINC (mg/K)	SILVER (mg/K)
1	Medical Clinic	1	B-1	Soil	0-6"	4.2	--	--	--	--	7,740
		2	B-2	Soil	0-6"	4.0	--	--	--	--	3,050
16	Clipper Cove Tank Farm	1	B-2	Soil	0-6"	--	130	--	--	--	--
		2	B-2	Soil	0-6"	--	89	--	--	--	--
		3(1)	B-2	Soil	0-6"	--	160	--	--	--	--
20	Auto Hobby Shop/ Transportation Center	1	B-3	Soil	0-6"	--	270	44	28	160	--
		2	B-3	Soil	0-6"	--	700	67	35	470	--
		3	B-3	Soil	0-6"	--	2,000	33	27	550	--
	Regulatory Threshold(2)						1,000	2,500	2,000	5,000	500

NOTES:

-- Analysis not performed.
ND Not detected.

(1) Three other samples were also obtained and analyzed but results have been discarded due to assumed improper sampling procedures.
(2) State of California, Total Threshold Limit Concentration (TTLC), CAC, Title 22, Division 4, Chapter 30.

AMB/1216a

TABLE B-2

PETROLEUM AND PCB ANALYSES

SITE NO.	SITE DESCRIPTION	SAMPLE NUMBER	PLATE REF.	SAMPLE TYPE	DEPTH	OIL/GREASE (mg/K)	TOTAL PETROLEUM HYDROCARBONS (ug/G)	POLYCHLORINATED BIPHENYLS(1) 1016	1221	1232	1242	1248	1254	1260
3	PCB Equipment Storage Area	1	B-1	Wipe	Surface	--	--	ND	ND	ND	ND	ND	ND	ND
		2	B-1	Wipe	Surface	--	--	ND	ND	ND	ND	ND	ND	2.6
		3	B-1	Wipe	Surface	--	--	ND	ND	ND	ND	ND	ND	ND
		4	B-1	Wipe	Surface	--	--	ND	ND	ND	ND	ND	ND	ND
		5	B-1	Wipe	Surface	--	--	ND	ND	ND	ND	ND	ND	3.5
		6	B-1	Wipe	Surface	--	--	ND	ND	ND	ND	ND	ND	ND
		7	B-1	Wipe	Surface	--	--	ND	ND	ND	ND	ND	ND	ND
		8	B-1	Asphalt	Surface	--	--	ND	ND	ND	ND	ND	ND	ND
4,19	Hydraulic Training School, Refuse Transfer Area	1	B-2	Soil	0-6"	68,800	50,000	ND	ND	ND	ND	ND	ND	ND
		2	B-2	Soil	0-6"	77,300	53,000	ND	ND	ND	ND	ND	ND	ND
		4(2)	B-2	Soil	6-12"	7,030	5,800	ND	ND	ND	ND	ND	ND	ND
16	Clipper Cove Tank Farm	1	B-2	Soil	0-6"	--	310	--	--	--	--	--	--	--
		2	B-2	Soil	0-6"	--	540	--	--	--	--	--	--	--
		3(3)	B-2	Soil	0-6"	--	240	--	--	--	--	--	--	--
20	Auto Hobby Shop/ Transportation Center	1	B-3	Soil	0-6"	13,300	9,700	--	--	--	--	--	--	--
		2	B-3	Soil	0-6"	28,200	25,000	--	--	--	--	--	--	--
24	Fifth Street Fuel Releases	1	B-3	Soil	Dirt Pile	7,450	5,100	--	--	--	--	--	--	--
		2	B-3	Soil	Dirt Pile	5,130	2,500	--	--	--	--	--	--	--
		3	B-3	Soil	Dirt Pile	470	180	--	--	--	--	--	--	--
		4	B-3	Soil	0-6"	680	500	--	--	--	--	--	--	--
--	Transformer Storage, Bldg. 445	1	B-4	Wipe	Surface	--	--	ND	ND	ND	ND	ND	ND	ND
		2	B-4	Wipe	Surface	--	--	ND	ND	ND	ND	ND	ND	ND
	Regulatory Threshold					None	100(4)	50(5)	50	50	50	50	50	50

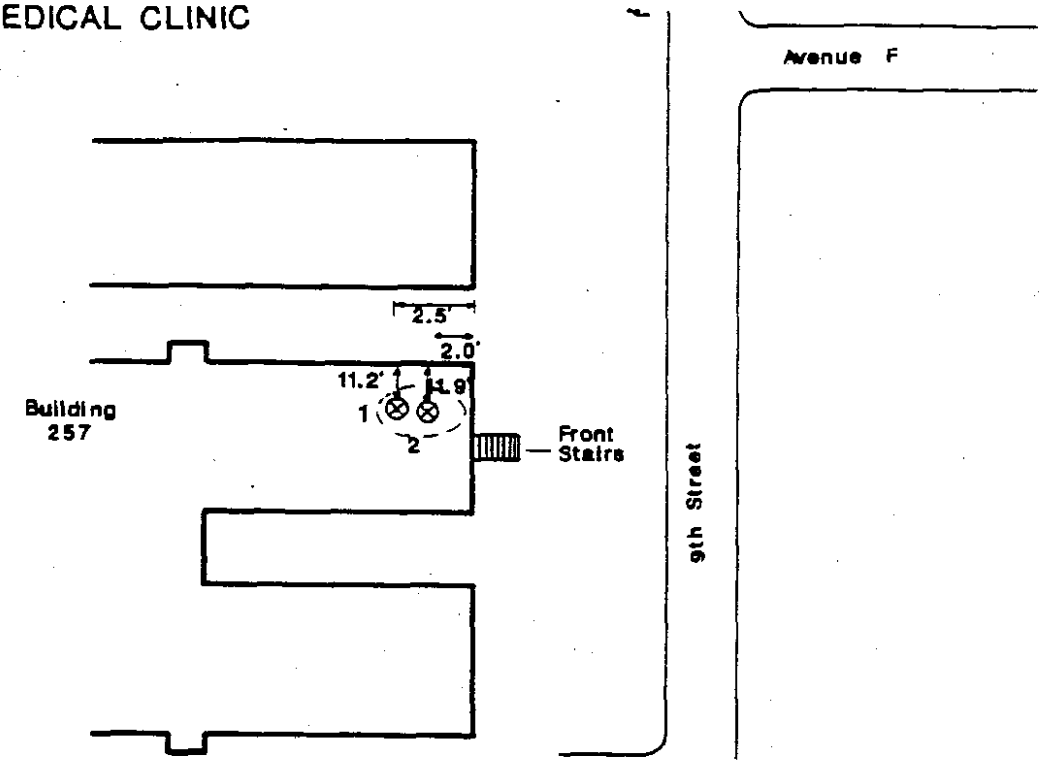
NOTES:

-- Analysis not performed.
ND Not detected.

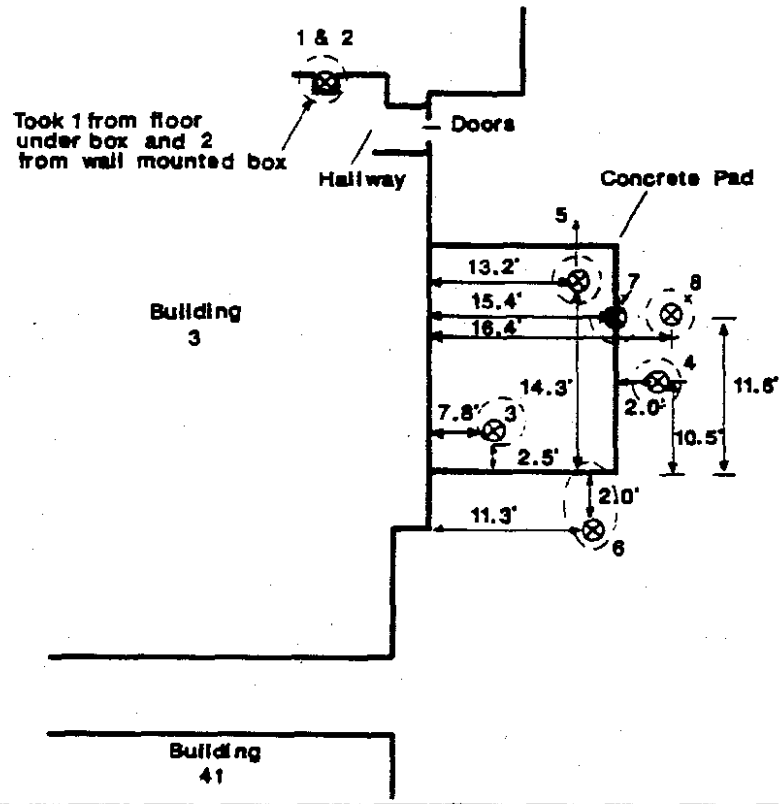
(1) Units are ug/100 cm2 for wipe samples, ug/K for soil samples.
(2) Sample number 3 was broken in shipment.
(3) Three other samples were also obtained and analyzed but results have been discarded due to assumed improper sampling procedures.
(4) California Regional Water Quality guideline for fuel leaks, San Francisco Bay Region, September 1985.
(5) No regulatory limits have been developed for wipe samples. Limits shown are the total threshold limit concentration (TTLC) from the California Assessment Manual (CAM), 1985, for bulk samples. Units are milligrams/Kilogram.

AMB/1217a

A) SITE 1: MEDICAL CLINIC



B) SITE 3: PCB EQUIPMENT STORAGE AREA



DRAWINGS NOT TO SCALE

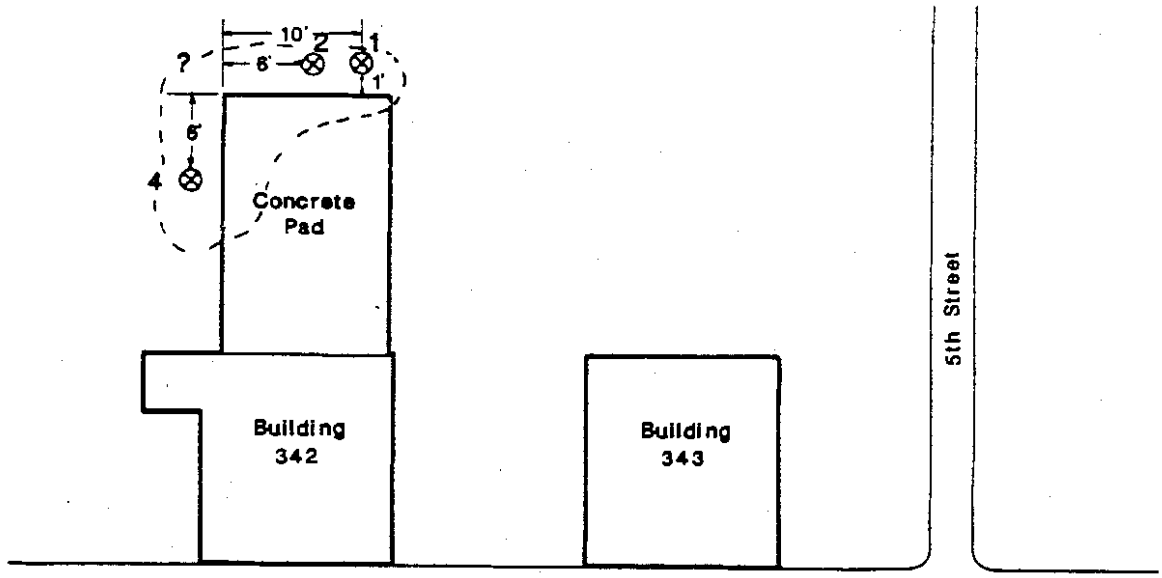
KEY

⊗ SAMPLE LOCATION

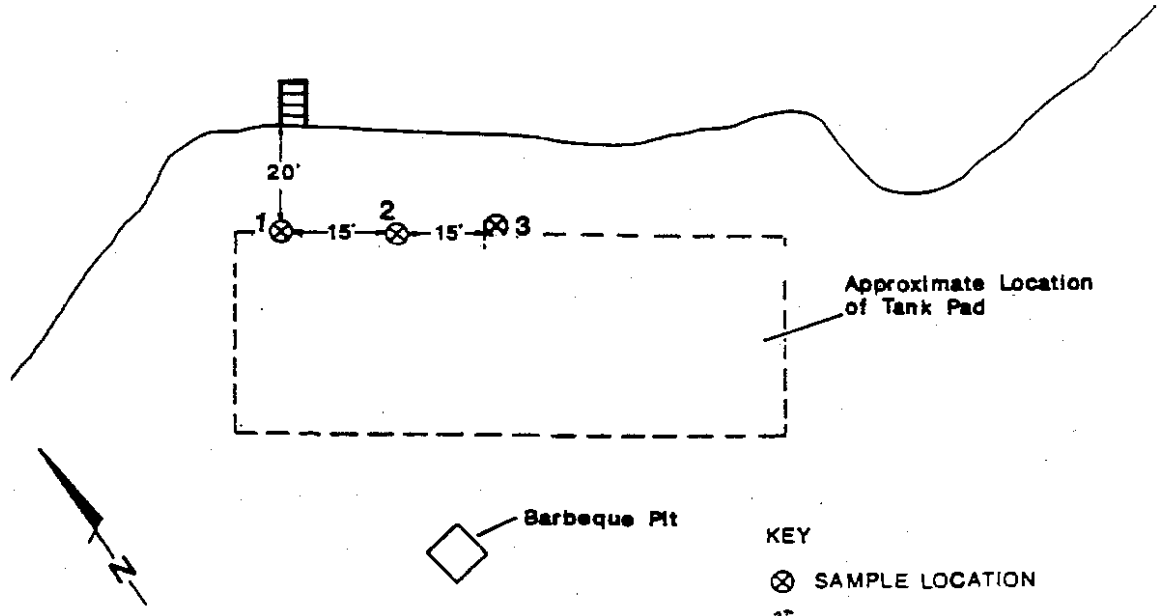
◌ LOCATION OF STAINING

PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	**CONFIRMATION SAMPLING LOCATIONS - SITES 1 AND 3**	FIGURE B-1

C) SITE 4: HYDRAULIC TRAINING SCHOOL
SITE 19: REFUSE TRANSFER AREA



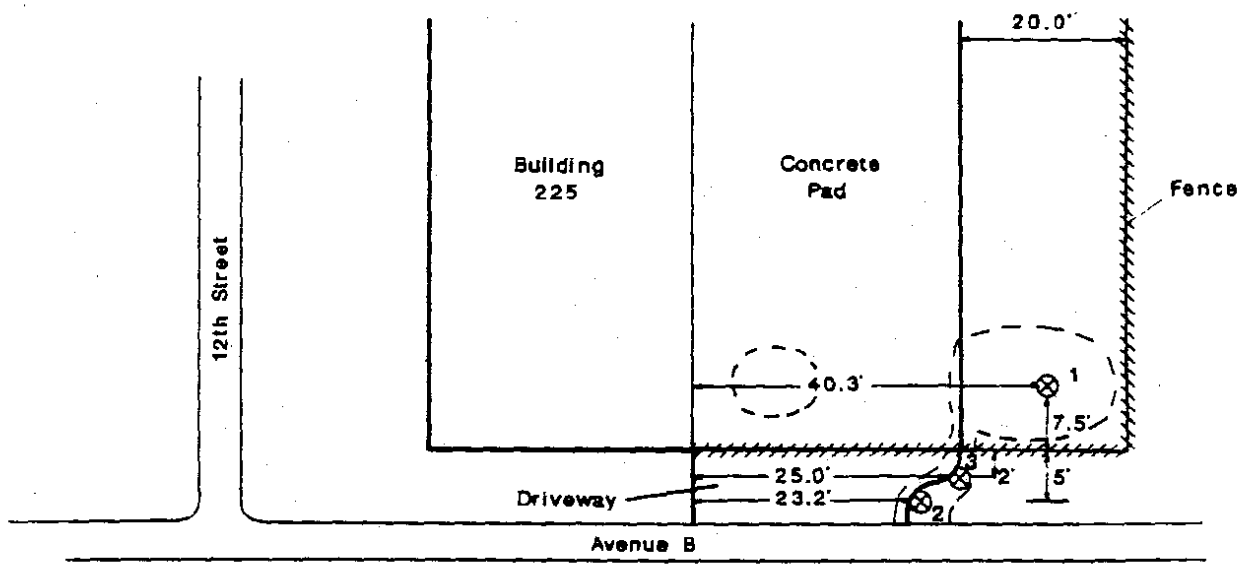
D) SITE 16: CLIPPER COVE TANK FARM



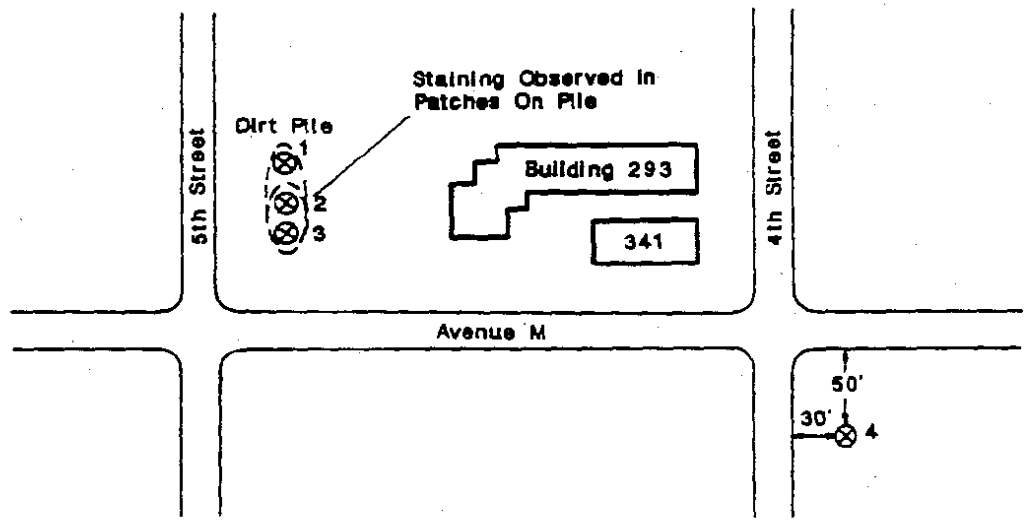
DRAWINGS NOT TO SCALE

PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	**CONFIRMATION SAMPLING LOCATIONS - SITES 4, 19, AND 16**	FIGURE B-2

E) SITE 20: AUTO HOBBY SHOP/TRANSPORTATION CENTER



F) SITE 24: FIFTH STREET FUEL RELEASES



DRAWINGS NOT TO SCALE

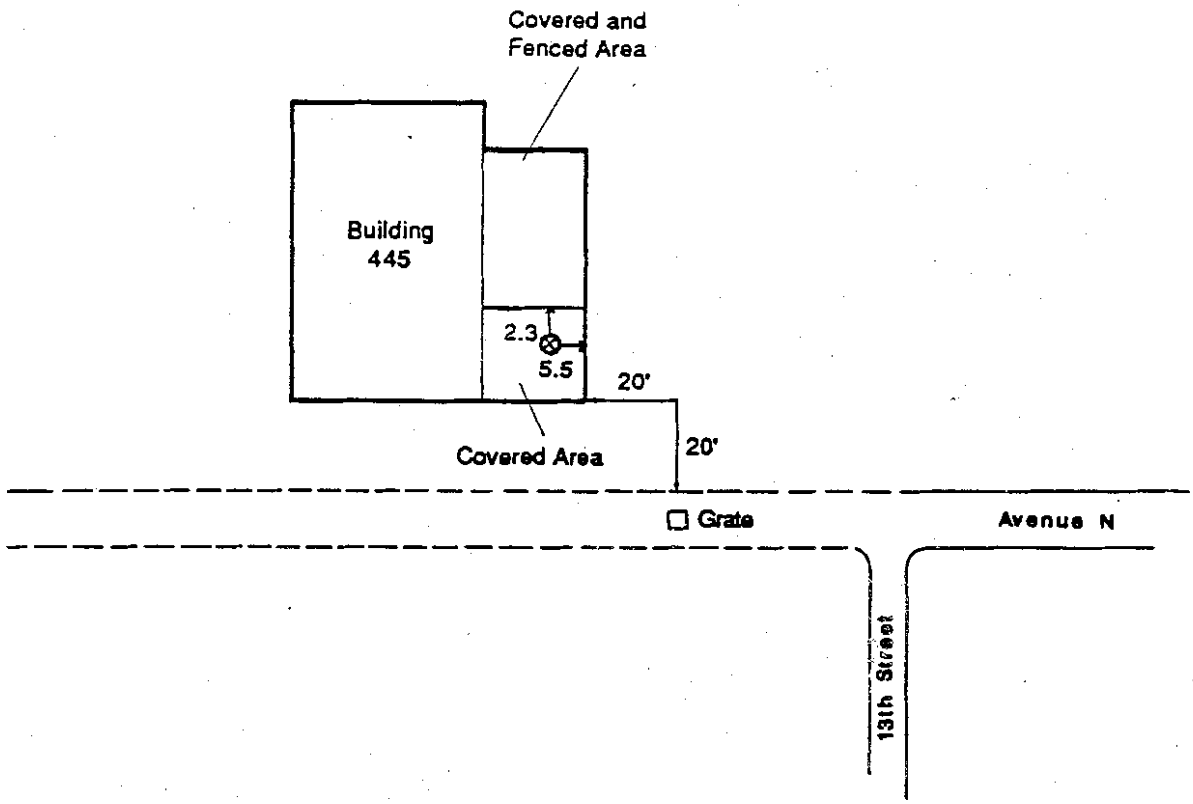
KEY

⊗ SAMPLE LOCATION

◌ LOCATION OF STAINING

PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	**CONFIRMATION SAMPLING LOCATIONS - SITES 20 AND 24**	FIGURE B-3

G) TRANSFORMER STORAGE AREA, BUILDING 445



DRAWING NOT TO SCALE

KEY

⊗ SAMPLE LOCATION

PRELIMINARY ASSESSMENT/ SITE INSPECTION NAVSTA Treasure Island, Ca.	**CONFIRMATION SAMPLING LOCATIONS - BUILDING 445**	FIGURE B-4

FEDERAL FACILITY
SITE REMEDIATION AGREEMENT

for

TREASURE ISLAND NAVAL STATION

September 29, 1992

TOXICS LEGAL OFFICE
State of California
Department of Toxic Substances Control
400 P Street, Rm. 4480
P. O. Box 806
Sacramento, CA 95812-0806

Federal Facility Site
Remediation Agreement for
Treasure Island Naval Station

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STATE OF CALIFORNIA
AND THE
UNITED STATES DEPARTMENT OF THE NAVY

IN THE MATTER OF: The U.S. Department of the Navy Treasure Island Naval Station	Federal Facility Site Remediation Agreement Under California Health and Safety Code §§ 25355.5, 25353 and 25347.6

Based on the information available to the Parties on the effective date of this Federal Facility Site Remediation Agreement (Agreement), and without trial or adjudication of any issues of fact or law, the Parties agree as follows:

1. PURPOSE

1.1 To reach the purposes described below, the Parties agree that their overall intent in executing this Agreement is to fully cooperate in accelerating and streamlining the remediation process at Treasure Island Naval Station to the maximum extent possible consistent with applicable state and federal laws. The Parties intend to use consensus problem solving, to the maximum extent practicable, to achieve the Parties' primary goal of environmental restoration.

1.2 The general purposes of this Agreement are to:

(a) Ensure that the environmental impacts associated with past and present activities at Treasure Island Naval Weapon are thoroughly investigated.

(b) Ensure that appropriate remedial action is taken as necessary to protect the public health, welfare and the environment;

(c) Establish a procedural framework and schedule for developing, implementing and monitoring appropriate response

actions at the Site in accordance with applicable state law and other applicable promulgated requirements, and consistent, to the maximum extent possible, with the priorities, guidelines, criteria, and regulations contained in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

(d) Facilitate cooperation, exchange of information and participation of the Parties in such action; and,

(e) Ensure the adequate assessment of potential injury to natural resources, and the prompt notification of and cooperation with the Federal and State Natural Resources Trustees necessary to guarantee the implementation of response actions achieving appropriate cleanup levels.

(f) Recognize and reach compromise on perceived conflicts between State and Department of Defense response authorities under applicable state and federal law, and to preserve any rights or entitlements each party may have under applicable state and federal law.

1.3 Specifically, the purposes of this Agreement are to:

(a) Establish requirements for the performance of pre-remedial work and Remedial Investigation (RI) to determine fully the nature and extent of the threat to the public health or welfare or the environment caused by the release and threatened release of hazardous substances, wastes (only to the extent that the definition of waste in Water Code Section 13050 covers hazardous substances, pollutants, and contaminants), pollutants, or contaminants at the Site and to establish requirements for the performance of a Feasibility Study (FS) for the Site to identify, evaluate, and select alternatives for the appropriate remedial action(s) to prevent, mitigate, or abate the release or threatened release of hazardous substances, wastes (only to the extent that the definition of waste in Water Code Section 13050 covers hazardous substances, pollutants, and contaminants), pollutants, or contaminants at the Site in accordance with applicable state and federal law;

(b) Identify the nature, objective, and schedule of response actions to be taken at the Site. Response actions at the Site shall attain that degree of cleanup of hazardous substances, wastes (only to the extent that the definition of waste in Water Code Section 13050 covers hazardous substances,

pollutants, and contaminants) , pollutants or contaminants mandated by applicable state and federal law;

(c) Implement the selected remedial actions(s) in accordance with applicable state and federal law;

(d) Assure compliance, through this Agreement, with applicable state and federal hazardous waste and water quality laws and regulations for matters covered herein;

(e) Coordinate response actions at the Site with the mission, national security, and support activities at Treasure Island Naval Station;

(f) Expedite the cleanup process to the extent consistent with protection of human health and the environment;

(g) Provide for initiation, development, selection and implementation by the Navy of response actions, including operable units and the final remedial action(s), to be undertaken at Treasure Island Naval Station.

(h) Provide for State oversight of and participation in the initiation, development, selection and implementation of response actions, including operable units and the final remedial action(s), to be undertaken at Treasure Island Naval Station, including the review of all applicable data as it becomes available and the development of studies, reports, and action plans; and, preserve the state's right to enforcement pursuant to applicable state and federal law; and

(i) Provide for operation and maintenance of any remedial action selected and implemented pursuant to this Agreement.

(j) Identify operable unit (OU) alternatives which are appropriate at the Site prior to the implementation of final remedial action(s) for the Site. OU alternatives shall be identified to the parties as early as possible prior to proposal of OUs to the State. This process is designed to promote cooperation among the Parties in identifying OU alternatives prior to the final selection of OUs.

2. PARTIES

2.1 The Parties to this Agreement are the Navy, and the State of California. The terms of the Agreement shall apply to and be binding upon the State of California and the Navy.

2.2 This Agreement shall be enforceable against all of the Parties to this Agreement. This Section shall not be construed as an agreement to indemnify any person. The Navy shall notify its agents, members, employees, response action contractors for the Site, and all subsequent owners, operators, and lessees of the Site of the existence of this Agreement.

2.3 Each Party shall be responsible for ensuring that its contractors comply with the terms and conditions of this Agreement. Failure of a Party to provide proper direction to its contractors and any resultant noncompliance with this Agreement by a contractor shall not be considered a Force Majeure event or other good cause for extensions under Section 9 (Extensions), unless the Parties so agree, or unless established by the Dispute Resolution process contained in Section 12. The Navy will notify the State of the identity and assigned tasks of each of its contractors performing work under this Agreement upon their selection.

2.4 The State of California is represented by the California Department of Toxic Substances Control (DTSC) as lead agency and the California Regional Water Quality Control Board (RWQCB) as support agency. The responsibilities of the lead and support agencies are set forth in this Agreement, the Memorandum of Understanding between DTSC and the State Water Resources Control Board and the Regional Water Quality Control Boards for the Cleanup of Hazardous Waste Sites (Aug. 1, 1990), and the Regional Memorandum of Understanding between DTSC, Region 2, and RWQCB, San Francisco Bay Region, when and if it becomes effective. In the event of conflict, between any of the above documents and this Agreement, this Agreement shall govern. Copies of said memorandum(s) shall be made an attachment(s) to this Agreement, and are incorporated herein by this reference. The State may change the State lead agency during the performance of this Agreement. Such change of State lead agency is not subject to dispute resolution, but may constitute good cause for a request for an extension under Section 9 of this Agreement. The State shall notify the Navy of such change of State lead agency within 14 days after the decision is made. If the State lead agency changes, the new lead agency will accept all work previously accepted by the prior lead agency for the State.

3. JURISDICTION

3.1 The Parties enter into this Agreement pursuant to the following authorities:

Chapters 6.5 and 6.8 of Division 20, sections 102 and 25355.5(a)(1)(C), of the California Health and Safety Code, Division 7 of the California Water Code, CERCLA sections 120(a)(4), 120(f), 121, 42 U.S.C. sections 9620(a)(4), 9620(f), and 9621, the National Environmental Policy Act, 42 U.S.C. section 4321, and the Defense Environmental Restoration Program (DERP), 10 U.S.C. section 2701 et seq.

4. DEFINITIONS

4.1 Except as noted below or otherwise explicitly stated, the definitions provided in the California Health and Safety Code, California Water Code, and Titles 22 and 23 of the California Code of Regulations shall control the meaning of terms used in this Agreement. In the event of conflict in definitions contained in California law, DTSC and RWQCB shall notify the Navy of the conflict immediately upon discovery of the conflict, and shall resolve their conflict pursuant to the dispute resolution process in the Memorandum of Understanding between DTSC and RWQCB. DTSC and RWQCB shall notify the Navy of their decision within 10 days after the conflict is resolved. Any conflict between state and federal law is subject to the dispute resolution process as provided in Section 12 of this Agreement.

(a). "Agreement" shall refer to this document and shall include all Appendices to this document to the extent they are consistent with the original Agreement as executed or modified, or amended in accordance with Section 37 (Appendices and Attachments).

(b). "ARARs" shall mean state and federal applicable or relevant and appropriate requirements, standards, criteria, or limitations selected in the manner set forth in section 121 of CERCLA. ARARs shall apply in this same manner and to the same extent as are applied to any non-governmental entity, facility, unit, or site, as set forth in CERCLA section 120(a)(1), 42 U.S.C. section 9620(a)(1), subject to CERCLA section 121(d)(4), 42 U.S.C. section 9621(d)(4) and E.O. 12580 section 2(d) & (g).

(c). "CERCLA" shall mean the Comprehensive Environmental Response, Compensation and Liability Act, Public Law 96-510,

42 U.S.C. § 9601 et. seq., as amended by the Superfund Amendments and Reauthorization Act of 1986, Public Law 99-499 (SARA), and any subsequent amendments.

(d). "Days" shall mean calendar days, unless business days are specified. Any submittal that under the terms of this Agreement would be due on Saturday, Sunday, or state or federal holiday shall be due on the following business day. References herein to specific numbers of days shall be understood to exclude the day of occurrence.

(e). "DERP" shall refer to the Defense Environmental Restoration Program, as defined in 10 U.S.C. section 2701, et seq.

(f). "DTSC" shall mean the California Department of Toxic Substances Control, its successors and its employees and authorized representatives.

(g). "Federal Facility" shall include Treasure Island Naval Station and any real property identified in Attachment "A" (Maps), as of the date of this Agreement.

(h). "Feasibility Study" or "FS" shall have the same meaning as provided in the California Health and Safety Code section 25314, CERCLA, and the NCP. In the context of this agreement FS shall mean a study conducted pursuant to state law and consistent with the NCP which fully develops, screens and evaluates in detail remedial action alternatives to prevent, mitigate, or abate the migration or the release of hazardous substances, pollutants, or contaminants at and from the Site. The Navy shall conduct and prepare the FS in a manner to support the intent and objectives of Section 17 (Statutory Compliance and Corrective Action) of this Agreement.

(i). "Meeting," in regard to Project Managers, shall mean an in-person discussion at a single location or a conference telephone call of all Project Managers. A conference call will suffice for an in-person meeting at the concurrence of all the Project Managers.

(j). "National Contingency Plan" or "NCP" shall refer to the regulations contained in 40 CFR 300.1 et seq., and any amendments thereto.

(k). "Natural Resources Trustees" and "Federal or State Natural Resource Trustees" shall have the same meaning as provided in CERCLA and the NCP.

(l). "Natural Resource Trustee(s) Notification and Coordination" shall have the same meaning as provided in CERCLA and the NCP.

(m). "Navy" shall mean U.S. Navy, its employees, members, agents, and authorized representatives. "Navy" shall also include the Department of Defense (DOD), to the extent necessary to effectuate the terms of this Agreement, including, but not limited to, appropriations and Congressional reporting requirements.

(n). "Operable Unit" or "OU" shall have the meaning provided in the NCP.

(o). "Operation and maintenance" shall mean activities required to maintain the effectiveness of response actions.

(p). "Promulgated" shall have the same meaning as provided in section 300.400(g)(4) of the NCP.

(q). "RCRA" or "RCRA/HSWA" shall mean the Resource Conservation and Recovery Act of 1976, Public Law 94-580, 42 U.S.C. § 6901 et. seq., as amended by the Hazardous and Solid Waste Amendments of 1984, Public Law 98-616, and any subsequent amendments.

(r). "Remedial Action Plan" or "RAP" shall have the same meaning as provided in California Health and Safety Code section 25356.1.

(s). "Remedial Design" or "RD" shall have the same meaning as provided in California Health and Safety Code section 25322.1, CERCLA, and the NCP.

(t). "Remedial Investigation" or "RI" shall have the same meaning as provided in California Health and Safety Code section 25322.2, CERCLA, and the NCP. In the context of this agreement, it shall mean that investigation conducted pursuant to state and federal law and consistent with the NCP. The RI serves as a mechanism for collecting data for Site evaluation and waste characterization and conducting treatability studies as necessary to evaluate performance and cost of the treatment technologies. The data gathered during the RI will also be

used to conduct a baseline risk assessment, perform a feasibility study, and support the design of a selected remedy. The Navy shall conduct and prepare the RI in a manner to support the intent and objectives of Section 17 (Statutory Compliance and Corrective/Remedial Action).

(u). "Remedy" or "Remedial Action" or "RA" shall have the same meaning as provided in section 25322 of the California Health and Safety Code, CERCLA, and the NCP, except with respect to the expenditure of federal funds for the relocation of residents, businesses, and community facilities. With respect to such relocations, the authority to make determinations as to the expenditure of federal funds for this purpose, is retained by the Navy (as delegated by the President of the United States), consistent with CERCLA, section 104(i)(11)(B) and E.O. 12580. The State retains its authority with respect to the expenditure of state funds for such purposes.

(v). "Remove" or "Removal" shall have the same meaning as provided in section 25323 of the California Health and Safety Code, CERCLA, and the NCP.

(w). "RWQCB" shall mean the Regional Water Quality Control Board, San Francisco Bay Region, its successors and its employees, members and authorized representatives.

(x). "Site," for purposes other than obtaining permits, shall include the Federal Facility as defined above, and any area necessary for the performance of response actions. For the purposes of obtaining permits, the term "on-site" shall have the same meaning as provided in the NCP, and "off-site" shall mean all locations that are not "on-site".

(y). "State" shall mean the State of California and its employees and authorized representatives, and shall refer to both DTSC and the RWQCB unless otherwise specified.

5. DETERMINATIONS

5.1 Treasure Island Naval Station is a facility under the jurisdiction, custody, or control of the U.S. Department of Defense within the meaning of Executive Order 12580, 52 Federal Register 2923, 29 January 1987. The Department of the Navy is authorized to act on behalf of the Secretary of Defense for all functions delegated by the President through Executive Order 12580 which are relevant to this Agreement.

5.2 Treasure Island Naval Station is a federal facility under the jurisdiction of the Secretary of Defense within the meaning of CERCLA section 120 and SARA section 211, and subject to the Defense Environmental Restoration Program (DERP), 10 U.S.C. section 2701, et seq.

5.3 For the purposes of this Agreement, the Department of the Navy is the authorized delegate of the President under E.O. 12580 for receipt of notification by the State of its ARARs in the manner set forth in CERCLA section 121(d)(2)(A)(ii), 42 U.S.C. section 9621(d)(2(A)(ii) and the NCP.

5.4 The authority of the Navy to exercise the delegated removal authority of the President pursuant to CERCLA section 104, 42 U.S.C. section 9604, is not altered by this Agreement, except to the extent that CERCLA section 120(a)(4) requires application of state laws.

5.5 The actions to be taken pursuant to this Agreement are reasonable and necessary to protect the public health, welfare, or the environment.

5.6 There have been releases of hazardous substances, pollutants or contaminants at or from the Federal Facility into the environment within the meaning of section 25320 of the California Health and Safety Code and the NCP, and discharges of waste within the meaning of Division 7 of the California Water Code.

5.7 With respect to these releases, the Navy is an owner and/or operator within the meaning of California Health and Safety Code section 25323.5(a), and is a person within the meaning of Division 7 of California Water Code, and California Health and Safety Code section 25118.

5.8 Included as an Attachment to this Agreement is a map showing source(s) and areas of suspected and known contamination based on information available at the time of the signing of this Agreement.

5.9 In accordance with Section 300.600(b)(3) of the National Contingency Plan, and Section 107(f) of CERCLA (42 U.S.C., § 9707(f)), the Secretary of Defense is the trustee for natural resources located on, over, or under the Federal Facility, to the extent such natural resources are not specifically entrusted to the Secretary of Commerce or the Secretary of the Interior.

6. WORK TO BE PERFORMED

6.1 The Parties agree to perform the tasks, obligations and responsibilities described in this Section in accordance with applicable state and federal law and consistent, to the maximum extent possible, with the priorities, guidelines, criteria, and regulations in the NCP, and in accordance with all terms and conditions of this Agreement including documents prepared and incorporated in accordance with Section 7 (Review and Approval).

6.2 The Navy agrees to undertake, seek adequate funding for, fully implement and report on the following tasks, with participation of the Parties as set forth in this Agreement:

(a) Remedial Investigations of the Site;

(b) Feasibility Studies for the Site;

(c) All response actions for the Site;

(d) Operation and maintenance of response actions at the Site.

(e) Federal and State Natural Resource Trustee Notification and Coordination;

6.3 The Parties agree to:

(a) Make their best efforts to expedite the initiation of response actions for the Site;

(b) Carry out all activities under this Agreement so as to protect the public health, welfare and the environment.

6.4 Upon request, the State agrees to provide any Party with assistance in obtaining and interpreting guidance relevant to the implementation of this Agreement.

6.5 In the event that any work required to be performed, or any document required to be prepared, pursuant to this Agreement, is to be performed or prepared by a contractor of the Navy (other than an agency of the federal government), such work shall be performed or document prepared, by or under the supervision of a registered geologist licensed in the State of California, a licensed professional engineer, or other licensed professional, appropriate to the type of work or document required.

6.6 The Parties recognize that any discovered release of hazardous substances determined to have originated either on or off the site and to have been caused by a party other than the Navy, including groundwater plumes commingled with plumes originating on the site, may be addressed by a separate agreement between the responsible parties and appropriate regulatory agencies. Nothing in this section 6.6 shall reduce or otherwise affect the Navy's obligations under this Agreement, except as specifically provided in other agreements between such responsible parties and regulatory agencies.

7. REVIEW AND APPROVAL

7.1 Applicability: The provisions of this Section establish the procedures that shall be used by the Parties to provide each other with appropriate technical support, notice, review, comment, approval and response to comments regarding PA/SI, RI/FS, and RD/RA documents, specified herein as either primary or secondary documents. In accordance with CERCLA sections 120 and 121, DERP, and the NCP, the Navy will be responsible for preparing and distributing primary and secondary documents. As of the effective date of this Agreement, all draft, draft final and final deliverable documents identified herein shall be prepared, distributed and subject to dispute in accordance with subsections 7.2 through 7.12 below. The designation of a document as "draft", "draft final" or "final" is solely for purposes of review and approval by the State in accordance with this Section. Such designation does not affect the obligation of the Parties to issue documents, which may be referred to herein as "final", to the public for review and comment as appropriate and as required by law.

7.2 General Process for PA/SI, RI/FS, and RD/RA documents:

(a) Primary documents include those reports that are major, discrete, portions of PA/SI, RI/FS, and/or RD/RA activities. Primary documents are initially issued by the Navy in draft subject to review and approval by the State. Within sixty (60) days following receipt of comments on a particular draft primary document, the Navy will respond to the comments received and issue a draft final primary document subject to dispute resolution. The draft final primary document will become the final primary document either thirty (30) days after the receipt by the state of a draft final document if dispute resolution is not invoked or as modified by decision of the dispute resolution process.

(b) Secondary documents include those reports that are discrete portions of the primary documents and are typically input or feeder documents. Secondary documents are prepared by the Navy in draft subject to review and approval by the State. Although the Navy will respond to comments received, the draft secondary documents may be finalized in the context of the corresponding primary documents. A secondary document may be disputed at the time the corresponding draft final primary document is issued.

7.3 Primary Documents:

(a) The Navy shall complete and transmit drafts of the following primary documents for each operable unit and for the final remedy to the State, for review, comment and approval in accordance with the provisions of this Section; provided, however, that the Navy need not complete a draft primary document for an operable unit if (x) the same primary document completed or to be completed with respect to another operable unit covers all topics relevant to the operable unit at issue, and (y) the Parties agree in writing that such draft primary document need not be completed. The Parties may agree to merge or combine multiple documents if deemed appropriate and, if so, may adjust deadlines accordingly.

(1) PA/SI, RI/FS Workplans, including Sampling and Analysis Plans, and identification of operable unit.

(2) Quality Assurance Project Plans (QAPPs)

(3) Public Participation Plans/Community Relations Plans (Such plans may be amended as appropriate to address Operable Units. Any such amendments shall not be subject to the threshold requirements of Subsection 7.11. Any disagreement regarding amendment of the Public Participation Plans/Community Relations Plans shall be resolved pursuant to Section 12 (Dispute Resolution).)

(4) RI Reports

(5) FS Reports

(6) Proposed Plans

(7) Remedial Action Plans (RAPs)/Records of Decision (RODs)

(8) Remedial Designs (RDs)

(9) Remedial Action Work Plans, which may include operation and maintenance plans

(10) Health and Safety Plans

(b) Only the final draft of primary documents shall be subject to dispute resolution. The Navy shall complete and transmit draft primary documents in accordance with the timetable and deadlines established in Section 8 (Deadlines) of this Agreement.

(c) Planning documents for primary documents shall include target dates for subtasks, including those described in subsections 7.4(b) and 18.3. The purpose of target dates is to assist the Navy in meeting deadlines, but target dates do not become enforceable by their inclusion in the primary documents and are not subject to Section 8 (Deadlines), Section 9 (Extensions) or Section 13 (Enforceability).

(d) If a draft primary document is prepared by a contractor of the Navy (other than an agency of the federal government), such contractor shall be a registered geologist licensed in the State of California, a licensed professional engineer, or other licensed professional, appropriate to the type of work or document required.

(e) The draft Health and Safety Plan must be signed by a Certified Industrial Hygienist who he/she has adequate knowledge of the control of occupational health hazards that arise as a result of or during work.

7.4 Secondary Documents:

(a) The Navy shall complete and transmit drafts of the following secondary documents for each operable unit and for the final remedy to the State for review, comments, and approval; provided, however, that the Navy need not complete a draft secondary document for an operable unit if (x) the same secondary document or a primary document completed or to be completed with respect to another operable unit covers all topics relevant to the operable unit at issue, and (y) the Parties agree in writing that such draft secondary document need not be completed. The parties agree the secondary documents and their corresponding primary documents shall be as follows:

Secondary Document		Corresponding Primary Document
(1)	Sampling and Data Results	RI
(2)	Removal Action Reports (if generated)	RI
(3)	Baseline Risk Assessment	RI
(4)	Public Notices and Fact Sheets	FS/RD
(5)	Treatability Study (if generated)	FS
(6)	Initial Screening of Alternatives	FS
(7)	Detailed Analysis of Alternatives	FS
(8)	Proposed Plan	RAP
(9)	Remedial Action Schedules	RAP
(10)	Health & Safety Plan	RD
(11)	Engineering Plans	RD
(12)	Post-Remedial Sampling Design Plan	RA
(13)	Post-Remedial Sampling Completion Report (if generated)	RA
(14)	Action Memorandum (if generated)	RI
(15)	Operations & Maintenance	RA
(16)	Implementation Schedules	RA

(b) Although the State may comment on the drafts for the secondary documents listed above, such documents shall not be subject to dispute resolution except as provided by Subsection 7.2 hereof. Target dates for the completion and transmission of draft secondary documents shall be established by the Project Managers. The Project Managers also may agree

upon additional secondary documents that are within the scope of the corresponding primary documents.

7.5 California Environmental Quality Act (CEQA)

The Navy agrees to cooperate with and assist the State in complying with the State's obligations under the California Environmental Quality Act (CEQA) [Calif. Public Res. C. Sec. 21000, et seq.], as applicable to the subject matter of this agreement. To this end, the Parties shall consult and jointly prepare a CEQA coordination plan as soon after the effective date of this agreement as is reasonably possible. The State shall memorialize the plan and the Navy shall furnish its concurrence in writing. The purpose of the coordination plan will be to identify the issues, documents, notices, hearings and time frames necessary for compliance with CEQA and to develop a joint approach for integration of CEQA procedures into the site remediation process. By agreeing to assist the State in this manner, the Navy does not concede that CEQA governs Navy activities on Treasure Island Naval Station. If compliance with CEQA requirements prevents the State from fulfilling its obligations under this Agreement, the Parties shall be excused from further compliance with the Agreement to the extent that further participation by the State would put it in violation of CEQA requirements, any disagreement arising under this subsection shall be subject to dispute resolution.

7.6 Meetings of the Project Managers. (See also Subsection 18.3) The Project Managers shall meet in person approximately every sixty (60) days, except as otherwise agreed by the Parties, to review and discuss the progress of work being performed at the Site, including progress on the primary and secondary documents. However, progress meetings may be held more frequently as needed upon agreement by all Project Managers. Prior to preparing any draft document specified in subsections 7.3 and 7.4 above, the Project Managers shall meet in an effort to reach a common understanding with respect to the contents of the draft document.

7.7 Identification and Determination of Potential ARARs:

(a) The State lead agency will contact in writing those State and local governmental agencies that are potential sources of ARARs in a timely manner as set forth in NCP section 300.515(d).

(b) Prior to the issuance of a draft primary or secondary document for which ARAR determinations are appropriate, the Project Managers shall meet to identify and

propose all potential pertinent ARARs, including any permitting requirements that may be a source of ARARs. At that time and within the time period described in NCP section 300.515(h)(2), the State shall submit the ARARs obtained pursuant to paragraph 7.7(a) to the Navy, along with a list of agencies that failed to respond to the State's solicitation of ARARs and copies of the solicitations and any related correspondence.

(c) The Navy will contact the agencies that failed to respond and again solicit their inputs.

(d) The Navy will prepare draft ARAR determinations in accordance with CERCLA section 121(d)(2), 42 U.S.C. section 9621(d(2), and the NCP.

(e) In identifying potential ARARs, the Parties recognize that actual ARARs can be identified only on a site-specific basis and that ARARs depend on the specific hazardous substances, pollutants and contaminants at a site, the particular actions associated with a proposed remedy and the characteristics of a site. The Parties recognize that ARAR identification is necessarily an iterative process and that potential ARARs must be identified and discussed among the Parties as early as possible, and must be reexamined throughout the RI/FS process until the final remedial action is selected and approved.

7.8 Review and Comment on Draft Documents:

(a) The Navy shall complete and transmit each draft primary document to the State on or before the corresponding deadline established for the issuance of the document. The Navy shall complete and transmit the draft secondary documents in accordance with the target dates established for the issuance of such documents.

(b) Unless the Parties mutually agree to another time period, all draft documents shall be subject to a sixty (60) day period for review, comment and approval by the State. At or before the close of the comment period, the State shall transmit its written comments to the Navy. Review of any document by the State may extend to all aspects of it (including completeness) and shall include, but not be limited to, technical evaluation of any aspect of the document, and conformance to applicable state law, consistency, to the maximum extent possible, with the NCP and any pertinent

promulgated guidance or policy issued by the State and the U.S. EPA. To expedite the review process, the Navy shall make an oral presentation of each primary document to the Parties at the next scheduled meeting of the Project Managers following transmittal of the draft document and shall do so with respect to secondary documents if all other Project Managers so request. Comments by the State shall be provided with adequate specificity so that the Navy may respond to the comment and, if appropriate, make changes to the draft document. Comments shall refer to any pertinent sources of authority or references upon which the comments are based and, upon request of the Navy or the State, as appropriate, the other party shall provide a copy of the cited authority or reference. In cases involving complex and unusually lengthy reports, the State may extend the sixty (60) day comment period for an additional thirty (30) days by written notice to the Navy prior to the end of the sixty (60) day period. On or before the close of the comment period, the State shall transmit its written comments to the Navy. In appropriate circumstances, this time period may be further extended in accordance with Section 9 (Extensions).

(c) Representatives of the Navy shall make themselves readily available to the State during the comment period for purposes of informally responding to questions and comments on draft documents. Oral comments made during such discussions need not be the subject of a written response by the Navy on the close of the comment period.

(d) In commenting on a draft document which contains a proposed ARAR determination, the State shall include a reasoned statement of whether it objects to any portion of the proposed ARAR determination. To the extent that the State does object, it shall explain the basis for its objection in detail and shall identify any ARARs which it believes were not properly addressed in the proposed ARAR determination.

(e) Following the close of the comment period for a draft document, the Navy shall give full consideration to all written comments. If either party requests, within fifteen (15) days following the close of the comment period on a draft secondary document or draft primary document the Parties shall hold a meeting to discuss all comments received. On a draft secondary document the Navy shall, within sixty (60) days of the close of the comment period, transmit to the State its written response to the comments received. On a draft primary document the Navy shall, within sixty (60) days of the close

of the comment period, transmit to the State a draft final primary document, which shall include the Navy's response to all written comments received within the comment period. While the resulting draft final document shall be the responsibility of the Navy, it shall be the product of consensus to the maximum extent possible.

(f) The Navy may extend the sixty (60) day periods for responding to comments on a draft document and for issuing the draft final primary document for an additional thirty (30) days each by providing written notice to the State. In appropriate circumstances, this time period may be further extended in accordance with Section 9 (Extensions).

7.9 Availability of Dispute Resolution for Draft Final Primary Documents:

(a) Dispute resolution shall be available to the Parties for draft final primary documents as set forth in Section 12 (Dispute Resolution).

(b) When dispute resolution is invoked on a draft final primary document, work may be stopped in accordance with the procedures set forth in Subsection 12.10 regarding dispute resolution.

7.10 Finalization of Documents: The draft final primary document shall serve as the final primary document if no party invokes dispute resolution regarding the document or, if invoked, at completion of the dispute resolution process should the Navy's position be sustained. If the Navy's determination is not sustained in the dispute resolution process, the Navy shall prepare, within no more than sixty (60) days after the close of the dispute resolution process, a revision of the final draft document which conforms to the results of dispute resolution. In appropriate circumstances, the time period for this revision period may be extended in accordance with Section 9 (Extensions).

7.11 Subsequent Modification of Final Documents: Following finalization of any primary document pursuant to Subsection 7.10 above, any Party may seek to modify the document including seeking additional field work, pilot studies, computer modeling or other supporting technical work, only as provided in subparagraphs (a) and (b) below. (These restrictions do not apply to the Community Relations Plan/ Public Participation Plan.)

(a) Any Party may seek to modify a document after finalization by submitting a concise written request to the Project Managers of the other Parties. The request shall specify the nature of the requested modification and how the request is appropriate under subsections 7.11(b)(1) and (2) below.

(b) In the event that a consensus is not reached by the Project Managers on the need for a modification, any Party may invoke dispute resolution to determine if such modification shall be conducted. Modification of a document shall be required only upon a showing that:

(1) The requested modification is based on information that is (a) new (i.e., information that becomes available or known after the document was finalized and (b) significant; and

(2) The requested modification could be of significant assistance in evaluating impacts on the public health or the environment, in providing an equally protective but less expensive technology, in evaluating the selection of remedial alternatives, or in protecting human health and the environment.

(c) Nothing in this Section shall alter the State's ability to request the performance of additional work which was not contemplated by this Agreement. The Navy's obligation to perform such work under this Agreement must be established by either a modification of a document or by amendments to this Agreement.

7.12 Finalization of Remedial Action Plans

For each OU and for the final remedy for the federal facility, the Navy shall be responsible for selection of the remedial action alternative and shall prepare a Remedial Action Plan (RAP) in accordance with California Health and Safety Code section 25356.1 for State approval. The State shall be responsible for circulating the RAP for public comment, furnishing appropriate notice, and conducting meetings or hearings. The Parties shall jointly consider public comments, incorporate appropriate changes, and issue the final RAP. Disputes concerning the RAP process will be subject to Section 12 (Dispute Resolution) of this Agreement.

7.13 If the State does not approve a document pursuant to this Section, and the Parties are not able to resolve their differences

through the exhaustion of the dispute resolution process in Section 12, the Navy reserves any legal right it may have to proceed with the work described in this Agreement. The State reserves any legal right the State may have to prevent the Navy from proceeding with the work described in this Agreement.

8. DEADLINES

8.1. All deadlines agreed upon before the effective date of this Agreement shall be made an Appendix to this Agreement. To the extent that deadlines have already been mutually agreed upon by the Parties prior to the execution of this Agreement, they will satisfy the requirements of this Section and remain in effect, and shall be incorporated into the appropriate work plans.

8.2 Within twenty-one (21) days of the approval of the Remedial Action Plan in accordance with section 25356.1 of the California Health and Safety Code and consistent with the NCP to the maximum extent possible, the Navy shall propose deadlines for completion of the following draft primary documents:

(a) Remedial Designs

(b) Remedial Action Work Plans (to include operation and maintenance plans, and schedules for RA)

8.3 Within fifteen (15) days of receipt of the proposed deadlines, the State shall review and provide comments to the Navy. Within fifteen (15) days following receipt of the comments the Navy shall, as appropriate, make revisions and reissue the proposal. The parties shall meet as necessary to discuss and finalize the proposed deadlines. All agreed-upon deadlines shall be incorporated into the appropriate work plans. If the parties fail to agree within thirty (30) days on the proposed deadlines, the matter shall immediately be submitted for dispute resolution pursuant to Section 12 (Dispute Resolution). The final deadlines established pursuant to this subsection shall be enforceable by the State to the extent provided by the state and federal law, and shall become an Appendix to this Agreement.

8.4 For any operable units not identified for RI/FS as of the effective date of this Agreement, the Navy shall propose deadlines for all documents listed in subsection 7.3(a)(1) through (11) (with the exception of the Community Relations Plan/Public Participation Plan and any document that comes within the proviso to such subsection) within twenty-one (21) days of agreement on the proposed operable unit by all Parties. These deadlines shall be

proposed and finalized using the procedures set forth in subsection 8.3.

8.5 The deadlines set forth in this Section, or to be established as set forth in this Section, may be extended pursuant to Section 9 (Extensions). The Parties recognize that one possible basis for extension of the deadlines for completion of the Remedial Investigation and Feasibility Study Reports is the identification of significant new Site conditions during the performance of the remedial investigation.

9. EXTENSIONS

9.1 Timetables, deadlines and schedules shall be extended upon receipt of a timely request (if practicable, at least seven (7) days prior to the due date) for extension and when good cause exists for the requested extension. Any request for extension by a Party shall be submitted to the other Parties in writing and shall specify:

(a) The timetable, deadline or schedule that is sought to be extended;

(b) The length of the extension sought;

(c) The good cause(s) for the extension; and

(d) The extent to which any related timetable and deadline or schedule would be affected if the extension were granted.

9.2 Good cause exists for an extension when sought in regard to:

(a) An event of Force Majeure;

(b) A delay caused by another Party's failure to meet any requirement of this Agreement;

(c) A delay caused by the good faith invocation of dispute resolution or the initiation of judicial action;

(d) A delay caused, or which is likely to be caused, by an extension in regard to another timetable and deadline or schedule;

(e) A delay caused by the need to respond to unusually extensive public comments during a public comment period required under state law or the NCP (including the parties' agreement to perform additional work).

(f) Any work stoppage within the scope of Section 11 (Emergencies and Removals); or

(g) Any other event or series of events mutually agreed to by the Parties as constituting good cause.

(h) A delay caused by increased security measures resulting from upgrades in threat condition for combatting terrorism on the Federal Facility;

(i) A delay caused or which is likely to be caused by consultation requirements with regulatory agencies and Natural Resources Trustees.

9.3 Absent agreement of the Parties with respect to the existence of good cause, a Party may seek and obtain a determination through the dispute resolution process that good cause exists.

9.4 Within seven (7) days of receipt of a request for an extension of a timetable, deadline or schedule, each receiving Party shall advise the requesting Party in writing of the receiving Party's position on the request. Any failure by a receiving Party to respond within the 7-day period shall be deemed to constitute concurrence with the request for extension. If a receiving Party does not concur in the requested extension, it shall include in its statement of nonconcurrence an explanation of the basis for its position.

9.5 If there is consensus among all Parties that the requested extension is warranted, the Navy shall extend the affected timetable and deadline or schedule accordingly. If there is no consensus among the Parties as to whether all or part of the requested extension is warranted, the timetable and deadline or schedule shall not be extended except in accordance with a determination resulting from the dispute resolution process.

9.6 Within seven (7) days of receipt of a statement of nonconcurrence with the requested extension, the requesting Party may invoke dispute resolution.

10. FORCE MAJEURE

10.1 A Force Majeure shall mean any event arising from causes beyond the control of a Party that causes a delay in or prevents the performance of any obligation under this Agreement, including, but not limited to,

(a) acts of God;

(b) fire;

(c) war, or national conflict or emergency declared by the President or Congress and affecting the Navy;

(d) insurrection;

(e) civil disturbance;

(f) explosion;

(g) unanticipated breakage or accident to machinery, equipment or lines of pipe despite reasonably diligent maintenance;

(h) adverse weather conditions that could not be reasonably anticipated;

(i) unusual delay in transportation;

(j) restraint by court order or order of public authority;

(k) inability to obtain, at reasonable cost and after exercise of reasonable diligence, any necessary authorizations, approvals, permits, or licenses due to action or inaction of any governmental agency or authority other than the Navy;

(l) delays caused by compliance with applicable statutes or regulations governing contracting, procurement or acquisition procedures, despite the exercise of reasonable diligence; and

(m) insufficient availability of appropriated funds which have been diligently sought, or personnel reduction resulting therefrom.

In order for Force Majeure based on insufficient funding to apply to the Navy, the Navy under Subsection 10.1 (m) of this Agreement, shall have made timely request for such funds as part of the budgetary process as set forth in Section 15 (Funding). A Force Majeure shall also include any strike or other labor dispute, whether or not within the control of the Parties affected thereby. Force Majeure shall not include increased costs or expenses of Response Actions, whether or not anticipated at the time such Response Actions were initiated, except to the extent that funding has been diligently sought for increased costs whose cause could not reasonably have been anticipated at the time the original cost estimate was prepared. Upon request by the State the Navy shall provide a complete explanation of all efforts undertaken to avoid force majeure.

11. EMERGENCIES AND REMOVALS

11.1 Discovery and Notification.

If any Party discovers or becomes aware of an emergency or other situation that may present an endangerment to public health, welfare or the environment at or near the Site, which is related to or may affect the work performed under this Agreement, that Party shall immediately orally notify all other Parties and will follow-up with written notification within seven (7) days. If the emergency arises from activities conducted pursuant to this Agreement, the Navy shall then take immediate action to notify the appropriate State and local agencies and affected members of the public.

11.2 Work Stoppage

In the event any Party determines that activities conducted pursuant to this Agreement will cause or otherwise be threatened by a situation described in Subsection 11.1, the Party may propose the termination of such activities. If the Parties mutually agree, the activities shall be stopped for such period of time as required to abate the danger. In the absence of mutual agreement, the activities shall be stopped in accordance with the proposal, and the matter shall be immediately referred to the DTSC's Regional Administrator for Region 2 for a work stoppage determination. Such determination may be subject to the expedited dispute resolution process as provided in Section 12.14 (Expedited Dispute Resolution) of this Agreement.

11.3 Removal Actions

(a) The provisions of this Section shall apply to all removal actions as defined in CERCLA section 101(23), 42 U.S.C. § 9601(23) and Health and Safety Code section 25323, including all modifications to, or extensions of, the ongoing removal actions, and all new removal actions proposed or commenced following the effective date of this Agreement.

(b) Any removal actions conducted at the Site shall be subject to applicable state law and conducted in a manner consistent with this Agreement, Executive Order 12580, CERCLA, and to the maximum extent possible, the NCP.

(c) Except to the extent that CERCLA requires the application of state laws, nothing in this Agreement shall alter the Navy's authority with respect to removal actions conducted pursuant to CERCLA, section 104 and DERP.

(d) Nothing in this Agreement shall alter any authority the State may have with respect to removal actions conducted at the Site.

(e) All reviews conducted by the State pursuant to 10 U.S.C. § 2705(b)(2) will be expedited so as not to unduly jeopardize fiscal resources of the Navy for funding the removal actions.

(f) If a Party determines that there may be an endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance, pollutant or contaminant at or from the Site, the Party may request that the Navy take such response actions as may be necessary to abate such danger or threat and to protect the public health or welfare or the environment. Any dispute arising out of this Subsection 11.3(f) may be subject to the expedited dispute resolution as provided in Subsection 12.14 of this Agreement.

11.4 Notice and Opportunity to Comment.

(a) The Navy shall provide the State with timely notice and opportunity to review and comment upon any proposed removal action for the Site, in accordance with 10 U.S.C. § 2705(a) and (b). The Navy agrees to provide the information described below pursuant to such obligation.

(b) For emergency response actions, the Navy shall provide the State with notice in accordance with Subsection 11.1. Such oral notification shall, except in the case of extreme emergencies, include adequate information concerning the Site background, threat to the public health and welfare or the environment (including the need for response), proposed actions and costs (including a comparison of possible alternatives, means of transportation of any hazardous substances off-site, and proposed manner of disposal), expected change in the situation should no action be taken or should action be delayed (including associated environmental impacts), any important policy issues, and the Navy's recommendations. Within sixty (60) days of completion of the emergency action, the Navy will furnish the State with an Action Memorandum addressing the information provided in the oral notification, and any other information required pursuant to applicable state law for such actions.

(c) For other removal actions, the Navy will provide the State with a written Removal Work Plan which sets forth all information required by applicable state and federal law and required to be provided in accordance with Subsection 11.4(b). Removal Work Plan shall be prepared and reviewed in accordance with this section and shall not be subject to the general requirements for primary and secondary documents contained in Section 7 (Review and Approval). The Removal Work Plan shall be submitted to the State for review and comment at least forty-five (45) days before the response action is to begin. The State shall have two weeks from the date of receipt to review the Removal Work Plan and transmit comments or notice of concurrence to the Navy. Not less than ten (10) before the response action is scheduled to begin, the Navy shall notify the State of the Navy's response to the State's comments concerning the Removal Work Plan. This response shall be subject to expedited dispute resolution in accordance with Section 12.14.

(d) All activities related to ongoing removal actions shall be reported by the Navy in the progress reports as described in Section 18 (Project Managers).

12. DISPUTE RESOLUTION

12.1 Except as specifically set forth elsewhere in this Agreement, if a dispute arises under this Agreement, the procedures of this Section shall apply. Any party may invoke this dispute resolution procedure. All Parties to this Agreement shall make

reasonable efforts to informally resolve disputes at the Project Manager or immediate supervisor level. If resolution cannot be achieved informally, the procedures of this Section shall be implemented to resolve a dispute.

12.2 Within thirty (30) days after: (a) the receipt of a draft final primary document pursuant to Section 7 (Review and Approval), or (b) any action which leads to or generates a dispute, the disputing Party shall submit to the Dispute Resolution Committee (DRC) a written statement of dispute setting forth the nature of the dispute, the work affected by the dispute, the disputing Party's position with respect to the dispute and the technical, legal or factual information the disputing Party is relying upon to support its position.

12.3 Prior to any Party's issuance of a written statement of a dispute, the disputing Party shall engage the other Parties in informal dispute resolution among the Project Manager and/or their immediate supervisors. During this informal dispute resolution period the Parties shall meet as many times as are necessary to discuss and attempt resolution of the dispute.

12.4 The DRC will serve as a forum for resolution of dispute for which agreement has not been reached through informal dispute resolution. The Parties shall each designate one individual and an alternate to serve on the DRC. The individuals designated to serve on the DRC shall be employed at the policy level or be delegated the authority to participate on the DRC for the purposes of dispute resolution under this Agreement. The Navy's designated member is the Facilities Management Director, WESTNAVFACENGCOM. The DTSC representative is the Chief of the Site Mitigation Branch, Region 2. The RWQCB representative is the Division Chief, RWQCB, San Francisco Bay Region. Written notice of any delegation of authority from a Party's designated representative on the DRC shall be provided to all other Parties pursuant to the procedures of Section 21 (Notification).

12.5 Following elevation of a dispute to the DRC, the DRC shall have twenty-one (21) days to unanimously resolve the dispute and issue a written decision. If the DRC is unable to unanimously resolve the dispute within this twenty-one (21) day period, the written statement of dispute shall be forwarded to the Senior Executive Committee (SEC) for resolution within seven (7) days after the close of the twenty-one (21) day resolution period.

12.6 The SEC will serve as the forum for resolution of disputes for which agreement has not been reached by the DRC. The

Navy's representative on the SEC is the Commanding Officer, WESTNAVFACENGCOM. DTSC representative on the SEC is the Regional Administrator, Region 2. The RWQCB representative on the SEC is the Executive Officer of the San Francisco Bay Region.

12.7 If unanimous resolution of the dispute is not reached by the SEC within twenty-one (21) days, the written statement of dispute shall be immediately forwarded to (a) the Navy's Secretariat representative, representing the Navy, (b) the Director of the Department of Toxic Substances Control Program, and (c) the Executive Officer of the San Francisco Bay Region, representing RWQCB, who shall confer, meet and exert their best efforts to resolve the dispute within twenty-one (21) days after receipt of the written statement of dispute.

12.8 In the event the dispute can not be resolved in accordance with Section 12 of this Agreement, each Party reserves its rights to take any action available to it under applicable state and federal law.

12.9 The pendency of any dispute under this Section shall not affect any Party's responsibility for timely performance of the work required by this Agreement, except that the time period for completion of work affected by such dispute shall be extended for a period of time usually not to exceed the actual time taken to resolve any good faith dispute in accordance with the procedures specified herein. All elements of the work required by this Agreement which are not affected by the dispute shall continue and be completed in accordance with the applicable timetable and deadline or schedule.

12.10 When dispute resolution is in progress, work affected by the dispute will immediately be discontinued if the Regional Administrator for the Department of Toxic Substances Control requests, in writing, that work related to the dispute be stopped because, in the State's opinion, such work is inadequate or defective, and such inadequacy or defect is likely to yield an adverse effect on human health or the environment, or is likely to have a substantial adverse effect on the remedy selection or implementation process. To the extent possible, the Party seeking a work stoppage shall consult with the other Parties prior to initiating a work stoppage request. After work stoppage, if a Party believes that the work stoppage is inappropriate or may have potential significant adverse impacts, the Party may meet with the other Parties to discuss the work stoppage. Following this meeting, and further considerations of this issue the Regional Administrator for the Department of Toxic Substances Control will

issue, in writing, a final decision with respect to the work stoppage. The final written decision of the DTSC's Regional Administrator may be subject to the expedited dispute resolution process as provided in Section 12.14 of this Agreement.

12.11 Within twenty-one (21) days of resolution of a dispute pursuant to the procedures specified in this Section, the Navy shall incorporate the resolution and final determination into the appropriate plan, schedule or procedures and proceed to implement this Agreement according to the amended plan, schedule or procedures.

12.12 Resolution of a dispute pursuant to this Section is a final resolution. Except as otherwise provided in Sections 7.13 and 31 of this Agreement, all Parties shall abide by the final resolution of the dispute.

12.13 For purposes of all dispute resolution procedures set forth in this Agreement and other decisions of the Parties that may be taken to dispute resolution, the Parties agree as follows:

(a) DTSC and RWQCB will jointly designate which of the two agencies shall voice the State's position for specified subjects and which shall do so for unspecified subjects. DTSC and RWQCB shall provide the Navy with an initial designation within thirty (30) days after the execution of this agreement. DTSC and RWQCB may modify the initial designation or subsequent designations. DTSC and RWQCB shall notify the Navy in writing of any modification. Such modification shall become effective upon receipt by the Navy.

(b) Although all Parties will participate in the discussions throughout the dispute resolution process, the agency designated in accordance with paragraph 12.13(a) shall represent the State with a single position at the end of each level of the dispute resolution process and in all decisions of the Parties that may be taken to dispute resolution.

12.14 Expedited Dispute Resolution:

(a) The following procedure shall apply whenever the provisions of this Agreement call for expedited dispute resolution.

(b) The dispute shall be submitted directly to the SEC. The SEC shall have seven (7) days to unanimously resolve the dispute. The SEC shall, within seven (7) days after the end

of the seven-day period, forward the unresolved dispute to the Parties' representatives as specified in Subsection 12.7 above for resolution. These representatives shall confer, meet and exert their best efforts to resolve the dispute within seven (7) days after receipt of the dispute.

(c) In the event the dispute cannot be resolved, each Party reserves its rights under applicable state and federal law.

13. ENFORCEABILITY

13.1 The Parties agree to exhaust their rights under Section 12 (Dispute Resolution) prior to seeking judicial review.

13.2 The Parties agree that all Parties shall have the right to enforce the terms of this Agreement in accordance with state and federal law. The Parties do not intend, by entering into this Agreement, to confer jurisdiction on each other when such jurisdiction does not exist under applicable state and federal law.

14. CIVIL PENALTIES

14.1. In the event that the Navy fails to submit a primary document listed in Section 7 (Review and Approval) to the State pursuant to the appropriate timetable or deadline in accordance with the requirements of this Agreement, or fails to comply with a term or condition of this Agreement which relates to the final remedial action, the State reserves its rights to seek civil penalties against the Navy either administratively or judicially. The Navy reserves its rights to contest any such civil penalties.

14.2. Upon determining that the Navy has failed in a manner set forth in Subsection 14.1, above, the State shall so notify the Navy in writing. If the failure in question is not already subject to dispute resolution at the time such notice is received, the Navy shall have fifteen (15) days after receipt of the notice to invoke dispute resolution on the question of whether the failure did in fact occur. The Navy shall not be liable for the civil penalty sought by the State if the failure is determined, through the dispute resolution process, not to have occurred or to otherwise have been excused under this Agreement. The State agrees not to seek civil penalties or review of related issues either judicially or administratively until the conclusion of the dispute resolution process relating to the civil penalty issue.

14.3. This Section shall not affect the ability of the Navy to obtain an extension of a timetable, deadline or schedule pursuant to Section 9 (Extensions).

14.4. Nothing in this Agreement shall be construed to render any officer or employee of the Navy personally liable for the payment of any civil penalty assessed pursuant to this Section.

15. FUNDING

15.1 It is the expectation of the Parties to this Agreement that all obligations of the Navy arising under this Agreement will be fully funded. The Navy agrees to seek sufficient funding through the DOD budgetary process to fulfill its obligations under this Agreement.

15.2 The Navy shall include, in its submission to the Department of Defense annual report to Congress, the specific cost estimates and budgetary proposals associated with the implementation of this Agreement.

15.3 Any requirement for the payment or obligation of funds, including civil penalties under Section 14, or State oversight costs under Section 33 of this Agreement, or under other terms of this Agreement, shall be subject to the availability of appropriated funds, and no provision herein shall be interpreted to require obligation or payment of funds in violation of the Anti-Deficiency Act, 31 U.S.C. § 1341, et seq. In cases where payment or obligation of funds would constitute a violation of the Anti-Deficiency Act, the dates established requiring the payment or obligation of such funds shall be appropriately adjusted.

15.4 If appropriated funds are not available to fulfill the Navy's obligations pursuant to this Agreement under circumstances not amounting to Force Majeure, the State reserves the right, subject to dispute resolution, to enforce this agreement through any appropriate means, to initiate an action against any other person, or to take any response action, which would be appropriate absent this Agreement.

15.5 Funds authorized and appropriated annually by Congress under the "Environmental Restoration, Defense" appropriation in the Department of Defense Appropriation Act and allocated by the Deputy Assistant Secretary of Defense for Environment to the Department of the Navy will be the source of funds for activities required by this Agreement consistent with section 211 of SARA, 10 U.S.C. However, should the Environmental Restoration, Defense

appropriation be inadequate in any year to meet the total Department of the Navy CERCLA implementation requirements, the Department of Defense shall employ and the Department of the Navy shall follow a standardized Department of Defense prioritization process which allocates that year's DERA appropriations in a manner which maximizes the protection of human health and the environment. A standardized Department of Defense prioritization model shall be developed and utilized with the assistance of U.S. EPA and the states.

16. EXEMPTIONS

16.1 The obligation of the Navy to comply with the provisions of this Agreement may be relieved by:

(a) A Presidential order of exemption issued pursuant to the provisions of CERCLA section 120(j)(1), 42 U.S.C. section 9620(j)(1), or RCRA section 6001, 42 U.S.C. section 6961; or

(b) The order of an appropriate court.

16.2 The State reserves any statutory right it may have to challenge any order relieving the Navy of its obligations to comply with this Agreement.

17. STATUTORY COMPLIANCE AND CORRECTIVE ACTION

17.1 The Parties intend to integrate into this comprehensive Agreement the Navy's CERCLA response obligations with the Navy's (a) RCRA corrective action obligations to the extent possible, (b) State corrective/remedial action obligations, and (c) obligations under all Orders and other statutory requirements of RWQCB, in each case relating to releases of hazardous substances, hazardous wastes, wastes (only to the extent that the definition of waste in Water Code Section 13050 covers hazardous substances, pollutants, contaminants, and hazardous wastes), pollutants or contaminants covered by this Agreement, and which have been or will be adequately addressed by the remedial actions provided for under this Agreement. Therefore, the Parties intend that any remedial action selected, implemented and completed under this Agreement will be protective of human health and the environment such that remediation of releases covered by this Agreement shall obviate the need for further corrective action under Chapter 6.5 of the California Health and Safety Code, federal RCRA (to the extent possible), and otherwise applicable state water quality protection laws. (i.e., no further corrective action shall be required). The Parties agree that with respect to releases of hazardous waste

covered by this Agreement, such state laws shall be considered applicable or relevant and appropriate requirements pursuant to CERCLA section 121.

17.2 The Parties recognize that the requirement to obtain permits for response actions undertaken pursuant to this Agreement shall be as provided for in section 25358.9 of the California Health and Safety Code and Section 19 of this Agreement. The Parties further recognize that on-going hazardous waste management activities at Treasure Island Naval Station may require the issuance of permits under federal and state laws. This Agreement does not affect the requirements, if any, to obtain such permits. However, if a permit is issued to the Navy for ongoing hazardous waste management activities at the Site, the issuing party shall reference and incorporate in a permit condition any appropriate provision, including appropriate schedules (and the provision for extension of such schedules), of this Agreement into such permit. The Parties intend that any judicial review of any corrective action, closure or other remediation activities mandated under RCRA, to the extent possible, or State hazardous waste or water quality permitting laws which have been subjugated to this Agreement in accordance with this section shall, to the extent authorized by law, only be reviewed under the applicable provisions of state hazardous substance and water quality laws, and CERCLA.

18. PROJECT MANAGERS

18.1 Within ten (10) days after the effective date of this Agreement, the Navy, and the State shall each designate a Project Manager and an alternate (each hereinafter referred to as Project Manager), for the purpose of overseeing the implementation of this agreement. The Project Managers shall be responsible on a daily basis for assuring proper implementation of the RI/FS and the RD/RA in accordance with the terms of the Agreement. In addition to the formal notice provisions set forth in Section 21 (Notification), to the maximum extent possible, communications among the Navy, and the State on all documents, including reports, comments, and other correspondence concerning the activities performed pursuant to this Agreement, shall be directed through the Project Managers. A contractor may not serve as Project Manager, unless all other Parties consent in writing.

18.2 The Navy and the State may change their respective Project Managers. The other Party shall be notified in writing within five days of the change.

18.3 The Project Managers shall meet to discuss progress as described in Subsection 7.6. Although the Navy has ultimate responsibility for meeting its respective deadlines or schedule, the Project Managers shall assist in this effort by consolidating the review of primary and secondary documents whenever possible, and by scheduling progress meetings to review reports, evaluate the performance of environmental monitoring at the Site, review RI/FS or RD/RA progress, discuss target dates for elements of the RI/FS, resolve disputes, and adjust deadlines or schedules. At least one week prior to each scheduled progress meeting, the Navy will provide to the other Parties a draft agenda and summary of the status of the work subject to this Agreement. The Navy Project Manager shall be responsible for preparation of minutes of all meetings and shall furnish copies on a timely basis to the other Project Manager(s). Unless the Project Managers agree otherwise, the minutes of each progress meeting, with the meeting agenda and all documents discussed during the meeting (which were not previously provided) as attachments, shall constitute a progress report. The Navy will send to all Project Managers (a) within ten business days after the meeting all such documents not previously provided and (b) within twenty-one (21) calendar days after the meeting, the minutes and agenda. The other Parties will have five (5) business days to submit comments to the Navy. If no comments are received by the Navy, the minutes shall become final. Unless otherwise agreed to by all the Project Managers, the Navy is responsible for supplying monthly progress reports to the other Parties on activities covered under this Agreement. These monthly progress report shall include the information that would normally be discussed in a progress meeting of the Project Managers. Other meetings shall be held more frequently upon agreement by all Project Managers.

18.4 The authority of the Project Managers shall include, but is not limited to:

(a) Taking samples and ensuring that sampling and other field work is performed in accordance with the terms of any final work plan and QAPP;

(b) Observing, and taking photographs and making such other reports on the progress of the work as the Project Managers deem appropriate, subject to the limitations set forth in Section 25 (Access to Federal Facility) hereof;

(c) Reviewing records, files and documents relevant to the work performed, subject to the limitations set forth in subsection 23.1 hereof.

(d) Determining the form and specific content of the Project Manager meetings and of progress reports based on such meetings; and

(e) Recommending and requesting minor field modifications to the work to be performed pursuant to a final work plan, or in techniques, procedures, or design utilized in carrying out such work plan.

18.5 The Navy may initiate necessary minor field modifications provided that the other Project Managers are notified in a timely manner. Any other field modification proposed by any Party pursuant to this Section must be approved orally by all Parties' Project Managers to be effective. The Navy Project Manager will make a contemporaneous record of such modification and approval in a written log, and a copy of the log entry will be provided as part of the next progress report. Even after approval of the proposed modification, no Project Manager will require implementation by a government contractor without approval of the appropriate Government Contracting Officer.

18.6 The Project Manager for the Navy shall be responsible for day-to-day field activities at the Site. The Navy Project Manager or other designated representative of Treasure Island Naval Station shall be present at the Site or reasonably available to supervise work during all hours of work performed at the Site pursuant to this Agreement. For all times that such work is being performed, the Navy Project Manager shall inform the Staff Engineer's Office at Treasure Island Naval Station of the name and telephone number of the designated representative responsible for supervising the work.

18.7 The Project Managers shall be reasonably available to consult on work performed pursuant to this Agreement and shall make themselves available to each other for the pendency of this Agreement. The absence of the State or Navy Project Managers from the facility shall not be cause for work stoppage of activities taken under this Agreement.

19. PERMITS

19.1 The Parties recognize that, under sections 121(d) and 121(e)(1) of CERCLA, 42 U.S.C. section 9621(d) and 9621(e)(1), and the NCP, portions of the response actions called for by this Agreement and conducted entirely on-site are exempted from the procedural requirement to obtain a federal, state, or local permit but must satisfy all the promulgated (as defined in NCP section

300.400(g)(4)) applicable or relevant and appropriate federal and State substantive standards, requirements, criteria, or limitations which would have been included in any such permit.

19.2 This section is not intended to relieve the Navy from any applicable regulatory requirements, including obtaining a permit, whenever it proposes a response action involving either the movement of hazardous substances, pollutants, or contaminants off-site, or the conduct of a response action off-site.

19.3 The Navy shall notify the State in writing of any permit required for off-site activities as soon as it becomes aware of the requirement. The Navy agrees to obtain any permits necessary for the performance of any work under this Agreement. Upon request, the Navy shall provide the State copies of all such permit applications and other documents related to the permit process. Copies of permits obtained in implementing this Agreement shall be appended to the appropriate submittal or progress report. Upon request by the Navy Project Manager, the Project Managers of the State will assist the Navy to the extent feasible in obtaining any required permit.

20. QUALITY ASSURANCE

20.1 In order to provide quality assurance and maintain quality control regarding all field work and sample collection performed pursuant to this Agreement, the Navy agrees to designate a Quality Assurance Officer (QAO) who will ensure that all work is performed in accordance with approved work plans, sampling plans and QAPPs. The QAO shall maintain for inspection a log of quality assurance field activities and provide a copy to the Parties upon request. A contractor may serve as QAO for the Navy.

20.2 All laboratories performing analysis on behalf of the Navy pursuant to this Agreement shall be California state certified or U.S. EPA certified laboratories for hazardous waste.

21. NOTIFICATION

21.1 All Parties shall transmit primary and secondary documents, and comments thereon, and all notices required herein by next day mail, hand delivery, or facsimile (and followed by an original by first-class mail), or by certified mail if transmitted sufficiently ahead of the applicable deadline. Notifications shall be deemed effective upon receipt.

21.2 Notice to the individual Parties pursuant to this Agreement shall be sent to the addresses specified by the Parties. Initially these shall be as follows:

Mr. Tom Lanphar, Project Manager
Site Mitigation Branch, Region 2
Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94710; and

Ms. Barbara Smith, Project Manager
California Regional Water Quality Control Board
San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, CA 94612

Mr. Ernesto Galang, Project Manager
Environmental Restoration Branch, Code 181
Western Division
Naval Facilities Engineering Command
900 Commodore Way
San Bruno, CA 94066-0720

21.3 All routine correspondence may be sent via first class mail to the above addressees.

22. DATA AND DOCUMENT AVAILABILITY

22.1 Each Party shall make all sampling results, test results or other data or documents generated through the implementation of this Agreement available to the other Parties. All quality assured data shall be supplied within one hundred and twenty (120) days of its collection, unless its corresponding draft document deadline is scheduled sooner pursuant to Section 8 of this Agreement, in which case the quality assured data shall be supplied with the corresponding draft document. The Navy shall make its best efforts to supply the quality assured data within ninety (90) days of its collection. The procedures of Section 9 (Extensions) shall apply to the one hundred and twenty (120) referred to herein.

22.2 The sampling Party's Project Manager shall notify the other Parties' Project Managers not less than ten (10) days in advance of any sample collection. If it is not possible to provide ten (10) days prior notification, the sampling Party's Project Manager shall notify the other Project Managers as soon as possible after becoming aware that samples will be collected. Each Party

shall allow, to the extent practicable, split or duplicate samples to be taken by the other Parties or their authorized representatives. Other Parties desiring to collect split or duplicate samples shall inform the sampling Party before the time of sample collection. Each Party receiving split or duplicate samples shall on request provide the sampling Party with its chain of custody documents relating to such sample.

23. RELEASE OF RECORDS

23.1 The Parties may request of one another access to or a copy of any record or document relating to this Agreement, or upon the requesting party's demonstration of the need to know, any other remediation activities conducted at the site. If the Party that is the subject of the request (the originating Party) has the record or document, that Party shall provide access to or a copy of the record or document; provided, however, that no access to or copies of records or documents need be provided if they are subject to claims of confidentiality because of attorney-client privilege, attorney work product, deliberative process, enforcement confidentiality, the Federal Privacy Act, or properly classified for national security under law or executive order.

23.2 Records or documents identified by the originating Party as confidential pursuant to (a) non-disclosure provisions of the Freedom of Information Act, 5 U.S.C. § 552, other than those listed in subsection 23.1 above, or (b) the California Public Records Act, section 6250, et.seq. of the California Government Code, shall be released to the requesting Party, provided the requesting Party states in writing that it will not release the record or document to the public without prior approval of the originating Party or, if the originating Party does not approve, giving that Party the opportunity to contest any preliminary decision to release a document, in accordance with applicable statutes and regulations. Records or documents which are provided to the requesting Party and which are not identified as confidential may be made available to the public without further notice to the originating Party.

23.3 The Parties will not assert one of the above exemptions, including any available under the Freedom of Information Act or California Public Records Act, even if available, if no governmental interest would be jeopardized by access or release as determined solely by the Party who could assert the privilege.

23.4 Subject to CERCLA section 120(j)(2), any documents required to be provided by Section 7 (Review and Approval), and analytical data showing test results will not be subject to subsection 23.2 or the proviso to subsection 23.1.

23.5 This Section does not change any requirement regarding press releases in Section 26 (Public Participation).

23.6 A determination not to release a document for one of the reasons specified above shall not be subject to Section 12 (Dispute Resolution). Any Party objecting to another Party's determination may pursue the objection through the determining Party's appeal procedures, concerning releasibility of documents.

24. PRESERVATION OF RECORDS

24.1 Despite any document retention policy to the contrary, the Parties shall preserve, during the pendency of this Agreement and for a minimum of ten years after its termination, all records and documents contained in the Administrative Record and any additional records and documents retained in the ordinary course of business which relate to the actions carried out pursuant to this Agreement. After this ten year period, each Party shall notify the other Parties at least forty-five (45) days prior to destruction of any such documents. Upon request by any Party, the requested Party shall make available such records or copies of any such records, unless withholding is authorized and determined appropriate by law.

25. ACCESS TO FEDERAL FACILITY

25.1 Without limitations on any authority conferred on the State by statute or regulation, the State or its authorized representatives, shall be allowed to enter Treasure Island Naval Station at reasonable times for purposes consistent with the provisions of the Agreement, subject to any statutory and regulatory requirements necessary to protect national security or mission essential activities. Such access shall include, but not be limited to, reviewing the progress of the Navy in carrying out the terms of this Agreement; ascertaining that the work performed pursuant to this Agreement is in accordance with approved work plans, sampling plans and QAPPs; and conducting such tests as the State, represented by the Project Manager(s), deems necessary.

25.2 The Navy shall honor all reasonable requests for access by the State, conditioned upon presentation of proper credentials. The Navy Project Manager or his/her designee will provide briefing information, coordinate access and escort to restricted or

controlled-access areas, arrange for base passes and coordinate any other access requests which arise.

25.3 The State shall provide reasonable notice (which shall, if practical, be seventy-two (72) hours advance notice) to the Navy Project Manager to request any necessary escorts. When circumstances require the State to give less than seventy-two (72) hours advance notice, the Navy shall make a reasonable effort to provide the necessary escorts as quickly as possible. The State shall not use any camera, sound recording or other recording device at Treasure Island Naval Station without the appropriate permission. The Navy shall not unreasonably withhold such permission.

25.4 State access granted in Subsection 25.1 of this Section, shall be subject to those regulations necessary to protect national security or mission essential activities. Such regulation shall not be applied so as to unreasonably hinder the State from carrying out its responsibilities and authority pursuant to this Agreement. In the event that access requested by the State is denied by the Navy, the Navy shall provide an explanation within 48 hours of the reason for the denial, including reference to the applicable regulations, and, upon request, a copy of such regulations. The Navy shall expeditiously make alternative arrangements for accommodating the requested access. The Parties agree that this Agreement is subject to CERCLA section 120(j), regarding the issuance of Site Specific Presidential Orders as may be necessary to protect national security.

25.5 If the State requests access in order to observe a sampling event or other work being conducted pursuant to this Agreement, and access is denied or limited, the Navy agrees to reschedule or postpone such sampling or work if the State so requests, until such mutually agreeable time when the requested access is allowed. The Navy shall not restrict the access rights of the State to any greater extent than the Navy restricts the access rights of its contractors performing work pursuant to this Agreement.

25.6 All Parties with access to Treasure Island Naval Station pursuant to this Section shall comply with all applicable health and safety plans.

25.7. To the extent the activities pursuant to this Agreement must be carried out on other than Navy property, the Navy shall use its best efforts to obtain access agreements from the owners which shall provide reasonable access for the Navy and the State and its

representatives. The Navy may request the assistance of the State in obtaining such access, and upon such request, the State will use its best efforts to obtain the required access. In the event that the Navy is unable to obtain such access agreements, the Navy shall promptly notify the State.

25.8 With respect to non-Navy property on which monitoring wells, pumping wells, or other response actions are to be located,the Navy shall use its best efforts to ensure that any access agreements shall provide for the continued right of entry for all Parties for the performance of such remedial activities. In addition, any access agreement shall provide that no conveyance of title, easement, or other interest in the property shall be consummated without the continued right of entry.

25.9 Nothing in this Section shall be construed to limit the State's full right of access as provided in California Health and Safety Code section 25185, except as that right may be limited by applicable national security regulations, or state or federal law.

26. PUBLIC PARTICIPATION

26.1 The Parties agree that any proposed removal actions and remedial action alternative(s) and plan(s) for remedial action at the Site arising out of this Agreement shall comply with the administrative record and public participation requirements of applicable state and federal law and relevant community relations provisions in the NCP. The State agrees to inform the Navy of all State requirements which it determines to pertain to public participation. The provisions of this Section shall be carried out in a manner consistent with, and shall fulfill the intent of, Section 17 (Statutory Compliance and Corrective Action).

26.2 The Navy shall develop and implement a Public Participation Plan/Community Relations Plan addressing the site remediation activities and elements of work undertaken by the Navy, except for those phases of work where the NCP does not require a Public Participation Plan/Community Relations Plan for the particular work to be performed.

26.3 The Navy shall establish and maintain an administrative record at a place, at or near the federal facility, which is freely accessible to the public, which record shall provide the documentation supporting the selection of each response action. The administrative record shall be established and maintained in accordance with relevant provisions of state and federal law. A copy of each document placed in the administrative record, not

already provided, will be provided by the Navy to the other Parties. The administrative record developed by the Navy shall be updated and new documents supplied to the other Parties on at least a quarterly basis. An index of documents in the administrative record will accompany each update of the administrative record.

26.4 Except in an emergency, any Party issuing a press release with reference to any of the work required by this Agreement shall advise the other Parties of such press release or fact sheet and the contents thereof, at least forty-eight (48) hours prior to issuance.

27. FIVE YEAR REVIEW

27.1 Consistent with CERCLA section 121(c) and in accordance with this Agreement, if the selected remedial action results in any hazardous substances, pollutants or contaminants remaining at the Site, the Navy shall review the remedial action program at least every five (5) years after the initiation of the final remedial action to assure that human health and the environment are being protected by the remedial action being implemented.

27.2 Copies of all documents generated by the five year review shall be made available to all other Parties in accordance with Section 21 of this Agreement. If, upon such review, any of the Parties proposes additional work or modification of work, such proposal shall be handled under Subsection 7.11 of this Agreement.

27.3 To synchronize the five-year reviews for all operable units and final remedial actions, the following procedure will be used: Review of operable units by the Navy will be conducted every five years counting from the initiation of the first operable unit, until initiation of the final remedial action for the Site. At that time, a separate review for all operable units shall be conducted. Review of the final remedial action by the Navy (including all operable units) shall be conducted every five years thereafter.

28. TRANSFER OF REAL PROPERTY

28.1 The Navy shall not transfer any real property comprising the federal facility except in compliance with section 120(h) of CERCLA, 42 U.S.C. § 9620(h) and 40 CFR Part 373. Prior to any sale of any portion of the land comprising the federal facility which includes an area within which any release of hazardous substance has come to be located, the Navy shall give written notice of that condition to the buyer of the land. At least thirty (30) days

prior to any conveyance subject to section 120(h) of CERCLA, the Navy shall notify all Parties of the transfer of any real property subject to this Agreement and the provisions made for any additional remedial actions, if required. The provisions of this Subsection shall not apply to the extent federal statutes adopted after the effective date of this Agreement place restrictions on transfer of real property by the Navy that are inconsistent with such provisions.

29. AMENDMENT OR MODIFICATION OF AGREEMENT

29.1 This Agreement can be amended or modified solely upon written consent of all Parties. Such amendments or modifications may be proposed by any Party and shall be effective the third business day following the day the last Party signing the amendment or modification sends its notification of signing to the other Parties. The Parties may agree to a different effective date.

30. TERMINATION OF THE AGREEMENT

30.1 The provisions of this Agreement shall be deemed satisfied and terminated upon receipt by the Navy of written notice from the State, that the Navy has demonstrated that all the terms of this Agreement have been completed. If the State denies the request for termination, the State shall provide a written statement of the basis for its denial and describe the Navy actions which, in the view of the State, would be a satisfactory basis for granting a notice of completion. Such denial or failure to grant the request for termination shall be subject to dispute resolution. If the State fails to either grant or deny the request for termination, or fails to provide a written statement for the basis for its denial, within one hundred eighty (180) days of receipt of the request, the request for termination shall be deemed granted.

30.2 This provision shall not affect the requirements for periodic review at maximum five (5) year intervals of the efficacy of the remedial actions.

31. COVENANT NOT TO SUE AND RESERVATION OF RIGHTS

31.1 In consideration for the Navy's compliance with this Agreement, and based on the information known to the Parties or reasonably available on the effective date of this Agreement, the Navy and the State agree that full compliance with this Agreement shall stand in lieu of any administrative, legal, and equitable remedies against the Navy available to the State regarding the releases or threatened releases of hazardous substances including

hazardous wastes, pollutants or contaminants at the Site which are the subject of any RI/FS conducted pursuant to this Agreement and which have been or will be adequately addressed by the remedial actions provided for under this Agreement.

31.2 Notwithstanding this Section, the State shall, subject to the provisions of Section 12 (Dispute Resolution), retain any right it may have under applicable state or federal law to obtain judicial review of any matter related to compliance with, or performance of this agreement.

31.3 When any dispute remains unresolved at the conclusion of the dispute resolution process, this Agreement shall not be interpreted as precluding any Party from exercising whatever rights it may have to proceed with the disputed work, including the right to select and implement appropriate remedial actions at the site.

32. OTHER CLAIMS

32.1 Nothing in this Agreement shall constitute or be construed as a bar or release from any claim, cause of action or demand in law or equity by or against any person, firm, partnership or corporation not a signatory to this Agreement for any liability it may have arising out of or relating in any way to the generation, storage, treatment, handling, transportation, release, or disposal of any hazardous substances, hazardous waste, wastes, pollutants, or contaminants found at, taken to, or taken from the federal property. Unless specifically agreed to in writing by the Parties, the State shall not be held as a party to any contract entered into by the Navy to implement the requirements of this Agreement.

32.2 This Agreement shall not restrict any Party from taking any legal or response action for any matter which is not part of the subject matter of this Agreement.

33. STATE SUPPORT SERVICES AND STATE OVERSIGHT COSTS

33.1 Compensation for State support services rendered in connection with those activities funded by the Defense Environmental Restoration Program (10 U.S.C. §2701, et seq.) carried out pursuant to this Agreement are governed by the Defense/State Memorandum of Agreement (DSMOA), executed on May 31, 1990, between DTSC on behalf of the State and the Department of Defense.

33.2 In the event that the DSMOA is terminated or no longer in effect for any reason, and until a new DSMOA takes effect, the parties agree to the provisions of this subsection and the remainder of Section 33. The Navy agrees to request funding, subject to Section 15 (Funding), and agrees to reimburse the State, subject to the conditions and limitations set forth in this Section, for all reasonable costs the State incurs in providing services in support of the Navy's activities conducted pursuant to this Agreement at the Site. The Navy shall provide upon request all necessary information to the State concerning the funding sources and amounts for all activities conducted by the Navy in the performance of this Agreement. In the event that certain activities carried out under this Agreement appear to be ineligible for DERA funds as determined by DOD and Navy policy, the Navy shall promptly notify the State in accordance with Section 21 (Notifications).

33.3 Total compensation to the State for services or oversight activities shall not exceed the percentage limit specified in the DSMOA and the most recent Cooperative Agreement, using the same procedures set forth in those documents. If no Cooperative Agreement is in effect, the State may withdraw from this Agreement or otherwise take any actions authorized by subsection 15.4 of this Agreement.

33.4 Within one-hundred twenty (120) days after the end of each quarter of the federal fiscal year, the State shall submit to the Navy an accounting of all State costs actually incurred during that quarter in providing support services under this Section. Such accounting shall be accompanied by cost summaries and be supported by documentation which meets federal auditing requirements. The summaries will set forth employee-hours and other expenses by major type of support service. All costs submitted must be for work directly related to implementation of this Agreement and not inconsistent with the NCP and the requirements described in OMB Circulars A-87 (Cost Principles for State and Local Governments) and A-128 (Audits for State and Local Cooperative Agreements with State and Local Governments) and Standard Forms 424 and 270. The Navy has the right to audit cost reports used by the State to develop the cost summaries. Not less than fourteen (14) months prior to the beginning of each federal fiscal year, the State shall supply a budget estimate of what it plans to do in the next year in the same level of detail as the billing documents.

33.5 Except as allowed pursuant to subsections 33.6 or 33.7 below, within ninety (90) days of receipt of the accounting

provided pursuant to Subsection 33.4 above, the Navy shall reimburse the State in the amount set forth in the accounting.

33.6 In the event the Navy contends that any of the costs set forth in the accounting provided pursuant to Subsection 33.4 above are not properly payable, the matter shall be resolved in accordance with Section 12 (Dispute Resolution).

33.7 The Parties recognize there is an outstanding issue concerning the Navy's continuing liability for payments to the State in such case as payments are not made by DOD pursuant to the DSMOA and Cooperative Agreements. The Parties acknowledge that at such time as there is a resolution of this issue, it will be an appropriate topic for an amendment to this Agreement.

34. EFFECTIVE DATE

34.1 This Agreement shall only be effective upon execution by the Navy, DTSC and RWQCB.

34.2 Any response action underway upon the effective date of this Agreement shall be subject to the terms of this Agreement unless the Parties agree otherwise.

35. BASE CLOSURE

35.1 The Navy does not currently plan to close the Treasure Island Naval Station. However, in the event that the Treasure Island Naval Station is closed, such closure, except as is otherwise specifically provided by law, will not affect the Navy's obligation to comply with the terms of this Agreement and to specifically ensure the following:

(a) Continuing rights of access for the State in accordance with the terms and conditions of Section 25 (Access to Federal Facility);

(b) Availability of a Project Manager to fulfill the terms and conditions of the Agreement;

(c) Designation of alternate DRC members as appropriate for the purposes of implementing Section 12 (Dispute Resolution); and

(d) Adequate resolution of any other problems identified by the Project Managers regarding the effect of base closure on the implementation of this Agreement.

35.2 Base closure will not, in and of itself, constitute a Force Majeure under Section 10 (Force Majeure), or good cause for extensions under Section 9 (Extensions), unless mutually agreed by the Parties.

35.3 The Navy will make every effort to ensure that Base closure cleanup funding will be allocated out of DERA funds, to the extent authorized by law, and the State will be reimbursed in accordance with the DSMOA. To the extent that oversight funding for closure cleanup is not reimbursed through the DSMOA, the Navy shall reimburse the State for work using the same criteria identified in the DSMOA.

36. SUBSEQUENT LISTING ON THE NATIONAL PRIORITIES LIST

36.1 This Agreement shall terminate in the event that the Navy signs a Federal Facility Agreement and/or Interagency Agreement with the United States Environmental Protection Agency, concerning environmental response activities at the Federal Facility undertaken or sought to be undertaken pursuant to the DERP, CERCLA, Sec. 120 (e), 42 U.S.C. Sec. 9620 (e)37.

37. APPENDICES AND ATTACHMENTS

37.1 Appendices shall include all final documents setting performance standards, specifications, requirements, or deadlines as designated by the Parties, that are incorporated into this Agreement by amendment in accordance with Section 29 (Amendment or Modification of Agreement). These documents will be enforceable to the extent they contain performance standards, specifications, requirements, or deadlines. Recommendations or suggestions shall not be interpreted to be enforceable mandates. Such documents shall include but are not limited to deadlines established in accordance with Section 8 (Deadlines) and Workplans. The Navy shall maintain, as a part of this Agreement, a list of Appendices which shall be updated as each new Appendix is added. All other documents prepared as deliverables under this Agreement shall be for information purposes, used as external reference documents, and included in the Administrative Record made available to the public in accordance with subsection 26.3.

37.2 Attachments shall be for information only and shall not be enforceable parts of this Agreement. The information in these attachments is provided to support the initial review and comment upon this Agreement, and they are only intended to reflect the conditions known at the signing of this Agreement. None of the facts related therein shall be considered admissions by, nor are

they legally binding upon, any Party with respect to any claims unrelated to, or persons not a Party to, this Agreement. They shall include:

(a) Map(s) of federal facility

(b) Chemicals of Concern

(c) Statement of Facts

(d) Installation Restoration Program Activities

(e) Memorandum of Understanding between DTSC, SWRCB, and RWQCB

Each undersigned representative of a Party certifies that he or she is fully authorized to enter into the terms and conditions of this Agreement and to legally bind such Party to this Agreement.

UNITED STATES DEPARTMENT OF THE NAVY

JACQUELINE E. SCHAFER
Assistant Secretary of the Navy
(Installations and Environment)

29 Sep 92
DATE

STATE OF CALIFORNIA
ENVIRONMENTAL PROTECTION AGENCY

JAMES M. STROCK
Secretary for Environmental Protection

9/29
DATE

BARBARA J. COOK, P.E.
Site Mitigation Chief
Region 2
Department of Toxic Substances Control

9/29/92
DATE

STEVEN R. RITCHIE
Executive Officer
Regional Water Quality Control Board
San Francisco Bay Region

9/29/92
DATE

APPENDIX A

DEADLINES PREVIOUSLY ESTABLISHED

Documents Submitted Before Effective Date:

1. The Parties agree that, the final RI/FS Workplan, RI/FS Sampling Plan, RI/FS Quality Assurance Project Plan, and RI/FS Health and Safety Plan, dated October 22, 1991 shall be renamed to Draft Final RI/FS Workplan, Draft Final RI/FS Sampling Plan, Draft Final Quality Assurance Project Plan, and Draft Final RI/FS Health and Safety Plan respectively. For the purpose of formally initiating the review and comment period set forth in Section 7 (Review and Approval), the effective date of this Agreement shall be deemed the submittal date of the above documents from the Navy.

APPENDIX B

OUTLINE OF TOPICS TO BE ADDRESSED IN TREASURE ISLAND NAVAL STATION

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) WORKPLAN

The following outline lists topics to be included at a minimum in the RI/FS Report for Treasure Island Naval Station. The workplan shall also include additional topics and tasks, as appropriate, set forth in the most recent version of the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (OSWER Directive 9355.3-01, Interim Final, October 1988) and applicable State law.

Any Party may request modification of any task of this Appendix in writing and shall specify:

1. The reason(s) for requesting the modification,
2. A clear description of the requested modification, and
3. Timetable and deadlines affected by the requested modification.

This appendix may be modified upon written agreement between the Project Managers of the DTSC, RWQCB, and the Navy.

I. RI/FS

1.0 MANAGEMENT PLAN OBJECTIVES

- 1.1 Determine the nature and full extent of contaminants in groundwater, surface water, surface soil, subsurface soil, sediments, air; and biota.
- 1.2 Characterize the geographical, geological, and hydrogeological condition of the Site;
- 1.3 Identify all existing and potential sources of contamination and migration pathways;
- 1.4 Identify federal and state applicable or relevant and appropriate requirements (ARARs);
- 1.5 Develop data quality objectives based on site-specific condition, ARARs, and public health and environmental protective criteria;
- 1.6 Conduct a base wide Public Health and Environmental Evaluation based on reliable RI/FS information and data, and;
- 1.7 Identify and evaluate remedial alternatives in accordance with RI/FS guidance.

2.0 REMEDIAL INVESTIGATION

2.0(A) Description of Current Situation

2.1 Site Description
2.2(A) Site History
2.2(B) Site Demographic Information and Potential Public Health and Environmental Impacts
2.3 Results of Previous Investigation
- 2.3.1 Ground Water Release Characterization
- 2.3.2 Surface Water Release Characterization
- 2.3.3 Surface and subsurface soil and sediment Release Characterization
- 2.3.4 Air Release Characterization
- 2.3.5 Geological Study Results
- 2.3.6 Hydrological Study Results
- 2.3.7 Natural Resources Damage Survey Results

2.0(B) Actual Remedial Investigation

2.4 Federal and State applicable or Relevant and Appropriate Requirements (ARARs)
ARARs can be identified only on a site-specific basis. ARARs shall be identified at the following stages in the remedial planning process:
- During scoping of RI/FS
- During site characterization phase
- During development of remedial alternatives in Operable Unit Feasibility Studies and the FS
- During screening of Alternatives
- During detail analysis of Alternatives
- When the preferred Alternative(s) is selected

2.5 Preparation of Plans
- 2.5.1 Quality Assurance Project Plan
- 2.5.2 Sampling Plan
- 2.5.3 Data Management Plan
- 2.5.4 Public Participation Plan

The investigations in sections 2.6 through 2.10 below should result in data of adequate technical content to characterize the site and its actual or potential hazard to public health and environment and support the development and evaluation of remedial alternatives during FS.

2.6 Environmental Settings

2.6.1 Regional Physiography and Topography
2.6.2 Regional and Site Geology
- 2.6.2.1 Stratigraphy
- 2.6.2.2 Soils' attenuation capacity and mechanisms
- 2.6.2.3 Other soil properties: structure, porosity, mineralogy, grain size distribution
- 2.6.2.4 Regional geology
- 2.6.2.5 Site geology

2.6.3 Regional and Site Hydrogeology
- 2.6.3.1 Hydraulic testings: obtain data for the development and evaluation of alternatives in OUFS and FS
- 2.6.3.2 Aquifer tests to determine aquifer parameters and connection between aquifers
- 2.6.3.3 Determine depths of water tables
- 2.6.3.4 Determine ground water flows
- 2.6.3.5 Define areas of recharge, discharge, tidal influence, and sea water intrusion
- 2.6.3.6 Vertical gradients
- 2.6.3.7 Hydraulic barriers (faults, bedrock, constant head sources)
- 2.6.3.8 Vadose Zone monitoring: moisture content, unsaturated conductivities and relative permeabilities
- 2.6.3.9 Regional ground water quality
- 2.6.3.1 Flow model(s)

2.6.4 Regional and site surface water quality
2.6.5 Regional and site meteorology and air quality
2.6.6 Regional and site ground water quality
2.6.7 Regional and site land use
2.6.8 Regional and site biology

2.7 Site-specific Source and Characterization Plan (efforts should begin with a survey of previous studies and other existing data, see section 2.3)

2.7.1 Ground water migration pathway characterization (contaminant-specific)
- 2.7.1.1 Vertical and horizontal extent of migration
- 2.7.1.2 Rate of migration
- 2.7.1.3 Ground water monitoring/contaminants transport model(s)
- 2.7.1.4 Quality assured monitoring and sampling results shall be presented in Progress Reports

2.7.1.5 Quality assured toxicity testing of ground water (results shall be presented in Progress Reports)

2.7.1.6 Quality assured tissue concentration in plants and animals exposed to contaminated ground water (results shall be presented in Progress Reports)

2.7.2 Contaminant surface Water Characterization

2.7.2.1 Route of contaminated surface water

2.7.2.2 Location and sampling frequencies

2.7.2.3 Sampling techniques/methods/analysis

2.7.2.4 Quality assured monitoring and sampling results shall be presented in Progress Reports

2.7.2.5 Quality assured toxicity testing of surface water (results shall be presented in Progress Reports)

2.7.2.6 Quality assured tissue concentration in plants and animals exposed to or collected from contaminated surface water (results shall be presented in Progress Reports)

2.7.3 Contaminated surface, Subsurface Soil and Sediment

2.7.3.1 Specific areas to be studied

2.7.3.2 Vertical and horizontal extent of contamination

2.7.3.3 Probable quantities of subsurface wastes

2.7.3.4 Predicted Rate of vertical migration

2.7.3.5 Predictions of the long term disposition of contaminants

2.7.3.6 Correlation among soil, subsoil, sediment, ground water, and surface water contamination

2.7.3.7 Locations of sampling stations and sampling frequencies

2.7.3.8 Sampling Techniques/Methods/Analysis

2.7.3.9 Quality assured sampling and chemical analyses (result shall be presented in Progress Reports)

2.7.3.10 Quality Assured Toxicity Testing (results shall be presented in Progress Reports)

2.7.3.11 Quality Assured Tissue Concentrations of Contaminants in Plants and Animals (result shall be presented in Progress Reports)

2.7.4 Determine the extent of atmospheric contamination (contaminant specific)
2.7.4.1 Tendency of substances to enter the atmosphere
2.7.4.2 Air monitoring program (base on information from study of contaminated surface soils)
2.7.4.3 Quality assured sampling and monitoring results shall be presented in Progress Reports

2.8 RCRA/CERCLA Integration

2.8.1 RCRA Facility Assessment (RFA)(to the extent one has been conducted by U.S. EPA under RCRA)
2.8.1.1 Areas of concern
2.8.1.2 Preliminary review
2.8.1.2.2.1 Gathering new information
2.8.1.2.2.1.1 Interview relevant individuals
2.8.1.2.2.1.2 Collecting additional information
2.8.1.2.2.2 Evaluating new information
2.8.1.2.2.3 Investigating facility waste generation process
2.8.1.2.2.4 Identifying Solid Waste Management Units (SWMUs)
2.8.1.2.2.5 Other potential release of concern
2.8.1.2.2.6 Evaluating the facility's release potential
2.8.1.2.2.7 Identifying significant Data gaps
2.8.1.2.2.8 Determining the need for further action during the RFA
2.8.1.2.2.8.1 Need for sampling visit
2.8.1.2.2.8.2 Need for Removal Action
2.8.1.2.2.8.3 Need for RI
2.8.1.3 Conducting the Sampling Visit
2.8.1.3.1 Developing sampling plan
2.8.1.3.2 Conducting the sampling visit
2.8.1.3.3 Analyzing and interpreting sampling results
2.8.1.4 Final RFA Recommendations for Further Action
2.8.1.4.1 Making RFA release determinations
2.8.1.4.2 Making recommendations for each SMWU or group of SWMUs

2.8.2 Further investigation of SWMUs under CERCLA
If 2.8.1.4 above recommends any further action, which is normally a task of a RCRA Facility Investigation (RFI), then the action shall be addressed under the RI.

2.8.3 Corrective Action of SWMUs under CERCLA
If 2.8.2 above requires Corrective Action(s) for any SMWU(s), then these corrective actions shall be addressed under CERCLA.

2.9 Site Characterization Analysis
Analyze all site investigation results to prepare a summary to ensure the investigation data are sufficient in quality and quantity to support the FS.

2.9.1 Organize and present logically the relationship between site investigations for each medium
2.9.2 Develop a summary of the types and extent of contaminants
2.9.3 Correlate the Contents of Contaminants in each medium with the results of toxicity testing and tissue concentrations in plants and animals.

2.10 Supplemental Surveys and Investigations
The Navy may need to perform additional tasks in order to accomplish the RI/FS objectives. Such tasks may include additional field work and studies to provide information on newly discovered contaminants, pathways of concern, and bench scale tests of possible remedial technologies.

2.11 Community Relation Support
This task includes but may not be limited to:
2.11.1 Revision and additions to the PPP

2.11.2 Analysis of community attitudes toward proposed action(s)

2.11.3 Preparation and dissemination of information
2.11.3.1 News releases
2.11.3.2 Fact sheets and updates
2.11.3.3 Slide shows
2.11.3.4 Exhibits
2.11.3.5 Audio and Visual Materials

2.11.4 Establishment of a Community Information Center

2.11.5 Arrangement for briefings and press conferences

2.12 Submit Progress Reports to DTSC and RWQCB

2.13 Remedial Investigation Report(s)
The RI report shall include all results from tasks 2.0(A) through 2.10 of this Appendix, interpretations of such results (including any graphical presentations, and statistical testing and analyses), correlations of such results among the contaminated media and biota, identification of data gaps, and a proposal for future work. If the plans prepared under section 2.5 of this Appendix are submitted separately, then the RI Report need not include those plans. The RI report shall be consistent with CERCLA, the NCP, applicable U.S EPA guidance, and state laws and guidance.

3.0 **FEASIBILITY STUDY**

3.1 Description of the current situation

3.1.1 The Navy shall summarize the current situation base on task 2.0(A) and new data and information obtained from tasks 2.0(B) through 2.11 of this Appendix.

3.1.2 Identify the actual and potential exposure pathways to humans that should be addressed by remedial action alternatives.

3.1.3 Identify the actual and potential exposure pathways to plants and animals that should be addressed by remedial action alternatives.

3.2 Baseline Risk Assessment (Risk Assessment for the No Action Alternative)

The Baseline Risk Assessment involves an ecological study and the following eleven steps which cover a range of complexity, quantification, and levels of effort.

3.2.1 STEP 1: SELECTION OF INDICATOR CHEMICALS FOR HUMAN HEALTH EFFECTS

3.2.1.1 Develop initial list of indicator chemicals

3.2.1.2 Select final indicator chemicals

Federal Facility Site
Remediation Agreement for
Treasure Island Naval Station

3.2.2 STEP 2: ESTIMATION OF EXPOSURE POINT CONCENTRATION OF INDICATOR CHEMICALS FOR HUMAN HEALTH EFFECTS

- 3.2.2.1 Identify exposure pathways
  - 3.2.2.1.1 Chemical release sources and media
  - 3.2.2.1.2 Identify and characterize possible exposure points
  - 3.2.2.1.3 Integrated release sources, transport media, exposure points, and exposure routes into exposure pathways
  - 3.2.2.1.4 Presence of sensitive human populations
- 3.2.2.2 Estimate exposure point concentrations
  - 3.2.2.2.1 Quantify chemical releases
  - 3.2.2.2.2 Predict Environmental Fate and Transport
- 3.2.2.3 Compare to Requirements, Standards, and Criteria
  - 3.2.2.3.1 Compare to ARARs:
    - -Maximum Contaminant Levels (MCL) and Maximum Contaminant Level Goal (MCLG)
    - -National Ambient Air Quality Standards (NAAQS)
    - -Federal Ambient Water Quality Criteria
    - -State Environmental Standards

3.2.3 STEP 3: ESTIMATION OF CHEMICAL INTAKES FOR HUMAN HEALTH EFFECTS

- 3.2.3.1 Calculate Air Intakes
- 3.2.3.2 Calculate Ground water intakes
- 3.2.3.3 Calculate surface water intakes
- 3.2.3.4 Calculate intakes from other exposure pathways
- 3.2.3.5 Combine pathway-specific intakes to yield total oral and total inhalation intakes

3.2.4 STEP 4: TOXICITY ASSESSMENT FOR HUMAN HEALTH EFFECTS

3.2.5 STEP 5: RISK ASSESSMENT FOR HUMAN HEALTH EFFECTS
- 3.2.5.1 Non-Carcinogenic effects
- 3.2.5.2 Potential carcinogenic effects
- 3.2.5.3 Uncertainties

3.2.6 STEP 6: SELECTION OF INDICATOR CHEMICALS FOR EFFECTS ON BIOTA

3.2.7 STEP 7: ESTIMATION OF EXPOSURE POINT CONCENTRATION OF INDICATOR CHEMICALS FOR EFFECTS ON BIOTA

3.2.8 STEP 8: ESTIMATION OF CHEMICAL INTAKES FOR EFFECTS ON BIOTA

3.2.9 STEP 9: TOXICITY ASSESSMENT FOR EFFECTS ON BIOTA

3.2.10 STEP 10: RISK ASSESSMENT FOR EFFECTS ON BIOTA

3.2.11 STEP 11: ENVIRONMENTAL RISK ASSESSMENT

3.3 Development of Performance Goals and Analysis of Risks for Each of Remedial Alternatives
Perform this sub-task (3.3) for each remedial action alternatives at the alternative evaluation stage

- 3.3.1 Re-Evaluate indicator chemicals
- 3.3.2 Identify potential exposure pathways
- 3.3.3 Determine target concentrations at human exposure points
- 3.3.4 Estimate target release rates
- 3.3.5 Assess chronic risk for non-carcinogens
- 3.3.6 Assess potential short-term health effects of each of the remedial alternatives

3.4 Development of Alternatives / FS Phase I
Alternatives should be developed concurrently with the RI site characterization, with the results of one influencing the other in an iterative fashion

3.4.1 Establishment of Remedial Response Objectives based on the Baseline Risk Assessment and ARARs identification. Remedial response objectives should be developed to specify contaminants and media of interest, exposure pathways, and

remediation goals that permit a range of treatment and containment alternatives to be developed.

3.4.2 Identifying volumes and areas of media to which treatment or containment action may be applied
3.4.3 Developing response actions for each medium
3.4.4 Identifying potential treatment technologies
3.4.5 Screening the technologies based on:
- 3.4.5.1 Public Health and Environmental Impact
- 3.4.5.2 Effectiveness
- 3.4.5.3 Implementability
- 3.4.5.4 Cost

3.4.6 Assembling technologies and their associated containments or disposal requirements into alternatives
3.4.7 Community Relations during FS Phase I
3.4.8 Reporting and communication during FS Phase I

3.5 Screening of Alternatives / FS Phase II
3.5.1 Initial screening of alternatives based on:
- 3.5.1.1 Health and environmental protection
- 3.5.1.2 Technical feasibility

3.5.2 Community Relation during FS Phase II
3.5.3 Reporting and communication during FS Phase II

3.6 Post-Screening Investigations
3.6.1 Determination of data requirements
3.6.2 Additional site characterization
3.6.3 Treatability Study
- 3.6.3.1 Conduct laboratory and/or bench scale studies to determine applicability of remedial technologies
- 3.6.3.2 Analyze the technologies to determine the testing requirements
- 3.6.3.3 Develop a testing plan:
  - 3.6.3.3.1 Testing types
  - 3.6.3.3.2 Testing goals
  - 3.6.3.3.3 Levels of effort
  - 3.6.3.3.4 Data management and interpretation guidelines
- 3.6.3.4 Perform tests
- 3.6.3.5 Evaluation of testing results
- 3.6.3.6 Scale-up those technologies based on testing results

3.7 Detail Analysis of the Remaining Alternatives / FS Phase III
3.7.1 Health information/environmental effects
3.7.2 Technical aspects of the remedial alternatives

3.7.3 Evaluation criteria for detail analysis of alternatives
- 3.7.3.1 Short-term effectiveness
- 3.7.3.2 Long-term effectiveness and permanence
- 3.7.3.3 Reduction of toxicity, mobility or volume
- 3.7.3.4 Implementability
- 3.7.3.5 Cost
- 3.7.3.6 Compliance with ARARs
- 3.7.3.7 Overall protection of human health and the environment
- 3.7.3.8 State acceptance
- 3.7.3.9 Community acceptance

3.7.4 Community relations during FS Phase III

3.7.5 Reporting and communication during FS Phase III

3.8 Recommended Remedial alternatives

3.9 Submit Progress Reports to DTSC and RWQCB pursuant to the progress report requirements.

3.10 Feasibility Study Report(s)
The report shall include the results of tasks from 3.1 through 3.8 of this Appendix. The FS report shall be consistent with CERCLA, the NCP, the U.S EPA Risk Assessment Guidance for Superfund (Volumes I & II) and any subsequent revisions thereof, the Superfund Exposure Assessment Manual, U.S EPA, Draft, April 1988 and any revisions thereof, the Compendium of Superfund Field Operations Methods, other applicable U.S EPA and State guidance, California Health and Safety Code, California Code of Regulations, Title 22, and the California Water Code.

II. Development of Proposed Plan for Remedial Action
The Proposed Plan shall be consistent with CERCLA, the NCP, California Health and Safety Code, California Code of Regulations, Title 22, California Water Code, and applicable U.S EPA and State guidance.

III. Public Review Comment
The Navy shall provide the public the opportunities of review and comment on the RI and FS reports and the Remedial Action Plan(s) in a manner consistent with Section 26, Public Participation, of this Agreement.

IV. Responsiveness Summary
The Navy shall prepare a Responsiveness Summary (part of the Record of Decision) after the public comment period in a

manner consistent with CERCLA, Section 26, Public participation, of this Agreement, U.S EPA Guidance on Community Relations for Operable Unit Response Action, the NCP, California Health and Safety Code, California Code of Regulations, Title 22, and applicable U.S EPA and State Guidance.

V. Remedial Action Plan(s)

1.0 The remedial action plan(s) shall be based upon Section 25350 of the California Health and Safety Code, Sub-part E of the NCP, and any amendments thereto and upon all of the following factors, to the extent that these factors are consistent with these federal regulations and do not require a less stringent level of cleanup than these federal regulations:

- 1.1 Health and safety risks posed by the conditions at the site
- 1.2 The effect of contamination or pollution levels upon present, future, and probable beneficial uses of contaminated, polluted, or threatened resources
- 1.3 The effect of alternative remedial action measures on the reasonable availability of groundwater resources for present, future, and probable beneficial uses
- 1.4 Site specific characteristics
  - 1.4.1 Potential of offsite migration of hazardous substances
  - 1.4.2 Surface, subsurface soil and hydrogeologic condition
  - 1.4.3 Preexisting background contamination levels
  - 1.4.4 Relationship of contaminant concentration to biological effects including human health and effects on biota
- 1.5 Cost effectiveness of alternative remedial action measures
  - 1.5.1 Total short-term and long-term costs of actions
- 1.6 Potential environmental impacts of alternative remedial action measures
- 1.7 Statement of reasons setting forth the basis for the removal and remedial actions selected
  - 1.7.1 Evaluation of each proposed alternative

1.7.2 Evaluation of the consistency of the removal and remedial actions with federal regulations

1.7.3 Reasons for rejection of alternative removal and remedial actions

1.8 Monitoring Plan

1.9 Nonbinding preliminary allocation of responsibility (NBAR)

VI. Remedial Design

The Navy shall prepare Preliminary and Final Remedial Design documents which provide detailed engineering design and specifications which will allow other Parties to review and to ensure the selected remedy(ies) fully considered by the Navy in the Design.

VII. Remedial Action Work Plan

The Navy shall prepare a Remedial Action Work Plan, using appropriate U.S EPA and State guidance and state laws, for each remedial action. The work plan(s) shall contain the following:

1.0 Tentative formulation of remedial action team, descriptions of duties, and lines of authority in the management o f the construction, operation and maintenance activities;

2.0 Description of the roles and relationships of the Navy, resident engineers, independent quality assurance team, remedial design professionals, and remedial constructor;

3.0 Process for selection of remedial action constructor(s);

4.0 Schedule for the remedial action(s) and process to continuously update the project schedule;

5.0 Methods to implement the construction quality assurance plan, including criteria and composition of the independent quality assurance team;

6.0 A health and safety plan for field construction activities;

7.0 Strategy for implementing the Contingency Plan

8.0 Procedure for data collection during the remedial action(s) to validate the completion of the project; and

9.0 Monitoring Plan

10.0 Requirements for project closeout.

VIII. Contingency Plan

The Navy shall develop a Contingency Plan, using appropriate U.S. EPA and State guidance and state laws, to protect the local affected human population and biota in the event of an accident or emergency. It may incorporate an air monitoring plan, a spill control, and countermeasures plan, if applicable, for the site.

IX. Five-Year Review

If the selected remedial action results in any hazardous substances, pollutants, or contaminants remaining at the site, the Navy shall review such remedial action and the Monitoring Plan no less often than each 5 years after the initiation of such remedial action as mandated in 9621(c) of SARA and the Monitoring Plan as required in Section VII.9 above.

X. Project Closeout

At the completion of the remedial action(s), the Navy shall prepare a Project Closeout Report which certifies that all items contained in the final Remedial Action Plan, including the completion of the Monitoring Plan and any additional remedial actions which may be necessary as a result of findings from the Monitoring Plan, have been completed. The report shall include proper documentation (e.g., test results) substantiating that the performance standards are being met. The report should also include "Record Drawings" of the project.

QUALITY ASSURANCE PROJECT PLAN OUTLINE

1.0 Bottom of title page should include signature blocks for the following approving personnel:
- 1.1 The Navy Project Manager
- 1.2 The Navy Responsible QA Officer
- 1.3 Funding organization's Project Officer
- 1.4 Funding organization's QA Officer

2.0 Table of Contents includes:
- 2.1 Introduction
- 2.2 Listing of the 16 QAPP components
- 2.3 Listing of Appendices required to augment the QAPP
- 2.4 Listing of all individuals receiving official copies of the QAPP and its revisions

3.0 Project Description

4.0 Project Organization and Responsibility

5.0 Quality Assurance Objectives for Measurement of Data. For each major parameter provide Quality Assurance Objectives for:
- 5.1 Precision
- 5.2 Accuracy
- 5.3 Completeness
- 5.4 Representativeness
- 5.5 Comparability

6.0 Sampling Procedures
- 6.1 Method of collection
- 6.2 Rational for sample site selection
- 6.3 Preparation of sampling equipment and containers
- 6.4 Type and volume of sample container
- 6.5 Description of decontamination procedures
- 6.6 Holding time and preservation method
- 6.7 Time consideration for sample shipping
- 6.8 Documentation of sampling history, conditions and analyses (including forms, note books, etc.)

7.0 Sample Chain of custody Procedures
- 7.1 Field Sampling Operation
  - 7.1.1 Documentation of exact location and consideration associated with sample acquisition
  - 7.1.2 Documentation of procedure for preparation of reagents
  - 7.1.3 Documentation of method for sample preservation
  - 7.1.4 Labeling techniques
  - 7.1.5 Availability of Chain of Custody form
- 7.2 Lab Operation
  - 7.2.1 Identification of sample custodian
  - 7.2.2 Lab procedure for sample handling, storage and dispersement for analysis
  - 7.2.3 Lab procedure for sample handling, storage and dispersement for analysis
  - 7.2.4 Specifications of lab sample custody procedures for sample handling, storage and dispersement for analysis

8.0 Calibration Procedures and Frequency and Information for Field Equipment and Lab Equipment:
- 8.1 Major measurement parameters
  - 8.1.1 Pollutant measurement system
  - 8.1.2 Standard Operation Procedure (SOP)
  - 8.1.3 Description of calibration procedures
- 8.2 List frequency of re-calibration
- 8.3 List calibration standards
- 8.4 Where calibration and repairs logged

9.0 Analytical Procedures
- 9.1 Cite method name and number
- 9.2 Description of analytical procedure for chemical analyses
  - 9.2.1 Analytes
  - 9.2.2 Parameter group
  - 9.2.3 Method name and number
  - 9.2.4 Detection limit
- 9.3 Description of procedures for toxicity testing
  - 9.3.1 Method name and description
  - 9.3.2 History of organism used in testing including collection site, date of collection, visual evaluation of organisms and other relevant information
  - 9.3.3 Results of positive (toxic) control tests

9.4 Description of procedures for tissue analyses
- 9.4.1 Method description
- 9.4.2 History of organisms used for tissue analyses including site characteristics, if evaluating field collected populations, and other information about collection if performing laboratory exposures of organisms to contaminated sites media (water, soil or sediment)
- 9.4.3 Designation of proper experimental control for comparison to contaminant-exposed organisms (e.g., uncontaminated local populations of organisms as a field control for comparison to site collected or the use of pre-exposed organisms as a baseline for laboratory-exposed organisms)

10. Data Reduction, Validation and Reporting
- 10.1 Data reduction scheme planned on collected data
- 10.2 Criteria used to validate data integrity during data collection and reporting
- 10.3 Methods used to identify and treat outliers
- 10.4 Reporting scheme for collection of raw data
- 10.5 Key individuals in this reporting scheme

11. Internal Quality Control Checks (both Lab and Field)
- 11.1 Replicates
- 11.2 Spiked samples
- 11.3 Split samples
- 11.4 Control blanks
- 11.5 Blanks
- 11.6 Internal standards
- 11.7 Zero and span gases
- 11.8 Quality control samples
- 11.9 Surrogate samples
- 11.10 Calibration standards and devises
- 11.11 Reagent checks
- 11.12 Toxicity Testing QC
  - 11.12.1 Relationship of result from positive (toxic) controls to laboratory and U.S. EPA standards
  - 11.12.2 High quality laboratory control test water as defined by the toxicity test method
  - 11.12.3 Water quality monitoring data from the duration of the test as required by the toxicity test method
  - 11.12.4 Random or "blind" testing of samples
  - 11.12.5 Replicates

11.12.6 Quality control samples
11.12.7 Split samples

11.13 Tissue Analysis QC
11.13.1 Replicates
11.13.2 Spikes
11.13.3 Split samples
11.13.4 Control Blanks
11.13.5 Pre-exposed tissue
11.13.6 Field-control population tissue
11.13.7 Blanks
11.13.8 Internal standards
11.13.9 Quality control samples
11.13.10 Surrogate samples
11.13.11 Calibration standards and devises
11.13.12 Reagent checks

12. Performance and System Audits
12.1 Internal Audits
12.1.1 Description of audits
12.1.2 Audited by
12.1.3 Frequency of audits
12.1.4 Person to receive audit reports
12.2 External Audits
12.2.1 Description of audits
12.2.2 Audited by
12.2.3 Person to receive audit reports
13. Preventive Maintenance
13.1 Schedule of maintenance to minimize downtime
13.2 Critical spare parts to minimize downtime
14. Routine Procedures Used to Assess:
14.1 Data Precision
14.2 Data Accuracy
14.3 Data Completeness
14.4 Data Comparability
14.5 Data Representativeness
15. Corrective Action
15.1 Procedures include the following:
15.1.1 Limit for data acceptability beyond which corrective action is required
15.1.2 Re-evaluation of analyst's work and instrumentation checks
15.1.3 Corrective action initiator and approver
15.2 Other QA activities may also initiate corrective action:
15.2.1 Performance audits
15.2.2 System audits

15.2.3 Lab/Inter-field comparison studies
15.2.4 QA program conducted by quality management staff (QAMS)

16. Quality Assurance Report and Management
16.1 Periodic assessment of data quality, precision and completeness
16.2 Results for performance audits
16.3 Results for system audits
16.4 QA problems and solutions
16.5 Frequency of report

SAMPLING PLAN OUTLINE

1 Objectives of the Sampling Effort
2 Maps of All Pertinent Locations and Sampling Points
3 Rationale for Sampling Location and Numbers of Samples
4 Request for Analyses
  - 4.1 Narrative request for analyses
  - 4.2 Tabular request for analyses

5 Field Methods and Procedures
  - 5.1 Sample collection
  - 5.2 Disposal of contaminated materials
  - 5.3 Equipment decontamination
  - 5.4 Sample containers
  - 5.5 Sample preservation
  - 5.6 Sample shipment
  - 5.7 Sample documentation
  - 5.8 Quality Assurance
    - 5.8.1 Replicates
    - 5.8.2 Blanks

DATA MANAGEMENT PLAN OUTLINE

Field sampling and analytical procedures for the acquisition and compilation of field and lab data and demonstrated activities are subject to data management procedures.

1. Document and track data, information, and results (all analytical data collected by the Navy shall be reported separately using the same format and in the same report for easy reference)
   - 1.1 Field activities
   - 1.2 Sample management and tracking
   - 1.3 Document control and inventory
2. Identify lab documentation procedures
3. Project file requirements
4. Project related progress

APPENDIX C

ALL PRIMARY AND SECONDARY DOCUMENTS WHICH WILL BE CREATED IN ACCORDANCE WITH **SECTION 7 (REVIEW AND APPROVAL)**

	Primary Documents	Secondary Documents
a.	RI/FS Workplans	
b.	RI/FS Sampling Plans	
c.	RI/FS Quality Assurance Plan	
d.	RI/FS Health & Safety Plan	
e.	Community Relations Plan	
f.	Remedial Investigation Reports	Sampling Result Data
		Removal Action Reports (IG)
		Baseline Risk Assessment
		Environmental Assessment
		Removal Action Memorandum (IG)
g.	Feasibility Study Reports	Public Notices & Fact Sheets
		Treatability Studies (IG)
		Initial Screening of Alternatives
		Detailed Analysis of Alternatives
h.	Remedial Action Plans	Proposed Plans (including maintenance plans)
		Remedial Action Schedules
		Public Health and Environmental Evaluation Plans
i.	Remedial Designs	Public Notices and Fact Sheets
		Engineering Plans (Plots and Schematics)
		Implementation Schedules
		Health & Safety Plans

j.	Remedial Action Completion Report	Post-Remedial Sampling Design Plan (IG) Post-Remedial Sampling Completion Report (IG) Operations & Maintenance

Note: IG -- If Generated

2 Nov 1992

MEMORANDUM

From: Code 1813EG EMG

To: Distribution

Subj: REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) FOR NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA

Encl: (1) FEDERAL FACILITY SITE REMEDIATION AGREEMENT (FFSRA) DATED 29 SEPTEMBER 1992

1. Enclosure (1) is provided for your file.

2. For additional information, please contact Mr. Ernesto M. Galang at (415) 244-2560.

Distribution:
Naval Station Treasure Island (Attn: Jim Sullivan)
COMNAVBASE San Francisco (Attn: Randy Friedman)
PRC Environmental Management, Inc. (Attn: Emily Pimentel)

APPENDIX D

ALL DEADLINES WHICH WILL BE ESTABLISHED IN ACCORDANCE WITH SECTION 8 (DEADLINES) AND WHICH MAY BE EXTENDED IN ACCORDANCE WITH **SECTION 9 (EXTENSIONS)**

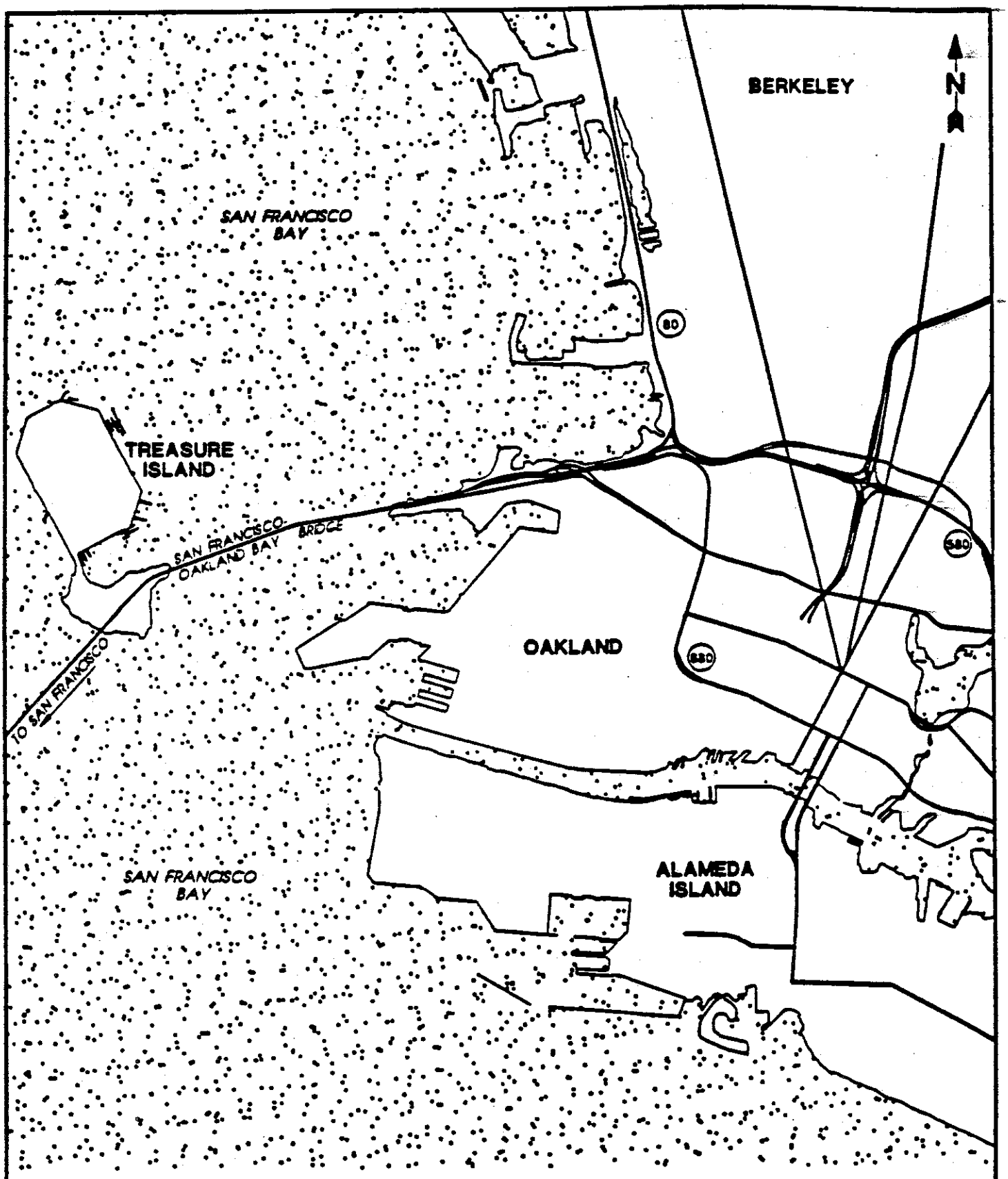
	Draft Primary Documents	Deadlines	Secondary Documents	Target Dates
a.	RI/FS Workplans	Submitted		
b.	RI/FS Sampling Plans	Submitted		
c.	RI/FS Quality Assurance Plan	Submitted		
d.	RI/FS Health & Safety Plan	Submitted		
e.	Community Relations Plan	11/30/91		
f.	Remedial Investigation Reports	11/08/93	Sampling Results Data	02/08/93
			Environmental Assessment	09/23/93
			Baseline Risk Assessment	09/23/93
			Removal Action Report	T.B.D
			Removal Action Memorandum	T.B.D
g.	Feasibility Study Reports	01/23/95	Public Notices and Fact Sheets	07/18/94
			Treatability Studies (IG)	T.B.D
			Initial Screening of Alternatives	01/03/94
			Detailed Analysis of Alternatives	08/01/94
h.	Remedial Action Plans	09/22/95	Proposed Plans	09/22/95
			Remedial Action Schedules	09/22/95
			Public Health & Environ'l Eval. Plans	09/22/95
			Health & Safety Plans	T.B.D
i.	Remedial Designs	T.B.D*	Public Notices and Fact Sheets	T.B.D
			Engineering Plans (30% Design)	T.B.D

		Implementation Schedules	T.B.D
		Health & Safety Plan	T.B.D
j.	Remedial Action Completion Rep. T.B.D*	Post-Remedial Sampling Design Plan (IG)	T.B.D
		Post-Remedial Sampling Compl'n Rep.(IG)	T.B.D
		Operations & Maintenance Plan (I.G)	T.B.D

Note: IG -- If Generated
T.B.D*-- To be determined pursuant to Section 8.3 of the Agreement

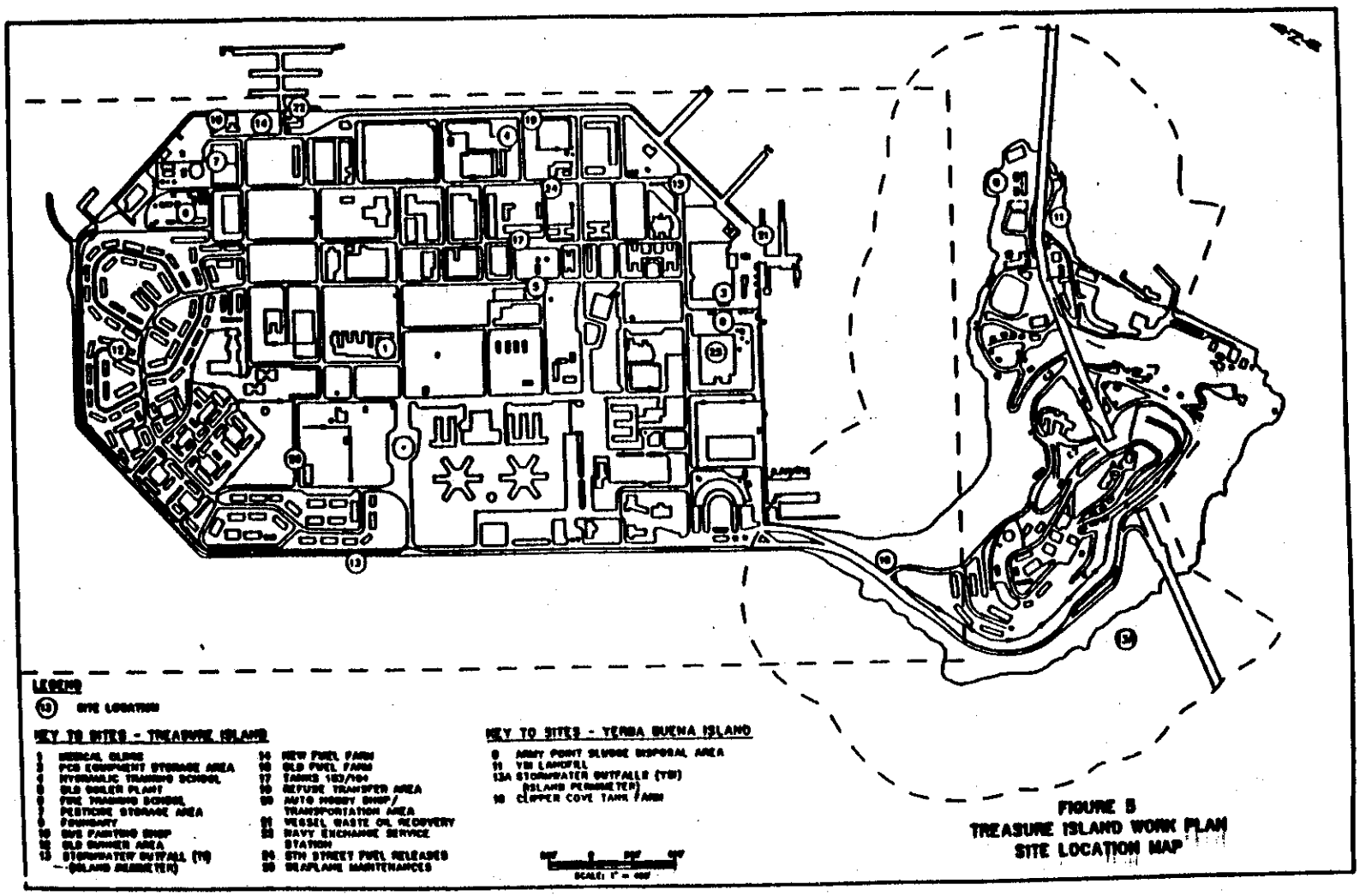
ATTACHMENT A

MAPS



ATTACHMENT A

TREASURE ISLAND LOCATION MAP



ATTACHMENT A

ATTACHMENT B

CHEMICALS OF CONCERN

This description of the toxicity of chemicals of concern at Treasure Island Naval Station is for reference only and should not be interpreted as describing effects on any individual person.

1.0 Asbestos. Inhalation or ingestion of asbestos can cause a debilitating lung disease called asbestosis; a rare cancer of the chest and abdominal lining called mesothelioma; and cancers of the lung, esophagus, stomach, colon, and other organs. Lung cancer may not develop until 35 to 40 years after heavy exposure , and other malignancies are also delayed. Combining smoking with occupational exposure to asbestos increases the lung cancer rate above the rate due to either smoking or asbestos exposure alone. Asbestos exposure to children is of special concern since they have a greater remaining life span than adults, their lifetime risk of developing mesothelioma is greater (U.S) EPA, June 1985). Asbestos is listed as carcinogen under Proposition 65.

2.0 Waste Acids. These acids included (but were not restricted to) acetic, nitric, sulfuric, phosphoric, hydrochloric. It is not clear exactly how much, individually and in total, acetic waste was deposited at the Sites. All of the above named acids are listed hazardous materials (acetic, #2; hydrochloric, No. 381; nitric, No. 540; phosphoric, No. 591; sulfuric, No. 705) in Section 66680, Title 22, California Administrative Code. In addition, hydrochloric acid is a listed "Extremely Hazardous Waste", as defined in Section 66720, Title 22, California Administrative Code. Health effects by waste acids are routed by ingestion, inhalation or skin contact. These effects are irritation to the eyes, nose, throat, lungs and mucous membrane linings. Contact with the skin will cause mild to severe irritation. Over exposure has been known to cause laryngeal, pulmonary edema, vomiting, diarrhea and shock. The waste acids named are incompatible with strong oxidizers, strong caustics, strong bases, organics, chlorates, metals and active metals.

3.0 Arsenic. Arsenic compounds have been shown to produce acute and chronic toxic effects which include systemic irreversible damage. The trivalent (III) compounds are the most toxic and tend to accumulate in the body. The compound is also corrosive to the skin. Evidence is know available incriminating arsenic compounds as a cause of lung cancer as well as skin cancer.

4.0 Copper. Copper salts act as irritants to skin causing itching, erythema, and dermatitis. Conjunctivitis, ulceration and turbidity of the cornea may be caused to the eye. Metallic copper may cause keratinization of the hands and soles of the feet. Fumes and dust may cause irritation of the upper respiratory tract, metallic taste in the mouth, nausea, metal fume fever, and in some instances discoloration of the skin and hair.

5.0 Barium. Alkaline barium compounds, such as hydroxide and carbonate, may cause local irritation to the eyes, nose, throat, and skin. When ingested, the soluble, ionized barium may exert an effect on all muscles, especially on smooth muscle. Other effects may include increased intestinal peristalsis, vascular constriction, bladder contraction, and increased voluntary muscle tension. The inhalation of barium sulfate dust may lead to baritosis, a benign pneumoconiosis.

6.0 Chromium (Total). Chromium compounds in the trivalent (III) state are less toxic than chromium in the hexavalent (VI) state. Chromium has been classified by the U.S. Environmental Protection Agency's Carcinogen Assessment Group (EPA CAG) in Class A (human carcinogen) through the inhalation route (U.S. EPA, 1985a). Chromium compounds are listed hazardous materials (No. 204) in Section 66680, Title 22, California Administrative Code. The U.S. EPA's MCL for total chromium in water is 51 ppb.

7.0 Lead. Short-term exposure to lead can cause reversible kidney damage, but prolonged exposure at high concentrations may result in progressive kidney damage and possibly kidney failure. Anemia, due to the inhibition of hemoglobin synthesis and a reduction in the life span of circulating red blood cells, is an early manifestation of lead poisoning (U.S. EPA, 1985c). The most serious effects associated with markedly elevated blood levels are severe neurotoxic effects that include irreversible brain damage, as indexed by the occurrence of acute or chronic encephalophatic symptoms (U.S. EPA, 1985d). Lead compounds are listed as hazardous materials (No. 406) in Section 66680, Title 22, California Administrative Code. The U.S. EPA's MCL for lead in water is 50 ppb.

8.0 Organochlorine pesticides. Humans may be exposed to pesticides through oral, dermal and central nervous system routes. Ingestion, inhalation or absorption of this material into the body can cause irritability, convulsions and depression. Continued exposure causes liver damage. Most of organochlorine pesticides have been reported to produce various effects on reproduction in a variety of species, e.g., decreased fertility and decreased viability of the young.

9.0 Polychlorinated Bi-phenyl (PCB's) may cause the formation of comedones, sebaceous cysts and chloracne. Irritation of eyes, nose and throat may also occur. Systemic effects are usually dependent upon the degree of chlorination; the higher the degree, the stronger the effects. Acute and chronic exposure can cause liver damage. Symptoms include edema, jaundice, vomiting, anorexia,

nausea, abdominal pains, and fatigue (Sittig, 1985). The IARC lists PCBs in Category I (sufficient evidence of human carcinogenicity) in its weight of evidence ranking for potential carcinogens (Gilbert, et al).

10.0 Acetone. Acetone primarily attacks the respiratory system and skin. Basic harmful effects and symptoms are irritation of the eyes, nose and throat, headaches, dizziness and dermatitis. Acetone is a listed hazardous material (No. 3) in Section 66680, Title 22, California Administrative Code. In addition, acetone is incompatible with oxidizers, sulfuric-nitric-acetic acid(s), chloroform, air, etc. (Sax, 1985).

11.0 Benzene. Exposure to liquid and vapor may produce primary irritation to the skin, eyes, and upper respiratory tract. If liquid is aspirated into the lung, it may cause pulmonary edema and hemorrhage. Erythema, vesiculation, and dry, scaly dermatitis may also develop from defatting of the skin. Acute exposure to benzene results in central nervous system depression. Headache, dizziness, nausea, convulsions, coma and death may result. Chronic exposure is well documented to cause blood changes. Aplastic anemia may develop with anemia, leukopenia, and thrombocytopenia. NIOSH has concluded that benzene is leukemogenic.

REFERENCES

Cassarett, L.J., and J. Doull, eds. 1975. Toxicology, The Basic Science of Poisons, New York: Macmillian Publishing Co., Inc.

Key, M.M., et al., eds. Revised Edition June 1977. Occupational Diseases, A Guide to Their Recognition, U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute for Occupational Safety and Health.

Sax, N.I. 1984. Dangerous Properties of Industrial Materials, 6th ed. New York: Van Nostrand Reinhold Co.

ATTACHMENT C

STATEMENT OF FACTS

ATTACHMENT C

STATEMENT OF FACTS

1.0 Site Description

The Site is located in central San Francisco Bay, midway between the cities of San Francisco and Oakland on a 580 acre man-made island (Treasure Island) that is anchored to the natural rock island of Yerba Buena. The Site is approximately 5.75 miles due east of the Golden Gate Bridge, and approximately 2.5 miles from the nearest bay shorelines to the east and west. Treasure Island was built in the 1930's for the Golden Gate International Exposition. Military use of the island started in the 1940's. Treasure Island is a man-made extension of Yerba Buena Island, created by filling the Yerba Buena Shoals and sand spit with 50 feet of dredged sands and silts from the Bay and Delta. The Island is essentially flat, ranging in elevation from 11 feet above sea level to sea level. Differential settlement accounts for most of the topographic relief on the Island. Yerba Buena Island is a natural island with steeply sloping rocky hills, ranging in elevation from sea level to over 300 feet. Slopes have grades ranging from 5 to 75 percent. Unconfined groundwater exists beneath the Site between 30 and 72 inches. The groundwater elevations are slightly influenced by tidal variation at a ratio of 50:1.

The Yerba Buena Island was described in 1901 as a "village site and burial ground" and was originally recorded in 1903 as an Archeological site (CA-SF-04). The site was located on the northeastern portion of Yerba Buena Island, north of the Bay Bridge Span. The site was apparently destroyed during construction of the Naval Parade Ground and associated structures at the turn of the century. The current condition of the site has not been documented.

Treasure Island was constructed by the Army Corps of Engineers between 1936 and 1937 as the site of the Golden Gate International Exposition, which was held from 1939 to 1940. The Site was also conceived as a trans-Pacific airport; however, the airport plan was abandoned in World War II.

Two buildings, Building 1 and the Administration Building, remain from the Exposition, and are eligible for listing in the National Register of Historic Places. In April 1990, the Treasure Island-Golden Gate International Exposition site became California Landmark No. 987. In July 1986, an agreement was executed

between the Department of Defense, each of its military branches, the National Conference of State Historic Preservation Officers, and the Advisory Council on Historic Preservation to survey World War II structures classified as "temporary" to determine those worthy of recordation as part of a study of the mobilization effort for the war.

The Site currently provides support for six home-ported ships as well as numerous other naval vessels visiting San Francisco. The Site provides administrative and support facilities for Pacific bound naval personnel and for the administrative operation of other Naval operating forces, the Naval Technical Training Center (NTTC), Marine Reserves (including housing and administrative offices), and non-military Federal activities (coordination of marine traffic for naval vessels in the Bay). Both officer and enlisted family housing facilities exist on the islands.

The San Francisco Unified School District holds two leases totalling 12.88 acres for the school facility that they operate on Treasure Island. The school facility services kindergarten through 5th grades. There is a total of 1,011 housing units on the two islands, which includes mixed single and multi-unit housing, Bachelor Officer Quarters, and Bachelor Enlisted Quarters. Other facilities include: a gymnasium, theater, bowling alley, Navy Exchange, enlisted club, a variety of ball fields and picnic areas, academic classrooms, storage and warehouse facilities, service craft pier, fueling pier, operations yard, sewage treatment plant, steam plant substations, reservoirs, assorted utilities, and Naval Brig and Correctional Custody Unit.

In April 1988, a Preliminary Assessment (PA) Report of the facility was prepared by Dames & Moore for the Naval Energy and Environmental Support Activity (NEESA). Based on information from historical records of past waste disposal, aerial photos, agency file search and interviews of occupants within the facility, twenty six (26) sites were identified that may have potential contamination. Seven (7) of these sites are located on Yerba Buena Island (YBI). The report also determined sites that need further remedial investigation. The following are the sites that were identified in the PA report: (1) Medical Clinic; (2) Radiation Training Area; (3) PCB Equipment Storage Area; (4) Hydraulic Training Area; (5) Old Boiler Plant; (6) Fire training School; (7) Pesticide Storage; (8) Sludge disposal Area; (9) Foundry; (10) Bus Painting Shop; (11) Landfill at Yerba Buena; (11) Fire Training School; (12) Old Bunker Area; (13) Storm Water Outfalls at Yerba Buena; (14) New Fuel Farm; (15) Old Fuel Farm; (16) Clipper Cove Tank at Yerba Buena; (17) Tanks 103 and 104;

MEMORANDUM OF UNDERSTANDING
BETWEEN
THE DEPARTMENT OF HEALTH SERVICES
AND
THE STATE WATER RESOURCES CONTROL BOARD
THE REGIONAL WATER QUALITY CONTROL BOARDS
FOR THE CLEANUP OF HAZARDOUS WASTE SITES

August 1, 1990

INTRODUCTION

This Memorandum of Understanding (MOU) consists of general and specific provisions for the cleanup of hazardous waste sites. General provisions include the scope of the agreement, which defines the parties and the type of sites to which the MOU applies; the principles, not found in law or regulation, which govern the conduct of the parties; and the methods for implementation, which explain the manner by which the parties will execute, and perform according to, this MOU.

Specific provisions, which address the protocol the parties will follow for the cleanup of hazardous waste sites, include: the method by which the lead agency and, consequently, the support agency are determined; the responsibilities of the lead and support agencies, which are defined in terms of tasks to be accomplished; procedures to be followed to ensure coordination; outputs to be produced to ensure that minimum technical requirements are satisfied; the manner by which the parties will enforce their respective authorities and settle their claims against hazardous waste site owners, operators, or dischargers; and the manner by which the parties will settle their disputes.

BACKGROUND

Based on a recommendation of the Governor's Task Force on Toxics, Waste, and Technology, Governor Deukmejian issued Executive Order D-55-86, which states, in part, that the Department of Health Services (DHS), the State Water Resources Control Board (SWRCB), and the Regional Water Quality Control Boards (RWQCB) shall enter into an MOU that specifies each agency's responsibilities in hazardous waste site cleanup, defines standards and criteria for use in Remedial Action Plan (RAP) development, and identifies a conflict resolution process to resolve interagency disputes. Subsequently, the Legislature included a provision in the Supplemental Report of the 1988 Budget Act requiring the development of this MOU.

Statutes of the State of California, embodied in the state codes, authorize certain actions or express fundamental principles which must govern the intent and goals of the MOU. Relevant code sections include, but are not limited to, the following:

A. DHS is mandated to carry out all hazardous waste management responsibilities imposed or authorized by the Resources Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and any regulations promulgated pursuant to these federal acts (Health and Safety Code [HSC] 25159.7).

B. DHS shall prepare a plan for the expeditious implementation of the Hazardous Substance Cleanup Bond Act of 1984 which shall include procedures required for the development and adoption of final RAPs by DHS and RWQCB (HSC 25351.6 and 25334.5).

C. DHS, or if appropriate, the RWQCB shall prepare or approve RAPs for all sites listed by DHS for Remedial Action (RA) (HSC 25356.1 and 25356).

D. DHS or the RWQCB shall review and consider any public comments, revise the draft plan if appropriate, and then issue the final RAP. (HSC 25356).

E. DHS shall implement procedures for the abatement of an imminent and substantial endangerment (HSC 25358.3).

F. DHS is authorized to spend funds from the Hazardous Substance Account or the Hazardous Substance Cleanup Fund for removal or remedial actions on any site included on the list established pursuant to HSC 25356 only if DHS enters into an enforceable agreement or issues an order and determines in writing that the potential responsible party(s) is not in compliance with the order or agreement. (HSC 25355.5)

G. The SWRCB and each RWQCB shall be the principal state agencies with primary responsibility for the coordination and control of water quality (Water Code [WC] 13001).

H. Each RWQCB shall obtain coordinated action in water quality control, including the prevention and abatement of water pollution and nuisance (WC 13225).

Under direction from the Governor, DHS signed a Defense (Department)-State Memorandum of Agreement (DSMOA) in May 1990, which allows for funding state oversight of remedial actions at military facilities in California. Although both DHS and the State and Regional Boards are eligible to receive payment for their oversight costs, federal funding is limited and qualified. Separate agreements between DHS regional offices and the RWQCBs for specific sites will be required in order to allocate available funding. This MOU provides a basis for DHS and the Boards to agree on funding and performance at military facilities.

DHS, also, has recently signed an Agreement in Principle (AIP) with the U.S. Department of Energy (DOE). The AIP will provide reimbursement of state costs for oversight of specified environmental compliance activities at DOE facilities. An Interagency Agreement between the DHS Environmental Health Division and the SWRCB will specify water quality oversight tasks which the State and Regional Boards will perform.

THE DHS AND THE SWRCB AND THE RWQCBS AGREE TO THE FOLLOWING:

I. SCOPE

This MOU is effective immediately and is binding upon DHS, the SWRCB, and the nine RWQCBs. It covers the cleanup of hazardous substances at all sites or facilities where such substances must be cleaned up in order to protect public health or the environment. The cleanup of other substances is not covered under this agreement. Sites include, but are not limited to, sites listed on the National Priorities List (NPL) and in the DHS Site Mitigation annual work plan. This MOU shall be used to determine the relationship of the parties and to guide the site-specific communications between them on activities at the sites. The provisions of this MOU are applicable both at sites where a state agency is the lead agency as well as at sites where the U.S. Environmental Protection Agency, Region 9 (EPA) is the lead agency. In the latter case, the provisions of this MOU shall be utilized to determine which state agency will act as the liaison between the State and EPA and how the state agencies will coordinate their review and comment on site-specific documents submitted by EPA.

Contracts and agreements also exist which involve DHS, SWRCB, RWQCB, and local agencies in the cleanup of leaking underground storage tanks. There are also other specific agreements between state and/or federal agencies. This MOU is not intended to conflict with the provisions of those contracts and agreements nor is it intended to add procedure and requirements which the agencies agree are not necessary for the satisfactory cleanup of leaking underground storage tanks.

A Memorandum of Agreement (MOA) exists between DHS and the SWRCB regarding coordination of activities at facilities subject to regulation pursuant to RCRA. For coordination of cleanup activities at these facilities, the agencies should refer to both this MOU and the RCRA MOA.

II. PRINCIPLES

The parties recognize that certain principles, not found in law or regulation, should govern their conduct. One principle is that the participation of both agencies acting within their respective authorities, jurisdiction, and expertise, whether acting as lead agency or support agency, is essential for the successful cleanup of hazardous waste sites and is in the best interest of the State.

In the cleanup of hazardous waste sites, mutual trust, confidence, cooperation, and communication between the parties are to be expected. It is a basic aim of this MOU and the policy of the parties that duplication of effort in the site cleanup program be avoided. Public health and the environment are best served by each party minimizing duplication of effort on the greatest number of sites possible. Both parties do, however, recognize that there are certain situations where one or the other will have the necessary technical resources, expertise, or authority. To the extent staff and other resources allow, and in a manner set forth in this MOU, the parties agree to assist each other. This cooperative approach is in the best interest of public health and the environment.

Finally, the parties recognize that cleanup of hazardous waste sites throughout California can best be achieved if the state agencies act with consistency and predictability. Both the public and the responsible parties expect that state government will apply rational methodologies and standards to site cleanup. Compliance with the terms of this MOU will eliminate or significantly reduce any apparent inconsistencies between the agencies. Consistency will be achieved by agreement on minimum technical and procedural requirements, coordination of enforcement actions, close and constant communication between project staff, and exchange of Applicable or Relevant and Appropriate Requirements (ARARs) or state standards for site cleanup. If either agency is developing such standards, that agency will involve the other agency in the development at an early stage so that consistency in technical issues can be maintained.

III. IMPLEMENTATION

In order to facilitate implementation of this MOU, the parties will establish an "MOU Technical Advisory Committee" (TAC) within four months of the effective date of this MOU. The TAC will serve to provide guidance and advice to management and staff on technical issues that develop during performance under this agreement and will assist, if called upon, in the settlement of technical disputes. The TAC will also evaluate the achievement of the goals of the Executive Order and the compliance principles of this MOU and will provide an annual report to management. This report will be submitted by March 1 of each year, will cover the prior calendar year and will, if appropriate, include recommendations for modifications to this MOU to improve attainment of the principles of the parties. The TAC will consist of a total of six members, each at a level equivalent to Supervising Engineer, Supervising Hazardous Materials Specialist, or above, as follows: one member from DHS Headquarters, two members from DHS Regional Sections, one member from SWRCB, and two members from RWQCBs. Annually the TAC will elect one of its members as chairman who will be responsible for coordinating the activities of the TAC.

IV. LEAD AGENCY DETERMINATION

DHS Regional Offices and RWQCBs will meet to determine the lead agency as appropriate under this section.

A. The agency which first discovers a potential or actual hazardous waste site shall serve as the lead agency until the criteria of this MOU are utilized to determine a lead agency.

B. Within 180 days after the effective date of this MOU, the agencies shall determine the lead and support agencies for each hazardous waste site on which either agency plans to work in Fiscal Year 1990-91. Each Regional Board Executive Officer (EO) and Department Regional Administrator (RA) shall compile an inventory of hazardous waste sites within their respective regions and shall determine whether resources are or will be available to perform the tasks required by this MOU. The EO and RA shall then agree on which agency shall be lead and which shall be support for sites of common jurisdiction. Sites for which neither agency has resources shall be listed in a holding pool until resources become available or priorities change. This process shall be repeated for each subsequent fiscal year as necessary to implement this MOU. The designation of lead agency may be changed at any time by agreement of the agencies.

C. The determination of a lead agency shall be made by considering the factors listed in Paragraph D of this section. It is probable that more than one factor may be applicable to a site. In these situations, more weight should be given to those factors listed first.

D. The lead agency as between DHS and SWRCB/RWQCB, for the cleanup of hazardous waste sites shall be determined using the following guidance:

1. DHS should be the lead agency at sites where there is no responsible party.

2. If the site does not meet the criteria in number 1 above, then the following conditions apply:

   a. If after reasonable enforcement actions are implemented, the responsible party is unwilling or is financially unable to perform cleanup and the expenditure of state Superfund monies is deemed appropriate to perform actual site cleanup, then DHS should be the lead agency.

   b. If the site is on the NPL, then DHS should be the lead agency.

   c. If one agency has a significantly longer history of involvement working to clean up the site, then it should be the lead agency.

   d. If the source of the contamination is a leaking underground storage tank, then the RWQCB or a local agency, upon delegation by a Regional Board, or by contracting with the state Board, should be the lead agency.

   e. If the contamination is primarily airborne, then DHS should be the lead agency in consultation with the Air Resources Board and the appropriate Air Quality Management District.

   f. If the site is primarily a result of agricultural activities, then the RWQCB should be the lead agency.

   g. If the source of the contamination is an inactive mine, then the RWQCB should be the lead agency.

   h. If the contamination is confined to soils, then DHS should be the lead agency.

   i. If the contamination is primarily impacting surface waters, then the RWQCB should be the lead agency.

j. If the source of the contamination is a RCRA regulated disposal facility, then DHS should be the lead.

k. If the source of the contamination is a non-RCRA surface impoundment, then the RWQCB should be the lead agency.

l. If the source of the contamination is a landfill which would not normally be regulated by DHS, then the RWQCB should be the lead agency in consultation with the California Integrated Waste Management Board.

E. Notwithstanding a determination under Paragraph D of this section, DHS Regional Offices and the RWQCB may otherwise agree which agency shall be lead agency at a particular site. Specific examples of situations where this provision may be used are where multiple sources are contributing to the same problem or where resource availability affects the determination; however, other situations may warrant a decision using this provision.

F. The agency determined to be the lead agency for purposes of site cleanup under this MOU is not necessarily the lead agency for implementing programs or tasks that are applicable to the site but not within its authority or jurisdiction. Where the support agency happens to have sole or primary responsibility or exclusive capability for a program or task related to cleanup activities, then that agency shall perform those required tasks pursuant to its exclusive lead authority in a manner consistent with its role under this MOU. Examples of such tasks and programs include, but are not limited to, issuance of a National Pollutant Discharge Elimination System permit, approval of a transportation plan, regulation of nonhazardous wastes, enforcement of the Toxic Pits Control Act, approval of a solid waste water quality assessment test report, performance of a public health evaluation, or the imposition of restrictions for land use. The support agency will coordinate all activities described in this paragraph with the lead agency.

G. Any dispute regarding the determination of the lead agency shall be resolved pursuant to Section VII.

V. RESPONSIBILITIES OF LEAD AND SUPPORT AGENCIES

A. Coordination Procedures

1. General

a. The lead agency is responsible for coordinating and communicating with the support agency in a timely manner. This includes, but is not limited to, providing schedules, technical reports, correspondence, and enforcement papers; soliciting and responding to comment, analysis, evaluation, and advice; and meeting, conferring and discussing the project.

b. The support agency is responsible for coordinating and communicating with the lead agency in a timely manner. This includes, but is not limited to, providing notification that selected sites are of particular interest; providing comment, analysis, evaluation, and advice, especially that within the unique expertise of the agency; and meeting, conferring, and discussing the project.

c. EPA will be the lead agency for many sites listed on the NPL. The State will designate a state lead agency using the criteria specified in Section IV. The agency so designated has the responsibility of maintaining communications between the State and EPA. This agency does not have responsibility for ensuring completion of the tasks listed in Section V B. However, this agency shall ensure that comments from all state agencies

are transmitted to EPA and shall coordinate the resolution of any disputes so that the State presents only one position to EPA.

d. Neither agency will significantly change its procedures for the cleanup of hazardous substances without notification to and review and comment from the other agency. Examples of such changes include technical guidance documents and applicable regulations.

2. Specific

a. Each agency will coordinate with the other agencies on its enforcement activities as specified in Section VI.

b. The lead agency shall provide to the support agency any California Environmental Quality Act (CEQA) documents at least ten working days prior to sending these documents to the state clearinghouse. If the support agency decides to comment, it shall do so within ten working days after receipt, or during the formal review process as mandated by CEQA.

c. The lead agency shall contact the support agency to identify ARARs for each specific site at the following times:

(1) During the scoping phase of the remedial investigation/ feasibility study (RI/FS) or equivalent.

(2) During the site characterization phase of the RI or equivalent.

(3) During the development of alternatives in the FS or equivalent.

(4) During Remedial Design (RD).

The support agency shall respond within 30 calendar days after a request for ARARs. The lead agency shall apply the ARARs identified by the support agency or it shall provide to the support agency, at least 20 calendar days prior to informing the responsible party or the public, a written memorandum which identifies ARARs that will not be applied and the reasons for such decisions.

For those sites where EPA is the lead agency, the state lead agency as determined according to this MOU, shall notify EPA of all ARARs identified by the parties to this agreement. However, the party identifying the ARARs shall be responsible for defending the application of its ARARs should EPA elect not to apply them.

d. The lead agency shall prepare or have the responsible party(ies) prepare the draft RAP or equivalent cleanup plan as an internal working draft document and provide a copy to the support agency at least 20 working days prior to general public distribution. If the support agency decides to comment, it will do so within 20 working days after receipt. Unless a shorter period of time is mutually agreed upon, any dispute shall be resolved by Section VII.

e. The lead agency shall provide all other technical documents, as specified in Section V.B.9., and not otherwise referred to above, within a time sufficient for review and comment. In all cases, the lead agency shall provide at least 15 working days for review and response by a support agency unless a shorter period of time is mutually agreed upon. The support agency shall respond, as appropriate, in a timely manner.

B. Tasks

1. For sites listed on the NPL or in the DHS Site Mitigation annual work plan:

a. The lead agency shall be responsible for ensuring completion of the following tasks:

(1) Identifying imminent threats and initiate removal actions (if necessary).

(2) Identifying responsible parties.

(3) Issuing an order or entering into an enforceable agreement (if necessary).

(4) Coordinating enforcement actions (see Enforcement and Settlement Section VI).

(5) Establishing and maintaining an administrative record.

(6) Providing project oversight:

(i) Assigning a remedial project manager.

(ii) Maintaining a field presence including, if necessary, providing an on-scene coordinator.

(iii) Preparing and maintaining site schedules and workplans.

(iv) Reviewing technical documents listed in Section 9 of this paragraph for comment or approval.

(v) Managing applicable contracts.

(vi) Accounting for project costs.

(7) Preparing and/or reviewing RI/FS which includes:

(i) Site characterization.

(ii) RA alternatives.

(iii) Risk assessment.

(8) Requiring and approving the Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP).

(9) Providing technical documents to the support agency, including, but not limited to, as appropriate:

(i) Site schedule.

(ii) RI/FS workplan.

(iii) RI report.

(iv) FS report.

(v) Health and Safety Plan.

(vi) QAPP.

(vii) SAP.

(viii) Community relations plan.

(ix) RAP.

(x) CEQA documents.

(xi) Transportation plan.

(10) Maintaining community relations:

(i) Developing and implementing a community relations program.

(ii) Managing any technical assistance grants.

(11) Compiling ARARs.

(12) Conducting a complete Public Health Evaluation (PHE) (as appropriate).

(13) Preparing and approving the RAP.

(14) Preparing and/or approving RD/RA

(15) Complying with CEQA.

(16) Recovering cost (if necessary).

(17) Overseeing operations and maintenance, including long-term monitoring (if necessary).

(18) Restricting land use (as appropriate).

b. The support agency shall be responsible for reviewing and, if appropriate, providing comments on the documents listed in Section V.B.1.a.(9) within the time periods determined utilizing Section V.A.2. or the lead agency may assume that the support agency does not have any comments. Additionally, the support agency shall always respond to a request for ARARs, and shall perform tasks as appropriate according to its exclusive authority or capability.

2. For sites not listed on the NPL nor on the DHS Site Mitigation annual work plan:

a. The lead agency shall be responsible for ensuring completion of the following tasks:

(1) Conducting removal actions (if necessary).

(2) Identifying a responsible party.

(3) Coordinating enforcement action (see Enforcement and Settlement, Section VI).

(4) Establishing and maintaining an administrative record.

(5) Providing project oversight.

(i) Assigning a project manager.

(ii) Preparing and maintaining site schedules and workplans.

(iii) Reviewing technical documents.

(iv) Maintaining a field presence, as necessary.

(6) Preparing or approving an Employee Health and Safety Plan.

(7) Characterizing the nature and extent of the problem.

(8) Requiring and approving quality assurance and sampling plans.

(9) Evaluating cleanup alternatives.

(10) Complying with CEQA.

(11) Conducting community relations.

(12) Preparing or approving the cleanup plan.

(13) Overseeing cleanup.

(14) Providing technical reports to the support agency.

b. The support agency shall be responsible for reviewing and, if appropriate, providing written comments on the documents submitted pursuant to Section V.B.2.a within the time periods determined utilizing Section V.A.2. or the lead agency may assume that the support agency does not have any comments. Additionally, the support agency shall always respond to a request for ARARs, and shall perform tasks as appropriate according to its exclusive authority or capability.

C. Technical Requirements

1. The following outputs or items, in whole or in part, are required to be addressed for the completion of RAs at hazardous waste sites:

a. For sites Listed on the NPL or in the DHS Site Mitigation annual work plan:

(1) RAs (if needed).

(2) Identification of responsible parties.

(3) Enforceable agreement or order.

(4) Cooperative agreement.

(5) Administrative record.

(6) Remedial project manager.

(7) On-scene coordinator.

(8) Site schedule.

(9) Workplans.

(10) Community relations plan.

(11) QAPP.

(12) SAP.

(13) RI.

(i) Site history.

(ii) Identification of sources.

(iii) Site characterization.

(14) ARARs.

(15) FS.

(16) Record of decision (ROD)/RAP

(17) RD

(18) RA.

(19) PHE.

(20) CEQA document.

(21) Health and Safety Plan.

(22) Transportation plan (if needed).

b. For sites not listed on the NPL nor in the DHS Site Mitigation annual work plan:

(1) RAs.

(2) Identification of responsible parties.

(3) Administrative record.

(4) Remedial project manager.

(5) Site schedule.

(6) Workplan.

(7) Quality assurance plan.

(8) Sampling and analysis plan.

(9) RAP or cleanup plan.

(i) Site history.

(ii) Identification of sources.

(iii) Site characterization.

(iv) Feasible remedial alternative.

(v) RD.

(10) Community relations plan.

(11) RA.

(12) Employee Health and Safety Plan.

(13) Community Health and Safety Plan (if needed).

(14) CEQA compliance.

(15) Transportation plan (if needed).

2. The agencies shall define these requirements, as appropriate, according to 40 CFR 300 et seq., and HSC 25350 et seq., in addition to the guidance documents listed in Attachment A.

VI. ENFORCEMENT AND SETTLEMENT

A. For purposes of this MOU, enforcement means the action by an agency to compel performance by a responsible party, such as the issuance of an order or the filing of a complaint. Settlement means the resolution by agreement with the responsible party, in whole or in part, of matters in dispute, such as the performance required for satisfactory remedial action, claims for money, or liability.

B. The lead agency will communicate with the other agencies regarding its enforcement and settlement activities for hazardous waste sites. Communication means, for example, notification at least 10 working days in advance, if feasible, of a decision to issue an order or to initiate settlement negotiations; provision of enforcement or settlement documents for information or for review and comment; and, to the extent feasible, modification of a proposed order or agreement to incorporate the other agency's concerns. Staffs will meet and confer, as necessary, during drafting of enforcement and settlement documents.

C. Unnecessary or redundant enforcement documents are to be avoided. Neither agency will take enforcement actions that are not compatible or complementary to the enforcement actions of the other agencies. To the extent possible, consistent with preserving their respective authority or mandates, each agency will coordinate time schedules and demands so that responsible parties can respond to consistent direction.

D. To the extent practicable, each agency will assist the other in enforcement. Information that may be used to determine compliance or noncompliance will be transmitted to the enforcing agency as soon as possible but no later than 15 working days after being obtained and formalized.

E. Upon a determination of noncompliance with an administrative order and a decision to pursue litigation (i.e., referral to the Attorney General or filing a complaint), the responsible agency will notify the other agencies at least seven working days prior to referring a matter to the Attorney General. Each agency will coordinate its legal actions to the extent practicable so that the Attorney General may bring joined or consolidated causes of action.

F. Negotiations may be commenced with a responsible party to enter into an enforceable agreement either to take cleanup action without the issuance of an order, to resolve noncompliance with an order that has been issued, or to resolve causes of action alleged in complaint. All decisions to negotiate with a responsible party will be coordinated between the agencies.

G. The lead agency will act as lead spokesperson for the negotiating team. The lead spokesperson will be responsible only for initiating and maintaining communications with the responsible parties, for coordinating the State's position, and for directing the agenda for settlement. The negotiating team will be composed of representatives from each agency with authority, with legitimate claims, and electing to participate. For purposes of dispute resolution in Federal Facility Agreements (FFAs), the lead agency and support agency may agree to designate which state agency will cast the State's vote.

Each agency is responsible for presenting its respective position. If an agency fails to attend negotiations or to meet other negotiating responsibilities without good cause, or without notifying the other participating agency in advance, then that agency must either defer to negotiating participants on issues discussed at the missed negotiation or withdraw from further negotiations relative to that particular site.

However, where practicable, in order to avoid unnecessary expenditure of resources for conducting negotiations, the support agency, after prior notification to and agreement by the lead agency, may elect to withdraw from or not participate in active negotiations, either temporarily or permanently. In such cases, the support agency is responsible for providing to the lead agency the details of their specific concerns regarding settlement. If this information is not provided, the lead agency will negotiate in the best interest of the State, but will have no responsibility to negotiate on behalf of the support agency issues for which the lead agency has neither authority nor assistance.

When the support agency does not attend negotiations, the lead agency is responsible for obtaining for the support agency terms of settlement identical to its own, provided that: the support agency provides the necessary information and assistance to the lead agency pursuant to this section; and the terms requested by the support agency are similar in scope and documentation to that of the lead agency ("identical terms" means similar percentage of settlement request or similar conditions as opposed to a dollar-for-dollar separation). Moreover, the lead agency is responsible for notifying the support agency if new issues arise which may be within the sole authority of the support agency, in order that the support agency has the opportunity to participate in those portions of the negotiations addressing such issues. The negotiation of FFAs with the federal government is an example of when this situation may occur. In this example, the lead agency will not settle for recovery of their costs without including those similarly justifiable costs of the support agency.

H. All communications with a responsible party related to negotiations will be coordinated by the lead spokesperson. Documents related to negotiations will be shared freely between the agencies and such documents which are confidential will be maintained in a manner consistent with any applicable requirements for confidentiality.

I. Each agency will support the other during negotiations. A single position is essential, and the agency advocating the most conservative or stringent position will be responsible for defending its position. A disagreeing agency will remain silent or request a recess. All agencies involved should meet prior to each negotiating session in order to minimize disagreements.

J. Before agreement or settlement with responsible parties can be reached, the concerns and claims of each agency regarding the issues to be agreed upon or settled will be resolved. An agency will not settle independently with responsible parties without advance concurrence by the other participating parties. Disputes shall be settled pursuant to the procedure described in Section VII.

K. Settlement with a responsible party will include provision for payment by the responsible party for all oversight costs incurred or to be incurred by any negotiating agency that will participate in the RA procedure.

VII. DISPUTE RESOLUTION

A. Disputes shall be resolved, if at all possible, through informal discussion, negotiation, and consensus. Such informal discussions may, if necessary, include staff at all levels, including those listed in Section VII.B.1. If the dispute cannot be resolved informally within a reasonable length of time or if continuing nonresolution of the dispute would place either party at a disadvantage, then either party may notify the other party that such a dispute exists and exercise the formal dispute resolution procedure described below.

B. Disputes shall be resolved formally using the following procedure:

1. Jointly the staffs of the agencies involved in the dispute shall prepare a memorandum describing the dispute. The lead agency shall provide copies to the appropriate RA of the Toxic Substances Control Program (TSCP) and to the Executive Officer (EO) of the appropriate Regional Board. The memorandum shall address and explain all sides to the dispute, shall state the consequences of each recommended decision and shall provide a date by which a decision is needed. The lead staff person for each agency shall co-sign the memorandum prior to submitting it to management.

2. If the DHS RA and the RWQCB EO cannot resolve the dispute within the time requested in the memorandum, then they will jointly present written notification of the dispute to both the Executive Director (ED) of the SWRCB and the Deputy Director of the TSCP.

3. If the SWRCB ED and the TSCP Deputy Director cannot resolve the dispute within 30 calendar days from the day the memorandum is delivered to them, then the memorandum shall be delivered to the SWRCB and the Director of DHS. If within 30 calendar days they cannot resolve the dispute, the memorandum shall be delivered to the Secretary of Environmental Affairs and to the Secretary of Health and Welfare. If within 30 calendar days they cannot resolve the dispute, the memorandum shall be delivered to the Governor.

4. When the dispute is resolved, a written decision shall be provided to all parties to this MOU.

C. During such time that any formal or informal dispute is not yet resolved, neither agency will comment adversely in public. The time required to resolve a dispute shall not be used to unnecessarily or unfairly delay action by either agency.

John J. Kearns
Acting Deputy Director
Toxic Substances Control Program
Department of Health Services
State of California

Date: 7/30/90

James W. Baetge
Executive Director
State Water Resources Control Board
State of California

Date: 7/31/90

ATTACHMENT A

APPLICABLE LAWS, REGULATIONS, AND GUIDANCE DOCUMENTS

A. California Water Code.

B. California Health and Safety Code.

C. Titles 22/23 (Subchapter 15) California Code of Regulations.

D. California Environmental Quality Act.

F. National Oil and Hazardous Substances Contingency Plan.

G. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.

H. Superfund Public Health Evaluation Manual.

I. Superfund Exposure Assessment Manual.

J. Methodology for Characterization of Uncertainty in Exposure Assessments.

K. RCRA Ground-Water Monitoring Technical Enforcement Guidance Document.

L. The Endangerment Assessment Handbook.

M. Superfund Remedial Design and Remedial Action Guidance.

N. Standard Operation Safety Guides (OSWER).

O. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (DHS [NIOSH]).

P. Data Quality Objectives for Remedial Response Activities (OSWER).

Q. Samplers and Sampling Procedures for Hazardous Waste Sources (EPA).

R. A Compendium of Superfund Field Operations Methods.

S. Handbook on Remedial Action on Waste Disposal Sites.

T. Uncontrolled Hazardous Waste Site Ranking System–A User's Manual.

U. Community Relations in Superfund: A Handbook (EPA) 03/86.

V. The California Site Mitigation Decision Tree Manual.

W. Small Site Cleanup Guidance Document (to be completed).

X. Leaking Underground Fuel Tank Manual.

ATTACHMENT B

ACRONYMS USED IN THE MEMORANDUM OF UNDERSTANDING

1.	AIP	Agreement In Principle
2.	ARARS	Applicable or Relevant and Appropriate Requirements
3.	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
4.	CEQA	California Environmental Quality Act
5.	DHS	Department of Health Services
6.	DOE	U.S. Department of Energy
7.	DSMOA	Defense (Department)-State Memorandum of Agreement
8.	ED	Executive Director
9.	EO	Executive Officer
10.	EPA	U.S. Environmental Protection Agency, Region 9
11.	FFA	Federal Facility Agreement
12.	FS	Feasibility Study
13.	HSC	Health and Safety Code
14.	MOA	Memorandum of Agreement
15	MOU	Memorandum of Understanding
16.	NPL	National Priorities List
17	PHE	Public Health Evaluation
18	QAPP	Quality Assurance Project Plan
19.	RA	Remedial Action or Regional Administrator
20.	RAP	Remedial Action Plan (State equivalent to ROD)
21.	RCRA	Resource Conservation and Recovery Act
22.	RD	Remedial Design
23.	RI	Remedial Investigation
24.	ROD	Record of Decision (Federal equivalent to RAP)
25.	RWQCB	Regional Water Quality Control Board

26.	SAP	Sampling and Analysis Plan
27	SWRCB	State Water Resources Control Board
28.	TAC	Technical Advisory Committee
29.	TSCP	Toxic Substances Control Program
30.	WC	Water Code

Appendix B to § 302.4_Radionuclides

Radionuclide	Atomic Number	Final RQ Ci (Bq)
Radionuclides@	.....	1&(3.7E 10)
Actinium-224	89	100 (3.7E 12)
Actinium-225	89	1 (3.7E 10)
Actinium-226	89	10 (3.7E 11)
Actinium-227	89	0.001 (3.7E 7)
Actinium-228	89	10 (3.7E 11)
Aluminum-26	13	10 (3.7E 11)
Americium-237	95	1000 (3.7E 13)
Americium-238	95	100 (3.7E 12)
Americium-239	95	100 (3.7E 12)
Americium-240	95	10 (3.7E 11)
Americium-241	95	0.01 (3.7E 8)
Americium-242m	95	0.01 (3.7E 8)
Americium-242	95	100 (3.7E 12)
Americium-243	95	0.01 (3.7E 8)
Americium-244m	95	1000 (3.7E 13)
Americium-244	95	10 (3.7E 11)
Americium-245	95	1000 (3.7E 13)
Americium-246m	95	1000 (3.7E 13)
Americium-246	95	1000 (3.7E 13)
Antimony-115	51	1000 (3.7E 13)

Antimony-116m	51	100	(3.7E 12)
Antimony-116	51	1000	(3.7E 13)
Antimony-117	51	1000	(3.7E 13)
Antimony-118m	51	10	(3.7E 11)
Antimony-119	51	1000	(3.7E 13)
Antimony-120 (16 min)	51	1000	(3.7E 13)
Antimony-120 (5.76 day)	51	10	(3.7E 11)
Antimony-122	51	10	(3.7E 11)
Antimony-124m	51	1000	(3.7E 13)
Antimony-124	51	10	(3.7E 11)
Antimony-125	51	10	(3.7E 11)
Antimony-126m	51	1000	(3.7E 13)
Antimony-126	51	10	(3.7E 11)
Antimony-127	51	10	(3.7E 11)
Antimony-128 (10.4 min)	51	1000	(3.7E 13)
Antimony-128 (9.01 hr)	51	10	(3.7E 11)
Antimony-129	51	100	(3.7E 12)
Antimony-130	51	100	(3.7E 12)
Antimony-131	51	1000	(3.7E 13)
Argon-39	18	1000	(3.7E 13)
Argon-41	18	10	(3.7E 11)
Arsenic-69	33	1000	(3.7E 13)
Arsenic-70	33	100	(3.7E 12)
Arsenic-71	33	100	(3.7E 12)
Arsenic-72	33	10	(3.7E 11)
Arsenic-73	33	100	(3.7E 12)
Arsenic-74	33	10	(3.7E 11)
Arsenic-76	33	100	(3.7E 12)

Arsenic-77	33	1000	(3.7E 13)
Arsenic-78	33	100	(3.7E 12)
Astatine-207	85	100	(3.7E 12)
Astatine-211	85	100	(3.7E 12)
Barium-126	56	1000	(3.7E 13)
Barium-128	56	10	(3.7E 11)
Barium-131m	56	1000	(3.7E 13)
Barium-131	56	10	(3.7E 11)
Barium-133m	56	100	(3.7E 12)
Barium-133	56	10	(3.7E 11)
Barium-135m	56	1000	(3.7E 13)
Barium-139	56	1000	(3.7E 13)
Barium-140	56	10	(3.7E 11)
Barium-141	56	1000	(3.7E 13)
Barium-142	56	1000	(3.7E 13)
Berkelium-245	97	100	(3.7E 12)
Berkelium-246	97	10	(3.7E 11)
Berkelium-247	97	0.01	(3.7E 8)
Berkelium-249	97	1	(3.7E 10)
Berkelium-250	97	100	(3.7E 12)
Beryllium-7	4	100	(3.7E 12)
Beryllium-10	4	1	(3.7E 10)
Bismuth-200	83	100	(3.7E 12)
Bismuth-201	83	100	(3.7E 12)
Bismuth-202	83	1000	(3.7E 13)
Bismuth-203	83	10	(3.7E 11)
Bismuth-205	83	10	(3.7E 11)
Bismuth-206	83	10	(3.7E 11)

Bismuth-207	83	10 (3.7E 11)
Bismuth-210m	83	0.1 (3.7E 9)
Bismuth-210	83	10 (3.7E 11)
Bismuth-212	83	100 (3.7E 12)
Bismuth-213	83	100 (3.7E 12)
Bismuth-214	83	100 (3.7E 12)
Bromine-74m	35	100 (3.7E 12)
Bromine-74	35	100 (3.7E 12)
Bromine-75	35	100 (3.7E 12)
Bromine-76	35	10 (3.7E 11)
Bromine-77	35	100 (3.7E 12)
Bromine-80m	35	1000 (3.7E 13)
Bromine-80	35	1000 (3.7E 13)
Bromine-82	35	10 (3.7E 11)
Bromine-83	35	1000 (3.7E 13)
Bromine-84	35	100 (3.7E 12)
Cadmium-104	48	1000 (3.7E 13)
Cadmium-107	48	1000 (3.7E 13)
Cadmium-109	48	1 (3.7E 10)
Cadmium-113m	48	0.1 (3.7E 9)
Cadmium-113	48	0.1 (3.7E 9)
Cadmium-115m	48	10 (3.7E 11)
Cadmium-115	48	100 (3.7E 12)
Cadmium-117m	48	10 (3.7E 11)
Cadmium-117	48	100 (3.7E 12)
Calcium-41	20	10 (3.7E 11)
Calcium-45	20	10 (3.7E 11)
Calcium-47	20	10 (3.7E 11)

Californium-244	98	1000 (3.7E 13)
Californium-246	98	10 (3.7E 11)
Californium-248	98	0.1 (3.7E 9)
Californium-249	98	0.01 (3.7E 8)
Californium-250	98	0.01 (3.7E 8)
Californium-251	98	0.01 (3.7E 8)
Californium-252	98	0.1 (3.7E 9)
Californium-253	98	10 (3.7E 11)
Californium-254	98	0.1 (3.7E 9)
Carbon-11	6	1000 (3.7E 13)
Carbon-14	6	10 (3.7E 11)
Cerium-134	58	10 (3.7E 11)
Cerium-135	58	10 (3.7E 11)
Cerium-137m	58	100 (3.7E 12)
Cerium-137	58	1000 (3.7E 13)
Cerium-139	58	100 (3.7E 12)
Cerium-141	58	10 (3.7E 11)
Cerium-143	58	100 (3.7E 12)
Cerium-144	58	1 (3.7E 10)
Cesium-125	55	1000 (3.7E 13)
Cesium-127	55	100 (3.7E 12)
Cesium-129	55	100 (3.7E 12)
Cesium-130	55	1000 (3.7E 13)
Cesium-131	55	1000 (3.7E 13)
Cesium-132	55	10 (3.7E 11)
Cesium-134m	55	1000 (3.7E 13)
Cesium-134	55	1 (3.7E 10)
Cesium-135m	55	100 (3.7E 12)

Cesium-135	55	10	(3.7E 11)
Cesium-136	55	10	(3.7E 11)
Cesium-137	55	1	(3.7E 10)
Cesium-138	55	100	(3.7E 12)
Chlorine-36	17	10	(3.7E 11)
Chlorine-38	17	100	(3.7E 12)
Chlorine-39	17	100	(3.7E 12)
Chromium-48	24	100	(3.7E 12)
Chromium-49	24	1000	(3.7E 13)
Chromium-51	24	1000	(3.7E 13)
Cobalt-55	27	10	(3.7E 11)
Cobalt-56	27	10	(3.7E 11)
Cobalt-57	27	100	(3.7E 12)
Cobalt-58m	27	1000	(3.7E 13)
Cobalt-58	27	10	(3.7E 11)
Cobalt-60m	27	1000	(3.7E 13)
Cobalt-60	27	10	(3.7E 11)
Cobalt-61	27	1000	(3.7E 13)
Cobalt-62m	27	1000	(3.7E 13)
Copper-60	29	100	(3.7E 12)
Copper-61	29	100	(3.7E 12)
Copper-64	29	1000	(3.7E 13)
Copper-67	29	100	(3.7E 12)
Curium-238	96	1000	(3.7E 13)
Curium-240	96	1	(3.7E 10)
Curium-241	96	10	(3.7E 11)
Curium-242	96	1	(3.7E 10)
Curium-243	96	0.01	(3.7E 8)

Curium-244	96	0.01 (3.7E 8)
Curium-245	96	0.01 (3.7E 8)
Curium-246	96	0.01 (3.7E 8)
Curium-247	96	0.01 (3.7E 8)
Curium-248	96	0.001 (3.7E 7)
Curium-249	96	1000 (3.7E 13)
Dysprosium-155	66	100 (3.7E 12)
Dysprosium-157	66	100 (3.7E 12)
Dysprosium-159	66	100 (3.7E 12)
Dysprosium-165	66	1000 (3.7E 13)
Dysprosium-166	66	10 (3.7E 11)
Einsteinium-250	99	10 (3.7E 11)
Einsteinium-251	99	1000 (3.7E 13)
Einsteinium-253	99	10 (3.7E 11)
Einsteinium-254m	99	1 (3.7E 10)
Einsteinium-254	99	0.1 (3.7E 9)
Erbium-161	68	100 (3.7E 12)
Erbium-165	68	1000 (3.7E 13)
Erbium-169	68	100 (3.7E 12)
Erbium-171	68	100 (3.7E 12)
Erbium-172	68	10 (3.7E 11)
Europium-145	63	10 (3.7E 11)
Europium-146	63	10 (3.7E 11)
Europium-147	63	10 (3.7E 11)
Europium-148	63	10 (3.7E 11)
Europium-149	63	100 (3.7E 12)
Europium-150 (12.6 hr)	63	1000 (3.7E 13)
Europium-150 (34.2 yr)	63	10 (3.7E 11)

Europium-152m	63	100	(3.7E12)
Europium-152	63	10	(3.7E11)
Europium-154	63	10	(3.7E11)
Europium-155	63	10	(3.7E11)
Europium-156	63	10	(3.7E11)
Europium-157	63	10	(3.7E11)
Europium-158	63	1000	(3.7E13)
Fermium-252	100	10	(3.7E11)
Fermium-253	100	10	(3.7E11)
Fermium-254	100	100	(3.7E12)
Fermium-255	100	100	(3.7E12)
Fermium-257	100	1	(3.7E10)
Fluorine-18	9	1000	(3.7E13)
Francium-222	87	100	(3.7E12)
Francium-223	87	100	(3.7E12)
Gadolinium-145	64	100	(3.7E12)
Gadolinium-146	64	10	(3.7E11)
Gadolinium-147	64	10	(3.7E11)
Gadolinium-148	64	0.001	(3.7E7)
Gadolinium-149	64	100	(3.7E12)
Gadolinium-151	64	100	(3.7E12)
Gadolinium-152	64	0.001	(3.7E7)
Gadolinium-153	64	10	(3.7E11)
Gadolinium-159	64	1000	(3.7E13)
Gallium-65	31	1000	(3.7E13)
Gallium-66	31	10	(3.7E11)
Gallium-67	31	100	(3.7E12)
Gallium-68	31	1000	(3.7E13)

Gallium-70	31	1000	(3.7E 13)
Gallium-72	31	10	(3.7E 11)
Gallium-73	31	100	(3.7E 12)
Germanium-66	32	100	(3.7E 12)
Germanium-67	32	1000	(3.7E 13)
Germanium-68	32	10	(3.7E 11)
Germanium-69	32	10	(3.7E 11)
Germanium-71	32	1000	(3.7E 13)
Germanium-75	32	1000	(3.7E 13)
Germanium-77	32	10	(3.7E 11)
Germanium-78	32	1000	(3.7E 13)
Gold-193	79	100	(3.7E 12)
Gold-194	79	10	(3.7E 11)
Gold-195	79	100	(3.7E 12)
Gold-198m	79	10	(3.7E 11)
Gold-198	79	100	(3.7E 12)
Gold-199	79	100	(3.7E 12)
Gold-200m	79	10	(3.7E 11)
Gold-200	79	1000	(3.7E 13)
Gold-201	79	1000	(3.7E 13)
Hafnium-170	72	100	(3.7E 12)
Hafnium-172	72	1	(3.7E 10)
Hafnium-173	72	100	(3.7E 12)
Hafnium-175	72	100	(3.7E 12)
Hafnium-177m	72	1000	(3.7E 13)
Hafnium-178m	72	0.1	(3.7E 9)
Hafnium-179m	72	100	(3.7E 12)
Hafnium-180m	72	100	(3.7E 12)

Hafnium-181	72	10	(3.7E 11)
Hafnium-182m	72	100	(3.7E 12)
Hafnium-182	72	0.1	(3.7E 9)
Hafnium-183	72	100	(3.7E 12)
Hafnium-184	72	100	(3.7E 12)
Holmium-155	67	1000	(3.7E 13)
Holmium-157	67	1000	(3.7E 13)
Holmium-159	67	1000	(3.7E 13)
Holmium-161	67	1000	(3.7E 13)
Holmium-162m	67	1000	(3.7E 13)
Holmium-162	67	1000	(3.7E 13)
Holmium-164m	67	1000	(3.7E 13)
Holmium-164	67	1000	(3.7E 13)
Holmium-166m	67	1	(3.7E 10)
Holmium-166	67	100	(3.7E 12)
Holmium-167	67	100	(3.7E 12)
Hydrogen-3	1	100	(3.7E 12)
Indium-109	49	100	(3.7E 12)
Indium-110 (69.1 min)	49	100	(3.7E 12)
Indium-110 (4.9 hr)	49	10	(3.7E 11)
Indium-111	49	100	(3.7E 12)
Indium-112	49	1000	(3.7E 13)
Indium-113m	49	1000	(3.7E 13)
Indium-114m	49	10	(3.7E 11)
Indium-115m	49	100	(3.7E 12)
Indium-115	49	0.1	(3.7E 9)
Indium-116m	49	100	(3.7E 12)
Indium-117m	49	100	(3.7E 12)

Indium-117	49	1000 (3.7E 13)
Indium-119m	49	1000 (3.7E 13)
Iodine-120m	53	100 (3.7E 12)
Iodine-120	53	10 (3.7E 11)
Iodine-121	53	100 (3.7E 12)
Iodine-123	53	10 (3.7E 11)
Iodine-124	53	0.1 (3.7E 9)
Iodine-125	53	0.01 (3.7E 8)
Iodine-126	53	0.01 (3.7E 8)
Iodine-128	53	1000 (3.7E 13)
Iodine-129	53	0.001 (3.7E 7)
Iodine-130	53	1 (3.7E 10)
Iodine-131	53	0.01 (3.7E 8)
Iodine-132m	53	10 (3.7E 11)
Iodine-132	53	10 (3.7E 11)
Iodine-133	53	0.1 (3.7E 9)
Iodine-134	53	100 (3.7E 12)
Iodine-135	53	10 (3.7E 11)
Iridium-182	77	1000 (3.7E 13)
Iridium-184	77	100 (3.7E 12)
Iridium-185	77	100 (3.7E 12)
Iridium-186	77	10 (3.7E 11)
Iridium-187	77	100 (3.7E 12)
Iridium-188	77	10 (3.7E 11)
Iridium-189	77	100 (3.7E 12)
Iridium-190m	77	1000 (3.7E 13)
Iridium-190	77	10 (3.7E 11)
Iridium-192m	77	100 (3.7E 12)

Iridium-192	77	10	(3.7E 11)
Iridium-194m	77	10	(3.7E 11)
Iridium-194	77	100	(3.7E 12)
Iridium-195m	77	100	(3.7E 12)
Iridium-195	77	1000	(3.7E 13)
Iron-52	26	100	(3.7E 12)
Iron-55	26	100	(3.7E 12)
Iron-59	26	10	(3.7E 11)
Iron-60	26	0.1	(3.7E 9)
Krypton-74	36	10	(3.7E 11)
Krypton-76	36	10	(3.7E 11)
Krypton-77	36	10	(3.7E 11)
Krypton-79	36	100	(3.7E 12)
Krypton-81	36	1000	(3.7E 13)
Krypton-83m	36	1000	(3.7E 13)
Krypton-85m	36	100	(3.7E 12)
Krypton-85	36	1000	(3.7E 13)
Krypton-87	36	10	(3.7E 11)
Krypton-88	36	10	(3.7E 11)
Lanthanum-131	57	1000	(3.7E 13)
Lanthanum-132	57	100	(3.7E 12)
Lanthanum-135	57	1000	(3.7E 13)
Lanthanum-137	57	10	(3.7E 11)
Lanthanum-138	57	1	(3.7E 10)
Lanthanum-140	57	10	(3.7E 11)
Lanthanum-141	57	1000	(3.7E 13)
Lanthanum-142	57	100	(3.7E 12)
Lanthanum-143	57	1000	(3.7E 13)

Lead-195m	82	1000	(3.7E 13)
Lead-198	82	100	(3.7E 12)
Lead-199	82	100	(3.7E 12)
Lead-200	82	100	(3.7E 12)
Lead-201	82	100	(3.7E 12)
Lead-202m	82	10	(3.7E 11)
Lead-202	82	1	(3.7E 10)
Lead-203	82	100	(3.7E 12)
Lead-205	82	100	(3.7E 12)
Lead-209	82	1000	(3.7E 13)
Lead-210	82	0.01	(3.7E 8)
Lead-211	82	100	(3.7E 12)
Lead-212	82	10	(3.7E 11)
Lead-214	82	100	(3.7E 12)
Lutetium-169	71	10	(3.7E 11)
Lutetium-170	71	10	(3.7E 11)
Lutetium-171	71	10	(3.7E 11)
Lutetium-172	71	10	(3.7E 11)
Lutetium-173	71	100	(3.7E 12)
Lutetium-174m	71	10	(3.7E 11)
Lutetium-174	71	10	(3.7E 11)
Lutetium-176m	71	1000	(3.7E 13)
Lutetium-176	71	1	(3.7E 10)
Lutetium-177m	71	10	(3.7E 11)
Lutetium-177	71	100	(3.7E 12)
Lutetium-178m	71	1000	(3.7E 13)
Lutetium-178	71	1000	(3.7E 13)
Lutetium-179	71	1000	(3.7E 13)

Magnesium-28	12	10	(3.7E 11)
Manganese-51	25	1000	(3.7E 13)
Manganese-52m	25	1000	(3.7E 13)
Manganese-52	25	10	(3.7E 11)
Manganese-53	25	1000	(3.7E 13)
Manganese-54	25	10	(3.7E 11)
Manganese-56	25	100	(3.7E 12)
Mendelevium-257	101	100	(3.7E 12)
Mendelevium-258	101	1	(3.7E 10)
Mercury-193m	80	10	(3.7E 11)
Mercury-193	80	100	(3.7E 12)
Mercury-194	80	0.1	(3.7E 9)
Mercury-195m	80	100	(3.7E 12)
Mercury-195	80	100	(3.7E 12)
Mercury-197m	80	1000	(3.7E 13)
Mercury-197	80	1000	(3.7E 13)
Mercury-199m	80	1000	(3.7E 13)
Mercury-203	80	10	(3.7E 11)
Molybdenum-90	42	100	(3.7E 12)
Molybdenum-93m	42	10	(3.7E 11)
Molybdenum-93	42	100	(3.7E 12)
Molybdenum-99	42	100	(3.7E 12)
Molybdenum-101	42	1000	(3.7E 13)
Neodymium-136	60	1000	(3.7E 13)
Neodymium-138	60	1000	(3.7E 13)
Neodymium-139m	60	100	(3.7E 12)
Neodymium-139	60	1000	(3.7E 13)
Neodymium-141	60	1000	(3.7E 13)

Neodymium-147	60	10 (3.7E 11)
Neodymium-149	60	100 (3.7E 12)
Neodymium-151	60	1000 (3.7E 13)
Neptunium-232	93	1000 (3.7E 13)
Neptunium-233	93	1000 (3.7E 13)
Neptunium-234	93	10 (3.7E 11)
Neptunium-235	93	1000 (3.7E 13)
Neptunium-236 (1.2 E 5 yr)	93	0.1 (3.7E 9)
Neptunium-236 (22.5 hr)	93	100 (3.7E 12)
Neptunium-237	93	0.01 (3.7E 8)
Neptunium-238	93	10 (3.7E 11)
Neptunium-239	93	100 (3.7E 12)
Neptunium-240	93	100 (3.7E 12)
Nickel-56	28	10 (3.7E 11)
Nickel-57	28	10 (3.7E 11)
Nickel-59	28	100 (3.7E 12)
Nickel-63	28	100 (3.7E 12)
Nickel-65	28	100 (3.7E 12)
Nickel-66	28	10 (3.7E 11)
Niobium-88	41	100 (3.7E 12)
Niobium-89 (66 min)	41	100 (3.7E 12)
Niobium-89 (122 min)	41	100 (3.7E 12)
Niobium-90	41	10 (3.7E 11)
Niobium-93m	41	100 (3.7E 12)
Niobium-94	41	10 (3.7E 11)
Niobium-95m	41	100 (3.7E 12)
Niobium-95	41	10 (3.7E 11)
Niobium-96	41	10 (3.7E 11)

Niobium-97	41	100	(3.7E 12)
Niobium-98	41	1000	(3.7E 13)
Osmium-180	76	1000	(3.7E 13)
Osmium-181	76	100	(3.7E 12)
Osmium-182	76	100	(3.7E 12)
Osmium-185	76	10	(3.7E 11)
Osmium-189m	76	1000	(3.7E 13)
Osmium-191m	76	1000	(3.7E 13)
Osmium-191	76	100	(3.7E 12)
Osmium-193	76	100	(3.7E 12)
Osmium-194	76	1	(3.7E 10)
Palladium-100	46	100	(3.7E 12)
Palladium-101	46	100	(3.7E 12)
Palladium-103	46	100	(3.7E 12)
Palladium-107	46	100	(3.7E 12)
Palladium-109	46	1000	(3.7E 13)
Phosphorus-32	15	0.1	(3.7E 9)
Phosphorus-33	15	1	(3.7E 10)
Platinum-186	78	100	(3.7E 12)
Platinum-188	78	100	(3.7E 12)
Platinum-189	78	100	(3.7E 12)
Platinum-191	78	100	(3.7E 12)
Platinum-193m	78	100	(3.7E 12)
Platinum-193	78	1000	(3.7E 13)
Platinum-195m	78	100	(3.7E 12)
Platinum-197m	78	1000	(3.7E 13)
Platinum-197	78	1000	(3.7E 13)
Platinum-199	78	1000	(3.7E 13)

Platinum-200	78	100 (3.7E 12)
Plutonium-234	94	1000 (3.7E 13)
Plutonium-235	94	1000 (3.7E 13)
Plutonium-236	94	0.1 (3.7E 9)
Plutonium-237	94	1000 (3.7E 13)
Plutonium-238	94	0.01 (3.7E 8)
Plutonium-239	94	0.01 (3.7E 8)
Plutonium-240	94	0.01 (3.7E 8)
Plutonium-241	94	1 (3.7E 10)
Plutonium-242	94	0.01 (3.7E 8)
Plutonium-243	94	1000 (3.7E 13)
Plutonium-244	94	0.01 (3.7E 8)
Plutonium-245	94	100 (3.7E 12)
Polonium-203	84	100 (3.7E 12)
Polonium-205	84	100 (3.7E 12)
Polonium-207	84	10 (3.7E 11)
Polonium-210	84	0.01 (3.7E 8)
Potassium-40	19	1 (3.7E 10)
Potassium-42	19	100 (3.7E 12)
Potassium-43	19	10 (3.7E 11)
Potassium-44	19	100 (3.7E 12)
Potassium-45	19	1000 (3.7E 13)
Praseodymium-136	59	1000 (3.7E 13)
Praseodymium-137	59	1000 (3.7E 13)
Praseodymium-138m	59	100 (3.7E 12)
Praseodymium-139	59	1000 (3.7E 13)
Praseodymium-142m	59	1000 (3.7E 13)
Praseodymium-142	59	100 (3.7E 12)

Praseodymium-143		59	10 (3.7E 11)
Praseodymium-144		59	1000 (3.7E 13)
Praseodymium-145		59	1000 (3.7E 13)
Praseodymium-147		59	1000 (3.7E 13)
Promethium-141		61	1000 (3.7E 13)
Promethium-143		61	100 (3.7E 12)
Promethium-144		61	10 (3.7E 11)
Promethium-145		61	100 (3.7E 12)
Promethium-146		61	10 (3.7E 11)
Promethium-147		61	10 (3.7E 11)
Promethium-148m		61	10 (3.7E 11)
Promethium-148		61	10 (3.7E 11)
Promethium-149		61	100 (3.7E 12)
Promethium-150		61	100 (3.7E 12)
Promethium-151		61	100 (3.7E 12)
Protactinium-227		91	100 (3.7E 12)
Protactinium-228		91	10 (3.7E 11)
Protactinium-230		91	10 (3.7E 11)
Protactinium-231		91	0.01 (3.7E 8)
Protactinium-232		91	10 (3.7E 11)
Protactinium-233		91	100 (3.7E 12)
Protactinium-234		91	10 (3.7E 11)
Radium-223		88	1 (3.7E 10)
Radium-224		88	10 (3.7E 11)
Radium-225		88	1 (3.7E 10)
Radium-226Φ	88		0.1 (3.7E 9)
Radium-227		88	1000 (3.7E 13)
Radium-228		88	0.1 (3.7E 9)
Radon-220		86	0.1 (3.7E 9)

Radon-222	86	0.1 (3.7E 9)
Rhenium-177	75	1000 (3.7E 13)
Rhenium-178	75	1000 (3.7E 13)
Rhenium-181	75	100 (3.7E 12)
Rhenium-182 (12.7 hr)	75	10 (3.7E 11)
Rhenium-182 (64.0 hr)	75	10 (3.7E 11)
Rhenium-184m	75	10 (3.7E 11)
Rhenium-184	75	10 (3.7E 11)
Rhenium-186m	75	10 (3.7E 11)
Rhenium-186	75	100 (3.7E 12)
Rhenium-187	75	1000 (3.7E 13)
Rhenium-188m	75	1000 (3.7E 13)
Rhenium-188	75	1000 (3.7E 13)
Rhenium-189	75	1000 (3.7E 13)
Rhodium-99m	45	100 (3.7E 12)
Rhodium-99	45	10 (3.7E 11)
Rhodium-100	45	10 (3.7E 11)
Rhodium-101m	45	100 (3.7E 12)
Rhodium-101	45	10 (3.7E 11)
Rhodium-102m	45	10 (3.7E 11)
Rhodium-102	45	10 (3.7E 11)
Rhodium-103m	45	1000 (3.7E 13)
Rhodium-105	45	100 (3.7E 12)
Rhodium-106m	45	10 (3.7E 11)
Rhodium-107	45	1000 (3.7E 13)
Rubidium-79	37	1000 (3.7E 13)
Rubidium-81m	37	1000 (3.7E 13)
Rubidium-81	37	100 (3.7E 12)

Rubidium-82m	37	10 (3.7E 11)
Rubidium-83	37	10 (3.7E 11)
Rubidium-84	37	10 (3.7E 11)
Rubidium-86	37	10 (3.7E 11)
Rubidium-88	37	1000 (3.7E 13)
Rubidium-89	37	1000 (3.7E 13)
Rubidium-87	37	10 (3.7E 11)
Ruthenium-94	44	1000 (3.7E 13)
Ruthenium-97	44	100 (3.7E 12)
Ruthenium-103	44	10 (3.7E 11)
Ruthenium-105	44	100 (3.7E 12)
Ruthenium-106	44	1 (3.7E 10)
Samarium-141m	62	1000 (3.7E 13)
Samarium-141	62	1000 (3.7E 13)
Samarium-142	62	1000 (3.7E 13)
Samarium-145	62	100 (3.7E 12)
Samarium-146	62	0.01 (3.7E 8)
Samarium-147	62	0.01 (3.7E 8)
Samarium-151	62	10 (3.7E 11)
Samarium-153	62	100 (3.7E 12)
Samarium-155	62	1000 (3.7E 13)
Samarium-156	62	100 (3.7E 12)
Scandium-43	21	1000 (3.7E 13)
Scandium-44m	21	10 (3.7E 11)
Scandium-44	21	100 (3.7E 12)
Scandium-46	21	10 (3.7E 11)
Scandium-47	21	100 (3.7E 12)
Scandium-48	21	10 (3.7E 11)

Scandium-49	21	1000	(3.7E 13)
Selenium-70	34	1000	(3.7E 13)
Selenium-73m	34	100	(3.7E 12)
Selenium-73	34	10	(3.7E 11)
Selenium-75	34	10	(3.7E 11)
Selenium-79	34	10	(3.7E 11)
Selenium-81m	34	1000	(3.7E 13)
Selenium-81	34	1000	(3.7E 13)
Selenium-83	34	1000	(3.7E 13)
Silicon-31	14	1000	(3.7E 13)
Silicon-32	14	1	(3.7E 10)
Silver-102	47	100	(3.7E 12)
Silver-103	47	1000	(3.7E 13)
Silver-104m	47	1000	(3.7E 13)
Silver-104	47	1000	(3.7E 13)
Silver-105	47	10	(3.7E 11)
Silver-106m	47	10	(3.7E 11)
Silver-106	47	1000	(3.7E 13)
Silver-108m	47	10	(3.7E 11)
Silver-110m	47	10	(3.7E 11)
Silver-111	47	10	(3.7E 11)
Silver-112	47	100	(3.7E 12)
Silver-115	47	1000	(3.7E 13)
Sodium-22	11	10	(3.7E 11)
Sodium-24	11	10	(3.7E 11)
Strontium-80	38	100	(3.7E 12)
Strontium-81	38	1000	(3.7E 13)
Strontium-83	38	100	(3.7E 12)

Strontium-85m	38	1000	(3.7E 13)
Strontium-85	38	10	(3.7E 11)
Strontium-87m	38	100	(3.7E 12)
Strontium-89	38	10	(3.7E 11)
Strontium-90	38	0.1	(3.7E 9)
Strontium-91	38	10	(3.7E 11)
Strontium-92	38	100	(3.7E 12)
Sulfur-35	16	1	(3.7E 10)
Tantalum-172	73	100	(3.7E 12)
Tantalum-173	73	100	(3.7E 12)
Tantalum-174	73	100	(3.7E 12)
Tantalum-175	73	100	(3.7E 12)
Tantalum-176	73	10	(3.7E 11)
Tantalum-177	73	1000	(3.7E 13)
Tantalum-178	73	1000	(3.7E 13)
Tantalum-179	73	1000	(3.7E 13)
Tantalum-180m	73	1000	(3.7E 13)
Tantalum-180	73	100	(3.7E 12)
Tantalum-182m	73	1000	(3.7E 13)
Tantalum-182	73	10	(3.7E 11)
Tantalum-183	73	100	(3.7E 12)
Tantalum-184	73	10	(3.7E 11)
Tantalum-185	73	1000	(3.7E 13)
Tantalum-186	73	1000	(3.7E 13)
Technetium-93m	43	1000	(3.7E 13)
Technetium-93	43	100	(3.7E 12)
Technetium-94m	43	100	(3.7E 12)
Technetium-94	43	10	(3.7E 11)

Technetium-96m	43	1000	(3.7E13)
Technetium-96	43	10	(3.7E11)
Technetium-97m	43	100	(3.7E12)
Technetium-97	43	100	(3.7E12)
Technetium-98	43	10	(3.7E11)
Technetium-99m	43	100	(3.7E12)
Technetium-99	43	10	(3.7E11)
Technetium-101	43	1000	(3.7E13)
Technetium-104	43	1000	(3.7E13)
Tellurium-116	52	1000	(3.7E13)
Tellurium-121m	52	10	(3.7E11)
Tellurium-121	52	10	(3.7E11)
Tellurium-123m	52	10	(3.7E11)
Tellurium-123	52	10	(3.7E11)
Tellurium-125m	52	10	(3.7E11)
Tellurium-127m	52	10	(3.7E11)
Tellurium-127	52	1000	(3.7E13)
Tellurium-129m	52	10	(3.7E11)
Tellurium-129	52	1000	(3.7E13)
Tellurium-131m	52	10	(3.7E11)
Tellurium-131	52	1000	(3.7E13)
Tellurium-132	52	10	(3.7E11)
Tellurium-133m	52	1000	(3.7E13)
Tellurium-133	52	1000	(3.7E13)
Tellurium-134	52	1000	(3.7E13)
Terbium-147	65	100	(3.7E12)
Terbium-149	65	100	(3.7E12)
Terbium-150	65	100	(3.7E12)

Terbium-151	65	10	(3.7E 11)
Terbium-153	65	100	(3.7E 12)
Terbium-154	65	10	(3.7E 11)
Terbium-155	65	100	(3.7E 12)
Terbium-156m (5.0 hr)	65	1000	(3.7E 13)
Terbium-156m (24.4 hr)	65	1000	(3.7E 13)
Terbium-156	65	10	(3.7E 11)
Terbium-157	65	100	(3.7E 12)
Terbium-158	65	10	(3.7E 11)
Terbium-160	65	10	(3.7E 11)
Terbium-161	65	100	(3.7E 12)
Thallium-194m	81	100	(3.7E 12)
Thallium-194	81	1000	(3.7E 13)
Thallium-195	81	100	(3.7E 12)
Thallium-197	81	100	(3.7E 12)
Thallium-198m	81	100	(3.7E 12)
Thallium-198	81	10	(3.7E 11)
Thallium-199	81	100	(3.7E 12)
Thallium-200	81	10	(3.7E 11)
Thallium-201	81	1000	(3.7E 13)
Thallium-202	81	10	(3.7E 11)
Thallium-204	81	10	(3.7E 11)
Thorium-226	90	100	(3.7E 12)
Thorium-227	90	1	(3.7E 10)
Thorium-228	90	0.01	(3.7E 8)
Thorium-229	90	0.001	(3.7E 7)
Thorium-230	90	0.01	(3.7E 8)
Thorium-231	90	100	(3.7E 12)
Thorium-232Φ	90	0.001	(3.7E 7)

Thorium-234	90	100	(3.7E 12)
Thulium-162	69	1000	(3.7E 13)
Thulium-166	69	10	(3.7E 11)
Thulium-167	69	100	(3.7E 12)
Thulium-170	69	10	(3.7E 11)
Thulium-171	69	100	(3.7E 12)
Thulium-172	69	100	(3.7E 12)
Thulium-173	69	100	(3.7E 12)
Thulium-175	69	1000	(3.7E 13)
Tin-110	50	100	(3.7E 12)
Tin-111	50	1000	(3.7E 13)
Tin-113	50	10	(3.7E 11)
Tin-117m	50	100	(3.7E 12)
Tin-119m	50	10	(3.7E 11)
Tin-121m	50	10	(3.7E 11)
Tin-121	50	1000	(3.7E 13)
Tin-123m	50	1000	(3.7E 13)
Tin-123	50	10	(3.7E 11)
Tin-125	50	10	(3.7E 11)
Tin-126	50	1	(3.7E 10)
Tin-127	50	100	(3.7E 12)
Tin-128	50	1000	(3.7E 13)
Titanium-44	22	1	(3.7E 10)
Titanium-45	22	1000	(3.7E 13)
Tungsten-176	74	1000	(3.7E 13)
Tungsten-177	74	100	(3.7E 12)
Tungsten-178	74	100	(3.7E 12)
Tungsten-179	74	1000	(3.7E 13)

Tungsten-181		74	100 (3.7E 12)
Tungsten-185		74	10 (3.7E 11)
Tungsten-187		74	100 (3.7E 12)
Tungsten-188		74	10 (3.7E 11)
Uranium-230		92	1 (3.7E 10)
Uranium-231		92	1000 (3.7E 13)
Uranium-232		92	0.01 (3.7E 8)
Uranium-233		92	0.1 (3.7E 9)
Uranium-234φ	92		0.1 (3.7E 9)
Uranium-235φ	92		0.1 (3.7E 9)
Uranium-236		92	0.1 (3.7E 9)
Uranium-237		92	100 (3.7E 12)
Uranium-238φ	92		0.1& (3.7E 9)
Uranium-239		92	1000 (3.7E 13)
Uranium-240		92	1000 (3.7E 13)
Vanadium-47		23	1000 (3.7E 13)
Vanadium-48		23	10 (3.7E 11)
Vanadium-49		23	1000 (3.7E 13)
Xenon-120		54	100 (3.7E 12)
Xenon-121		54	10 (3.7E 11)
Xenon-122		54	100 (3.7E 12)
Xenon-123		54	10 (3.7E 11)
Xenon-125		54	100 (3.7E 12)
Xenon-127		54	100 (3.7E 12)
Xenon-129m		54	1000 (3.7E 13)
Xenon-131m		54	1000 (3.7E 13)
Xenon-133m		54	1000 (3.7E 13)
Xenon-133		54	1000 (3.7E 13)
Xenon-135m		54	10 (3.7E 11)

Xenon-135	54	100	(3.7E 12)
Xenon-138	54	10	(3.7E 11)
Ytterbium-162	70	1000	(3.7E 13)
Ytterbium-166	70	10	(3.7E 11)
Ytterbium-167	70	1000	(3.7E 13)
Ytterbium-169	70	10	(3.7E 11)
Ytterbium-175	70	100	(3.7E 12)
Ytterbium-177	70	1000	(3.7E 13)
Ytterbium-178	70	1000	(3.7E 13)
Yttrium-86m	39	1000	(3.7E 13)
Yttrium-86	39	10	(3.7E 11)
Yttrium-87	39	10	(3.7E 11)
Yttrium-88	39	10	(3.7E 11)
Yttrium-90m	39	100	(3.7E 12)
Yttrium-90	39	10	(3.7E 11)
Yttrium-91m	39	1000	(3.7E 13)
Yttrium-91	39	10	(3.7E 11)
Yttrium-92	39	100	(3.7E 12)
Yttrium-93	39	100	(3.7E 12)
Yttrium-94	39	1000	(3.7E 13)
Yttrium-95	39	1000	(3.7E 13)
Zinc-62	30	100	(3.7E 12)
Zinc-63	30	1000	(3.7E 13)
Zinc-65	30	10	(3.7E 11)
Zinc-69m	30	100	(3.7E 12)
Zinc-69	30	1000	(3.7E 13)
Zinc-71m	30	100	(3.7E 12)
Zinc-72	30	100	(3.7E 12)

Zirconium-86	40	100 (3.7E 12)
Zirconium-88	40	10 (3.7E 11)
Zirconium-89	40	100 (3.7E 12)
Zirconium-93	40	1 (3.7E 10)
Zirconium-95	40	10 (3.7E 11)
Zirconium-97	40	10 (3.7E 11)

Ci_Curie. The curie represents a rate of radioactive decay. One curie is the quantity of any radioactive nuclide which undergoes 3.7E 10 disintegrations per second.

Bq_Becquerel. The becquerel represents a rate of radioactive decay. One becquerel is the quantity of any radioactive nuclide which undergoes one disintegration per second. One curie is equal to 3.7E 10 becquerel.

@_Final RQs for all radionuclides apply to chemical compounds containing the radionuclides and elemental forms regardless of the diameter of pieces of solid material.

&_The adjusted RQ of one curie applies to all radionuclides not otherwise listed. Whenever the RQs in table 302.4 and this appendix to the table are in conflict, the lowest RQ shall apply. For example, uranyl acetate and uranyl nitrate have adjusted RQs shown in table 302.4 of 100 pounds, equivalent to about one-tenth the RQ level for uranium-238 listed in this appendix.

E_Exponent to the base 10. For example, 1.3E 2 is equal to 130 while 1.3E 3 is equal to 1300.

m_Signifies a nuclear isomer which is a radionuclide in a higher energy metastable state relative to the parent isotope.

φ_Notification requirements for releases of mixtures or solutions of radionuclides can be found in § 302.6(b) of this rule. Final RQs for the following four common radionuclide mixtures are provided: radium-226 in secular equilibrium with its daughters (0.053 curie); natural uranium (0.1 curie); natural uranium in secular equilibrium with its daughters (0.052 curie); and natural thorium in secular equilibrium with its daughters (0.011 curie).

Tiburon
Belvedere
Raccoon Strait
Campbell Pt
Knox Pt
Lighthouse
Blunt Pt
Lighthouse
MARIN CO
SAN FRANCISCO CO
GOLDEN GATE
NAT RECREATION AREA
Alcatraz
Island
Lighthouse
SAN FRANCISCO
BAY
Richmond
San Rafael
Ferry
Freight
U.S. NAVAL
RESERVATION
Treasure
Island
North Point
U.S. COAST GUARD
RESERVATION
Yerba Buena
Island
OAKLAND BAY BRIDGE
TOLL
TRANS-BAY
TUBE
SAN FRANCISCO
Rincon Point
China Basin
Berkeley
Yacht Harbor
Berkeley
Pier
Emeryville
Radio
Towers
Alameda
Naval
Air
Station

Aerial Photo of TI and YBI showing connecting causeway

2004-9-14 website www.navfac.navy.mil/brc/cf-bin/dispmap/activity.cfm

US Map | Back to Previous Map | LUCIS

Naval Station Treasure Island at San Francisco, CA

BRAC: 93-Major Closure **EFD/EFA:** SWESTDIV

Background

Cease Mission: 31 Mar 1997 **Operational Closure:** 30 Sep 1997

Pre-Closure Staffing: **Military:** 637 **Civilian:** 335

Property Summary

Total Acres: 1,074.50 **Acres to be Disposed:** 1,074.50

Acres Disposed to Date: 155.00 **Balance to be Disposed:** 919.50

Acres Retained: 0.00

Caretaker Information

Services

Security: Coop. Agreement
Fire Protection: Coop. Agreement
Police: Coop. Agreement
RPM/PPM: Combo, See Notes

Utilities

Sewer: Coop. Agreement
Water: Coop. Agreement
Telephone: Coop. Agreement
Electricity: Coop. Agreement
Steam: None

Disposal Summary

Reuse

LRA: **Reuse Plan Approved:** N/A

LRA Formed: 14 Jul 1997

Parcel Information

Parcel:	Transfer Date:	Method:	Recipient:	Acres:	FOST:	FOSET:
Job Corps	03 Mar 1998	Fed	Department of Labor	36.50	20 Dec 1995	N/A
Coast Guard	17 Apr	Fed	U. S. Coast Guard	10.50	20 Dec	N/A

Upland	1998				1995	
YBI - FHWA	25 Oct 2000	Fed	Federal Highways Association	97.50	N/A	N/A
Coast Guard Submerged	26 Nov 2002	Fed	U.S. Coast Guard	10.50	13 Sep 2002	N/A
YBI - FHWA 2	31 Aug 2004	FAH	FHWA/Caltrans	.20	N/A	N/A
TI Core Parcel	28 Feb 2005	EDC	City of San Francisco	70.00	30 Apr 2005	N/A
Hotel South Waterfront Parcel	28 Feb 2005	EDC	City of San Francisco	105.00	30 Apr 2005	N/A
Yerba Buena Developed Parcel	28 Feb 2005	EDC	City of San Francisco	65.80	30 Apr 2005	N/A
Yerba Buena Undeveloped Parcel	29 Apr 2005	EDC	City of San Francisco	10.00	28 Feb 2005	N/A
Public Use Parcel	29 Apr 2005	EDC	City of San Francisco	24.00	28 Feb 2005	N/A
Submerged Parcel	28 Feb 2006	EDC	City of San Francisco	477.50	31 Dec 2005	N/A
Film Production Parcel	31 May 2007	EDC	City of San Francisco	12.00	28 Feb 2007	N/A
TI Housing Parcel	31 Oct 2007	EDC	City of San Francisco	112.00	31 Aug 2007	N/A
Visitor Attraction Parcel	31 Oct 2011	EDC	City of San Francisco	43.00	31 Aug 2011	N/A

Disposal Legend

(ET): Early Transfer
EDCNC: EDC - No Cost
FAH: Federal Aid Highways Conveyance
Fed: Fed To Fed
PBC: Public Benefit Conveyance
TBD: To Be Determined

Activity Timeline

Operational Closure:	**EBS:**	**Reuse:**	**Final FOST:**	**First Transfer:**	**Final Transfer:**
30 Sep 1997	19 May 1995	N/A	31 Aug 2011	03 Mar 1998	31 Oct 2011

Abbreviation Legend

FOST: Finding of Suitability to Transfer
FOSET: Finding of Suitability for Early Transfer
EBS: Environmental Baseline Survey

LRA: Local Redevelopment Authority
EFD/EFA: Engineering Field Division/Engineering Field Activity
RPM/PPM: Real Property Maintenance/Personal Property Maintenance

Extract based on operational data posted through:	14 Sep 2004

www.epa.gov.fedfac/ff/treasure.htm

U.S. Environmental Protection Agency

Federal Facilities Restoration and Reuse

About FFRRO
Partners In Cleanup
Federal Facility Site Information
Stakeholder Involvement
Laws, Regulations, Policy, and Guidance
Information Resources
FFRRO Library

Treasure Island Naval Station

Address:	410 Palm Avenue San Francisco, CA 94130
EPA Region:	Region 9
Site Type:	BRAC
Agency:	Navy
EPA ID:	110000781574
CERCLIS ID:	CA7170023330
NPL Status:	Not on The NPL

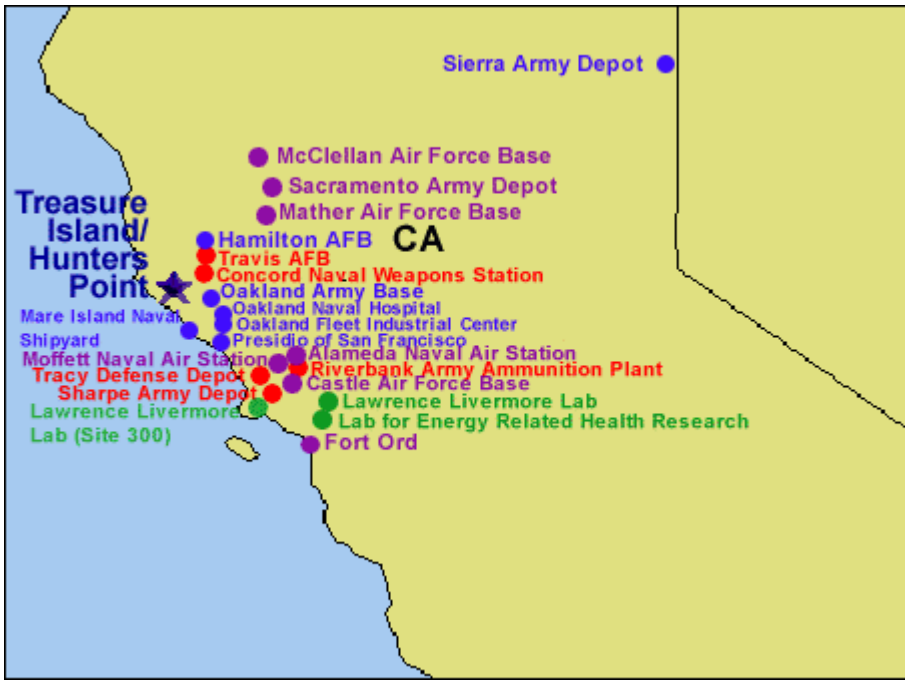
More Information on Treasure Island Naval Station:
(links will open in a new window)

EPA Links

- EPA Region 9 Site Fact Sheet
- NPL Listing

EPA Reports

- Enforcement and Compliance History Online (ECHO)
- Envirojustice Demographic Repor
- Envirofacts Report
- RCRA Info
- CERCLIS Report
- Superfund RODS Report
- EPA TRI Report for site Zip Code



Treasure Island Naval Station

NPL Sites in CA

BRAC Sites in CA

DOE Sites in CA

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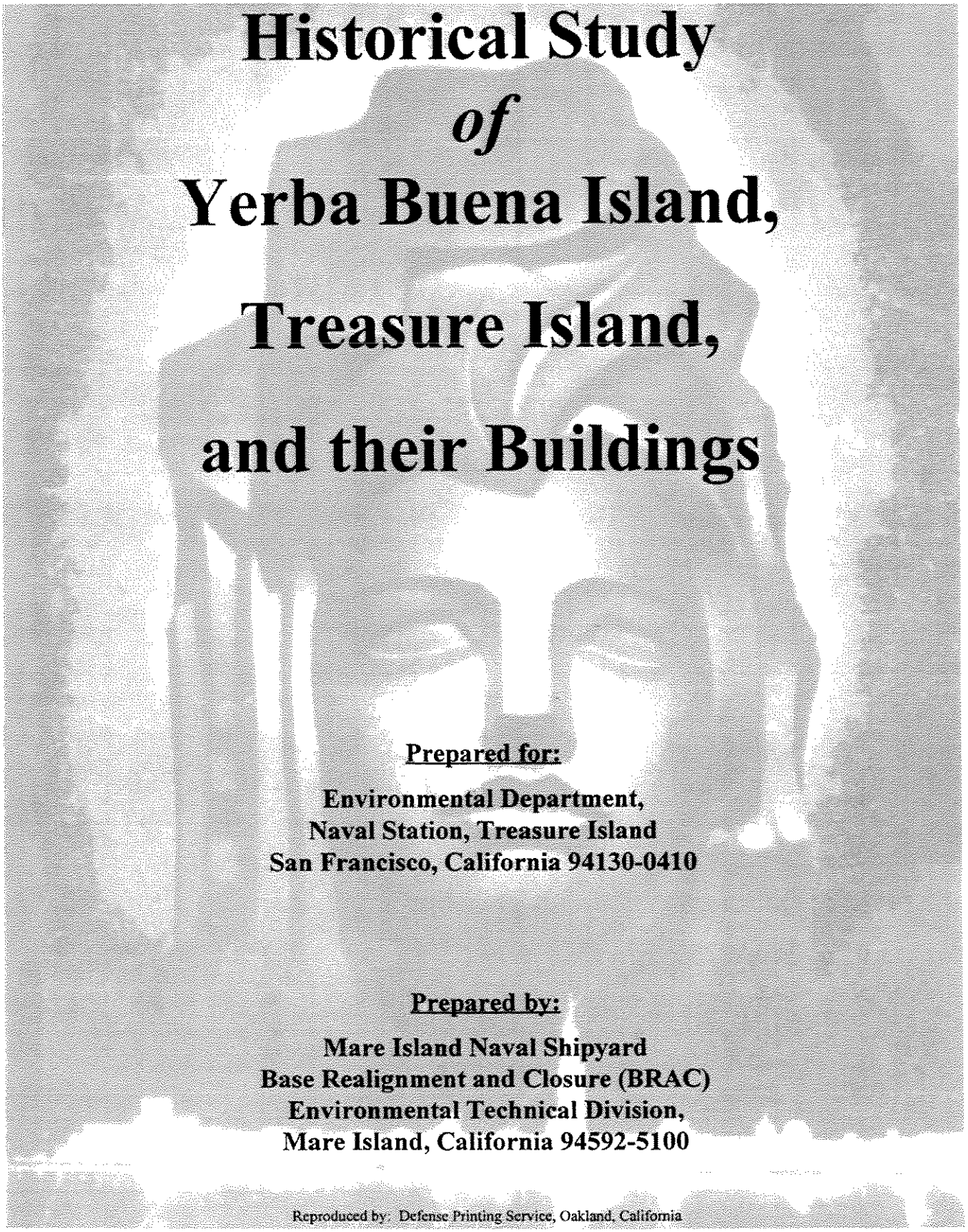
Maps

- EPA's Enviromappe
- Defense Environmental Restoration Program Geographic Information System EXIT disclaimer
- U.S. Census Bureau Maps EXIT disclaimer

Other Links

- ATSDR Report EXIT disclaimer
- Naval Air Station, Treasure Island EXIT disclaimer
- CA DTSC Site Summary EXIT disclaimer

Historical Study
of
Yerba Buena Island,
Treasure Island,
and their Buildings



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About the Cover:

The face of "Pacifica" floats over the 1939 skyline of the Golden Gate International Exposition, as seen from San Francisco. "Pacifica" was the Exposition's eighty foot theme statue sculpted by Ralph Stackpole. It's ghost like appearance on this cover symbolizes the continuing tie between the celebration of the Pacific (in 1939) and the historical role played by both Treasure Island and Yerba Buena Island as Guardians of the Gateway to the Pacific.

"Pacifica" was electronically scanned from the cover of the twenty five cent 1939 Official Guide to the Golden Gate International Exposition, published by The Crocker Company of San Francisco, California.

HISTORICAL STUDY

of

Yerba Buena Island
Treasure Island

And their Buildings

Revision 01

March 1996

Historical Study of Yerba Buena Island, Treasure Island, and their Buildings

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Preface

The Defense Base Realignment and Closure Act of 1990 (BRAC) requires a ". . . timely closure and realignment of military installations." One action of the 1993 BRAC Commission placed Naval Station Treasure Island (NAVSTATI) on the list of closing military facilities and, in so doing, established a closure date of September 30, 1997 for the Naval Station. As the "draw-down" of the facility began, NAVSTATI Environmental Office realized that key personnel could take vital historical information with them as they were transferred or retired. Therefore, this historical study was commissioned to record historical data, while there was still time to access personnel and records. This historical study is divided into two chapters. Chapter 1 is the History of Yerba Buena and its buildings Pre-1835 to the present. Chapter 2 is the History of Treasure Island and its buildings from 1936 to 1995.

The history of these two islands is quite unique. Yerba Buena Island is a natural island occupied by Native Americans for hundreds of years before the arrival of the Europeans. Treasure Island, a "man-made" island, is a tribute to man's ingenuity and the engineering strides of the 20th Century.

Yerba Buena Island, discovered by the Spanish, was known over the years by a variety of names, such as "Isla de Alcatraces, "Yerba Buena Island", and "Goat Island", to name a few. After the Spanish, other European settlers came and claimed the island for themselves. In 1848, when California became the property of the United States, the United States (US) government solved the problem of ownership by claiming all coastal islands. This set the stage for the US military to establish control of the island that spanned the next one hundred and eleven years. The US Army established a post in 1866 and remained the primary tenant until 1898. In 1875, the Department of Treasury (DOT) installed a lighthouse on the Island. It was operated by the Lighthouse Service until 1939, when it was turned over to the US Coast Guard via intra-departmental transfer of function.. The US Navy became the Island's primary tenant in 1898, when it established a Recruit Training Station. Today, ninety-seven years later, the US Navy continues in that role. The US Army remained as co-tenant until 1959. The US Coast Guard will continue to operate at Yerba Buena Island after the US Navy closes the Naval Station in 1997.

Treasure Island was created to celebrate the completion of the great engineering marvels of the Golden Gate Bridge and San Francisco-Oakland Bay Bridge, and to provide San Fransisco with an airport site. The construction of Treasure Island commenced on February 11, 1936. The Army Corps of Engineers completed the construction, under budget by $4,100, eighteen and one-half months later on August 24, 1937. On February 18, 1939, the Golden Gate International Exposition opened for two years of celebration. It closed on September 29, 1940. Because of the beginning of World War II in Europe in 1939, the US Navy was granted a lease for use of the island on February 28, 1941. In 1943, the Navy, liking the location of the island, offered the City of San Francisco a large parcel of land in San Bruno as an exchange for the Treasure Island property. The results of the trade netted the City of San Francisco land for its proposed international airport, while the Navy secured a permanent base within the San Francisco Bay.

With the closure of Naval Station Treasure Island, along with Mare Island Naval Shipyard, Naval Air Station Alameda, Fleet Industrial Supply Center Oakland (ex-Oakland Naval Supply Center), the Oakland Army Base and the Army Presidio in San Francisco, the long tradition of military presence in the San Francisco Bay Area is concluding. An era of military, local, and state history, as well as National history is also drawing to an end.

Timeline

Yerba Buena Island, 1579 – 1994

1579
- Sir Francis Drake sails by the opening to San Francisco Bay, but does not document the existence of the Bay.

1769
- Gaspar de Portola first documents the San Francisco Bay.

1775
- Juan Manuel de Ayala is the first person to survey and map San Francisco Bay and gives Yerba Buena Island the name "Isla de la Alcatraces".

1826
- Captain Beechey of the British research ship *Blossom* copies Ayala's map but puts "Isla de la Alcatraces" on an island to the northwest of Yerba Buena Island. Consequently, he is the first to use the name "Yerba Buena Island" for this island.

1835
- Private ownership begins:
- 1835 - 1849 – Nathan Spear is the first American claimant and first to introduce goats to Yerba Buena Island. Because of this the Island becomes locally known as "Goat Island".
- 1849 - 1850 – Edward King buys claim from Spear but never occupies the island.
- 1850 - 1856 – Thomas Dowling and Mr. Jennings claim and live on the island.
- 1856 - 1866 – Thomas Dowling, Charles Scott, and John Vandewater claim the island in a partnership.
- 1866 - 1867 – Benjamin S. Brooks buys all claims to the island and then sells to Egbert Judson. Brooks, Dowling and Judson continue to live on the island until the Army confiscates the island in 1867 and forces them to leave.

1850
- Mexican control ends, United States takes control of California.
- President Filmore claims all coastal islands for the US Government which is later interpreted to include Yerba Buena Island.

1867
- Army establishes it's presence and claims the island forcing the end of Private ownership.

1868
- Army establishes artillery base on the east cove.

1871
- Army Fourth Artillery Detachment assigned to Yerba Buena Island.

1872
- Army base is officially listed as an Army Quartermaster Depot.

1875
- A lighthouse and buoy depot, operated by the US Lighthouse Service, is established on the south point of the island.

1879
- Army Fourth Artillery Detachment transferred to the Presidio of San Francisco.

1887	• Replanting of trees starts with celebration of California State's first Arbor Day on the island. (Note: Deforestation occurred over the previous years by inhabitants.)
1891	• Army Torpedo Station built on east point.
1892	• Torpedo Station and all real estate with the exception of the lighthouse reservation is transferred from the Army Quartermasters to the Army Corps of Engineers.
1895	• US Geographic Board officially changes the name of the island from Yerba Buena Island to Goat Island to reflect common usage.
1898	• Control of most of the island is transferred to the Navy. The Army Torpedo Station remains under Army control and the Lighthouse Reservation remains under Lighthouse Service control. • Navy establishes a Naval Training Station.
1899	• Receiving Ship, San Francisco is established on Yerba Buena Island.
1923	• Naval Training Station closed, Training Command is transferred to San Diego.
1931	• After a major lobbying campaign by the Native Daughters of the Golden West, the US Geographic Board officially changes the name of Goat Island back to Yerba Buena Island.
1933	• San Francisco - Oakland Bay Bridge construction begins.
1936	• San Francisco - Oakland Bay Bridge is completed.
1939	• US Coast Guard takes over operation of the Lighthouse Reservation and Bouy Depot.
1946	• Receiving Ship, San Francisco is officially transferred to Treasure Island, as are all other administrative functions.
1966	• New enlisted family quarters built on Treasure Island and all enlisted personnel families are transferred to Treasure Island. New Officer's family housing is built and occupied on Yerba Buena Island.
1973	• Navy transfers ownership of a large part of the old Naval Training Station to the US Coast Guard.
1993	• The Base Realignment and Closure (BRAC) Commission identifies NAVSTA, Treasure Island for closure in 1997. This affects all Navy property on Yerba Buena Island, as well as the property on Treasure Island.

Treasure Island, 1936 – 1994

1936	• Construction of Treasure Island begins.
1938	• Pan American Airlines starts its China Clipper service.
1939	• The Golden Gate International Exposition opened on February 18th.
1940	• The Golden Gate International Exposition closed on September 29th. • US Navy unofficially leases Treasure Island from the City of San Francisco.
1941	• City of San Francisco officially leases Treasure Island to the US Navy on February 28th. • Treasure Island designated as Naval Training and Distribution Center (TADCEN), Treasure Island.
1942	• First WAVES arrive onboard TADCEN, Treasure Island to provide support for the war effort.
1946	• Pan America Airlines closes its China Clipper service. • Receiving Ship, San Francisco command is transferred from Yerba Buena Island.
1947	• TADCEN, Treasure Island is designated Naval Station (NAVSTA), Treasure Island. • After a major fire burns Palaces I, J, and K, all palaces and most remaining statuary are razed.
1966	• Enlisted families are relocated from Yerba Buena Island to the new housing on Treasure Island.
1969	• Twelfth Naval District establishes its headquarters at NAVSTA, Treasure Island.
1975	• NAVSTA, Treasure Island is designated Naval Support Activity (NSA), Treasure Island.
1977	• Twelfth Naval District is disestablished.
1980	• NSA, Treasure Island is designated NAVSTA, Treasure Island.
1993	• The Base Realignment and Closure (BRAC) Commission identifies NAVSTA, Treasure Island for closure in 1997.

YERBA BUENA ISLAND

TREASURE ISLAND

1570's | 1580's thru 1750's | 1760's | 1770's | 1780's | 1790's | 1800's | 1810's | 1820's | 1830's | 1840's | 1850's | 1860's | 1870's | 1880's | 1890's | 1900's | 1910's | 1920's | 1930's | 1940's | 1950's | 1960's | 1970's | 1980's | 1990's

Date and Event

1578 - Sir Francis sails by San Francisco Bay

1768 - Caspar de Portola documents San Francisco Bay

1775 - Juan Manuel de Ayala survey and maps San Francisco Bay and gives Yerba Buena Island the name "Isla de la Alcatraces".

1826 - Captain Beechey of the research ship Blossom copies Ayala's maps and mistakenly gives a island northwest of Yerba Buena Island the name Isla de la Alcatraces

1835 - Private ownership of Yerba Island begins.

1835-1849 - Nathan Spear is first American claimant, first to introduce goats to the island, first to use the name "Goat Island"

1849-1850 - Edward King buys claim from Spear but never occupies the island.

1850-1856 - Thomas Dowling and Mr. Jennings claim and live on the island.

1856-1866 - Thomas Dowling, Charles Scott, and John Vandewater claim the island in a partnership.

1866-1867 - Benjamin S. Brooks buys all claims to the island and then sells the island to Egbert Judson. Brooks, Dowling and Judson continue to live on the island until US Army confiscates the island in 1867 and forces the three men to leave.

1850 - Mexican control ends. United States takes control of California.

1850 - President Filmore claims all coastal islands for United States government which includes Yerba Buena Island.

1867 - US Army establishes presence and claims ownership of Yerba Buena Island. Private ownership of the island ends.

1868 - US Army establishes artillery base on the ease cove of the island.

1871 - US Army for the Artillery Detachment assigned to Yerba Buena Island.

1872 - US Army base is officially listed as an Army Quartermaster Depot.

1875 - A lighthouse and bouy depot, operated by the US Lighthouse Service, is established on the south point of the island.

1879 - US Army Fourth Artillery Detachment transferred to the Presidio of San Francisco

1887 - Replanting of trees on the island starts the first celebration of California's Arbor Day.

1891 - US Army Torpedo Station built on the east point of the island.

1892 - Torpedo Station and all real estate is transferred from the Army Quartermasters to the Army Corps of Engineers, except for the Lighthouse Reservation.

1895 - US Geographic Board officially changes name of "Yerba Buena Island" to "Goat Island" to reflect common usage.

1898 - Control of the island is transferred to the US Navy. Torpedo Station remains under US Army control. Lighthouse Reservation remains under Lighthouse Service control.

1899 - Receiving Ship, San Francisco established at Yerba Buena Island.

1923 - Naval Training Station Closed, Training Command is transferred to San Diego.

1931 - After major lobbying by the Native Daughters of the Golden West, US Geographic Board officially changes name of the island from "Goat Island" back to "Yerba Buena Island.

1933 - San Francisco Bay Bridge construction begins.

1936 - San Francisco Bay Bridge construction is completed.

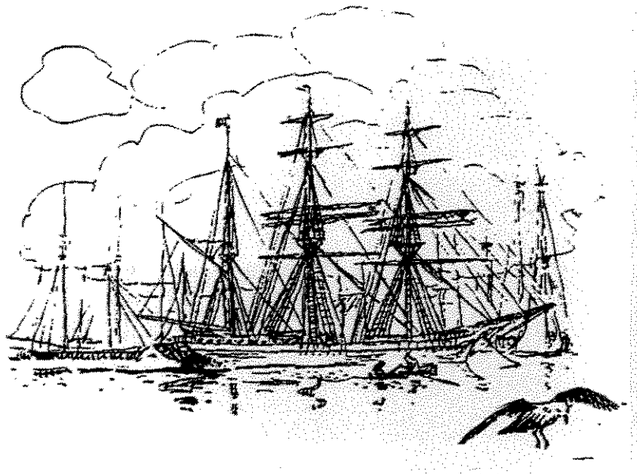
1939 - US Coast Guard takes over operation of the Lighthouse Reservation and Depot.

1946 - Receiving Ship, San Francisco is officially transferred to Treasure Island, as are all other administrative functions.

1966 - Enlisted families are transferred to Treasure Island to be housed in new housing there. New Officer's family housing is built and occupied on Yerba Buena Island.

1973 - Navy transfers ownership of a large part of the old Naval Training Station to the US Coast Guard.

1993 - The Base Relignment and Closure (BRAC) Commission identifies Treasure Island for closure in 1997. This affects all Navy property on Yerba Buena Island.



1936 - Construction of Treasure Island begins.

1938 - Pan American Airlines begins its China Clipper Service.

1939 - The Golden Gate Exposition opened on February 18th.

1940 - The Golden Gate Exposition closed on September 29th.

1940 - US Navy unofficially leases Treasure Island from the City of San Francisco.

1941 - City of San Fracisco officially leases Treasure Island to the US Navy on February 28th.

1941 - Treasure Island designated as Naval Training and Distribution Center (TADCEN), Treasure Island

1942 - First WAVES arrive onboard TADCEN, Treasure Island to provide support for the war effort.

1946 - Pan American Airlines closes its China Clipper service.

1946 - Receiving Ship, San Francisco command is transferred from Yerba Buena Island.

1947 - Naval Training and Distribution Center (TADCEN), Treasure Island is designated Naval Station (NAVSTA), Treasure Island.

1947 - After a major fire burns Palaces I, J, and K, all palaces and most remaining statuary are razed.

1966 - Enlisted families are relocated from Yerba Buena Island to Treasure Island.

1969 - Twelfth Naval District establishes its headquarters at NAVSTA, Treasure Island

1975 - NAVSTA, Treasure Island is designated Naval Support Activity (NSA), Treasure Island.

1977 - Twelfth Naval District is disestablished.

1980 - NSA, Treasure Island is designated NAVSTA, Treasure Island

1993 - The Base Realignment and Closure (BRAC) Commission identifies NAVSTA, Treasure Island for closure in 1997.

Figure 1
Timeline of Yerba Buena Island
and Treasure Island, 1570 - 1994

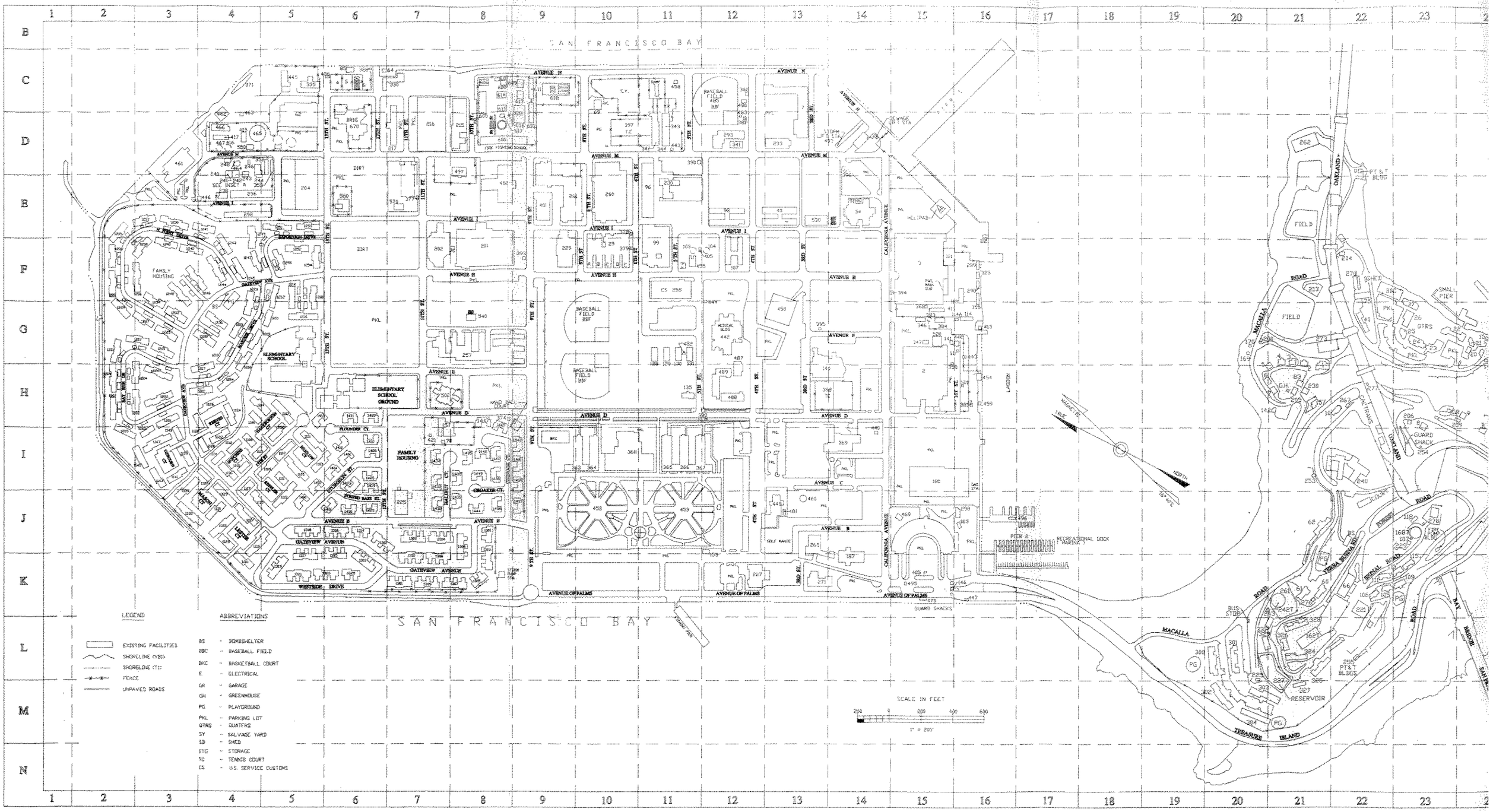


Figure 2
Map of Yerba Buena Island
and Treasure Island, 1955

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The history of both Yerba Buena Island and Treasure Island is buried in archives located throughout the San Francisco Bay area. Research for this historical study has been diverse and extensive. Without the aid of the following people this report would not have been possible.

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- **Jeanne M. Day**, Resident of Yerba Buena Island since 1987, who willingly shared the results of all her historical research relating to Yerba Buena Island.

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- Personal Library of Jeanne M. Day; Yerba Buena Island, CA
- Personal Library of John Underhill; Richmond, CA
- San Francisco Public Library, Newspaper and California Rooms; San Francisco, CA
- Treasure Island Museum Library, Naval StationTreasure Island; San Francisco, CA
- Treasure Island Library, Naval StationTreasure Island; San Francisco, CA
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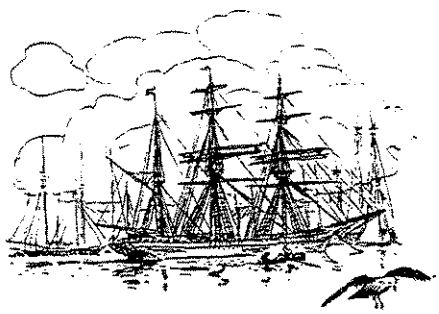


Chapter 1 Yerba Buena Island

1.1 Introduction

Situated in the middle of the San Francisco Bay, easily visible from San Francisco, Oakland and most of the towns of the San Francisco Peninsula and the Contra Costa (coastline opposite the San Francisco Peninsula), Yerba Buena Island has long been a magnet for legends and ambitions. It is the southernmost of the three major islands of the Bay. The other two islands are Angel Island to the northwest and Alcatraz Island to the west of Yerba Buena Island.

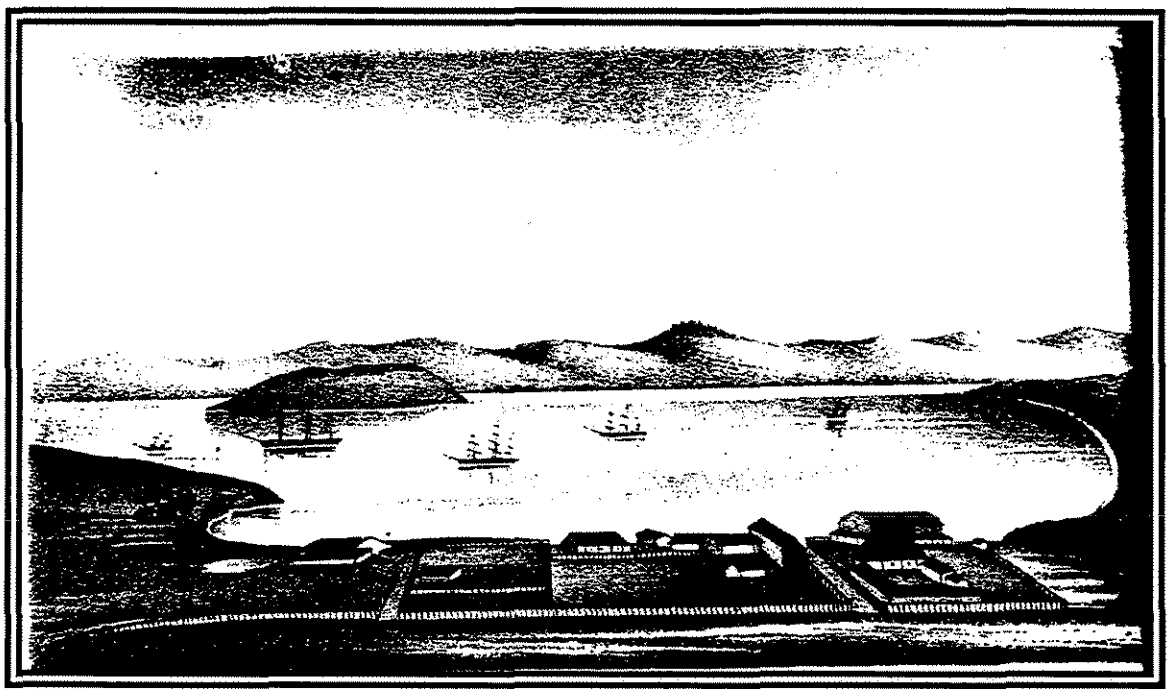


FIGURE 3: ***The Hamlet of Yerba Buena. Circa 1835.***
Note: Yerba Buena Island and the Contra Costa in the distance.

Over the years, Yerba Buena Island has had several names. Known originally as the "Isla del Carmen" on the earliest Spanish charts (Ref. BB), the island was eventually renamed the "Isla de Alcatraces", "Yerba Buena Island", "Goat Island", and finally "Yerba Buena Island" again. This parade of names started with Juan Manuel de Ayala who, in his survey of the San Francisco Bay in 1775, named it "Isla de Alcatraces" ("Pelican Island" in English). Later in 1826, an English cartographer, Captain Frederick W. Beechey of the British scientific exploration ship *Blossom* copied Ayala's map of San Francisco Bay and inadvertently transposed the name of "Isla de Alcatraces" to an unnamed island located a little northwest of Yerba Buena Island. Thus did Alcatraz Island get its name. Captain Beechey then needed to rename the original "Pelican Island". He decided to name it "Yerba Buena" (Good Herb) for the mint like herb (Micromeria chamissonis) that grew wild on the island. (Ref. K). This name was corrupted to "Mint Island"

by the English speaking residents of San Francisco, as noted in the 1842 personal log of Gunner William H. Meyers of the sloop of war *Cyane*. (Ref. UU). The herb can no longer be found on the island due to later plant imports which have displaced the mint.

The island became known as "Goat Island" when, in approximately 1837, a herd of goats was brought to the island. The herd flourished on the island until the late 1840s. The last known goat inhabiting the island, "Lonesome Billy", was a thin, one horned male. He died just after the turn of the century at an age of 30 years plus. Because of his cantankerous personality, there is no record of any mourning for Lonesome Billy. His head was stuffed, mounted, and displayed in the Goat Island Training Station administration building for several years; but, unfortunately, was lost sometime around 1931. Though most of the goats were gone by 1850, the name "Goat Island" remained as the popular name for the island. During the next one hundred years, 1840s to 1940s, names for the island were used interchangably. However, in 1895, the US Geographic Board officially changed the name of the island from "Yerba Buena Island" to "Goat Island". It remained this way until 1931 when an intense campaign led by the Native Daughters of the Golden West succeeded in convincing the same board to reverse its previous decision and restore the name "Yerba Buena" to the island. (Ref. Z). It has been documented that instead of tossing Lonesome Billy's stuffed head into the Bay, Navy Radioman Jack Lowe dressed up in a goat suit and Rear Admiral W. C. Cole, the Commanding Officer of the Training Station, kicked him off the end of the pier to mark the Island's name change. (Ref. Z). Since about 1940, the name "Goat Island" has fallen out of usage , while "Yerba Buena Island" has been accepted by the local populace, as well as by the U.S. Geographic Board.

Other unofficial names for Yerba Buena Island included: "Sea Bird Island" or just "Bird Island", stemming from Ayala's naming it "Pelican Island" (Ref. J); "Wood Island", so named because of the wood on the island which was cut and supplied to the sailing vessels; "Spear's Island", named after Nathan Spear, a resident of San Francisco, who claimed ownership of the island from 1835 to 1849 and who originally brought the goats to the island (Ref. HH); and "Treasure Island", named for the various treasures that are rumored to have been buried on the island over the years. (Ref. E).

The early history of Yerba Buena can be divided into three eras:

- Prehistory and Early Mexican Control, Pre–1835
- Private Ownership, 1835 - 1867
- Military Control, 1867 - 1898

The modern history of Yerba Buena Island consists of three eras:

- West Coast Naval Training Station (also known as Goat Island) and the West Coast Naval Receiving Station, 1898 - 1923
- West Coast Naval Receiving Station, 1923 - 1941
- Housing for permanent naval residents of Treasure Island (Officers only since 1966) and United States (US) Coast Guard Station, 1941 - Present (1995)

1.2 Early History of Yerba Buena Island

1.2.1 Prehistory and Early Mexican Control, Pre–1835

The first people to inhabit Yerba Buena Island were American Indians. The earliest descriptions of Yerba Buena Island depict it as an Indian fishing village with ceremonial huts and cremation pits located in the area of the island's east cove area. The tribe was identified in early newspaper accounts as the Tuchayunes who were referred to as hostile by the earliest settlers. (Ref. V, Arbor Day). Their dress and tools were similar to the Mission Dolores Indians shown in the accompanying drawings. (Ref. U).

The native people at Yerba Buena Island belonged to the Costanoan language family which included eight separate and distinct languages. Based on linguistic evidence, the Costanoans moved into the San Francisco Bay area about 500 AD. The Costanoans occupied the San Francisco peninsula south to the Carmel and Sur Rivers, and also the eastern side of the Bay from Carquinez Strait south to the lower Salinas River. In 1770, the Costanoans were comprised of approximately 50 politically autonomous tribelets. The boundaries of tribelets were defined by geographic boundaries Each tribelet had one or more permanent villages and a series of seasonal camps. Tribelets in what is now San Mateo and San Francisco counties spoke the Ramaytush language. Tribelets on the east side of the Bay spoke Chochenyo. (Ref. VV)

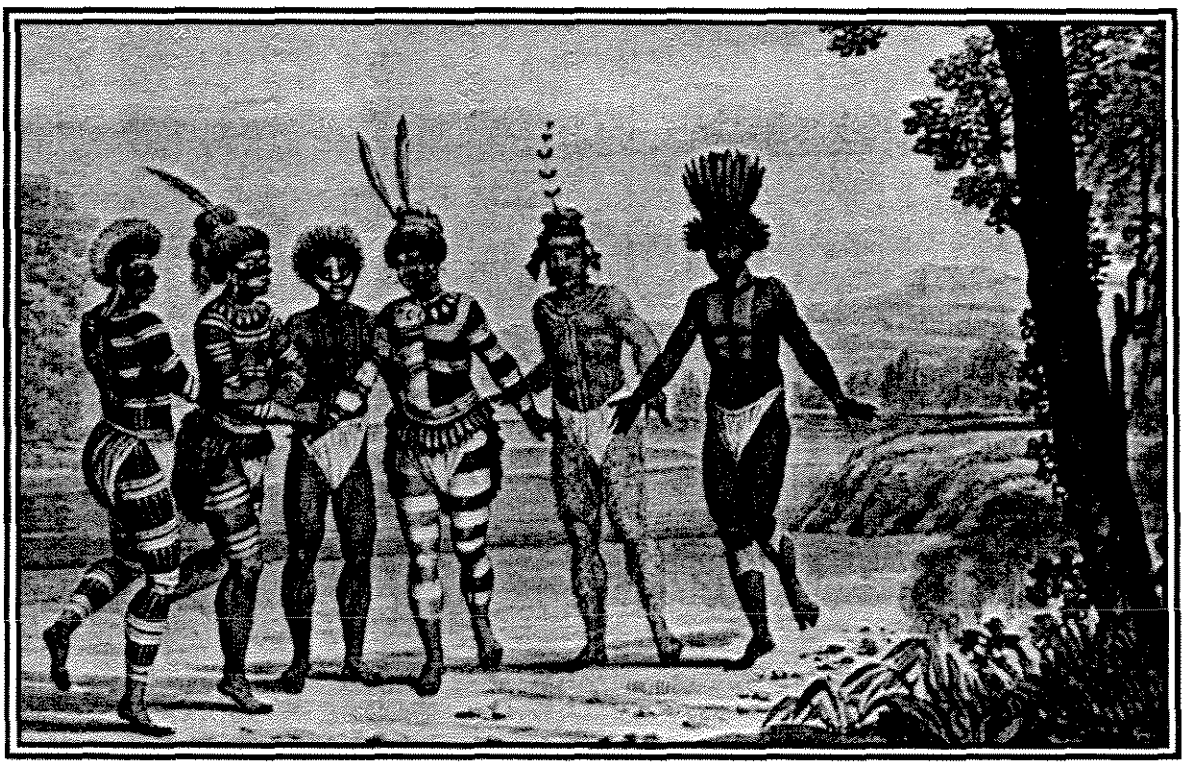


FIGURE 4: ***California Indians. Circa 1806.***
Note: These painted and feathered California Indians were drawn at San José de Guadalupe mission in 1806 by Wilhelm von Teleman, a German artist with a Russian exploring expedition..

FIGURE 5: ***Tule Boat. Circa Pre–1800.***

It is thought that Sir Francis Drake, the English explorer/privateer, may have been the first European to sight San Francisco Bay in 1579. He certainly sailed past the opening to the Bay. He may have left behind a brass plate claiming Nova Albion (New England) in the name of the Queen. A brass plate which is considered to be Sir Francis Drake's Nova Albion plate was found in 1937 and is currently owned by the Bancroft Library at University of California, Berkeley. Its authenticity continues to be questioned. However, had he actually entered San Francisco Bay, it would seem likely that he would have commented on the harbor in much the way that the Spanish explorer, Gaspar de Portola, did. Consequently, Portola is generally given credit for being the first European to sight and document the San Francisco Bay in his 1769 journey up the coast of California. One of his men, Crespi, described the harbor as a "... very large and fine harbor, such that not only all the navy of our most Catholic Majesty but those of all Europe could take shelter in it."

In 1773, Antonio Maria Bucareli y Ursua, the Spanish Governor of Mexico, sent a land expedition to Alta (Northern) California with a twofold purpose: (1) to survey the land; and (2) to establish a Spanish presence in the area to counteract the Russians who were coming south from Canada, as well as the British from the east. During 1775, he also sent Juan Manuel de

Ayala north by sea with the same purpose. Ayala made the first confirmed sea entry into San Francisco Bay aboard the *San Carlos*. He was the first to survey and map the Bay and initially name the islands within it. The San Francisco Presidio and Mission were established in 1776 by Juan Bautista Anza. Both establishments struggled at first, but eventually prospered and grew in importance to the region.

News of the successful Mexican Revolution of 1821 reached California in 1822, and the Spanish leaders promptly acceded to the new Mexican government. This new successor government had many of the same concerns as the old Spanish government. Mexico wanted to ensure that its claims in the Alta California area were maintained. During his two years of service, Governor Jose Figueroa (Mexican Governor of Alta California from 1833 till his death in 1835) sent General Mariano Guadalupe Vallejo (later to be the last Mexican Governor of Alta California) to Alta California. His mission was to investigate the Russian venture at Fort Ross and countercolonize the area. General Vallejo reported that Fort Ross was basically a fur gathering base and not really a threat to their claims. However, he did establish settlements at Petaluma and Santa Rosa. His own rancho was located in what is now the town of Sonoma. The house he built and lived in is maintained as a museum today.

Another action of Governor Figueroa was to order the secularization of the missions in Alta California. This was actually against his recommendation, but it was ordered by the Mexican government in Mexico City. This order resulted in the earliest of the treasure stories of Yerba Buena. (Ref. H). The story is told that in 1833, when word of the coming secularization reached the padres at Mission San Dolores, they packed up all the gold and silver altar pieces used in the church and put them aboard a ship for return to Spain. However, as soon as the ship left harbor, a storm came up that blew the ship onto the shoals at Yerba Buena Island. Someone on the ship removed the treasure from the sinking vessel and buried it on the island for safekeeping. Over the years, the lost treasure of the Mission has never been found despite many searches.

A famous treasure story of Yerba Buena Island concerns a whaling ship. It had stopped at Callao, Peru at the time of a local revolt against the Spanish rulers. Some of the rich folks brought out two barrels of coins and a cask of jewels for the ship's captain to protect while they put down the rebellion. The Captain got nervous and left. Upon his arrival in the San Francisco Bay, he and two crewmen (one of whom was Charles Stewart) took the barrels and cask and buried them on Yerba Buena Island. The Captain then sailed his whaling ship to the Arctic and never returned. However, Charles Stewart had jumped ship before it sailed from San Francisco. Though he lived in the Bay Area for the rest of his life, he claimed to have taken an oath not to reveal the location of the treasure and being an "honorable man", he refused to divulge the secret and took it to his grave. The treasure (if it actually exists) remains buried on Yerba Buena Island.

The most common "treasure", however, to be actually buried on the island was opium. Until the Navy moved onto Yerba Buena Island in 1899, the island was used extensively by smugglers. Once the lighthouse keeper nearly caught a group of smugglers, but by the time he got his gun, they were off the shore and pulling oars for San Francisco. (Ref. E).

Early local settlers heard of a legend about a race of giants living on Yerba Buena Island. The legend was born from the finding of several skeletons on the island that measured 6'6" and taller, though no giants had ever been seen by Europeans. The skeletons were found in 1899 during the

construction of the barracks and parade grounds. Suprisingly, a mastodon tusk was also found in the Yerba Buena Island shoals during the building of the Bay Bridge. (Ref. V.)

1.2.2 Private Ownership Era, 1835–1867

Governor Figueroa died in December of 1835. Supposedly a Captain Gorham Nye used his vessel, the *Fama* (or perhaps the *Avon*), to transport the Governor's body from Monterey to Santa Barbara. Once there, it was expected to be transferred immediately to Mexico for final internment. For his services, Captain Nye was given a paper from the Mexican government "...certifying that he was the sole owner of Yerba Buena Island." Captain Nye regarded this paper as a gift deed and occupied the island as his home port. (Ref. S.) As research indicates, the accounting of this event appears to be flawed in that there is no evidence proving Captain Nye ever used the island as a base. Rather all accountings indicate that he allowed Nathan Spear to use the island. In return Captain Nye had free access to the wood and goats of the island, for which Mr. Spear would have otherwise charged a fee. Another twist to this story is that Governor Figueroa's body never actually left Santa Barbara, but was instead buried in a crypt under the sanctuary of the Mission San Carlos Borromeo (Carmelo). The Governor's remains were found in his wooden coffin at the Mission in 1911. To this day, his remains are still located at the mission. (Ref. O).

Captain Nye transported goats from the Sandwich Islands (Hawaii) to the San Francisco Bay Area on the brig *Bolivar Liberdora.* Subsequently, a flock of these goats were introduced to Yerba Buena Island in late 1836 or early 1837 by Nathan Spear. There they freely roamed. As needed to supply ships, a Mr. Fuller was employed to trap and butcher the goats. He also supplied visiting ships with the wood of the California Oak trees that grew on the island. Eventually this resulted in the island's deforestation. Because Nathan Spear continued to use the island as if it were his personal property, it soon became known to the neighboring people as "Spear Island". Spear claimed ownership of Yerba Buena Island by way of the Mexican prescription method. This method allows ownership based on use of the land. In 1849, Nathan Spear sold the island to Edward King, the Harbormaster of the Port of San Francisco, who had big plans for the island. His plans included a town, named "Spearsville," to be located on the east side of the island. During his ownership, the island was virtually uninhabited, except for the goats which had survived after Mr. Fuller left in the late 1840's.

Early in 1849, William Bernard, later famous as "Barnacle Bill", and a friend landed on Yerba Buena Island. After exploring the island they found it uninhabited, except for the goats, and they both soon left. Although Bill returned years later (approximately 1881) as the caretaker for the Army post which was abandoned in 1879, he was never involved in claiming ownership of the island. Later in 1849, two gentlemen named Jennings and Thomas Dowling occupied the island. In January, 1850, Dowlings filed a claim by right of occupancy and improvement with the Recorders Office. In 1852, Jennings also filed a claim for his portion of the island. They both filed under the Land Act of 1850. Because the City of San Francisco passed the Van Ness Act and since Yerba Buena Island was within the San Francisco City limits, Jennings and Dowling again refiled their claim in 1855. The Van Ness Act was passed "...for quieting the land titles in the City of San Francisco". This act, which disregarded all Mexican land grants, gave titles to those who occupied land within the borders of the City of San Francisco.

Jennings built a barn, stable, windmill, carpenter's shop, forge, wharf, oyster beds, and other buildings on his portion of the island; while Dowling established a quarry that supplied building stone for San Francisco as well as ballast for ships. Dowling also built a boatway on his part of the island. At least one boat was erected there prior to the military taking possession of the island in 1867. Altogether, Dowling constructed a small house, a shack, two wells (one dry), a quarry, small boat repair facilities, and a little plank wharf atop light piles. The little wharf is the site where the Navy eventually built its long wharf. (Ref. E.) Sadly, one of Dowling's sons drowned and his remains are buried on the island.

In 1850, Elbert Jones presented a document (dated November 1838) to the Registrar by which he claimed that Governor Alvarez, via Mexican grant, transferred ownership of Yerba Buena Island to Juan José Castro. Supposedly, Castro had sent to the the island some sheep and hogs along with Indians to watch over them. There was no other evidence, however, of this taking place or any record of said grant located in document archives. Elbert Jones claimed to have purchased the grant from Senor Castro in November 1848, and was attempting to take ownership of Yerba Buena Island on this basis. Thus started a long story of litigation and battles over ownership of the island that continued into the early 1940's. The United States (US) Land Commission eventually rejected the grant claim of Mr. Jones and affirmed Nathan Spear's ownership from 1836 to 1849. However, it does not appear that they considered the matter of Captain Nye's grant. Eventually, the US Land Commission rejected all private claims to Yerba Buena Island, which cleared the way for the United States government to claim it for its sole use.

A few years later, Mr. J. Polack bought both the Castro grant from Mr. Jones and the ownership claim from Mr. King. He then sued Jennings and Dowling to stop them from quarrying the island; but the suit failed. In 1856, Dowling sold two-thirds of his claim to Charles Scott and John Vandewater. Sometime during 1864, Dowling bought the Mexican deed from the now retired Captain Nye who happened to be residing with him at the time. By 1866, through a set of complicated deals, Benjamin S. Brooks bought all claims to the island including Jennings claim. Once possession was obtained, Mr. Brooks then sold the entire island to Egbert Judson. (Ref. GG). Judson, Brooks and Dowling continued to live on the island until the US military forced them to leave in 1869. The military had already established their presence in 1867. Those who lived on the island were required to lease back the land on which they lived. Mr. Polack became one of the petitioners who sought government compensation for the 1867 confiscation of the island. (Ref. HH).

In 1867, the US military claimed the right to take the island based on the Mexican decree of July 1838. The decree stated that "... the islands of the Department of the Californias ..." are to be " ... added to the territory for public distribution ..." to those who demand them. Additionally, the 1848 treaty, under which California became property of the United States, mentioned the coastal islands as being given to the US Government. President Fillmore, in November 1850, issued a Presidential order claiming these islands for the US government. There were, however, several provisos regarding occupancy and time frames which the government appears to have ignored. Consequently, since the military never compensated the occupants for their loss, the manner in which the military took possession may have been illegal. In any case, it led to many years of bitter and acrimonious debate in the courts and Congress. Eventually, the government, in order to end the litigation, declared that it reserved all the islands in the bay for military or other public purposes. The claimants were never compensated for their losses (Ref. GG and Ref. HH).

The San Francisco Directory, 1861, (Ref. C), described Yerba Buena Island acreage as follows:

"198 ac. comprised of:
75 ac. of rich soil, well adapted for garden purposes
15 ac. are heavily timbered
23 ac. are jungle and brushwood
85 ac. are hilly, rocky and sandy, being thickly covered with the herb or mint plant.
Springs of excellent water abound on the eastern and western sides, in the midst of a fertile valley. The apex of this island is 343 feet above high water."

1.2.3 Military Control, 1867–1898

The military established their presence on Yerba Buena Island in February of 1867. The military use of and presence on the Island for 31 years was intermittent, despite the extraordinary measures the military used in order to retain possession of the Island.

Special Order No. 252 of the Commanding General at San Francisco December 19, 1866 reads: "The Commanding Officer of Alcatraz Island will send tomorrow morning a detachment of one sergeant and ten privates under a commissioned officer from his command to take post at Yerba Buena". (Ref. AA). Although the order was to be carried out on December 20, 1866, it appears that it was not actually fulfilled until February 1867. The stated purpose was to " . . .garrison the island . . ."; however, it probably had more to do with a conflict between Dowling and a Mr. J. Pelter. Against Dowling's will, Mr. Pelter was occupying a house on the island. The bitter rivalry had nearly come to a draw of pistols. It appears that the Commander was disturbed by this and, therefore, under the pretense of garrisoning the island, put a force in place to keep both men in line and to simultaneously establish military claim to the island. In any case, a small force commanded by Major Mansfield landed on the island and finally established the military's presence. Major Mansfield eventually bought six hogs from Dowling for $40. He also determined that the only building of use to the Army was the main house owned by Dowling.

As early as 1865, it had been proposed that the Navy should establish a drydock on Yerba Buena Island. The proposal was rejected because the Navy had already built the Navy Yard at Mare Island near Vallejo. In 1868, an Army detachment of 125 men were sent to Yerba Buena Island. Their mission was to establish a regular artillery post and depot on the island. The base was built on the Island's eastern side at the edge of the cove. In a pattern that would become familiar throughout the military, buildings and structures were erected in a square around a large clearing. See Figures 6 and 7. The clearing was used as a parade ground. A large two-wing Barracks (adequate for two companies of soldiers), a Mess Hall, Laundresses Quarters, Commanding Officer Quarters, two Officer's Quarters, a Hospital (once Dowling's house), a Guard House, a Bakery, a Sutler's store, an Engineer's Store House, a Wharf, and a Boat House were erected. The base had a capacity for 150 soldiers and 4 officers. From 1871 until 1879, the Fourth United States Artillery Detachment occupied the site. Unfortunately, a major fire devastated the original Barracks sometime during 1875. (Ref. X, July 10, 1881) Most of the Army men hated their daily life on Yerba Buena Island. In 1879, General McDowell, decided to transfer the command back to the Presidio of San Francisco, which was a welcomed relief to those servicemen living on the island. General McDowell ordered the buildings on Yerba Buena dismantled and rebuilt at the Presidio. However, it appears that the buildings were not removed. They were mentioned in a newspaper article well after the Army had left. (Ref. X, July 10, 1881.) From 1872 to 1892, the base was officially listed as an Army Quartermaster Depot.

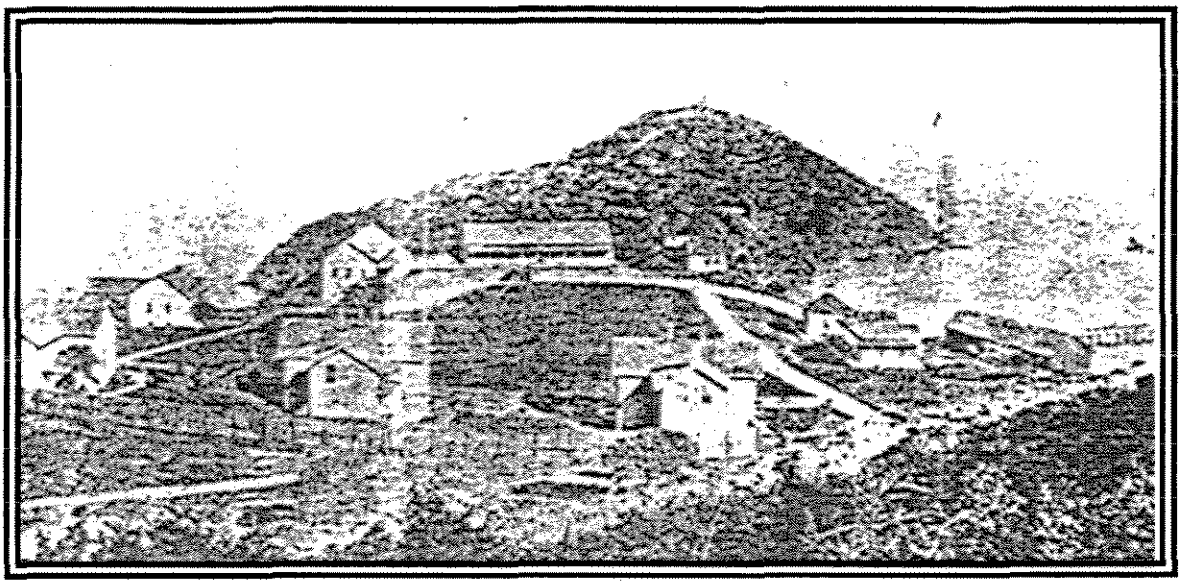


Figure 6. Army Post and Depot, Yerba Buena Island. 1871.
Note: Photograph taken from mid-island looking towards east point. East cove is located to the right of the Hospital (originally Dowling's House). Refer to Figure 7, locator "D" for orientation.

After the Artillery detachment left Yerba Buena Island in 1879, over a decade passed before the government once again returned in 1891. This time, the government decided that a Torpedo (Mine) Station should be installed on Yerba Buena Island under the US Army Coast Artillery Corps command. With the location of the island providing a commanding view of the entrance to the San Francisco Bay and protection from the ocean fogs, it was determined that the island would be perfect for the Torpedo Station as well as a gun emplacement which would deal with any undesirable ship that made it past the guns at Fort Mason. (Ref. B.)

The Torpedo Station, built in 1891 on the northeastern point of the island, included: a Torpedo (Mine) Assembly building, a Storehouse, a Wharf, and Officer's Quarters. Today, the Officer's Quarters, Storehouse, and Wharf are gone, but the Torpedo (Mine) Assembly building still stands under the eastern approach of the Bay Bridge. The Navy proposed razing the assembly building for the Bay Bridge construction in the mid-1930's, but the Army which owned the building, refused to destroy it without a replacement. Consequently, the Torpedo (Mine) Assembly building, today known as Building 262, remains intact. Included in the Congressional appropriation to build the Torpedo Station was the idea of building a war college on Yerba Buena Island; however, there is no evidence that the college was ever built. (Ref. W). During 1892, Yerba Buena Island and the Torpedo Station were turned over to the Army Corps of Engineers. The Corps retained jurisdiction until the Navy arrived on the island in 1898. The Army and the Navy were joint tenants on the island until the Army departed in 1960.

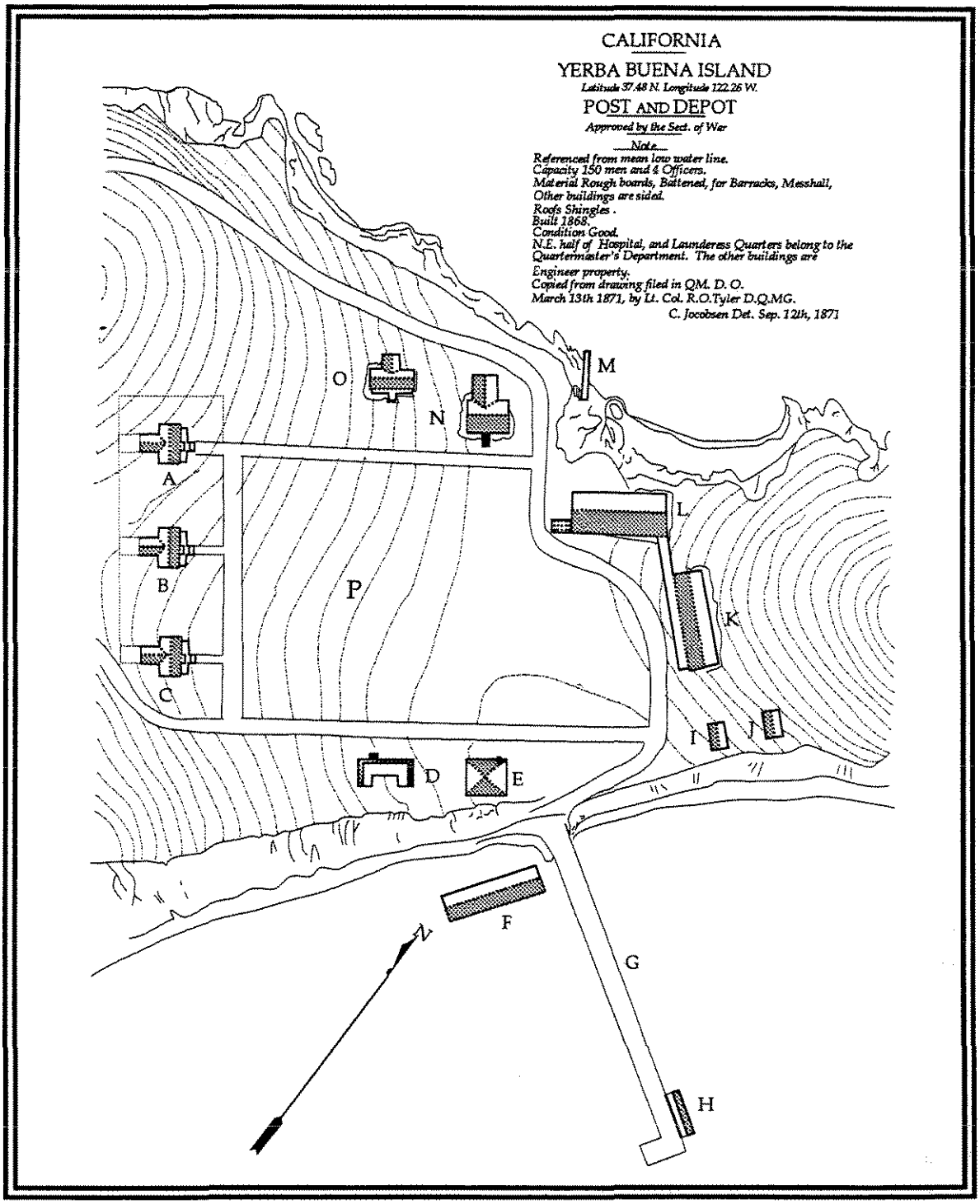


Figure 7. ***Cartograph of the Army Post and Depot, Yerba Buena Island. 1871.***

Note: This cartograph of Yerba Buena Island, a portion of the original 1871 blueprint, has been prepared via computer aided drawing. Letter definitions are: A - Commanding Officer's Quarters, B and C - Officer's Quarters, D - Hospital (originally Dowling's House), E - Guard House, F - Engineer Store House, G - Wharf (located in the east cove relative to the same location as the "Long Wharf" (Pier 2)), H - Boat House, I - Bakery, J - Sutler (Store), K - South Barracks, L - North Barracks, M - Sinks, N - Mess Hall, O - Laundress Quarters, P - Parade Grounds.

In 1872, while the artillery detachment was still on the island, the Secretary of War issued a permit authorizing the Department of the Treasury to install a lighthouse on Yerba Buena Island. A lighthouse, a lighthouse keeper's residence, and appropriate support buildings were built on the south point of the island in 1875. The lighthouse, relatively small in size but twenty feet tall in stature, was erected at a point sixty feet above the shoreline, giving it an overall rise of eighty feet above the water. Brought to the island from Yaquina Bay in Oregon, it was accompanied by a steam powered fog whistle and a chain-driven fog bell from Point Conception. Visible for twelve miles, it is a light of the fifth order and the weakest lighthouse in use by the US government. Since there was no school on the island, the three daughters of the lighthouse keeper attended school in San Francisco. Daily, they made the trip across the San Francisco Bay in their sloop, as shown in Figure 8. Presently, the lighthouse and the lighthouse keepers residence remain in place and are still in use. Transportation to and from the island has greatly improved over the years. The residence is currently occupied by a Vice Admiral, US Coast Guard.

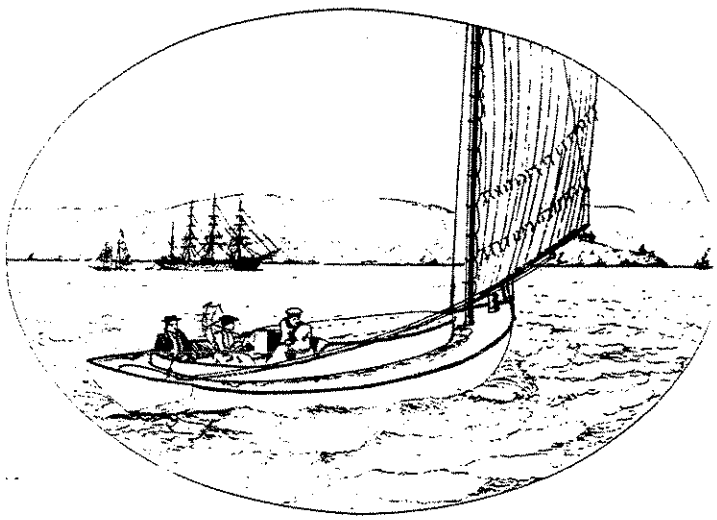


FIGURE 8. ***Evening Rush Hour, Circa 1880.***
(Pen sketch by W. A. Coulter)

Simultaneous to the installation of the lighthouse in 1875, a wharf and warehouses were built around the island point to the northeast. This soon became the Lighthouse Supply and Buoy Depot for the West Coast. See Figure 9. The entire facility included one large storehouse, two small storehouses, a paint shop, a machine shop, a wharf, a dock, and two residences for the men who worked there. Supplies needed for all twenty-eight lighthouses within Lighthouse Department District 12 passed through the depot for storage, issue, and sometimes just accountability/checkoff. Buoys were brought to the island for refurbishment and storage on the wharf until they were needed.

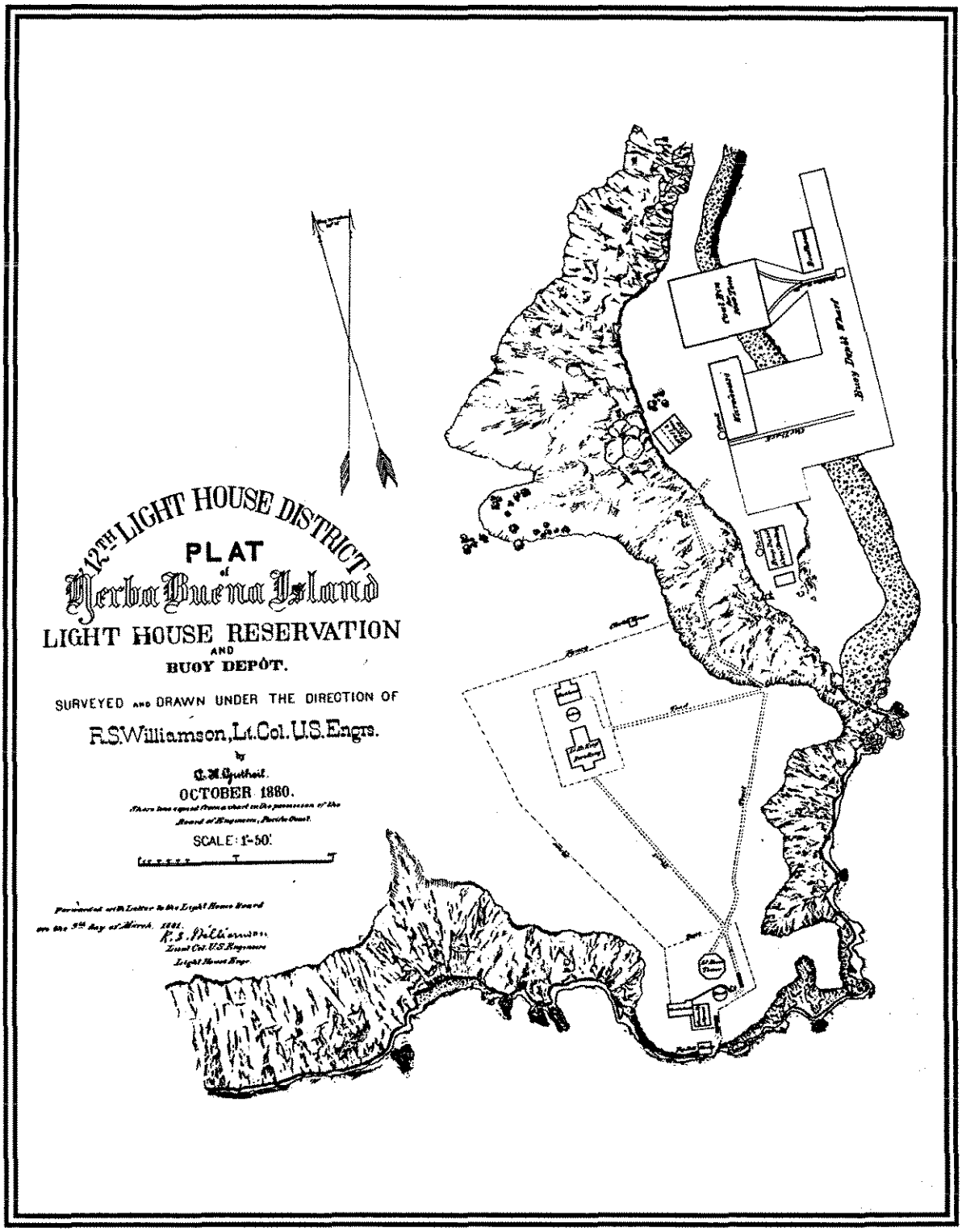


Figure 9. ***Yerba Buena Island Lighthouse Reservation and Bouy Depot. October 1880.***

Note: The Lighthouse Reservation is located on the southeast point of Yerba Buena Island (identified by broken line permiter in lower right corner of the map). The Bouy Depot is located on the east side of the island (identified by structures in upper right corner of the map), just south of the east cove (not shown).

An interesting side note to this period in Yerba Buena Island's history was the attempt by Leland Stanford and the Central Pacific Railroad to make Yerba Buena Island the western terminus of the railroad. They planned to obtain posession of the island from the US government, level the land, fill in the shoals, and build a causeway over the Bay waters to the Contra Costa. The City of San Francisco bitterly opposed the plan. They were concerned that this plan was an intentional ploy to insure San Francisco would lose out on transcontinental rail trade. From comments made at the time by Leland Stanford, they were absolutely right. The fight was carried on in the state capital, where the railroads won; and in Washington, DC, where the City of San Francisco finally prevented the transfer of Yerba Buena to the railroads (Ref. JJ). The victory soon became a hollow one for the City, because the Central Pacific Railroad constructed their western terminus in Oakland, still ignoring San Francisco. This event was significant because it marked the first serious discussion relative to the building of a bridge across the San Francisco Bay and the filling in of the Yerba Buena shoals. Marine engineers debated the effects that different types of bridge supports would have on the bay waters, especially silting. These debates and the resulting research was later used to help determine the manner in which the San Francisco - Oakland Bay Bridge was constructed. One of the first proposals to build an artificial island to the northeast of Yerba Buena Island had been put forth about eight years earlier. In the 1861 Directory of San Francisco, a description of this artificial island suggested the possibility of filling in the Yerba Buena shoals with earth from Yerba Buena Island. (Ref. C). This later became the location of the Treasure Island of today.

After 1879, when the Army Artillery detachment moved back to the Presidio, the island had been denuded of its trees and had become, in the words of the *San Francisco Call* of August 11, 1889 "...an offense and an eyesore to those fated to journey daily from San Francisco to Oakland...". This resulted in at least two proposals to: (1) replant the island with trees, and (2) make it into a resort. One interested party even went so far as to propose the idea of a special ferry service which could be operated from the Market Street wharf in San Francisco with a round trip fare of 10 cents.

The resort proposals never came to fruition, but Joaquin Miller, the early Californian poet, mounted a campaign to plant trees at three different locations, Yerba Buena Island, the Presidio, and Fort Mason (Black Point); however, the primary focus was Yerba Buena Island. At the island, the planting was laid out in a Greek cross with the center at the high point of the island to, as one newspaper put it "...remember...the fact that we all have some cross to bear...". (Ref. V, Arbor Day). The interest in replanting and beautification of the area resulted in California's first Arbor Day, March 5, 1887. Several dignitaries were on hand to participate in the ceremonies including Joaquin Miller, ex-Governor Perkins, General Howard, Adolph Sutro, and General Vallejo who was to give the main address. The elderly General Vallejo was unable to climb the hill in time to present his speech, so another man read General Vallejo's remarks. However, the General did reach the hilltop in time to plant a tree. Although the trees planted by these dignitaries did not survive because of exposure to weather atop the island's ridge and eventually a fire, some of the trees planted at the lower elevations are believed to be among those beautifying the island today. Additional plantings during 1900, 1902, 1908, 1917, 1939, 1944, and 1945 have contributed to the luxuriant vegetation and beauty the island now bears.

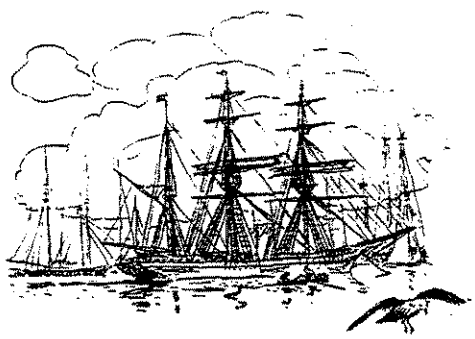
The first wedding to take place on Yerba Buena Island occurred in 1892. The special occasion was reported in the August 22, 1892 edition of the *San Francisco Call*:

> "Yesterday the first wedding in Goat Island's history united Mr. Charles McCarthy, lighthouse-keeper at the Oakland mole, and Mrs. Jennie Lewis of this city.
>
> The interesting event took place in the residence of Captain Linne, the station-keeper at Goat Island, a friend of the parties, at 2:30 o'clock, the ceremony being performed by the Rev. J. Fuendeling. . . "

In 1896, the Navy once again cast an admiring eye at Yerba Buena Island for the possibility of establishing the West Coast Training Center there. The introduction of the 1902 Yerba Buena Naval Training Station was described as follows:

> "The island's practical isolation and at the same time close proximity to San Francisco rendered it an ideal spot . . . Climatic conditions were decidedly in favor of the San Francisco station, for there is no long, dreary winter during which the lads at the station must be housed within doors. On the other hand, out of the whole 365 days of the year there is not one in which some out-door work cannot be done. During the summer months there is the same distinction, the thermometer at this season never running above 70, with cool, refreshing nights, which condition these lads to their best endeavor, and tends to a rapid physical and mental development . . ."

The State of California, willing to transfer the Island to federal control, passed an Act of the Legislature on March 9, 1897 granting the military possession of Yerba Buena Island which included the surrounding waters within 300 yards of shore. At the federal level, the Navy had a champion in Senator Perkins. As the war clouds thickened for the Spanish-American War, President McKinley signed an executive order on April 12, 1898 which set aside the majority of Yerba Buena Island for the Navy's sole use. A follow-up order was signed on January 26, 1899. Although the Army continued to occupy and operate the Torpedo Station, the Navy occupied the remainder of the island, except for the Lighthouse Reservation. Thusly, the Modern Era of Yerba Buena Island began.



1.3 Modern History of Yerba Buena Island

1.3.1 Naval Training Station of the Pacific, 1898–1923

Initial planning of the Naval Training Station was conducted in 1898 by civil engineer F. C. Prindle and Captain F. W. Dickens. Together, they selected the building sites, drew plans, and prospected for a water supply. In March 1899, Captain Henry Glass (later Rear Admiral) of Dewey's Asiatic Fleet, took command of the Naval Training Station. He sailed his ship, the USS *Pensacola* (a veteran ship of the Civil War that once carried President Lincoln and his cabinet), from the Mare Island Navy Yard and anchored it in the south cove of Yerba Buena Island. There he established the Training Station which operated off his ship until buildings could be constructed on the island.

FIGURE 10. ***Rear Admiral Henry Glass. 1902.***

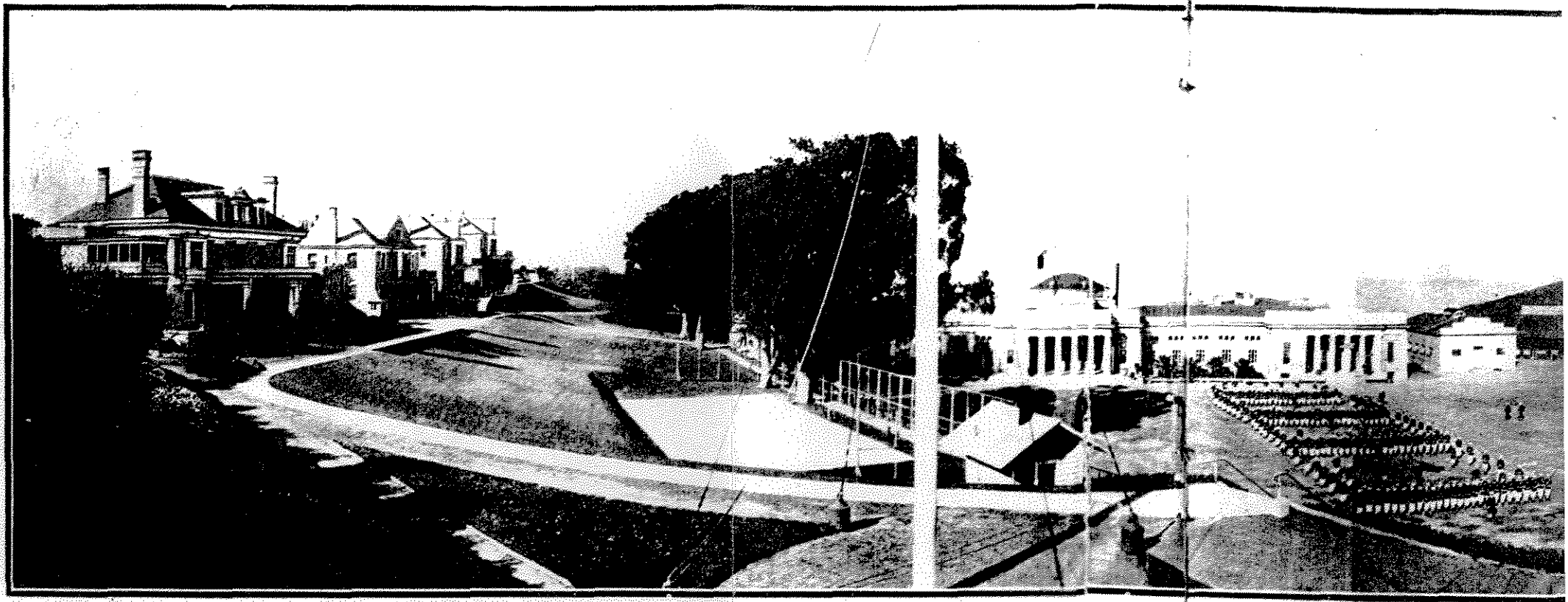
The Barracks was the first building constructed for the Training Station. Built by Campbell and Pettus of San Francisco for $74,000, its construction was completed on January 10, 1900. The facility would provide living quarters for 500 men, as well as having the largest drill hall on the Pacific coast with a clear floor of 300 feet by 60 feet, and an overall size of the building of 300 feet by 260 feet. The drill hall was surrounded by a second floor gallery where apprentices hung

their hammocks. A west wing housed the offices, library, schoolroom, dispensary and brig; an east wing contained the mess hall, kitchen, pantry, storehouse, and petty officer's quarters. The grounds area in front of the Barracks had been excavated and leveled during construction and the extracted dirt used to build the drill and parade ground. The Commandant's house was the next structure to be built with its construction completed on January 23, 1900, followed by the building of two Officer's Quarters that were finished on March 23, 1900. See Figure 11.

Yerba Buena Island was one of four Naval Training Stations located in the United States. The other three were located at Newport, RI; North Chicago, IL; and Norfolk, VA. When a recruit enlisted in the Navy, he was provided with a Pullman train ticket, subsistence from the place of enlistment to a predetermined Naval Training Station, and written orders. Upon arrival at the Training Station, the recruit was subjected to a physical examination, issued clothing, and assigned to his isolation quarters. There he would reside for 3 weeks to ensure that he wasn't carrying a communicable disease into the Main Barracks.

Apprentices had to be between the ages of fifteen and seventeen years, healthy, have some rudiments of education, and were not allowed to use any vulgarity or profanity. They were furnished with a full outfit of clothing and assigned to a division as an "apprentice third class" (during the first six months addressed as a "landsman"). Their pay was $9.00 per month. They also received one food ration per day which was the equivalent of $9.30 per month for food. After completing the tour of service on a training ship at cruise, usually about 1 year after starting the apprenticeship, an "apprentice third class" could advance to "apprentice second class" and receive $15.00 per month in pay alone. The next rate increase occurred after serving one year on a cruising man-of-war, at which time the "apprentice second class" became an "apprentice first class" and a pay increase to $21.00 per month. The March 1991 issue of *Forbes* Magazine reported a monetary comparison as " ... $1.00 in the year 1909 is equal to $11.38 today (1991) ..." (Ref. EE.)

In 1900, the Training Station commanded 392 apprentices with only one death and one desertion reported. However, as the training evolved, these numbers increased, especially those relative to desertions. A July 9, 1901, newspaper article reads in part, "The apprentice boys on Goat Island and those on the training ship *Pensacola* have suddenly acquired a mania for deserting. Hardly a day passes but a youngster is yanked ashore from the tug *Vigilant*, while dozens of them have been caught trying to steal a launch or one of the ship's boats in order to reach Oakland or San Francisco." It goes on to detail a somewhat humorous revelation that, "Yesterday the whole sextet was satisfied that bread and water was better than paddling across to Oakland on a log on a cold night and in ice-cold water". (Ref. V) Sickness presented another problem at the Training Station. An outbreak of mild diphtheria resulted in the island being quarantined for a month. (Ref. V, October 6, 1900). However, overall the general health of those on the island was excellent and was even cited as a contributing factor to the success of theTraining Station.



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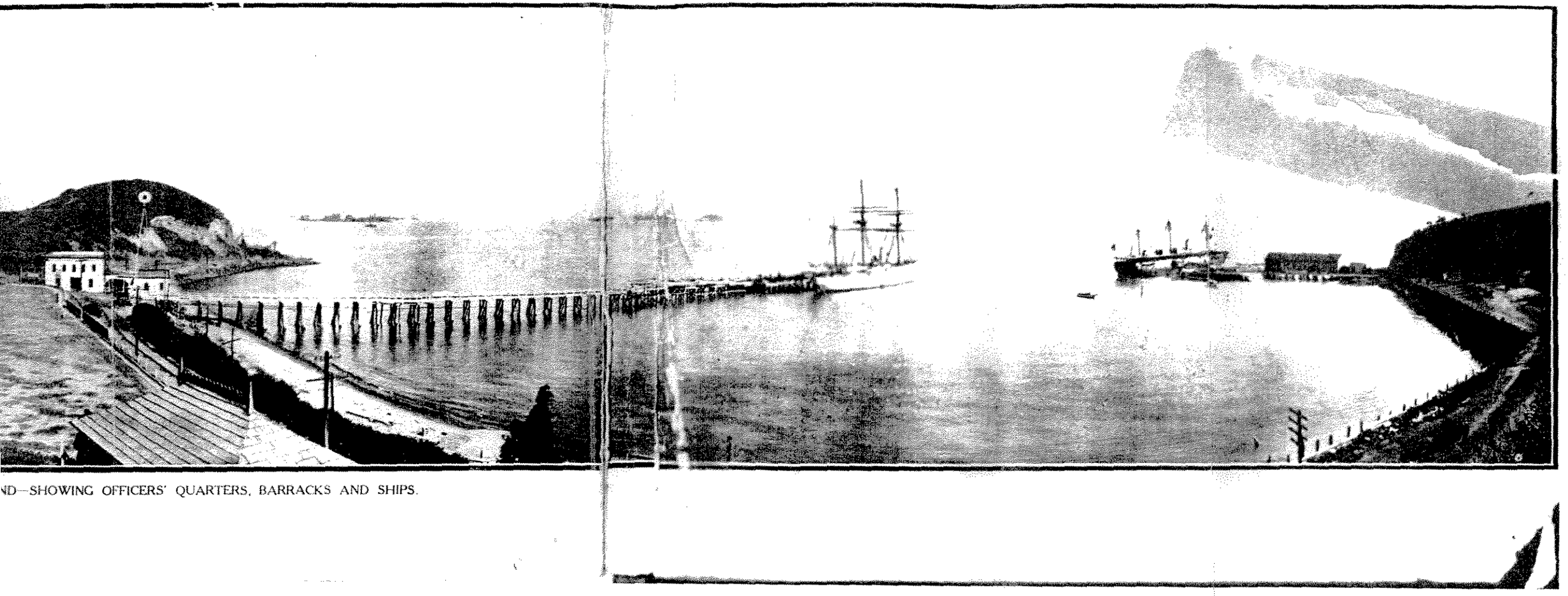


ND—SHOWING OFFICERS' QUARTERS, BARRACKS AND SHIPS.

Figure 11
Yerba Buena Island Officer's Quarters and Barracks. 1917

The normal daily schedule for apprentices was extremely regimented. The following depicts an average day:

- 6AM — Reveille
- 6:30AM — Wash
- 7AM — Inspection by Master-at-Arms, with shirts off to see they were clean
- 7:30AM — Breakfast
- Cleaning the ship
- 9:15AM — Quarters inspected (including: clean clothes, blackened shoes) by the officer of the day
- Two drill periods
- 12:00PM — Lunch
- 1:15PM — Two more drill periods
- 3:00PM — Those with dirty clothes were required to scrub their clothing and sea bags were inspected
- Every afternoon, every apprentice was required to go over the masthead
- 9PM — Taps

The course of study included six months at the on-shore training facility and a six month tour of duty on a training ship. The training resulted in a transfer to positions of seamen and petty officers in the fleet. The required courses and drills taught to the apprentices at the training facility were:

- Knotting and splicing
- Names of parts of ship, sails, spars and different ropes
- Exercise at setting, reefing and furling sails
- Instruction in four inch rapid fire guns, a number of smaller rapid-fire pieces
- Setting up exercises, facing and marching, (without arms and with arms)
- Signaling, wigwag with small flags, taught Army and Navy codes, general Navy signaling and International code
- Instruction in reading, writing, geography, American history, and arithmetic (taught by the Chaplain)
- Instruction in pulling and sailing (in boat crews of twelve)

The Naval Training Station usually had a full complement of landsmen and apprentices. It replaced its first training ship, the USTS *Adams* with the USTS *Alert*, then added a second training ship, the USTS *Intrepid*. Basically, until the outbreak of World War I, the island maintained its growth rate without much difficulty. Reports indicated that the 1906 San Francisco Earthquake spared the island from damage. San Francisco quake victims in need of emergency care were sent to the Hospital at Goat Island. Less seriously injured victims were sent to the Naval Hospital at Mare Island.

The start of World War I had two long range effects which (1) resulted in a major building project that vastly increased the capacity of the Naval Training Station, and (2) demonstrated the size limitations of Yerba Buena Island (approximately 150 acres, not all usable). Many buildings were erected during this time. See Figures 12 through 27. Tents of the landsmen covered the island in neat, orderly rows separated by wood walkways. The Lighthouse Service

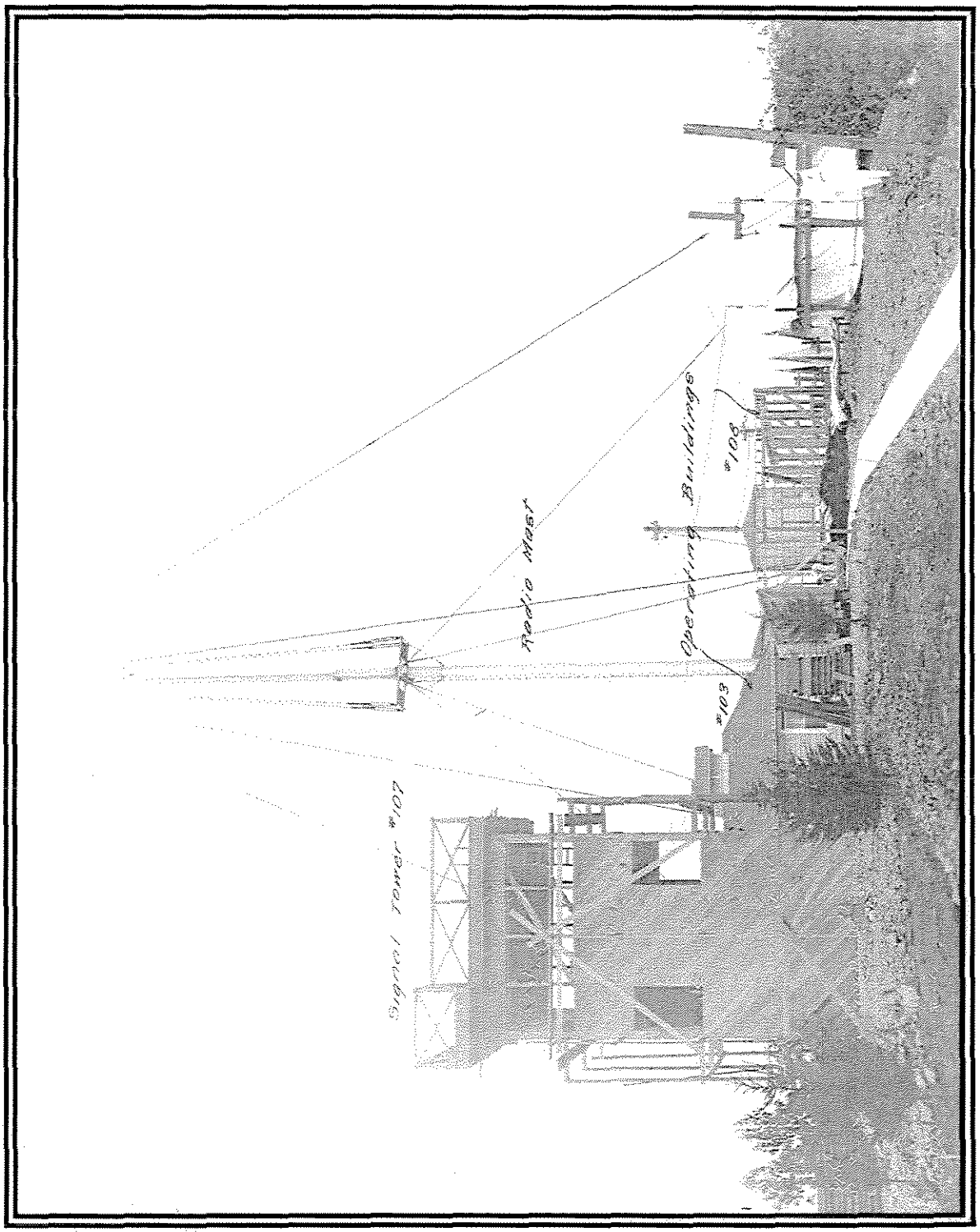


FIGURE 12. ***The Communication Complex (during construction atop the highest point on Yerba Buena Island). August 28, 1917.***

Note: Photograph shows Buildings 103, 107, and 108 (all built in 1917). The tents to the right are probably for the Navy Signalmen and Radiomen assigned to the complex.

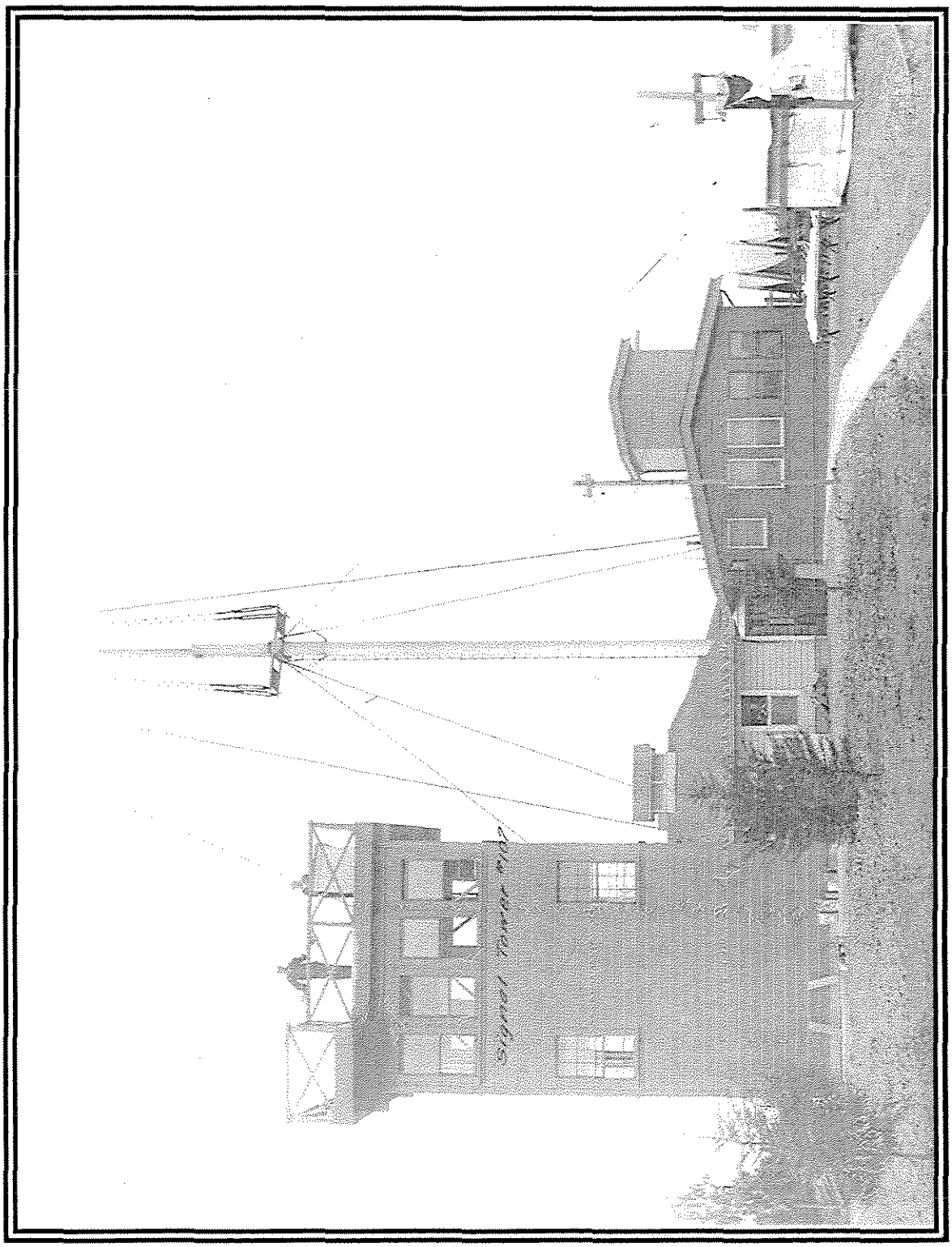


FIGURE 13. ***The Communication Complex (after construction). September 28, 1917.***
Note: Thirty days after FIGURE 12 was taken, the construction of Buildings 103 and 107 had been completed. Building 107 still stands today and is used as an Auxiliary Power House.

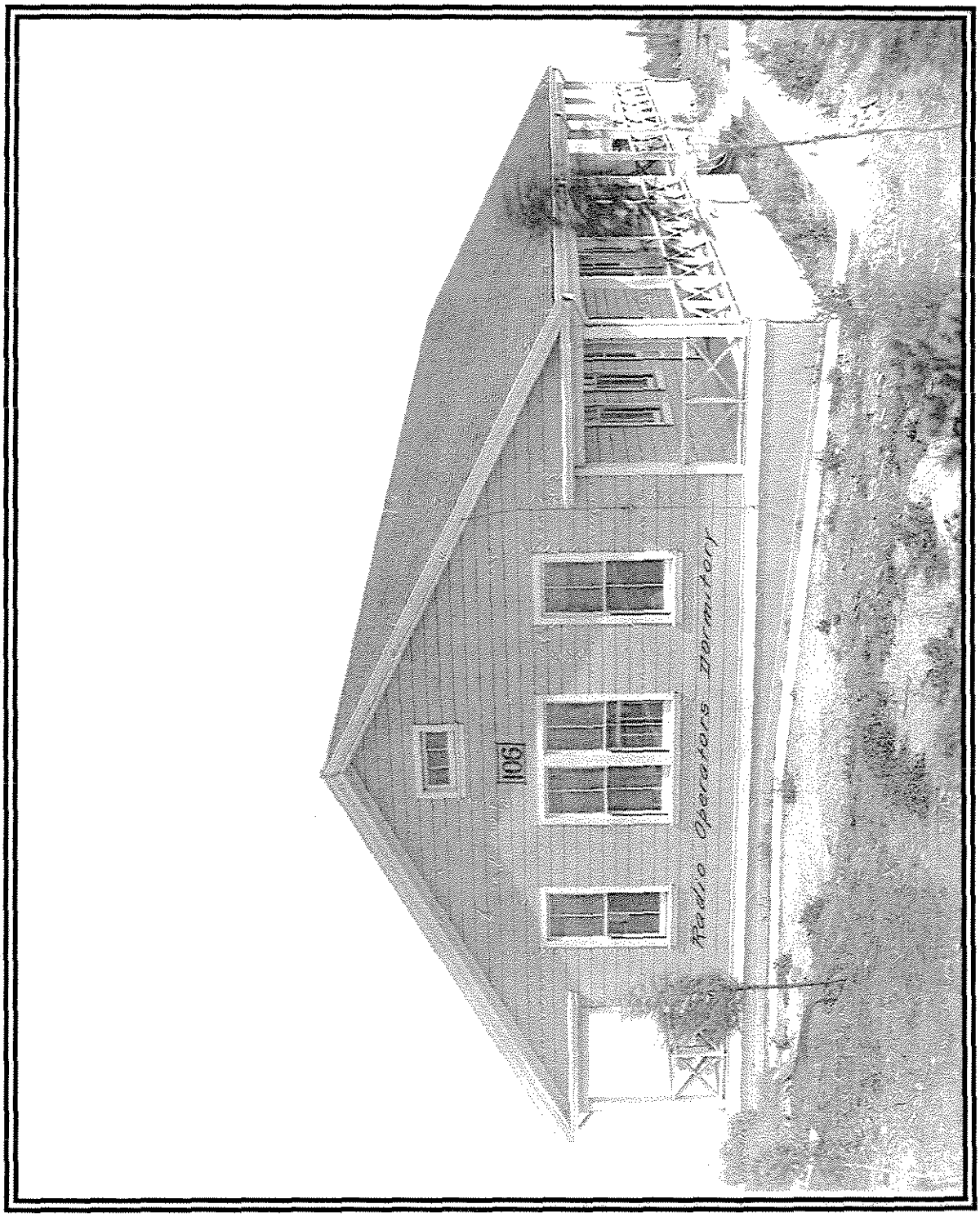


FIGURE 14. ***Radio Operators Dormitory. August 28, 1917.***

Note: Radio Operators Dormitory (Building 106, built 1917) is the first and original of two buildings numbered "106". Its location was west of Building 107. The Dormitory was demolished in 1934 for the construction of the SFO Bay Bridge. The second and current Building 106 is located well east of the original location and east of Building 111.

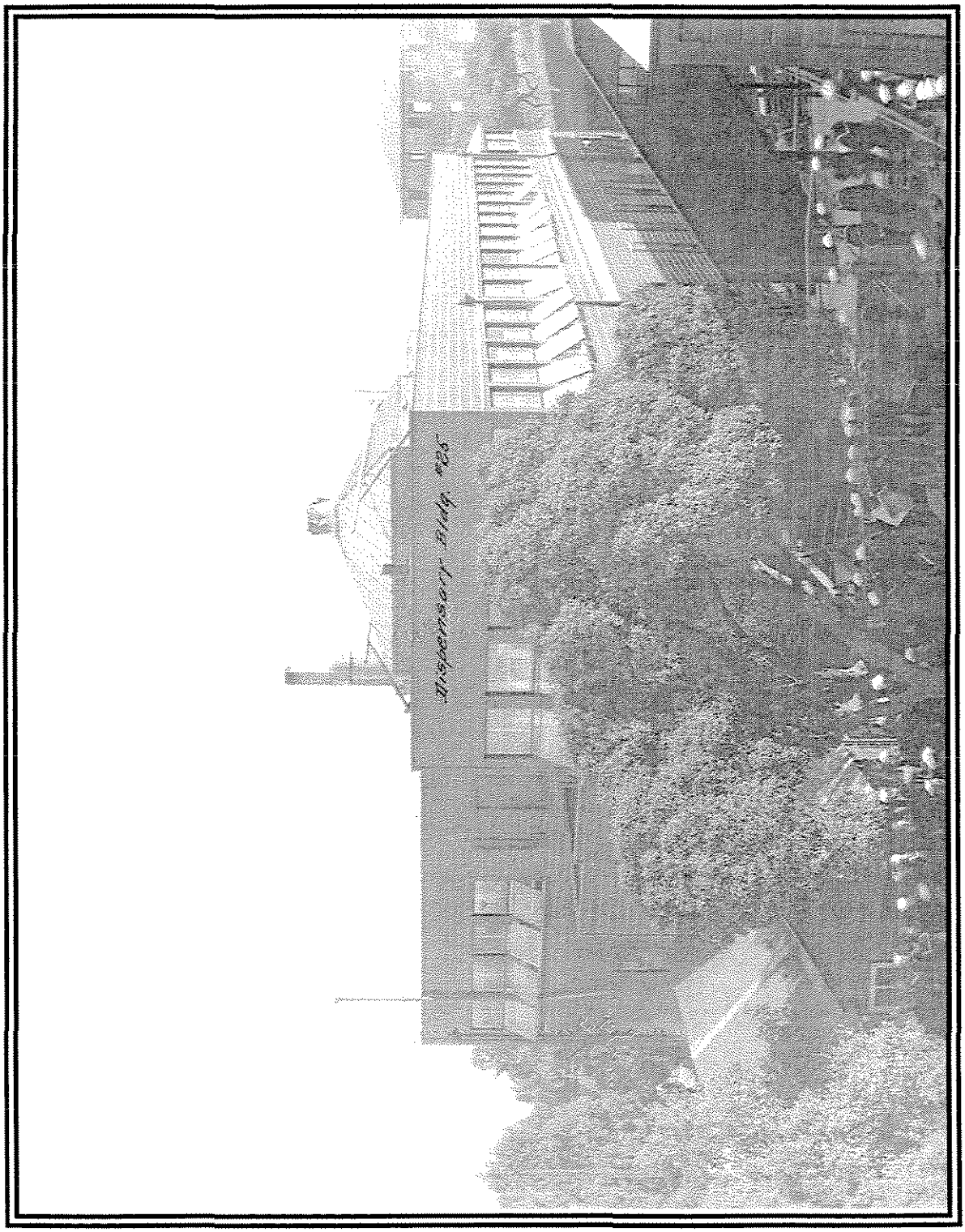


FIGURE 15. ***The Dispensary Building. November 28, 1917.***

Note: The Dispensary (Building 25) was built in 1908 and demolished in 1934. The sailors, at the bottom of the photo, appear to entering Building 24 (Yeomen School). Building 69 (Hospital Corp Quarter built 1917, demolished 1961) can be see in the background under construction.

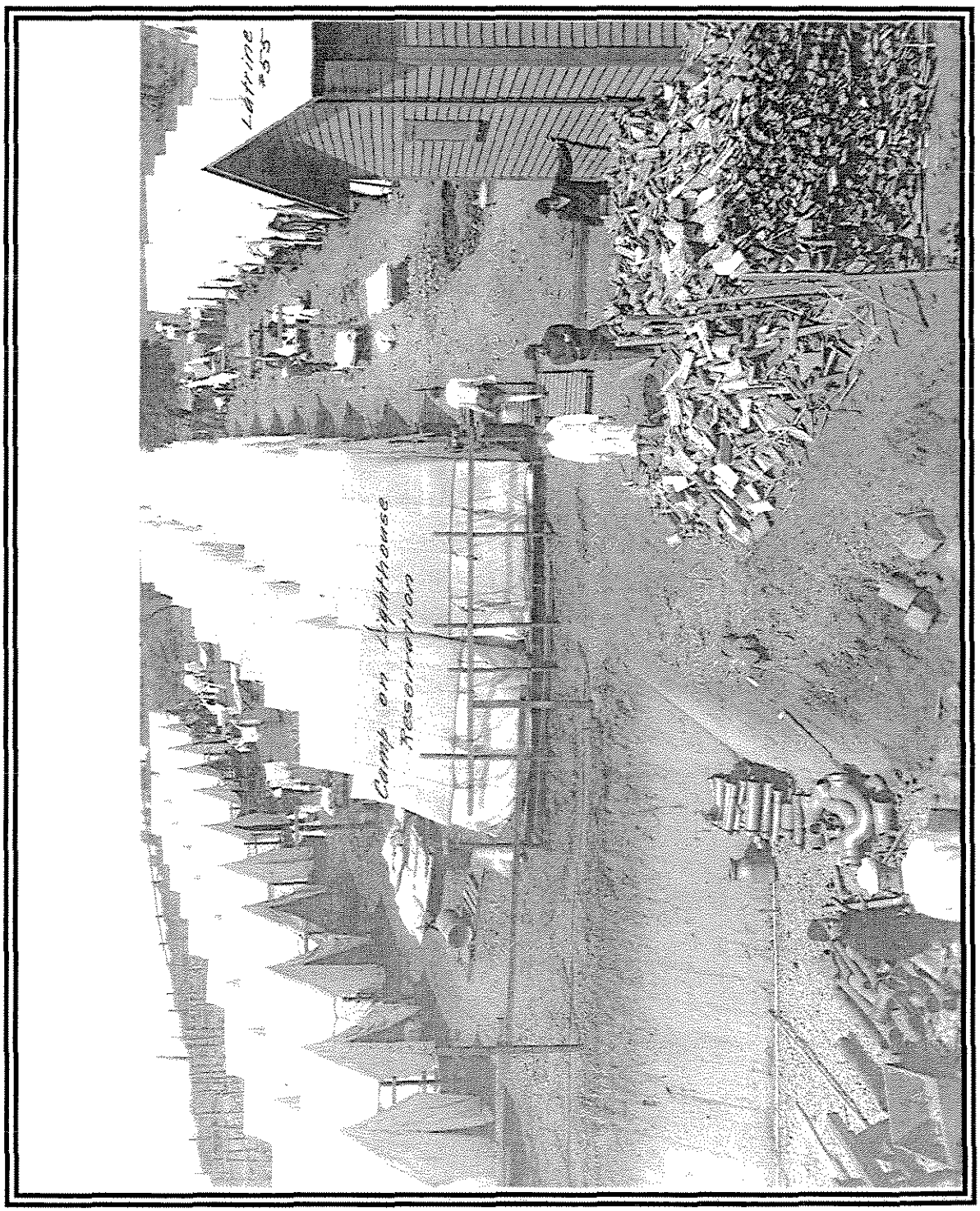


FIGURE 16. ***Lighthouse Reservation Camp. August 28, 1917.***

Note: In 1917, the Lighthouse Reservation Camp was established on the Lighthouse Reservation by carving into the hillside. By 1919, the camp was known as Camp Paul Jones. It was the second largest tent camp containing 806 tents. Each canvas tent sported a wooden floor and, if the occupants were lucky, a wooden sidewalk. The purpose of the excavation in the lower left corner of the photograph is unknown but may have been part of a barrow pit.

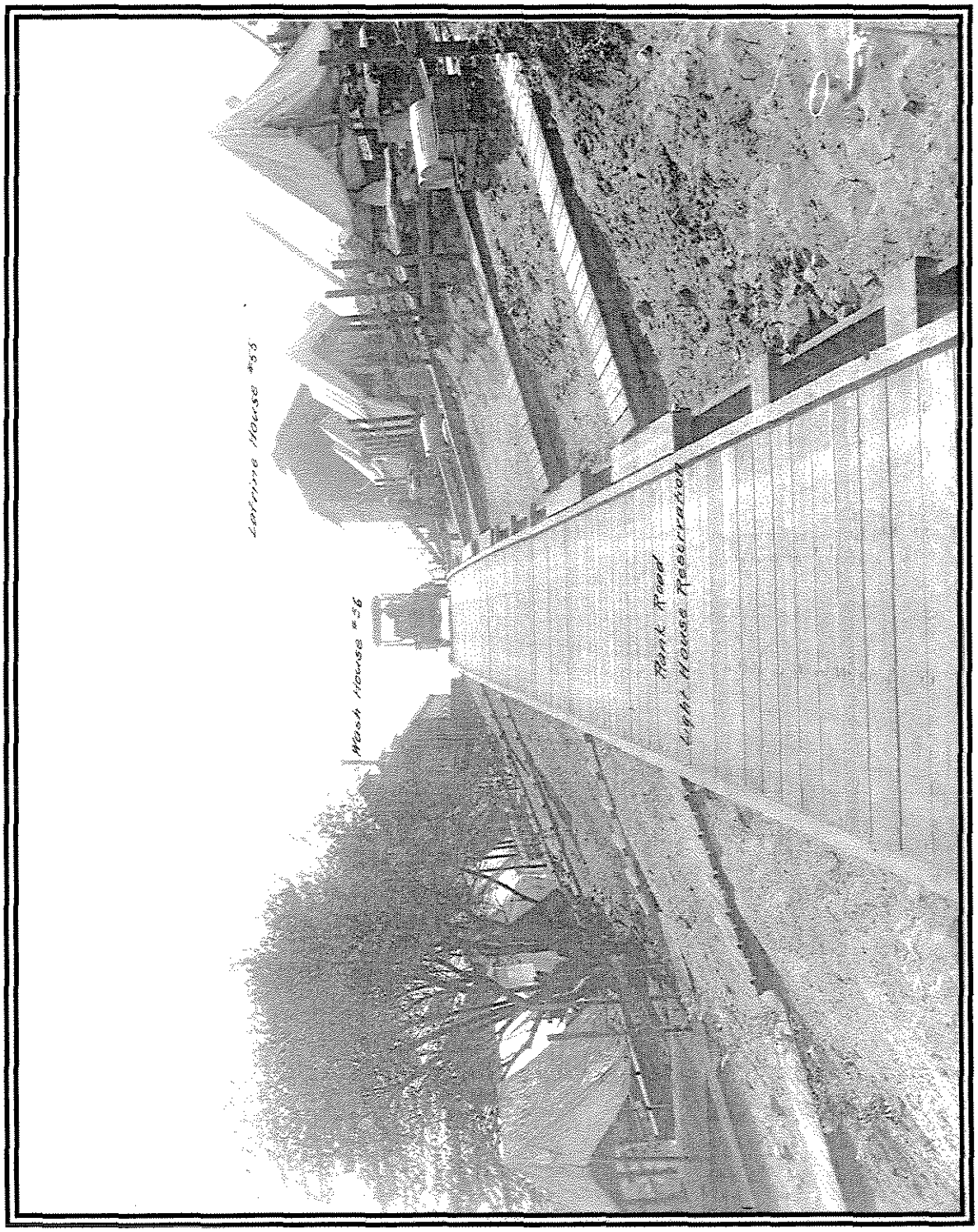


FIGURE 17. ***Plank Road in the Lighthouse Reservation. August 28, 1917.***
Note: The plank road shown in this photograph is believed to be the only plank road on Yerba Buena Island. Starting at Buildings 55 and 56 and terminating at the road near Building 8. It is possible that the construction of the plank roadway was the simplest method at that time to transverse the steep hillside.

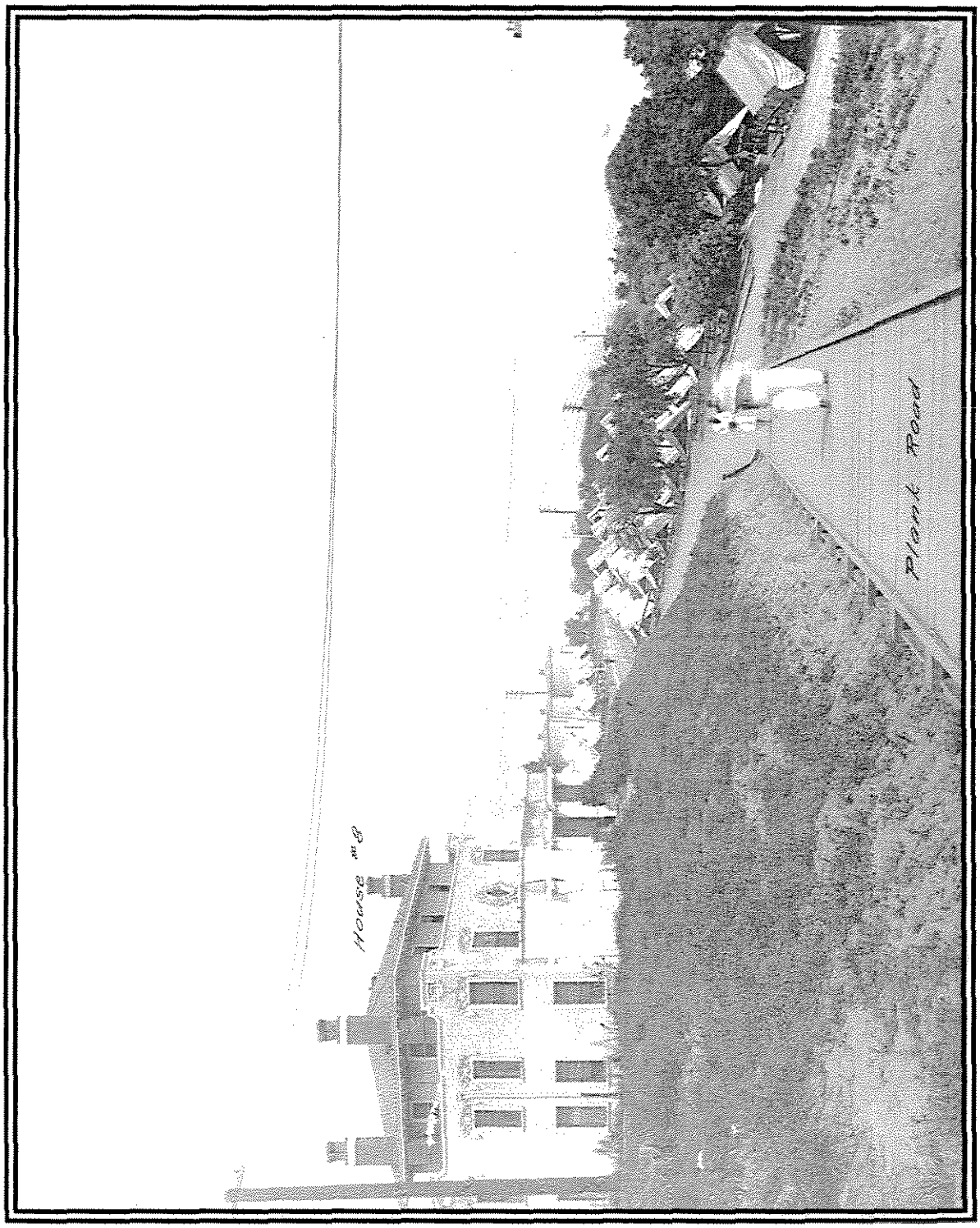


FIGURE 18. ***Officer's Quarters and Detention Camp. August 28, 1917.***

Note: The Officer's Quarters (Building 8, built in 1905), still stands today and can be seen when exiting from the westbound direction of the SFO Bay Bridge. The actual purpose of the Detention Camp is unknown, but it did contain 384 tents. The plank road begins at Building 8 and proceeds uphill to the Lighthouse Reservation (Camp Paul Jones) where it ends.

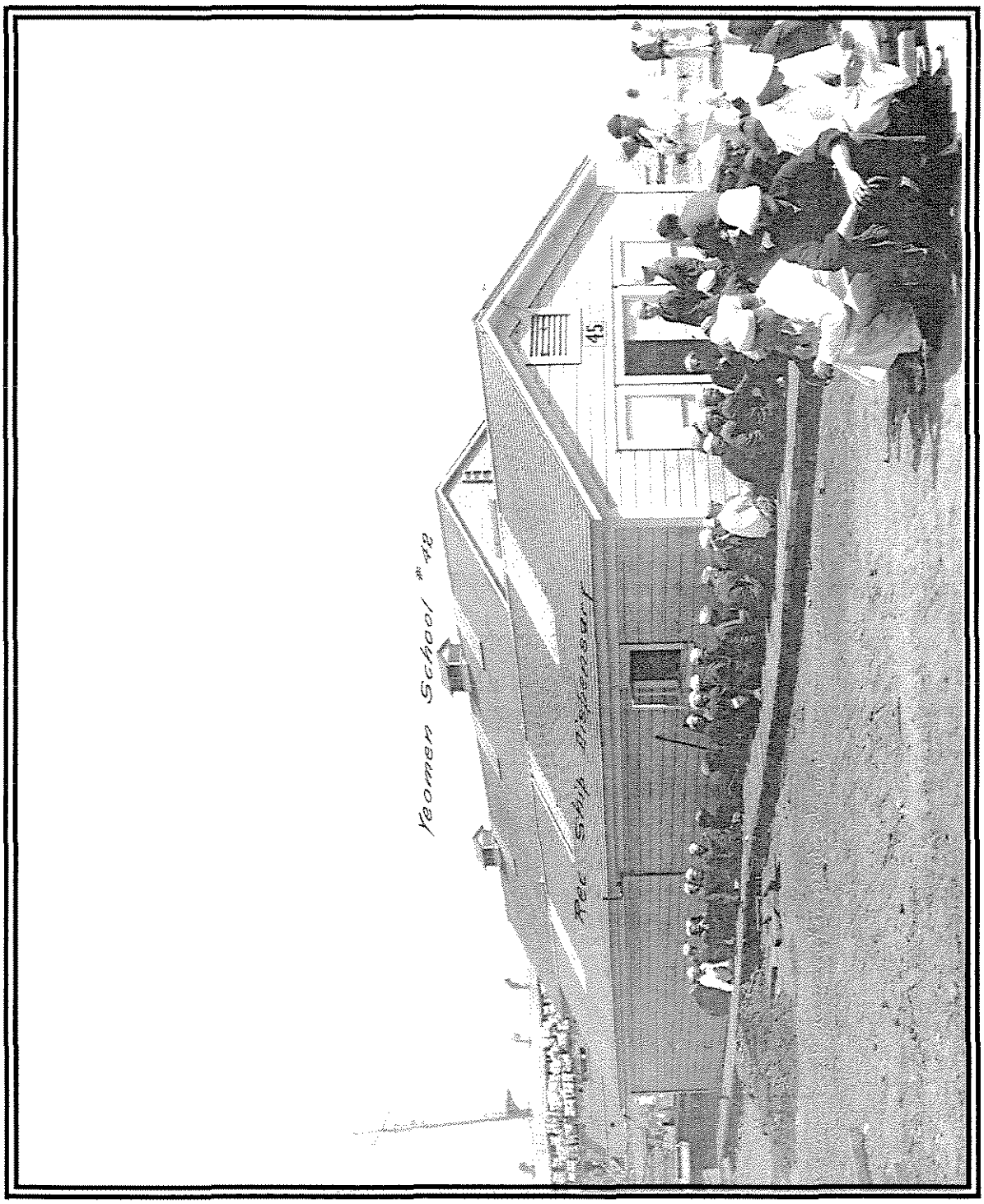


FIGURE 19. ***Receiving Ship Dispensary and Yeomen School. August 28, 1917.***

Note: In the foreground, the Receiving Ship Dispensary (Building 45, 1918 - 1961) provided "sick call" services, as well as processing sailors awaiting orders for deployment. Because of the large numbers of sailors, lines were sometimes long as shown in the photograph. The Yeomen School (Buildings 42, 1903 - 1938) is located to the back side of the Dispensary. The Receiving Ship can be partially seen in the photo at far left, behind Buildings 42 and 45.

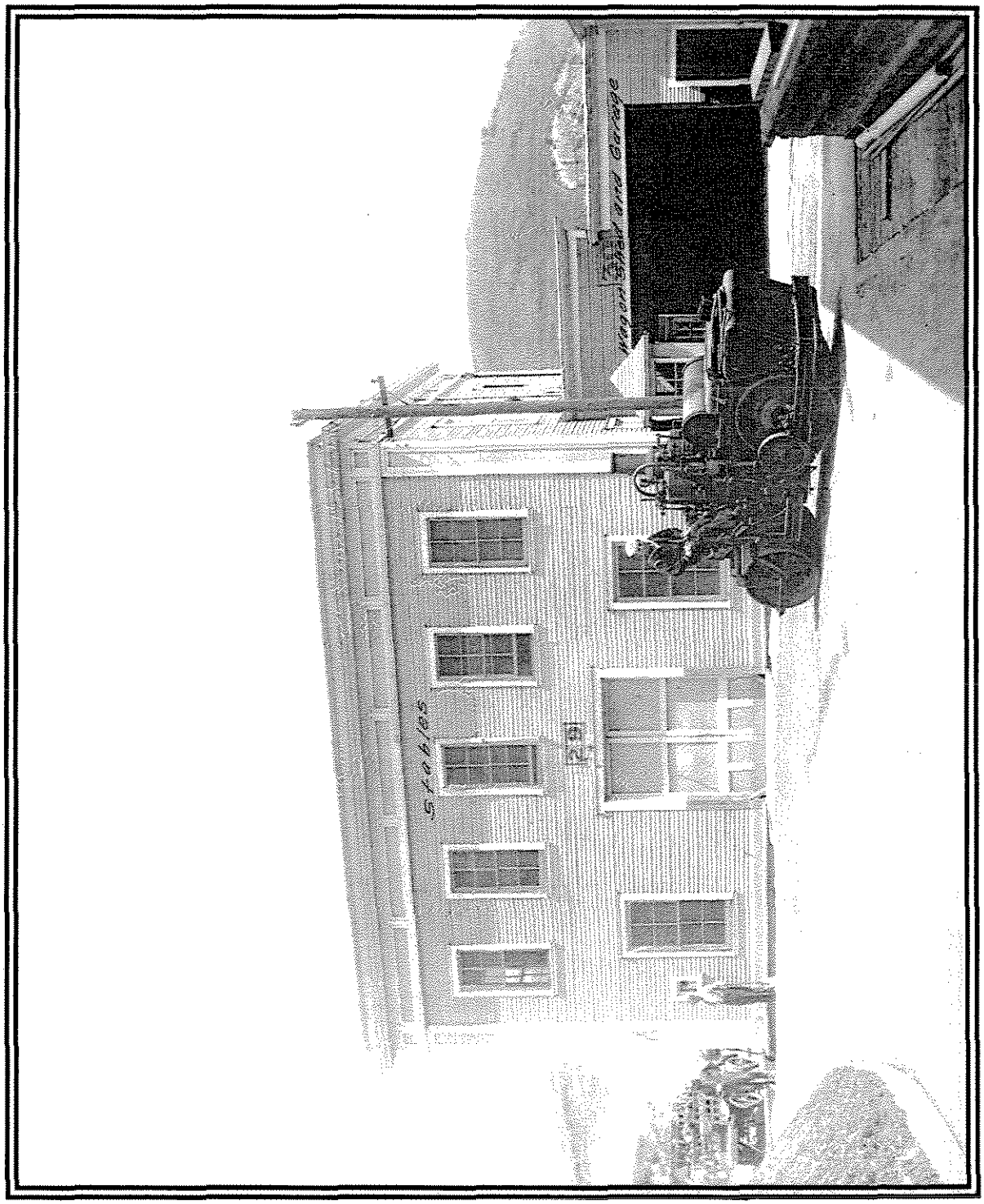


FIGURE 20. ***Stable/Garage/Signal School and Wagon Shed/Garage. August 28, 1917.***
Note: Stable/Garage/Signal School (Building 29, 1917 - 1934) and Wagon Shed/Garage (Building 30, 1917 - 1934) are located at the head of the Long Wharf directly to the right of Building 30. In 1934 Buildings 29, 30, 31 and 38 were combined into a single building, redesignated the "Firehouse", and renumbered Building 204. Building 204 stands today and continues to be used as a Fire Station.

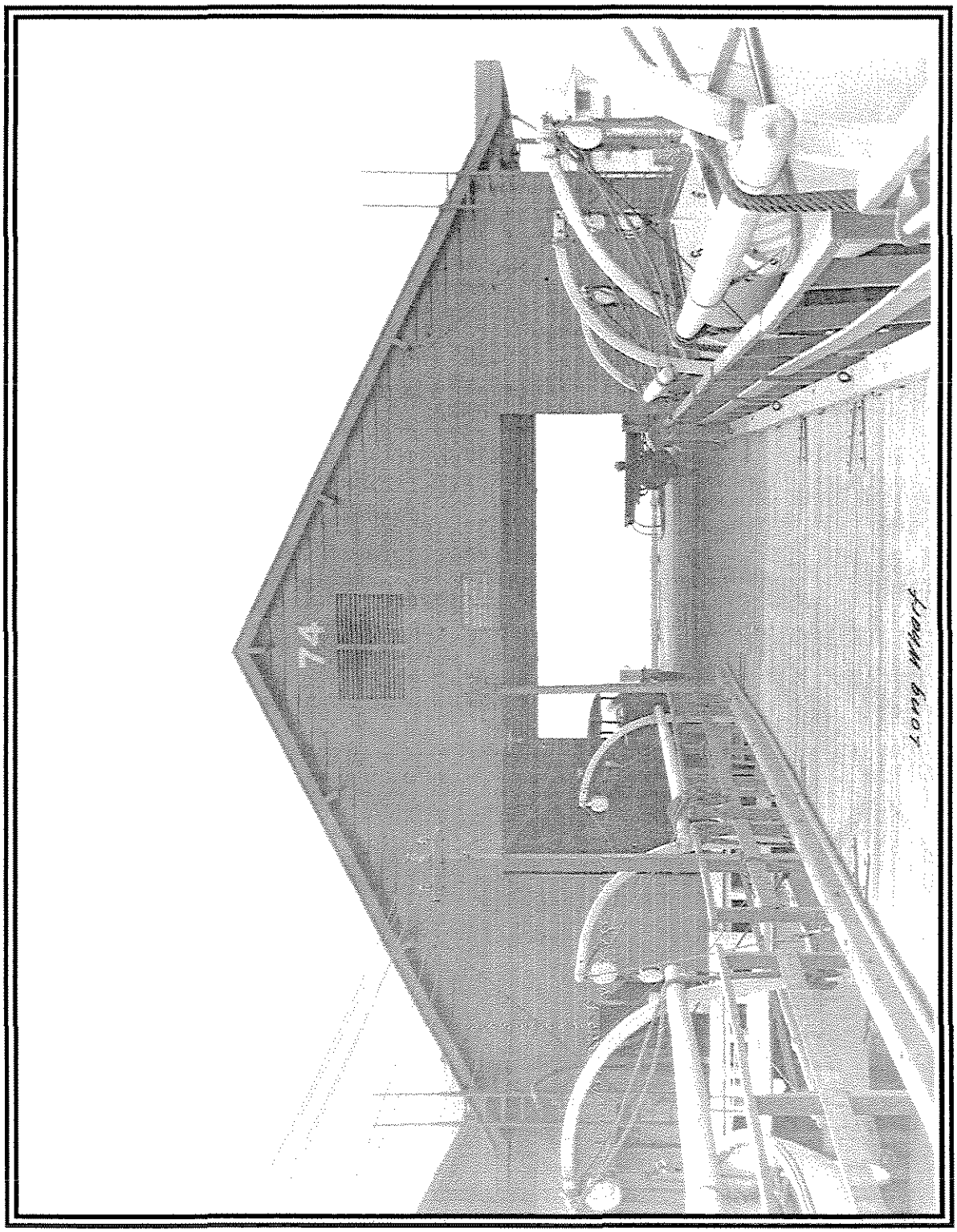


FIGURE 21. ***Long Wharf and Wharf House. April 13, 1918.***

Note: Wharf House (Building 74, 1918 - 1961) was built on the end of the Long Wharf (later known as Pier 2). The Long Wharf was demolished in 1961. Notice the whale boats in the davits on either side of the wharf. These boats were probably used for recruit training, as well as rescue.

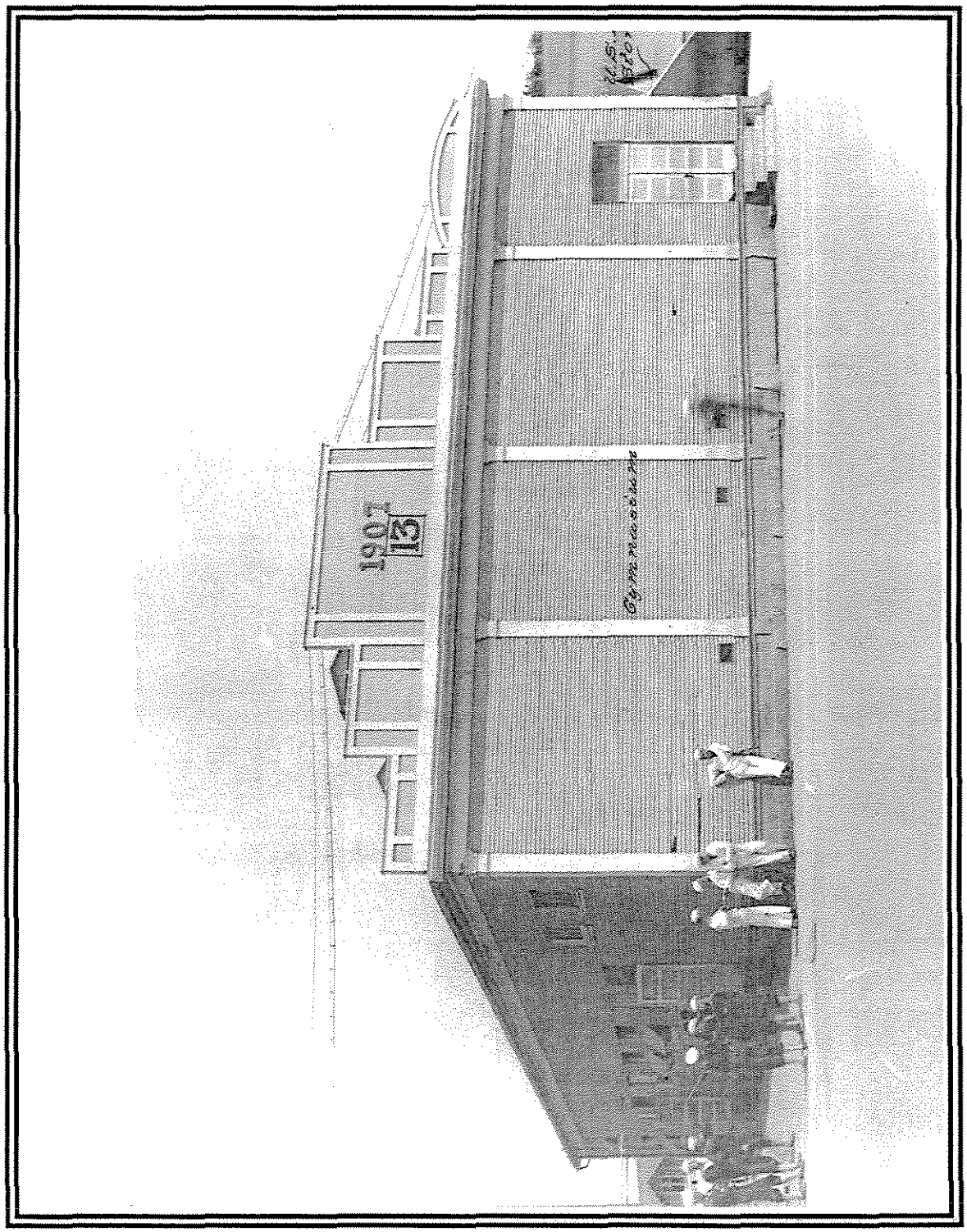


FIGURE 22. ***Gymnasium. August 28, 1917.***

Note:, Gymnasium (Building 13, built in 1907) still stands today. A second floor was added in the spring of 1918 and received extensive renovation in 1940. In 1940 it was renumbered Building 213 and continued to be used a recreational purposes until 1976 when it was converted to Firehouse No.3. By 1994 the building fell into disuse and remains empty today.

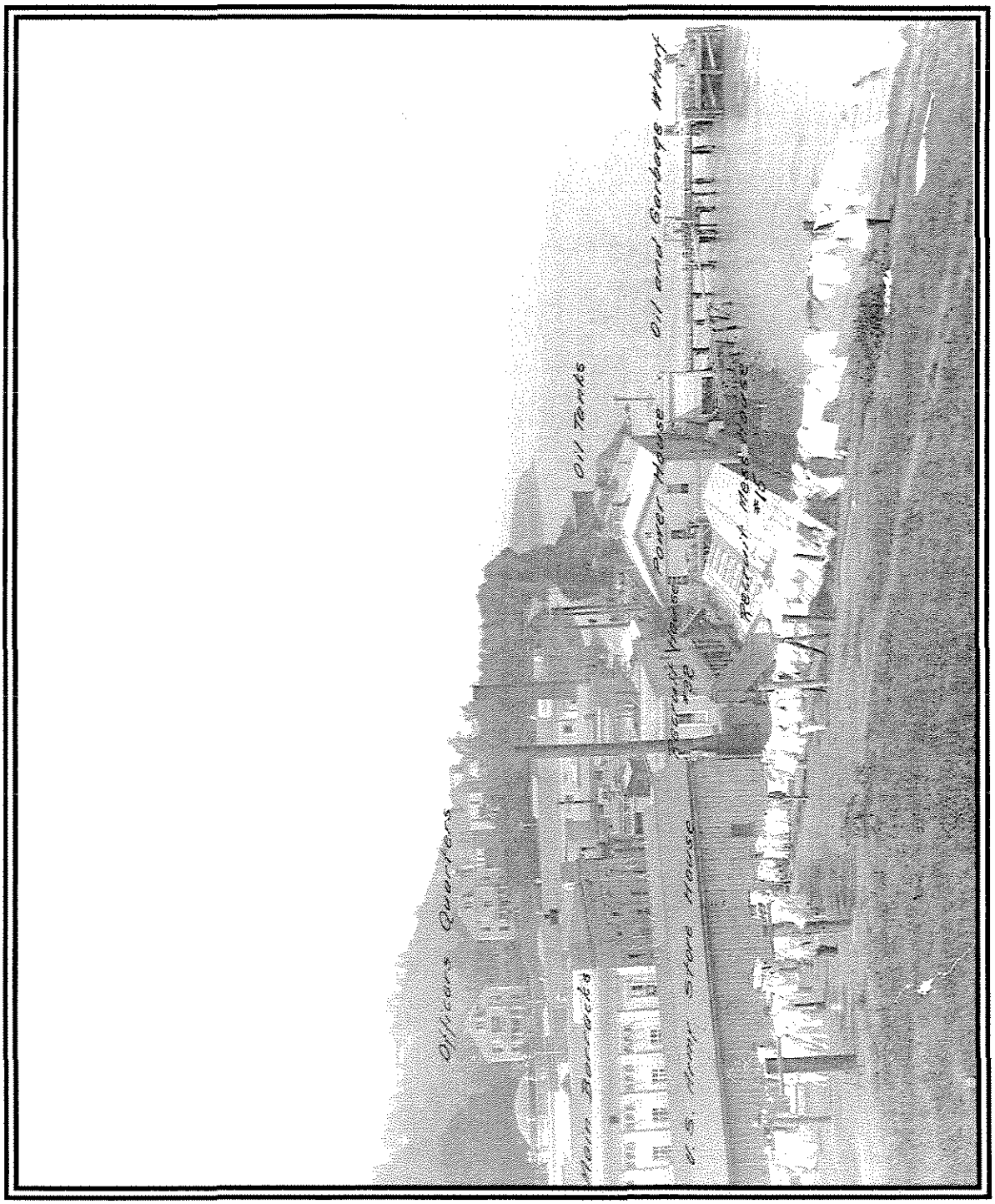


FIGURE 23. ***Main Barracks and Waterfront Area. August 28, 1917.***

Note: This photograph shows the development the western waterfront as a tightly packed community of buildings in and round the Main Barracks (Building 11, 1900 - 1960). The Main Barracks can be identified by it's "U-shaped" structure and domed roof. The east wing, center section, and domed roof can easily be seen in this photograph. The Power House (Building 14, 1907 - 1937) provided steam to the Main Barracks. The Army Store House was taken over by the Navy in 1953 and subsequently numbered Building 266 (1891 - 1961).

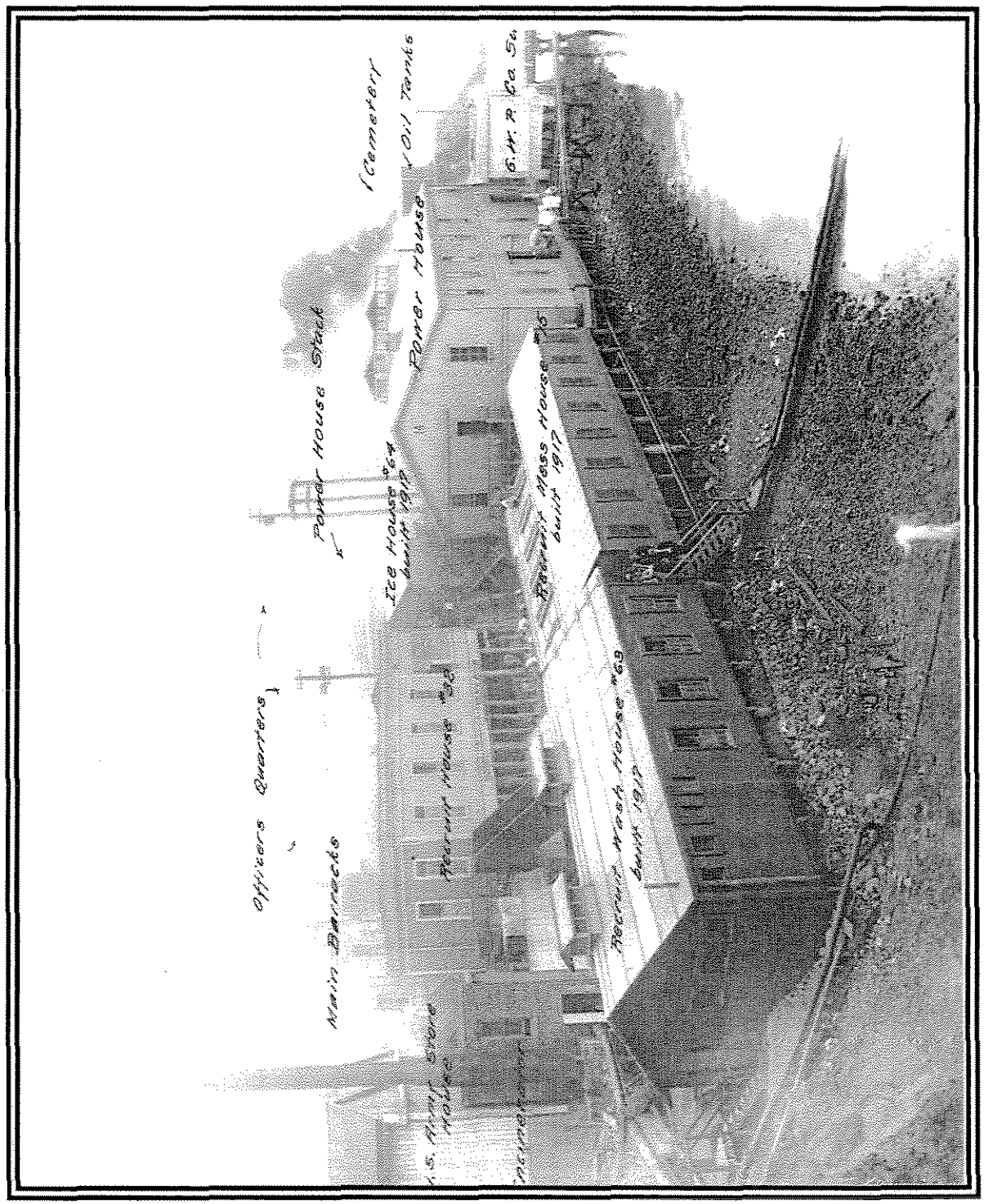


FIGURE 24. ***Main Barracks and Waterfront Buildings. August 28, 1917.***

Note: This photograph shows another view of the western waterfront development. A group of buildings located behind fog shrouded Main Barracks (Building 11) included the Recruit House (Buildings 32, 1917 - 1943), the Ice House (Building 64, 1917 - 1938), the Recruit Wash House (Building 63, 1917 - 1935), and Recruit Mess House (Building 15, 1917 - 1935), of which the latter two were built on the water's edge.

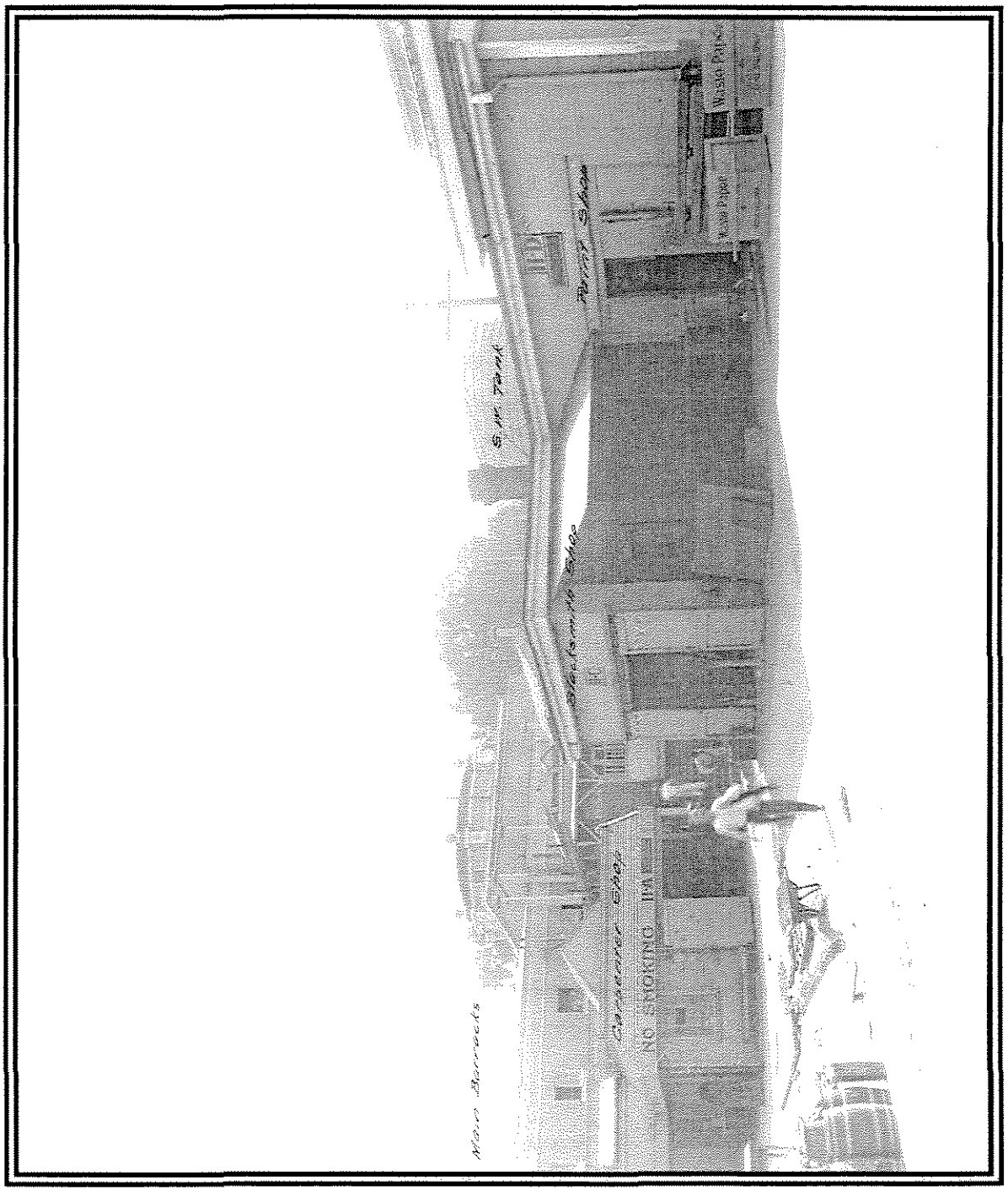


FIGURE 25. ***Main Barracks and Auxiliary Buildings. August 28, 1917.***

Note: When the Main Barracks (Building 11) was constructed in 1900, four auxiliary buildings (11A, 11B, 11C, and 11D) were also built. Building 11A was used as a Carpenter Shop and a Storehouse. Building 11B, not shown in this photograph but located to the right of Building 11A and behind Buildings 11C and 11D,was the Cobbler Shop. Building 11C served as the Blacksmith Shop (for an undetemined period) and the Prison/Brig. Building 11D was the Paint Shop and the Blacksmith Shop. By 1929, Buildings 11C and 11D were combined in order to expand the Prison/Brig and became known as Building 11C. Buildings 11A, 11B, and 11C were demolished in 1959.

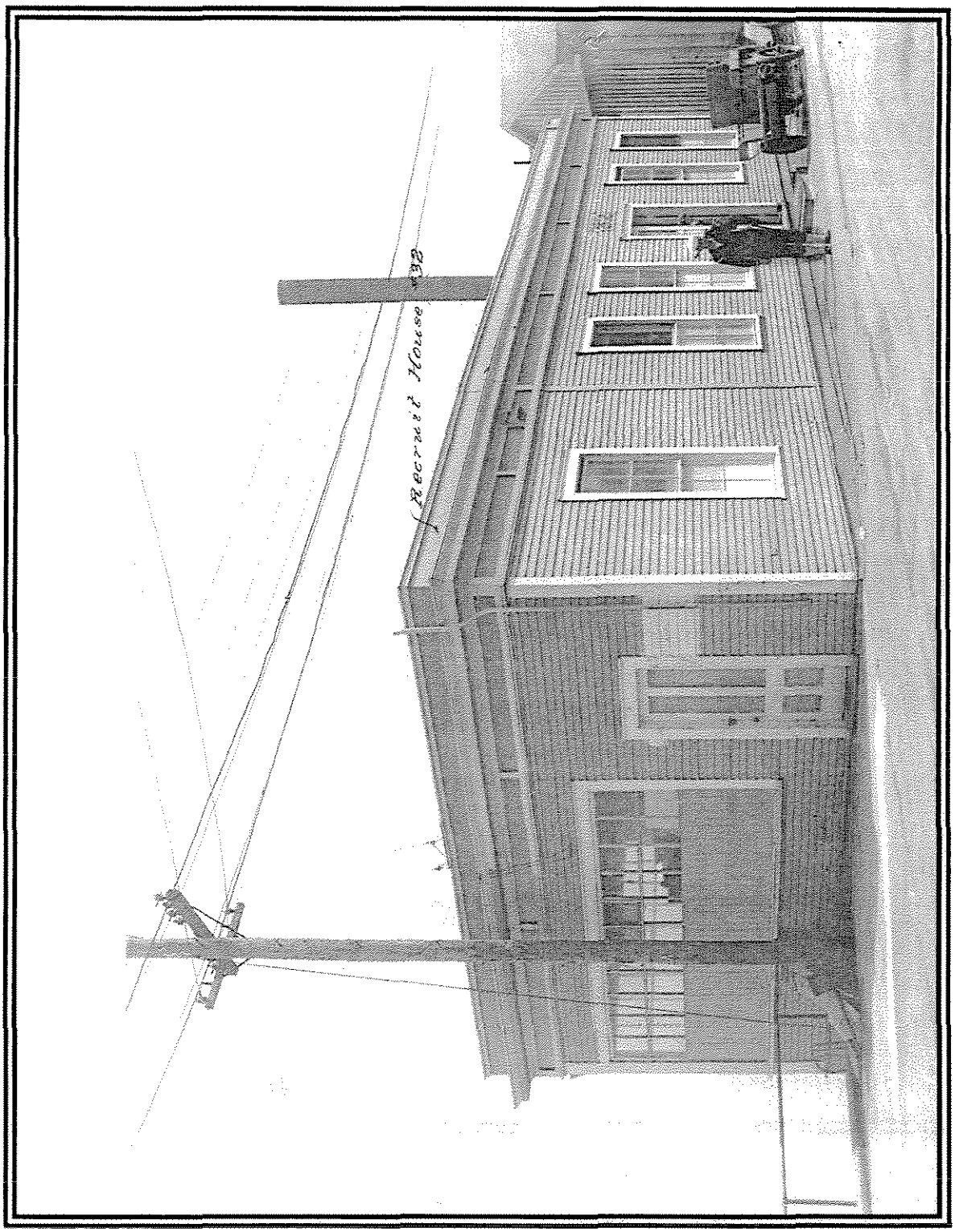


FIGURE 26. ***Recruit House. August 28, 1917.***

Note: Recruit House (Building 32, 1917 - ~1943), located west of the Main Barracks (Building 11) and directly east of the Recruit Mess House (Building 15), provided services to new recruits until 1929. Beginning in 1929, the building was utilized as the Commissary Store and Wash House until its demolition in 1943.

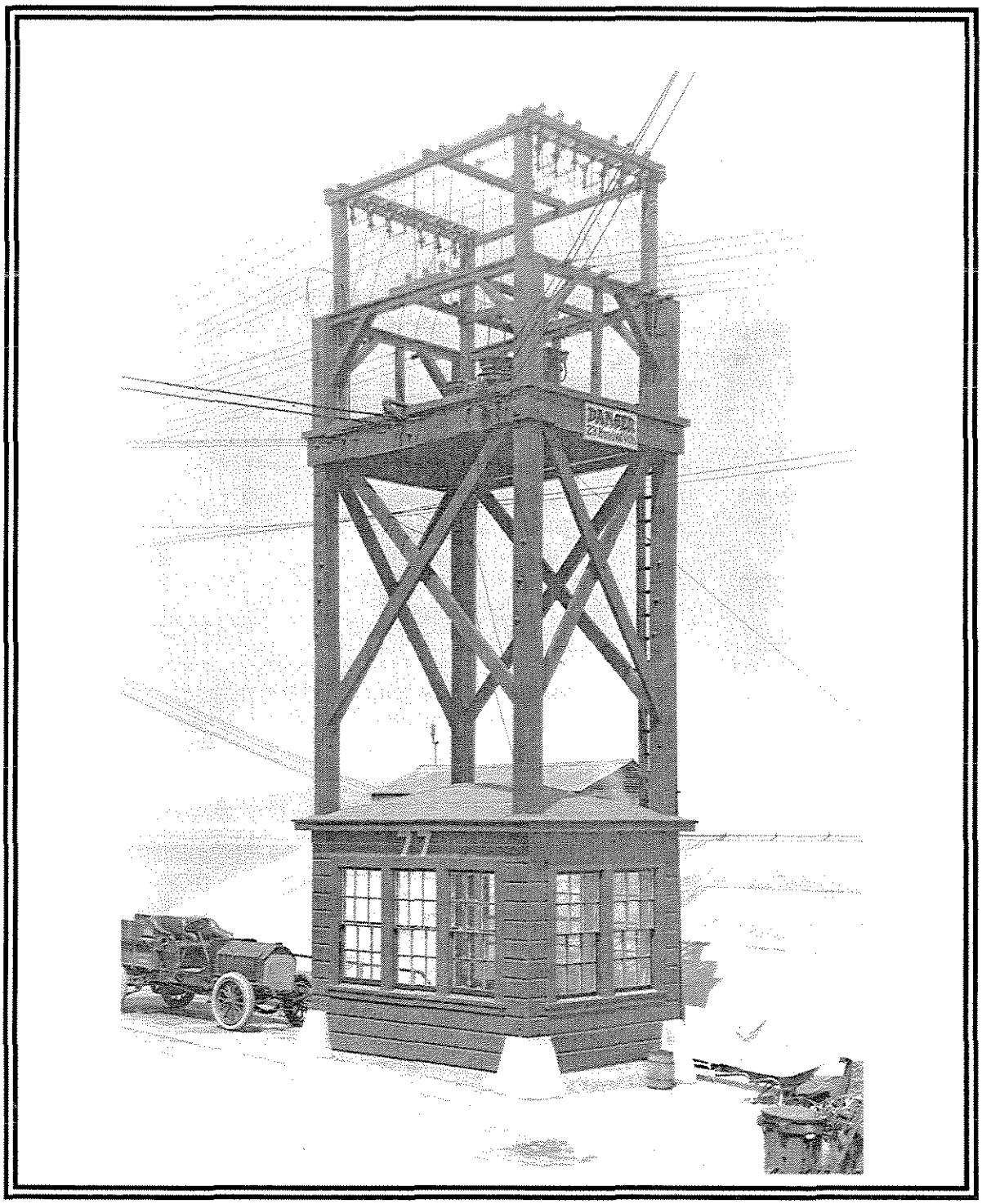


FIGURE 27. ***Transformer Station. Circa 1918.***

Note: The Transformer Station (Building 77, 1918 - 1945) was designed as a two tier, multi-purpose facility. The ground floor level was a building enclosed on three sides and sheltered by a hipped roof providing an open-bay or garage effect. This enclosure was used as an automobile pit until 1945. Extending from the hipped roof of the enclosure was a tower which contained a 2,300 volt transformer station. On some Base maps, this structure was identified as a Sterilizer House.

helped by designating 1.5 acres for use by the Navy under emergent conditions. The Navy erected one of its tent camps, Camp Paul Jones, on this acreage.

In 1918, a severe epidemic of influenza spread throughout the San Francisco Bay Area which caused Goat Island to be quarantined for several weeks. A young man, who just completed landsman training, was assigned as a boat orderly to one of the launches which transported caskets from the island to San Francisco for burial. He recalled that it got to the point where "...On Yerba Buena, funerals seemed an almost daily occurrence, sometimes with six to nine caskets. The first one to die *(that day)* had their casket placed on the traditional field piece. The rest of the caskets were loaded into a truck which followed along behind" (Ref. TT). This outbreak along with a fear of Meningaccous, the bacterium that causes cerebrospinal meningitis, caused three isolation camps to be established on the island. The "first camp", located near the top of the island, was set up as a regular tent camp where all recruits were placed for their first three weeks on the island and were not allowed to mix with the rest of the Island's population. Through this method of quarantine, the sickly and deceased personnel would not likely contaminate other trainees. After three weeks of quarantine, each recruit was evaluated and, if determined healthy, reassigned to another camp to begin their training. The "second camp" was a group of ten isolation cabins located behind the detention barracks. These cabins, identified jointly as Building 17, were apparently used as "sick bays" for ill recruits. The "third camp", also a tent camp, was established specifically for Meningaccous patients. It was located on the northwest point of the Island (where the Treasure Island causeway is now) right next to the cemetery. The Meningaccous disease appears to have been serious, judging by the large size of the camp in 1919.

Despite all the construction on Yerba Buena Island, training had also started in San Diego. Although moving the Training Station to San Diego had been proposed as early as 1908, the increase in military population at Yerba Buena Island, reaching a peak of 13,000 men during World War I, caused overcrowding which impacted the facility and provided the impetus for change. In 1922, the Navy decided to shift all training to San Diego. This eventually resulted in officially transferring the Training Station to San Diego in 1923. See Figure 28, a 1923 photograph of the US Naval Training Station at Treasure Island.

The April 23, 1923, San Francisco Chronicle reported the issuance of the following orders from Rear Admiral Roger Walles, commandant of the 11th Naval District:

> "The San Francisco Naval Training Station, the Navy Department stated, will be decommissioned July 31. Fifteen days prior to that time the radio school, the general electricians' school, the yeoman school and the musicians' school will be transferred to San Diego. The pharmacist mate school and the bakery school will follow in August.
>
> In addition to the orders transferring all naval training activities at Mare Island and San Francisco to San Diego, Admiral Washington also issued instructions to all recruiting stations west of Chicago to send all naval recruits here *[San Diego]* beginning July 15."

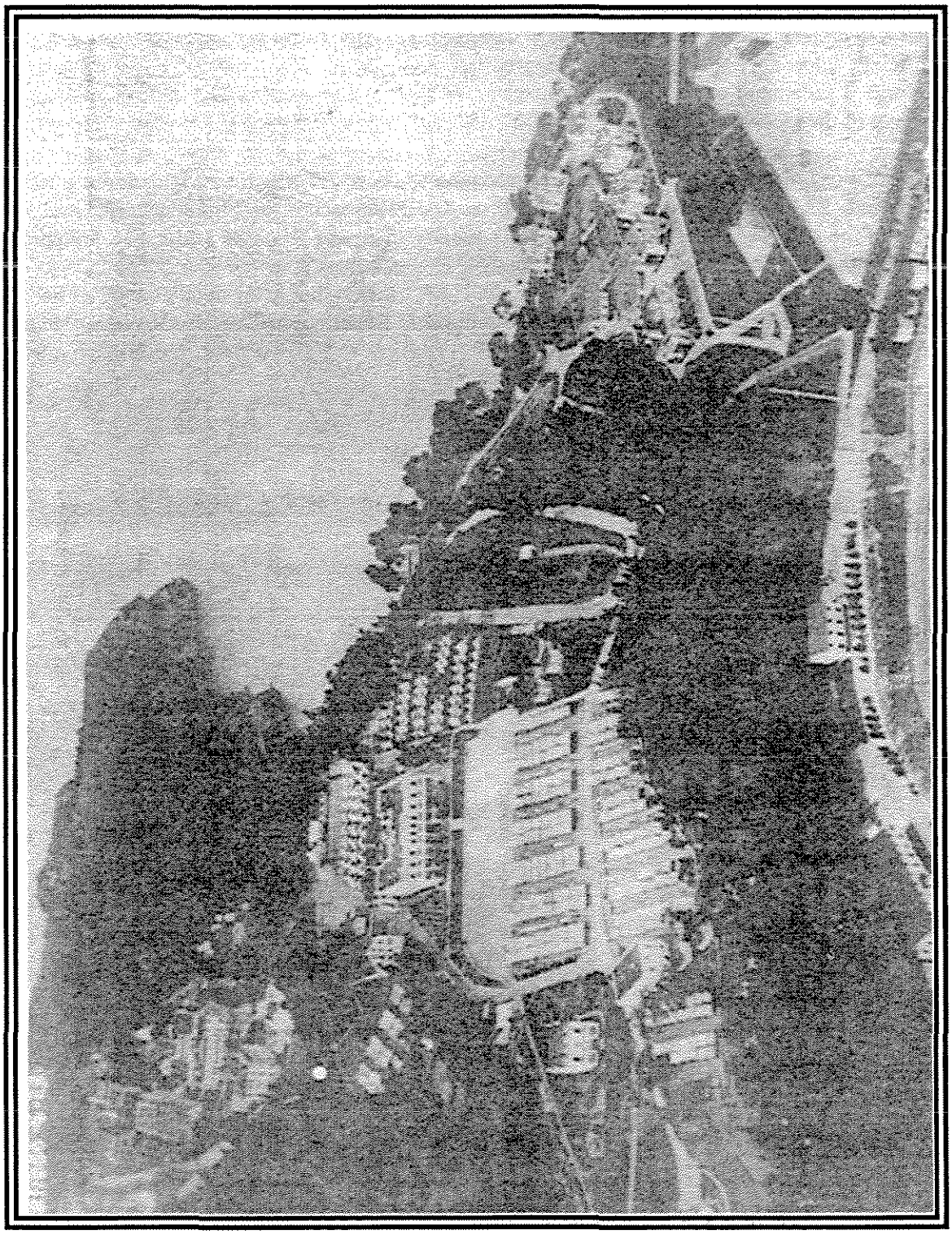


FIGURE 28. ***Aerial View of the US Naval Training Station, San Francisco. 1923.***
Note: Photograph taken from above the east cove's southeast side looking northwest. Rows of the Detention Camp's recruit tents appear left of center, Officer's Quarters to the left, and the Parade Ground in the lower right corner.

The August 1, 1923 issue of the San Francisco Chronicle reported the following within a small article located in the paper's back pages: "The naval training station at Goat Island was declared officially closed yesterday with the appropriate ceremonies under the direction of Captain George Landenburger, formerly commandant of the training station and now commanding officer of the receiving ship."

World War I also brought about a recommendation to convert Yerba Buena Island into a Naval Shipyard. The proposal was seriously considered and even reached the planning stage. A layout plan of the proposed shipyard (see Figure 29) was drawn up and proposed buildings were named and numbered. Docks, piers, and dry-docks would essentially surround Yerba Buena Island with extensions out onto the shoals. Eventually, the Navy decided that it was well enough served by those shipyards already in place, especially with Mare Island Naval Shipyard to the north, and therefore shelved the plan. (Ref. OO).

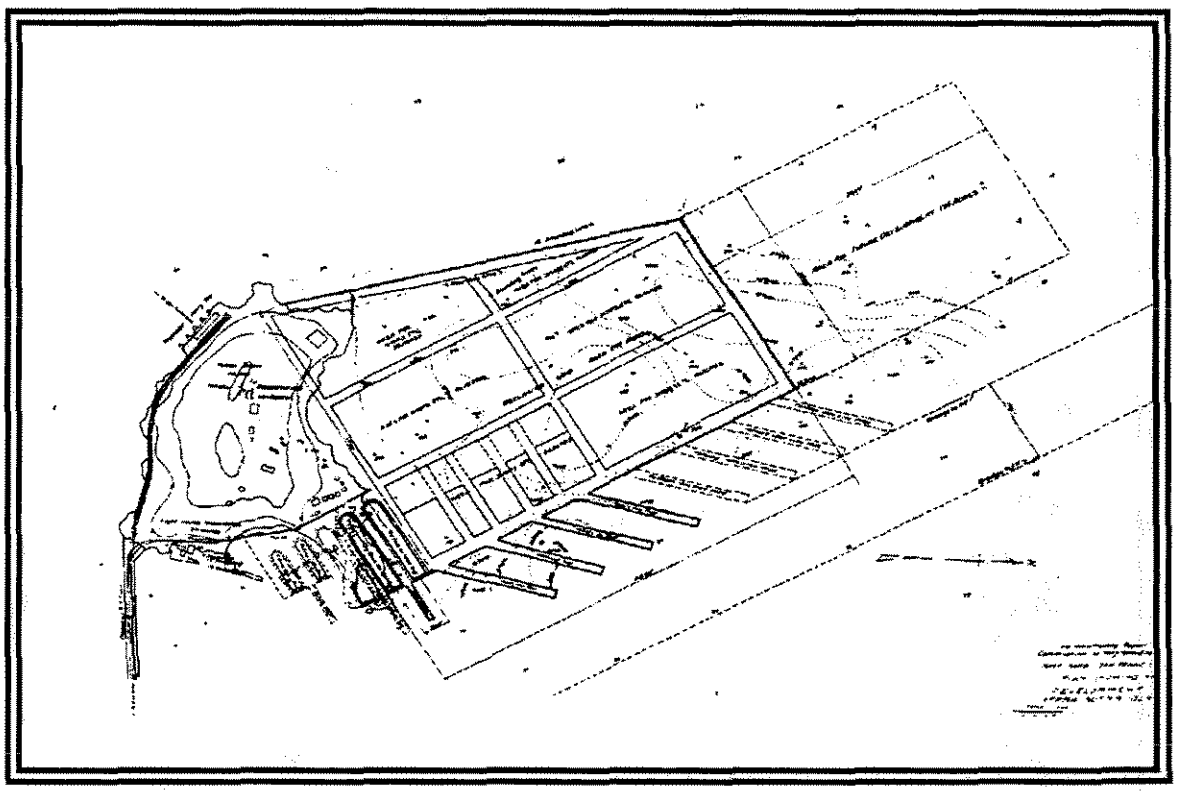


FIGURE 29. ***Plan of Proposed Yerba Buena Island Shipyard. 1917.***
Note: The major portion of the proposed shipyard spans the area where Treasure Island is today. The northeast point, where the Oakland side of the San Francisco-Oakland Bay Bridge is located, was the proposed drydock site.

1.3.2 Receiving Ship, San Francisco, 1899–1946

The "receiving ship" function had always been a part of the Naval Station on Goat Island, but it came to the forefront as the only significant reason for the Navy to remain on the island. The function of a receiving ship was explained in the same article that reported the closure of the Training Station:

> "The commander in chief of the battle fleet will notify Captain George Landenburger (*Receiving Ship Commanding Officer*) of his requirements, and these will be filled from the receiving ship with available men. In a similar manner the Bureau of Navigation will notify the receiving ship of men needed at various stations. Assignments of officer personnel, communications relating to enlisted personnel and such matters will be handled by Commander Gunther (*who worked for Captain Landenburger*)."

Except for the building of the San Francisco-Oakland (SFO) Bay Bridge, this time in the history of Yerba Buena Island was very quiet. To illustrate how little the base facilities were used after the Training Station moved to San Diego, facilities such as the swimming pool, basketball and tennis courts, and barracks were turned over to the San Francisco Playground Commission for use as a weekend camp for disadvantaged children who otherwise would not be able to go to summer camp (Ref. W, July 12, 1926).

Many buildings that were not used after the transfer of the Training Station to San Diego were found to have termite and teredoe (shipworm) damage. These buildings were demolished in the mid 1930's because (1) they were uneconomical to repair, and (2) preparations for the building of the San Francisco-Oakland Bay Bridge were underway. See Figure 30.

The building of the SFO Bay Bridge did not really change much about Yerba Buena Island directly. It was still the little island in the middle of the bay that everyone ignored. Only now they ignored it as they went through its tunnel instead of while passing it on the ferry. Eventually, however, the presence of the bridge led to the building of Treasure Island and that did have an enormous effect on Yerba Buena Island's mission.

The Yerba Buena Naval Station remained as a Receiving Ship until, once again, space limitations of the island were evident upon the advent of World War II. The approximate 150 acres of useable land was not enough acreage to satisfy expansion requirements. Treasure Island, on the other hand, with its 400 acres of ready-for-use flat land appealed to the expansion needs of the Navy. So, during World War II, the Receiving Ship functions gradually transferred to Treasure Island. The barracks on Yerba Buena Island continued to serve as the primary barracks until it was filled beyond capacity, causing even the theater and library to be used as additional space for berthing. Such overcrowding required men to be transferred to Treasure Island. To reduce the impact on Yerba Buena Island, the Navy instituted a liberal leave policy for men returning from overseas duty. Also, the Receiving Ship function was limited to that of receiving only those men returning from overseas for processing, leave, or other assignments. This allowed the Receiving Ship to handle far more than they would have been able to otherwise.

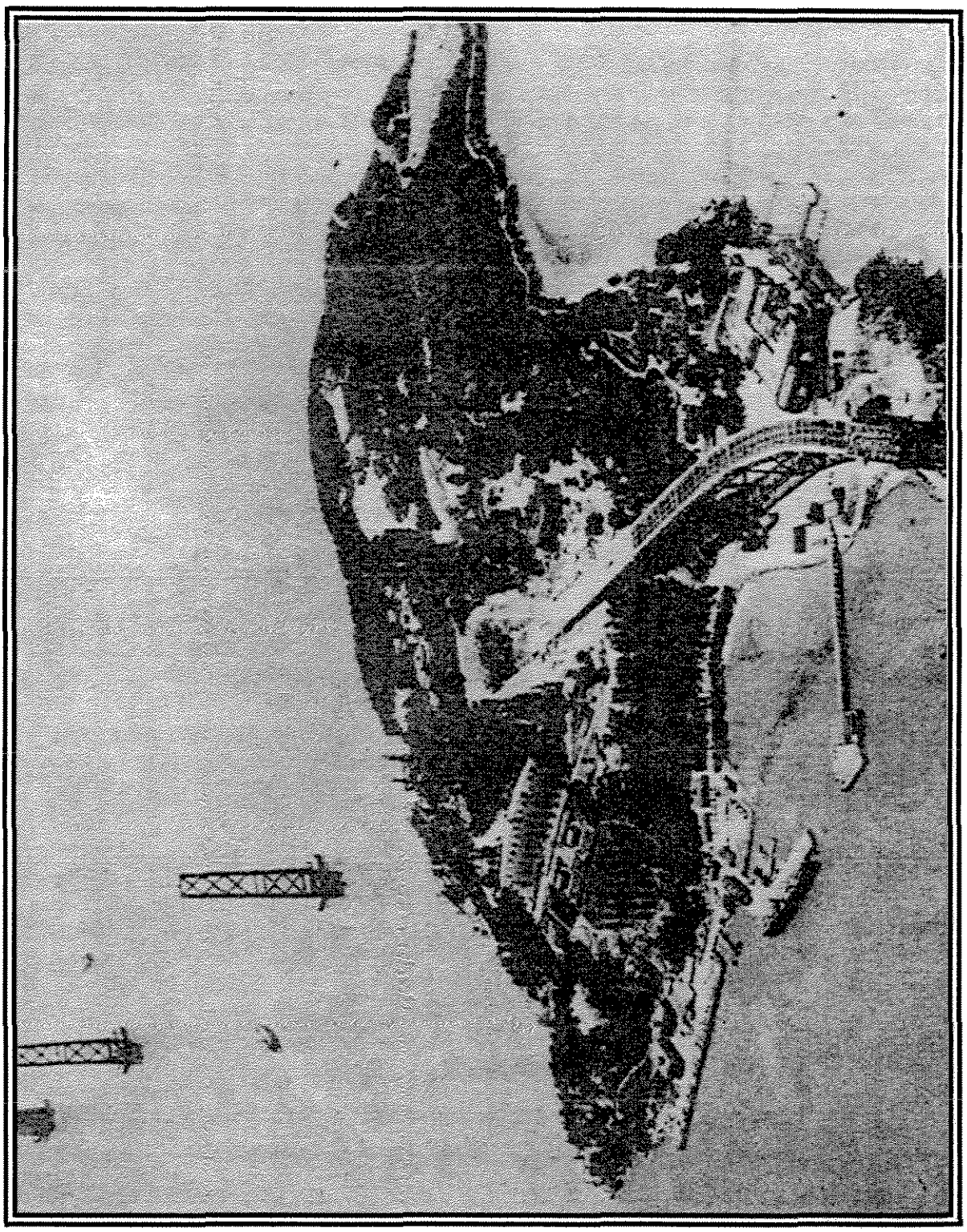


FIGURE 30. ***The Great Change. Circa 1935***

Note: Aerial view of the San Francisco-Oakland Bay Bridge under construction. Photograph takekn from Oakland looking towards San Francisco. East cove is located to the left of the San Francisco-Oakland Bay Bridge roadway.

In 1943, new office space on Treasure Island was provided to the Commanding Officer, Executive Officer, Personnel and Disbursing Departments of the Receiving Ship. During the same year, six and seven-tenths acres were added to Yerba Buena Island via landfill. Most of this new area was devoted to recreational facilities, athletic field, theaters, gymnasium and bowling alleys. In 1944, with a continued increase in barracks space on Treasure Island, Receiving Ship turned over its medical, dental, supply and public works offices to Naval Training and Distribution Center, Treasure Island (TADCEN).

During the course of the war, Receiving Ship handled an average of one thousand five hundred men per day. It had a high of twelve thousand men in one day. When the Magic Carpet of aircraft carriers, huge transports and liners brought returning veterans "stateside" at the end of the war, the Receiving Ship workload more than doubled to about three thousand five hundred per day with four thousand arriving every day. The processing of the first deluge of veterans as they swarmed down on Receiving Ship was hectic and quickly increased to one hundred thousand in the first month. The experience of these first weeks soon developed into a streamlined system which received a man, processed him, and sent him speedily on his way in an average time of seventy two hours. Finally, in 1946, the Navy acknowledged the existing situation and officially redesignated Receiving Ship, San Francisco at Yerba Buena Island to the Receiving Station, Treasure Island. Although Yerba Buena Island continued to be used for various functions, such as the Radio School, never again would it be the headquarters for a Navy command.

1.3.3 Residence and US Coast Guard, 1946–Present (1995)

After the Receiving Ship command was removed in 1946, Yerba Buena Island barracks was used for the overflow of Navy personnel from Treasure Island. The Officers' Quarters at Yerba Buena still served as housing for the upper level officers of Treasure Island. The Commandant's House (Building 1) continued to be used for the base Commandant until 1945 when he moved into Building 62. Although a major fire devastated Building 1 in 1934 requiring large scale rebuilding and the permanent closure of its third floor, the building continues to be used today as Flag Officer's Quarters. From July 1963 to March 1966, Fleet Admiral Chester Nimitz lived in the house; thereafter, Building 1 was informally known as the Nimitz Quarters. See Figure 31.

After World War II, the US Coast Guard became the primary user of the eastern side of Yerba Buena Island. When the Coast Guard took over the Lighthouse Reservation in 1939, they demolished the old buoy storehouses. Probably influenced by the Exposition on Treasure Island, the Coast Guard constructed new concrete storehouses in an Art Deco style. The buoy wharf was expanded and the dock was lengthened. In 1966, approximately, several new apartment style quarters were built on the north and west sides of the island and were occupied by officers. Along the same timeline, naval enlisted personnel were moved from Yerba Buena Island into the newly constructed enlisted personnel housing on Treasure Island. During 1973, a large portion of the old Training Station property was transferred from the US Navy to the US Coast Guard. Recently modernized and fully operational, the Coast Guard Station now monitors the San Francisco Bay and its adjoining waters. It will continue to be the only remaining naval presence on Yerba Buena and Treasure Islands after the closure of the Naval Station in 1997.

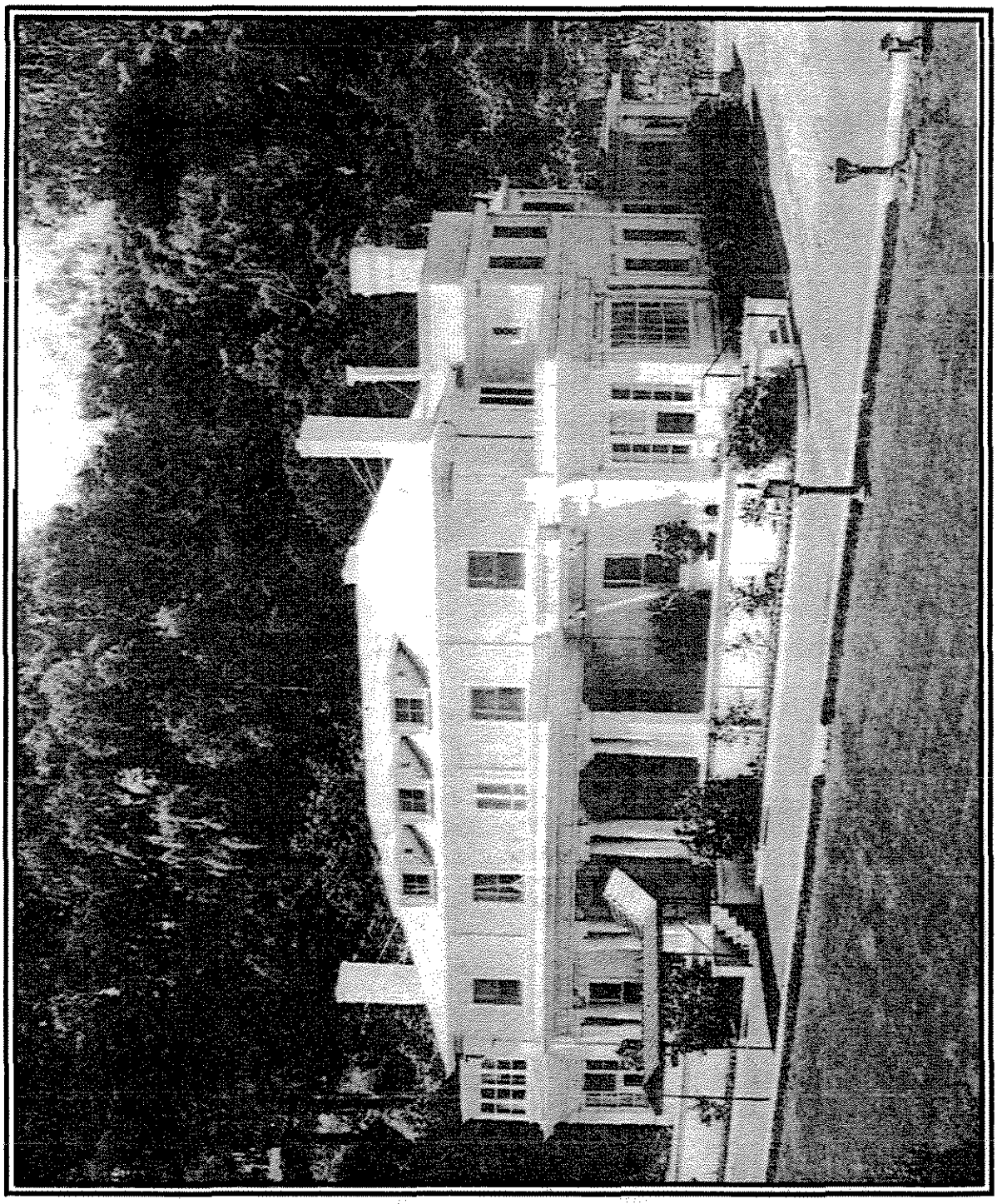


FIGURE 31. ***The Nimitz Quarters. Circa 1970.***

Note: The Nimitz Quarters (Building 1) was originally known as Yerba Buena Island's venerable "Navy Quarters 1". The home survived the 1906 earthquake and a structure fire in 1934. The quarters was locally known as the "Nimitz Quarters" in honor of Five-star Fleet Admiral Nimitz who occupied the home from July 1963 through March 1966. The impressive house has seven bedrooms, eight baths, high ceilings, an elevator, as well as exterior roman columns. The house was built in 1900 at a cost of $14,824. In 1978, it was valued at $280,000. On September 10, 1991, the Nimitz Quarters was added to the National Register of Historic Places.

1.4 The Graveyards of Yerba Buena Island

Yerba Buena had three burial areas. The first area was the formal cemetery located on the north side of the island, west of Macalla Road and just inland of the road leading to Treasure Island. The second area was at the top of the island where the signal tower is located. The third area, which contained multiple sites, was located inland (west), from the beach of the east cove, and the east point. See Figure 32. There were also four unmarked graves whose locations have been lost over the years.

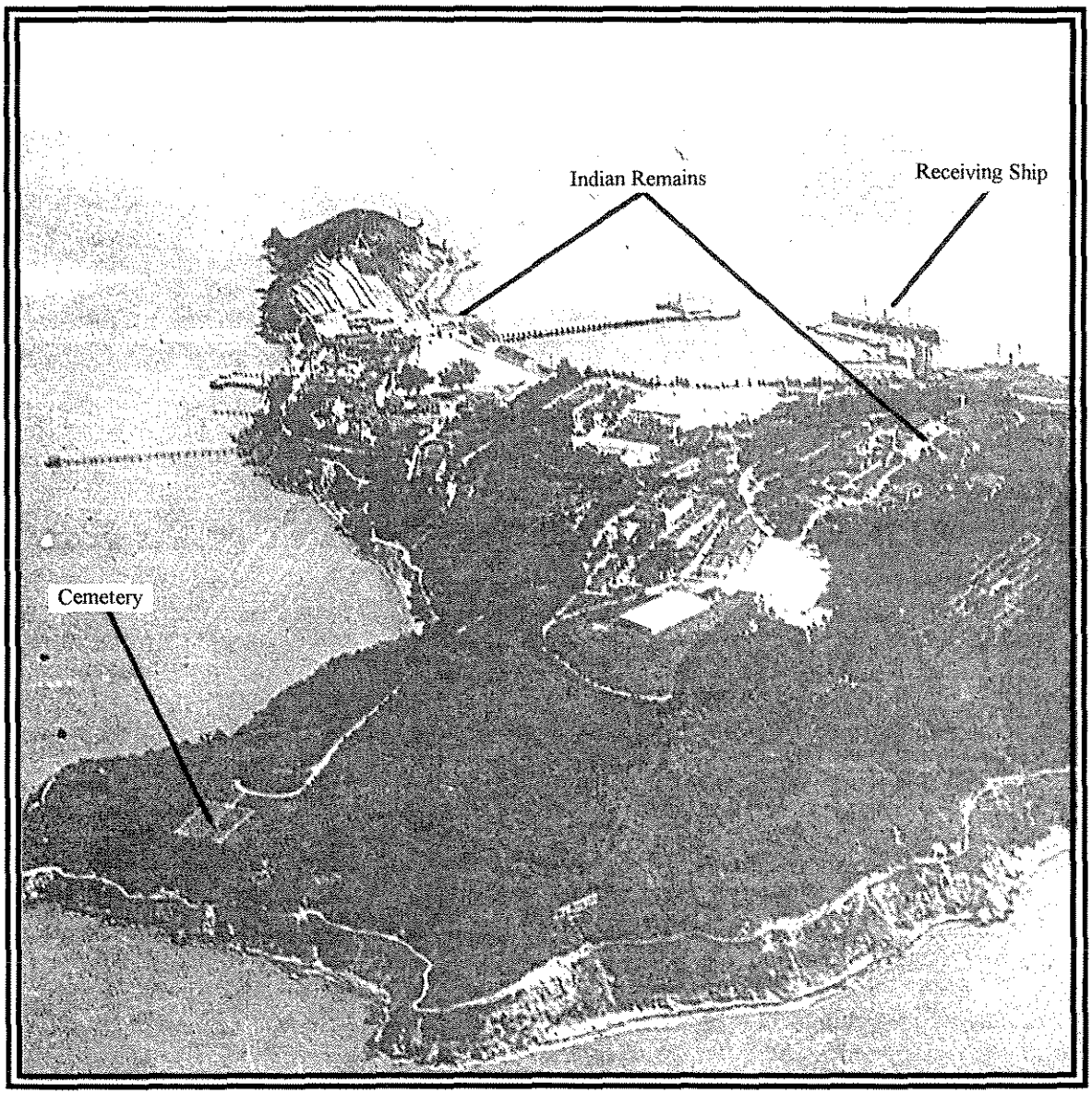


FIGURE 32. ***Aerial View of Yerba Buena Island Showing Location of Graveyards. Circa 1917.***

Note: Photograph taken from above Yerba Buena Island's western shore looking toward the island's east cove and point located at top center of photo.

1.4.1 Indian Graveyards, Pre–1835

Native American remains have been found in two areas on Yerba Buena Island. One is on top of the island where the signal tower stands. The remains of several Native Americans were unearthed in the early 1900s during the construction of the foundation for the signal tower. The second area containing two sites where burials have been found, was convenient to the major habitants. The area of the east cove offered a good beach and access to gentle sloping land between the hill on the east point, and the steep terrain of the hills to the west. Barnacle Bill was the first to mention, in 1849, the Native American fishing village, the temescal (ritual and/or therapeutic sweathouse), and the cremation and burial pits (Ref. X) This area was later to be occupied by the US Army, when it constructed an artillery base in 1868 (see Figure 7), and subsequently by the Navy, when it constructed the Naval Training Center in 1898.

The Island may have been used at different times by at least two different North American Indian tribes. One tribe, the Costanoans, who cremated their dead, inhabited the east cove area at the time of their discovery by the Europeans. Their cremation pits were described by Barnacle Bill in 1849. The Costanoans were of average height, approximately 5'6" tall. The Native American remains that were found in graves to the northeast of the east cove beach area were taller than average. During the early (c. 1890) excavations for the construction of the Naval Training Center (Ref. V, January 21,1899), some of the uncovered skeletal remains were those of men reported to be over 6'6" in height and at least one woman who was more that 6' tall. They had been buried in a sitting position, with legs drawn up to their chests and arms wrapped around their legs. During the excavation in 1933 of one of the San Francisco-Oakland Bay Bridge support tower foundation, Native American remains were uncovered (Ref. E, p. 12). Dr. E. W. Gifford (Department of Anthropology, University of California at Berkeley) was called to supervise the removal and to take custody of the remains.

1.4.2 Cemetery, 1849–1938

The Yerba Buena Island cemetery came into being in 1849. Most of the graves were those of service men who died on the island. Though somewhat different and interesting, the Island's first and second graves were double graves. Two brothers, John and Peter Black, had planned and attempted a mutiny on board the USS *Ewing*. Their intent had been to desert to the gold fields of California. They had succeeded by rendering their officer in charge unconscious, dumping him into the Bay, and escaping with three other men. All five men were caught on the Sacramento River near what is today Pittsburg and Antioch. The brothers were court-martialed and convicted on charges of mutiny, desertion, attempt to kill, and running away with a boat. Their sentence was to "die by hanging from the yardarms of the *Ewing* and the *Savannah* at 11 A.M. on October 23, 1849". The sentence was carried out and the log of the *Ewing* relates: "At 12:30 the body of John Black was lowered and prepared for internment. At 1:30 a boat came alongside from the *Savannah* with the body of Peter Black, and both were sent to the Island of Yerba Buena for internment." Less than two years later, an English barrister inquired of Reverend Ven Mehr, a chaplain at the executions, about two brothers who had called themselves by the name of Black. Apparently, the brothers were from a prominent Scottish family, and a relative, unaware of their execution, had left them a legacy of approximately 20,000 pounds sterling. Of the other three men involved in the mutiny, one was given a life sentence, and the other two men received "three years at hard labor". (Ref. X)

The second double grave was that of Captain Edward F. Lindsey and his son Edward L. Lindsey. Captain Lindsey, who transported convicts to Tazmania, lived there for ten years before coming to San Francisco in 1848 with a load of bricks and lumber for the gold mines. Though a resident of the City, he had fallen in love with Yerba Buena Island and often went there with his family for day outings. He had expressed the wish to be buried on his beloved Goat Island and when he died of a heart attack at the age of 38, his wife, Virginia, fulfilled his wishes. His son, who died 2 years later at the age of 17, was buried with him. Virginia placed a headstone for them that read in part "from the bereaved widow and mother." In 1979, Captain Lindsey's ship, the brig *Palmyra*, was found under what is now the Levi Strauss Plaza in San Francisco. Just about the time Captain Lindsey died, an adrift ship, abandoned by its crew in their rush to the gold fields, rammed the *Palmyra* and put a large hole in its hull. Rather than try to repair the brig, Virginia had the ship grounded and there it remained, covered over with landfill, until its unearthing 125 years later. (Ref. SS.)

Other graves also include that of a Russian soldier, whose original headboard was burned, leaving only a part of his headboard which read "Lai - loff - Sitka." An Italian noble committed suicide by digging his own grave near the top of the island and arranging the dirt and some boards in such a way that when he shot himself and fell into the hole, the dirt would be dropped over him. His plan worked, but the soldiers who found the grave the next day exhumed him and the coroner took his remains back to the mainland where he was buried in a pauper's grave. A few days later, someone else tried to commit suicide the same way, but drank too much and passed out before he could shoot himself. D. R. A. Dowling, one of Thomas Dowling's sons, is buried atop the island. He happened to be playing on a stone scow when it broke loose of its moorings and was dashed against the rocks. Sadly, the boy was swept overboard and drowned. (Ref. E)

The older graves were marked with various markers. The markers had worn to the point of mutilation and were eventually replaced by uniform granite markers. When the new markers arrived, it was found that the old ones had already been removed; however, no one had recorded their locations. The plot naming the different graves had also been misplaced. The job of replacing the headstones was assigned to a Marines sergeant, who attempted to install them in alphabetical order! Fortunately, the Navy files in Washington turned out to have the correct plot identifications and the headstones were replaced properly. (Ref. E.)

The actual site location of four unmarked graves remains unknown. Of the four graves, the first grave is that of Dowling's son who drowned. The second grave was that of the mate of the bark *Melanchton* who was killed in a fall from the rigging on board the ship. The third grave is that of a young woman who came to Yerba Buena Island with her husband, an officer in the Army Engineer Corps. After finding out that he was cheating on her, she supposedly died of grief. Her grave overlooked San Francisco, but it had no marker and in one of the fires that swept the island in the late 1800's, the fence around her grave burned, leaving no indication of the actual location. The fourth grave is that of a horse, Mathilda, who faithfully pulled the Victoria (coach) of the Commandant from his home to Assembly in front of the Administration building every day in the early 1900's. The horse was quite the character and after her demise she was buried with mementos from all the men serving on the base at the time. These included a Good Conduct Medal that the owner commented she (being Mathilda) deserved more than him. Since Mathilda's grave was marked with a concrete slab, "undefiled by epitaph", it is no longer known where exactly the "horse of Good Conduct" is buried. (Ref. E)

There are no traces of any of the graveyards in existence today. Sadly, the Indian graveyards were destroyed by the military and by bridge construction. The formal graveyard, located alongside the access road to Treasure Island, was transferred to the San Francisco Presidio Cemetery in June of 1938 to keep it from being a depressing sight to visitors attending the Golden Gate International Exposition.

1.5 Buildings of Yerba Buena Island

The buildings of Yerba Buena Island can easily be divided into two categories, those built "pre-1891", prior to the establishment of the Torpedo Station, and those built "post- 1891". Maps used were generated in the years 1919, 1929, 1935, 1940, 1943, 1945, 1948, 1950, 1953, 1961, 1970, 1980, 1992 and 1994. All map quad references are to the current maps. The review of maps for the determination of when a building appeared or disappeared provided the basis for the dating and categorizing buildings. For a few buildings, mostly pre-1919, determination was based on photographs. Thus, a building that is described as "Year Demolished: "NLT 1948" would have been on the 1945 map but was gone on the 1948 map. Table acronyms are defined as: "NLT" = No Later Than; "Year Demolished: NA" indicates the building was still standing as of December 1, 1994; and "~" = Approximately. Building "uses" indicated in **"Bold"** text indicate possible environmental concerns.

1.5.1 Buildings Built Pre–1891

In 1871, a small Army base was established in the cove on the northeast side of Yerba Buena Island. A detachment of the 4th Artillery Division occupied the base from 1871 to 1879. Base buildings were last reported to be standing in 1881. Prior to 1891, a fire destroyed this grouping of buildings. A newspaper account of the island, written in the late 1880's, lists only the lighthouse depot buildings as standing. Although not a part of this report, yet noteworthy, both the lighthouse and lighthouse keeper's residence, built in 1875, remain standing and are in use by the US Coast Guard (USCG). The house is currently occupied by a Vice Admiral, US Coast Guard. A list of those buildings constructed pre–1891, that are not under USCG cognizance, is provided in Table 1.

1.5.2 Buildings Built Post–1891

A list of the buildings that have existed on Yerba Buena Island since the US Army established the Torpedo Station there is provided in Table 2. The list does not include buildings presently owned or operated by the USCG.

Table 1

Buildings of Yerba Buena Island Built Pre–1891*

Structure	Map Quad
Bakery	E21
Barracks (North wing)	F21
Barracks (South wing)	F21
Boat House	F23
Engineer's Storehouse	F22 (on pier)
Guard House	G21
Hospital (the old Dowling house) **	G22
Laundresses Quarters	G20
Mess Hall	G20
Officer's Quarters	H21
Officer's Quarters	H21
Officer's Quarters	H21
Sutler's Store	E21

* The buildings listed in this table were destroyed by fire between the years 1881 and 1891.

** This was the only remaining building from the civilian settlers on Yerba Buena Island between 1850 and 1867.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
1	Map Quad: H21 Year Built: 1900 Year Demolished: NA Uses: 1900 - 1945 — Naval Station Commandant's Quarters 1945 - Present — Flag Officer's Quarters Notes: 1. Building is titled "Nimitz Quarters". 2. Heavily damaged by fire in 1934. The first two floors were rebuilt in 1935. The third floor was not repaired and was sealed off to prevent reuse.
2	Map Quad: H21 Year Built: 1900 Year Demolished: NA Uses: 1900 - Present — Senior Officer's Quarters
3	Map Quad: H21 Year Built: 1901 Year Demolished: NA Uses: 1901 - Present — Officer's Quarters
4	Map Quad: H21 Year Built: 1901 Year Demolished: NA Uses: 1901 - Present — Officer's Quarters
5	Map Quad: H20 Year Built: 1901 Year Demolished: NA Uses: 1901 - Present — Officer's Quarters
6	Map Quad: H20 Year Built: 1903 Year Demolished: NA Uses: 1903 - Present — Officer's Quarters
7	Map Quad: H20 Year Built: 1903 Year Demolished: NA Uses: 1903 - Present — Officer's Quarters
8	Map Quad: H23 Year Built: 1905 Year Demolished: NA Uses: 1905 - Present — Officer's Quarters
9	Map Quad: H23 Year Built: 1918 Year Demolished: NTL 1941 Uses: 1918 - ~1941 — Master of Tugs' Quarters
9	Map Quad: H23 Year Built: 1941 Year Demolished: NA Uses: 1941 - Present — Officer's Quarters
10	Map Quad: H21 Year Built: 1918 Year Demolished: 1948 Uses: 1918 - 1948 — Officer's Quarters

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
10	Map Quad: H21 Year Built: 1948 Year Demolished: NA Uses: 1948 - Present — Officer's Quarters - USCG is the present tenant Notes: Quarters 10 was rebuilt or at least extensively modified in 1948. It appears to have been moved a few feet closer to the road and is larger and has a rounded end that did not exist prior to 1945. Therefore, as an explanation, this separate building entry is made to document building differences.
11	Map Quad: G21 Year Built: 1900 Year Demolished: 1960 Uses: 1900 - 1945 — Main barracks and galley Classrooms (including **Ordnance**) 1945 - 1960 — Administration
11	Map Quad: G21 Year Built: 1917 Year Demolished: 1936 Uses: 1917 - 1936 — Galley extension Notes: Building is titled "Lean-to".
11A	Map Quad: G21 Year Built: 1900 Year Demolished: 1959 Uses: 1900 - 1959 — Carpenter shop and storehouse
11B	Map Quad: G21 Year Built: 1900 Year Demolished: 1959 Uses: 1900 - 1929 — Cobbler shop 1929 - 1945 — Contagious disease bay 1945 - 1959 — Crew showers and toilet
11C (See 11D)	Map Quad: G21 Year Built: 1900 Year Demolished: 1959 Uses: 1900 - 1959 — Prison Notes: 1. For an undetermined duration around 1917, Building 11C was used as a blacksmiths shop. (See Figure 25.) 2. In approximately 1929, Building 11C absorbed Building 11D during an expansion of the Prison/Brig.
11D (See 11C)	Map Quad: G21 Year Built: 1900 Year Demolished: See "Notes" Uses: 1900 - 1929 — **Blacksmith shop** and **paint shop** Notes: In approximately 1929, Building 11D was absorbed by Building 11C during an expansion of the Prison/Brig.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
12	Map Quad: G21 Year Built: 1900 Year Demolished: 1959 Uses: 1900 - 1959 — **Swimming tank**
12A	Map Quad: G21 Year Built: 1918 Year Demolished: NLT 1948 Uses: 1918 - 1929 — Bunkhouse ground detail 1929 - 1945 — Officer's dressing room 1945 - ~1948 — Attendant's quarters
13 (See #213)	Map Quad: G20 Year Built: 1907 Year Demolished: See "Notes" Uses: 1907 - 1940 — Recreation building. Included a gym, library, chapel, theater, Marine barracks and more. Notes: Built originally as Building 13, it was renumbered as Building 213 after major remodeling in 1940.
14 (See #214)	Map Quad: G20 Year Built: 1907 Year Demolished: See "Notes" Uses: 1907 - 1937 — **Power (boiler) house** for Main Barracks Notes: Built originally as Building 14, it was renumbered as Building 214 after major remodeling in 1943.
14A	Map Quad: G20 Year Built: 1906 Year Demolished: 1938 Uses: 1906 - 1938 — **Machine shop**
14B	Map Quad: G20 Year Built: 1920 Year Demolished: NLT 1945 Uses: 1920 - ~1945 — **Powerhouse storeroom**
15	Map Quad: F20-G20 Year Built: 1917 Year Demolished: 1940 Uses: 1917 - 1923 — Recruit mess house 1923 - 1940 — Laundry
16	Map Quad: I22 Year Built: 1905 Year Demolished: NLT 1943 Uses: 1905 - ~1943 — Marine barracks, detention barracks (Barracks "D")
17	Map Quad: I21 Year Built: 1917 Year Demolished: NLT 1935 Uses: 1917 - ~1935 — Isolation shacks Notes: This building number was used for a group of 10 shacks, most of which were behind Building 16. Most were gone by 1929, all by 1935.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
18	Map Quad: I22-J22 Year Built: 1916 Year Demolished: 1938 Uses: 1916 - 1938 — Recruit kitchen
19	Map Quad: J22 Year Built: 1916 Year Demolished: NLT 1943 Uses: 1916 - ~1943 — Recruit mess hall
20	Map Quad: J22 Year Built: 1916 Year Demolished: NLT 1935 Uses: 1916 - ~1935 — Lavatory
21	Map Quad: K22 Year Built: 1918 Year Demolished: NLT 1929 Uses: 1918 - ~1929 — Pharmaceutical and **chemical lab**, medical department
22	Map Quad: K21 Year Built: 1918 Year Demolished: NLT 1929 Uses: 1918 - ~1929 — Medical school, library, **X-Ray room**
23	Map Quad: K21 Year Built: 1918 Year Demolished: NLT 1929 Uses: 1918 - ~1929 — Medical school and **bacteriological laboratory**
24	Map Quad: K21 Year Built: 1916 Year Demolished: NLT 1943 Uses: 1916 - ~1943 — Yeoman school
25	Map Quad: J21-K21 Year Built: 1908 Year Demolished: 1934 Uses: 1908 - 1934 — **Dispensary**
26	Map Quad: J21 Year Built: 1911 Year Demolished: 1937 Uses: 1911 - 1937 — **Hospital boiler house**
26A	Map Quad: J21 Year Built: 1911 Year Demolished: 1937 Uses: 1911 - 1937 — Shed
26B	Map Quad: J21 Year Built: 1911 Year Demolished: 1934 Uses: 1911 - 1934 — Valve house
27	Map Quad: K21 Year Built: 1917 Year Demolished: NLT 1943 Uses: 1917 - ~1943 — Sterilizing house

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
28 (See #267)	Map Quad: H22 Year Built: 1918 Year Demolished: See "Notes" Uses: 1918 - ~ 1948 — Salt water pump and valve house Notes: Building 28 was originally built in map quad I22. In about 1935, the building was moved to Quarters 10 in map quad H22 to make way for the construction of the San Francisco-Oakland Bay Bridge. Maps of 1947 indicate that Building 28 became the garage for Quarters 10 (Building 267), and that its structure had changed in size and had been moved even closer to Quarters 10. It is not known if Building 28 was at that time demolished and rebuilt as a new structure, or if it was remodeled.
29 (See #204)	Map Quad: F22 Year Built: 1917 Year Demolished: See "Notes" Uses: 1917 - 1929 — Stables, Garage, and Signal School 1929 - 1934 — Marine Barracks and Garage Notes: In 1934, Buildings 29, 30, 31 and 38 were combined to become Building 204.
30 (See #204)	Map Quad: F22 Year Built: 1917 Year Demolished: See "Notes" Uses: 1917 - 1934 — Wagon shed and garage Notes: In 1934, Buildings 29, 30, 31 and 38 were combined to become Building 204.
31 (See #204)	Map Quad: F22 Year Built: 1917 Year Demolished: See "Notes" Uses: 1917 - 1929 — Garage storehouse 1929 - 1934 — **Blacksmith shop** for Building 29 Notes: In 1934, Buildings 29, 30, 31 and 38 were combined to become Building 204.
32	Map Quad: F21 Year Built: 1917 Year Demolished: NLT 1943 Uses: 1917 - 1929 — Recruit house 1929 - ~1943 — Commissary store and wash house
33	Map Quad: F21 Year Built: 1916 Year Demolished: 1940 Uses: 1916 - 1940 — Hose cart and **chemical shack** south of US Army Storehouse

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
34	Map Quad: I21 Year Built: 1904 Year Demolished: NLT 1960 Uses: 1904 - ~1960 — Greenhouse Notes: Rebuilt in 1936
35	Map Quad: I21 Year Built: 1904 Year Demolished: NLT 1960 Uses: 1904 - ~1960 — Greenhouse storehouse
36	Map Quad: I21 Year Built: 1917 Year Demolished: NLT 1935 Uses: 1917 - ~1935 — Wagon shed
37	Map Quad: I22 Year Built: 1918 Year Demolished: NLT 1948 Uses: 1918 - ~1948 — Storehouse for Quarters 10
38 (See #204)	Map Quad: F22 Year Built: 1917 Year Demolished: See "Notes" Uses: 1917 - 1929 — **Ordnance school** 1929 - 1934 — Storehouse, Seaman guard house Notes: In 1934, Buildings 29, 30, 31 and 38 were combined to become Building 204.
39	Map Quad: F23 Year Built: 1910 Year Demolished: NLT 1961 Uses: 1910 - ~1961 — Storehouse on Long Dock
40 (See #215)	Map Quad: G22 Year Built: 1917 Year Demolished: NA Uses: ~1904 - 1917 — Fresh water pump house (original structure, ~1904-1917) 1917 - 1943 — Fresh water pump house 1943 - 1961 — Commissary store 1961 - 1969 — Twelfth Naval District (12ND) Survey office 1969 - 1970 — Westdocks Survey Team office 1970 - Present — Transferred to United States Coast Guard (USCG) Notes: 1. From the maps and photos, it would appear that there was a smaller fresh water pump house built originally at the site of Building 40 (~1904-1917). With the advent of WW I and the influx of recruits that it brought, it appears that the original building was razed and a larger one built in its place with no change of designator. 2. From about 1943 to 1945, after remodeling as the Commissary store, the number was changed to Building 215. For some reason, it was then changed back to Building 40. It is presently listed as Building 40.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
40A	Map Quad: G22 Year Built: 1918 Year Demolished: 1940 Uses: 1918 - 1940 — Bunk house
41	Map Quad: F22 Year Built: 1919 Year Demolished: NLT 1961 Uses: 1918 - 1929 — Naval relief canteen 1929 - 1940 — Motion picture exchange, barber and tailor shop 1940 - 1945 — **Blacksmith shop** 1945 - ~1961 — Barracks Notes: Circa 1935, this building was moved slightly north to make way for bridge construction.
42	Map Quad: G24 Year Built: 1903 Year Demolished: 1938 Uses: 1903 - 1938 — Yeoman school and Receiving ship clubhouse
42A	Map Quad: G24 Year Built: 1903 Year Demolished: 1938 Uses: 1903 - 1938 — Receiving ship clubhouse annex
43	Map Quad: G23 Year Built: 1909 Year Demolished: 1933 Uses: 1909 - 1923 — Receiving ship Radio school 1923 - 1933 — Temporary enlisted barracks
44	Map Quad: H24 Year Built: 1912 Year Demolished: NLT 1961 Uses: 1918 - 1945 — Receiving ship bunkhouse 1945 - ~1961 — Bachelor officer's quarters
45	Map Quad: G24 Year Built: 1918 Year Demolished: NLT 1961 Uses: 1918 - 1929 — Receiving ship dispensary 1929 - 1952 — Quarters 1952 - ~1961 — Barracks Notes: Rebuilt in 1942
46 (See #216)	Map Quad: G23 Year Built: 1905 Year Demolished: See "Notes" Uses: 1905 - 1933 — Receiving ship **paint** and **blacksmith shop** Notes: After remodeling in 1933, Building 46 was renumbered to Building 216.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
47	Map Quad: H24 Year Built: 1918 Year Demolished: NLT 1970 Uses: 1918 - 1952 — Receiving ship **boiler house** 1952 - ~1970 — Storage
48	Map Quad: I22 Year Built: 1917 Year Demolished: NLT 1943 Uses: 1917 - ~1943 — Latrine
49	Map Quad: I22 Year Built: 1917 Year Demolished: NLT 1943 Uses: 1917 - ~1943 — Wash house
50	Map Quad: I22 Year Built: 1917 Year Demolished: NLT 1943 Uses: 1917 - ~1943 — Wash house and latrine
51	Map Quad: I22 Year Built: 1917 Year Demolished: NLT 1943 Uses: 1917 - ~1943 — Scrub shed
52	Map Quad: H22 Year Built: 1917 Year Demolished: NLT 1929 Uses: 1917 - ~1929 — Latrine house
53	Map Quad: H22 Year Built: 1917 Year Demolished: NLT 1929 Uses: 1917 - ~1929 — Wash house
54	Map Quad: H22 Year Built: 1917 Year Demolished: NLT 1929 Uses: 1917 - ~1929 — Dressing house
55	Map Quad: I24 Year Built: 1917 Year Demolished: NLT 1929 Uses: 1917 - ~1929 — Latrine
56	Map Quad: I24 Year Built: 1917 Year Demolished: NLT 1929 Uses: 1917 - ~1929 — Wash house Notes: Plank road, lighthouse reservation
57	Map Quad: I24 Year Built: 1917 Year Demolished: NLT 1929 Uses: 1917 - ~1929 — Latrine

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
57	Map Quad: H24 Year Built: NLT 1929 Year Demolished: NA Uses: ~1929 - 1952 — Public school for Navy Personnel Dependents 1952 - 1969 — Classrooms 1969 - 1970 — Secured 1970 - c. 1980 — Motel Circa 1980 - Present — Secured Notes: This number was originally used for a latrine in Camp Paul Jones. Either some of the structure was used to build the school in the new location, or someone reused a number not realizing it had already been used.
58	Map Quad: H24 Year Built: 1917 Year Demolished: NLT 1929 Uses: 1917 - ~1929 — Latrine
59	Map Quad: F22 Year Built: 1917 Year Demolished: NLT 1961 Uses: 1917 - 1929 — Small stores 1929 - 1940 — Storehouse 1940 - ~1961 — Marine barracks
60	Map Quad: K21 Year Built: 1917 Year Demolished: NA Uses: 1917 - 1929 — Isolation ward 1929 - 1952 — Quarters 1952 - 1966 — Double civilian quarters 1966 - Present — Double officer's quarters
60A	Map Quad: K21 Year Built: 1920 Year Demolished: 1936 Uses: 1920 - 1936 — Wood shed for Building 60
61	Map Quad: K21 Year Built: 1917 Year Demolished: NA Uses: 1917 - 1929 — Isolation ward 1929 - 1945 — Quarters 1945 - 1952 — Civilian quarters 1952 - Present — Officer's quarters
62	Map Quad: J21 Year Built: 1917 Year Demolished: NA Uses: 1917 - 1920 — Isolation ward (adjacent to Dispensary) 1920 - 1945 — Quarters 1945 - Present — Naval Station Commanding Officer's Quarters Notes: Building 62 was rebuilt in 1944.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
63	Map Quad: F21 Year Built: 1917 Year Demolished: 1935 Uses: 1917 - 1935 — Recruit wash house
64	Map Quad: G21 Year Built: 1917 Year Demolished: 1938 Uses: 1917 - 1938 — Ice house
65	Map Quad: I22 Year Built: 1917 Year Demolished: 1936 Uses: 1917 - 1936 —Commissary building
66	Map Quad: K22 Year Built: 1917 Year Demolished: NA Uses: 1917 - 1923 — Barracks for Hospital Corps training school 1923 - 1945 — Barracks 1945 - 1966 — Enlisted Personnel quarters (8 apartment) 1966 - Present — Married Officer's quarters Notes: Between about 1950 and the late 1980's, there also appears to have been a dental clinic in this building.
67	Map Quad: G24 Year Built: 1917 Year Demolished: NLT 1935 Uses: 1917 - ~1935 — Receiving ship bath house
68	Map Quad: J22 Year Built: 1917 Year Demolished: NLT 1961 Uses: 1917 - 1923 — Hospital corps quarters 1923 - 1945 — Quarters 1945 - ~1961 — Enlisted personnel quarters (8 apartments)
69	Map Quad: I22 Year Built: 1917 Year Demolished: 1936 Uses: 1917 - 1936 — YMCA building (Farragut Club)
70	Map Quad: H23 Year Built: 1917 Year Demolished: NLT 1961 Uses: 1917 - ~1961 — Chief Petty Officer's (CPO) quarters
70A	Map Quad: H23 Year Built: 1917 Year Demolished: NLT 1945 Uses: 1917 - ~1945 — Kitchen and **heating plant** for Building 70 Notes: Building 70A was remodeled in 1944.
71	Map Quad: G24 Year Built: 1917 Year Demolished: 1936 Uses: 1917 - 1936 — Garage and rock bin

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
71A	Map Quad: G24 Year Built: 1920 Year Demolished: 1938 Uses: 1920 - 1938 — **Gasoline pump house**
72	Map Quad: L21 Year Built: 1917 Year Demolished: 1935 Uses: 1917 - 1935 — Latrine
73	Map Quad: K21 Year Built: 1917 Year Demolished: 1933 Uses: 1917 - 1933 — Scrub shed
74	Map Quad: F23 Year Built: 1918 Year Demolished: NLT 1961 Uses: 1918 - ~1961 — Wharf house on Long wharf (Pier 2)
74A	Map Quad: F23 Year Built: 1918 Year Demolished: NLT 1961 Uses: 1918 - ~1961 — Office on Long wharf (Pier 2)
74B	Map Quad: F23 Year Built: 1918 Year Demolished: NLT 1961 Uses: 1918 - ~1961 — **Paint locker** and latrine
75	Map Quad: G22 Year Built: 1918 Year Demolished: NA Uses: 1918 - 1970 — **Carpenter shop** 1970 - Present — Storage
76	Map Quad: E21 Year Built: 1918 Year Demolished: NLT 1929 Uses: 1918 - ~1929 — Signal school
77 (See #200)	Map Quad: G20 Year Built: 1918 Year Demolished: See "Notes" Uses: 1918 - 1929 — **2,300 volt transformer house** (upper level), Sterilizerhouse (lower level) 1929 - 1945 — **2,300 volt transformer house** (upper level), **Automobile pit** (lower level) Notes: Beginning in 1918, on maps reviewed, the number "77" was used interchangeably with the number "200" for this building.
78	Map Quad: G20 Year Built: 1918 Year Demolished: 1938 Uses: 1918 - 1938 — Tool house

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
79	Map Quad: L21 Year Built: 1918 Year Demolished: 1936 Uses: 1918 - 1923 — Storehouse, Hospital Corps training school 1923 - 1936 — Garage and hose reel #9
80	Map Quad: H23 Year Built: 1918 Year Demolished: 1936 Uses: 1918 - 1929 — Receiving ship office 1929 - 1936 — Band quarters
81	Map Quad: Year Built: Year Demolished: Uses: Notes: No information found.
82	Map Quad: G20 Year Built: 1918 Year Demolished: 1932 Uses: 1918 - 1932 — Addition to **transformer substation**
83	Map Quad: H21 Year Built: 1918 Year Demolished: NA Uses: 1918 - 1961 — Garage extension and chauffeur's quarters 1961 - 1969 — Rental quarters and "three-car" garage 1969 - Present — Family quarters and garage
84	Map Quad: H23 Year Built: 1918 Year Demolished: NLT 1961 Uses: 1918 - ~1961 — Latrine house and electrical storeroom
85	Map Quad: L22 Year Built: 1917 Year Demolished: NLT 1935 Uses: 1917 - ~1935 — Wash and latrine house
86	Map Quad: F21 Year Built: 1918 Year Demolished: NLT 1929 Uses: 1918 - ~1929 — Camp Decatur isolation camp wash and latrine
87	Map Quad: F21 Year Built: 1918 Year Demolished: 1935 Uses: 1918 - 1935 — Storehouse on Army Point
88	Map Quad: I22 Year Built: 1918 Year Demolished: 1936 Uses: 1918 - 1936 — Bake oven house (addition to Building 65)

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
89	Map Quad: G22 Year Built: 1918 Year Demolished: 1933 Uses: 1918 - 1933 — Grand stand
90	Map Quad: I21 Year Built: 1918 Year Demolished: NLT 1929 Uses: 1918 - ~1929 — Wash house and latrine at **Meningaccous disease isolation camp**
91	Map Quad: I22 Year Built: 1918 Year Demolished: 1938 Uses: 1918 - 1929 — Barber shop for detention camp 1929 - 1938 — Quarters
92	Map Quad: H20 Year Built: 1904 Year Demolished: NLT 1961 Uses: 1904 - 1952 — Small arms magazine 1952 - ~1961 — Storage
93	Map Quad: L23 Year Built: 1918 Year Demolished: 1936 Uses: 1918 - 1936 — Wash house and latrine
94	Map Quad: K21 Year Built: 1918 Year Demolished: NLT 1929 Uses: 1918 - ~1929 — Latrine house
95	Map Quad: I22 Year Built: 1918 Year Demolished: 1934 Uses: 1918 - 1934 — Wash house and latrine
96	Map Quad: H22 Year Built: 1918 Year Demolished: NLT 1929 Uses: 1918 - ~1929 — Storehouse (lighthouse area)
97	Map Quad: L22 Year Built: 1920 Year Demolished: 1960 Uses: 1920 - 1960 — Recreation building and gymnasium; General Court Martials and barracks
98	Map Quad: G20 Year Built: 1918 Year Demolished: NLT 1948 Uses: 1918 - ~1948 — Pump house for the seawater fire system
99	Map Quad: K21 Year Built: 1919 Year Demolished: 1936 Uses: 1919 - 1936 — Drying house

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
100	Map Quad: K22 Year Built: 1903 Year Demolished: 1930 Uses: 1903 - 1930 — Radio Mess Hall and Galley
101	Map Quad: K22 Year Built: 1904 Year Demolished: 1932 Uses: 1904 - 1932 — Radio storehouse
102	Map Quad: K22 Year Built: 1917 Year Demolished: NLT 1935 Uses: 1917 - ~1935 — Radio covered walk
103	Map Quad: K22 Year Built: 1917 Year Demolished: NLT 1935 Uses: 1917 - ~1935 — Radio operating building
104	Map Quad: K22 Year Built: 1916 Year Demolished: 1940 Uses: 1916 - 1940 — Radio machine shop and garage
105	Map Quad: K23 Year Built: 1917 Year Demolished: 1934 Uses: 1917 - 1929 — Radio operator's quarters 1929 - 1934 — Chief Petty Officer (CPO) quarters Notes: In 1934, the original Building 105, located in Map Quad K22, was demolished to make way for the construction of the San Francisco-Oakland Bay Bridge. That same year, a new Building 105 was built in Map Quad K23.
105	Map Quad: K22 Year Built: 1934 Year Demolished: NA Uses: 1934 - 1966 - Double CPO and Enlisted quarters 1966 - Present - Married Officer's Quarters Notes: In 1934, the original Building 105, located in Map Quad K22, was demolished to make way for the construction of the San Francisco-Oakland Bay Bridge. That same year, a new Building 105 was built in Map Quad K23.
106	Map Quad: J23 Year Built: 1917 Year Demolished: 1934 Uses: 1917 - 1934 — Radio operator's dormitory Notes: In 1934, the original Building 106, located in Map Quad J23, was demolished to make way for the construction of the San Francisco-Oakland Bay Bridge. That same year, a new Building 106 was built in Map Quad K22.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
106	Map Quad: K22 Year Built: 1934 Year Demolished: NA Uses: 1934 - 1966 — Double CPO and Enlisted quarters 1966 - Present — Married Officer's Quarters Notes: In 1934, the original Building 106, located in Map Quad J23, was demolished to make way for the construction of the San Francisco-Oakland Bay Bridge. That same year, a new Building 106 was built in Map Quad K22.
107	Map Quad: J23 Year Built: 1917 Year Demolished: NA Uses: 1918 - Present — Signal tower 1961 - Present — Auxiliary power house
108	Map Quad: K22 Year Built: 1917 Year Demolished: NLT 1929 Uses: 1918 - ~1929 — Radio operating building built after Building 103.
109	Map Quad: J23-K23 Year Built: 1918 Year Demolished: 1934 Uses: 1918 - 1934 — Radio Commissary Building Notes: In 1934, the original Building 109, located in Map Quads J23-K23, was demolished to make way for the construction of the San Francisco-Oakland Bay Bridge. That same year, a new Building 109 was built in Map Quad K22.
109	Map Quad: K22 Year Built: 1934 Year Demolished: NA Uses: 1934 - 1966 — Double CPO and Enlisted quarters 1966 - Present — Married Officer's Quarters Notes: In 1934, the original Building 109, located in Map Quads J23-K23, was demolished to make way for the construction of the San Francisco-Oakland Bay Bridge. That same year, a new Building 109 was built in Map Quad K22.
110	Map Quad: J23 Year Built: 1918 Year Demolished: NLT 1935 Uses: 1918 - ~1935 — Radio direction finder building
111	Map Quad: K22 Year Built: 1921 Year Demolished: NA Uses: 1921 - 1966 — Double CPO quarters with Building 112 1966 - Present — Married Officer's Quarters

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
112	Map Quad: K22 Year Built: 1921 Year Demolished: NA Uses: 1921 - 1966 — Double CPO quarters with Building 111 1966 - Present — Married Officer's Quarters
113	Map Quad: K22 Year Built: 1921 Year Demolished: NA Uses: 1921 - 1966 — Double CPO quarters with Building 114 1966 - Present — Married Officer's Quarters
114	Map Quad: K22 Year Built: 1921 Year Demolished: NA Uses: 1921 - 1966 — Double CPO quarters with Building 113 1966 - Present — Married Officer's Quarters
115	Map Quad: K23 Year Built: 1921 Year Demolished: NA Uses: 1921 - 1966 — Double CPO quarters with Building 116 1966 - Present — Married Officer's Quarters
116	Map Quad: K23 Year Built: 1921 Year Demolished: NA Uses: 1921 - 1966 — Double CPO quarters with Building 115 1966 - Present — Married Officer's Quarters
117	Map Quad: J22 Year Built: NLT 1929 Year Demolished: NLT 1943 Uses: ~1929 - ~1943 — Elevated tank and pump house
118	Map Quad: J23 Year Built: 1922 Year Demolished: NA Uses: 1922 - Present — **Transformer house**
119	Map Quad: G24 Year Built: NLT 1929 Year Demolished: NLT 1950 Uses: ~1929 - ~1950 — Master-at-Arms Office
120	Map Quad: Year Built: Year Demolished: Uses: Notes: No information found.
121	Map Quad: F23 Year Built: 1920 Year Demolished: NLT 1961 Uses: 1920 - ~1961 — Storeroom under shed for yard craft crew (on the Long Wharf)

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
122	Map Quad: G20 Year Built: NLT 1929 Year Demolished: NLT 1943 Uses: ~1929 - ~1943 — **Transformer house**
123	Map Quad: H22 Year Built: 1919 Year Demolished: NLT 1961 Uses: 1919 - ~1961 — **Paint shop**
124	Map Quad: I22 Year Built: 1918 Year Demolished: 1934 Uses: 1918 - 1934 — Scrub shed
125	Map Quad: Year Built: Year Demolished: Uses: Notes: No information found
126	Map Quad: H24 Year Built: 1922 Year Demolished: NLT 1970 Uses: 1922 - ~1970 — **Transformer house** and moving picture storehouse
127	Map Quad: G24 Year Built: NLT 1929 Year Demolished: NLT 1945 Uses: ~1929 - ~1945 — **Machine shop** and tool room
128	Map Quad: G24 Year Built: NLT 1929 Year Demolished: NLT 1943 Uses: ~1929 - ~1943 — Shed for **chemical cart**
129	Map Quad: J22 Year Built: 1922 Year Demolished: NLT 1970 Uses: 1922 - ~1970 — Storage and hose cart house Notes: Previously part of Building 17 (1 of 10 shacks). Moved from Map Quad J23 to make way for the construction of the San Francisco-Oakland Bay Bridge in 1935.
130	Map Quad: I22 Year Built: NLT 1929 Year Demolished: NLT 1943 Uses: ~1929 - ~1943 — Tool house
131	Map Quad: I21 Year Built: NLT 1929 Year Demolished: NLT 1961 Uses: ~1929 - ~1961 — Valve house and shed
132	Map Quad: I22 Year Built: 1918 Year Demolished: NLT 1961 Uses: 1918 - ~1961 — Dressing room and shed

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
133	Map Quad: J22 Year Built: NLT 1929 Year Demolished: NLT 1943 Uses: ~1929 - ~1943 — Tank house
134	Map Quad: J23 Year Built: NLT 1929 Year Demolished: NLT 1935 Uses: ~1929 - ~1935 — Shed
135	Map Quad: J23 Year Built: NLT 1929 Year Demolished: NLT 1935 Uses: ~1929 - ~1935 — Shed
136	Map Quad: H18 Year Built: 1920 Year Demolished: 1936 Uses: 1920 - 1936 — Radio shed
137	Map Quad: I21 Year Built: 1918 Year Demolished: 1936 Uses: 1918 - 1936 — Chicken house
138	Map Quad: I21 Year Built: 1918 Year Demolished: 1936 Uses: 1918 - 1936 — Chicken house
139	Map Quad: I20 - 21 Year Built: 1918 Year Demolished: 1936 Uses: 1918 - 1936 — Chicken house and Greenhouse
140	Map Quad: H22 Year Built: NLT 1929 Year Demolished: 1933 Uses: ~1929 - 1933 — Handball court
141	Map Quad: H21 Year Built: NLT 1919 Year Demolished: 1936 Uses: ~1919 - 1936 — Sentry box
142	Map Quad: H20 Year Built: 1916 Year Demolished: NA Uses: 1916 - Present — Storage (Nursery tool shed) Notes: Although this building is identified as still being in existence on the present map, the physical building structure could not be located at the time of this survey.
143	Map Quad: F21 Year Built: 1938 Year Demolished: NLT 1945 Uses: 1938 - ~1945 — Handball court

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
144 (See #245)	Map Quad: F21 Year Built: 1891 Year Demolished: See "Notes" Uses: 1891 - ~1970 — **Incinerator** Notes: Building 144 was originally built as an incinerator for the Army Reservation on the point. In 1919, the building was taken over by the Navy. In 1943, it was renumbered to Building 245.
145	Map Quad: M21 Year Built: 1920 Year Demolished: NLT 1961 Uses: 1920 - ~1961 — Battery Saluting Platform
146	Map Quad: G22 Year Built: 1904 Year Demolished: 1940 Uses: 1904 - 1940 — Fresh Water Tank #1 (40,000 gallon)
147	Map Quad: G22 Year Built: 1904 Year Demolished: 1940 Uses: 1904 - 1940 — Fresh Water Tank #2 (40,000 gallon)
148	Map Quad: H22 Year Built: NLT 1917 Year Demolished: 1933 Uses: ~1917 - 1933 — Fresh Water Tank #3 (35,500 gallon)
149	Map Quad: H22 Year Built: NLT 1917 Year Demolished: 1933 Uses: ~1917 - 1933 — Fresh Water Tank #4 (20,000 gallon)
150	Map Quad: I22 Year Built: NLT 1917 Year Demolished: NLT 1945 Uses: ~1917 - ~1945 — Fresh Water Tank #5 (41,500 gallon) Notes: In 1935, Building 150 was moved from the southwest to the northeast corner of Map Quad I22 to make way for the construction of the San Francisco-Oakland Bay Bridge.
151	Map Quad: I22 Year Built: NLT 1917 Year Demolished: NLT 1945 Uses: ~1917 - ~1945 — Fresh water tank #6 (41,500 gallon) Notes: In 1935, Building 151 was moved from the southwest to the northeast corner of Map Quad I22 to make way for the construction of the San Francisco-Oakland Bay Bridge.
152	Map Quad: K22 Year Built: 1909 Year Demolished: 1932 Uses: 1909 - 1932 — Fresh Water Tank #7 (40,000 gallon)

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
153	Map Quad: K23 Year Built: NLT 1917 Year Demolished: NLT 1961 Uses: ~1917 - ~1961 — Fresh Water Tank #8 (41,500 gallon)
154	Map Quad: K22 Year Built: 1904 Year Demolished: 1932 Uses: 1904 - 1932 — Fresh Water Tank #9 (10,500 gallon)
155	Map Quad: J22 Year Built: NLT 1917 Year Demolished: NLT 1968 Uses: ~1917 - ~1968 — Fresh Water Tank #10 (54,000 gallon)
156	Map Quad: I21 Year Built: 1909 Year Demolished: 1938 Uses: 1909 - 1938 — Fresh Water Tank #11 (20,000 gallon)
157	Map Quad: I21 Year Built: 1909 Year Demolished: 1938 Uses: 1909 - 1938 — Fresh Water Tank #12 (30,000 gallon)
158	Map Quad: J21 Year Built: NLT 1917 Year Demolished: NLT 1950 Uses: ~1917 - ~1950 — Fresh Water Tank #13
159	Map Quad: I22 Year Built: NLT 1917 Year Demolished: NLT 1943 Uses: ~1917 - ~1943 — Fresh Water Tank #14
160	Map Quad: J22 Year Built: 1909 Year Demolished: 1938 Uses: 1909 - 1938 — Fresh Water Tank #15 (84,000 gal)
161	Map Quad: K22 Year Built: 1912 Year Demolished: 1932 Uses: 1912 - 1932 — Fresh Water Tank #16 (4,005 gal)
162	Map Quad: L21 Year Built: 1919 Year Demolished: NA Uses: 1919 - Present — Fresh Water Tank #17
163	Map Quad: L21 Year Built: NLT 1929 Year Demolished: NLT 1943 Uses: ~1929 - ~1943 — Fresh Water Tank #18
164	Map Quad: J22 Year Built: NLT 1919 Year Demolished: NLT 1961 Uses: ~1919 - ~1961 — Salt Water Tank #1 (364,000 gallon)

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
165	Map Quad: L21 Year Built: 1917 Year Demolished: 1932 Uses: 1917 - 1932 — Salt Water Tank #2 (51,500 gallon)
166	Map Quad: L21 Year Built: 1916 Year Demolished: 1932 Uses: 1916 - 1932 — Salt Water Tank #3 (30,356 gal)
167	Map Quad: G21 Year Built: 1929 Year Demolished: 1938 Uses: 1929 - 1938 — Salt Water Tank #4 (20,000 gal)
168	Map Quad: J23 Year Built: 1919 Year Demolished: NA Uses: 1919 - Present — Salt Water Tank #5
169	Map Quad: G20 Year Built: NLT 1916 Year Demolished: NA Uses: ~1916 - Present — **Oil Tank #1**
170	Map Quad: G20 Year Built: NLT 1916 Year Demolished: NA Uses: ~1916 - Present — **Oil Tank #2**
171	Map Quad: K22 Year Built: 1917 Year Demolished: NLT 1943 Uses: 1917 - ~1943 — **Oil Tank #3**
172	Map Quad: H24 Year Built: NLT 1929 Year Demolished: NLT 1943 Uses: ~1929 - ~1943 — **Oil Tank #4**
173-180	Map Quad: Year Built: Year Demolished: Uses: Notes: These building numbers were never assigned to any structures.
181	Map Quad: L18 Year Built: 1939 Year Demolished: NLT 1970 Uses: 1939 - ~1970 — **Gasoline storage tanks** Notes: Buildings 181 and 182 are listed on the Treasure Island map instead of the Yerba Buena map. This is because they were built as part of the Pan Am China Clipper service which was part of the Treasure Island project. However, they are physically on Yerba Buena Island, so they have been included here.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
182	Map Quad: L18 Year Built: 1939 Year Demolished: NLT 1970 Uses: 1939 - ~1970 — **Gasoline pump house** Notes: Buildings 181 and 182 are listed on the Treasure Island map instead of the Yerba Buena map. This is because they were built as part of the Pan Am China Clipper service which was part of the Treasure Island project. However, they are physically on Yerba Buena Island, so they have been included here.
183-199	Map Quad: Year Built: Year Demolished: Uses: Notes: These building numbers were never assigned to any structures.
200 (See #77)	Map Quad: G20 Year Built: See "Notes" Year Demolished: NA Uses: 1918 - Present — **Transformer station**, same as Building 77 (interchangeable since 1918) Notes: Beginning in 1918, on maps reviewed, the number "77" was used interchangeably with the number "200" for this building.
201	Map Quad: Year Built: Year Demolished: Uses: Notes: No information found
202	Map Quad: G22 Year Built: Unknown Year Demolished: NLT 1945 Uses: Unknown - ~1945 — **Paint shop and oil storage**
203	Map Quad: I22 Year Built: Unknown Year Demolished: NLT 1945 Uses: Unknown - ~1945 — Shed over scrubbing table
204 (See #29, 30, 31, and 38)	Map Quad: F22 Year Built: See "Notes" Year Demolished: NA Uses: 1934 - Present — Firehouse Notes: In 1934, Buildings 29, 30, 31 and 38 were combined to become Building 204.
205	Map Quad: H21 Year Built: 1936 Year Demolished: NA Uses: 1936 - Present — Garage (five car)

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
206	Map Quad: H23 Year Built: 1944 Year Demolished: NA Uses: 1944 - Present — Garage and apartment
207	Map Quad: I23 Year Built: 1936 Year Demolished: NA Uses: 1936 - Present — Garage for Quarters 9
208	Map Quad: F22 Year Built: 1939 Year Demolished: NLT 1961 Uses: 1939 - ~1961 — **Gasoline station**
209	Map Quad: H24 Year Built: NLT 1943 Year Demolished: NLT 1953 Uses: ~1943 - ~1953 — Shed over Marine Railway
210	Map Quad: Year Built: Year Demolished: Uses: Notes: No information found.
211	Map Quad: Year Built: Year Demolished: Uses: Notes: No information found.
212	Map Quad: F22 Year Built: 1922 Year Demolished: 1938 Uses: 1922 - 1938 — Garbage **incinerator**
213 (See #13)	Map Quad: F21 Year Built: See "Notes" Year Demolished: NA Uses: 1940 - 1961 — Recreation building 1961 - 1976 — Storage 1976 - 1994 — Firehouse #3 1994 - Present — Not in use Notes: Built originally as Building 13, it was renumbered as Building 213 after major remodeling in 1940.
214 (See #14)	Map Quad: G20 Year Built: See "Notes" Year Demolished: Mid 1980's Uses: 1943 - Mid 1980's — Heating plant Notes: Built originally as Building 14, it was renumbered as Building 214 after major remodeling in 1943.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
215 (See #40)	Map Quad: G22 Year Built: See "Notes" Year Demolished: 1945 Uses: 1940 - 1945 — Commissary store Notes: In 1940, after remodeling to Commissary store, Building 40 was renumbered to Building 215. By 1945, Building 215 was reassigned its original building number of Building 40.
216 (See #46)	Map Quad: G23 Year Built: See "Notes" Year Demolished: NLT 1945 Uses: 1933 - 1940 — **Receiving ship paint and blacksmith shop** 1940 - ~1945 — **Auto shed** Notes: Previously Building 46. Renumbered, after remodeling in 1933, to Building 216.
217	Map Quad: G22 Year Built: 1941 Year Demolished: NLT 1961 Uses: 1941 - ~1961 — Storehouse
218	Map Quad: L20 Year Built: NA Year Demolished: NA Uses: Notes: Listed as "planned" on 1943 map. Referred to as "Gas Chamber". Not shown on 1945 map. Probably not built.
219	Map Quad: L20 Year Built: 1941 Year Demolished: NLT 1970 Uses: 1941 - 1950 — Gun shed 1950 - ~1970 — Water control office
220	Map Quad: L21 Year Built: 1943 Year Demolished: Mid 1980's Uses: 1943 - Mid 1980's — Brig
221	Map Quad: L22 Year Built: 1943 Year Demolished: NA Uses: 1943 - Present — Prisoner's work shop
222	Map Quad: L22 Year Built: 1943 Year Demolished: 1960 Uses: 1943 - 1960 — Marine Detention Barracks
223	Map Quad: J23 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - ~1961 — Storage

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
224	Map Quad: J23 Year Built: 1943 Year Demolished: 1960 Uses: 1943 - 1960 — Radio school (Radar)
225	Map Quad: L21 Year Built: 1938 Year Demolished: NA Uses: 1938 - Present — Pump House
226	Map Quad: L21 Year Built: 1943 Year Demolished: NLT 1961 Uses: 1943 - ~1961 — Washroom and storage (prisoner's effects)
227	Map Quad: M20 Year Built: 1938 Year Demolished: NA Uses: 1938 - Present — Fresh Water Tank
228	Map Quad: Year Built: Year Demolished: Uses: Notes: No information found.
229	Map Quad: J23 Year Built: 1944 Year Demolished: NA Uses: 1944 - Present — Tower annex, Communications, and storage
230	Map Quad: H21 Year Built: 1944 Year Demolished: NA Uses: 1944 - Present — Garage (3 car) and quarters
231	Map Quad: F22 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — **Incinerator**
232	Map Quad: E21 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Barracks
233	Map Quad: E21 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Subsistence
234	Map Quad: F21 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Barracks
235	Map Quad: E21 Year Built: 1944 Year Demolished: 1961 Uses: 1944 - 1961 — Barracks

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
236	Map Quad: G22 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - ~1969 — **Gas storage**, bag storage
237	Map Quad: G22 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - ~1969 — Garage (Westdocks Survey Team storage)
238	Map Quad: G23 Year Built: 1944 Year Demolished: NLT 1970 Uses: 1944 - ~1970 — Recreation building (theater, bowling alley, pool hall, reading room, library, boxing, basketball, handball, squash, wrestling, weight lifting, etc.)
239	Map Quad: H23 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Bachelor Officer's Quarters
240	Map Quad: I22 Year Built: 1944 Year Demolished: NA Uses: 1944 - ~1966 — Dispensary and ward ~1966 - Present — Officer's Quarters (12 apartments)
241	Map Quad: L22 Year Built: 1944 Year Demolished: Mid 1980's Uses: 1944 - Mid 1980's — Brig
242	Map Quad: K21 Year Built: 1944 Year Demolished: NA Uses: 1944 - Present — Fresh Water Tank
243	Map Quad: K20 Year Built: 1944 Year Demolished: NA Uses: 1944 - Present — Pump House
244	Map Quad: F21 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1945 - 1950 — Drying Building 1950 - 1961 — Barracks
245 (See #144)	Map Quad: F21 Year Built: 1891 Year Demolished: NLT 1970 Uses: 1891 - NLT 1970 — Trash and Laundry Notes: Building 245 was the former Army incinerator (Building 144, 1891 - 1943). Building 144 was renumbered to Building 245 after its conversion to the Trash and Laundry facility in 1943.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
246	Map Quad: H23 Year Built: 1938 Year Demolished: NLT 1961 Uses: 1938 - ~1961 — Loading shed
247	Map Quad: E21 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Bag storage
248	Map Quad: L21 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — Barracks
249	Map Quad: L21 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - ~1961 — Showers
250	Map Quad: F22 Year Built: 1945 Year Demolished: NLT 1961 Uses: 1945 - ~1961 — Drying room
251	Map Quad: E21 Year Built: 1945 Year Demolished: NLT 1961 Uses: 1945 - ~1961 — Garbage shed
252	Map Quad: G21 Year Built: 1945 Year Demolished: NLT 1961 Uses: 1945 - ~1961 — Storage shed
253	Map Quad: J21 Year Built: 1945 Year Demolished: NA Uses: 1945 - Present — Storage shed for Quarters 62
254	Map Quad: I23 Year Built: 1945 Year Demolished: NA Uses: 1945 - Present — Storage shed for Quarters 8
255	Map Quad: L22 Year Built: 1947 Year Demolished: NA Uses: 1947 - Present — **Chlorinator** (San Francisco pipeline)
256	Map Quad: H23 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Meat cutting and store room
257	Map Quad: F22 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Saw mill

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
258	Map Quad: F22 Year Built: 1942 Year Demolished: 1960 Uses: 1942 - 1960 — Storage and gymnasium
259	Map Quad: H23 Year Built: 1944 Year Demolished: NLT 1992 Uses: 1944 - ~1992 — Storage and carport for Quarters 9
260	Map Quad: E21 Year Built: 1946 Year Demolished: NLT 1961 Uses: 1946 - ~1961 — Assembly shed
261	Map Quad: K21 Year Built: 1948 Year Demolished: NA Uses: 1948 - Present — **Chlorinator** (Oakland pipeline).
262	Map Quad: D21 Year Built: 1891 Year Demolished: NA Uses: 1891 - 1953 — **Torpedo (Mine)** Assembly Building (Army) 1953 - Present — Storage, Long Range Accuracy (LORAC) Storage (Army) Notes: Buildings 262 through 266 were the US Army Torpedo Station on Yerba Buena Island established in 1891. This Army Reservation remained independent until after WW II. Finally, by 1953, it was taken over by the Navy and essentially no longer used. Only the Mine Assembly building still stands out on the tip of the northeast point under the SFO Bay Bridge.
263	Map Quad: D21 Year Built: 1891 Year Demolished: NLT 1961 Uses: 1891 - ~1961 — Married Enlisted Men's Quarters (Former Army Officer's Quarters for Torpedo Station) Notes: Buildings 262 through 266 were the US Army Torpedo Station on Yerba Buena Island established in 1891. This Army Reservation remained independent until after WW II. Finally, by 1953, it was taken over by the Navy and essentially no longer used. Only the Mine Assembly building still stands out on the tip of the northeast point under the SFO Bay Bridge.
264	Map Quad: E22 Year Built: 1891 Year Demolished: NLT 1961 Uses: 1891 - ~1961 — Storage (Former Army) Notes: Buildings 262 through 266 were the US Army Torpedo Station on Yerba Buena Island established in 1891. This Army Reservation remained independent until after WW II. Finally, by 1953, it was taken over by the Navy and essentially no longer used. Only the Mine Assembly building still stands out on the tip of the northeast point under the SFO Bay Bridge.

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
265	Map Quad: D21 Year Built: 1891 Year Demolished: NLT 1961 Uses: 1891 - ~1961 — Storage (Former Army) Notes: Buildings 262 through 266 were the US Army Torpedo Station on Yerba Buena Island established in 1891. This Army Reservation remained independent until after WW II. Finally, by 1953, it was taken over by the Navy and essentially no longer used. Only the Mine Assembly building still stands out on the tip of the northeast point under the SFO Bay Bridge.
266	Map Quad: F21 Year Built: 1891 Year Demolished: NLT 1961 Uses: 1891 - 1953 — Storage, **Torpedo Tank House** 1953 - ~1961 — Storage Notes: Buildings 262 through 266 were the US Army Torpedo Station on Yerba Buena Island established in 1891. This Army Reservation remained independent until after WW II. Finally, by 1953, it was taken over by the Navy and essentially no longer used. Only the Mine Assembly building still stands out on the tip of the northeast point under the SFO Bay Bridge.
267 (See #28)	Map Quad: H22 Year Built: See "Notes" Year Demolished: NA Uses: 1947 - Present — Garage for Quarters 10 Notes: Building 28 was originally built in map quad I22. In about 1935, the building was moved to Quarters 10 in map quad H22 to make way for the construction of the San Francisco-Oakland Bay Bridge. Maps of 1947 indicate that Building 28 became the garage for Quarters 10 (Building 267), and that its structure had changed in size and had been moved even closer to Quarters 10. It is not known if Building 28 was at that time demolished and rebuilt as a new structure, or if it was remodeled.
268	Map Quad: H22 Year Built: NLT 1961 Year Demolished: NLT 1970 Uses: ~1961 - ~1970 — Gate House
269	Map Quad: I23 Year Built: NLT 1961 Year Demolished: NLT 1970 Uses: ~1961 - ~1970 — Gate House
270	Map Quad: F22 Year Built: NLT 1961 Year Demolished: NA Uses: ~1961 - Present — **Heating Plant (HVAC)**
271	Map Quad: F22 Year Built: NLT 1961 Year Demolished: NLT 1992 Uses: ~1961 - ~1992 — **Imhoff Tank** (part of sewage system)

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
272	Map Quad: F22 Year Built: NLT 1961 Year Demolished: NLT 1992 Uses: ~1961 - ~1992 — **Sewage Lift Station**
273	Map Quad: G21 Year Built: 1940 Year Demolished: NA Uses: 1940 - Present — Tennis courts
274	Map Quad: J21 Year Built: NLT 1970 Year Demolished: NA Uses: ~1970 - Present — Public Works (PW) maintenance storage, fallout shelter
275	Map Quad: Year Built: Year Demolished: Uses: Notes: No information found.
276	Map Quad: K21 Year Built: 1968 Year Demolished: NA Uses: 1968 - Present — Community laundry and HW building
277	Map Quad: H22 Year Built: 1965 Year Demolished: NA Uses: 1965 - Present — Restrooms
278	Map Quad: J23 Year Built: 1969 Year Demolished: NA Uses: 1969 - Present — Inner harbor radar equipment building
279-299	Map Quad: Year Built: Year Demolished: Uses: Notes: These building numbers were never assigned to any structures.
300	Map Quad: L19 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
301	Map Quad: L20 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
302	Map Quad: M20 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters

Table 2

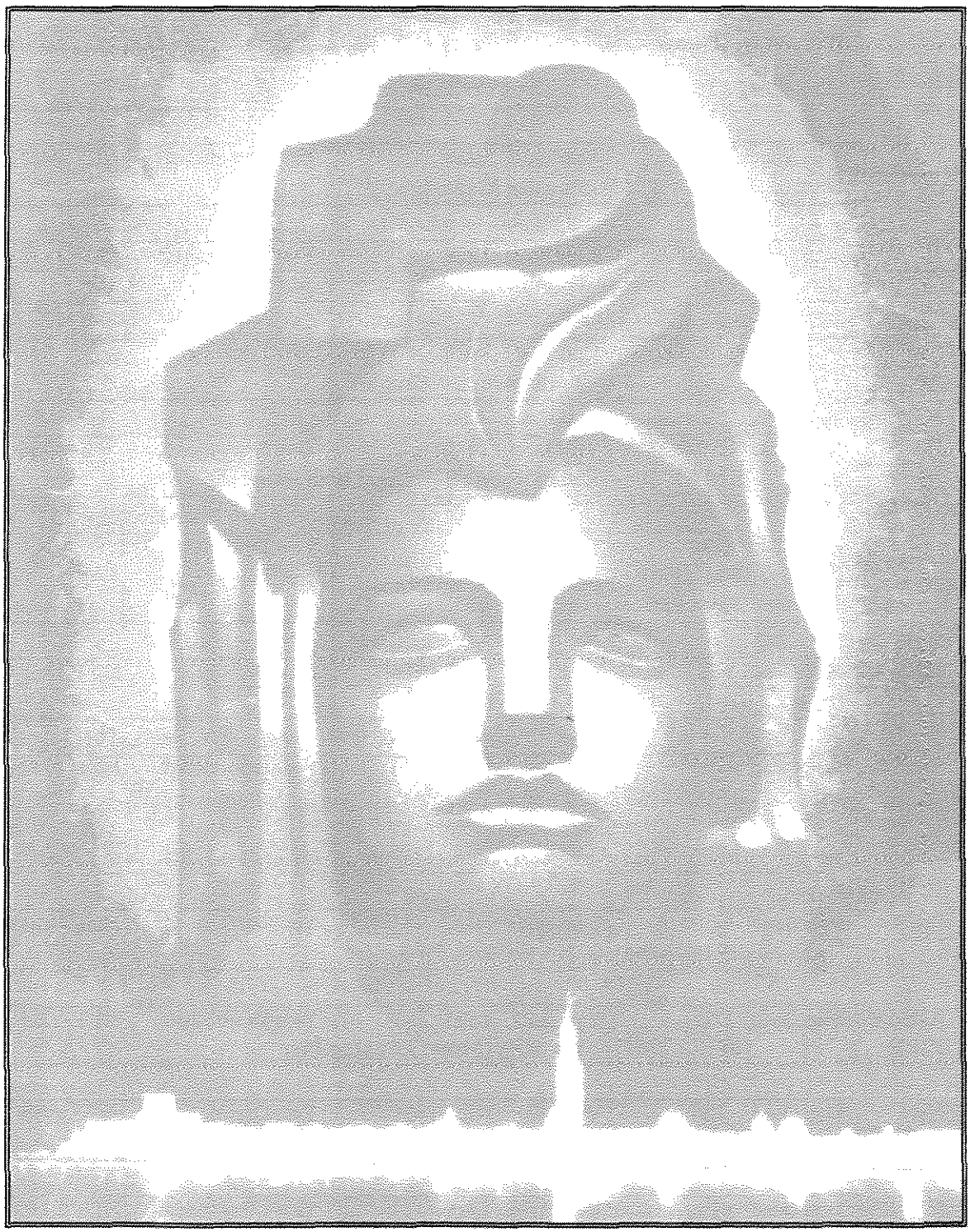
Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
303	Map Quad: M20 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
304	Map Quad: M20 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
305-323	Map Quad: Year Built: Year Demolished: Uses: Notes: These building numbers were for planned buildings that were never built.
324	Map Quad: L21 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
325	Map Quad: L21 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
326	Map Quad: L21 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
327	Map Quad: M21 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
328	Map Quad: L21 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
329	Map Quad: L20 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters
330	Map Quad: Year Built: Year Demolished: Uses: Notes: No information found.
331	Map Quad: L20 Year Built: 1966 Year Demolished: NA Uses: 1966 - Present — Officer's Quarters

Table 2

Buildings of Yerba Buena Island
Built Post-1891

Bldg. No.	Building Data
NA	Map Quad: I20 Year Built: 1929 Year Demolished: NLT 1935 Uses: 1929 - ~1935 — **Powder Magazine**
NA	Map Quad: F21-F22 Year Built: 1929 Year Demolished: NLT 1943 Uses: 1929 - ~1943 — **Dump**
NA	Map Quad: L20 Year Built: 1916 Year Demolished: NLT 1948 Uses: 1916 - ~1948 — **Targets for small arms**
NA	Map Quad: G19-H18 Year Built: 1920 Year Demolished: 1936 Uses: 1920 - 1936 — Radio Wharf (Building 136 to shore)
PIER 1	Map Quad: G24 Year Built: 1900 Year Demolished: NA Uses: 1900 - 1939 — Receiving Ship Pier 1939 - Present — USCG Pier
PIER 2	Map Quad: F23 Year Built: NLT 1916 Year Demolished: NLT 1961 Uses: ~1916 - ~1961 — Long Wharf
PIER 3	Map Quad: G20 Year Built: NLT 1916 Year Demolished: NLT 1992 Uses: ~1916 - ~1992 — **Fueling Pier** (definitely handled oil, gasoline and kerosene) Notes: The 1945 aerial photo of this area shows an apparent oil slick on the water.
PIER 4	Map Quad: G20 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Normal uses for a pier
ARMY PIER	Map Quad: D21 Year Built: 1891 Year Demolished: NLT 1961 Uses: 1891 - ~1961 — **Torpedo (Mine) Loading Pier**
NA	Map Quad: G24 Year Built: NLT 1929 Year Demolished: 1935 Uses: ~1929 - 1935 — Marine Railway (Boatways)
NA	Map Quad: F21 Year Built: 1919 Year Demolished: NLT 1935 Uses: 1919 - ~1935 — **Photog (photography** (?)) Building



Chapter 2 Treasure Island

2.1 Introduction

The history of Treasure Island is relatively short and easily divided into the following two eras:

- Construction through the Golden Gate International Exposition, 1936-1940
- Military use and occupation, 1940-Present (1995)

Construction of Treasure Island was started on February 11, 1936, by the Army Corps of Engineers. Eighteen and one-half months later, on August 24, 1937, construction of the island was completed on time and under budget. The building of the Exposition structures and the landscape preparation continued for the next eighteen months. On February 18, 1939, the Golden Gate International Exposition opened on schedule. The Exposition was built to celebrate the completion of the Golden Gate and San Francisco-Oakland Bay Bridges. It was also an attempt to draw the United States (US) citizens out of "the Depression" of the 1930s by a positive display of unity among nations. The building of the island would also give the City of San Francisco an international airport after the Exposition closed. The future was supposed to look bright. But, war clouds had already gathered on the horizon. War had already broken out in Europe, and Japan was well into its conquest of Korea, China, and Indochina. In fact, the Swastika flag of Nazi Germany and the Rising Sun Flag of Japan were two of the many flags waving at the Exposition's ground-breaking ceremony.

The reality of war was not to be denied. In the five months that followed the Exposition's September 29, 1940 closing, the Navy was granted a lease to take possession of Treasure Island "...until the passing of this present national emergency." The City of San Francisco exchanged the lease of Treasure Island to the Navy for the Navy's assistance in its obtaining bayshore property in the City of San Bruno for an airport. San Francisco realized that Treasure Island would become inadequate for use as an international airport. Advances in aircraft technology demonstrated the growing need for a much larger parcel of land that would allow future expansion. The San Francisco-Oakland Bay Bridge was becoming busier and planners could see potential safety risks because of the closeness of flight paths to the bridge and its traffic. The Navy, on the other hand, liked the placement of Treasure Island and preferred to remain there. So, the deal was struck to the satisfaction of both sides.

2.2 Treasure Island Construction through the Golden Gate International Exposition, 1936-1940

Built to celebrate the completion of the great engineering marvels of the Golden Gate Bridge and San Francisco-Oakland Bay Bridge, Treasure Island was itself a magnificent 20th Century engineering achievement. Constructed by the Army Corps of Engineers in the incredibly short time of 18½ months, the island has a perimeter seawall comprised of 287,000 tons of rock that supports 29,665,152 cubic yards of sand and gravel fill which was dredged from the bottom of San Francisco Bay. Once the seawall was raised to a height of 13 feet above sea level, the fill, a mixture of sand, gravel, and baywater, was poured into the newly created cavity via dredge lines. The baywater was separated from the sand and gravel and pumped from the developing island through several wells. Once the cavity was filled, desalinization of the fill was accomplished by

pumping millions of gallons of fresh water onto the surface of the island followed by the extraction of the saltwater, now diluted, from the land. Finally, at least a 6 foot layer of good topsoil, imported from the San Joaquin Valley, was used to surface the entire manmade island. Total cost for the creation of the island, exclusive of buildings, was $3,808,900.00.

From the onset of the project, the island remained unnamed. It did not take long, however, for someone to realize that the dirt used to fill the island was dirt washed down from the gold bearing mountains of the Sierra Nevada. Consequently the decision was made to use this theme as the basis for naming the island. "Gold Island" was proposed, but it did not quite sound right. Finally, someone suggested "Treasure Island", and the name became permanent. (Ref. G).

Original plans for Treasure Island included the construction of the island, holding a two year long Exposition, and then converting it into an international airport. The airport was to have the capability of supporting both sea going planes, such as the China Clipper, and large, land based planes. Most of the island would be runways, except for the south end which was to be reserved for the various support and maintenance buildings. See Figure 33. (Ref. KK).

The first three structures to be built on Treasure island were the two enormous hangars and the "U-shaped" Terminal and Administration Building. These buildings were constructed as permanent structures because of the intent to use them as airport facilities after the Exposition closed. The Terminal and Administration Building, with its unusual and beautiful marble clad curving hall, high ceilings, floors, and staircases, was an awesome portrayal of Art Deco design. Construction of these buildings began prior to the completion of the island. This was possible only because the south end of the island was formed first, over existing shoals, that allowed work to start as the rest of the island was being filled-in as it progressed northward into deeper water. The Terminal Building was later to be numbered Building 1 and the Hangers, Buildings 2 and 3. Building 1 and part of Building 2 were used by Pan American (PanAm) Airline's China Clipper Service, during a time period ranging from before the formal opening of the Exposition, in 1939, until 1945. PanAm retired the entire China Clipper fleet from service in 1945. The fleet had become obsolete because of the innovative airplane technology developed during World War II. (Ref. I). As a side note, testifying to the interest in the architecture of the Terminal Building, Hollywood movie makers, Steven Spielberg and George Lucas, selected it for the location to film a segment of the movie "Indiana Jones and the Last Crusade". The building was depicted as a World War II Berlin dirigible terminal. During the filming the Navy would not allow Spielberg and Lucas to actually drape the Nazi Banner and insignia props on the building. So, they simply filmed the segment without them and later added the Nazi paraphernalia to the segment by the use of "in-lab" special effects.

As soon as the construction of the island was finished, the great Exposition buildings were put up at a total cost of about $50,000,000. In all, 4,000 fully grown trees and shrubs, 800,000 annuals, 400,000 perennials, and 250,000 tulips were shipped to the island by barge and planted. The centerpiece of the Exposition was a 400 foot tall sculpture titled the "Tower of the Sun". The sculpture was a slim, octagonal needle with the statue of a phoenix bird at the top which represented the City of San Francisco's rise from the ashes of the 1906 earthquake and fire. The Tower also contained a set of bells, which were relocated to the Grace Cathedral in San Francisco after the Exposition closed. See Figure 34. (Ref. R). Erected at the north end of Treasure Island's main Avenue was the other focal point of the Exposition, the great statue of "Pacifica". The statue was an 80 foot high statue of a woman wearing Polynesian clothing. See

Figure 35. Sadly in 1941, "Pacifica" was one of the first of the Exposition structures to be removed by the Navy during the conversion of Treasure Island into a naval base.

"A Pageant of the Pacific" was the theme of the Exposition. The architecture used was of Mayan and Oriental influences. Countries, cultures, and plants were chosen to represent life as it is in the Pacific. Additionally, some of the individual displays of the fair were designed to represent a specific nation, such as the Japan building, but were not necessarily related architecturally to the rest of the Exposition. As a result, the overall appearance of the Exposition was a very eclectic and exotic display of differing ethnic styles.

Due to the size of the Exposition, "Elephant Trains" ran regular routes around the island transporting visitors. These "Elephant Trains" were small tractor pullers towing up to five cars. They were decorated to resemble elephants pulling circus cars. After the Exposition, their decorations were removed and they were sent to Mare Island Naval Shipyard. There, during WW II, they provided transportation around the shipyard for military and civilian personnel.

The entry to the Exposition faced the direction of the prevailing winds, which was mostly to the west. Portals to the ticket booths were built as wind breaks, protecting the "Court of Heaven" just inside the main entrance. The engineer while designing the entrance portals used a fan, models of the portals, and chicken feathers for preliminary testing. The "Court of Heaven" and the "Temple Court" were used as gathering places for the many concerts and speeches presented at the Exposition. Many different nations provided the Exposition with displays. These countries included: China, France, Netherlands, East Indies, Mexico, El Salvador, Panama, Guatemala, Peru, Colombia, Chile, Ecuador, Brazil, Argentina, Philippines, Australia, French Indochina, Johore (a South Pacific Island), New Zealand, Japan, Italy (using several varieties of Italian marble) and Norway. Unfortunately, the buildings reserved for the displays from France and Italy basically stood vacant during the 1940 Exposition because at the time the two countries were extensively involved in WW II.

The Exposition buildings representing Japan were quite unique. The Japanese brought their own workers, materials, and supplies from Japan instead using local supplies and labor from San Francisco as expected. Their buildings were erected using traditional Japanese building techniques consisting of wood, wooden bolts and nails, and rope lashings. No metal fasteners were used in the construction of the buildings. Typically, the roof was installed first, then the interior was completed, then the outside walls put in place for each building they constructed. See Figure 36.

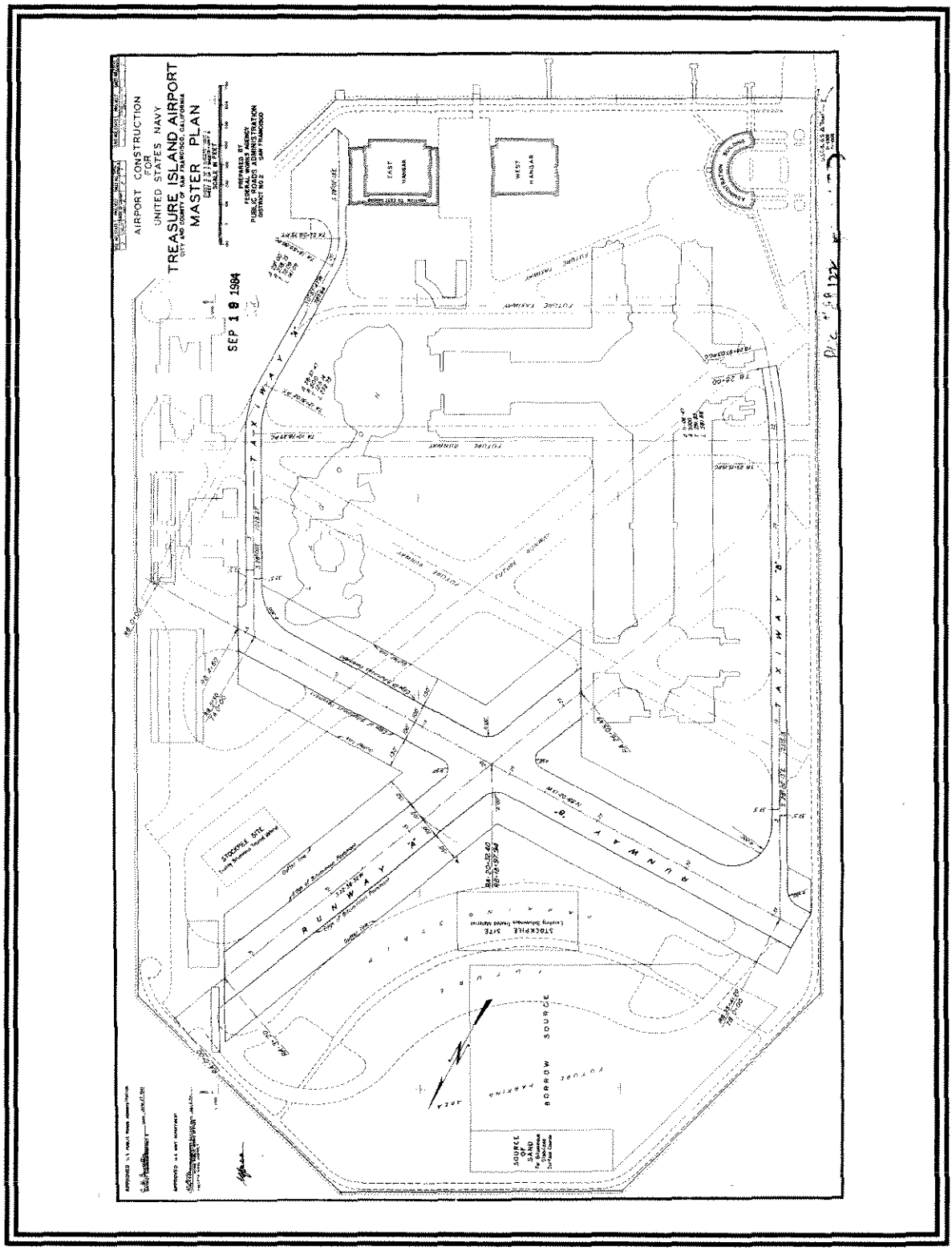


FIGURE 33. ***Plan of Proposed Treasure Island Airport. Circa 1939.*** (Ref. KK)
Note: The Plan of the Proposed Treasure Island Airport was to be implemented when the Exposition closed in 1940. Advances in avialtion quickly proved this design to be inadequate.

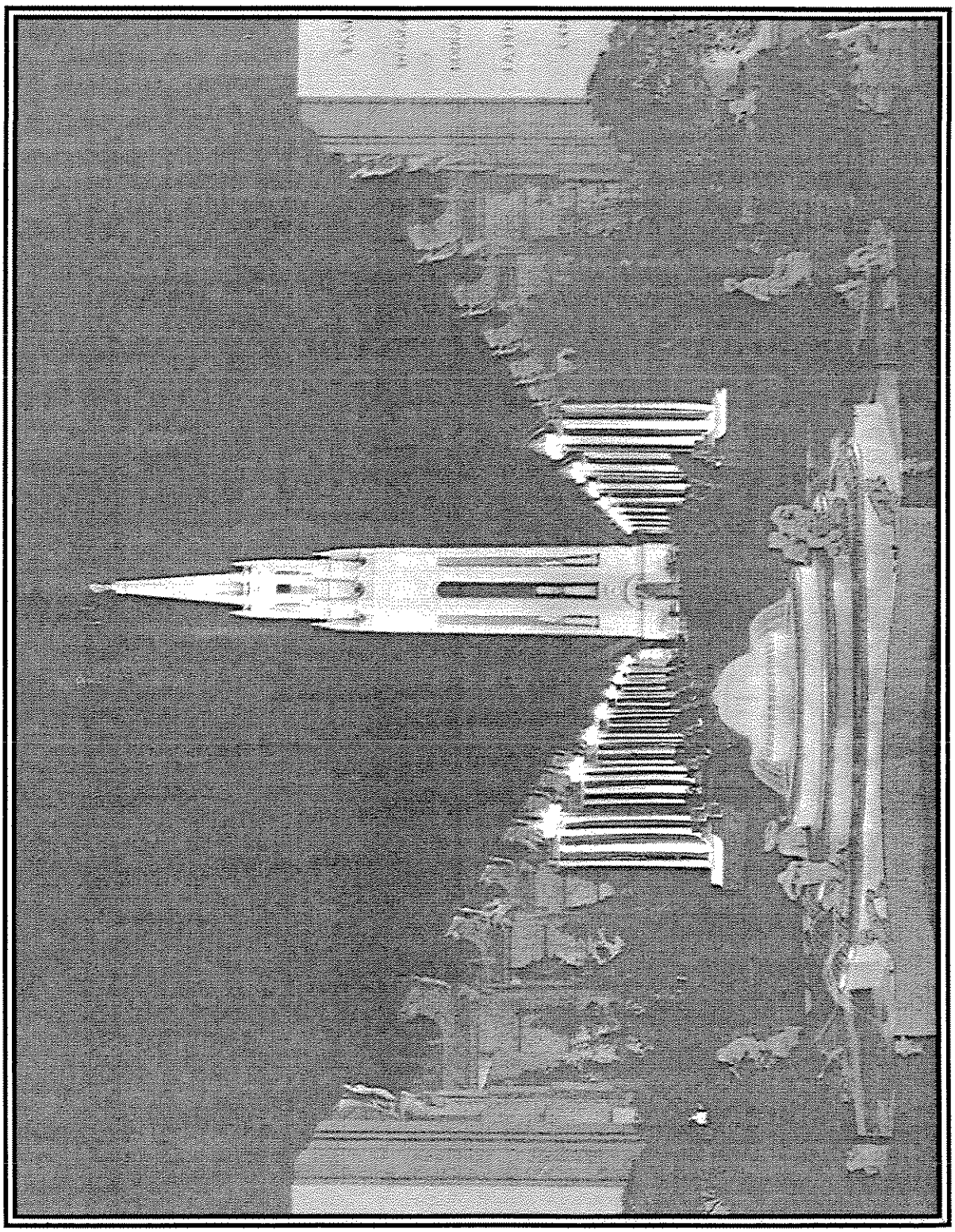


FIGURE 34. ***Court of the Seven Seas. Circa 1939.***
Note: A night photograph of the "Court of the Seven Seas" taken from the "Fountain of Western Waters" looking towards the "Tower of the Sun".

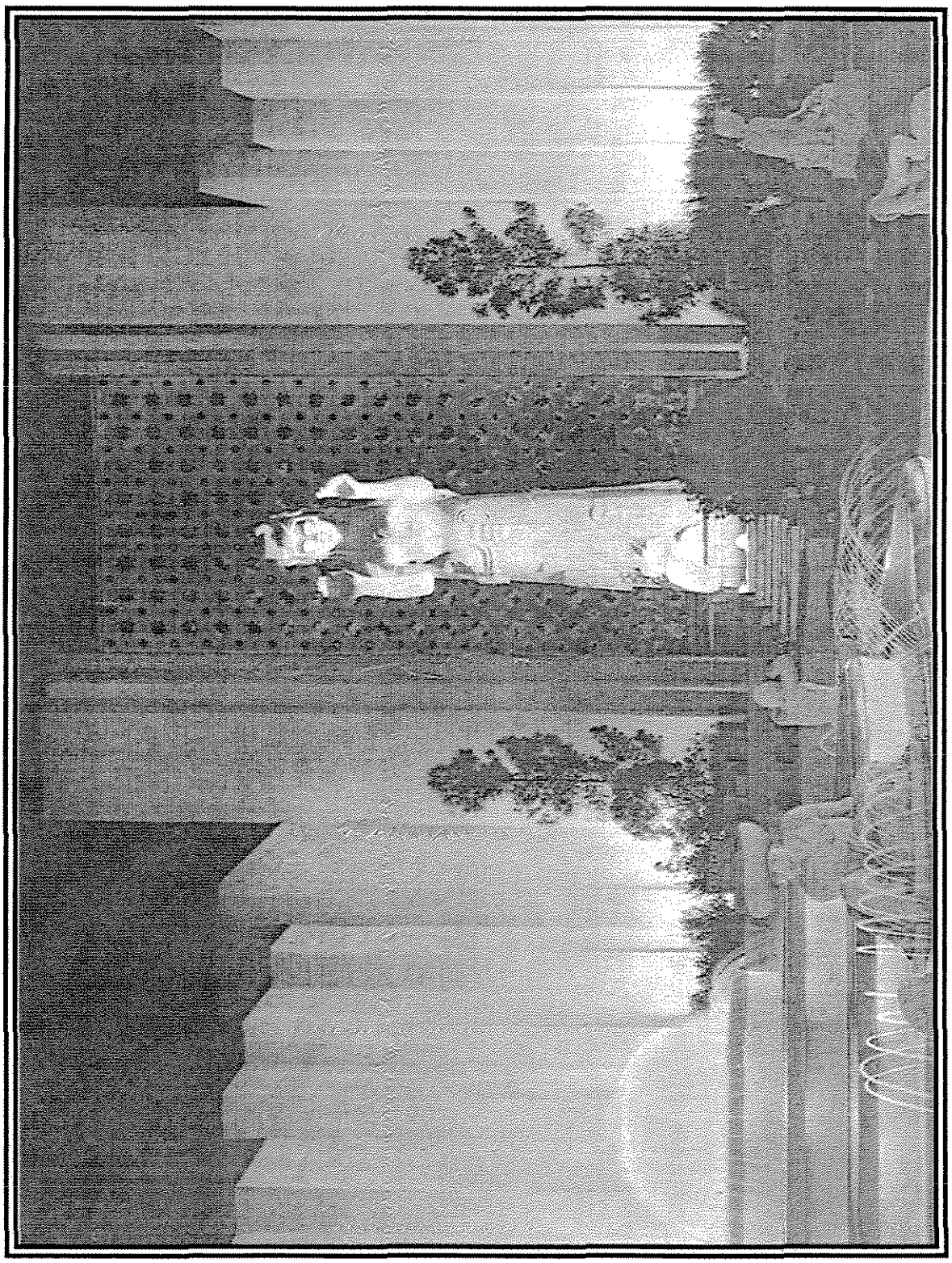


FIGURE 35. ***Court of Pacifica. Circa 1939.***
Note: A night photograph of the "Court of Pacifica" featuring the eighty foot statue of "Pacifica" (created by Ralph Stackpole) surrounded by the "Fountain of Western Waters".

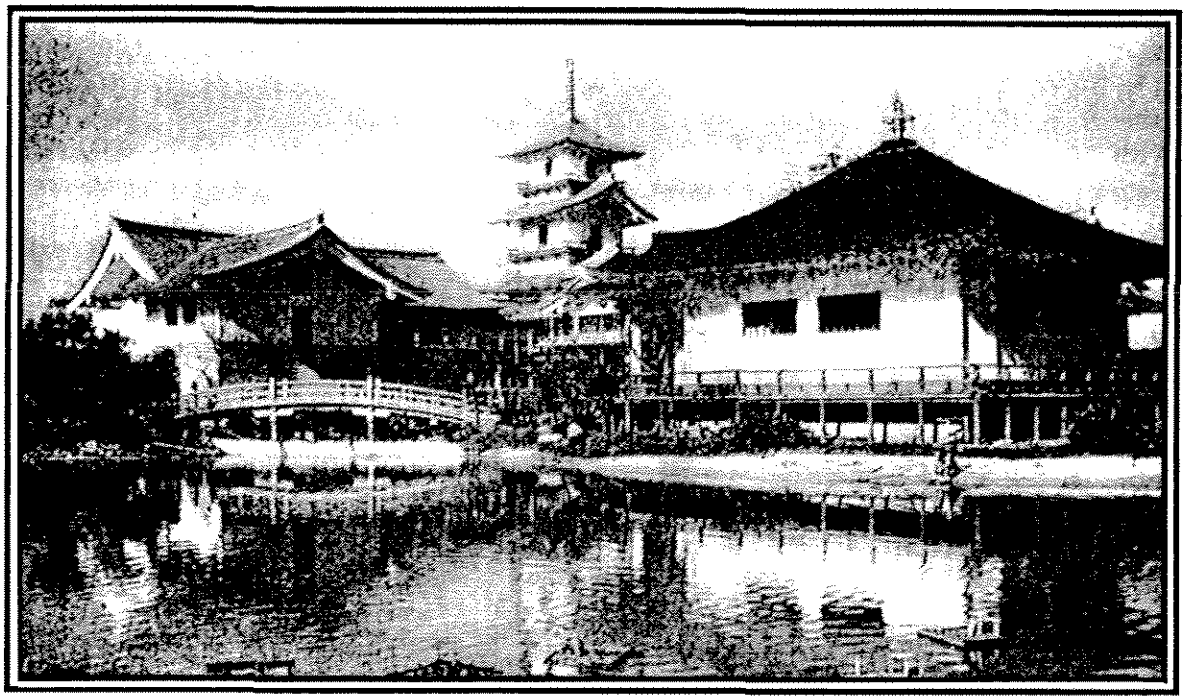


FIGURE 36. ***Japan's Samurai House and Temple on Medial Lake. Circa 1939.***

Exhibits from the United States include displays from a few states, such as Missouri, Illinois, Oregon and a "Western States" grouping. Most of the California counties provided displays also. County displays included groupings from the Southern Counties, Mission Trail Counties, and Redwood Empire Counties; while the individual county displays were from Alameda, Contra Costa, San Joaquin, Sacramento, Shasta, Cascade and San Francisco.

International, national, state, county and local displays, although a major part of the Exposition, were not the only displays of interest. Some of the more popular exhibits were: Metal Homes, a Dutch Restaurant, Ripley's "Believe It or Not", a Diving Bell, life and history of Mark Twain, and "Jerusalem - The Holy City", to name a few. Both the Sally Rand Nude Ranch and the Snake Show were considered by many "a must" for entertainment. Also, an unusual number of religions were represented at the Exposition. Displayed were a Hindu temple, a Moslem mosque, and a Christian Science room. The Christian Businessmen's Association even provided an exhibit. There was also a display called the "Temple of Religion" which contained 10 murals, a hand carved pearl portrayal of the "Last Supper" of Jesus, as well as a Biblical garden containing the 200 varieties of flowers mentioned in both the Old and New Testaments of the Bible.

As would be expected, there were foods and restaurants of all types available at the Exposition. The Dutch restaurant introduced the Javanese dish "rijsttafel" (rice table) to America. The Chinese village included a restaurant with chefs direct from China. Altogether, in 1939 the foreign restaurants included: two Chinese, a Javanese, a Dutch, a Scotch, a Russian, two French, an Italian, a Philippine, and a Mexican restaurant. In 1940, one French restaurant and the Italian restaurant closed because their sponsoring countries did not attend the Exposition that year.

American food restaurants represented at the Exposition included: a restaurant specializing in Tuna dishes, the Oakwood Barbecue with its outside barbecue pit to flavor the air, and, of course, the Ghirardelli Chocolate Building. Other American restaurants having displays were the Bean Pot, Jolly Roger, Doughnut Corp., Pig'n Blanket, Vacationland, California Coliseum Restaurant, Corn on the Cob, Fisherman's Grotto, Tropical Fruits, two Fish Stands, a Fike Coffee Shop, Louis Kahn stands, and a frozen custard stand.

The largest "entertainment" display at the Exposition was the "Cavalcade" show. In 1939, it was titled the "Cavalcade of the Golden West"; and "America! Cavalcade of a Nation", in 1940. The theater production, considered the "theme spectacle" of the Exposition, was performed in an auditorium that seated 7,000 people. The live action performance written by Art Linkletter covering 400 years of American history, was performed on a stage 400 foot in length and used stage sets that traveled on rails. The events depicted by the performance included the discovery of gold, the short reign of the Pony Express, and the San Francisco earthquake and fire. Some of the characters protrayed by the thespians were Portola, Balboa, Serra, Cortez, Fremont, Sutter, and Marshall.

Even before its official opening on February 18, 1939, the Golden Gate Exposition was a magnet for dignitaries and celebrities. President Roosevelt toured the island while the Exposition was under construction. Eleanor Roosevelt, during a separate tour than that of her husbands, actually operated a steam shovel (for a short time). J. Edgar Hoover also paid a short visit to the Exposition following its opening. The mayor of New York City, Fiorello LaGuardia, toured the Exposition with San Francisco's Mayor Rossi. Since New York was hosting the "World's Fair" at the same time as San Francisco was hosting the Exposition, there was the typical braggadocio attitude of "My city can do this better than your city." However, it is worth noting that after the Mayor returned to New York City the "World's Fair" adopted several methods used by the Golden Gate Exposition. Among the dignitaries that attended the Exposition were the Crown Prince of Denmark, and the Maharaja of Karputhala, India, who was accompanied by the British Consul, Sir Geoffrey Butler.

The Exposition drew "big name" entertainers. A partial list of those best known included: Bing Crosby, Bob Hope, Count Basey and his orchestra, Eddie Cantor, Al Jolson, Fibber McGee, Kate Smith, Burns and Allen, John B. Hughes (newscasts), the Billy Rose Aquacade with Johnny Weismuller and Esther Williams, Phil Harris Review with Jack Benny and Mary Livingstone, Betty Grable, the violinist Rubinoff, Benny Goodman and his orchestra, the Ziegfield Follies, the Folies Bergere, the Fred Waring Glee Club, Lily Pons and Andre Kostelanetz, and the legendary Leopold Stokowski (the conductor in the movie "Fantasia") directing the San Francisco Symphony. One of the most noted events of the Exposition was a concert given on September 24, 1940. The concert, titled "Those Who Make America's Music", was a joint venture presented by the American Society of Composers, Authors and Publishers. This group included thirty-six composers some of which were famous names, such as George M. Cohan, Mack Gordon, Jerome Kern, Dave Stamper, Hoagy Carmichael, and Irving Berlin. See Figure 37.

FIGURE 37. ***Celebrities at the Exposition. Circa 1939.***
Note: Photographs of President Hoover, New York City Mayor La Guardia,Comic Edgar Bergen, and Actor Eddie Cantor enjoying the Golden Gate Exposition.

One of the better stories relating to the Exposition that best illustrates the old adage "... even the best laid plans can often go astray..." was that of baseball when Joe Sprinz, the catcher of the San Francisco Seals, attempted to set a world record. (Ref. Q). The story is as follows:

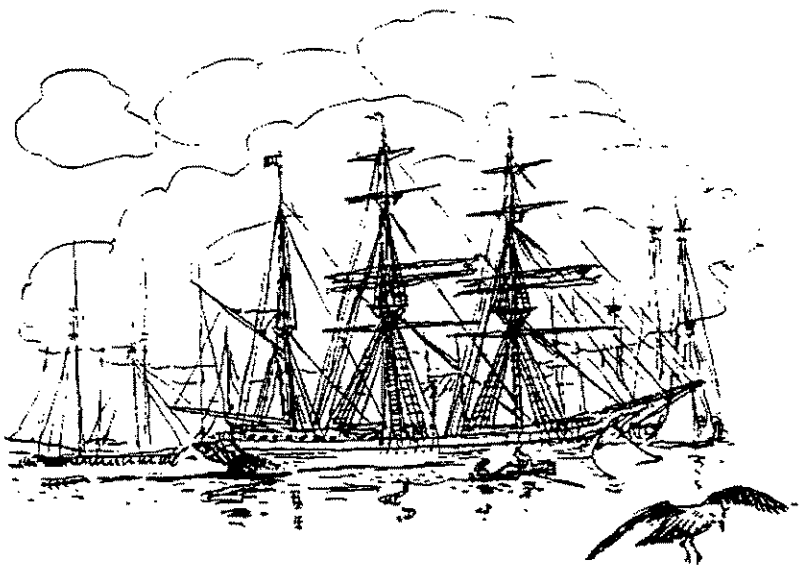
> "It was the hundredth anniversary of baseball - just the sort of historic event they loved to celebrate at Treasure Island - and the San Francisco Seals, of the erstwhile Pacific Coast League, sent their catcher, Joe Sprinz, over to the island for a jazzy demonstration of long - ball fielding.
>
> There was a sort of world record at stake. A man in Ohio had caught a ball dropped 758 feet from the top of the Terminal Tower in Cleveland. Sprinz figured to better that by nailing one tossed from the Goodyear blimp "Volunteer," hovering 800 feet above the field.
>
> The first drop fell into the stands, where 1,200 fans screamed and covered their heads. The second hit the field like a cannonball and buried itself six inches in the turf. The third was right to Sprinz, but the sun got in his eyes.
>
> They carried Sprinz to the hospital with a bashed nose, torn lips and four teeth knocked out of his dental bridge
>
> "Boy," said Sprinz, "I thought the blimp fell on me."

The "night lights" of the Exposition were simply spectacular. Their illumination filled the skies surrounding Treasure Island rendering it all aglow. Because of the beauty this bestowed on the island and the San Francisco Bay, the Golden Gate International Exposition was soon referred to as "The Floating City of Light" and "The Magic City". The display of lights, easily visible from San Francisco, was produced by a careful use of both colors and construction material. The walls of the 70-foot high buildings were light-colored stucco with embedded vermiculite (superheated mica flecks) causing each building to reflect light as if it were a movie screen. See Figure 38 and Figure 39. At sunset each evening, 10,000 strategically positioned colored floodlights would paint the building walls with radiant colors of pink, green, blue, and gold. Three hundred "black light" lamps shining on invisible weather-resistant luminescent paint located in niches, murals, and sculptures produced "colored pictures" that stood out in a phosphorescent glow against the adjacent colored walls. By combining assorted colored lights, as well as moving lights, a rainbow of colors from mauve to light green to dark blue to pale apricot were produced in a constantly changing array. To announce and celebrate special occasions or events, a marquee of twenty-four searchlights, each being thiry-six inches in diameter, displaying eight different colors, was mounted on the north end of Treasure Island. When turned on, the spotlights generated 1,440,000,000 watts (1.44 billion) of candlepower. The lights could be seen a hundred miles from the island.

Despite the excitement of the lights, the shows, the "big name" entertainers, the fact that the Exposition was happening during the largest economic depression in the history of the United States could not be ignored. Consequently, the number of visitors at the Exposition during 1939 was about half of that anticipated. Many of these visitors received "cut-rate" and "promotional" tickets which allowed them to attend the Exposition at a reduced price or without charge. As a result, the 1939 Exposition was a financial failure. For the 1940 Exposition, the promoters had

to cut display and vendor fees sharply. The emphasis on entertainment quickly changed from promoting the expensive "big name" entertainers and full concerts having separate admission, to "fast acts" that could entertain large crowds for free in the various Courts throughout the Exposition. See Figures 34, 35, 40, 41, and 42. Because of these changes, the 1940 Exposition survived economically.

While the Exposition drew public attention, so did the fact that the American involvement in World War II was becoming more and more certain; therefore, the Golden Gate International Exposition with its theme of "peace", closed on September 29, 1940. Ironically, the wheels were already in motion to convert the island for the purposes of war. Fifteen months later, the Japanese would bomb Pearl Harbor. The Navy's efforts in the War with Japan catapulted Treasure-Island into an important supporting role.



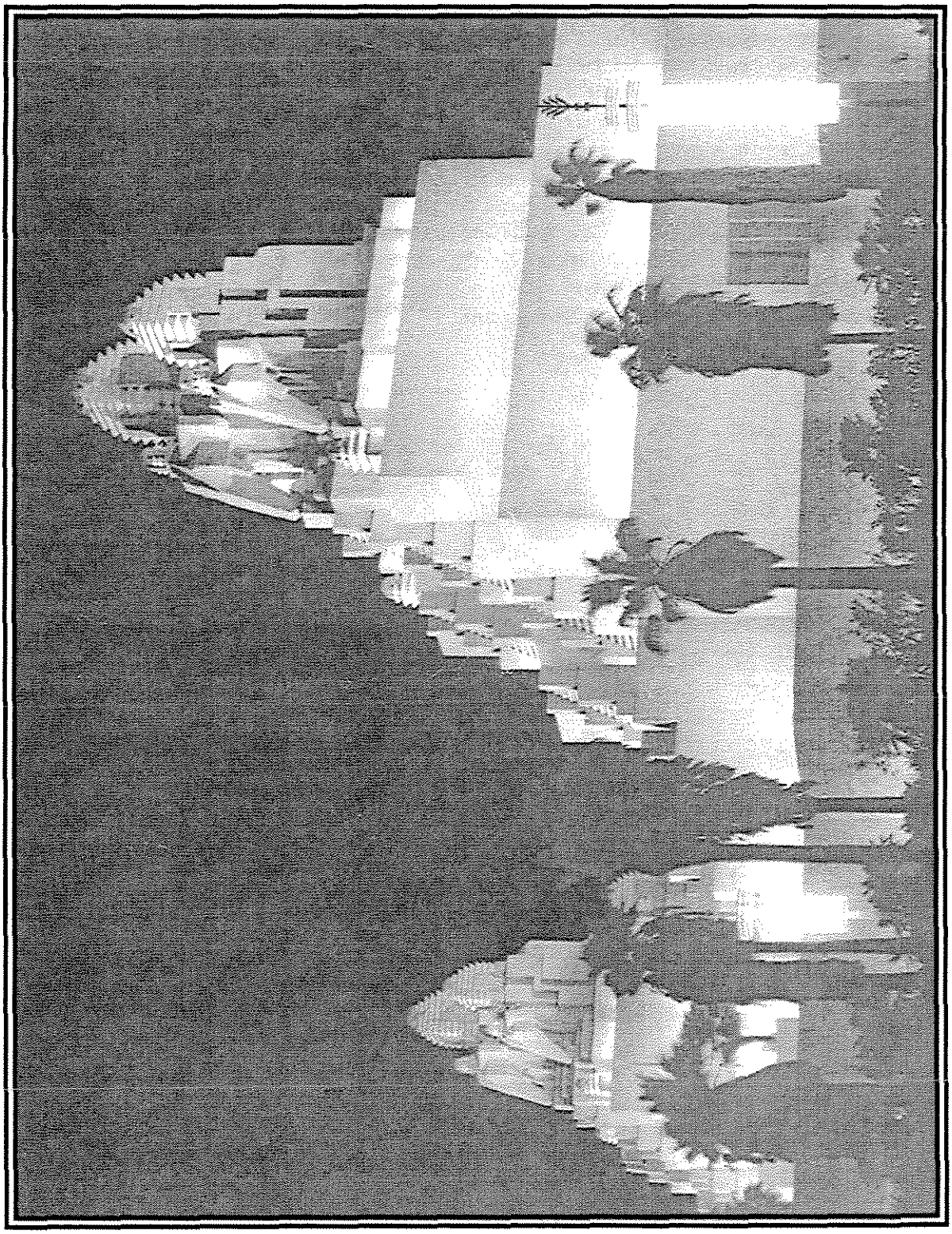


FIGURE 38. ***Elephant Towers at the Portals of the Pacific. Circa 1939.***
Note: A night photograph of the main gateway to the Exposition which featured the majestic "Elephant Towers".

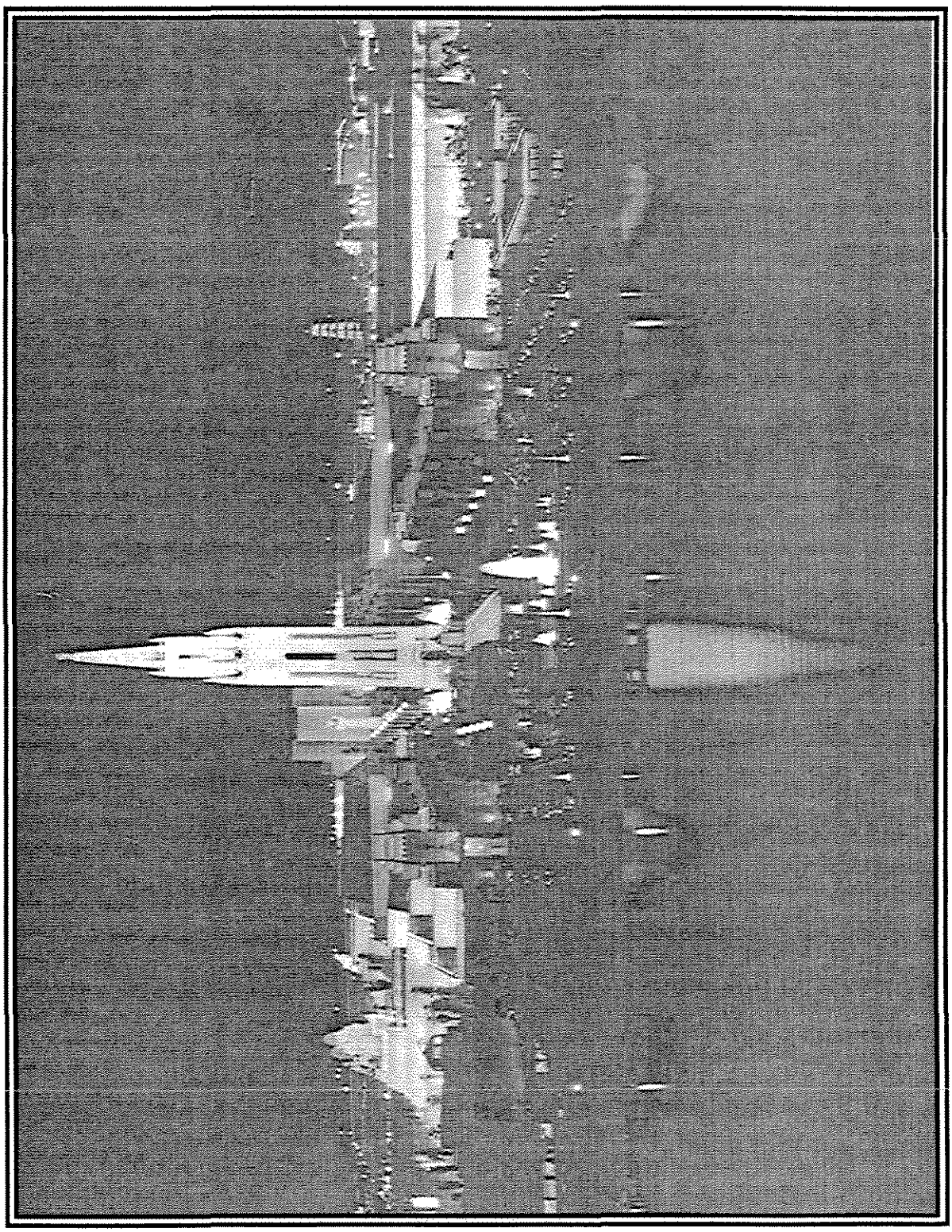


FIGURE 39. ***The Magic City Afloat. Circa 1939.***
Note: A night photograph of the Exposition at Treasure Island from Yerba Buena Island. The illuminated island gave it the appearance of a "Magic City Afloat" on the waters of the San Francisco Bay.

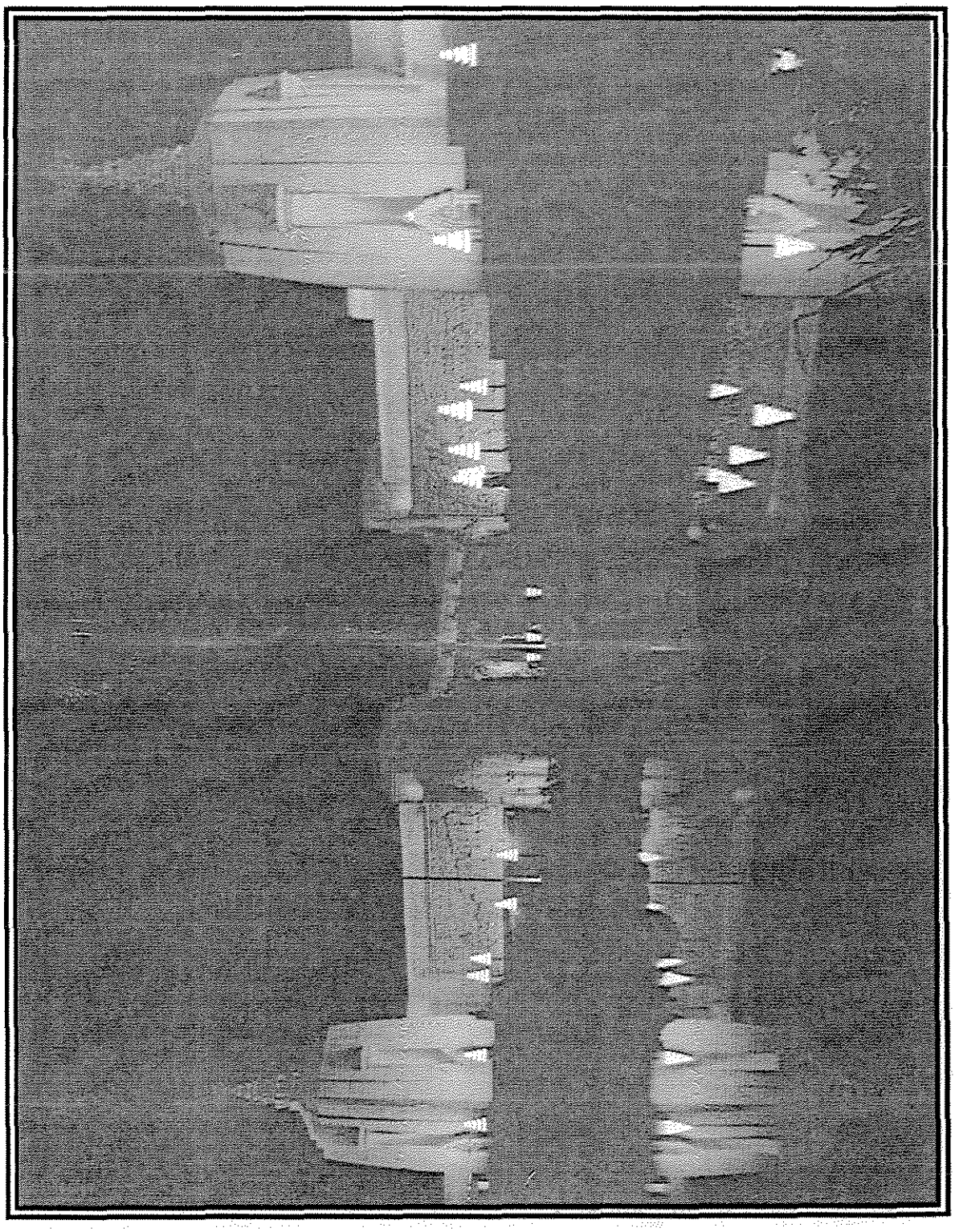


FIGURE 40. ***The Towers of the East. Circa 1939.***
Note: A night photograph of the "Towers of the East" at the Temple Compound casting their reflections in the placid waters of the "Lake of All Nations".

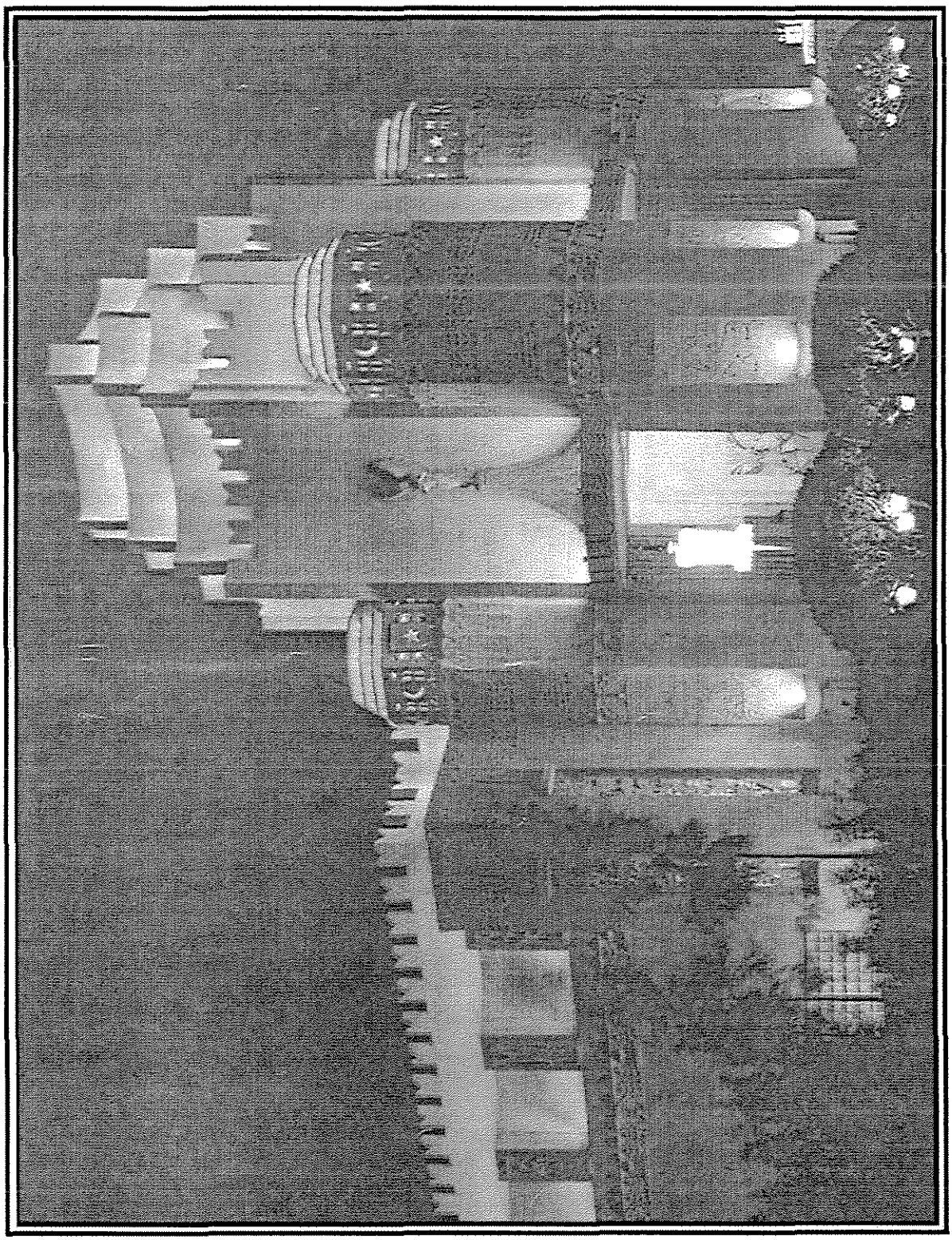


FIGURE 41. ***Tower of the South. Circa 1939.***
Note: A night photograph of the "Tower of the South" located in the "Court of the Moon". The awesome Tower was illuminated with orchid-tinted blue lights.

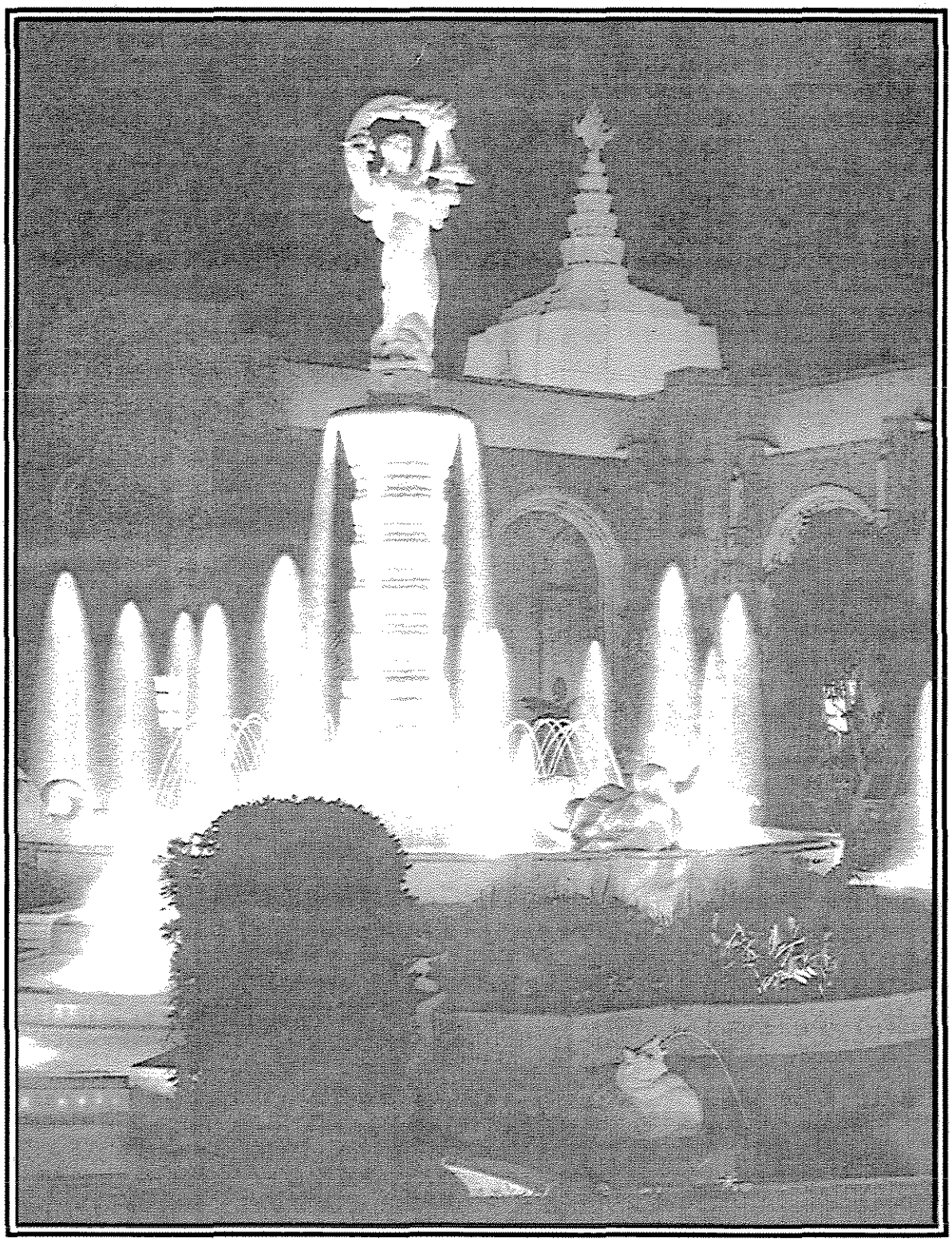


FIGURE 42. ***Court of Flowers Circa 1939.***
Note: A night photograph of the "Court of Flowers" featuring the "Girl and Rainbow" fountain (created by O.C.Malmquist). The "Tower of the East" is in the background.

2.3 Military Use and Occupation, 1940–Present (1995)

The World War II (WW II) Era and the Cold War Era are the two primary eras which divide the history of Treasure Island's military use and occupation. The WW II Era spans six years, 1940 through 1946. The Cold War Era began with the end of WW II and continued to 1989. With the "end" of the Cold War, military bases, such as Treasure Island, are being closed. For the purposes of this report, the post-Cold War Era (1990 and later) is considered to be the Cold War "demobilization" period.

2.3.1 World War II, 1940–1946

Even before the Golden Gate International Exposition had ended, the US Navy had realized the potential for a naval base at Treasure Island. Three months prior to the end of the Exposition, Admiral Greenslade sent a letter to the Navy Department in Washington DC requesting funds to lease the Island from the City of San Francisco. Since the military was concentrating on Hitler (the war in Europe), Admiral Greenslade's request was denied. However, Admiral Greenslade was undeterred in his quest. Convinced of the necessity, he sent a letter to the San Francisco City Council requesting the use of Treasure Island "for the duration of the National Emergency" (strong words, when there was no war on the West Coast). Fortunately for him, the City had already recognized the difficulties of making Treasure Island into an international airport. The City seized the opportunity of mutual aid and offered Admiral Greenslade the lease for Treasure Island in exchange for the Navy's assistance in obtaining bayshore land south of San Francisco for use as an international airport. This was agreeable to the Admiral. The Navy was granted a temporary lease to Treasure Island. Three months later, the Secretary of the Navy directed the Navy to negotiate with the City of San Francisco to "take over at the earliest possible moment and for the duration of the emergency as much or all of Treasure Island with suitable buildings as required for a Navy Section Base with barracks for four thousand and to serve as a combined Receiving Station, Distribution, and Training Center." On February 28, 1941, the City of San Francisco officially leased Treasure Island to the Navy. Negotiations for the airport land were completed in 1943; the City had its airport and the Navy gained title to Treasure Island.

2.3.1.1 Conversion Process

At first, the conversion from the Exposition to the Naval Training and Distribution Center, Treasure Island (TADCEN,TI) was fairly casual. Very little money was allocated by the Navy for the conversion process. Although the United States recognized Japan as a possible future problem, the US did not feel particularly threatened by the nation of the Rising Sun because Japan had been confining its actions to the Far East. Any US military development or "build-up" on the West Coast was more for general principles than because of any real sense of urgency. Obviously, the emphasis was still on the war in Europe. Hitler was already in control of most of the European countries and was starting to threaten England. The United States, heavily involved in the war there for at least a year, was devoting most of the available men and money to that war effort. Therefore, for most of 1941, the progress in the conversion of Treasure Island to a military installation was slow and, at times, haphazard. In fact, the only obvious hint of "progress" was the destruction of the Pacifica statue, who during the Exposition had proudly stood at the northern end of the Palaces as the centerpiece of the Court of Pacifica. Both Pacifica and the Tower of the Sun were demolished early in 1941. Eventually, the Tower of the Sun was replaced by a large, covered bandstand used for drill and muster. See Figures 43 and 44.

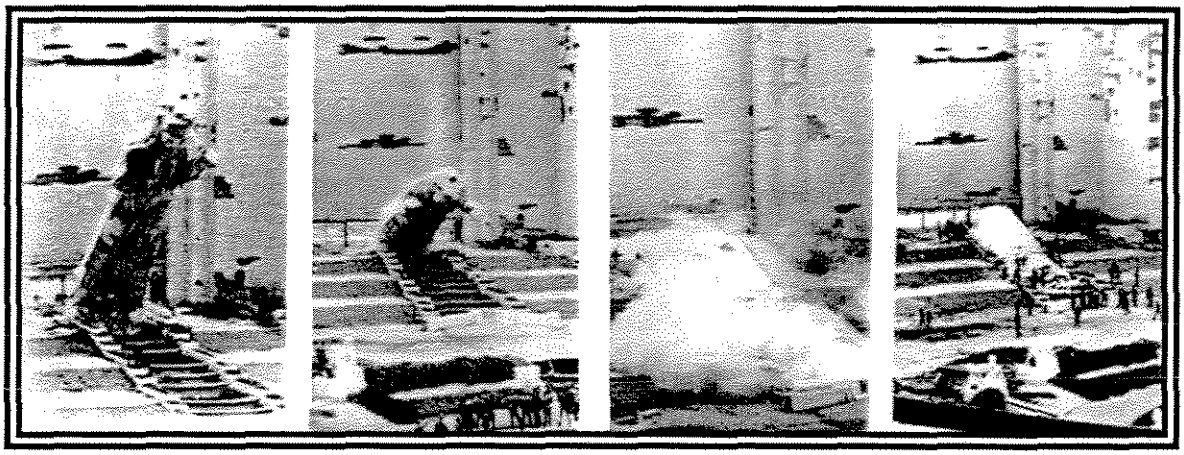


FIGURE 43. ***Demolition of "Pacifica". January 22, 1941.***

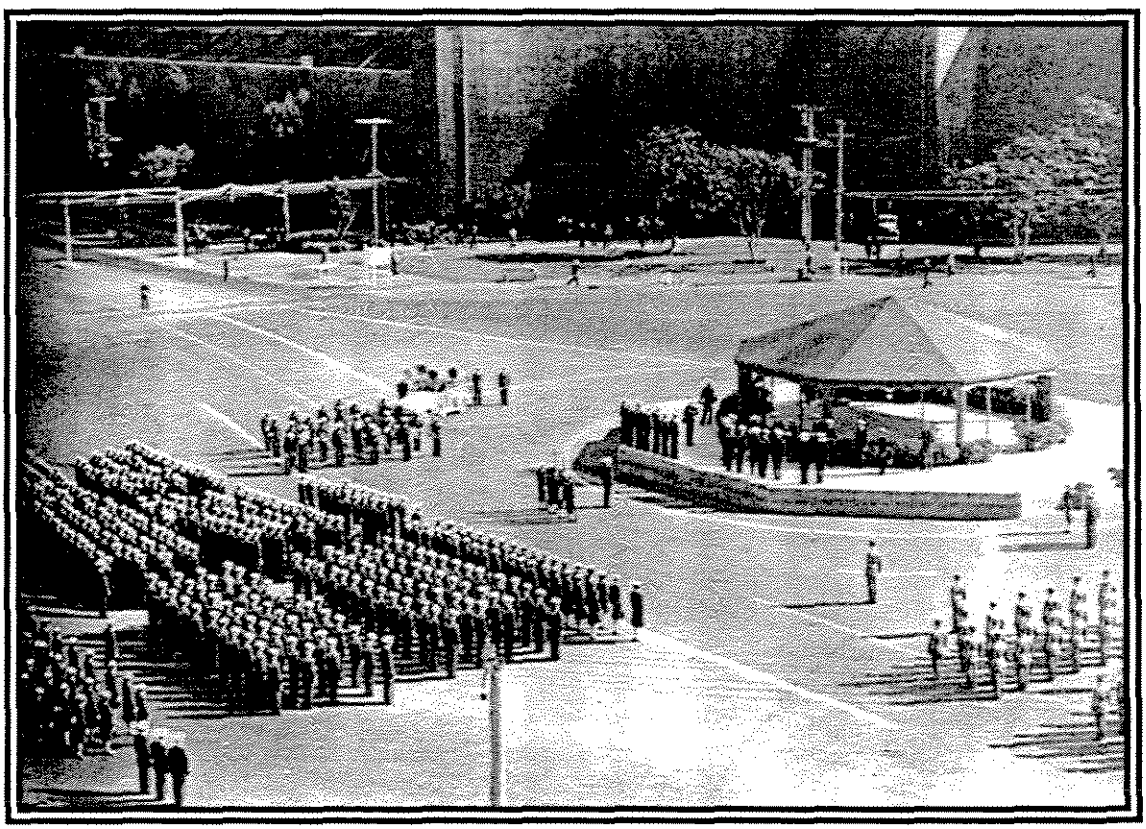


FIGURE 44. ***Troops on Review. Circa 1941.***

Note: The "Tower of the Sun", demolished in early 1941, was replaced by a large, covered bandstand which was used for drill and muster.

Captain Culp, Commanding Officer of the newly approved Section Base, established the base by bringing the *Delta Queen*. a paddlewheel river boat, down the Sacramento River to Treasure Island and tying her up at the ferry slip. The *Delta Queen* became the temporary barracks and training facility for the personnel of the "Local Defense Force" on the Island. The Supply Officer's account gives a sense of the situation at this early time of military presense:

> "The Supply activities of the 'Delta Queen Navy' consisted primarily of messing and this was accomplished after strenuous cleaning of the galley spaces. Grease was so thick that the best efforts failed to dislodge all of it, with the resultant galley fire, which thoroughly did the job of eliminating this grease hazard.
>
> The office consisted of flat boards on saw-horses, which had a tendency to fall apart at the passing of each rowboat. When requisitions were made for desks the answer was, 'what for?' Finally, by begging, pilfering, and other means, sufficient equipment was acquired to permit some semblance of an office."

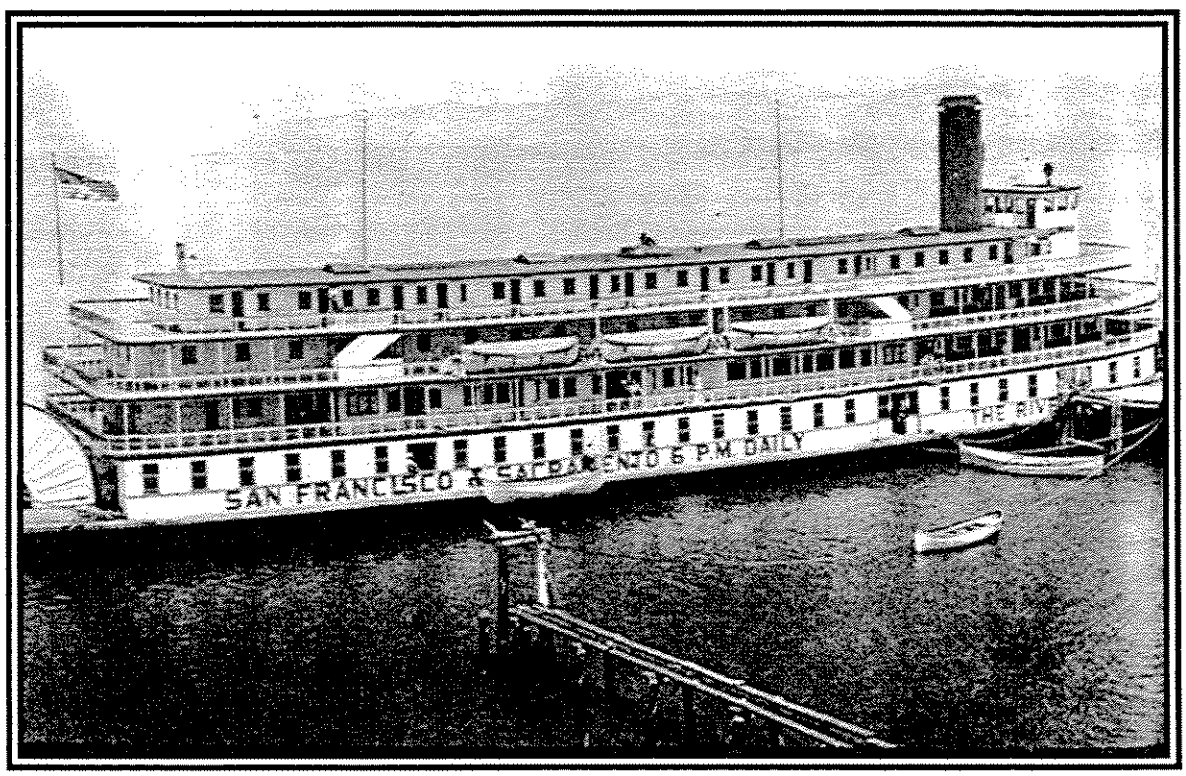


FIGURE 45. ***The Delta Queen. Circa 1941.***

Note: The Delta Queen had been making regularly scheduled runs between San Francisco and Sacramento, until, in 1941, Captain Culp procured the vessel for use by the newly established Section Base at Treasure Island. The Delta Queen served as temporary offices, barracks, training facility and galley until permanent building were erected on the island.

Rear Admiral Hugo R. Osterhaus, USN Retired, had joined the Navy in 1900. After having served in World War I and as Commanding Officer of Mare Island Naval Shipyard twice, the Rear Admiral retired. He again answered the call of his country when he came out of retirement and was reactivated as the Commander of the TADCEN and the United States Navy (USN) "Patrol Force". In spite of generally peaceful conditions on the West Coast, a USN "Patrol Force" was now in full operation because there were rumors of German submarine "Wolf Packs" attacking ships. Osterhaus and his mighty "Patrol Force" moved to Treasure Island on June 12, 1941.

The first major use of the Island by TADCEN was for training, inshore and offshore patrol, coastal lookouts, mine forces, and net defenses. The function of the base was to provide support for the Local Defense Forces. The installation also provided foul weather refuge for small patrol craft both inharbor and offshore, supplied small craft with stores and food, made minor ship repairs, and provided Quarters and recreational facilities for crews while in port for extended periods. With TADCEN and the Patrol Force located on the island, slowly but steadily, the deserted fairgrounds were converted to a naval station. Barracks were set up in what was known as the Hall of Western States during the days of the Exposition. A galley was commissioned in what had been the Federal Building. Fishing boats were converted to mine sweepers, and yachts to patrol craft. A local Harbor Defense School began the practical training of naval officers and a Radio Materiel School was established. The "Sick Bay" opened in July of 1941 with four doctors, one dentist, and nineteen corpsmen whose duties included sanitation, as well as the usual treating of the sick crew.

When Japan attacked Pearl Harbor, the nation's priorities quickly changed. Although the Germans were still on a rampage throughout Europe, Japan had attacked US soil. This caused the United States to take Japan seriously. The US immediately shifted its industrial and military systems into high gear. Japan's attack on Pearl Harbor did not alter the United States' war policies. Under the so-called "Hitler First Method", the war in Europe continued to be top priority, while the war in the Pacific came second.

The day after the attack on Pearl Harbor, the Port of the Tradewinds was jammed with fishing vessels, small craft, and luxury yachts released by their owners for emergency Naval Patrol service. Coastal tankers were considered targets for enemy submarines. Merchant vessels demanded gun crews and escorts. Until the arrival of four destroyers from San Diego, a grey-painted fishing vessel having good lines, fair speed, a couple of gun mounts, and a Navy crew served as that escort when the ships sailed through the huge submarine net which spanned the Golden Gate channel guarding the Harbor.

Twelve days after the Japanese attack on Pearl Harbor, the Armed Guard Center - Pacific came into existence as a command under TADCEN. The pre-war Navy could not envision the magnitude of the task ahead for the Armed Guard. This is depicted in an exerpt from the directive authorizing the establishment of the Center. The directive read: "It is contemplated that the administrative load will not exceed a maximum of one hundred fifty officers and one thousand two hundred men both at the Center and on duty at sea." Of course, this manpower count was rapidly exceeded. The Navy armed every merchant ship and transport vessel sailing from the US shore due west with an Armed Guard crew and at least one gun, usually a five inch, 38 caliber, dual purpose gun. It was the duty of the Armed Guardsmen to protect their ships from the attacking enemy planes and submarines. The first crew was assigned to duty aboard a

merchant vessel on December 20, 1941. Gear and, especially, men were extremely limited. Many crews went to sea with a "Petty Officer" in charge, rather than an officer, due to shortages of personnel. Even so, thirty-six vessels were equipped with gear and personnel within the ten day period of January 26 through February 5, 1942. At the end of the first six months, not one ship had been delayed in sailing while waiting for an Armed Guard crew or weapon.

In June of 1942, the Twelfth Naval District designated the Armed Guard Center as a Command. By December, 1942, one year after being established, the Armed Guard consisted of over eight thousand men and four hundred officers at sea. It was dangerous work since these vessels were in fact prime targets for Japanese and German Axis submarines. This sort of danger resulted in US military humor such as: "Sighted sub . . . blub . . . blub . . . blub . . . " and "Ready! Aim! . . . Abandon ship!".

Despite these hazards and difficulties, the Armed Guard grew to be one of the largest commands in the Navy. By the end of the war, it had grown to about fifteen times its originally anticipated size. At its largest size, it consisted of over forty five thousand enslisted men and over two thousand officers.

Realistically, a war in the Pacific would mean a large-scale naval war. As a result, within days the Treasure Island contingent was increased rapidly. Within a month, the conversion of the Exposition palaces into barracks, offices, and mess halls was well underway. Suddenly, new activities, new schools, and new commands arrived at TADCEN. Turning to "ship's company" for working personnel, huge changes were made to the island with materials and supplies that somehow were always delayed or followed far behind. To save time, World War I plans for "H" type barracks were broken out (Ref. P.) and used for building the new barracks to the east and north of the palaces. See Figure 46. The magnificent center section of the Federal Building was demolished and the two remaining wings were used for classrooms, a galley, and office space. See Figures 47 and 48.

Due to the rapid expansion, the Command was reorganized in June of 1942. Twenty separate divisions operated under three main command groups, Supply, Personnel, and Operations. Each were charged with several specific responsibilities to ensure the proper operation of the Island. All reported to the Chief Staff Officer, who in turn reported to TADCEN, still under the command of Rear Admiral Osterhaus. Under this new arrangement, the continued conversion of the palaces for military use was stressed. Most became barracks or training buildings, but some were converted based upon their earlier use. Palace K, the Foods and Beverages building, became the "mess hall", having a capacity to provide of over 7,000 meals per hour. Palace C-1, the Billy Rose Aquacade, became the swimming pool; Palace C-2 became the gymnasium. Both were used for recreation and combat training, such as "abandon ship" drills and "underway replenishment" training. Palace F, the Hall of Science, became the theater as did the north half of the Federal Building following the demolition of the Colonnade of States. The main warehouse, located on the northeast corner of the Island, soon became the First Lieutenant's Warehouse. The ferry landing and the athletic field, both located on the island's east side, remained as such. However, the western ferry landing was demolished. New piers were constructed on the eastern side of the island, as well as in the Port of the Trade Winds, which faced Yerba Buena Island.

The foreign pavilions and most of the state buildings, the Gayway, and the Cavalcade were demolished. The ponds were filled in to level the land. In their place came new buildings. These were mostly barracks and multipurpose structures used for administration and processing purposes.

Galley K, in its day, was considered to be the largest mess hall under one roof in the world. It served one man per second, operated six feeding lines simultaneously, and seated three thousand men at one time. See Figures 49 and 50. On occasion, eighteen thousand men were fed in a two hour period. The galley employed one hundred cooks, five hundred mess cooks (line servers and busboys), and one hundred bakers. The volume of food they prepared on a daily basis all but boggles the mind. The average daily food preparation included:

- Five thousand pounds of fresh baked bread
- Fifty thousand doughnuts (when served)
- Four thousand pies(when served).
  Note: Over five tons of apples were used for the pies for Christmas Day.
- Three hundred gallons of soup per meal
- Fifty gallons of freshly made mayonnaise per meal
- Two tons of steak per meal
- Two hundred gallons of gravy per meal

In 1946, a devistating fire destroyed Barracks I and J, as well as Galley K. During 1947, the remainder of the Palaces were razed, except for Palace C-1 (swimming pool) and the Elephant Gate Building.

For personal support of the military personnel stationed at Treasure Island, a large Ship's Service was established. The Ship's Service consisted of three main stores located on Treasure Island, and one additional store with a restaurant located on Yerba Buena Island. Each had branch services covering everything from a tire change to a permanent wave. Visiting a main store was equivalent to visiting a large department store. Under one roof was the general merchandise section, the cigar, drug, and candy counter, a restaurant, barber shops, photography studio, travel burea, jewelry store, watch repair shop, magazine counters, luggage shop, book store, florist, frosted malt shop, officers' clothing store, and main dining room. A million candy bars were sold each month; cigarette sales reached thirty-two thousand packs a day; and as many as ten thousand frozen malts were sold daily. The laundry had a quota of ten thousand bundles of laundry each week. The cobbler shop repaired fifteen hundred pairs of shoes each week. At the barber shops, twelve hundred heads of hair were cut each day.

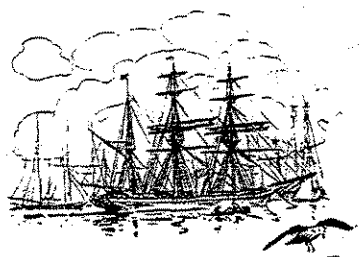


FIGURE 46. *"Grand Hotel" of Treasure Island. Circa 1942.*

Note: World War I plans of "H" type barracks were used to establish new barracks in and near the palaces of the Exposition. The photograph shows one of theses barracks located in what was once a spacious palace. This particular barracks, with bunks sandwiched one against another, became known as Treasure Island's "Grand Hotel"

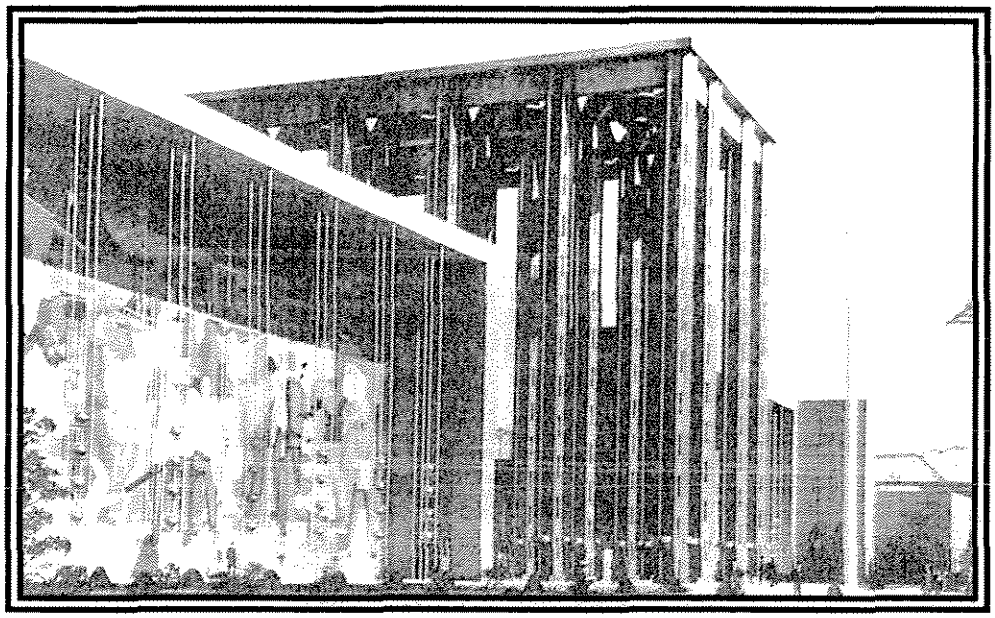


FIGURE 47. ***Federal Building (during the Exposition). Circa 1939.***

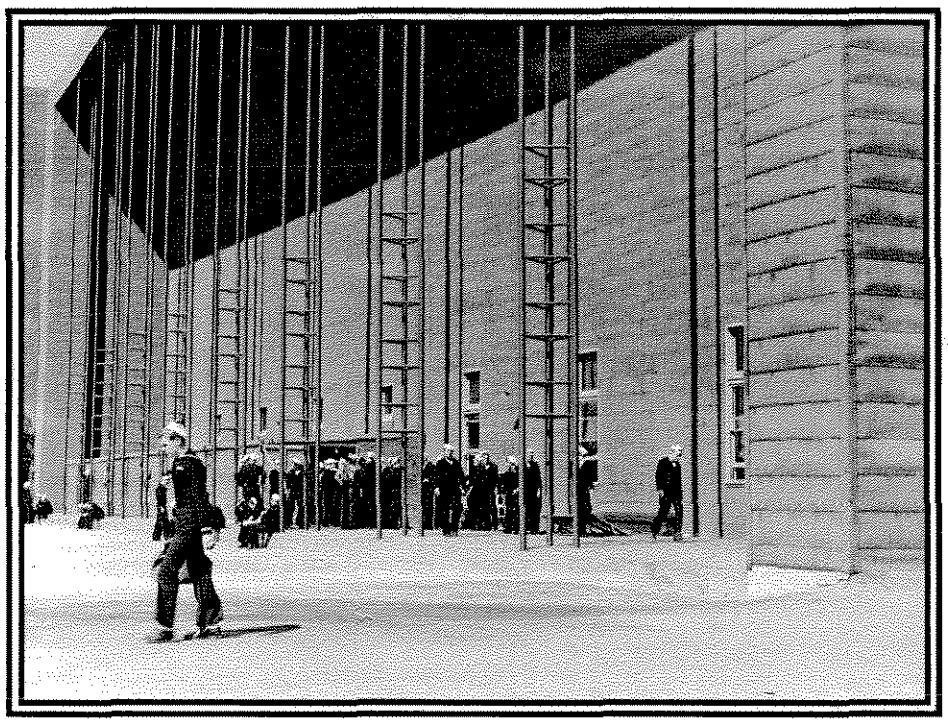


FIGURE 48. ***Federal Building (after military conversion). Circa 1943.***

Note: Both photographs, Figures 47 and 48, are representative of the same view of the Federal Building.

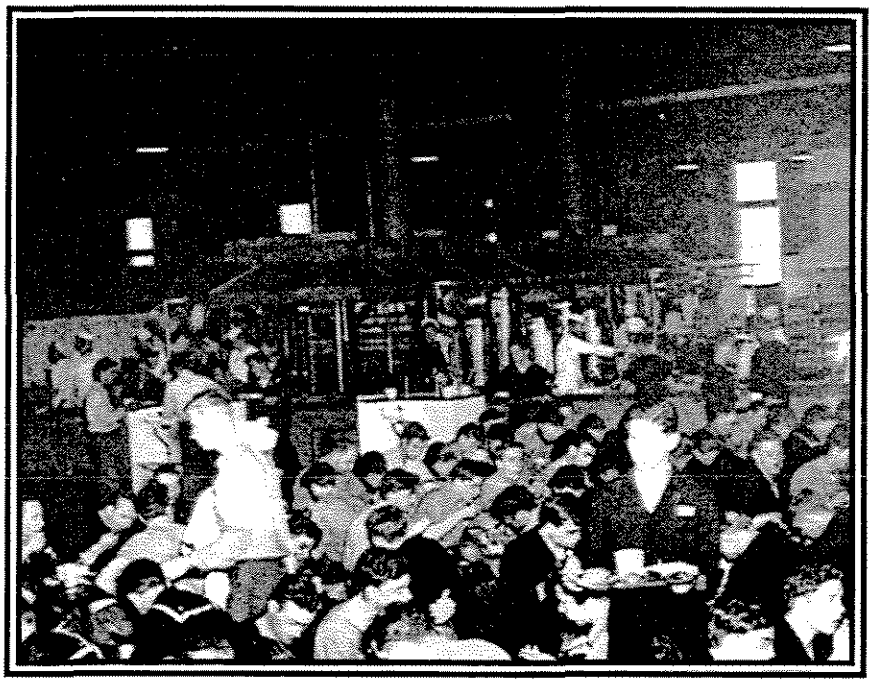


FIGURE 49. ***Chow time in Galley K. Circa 1942.***

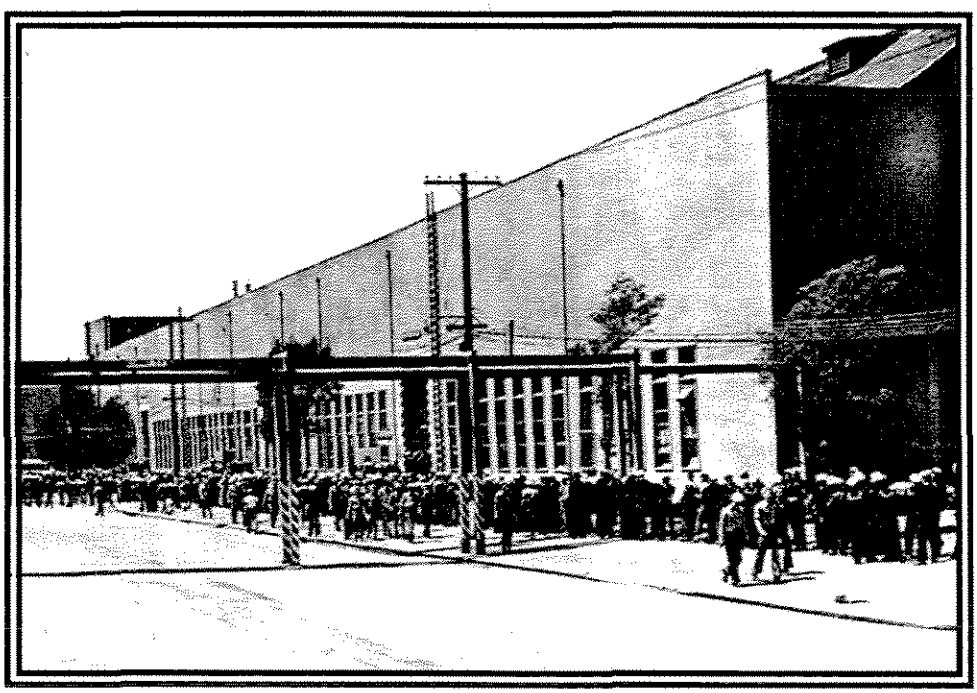


FIGURE 50. ***Galley K. Circa 1942***
Note: At Galley K, even when serving 7,000 men per hour, the chow line still stretched the length of the building and around the corner

2.3.1.2 Women's Appointed Volunteer Emergency Service (WAVES)

The war in Europe and Japan could not have been fought nearly as effectively if it had not been for the active, willing participation of women. As was true in much of the country, at Treasure Island these women took the title of Women's Appointed Volunteer Emergency Service (WAVES). The first eighteen WAVES came aboard Treasure Island on November 30, 1942. At first they were not particularly welcome in "this man's navy"; but as the operations overseas called for more and more Navy men, the WAVES took over an ever increasing number of jobs to keep the large naval station in running order which resulted a greater acceptance of their presence. Eventually, over eight hundred officers and enlisted women were attached to fifteen different activities at the island, including some traditionally held by men.

The largest number of WAVES stationed at TADCEN were to the supply and disbursing offices, the commissary, the fire fighting school, and the dispensary. The dispensary's Physical Therapy Department personnel/staff positions were mostly held by WAVES, including a WAVE "officer in charge". Other commands on the island also had large numbers of WAVES on duty. In most places, the WAVES worked in administrative, secretarial, and bookkeeping fields; however, there were always exceptions. The Communication Division was manned almost entirely by WAVES. See Figure 51. At the Operational Training School, WAVES taught signalling, damage control, lookout recognition, and navigation. The Gunnery School had ten WAVES on the instructor's roster. The Radio Materiel School boasted of having the only WAVE printer on the station who was one of a few throughout the country. She printed textbooks for instructional use, working with photography, developing, and printing materials.

The WAVES were originally housed in one barracks. They ate their meals in the Chief Petty Officers (CPO) Mess at Galley K. Gym time was allotted them for an exercise period. And they shared one of the theaters with the men. However, the number of WAVES increased quickly and, as expected, their needs expanded until they required six barracks, a separate mess hall, three theaters, and a beauty parlor. Also available to them were specialized courses in bridge, knitting, Spanish, and art, along with a womens sports program. As part of their training, the WAVES went through the "gas mask" drill, which included the gas chamber. The first group of WAVES that went through the drill did so without casualties. Their comment was — "We . . . consequently felt we were pretty well initiated into the service."

The number of WAVES stationed at Treasure Island peaked in February, 1945 to over eight hundred. Then, by way of attrition, promotion, and transfer, the numbers swiftly decreased. By December 1945, only one of the original eighteen WAVES was still stationed on the Island. By the end of the war, the WAVES had genuinely earned the tribute bestowed them by Admiral King — "An inspiration to all hands in the Naval service."

Figure 51. ***The WAVES at TADCEN, Communications Division. Circa 1943.***
Note: Over eight hundred officers and enlisted women were attached to fifteen different activities at the island. Some of these activities were traditionally held by men. The Communication Division was eventually manned almost entirely by WAVES.

2.3.1.3 Military Training

The first technical school to open on Treaure Island was the Radio Materiel School. The school opened October 1941, with nine officers, nine Chiefs and six hundred students. The conditions under which the newly established school functioned were a true indication of both the low priority Treasure Island had in the ranks of military schools, and the determination of the station to complete its mission. The construction of the buildings which housed the Radio School were not yet completed at the time of the first classes. As described in the book "The Naval History of Treasure Island" (Ref. P):

> "The Bay Area rainy season was in full swing and remained so for the first forty five days of school. The heating plant had blown up and a donkey boiler had been installed to provide warmth. The books and equipment for the school which had been promised by Washington, D.C. had failed to materialize and the only material on hand was some radio equipment that could not be utilized for some months to come. Classes were started using mimeographed pamphlets brought from Bellevue by some of the officers and men.
>
> Examinations were given previous to commencement of the school for the six hundred students, and the highest fifty that showed possibilities of being instructor material were chosen and in a very short time were given an outline of what would be expected of them in the next few days as teachers instead of students. Fortunately, among this first group were several Electrical Engineers, men of high caliber, who later became excellent instructors."

The first class attending the Radio Materiel School graduated in June, 1942. Shortly thereafter, the original quota of one hundred men per month was doubled to two hundred men per month. The student level continued to rise until it eventually leveled off at four hundred graduates per month. There the quota maintained throughout the remainder of the war. Interestingly, the Radio Materiel School on Treasure Island graduated more than ten thousand Radio Technicians by Victory in Japan Day (V-J Day), which accounted for more than half of all Radio Technicians trained by the Navy during that period.

As the war expanded, training grew at a rapid rate. From a humble beginning as a Local Defense School attached to TADCEN, the "Pre-Commissioning School" during the first eighteen months of the war successfully completed the training of twenty-five hundred reserve line officers, and administered "deck training" to numerous ships crews. Through development and expansion of the Pre-Commissioning Center, the Operational Training School was formed as the primary training unit. The Pre-Commissioning Training Center and the Operational Training School combined to create a "Treasure Island University" campus for training the crews of the Navy ships that steamed under the Golden Gate. The mission of the Operational Training School was to prepare crews for duty on (1) the new ships coming out of the shipyards, (2) fast cruisers, (3) destroyers of the "Tin Can Navy", (4) the large auxiliaries of the "A" Fleet, and (5) the "work horse" Coast Guard Cutters. The school also provided post-graduate training to thousands of military personnel, mostly serving on combatant and auxiliary ships of the Pacific Fleet, as well as to Armed Guardsmen and ratings of the Royal Canadian Navy. More importantly, the professors imparted the "facts of life" to more than one hundred thousand officers and bluejackets in order to help them fight a winning war at sea and return home safely.

By the spring of 1943, the overall training program of the Pre-Commissioning Training Center had greatly expanded. Training was not only provided at Treasure Island, but had also spread out to other local military facilities. The expanded training consisted of the following: Fire Fighting (at Mare Island Naval Shipyard), Gunnery (at Point Montara), Lookout (at the Navy Defense School), Gunnery and Gyro (at the Treasure Island Advanced Fleet Training School), as well as lectures given by the new ship's officers. Frequently, this resulted in a "hit-or-miss" quality to the training.

To remedy this problem, in May, 1944, the control military training for the servicemen was placed under the Commanding Officer of the Pre-Commissioning Center. Soon the concentration was on scheduling training based on classification to ensure that the right man was being put in the right job in accordance with his field of training. When ships were being initially manned with fifteen percent of personnel who had sea experience and eighty five percent of personnel who had never been on the ocean, the importance of this classification becomes obvious. The school obtained six vessels for use in practical training. These training vessels included: an auxiliary transport ship (AP), the USS *Arlington*; a destroyer (DD), the USS *Hanynesworth*; a patrol craft (PC) (vessel name undetermined) which was used for training in submarine hunting; a yard patrol craft (YP) (vessel name undetermined) which was used as a target; a converted yacht, the *Palomas*, which was used as a command vessel; and a yard barge ("covered lighter - self-propelled") (YF), the *YF-843*, which was also used as a target. In the process of training, each servicemen spent approximately one week aboard the vessels so they would not be completely "green" when they reported for duty in the fleet. In addition, the advanced training schools offered included such skills as: Fire Control, Gunner's Mates, Electric Hydraulics, Gyro Compass, Rangefinder Operation, Advanced Welding, and Underwater Cutting and Welding.

As mentioned before, even though Japan had struck at US soil, the war in Europe still took priority. Consequently, the land and naval forces in the Pacific were denied the resources necessary to prepare for a total war effort against the Japanese. Because Treasure Island was the closest spot to the war in the Pacific within the continental boundary of the nation, the station felt the impact of each battle — sending replacements of trained bluejackets (enlisted men) and officers and new ships, on one hand . . . and on the other, giving immediate hospital care to the wounded veterans and comfort to the weary who stepped off the battered ships. Necessarily, the rapid expansion of all training programs highlighted those troubled days. Under the command of TADCEN, the Fleet Operational Training School, Radio Materiel School, and the Advanced Naval Training School devised new and intensive courses, along with "stepped up" schedules, in order to successfully meet the needs of the fleet.

2.3.1.4 Hospital

The first "Sick Bay" on Treasure Island opened in July of 1941. Initially the facility was intended to provide care of minor routine complaints (sprains, colds, headache, and broken bones, etc.) of those sailors serving land duty at the island. It was not designed, however, to deal with the large number of men that flooded the island in the days surrounding the events at Pearl Harbor. To resolve the health care problem, in April 1942, a dispensary opened in the building which was prevoiusly known as the "California Southern Counties Building" during the Golden Gate International Exposition. The dispensary building provided room for forty dental units, five prosthetic operating units, and a laboratory. It was immediately in full operation, and like

everything else on the island, expanded rapidly due to necessity. Soon, there were sixty dentists; and eventually, the medical division was maintaining dispensaries at additional locations including: Treasure Island (2 each), Yerba Buena Island, San Francisco (on Market Street), and the "pre-embarkation" barracks (refer to Section 2.3.1.6).

Even with all the expansion, the existing dispensary system still could not meet the ever increasing needs of the military personnel. A new hospital, commissioned on April 4, 1942, received its first patient on July 15, 1942. By September 1942, the hospital had two hundred sixty seven patients, but, lacked proper accomodations for them. The hospital, built with a capacity of five hundred beds, was woefully inadequate for dealing with the demand. Patient admissions were limited to acute medical or surgical cases. The overflow of convalescing patients were taken to other nearby hospitals. By December 1942, eight months after commissioning, the hospital had cared for more than twenty five hundred patients and the load was still increasing. Through 1943, the hospital, with a staff of approximately sixty officers and three hundred enlisted corpsmen, admitted over ten thousand patients for medical care. A Physio-Therapy Department was placed in full operation in March 1943; and in September of that same year, the Epidemiology Department was added to list of specialty departments at the hospital.

All wounded servicemen flown in by plane from Fleet hospitals in the South and Central Pacific were routed to Treasure Island for care. None were turned away. To help handle the load, a new structure was built to house the Clinical Laboratory, Epidemiological Unit, Blood Bank, and School of Tropical Medicine. The Blood Bank not only handled all transfusions for the Treasure Island Hospital, but furnished whole blood when and where needed, as well as plasma to the ships deployed to the war zones. To ensure a good supply of plasma, the ships would send their crews to donate blood which was then converted to plasma and returned to the ship. Overall, the response to the need for blood was excellent.

The School of Tropical Medicine, located in the entire west wing of the new building, was established for the purpose of training Medical Officers and Corpsmen in the diagnosis, treatment, prevention, and control of diseases, as well as training in the conditions facing them during the island-hopping war. For officers, the course lasted five weeks. It was, however, a ten week course for the enlisted men. The primary teaching material available for laboratory training and examination was blood smears taken from malaria victims.

The year 1944 became the busiest in the history of the hospital. Patient admissions soared over seventeen thousand five hundred, while hospital staffing remained the same as that of 1942. In order to bolster the hospital's small staff, the district Medical Officer assigned Medical Officers and Corpsmen to the hospital on a temporary duty basis from those units being assembled and/or awaiting transportation to oversea assignments. This helped to reduce the working load of the hospital staff.

In 1945, WW II came to an end; but not before another ten thousand patients had passed through the doors of the hospital for admission. Of these patients, one hundred three repatriates, civilians returned from Japanese prison camps in the Philippines, were quartered (housed) at the hospital and given necessary treatment, physical check-ups, and Red Cross assistance pending the return to their homes.

The Hospital operated its own Welfare and Recreation department to provide comfort and entertainment for both ambulatory and bed-ridden patients. Patients often received visits from the Grey Ladies of the Red Cross and noted celebrities, watched movies, and enjoyed hobbies and crafts. When the Hollywood stars would visit Treasure Island, they would rarely leave without making a tour of the hospital. Some of the patients had "up close" visits from stars such as Sonja Henie and Bing Crosby.

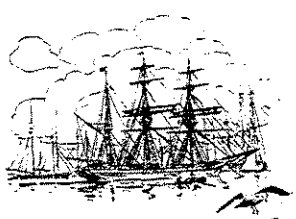
The busiest day of the hospital's history was V-J Day. Three complete surgical teams worked round-the-clock providing medical attention to those casualties of the "end of war celebrations". By the end of the night an entire ward had been designated just for patients having fractured their jaws during the celebrations. All in all, the surgeons treated one hundred twenty five cases that day and night, however, not one of them was a corpsman.

2.3.1.5 Recreation and Entertainment

The Navy was well aware of the recreational needs of the servicemen. To support their needs, Treasure Island, at its peak, provided three theaters, two gymnasiums, three swimming pools, three large athletic fields, several bowling alleys, the Hostess House, the Recreation Center, and Chief Petty Officer's (CPO) club. Each barracks had its own recreational lounge and reading room. The desire for news was satisfied by the *Masthead*, an eight page newspaper of the station which had a distribution of approximately twenty thousand every Saturday.

In line with this policy, the Navy continued to boost the morale of its men by bringing in "big name" entertainers, USO Camp Shows, dance bands on tour, night club floor shows, the San Francisco Symphony Orchestra, and nationally known musical stars. Just to name a few of the stars providing entertainment at Treasure Island, the following "big names", at one time or another, appeared on the station marquee: Bing Crosby, Bob Hope (see Figure 52), Jeannette McDonald, Grace McDonald, Gracie Fields, Kay Kyser, Bill Robinson, the Glenn Miller Band, Benny Goodman and his jazz band, the Marx Brothers, Jose Iturbi, Sonja Henie, Orson Welles, Carmen Miranda, and Linda Darnell. Station dances were held regularly in the big gymnasium with hostesses arriving by bus from USO Hospitality Houses, sororities, and civic clubs of the Bay Area to dance with the four thousand sailors to the sounds of the Navy bands. See Figure 54. The command also brought in special events, such as a complete three-ring circus, the Ice Follies (see Figure 53), a championship Rodeo, and the Aquacade.

Sports were also a major part of base recreation. During World War II and for a while thereafter, sports teams from the various military commands often competed on a level with the "better" college teams. Treasure Island supported such contests as baseball, football, basketball, swimming, and even rugby. See Figure 55 and Figure 56.



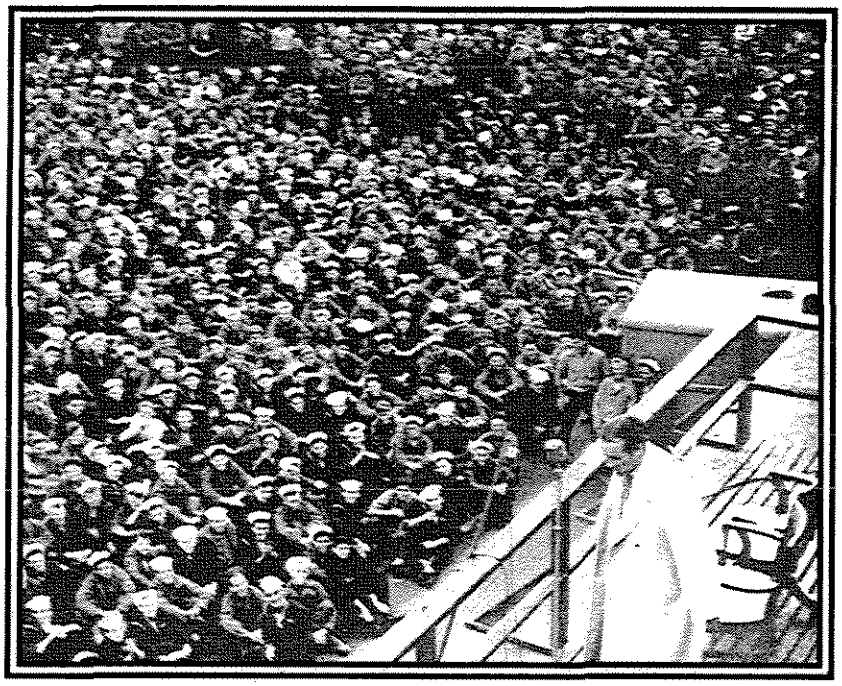


Figure 52. *Bob Hope at Treasure Island. Circa 1942.*

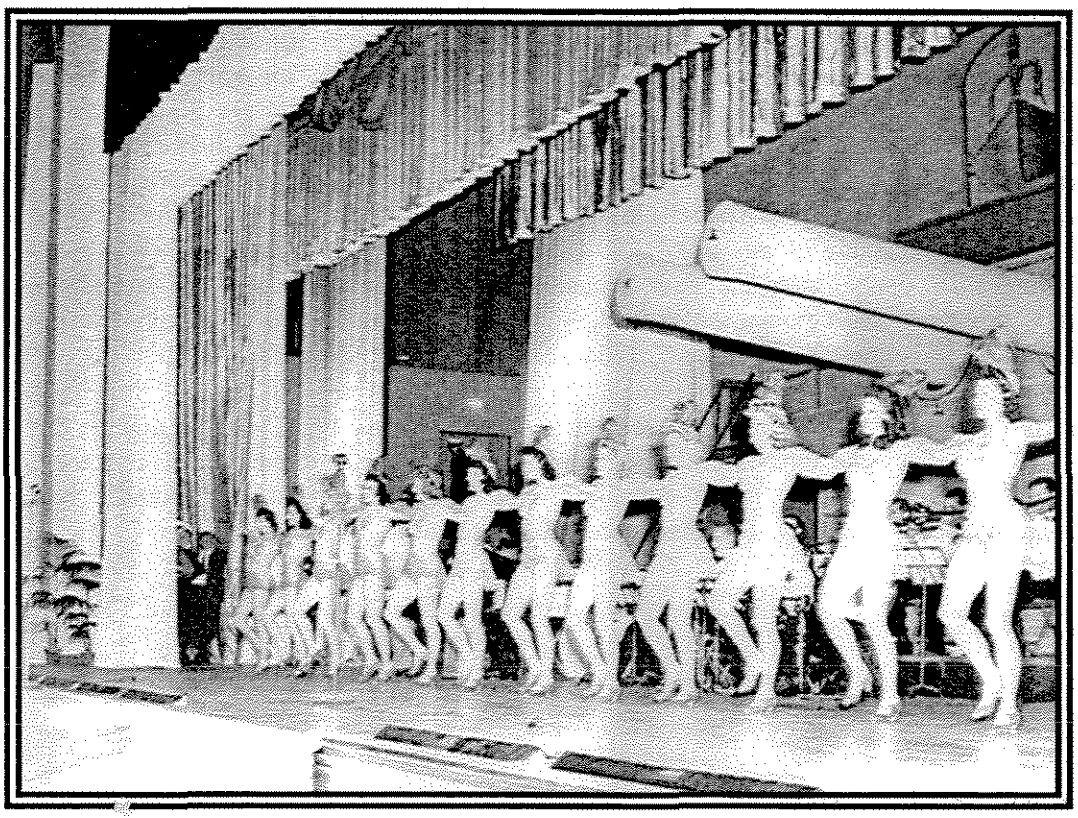


FIGURE 53. *"Follies" show at the Basilone Theater. Circa 1942.*

FIGURE 54. ***USO Dance. Circa 1942.***
Note: United Service Organization (USO) dances became a common form of entertainment for the sailors at Treasure Island. The dances featured many famous name entertainers, as well as Navy bands.

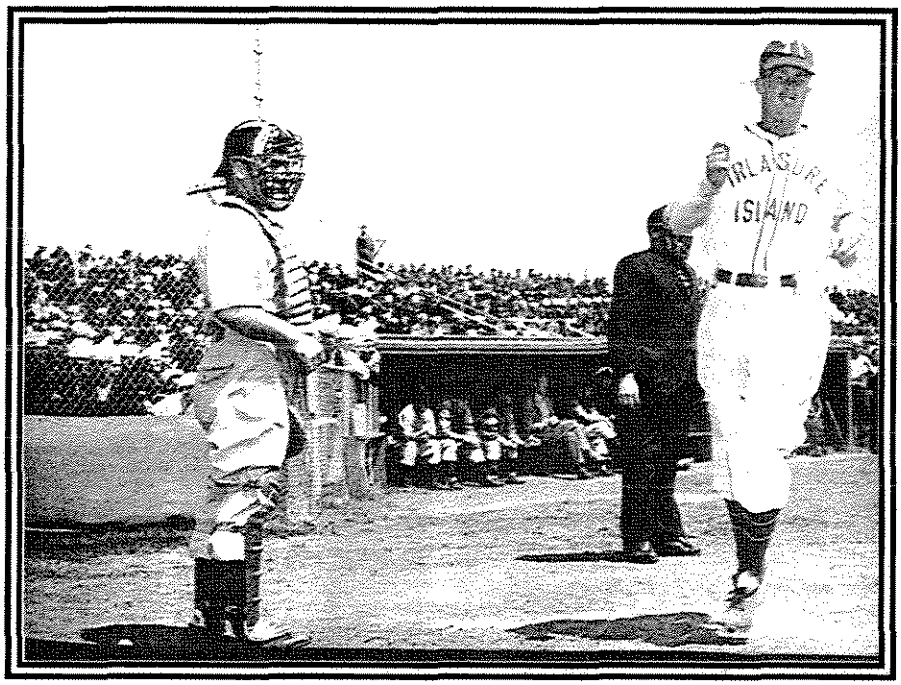
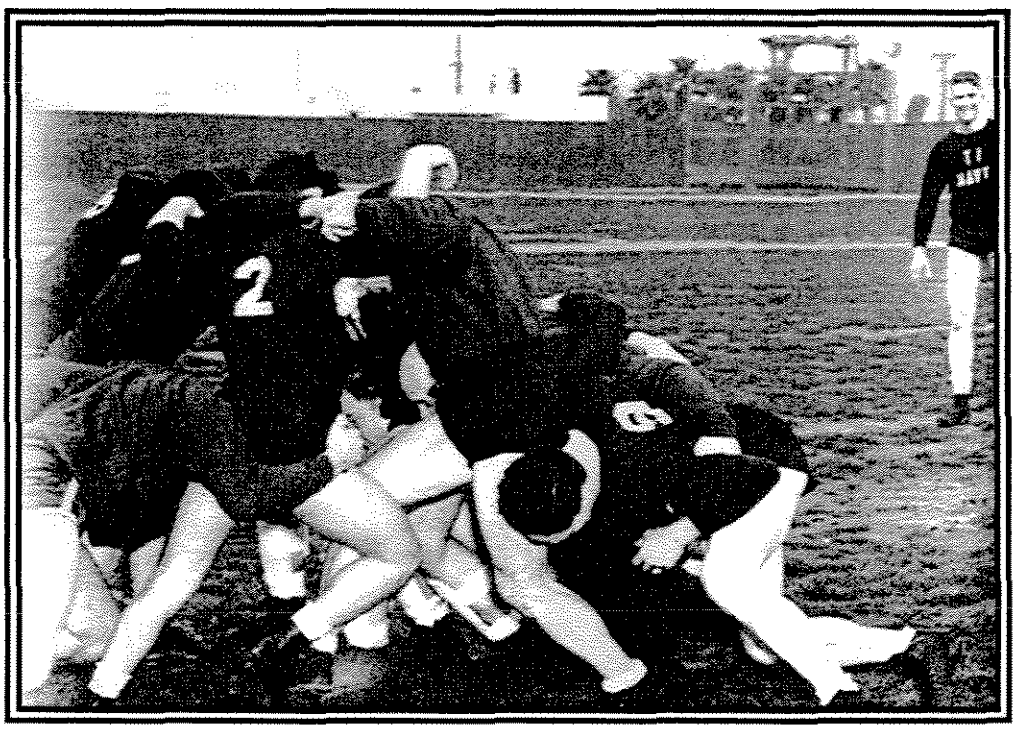


FIGURE 55. ***Baseball at Treasure Island. Circa 1942.***
Note: The attending crowd which filled the bleechers to capacity, cheered as another run was scored by Treasure Island.



FIGIRE 56. ***Rugby at Treasure Island. Circa 1942.***

2.3.1.6 Embarkation Barracks

During WW II, the single largest function of TADCEN was to group servicemen into ship's crews, train them, and then assign the crew to a ship bound for war. The final step of assembling the troops and placing them aboard their assigned duty ship, justified the second major wave of construction on Treasure Island. In 1943, after testing a new integrated method to assemble servicemen for embarkation, the station decided to implement the method which involved having everything a man would need prior to embarkation, available in one place. This included everything from getting a toothbrush to dental work to retaining a legal advisor (possibly to clear up any domestic entanglements). From February through April of 1944, the station set up an "embarkation" camp for the sole purpose of easy accessibility for prossessing the troups.

The Navy constructed barracks, a dispensary, a theater, athletic field, galley and other necessary buildings in a large area on the northeast side of the island. When construction was completed, a fence was installed about the perimeter of the entire area. All servicemen destined for deployment to their assigned ship were restricted to the area inside the fence unless they had obtained a pass. Althouth the men complained that they were basically being treated as prisoners, the Navy had its reasons for their containment. The reasons were primarily to make the process easier to (1) quickly gather all the men assigned to a ship should the ship's sailing schedule inadvertently change, as it so often did; and (2) pass messages, to those men they were intended for, via the loudspeaker systems of the day, as primitive as it was. The system did serve its function and, no matter how the men felt about their encampment, it did work well. The Treasure Island station was able to increase the rate of loading men aboard ships from three hundred men per hour to a thousand men per hour. This in turn raised the overall embarkation rate from twenty five thousand men per month to a capacity of sixty thousand men per month. See Figure 57. In all actuality, this capacity was never attained. The maximum number of men to ever embark in one month was forty three thousand men who were processing to go home from the war.

2.3.1.7 The Height of the War

In May 1944, Rear Admiral Hugo R. Osterhaus, commander of TADCEN and the "Patrol Force", was relieved of his duty by Captain R. W. Cary. Captain Cary was a Congressional Medal of Honor winner and a highly decorated veteran of the amphibious assaults on Sicily, Salerno and Anzio. His commands had included the USS *Savannah*, during the first assaults on Sicily and Salemo; and the USS *Brooklyn* in the assault on Anzio.

Captain Cary's first priority at Treasure Island was to evaluate the effectiveness of internal operations and their services to the forces afloat. Preparations were undertaken to meet an even greater demand for both training and distribution of personnel that were considered absolutely necessary at the time. The "just-completed" embarkation area of the island had been activated. In no time, it developed into a smooth, rapid, and accurate method of transferring men to their respective commands. Further consolidation of general services and an increase in berthing, mess, and recreational facilities found Treasure Island equipped to handle three times its supposedly maximum capacity during the final year of the war. This held true, not only of the embarkation rate, but also for the training programs.

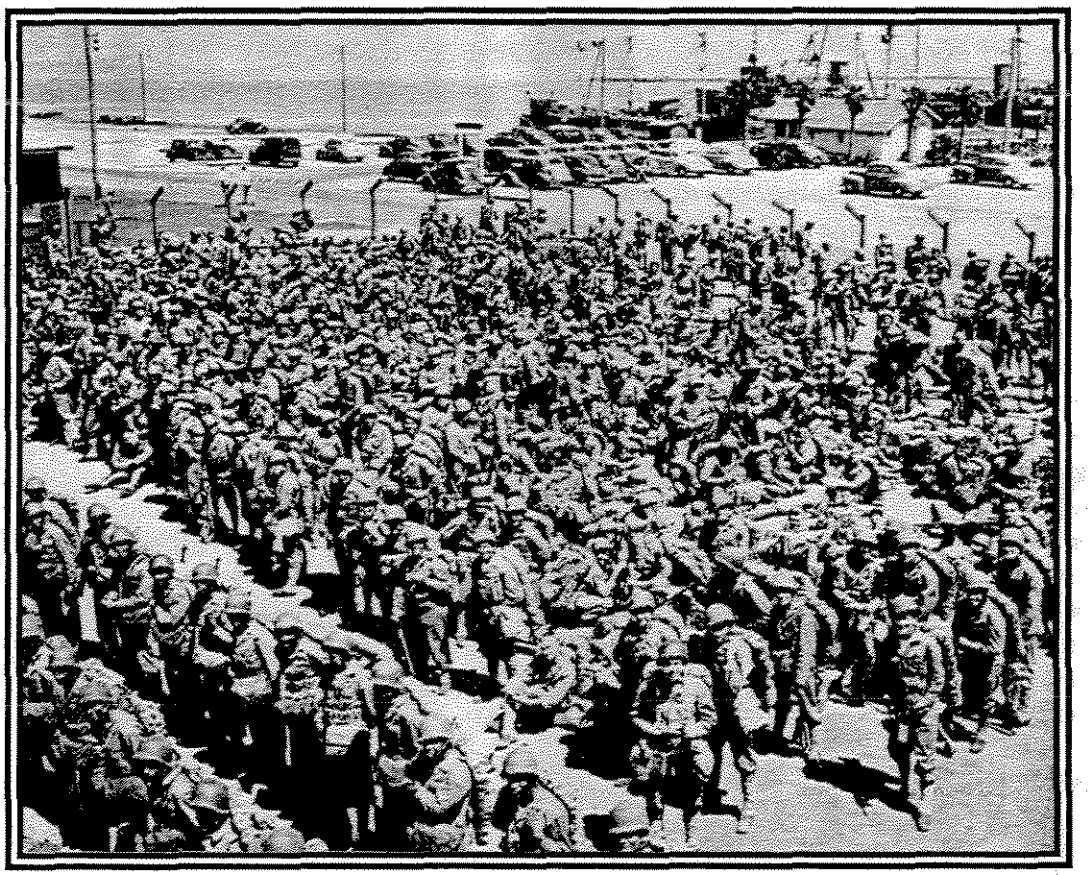


FIGURE 57. ***Troops mustered for overseas embarkation. Circa 1943.***

Note: The Navy constructed barracks, a dispensary, a theater, athletic field, galley and other necessary buildings in a large area on the northeast side of the island. When construction was completed, a fence was installed about the perimeter of the entire area. All servicemen destined for deployment to their assigned ship were restricted to the area inside the fence unless they had obtained a pass. The Treasure Island station was able to increase the rate of loading men aboard ships from three hundred men per hour to a thousand men per hour. This in turn raised the overall embarkation rate from twenty five thousand men per month to a capacity of sixty thousand men per month.. The maximum number of men to ever embark in one month was forty three thousand men who were processing to go home from the war.

2.3.1.8 Frontier Base

The Section Base under the TADCEN organization was redesignated the Frontier Base in 1942. This meant that TADCEN would carry out the duties of a Section Base, but on a larger scale. The Frontier Base was also responsible for craft assigned to Sea Frontiers, as well as coastal craft assigned to the base. Due to the nature of the war and the degree of damage incurred on the ships, the repair facilities in the Bay Area were overloaded. This resulted in the Frontier Base at Treasure Island having to accept even more work than was originally contemplated. The Frontier Base took on the assignment of completely servicing (1) both inshore and offshore operations, and (2) voyage and transient repairs for all craft (up to and including twenty-two hundred ton destroyers). In order to accomplish their assignments, the waterfront facilities at Treasure Island were operated by the Frontier Base and, in essence, formed an integral part of the base.

The facility termed the "Industrial Department" of the Frontier Base, although small compared to other industrial yards, achieved an enviable reputation for the both quality and quantity of work the facility completed. With work equally performed by both naval enlisted personnel and civilian personnel (approximately equal numbers of both were employed), they achieved an "...esprit de corps..." and a work record of which they were justifiably proud. After the war, the Frontier Base was disestablished and redesignated the US Navy Small Craft Facility, whose previous functions continued as before only on a reduced scale.

2.3.1.9 Embarkation Camp Construction

The rate at which buildings were constructed during the creation of the "embarkation" camp was phenomenal. Rather than try to describe it, compare the following photographs (see Figures 58 through 65) taken during this construction phase. In addition, the photographs provide a feeling for the rate of change from a small base processing about 4,000 men per month to a fully operational military base processing as many as 13,000 men a day.

The rapid changes to Treasure Island during the construction phase of the Embarkation Facility are shown in Figures 58 through 61. Most of the excavation, development, and construction were completed within a three to four month period.

The area of the Embarkation Facility which provided housing to the Bachelor Officers greatly changed in the one month period between March and April, 1944. See Figure 62 and Figure 63.

Figure 64 and Figure 65 are views of the same area of the Embarkation Facility. In two months time, as indicated by the photographs, the area was excavated, developed, and enclosed by a fence. This area was designated for Prisoners of War (POW) housing. The January 1944 photograph reveals the beginnings of the foundation work for Buildings 188 and 189. The March 1944 photograph reveals the quick development of the area, evident by the construction of Buildings 188, 189, 190 and 191. From June 1945 through March 1946, there were 1,300 German POWs, mostly members of General Rommel's Afrika Korps, held captive and emprisoned at the facility. The prisoners, while under the cognizance of the Security Office (Ref. P, page 134), were assigned work on the island in the same way that the Navy Brig assigned manual labor jobs to its prisoners.

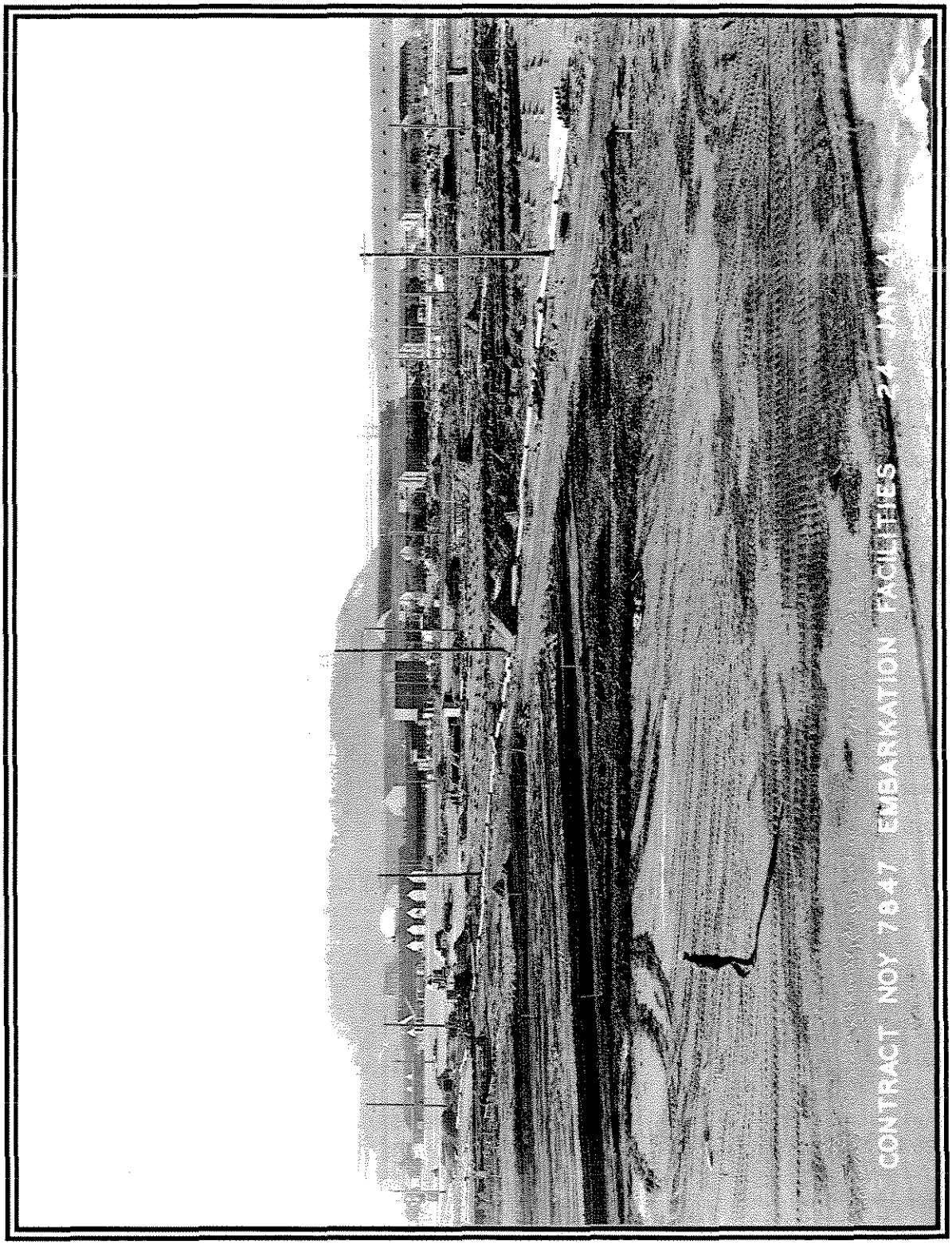


FIGURE 58. ***Treasure Island Embarkation Facilities Building Sites. January 24, 1944.***
Note: Photograph, taken from mid island looking south, shows the site excavation efforts in progress for soon to be constructed Buildings 208, 209, 215, 216, 217, and 218.

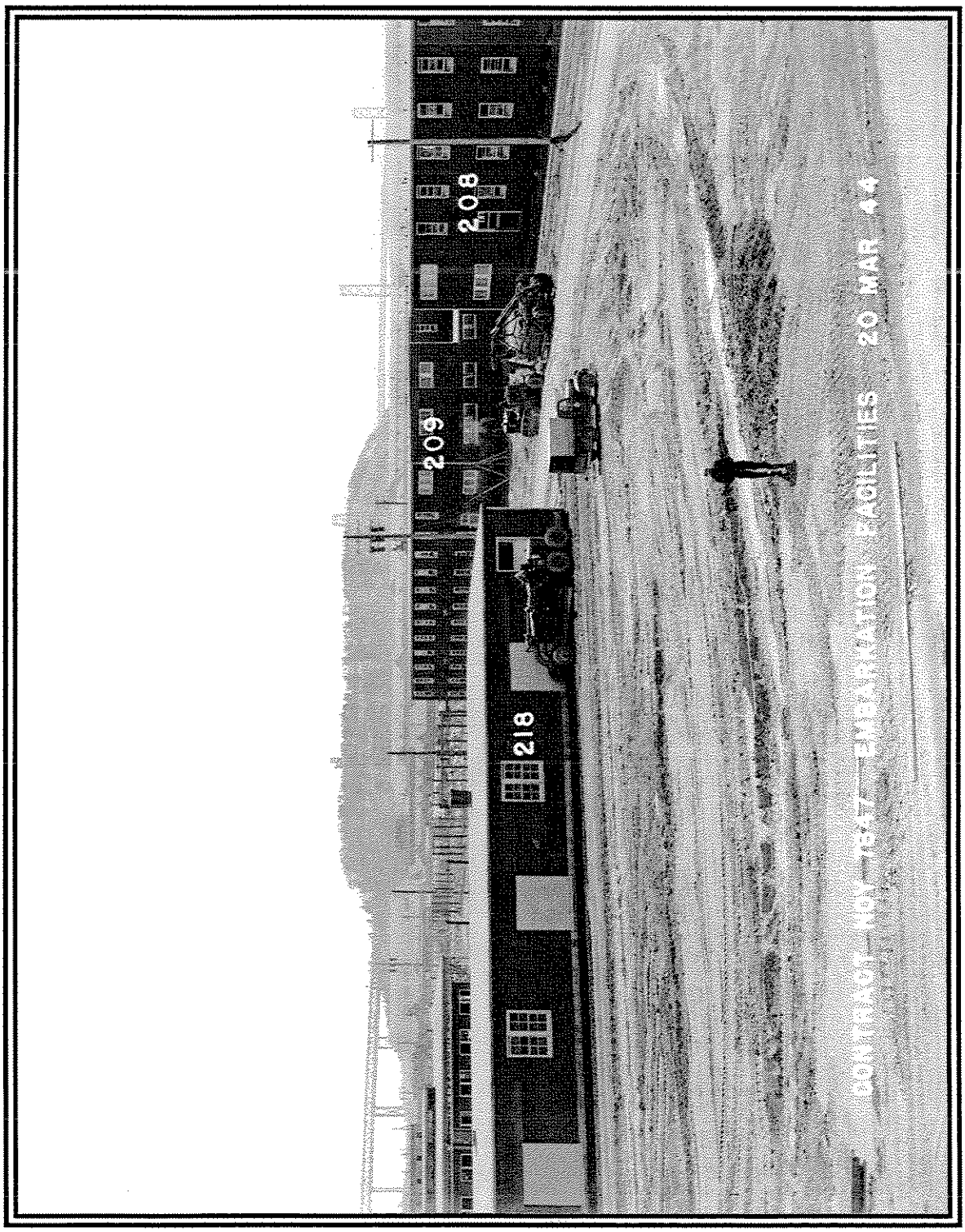


FIGURE 59. ***Treasure Island Embarkation Facilities Building Sites. March 20, 1944.***
Note: Photograph, taken from mid-island looking south, shows continued site excavation efforts and newly constructed Buildings 208, 209, and 218 (in foreground). The roofs of Buildings 215, 216, 217 (in background) are located behind Building 218.

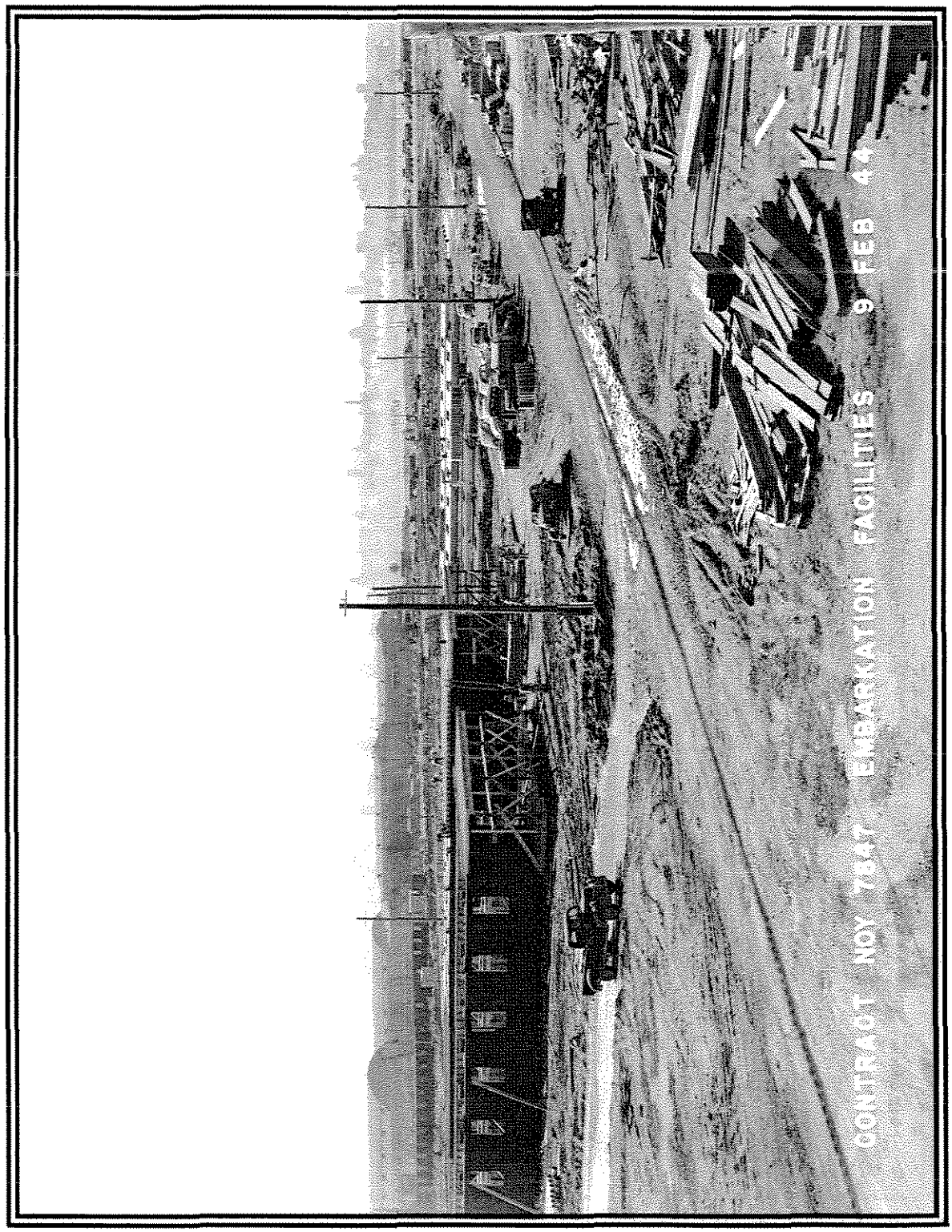


FIGURE 60. ***Treasure Island Embarkation Facilities. February 9. 1944.***
Note: Photograph, taken from mid island looking southeast, shows site excavation and new construction for Buildings 205, 206, 207, 208.

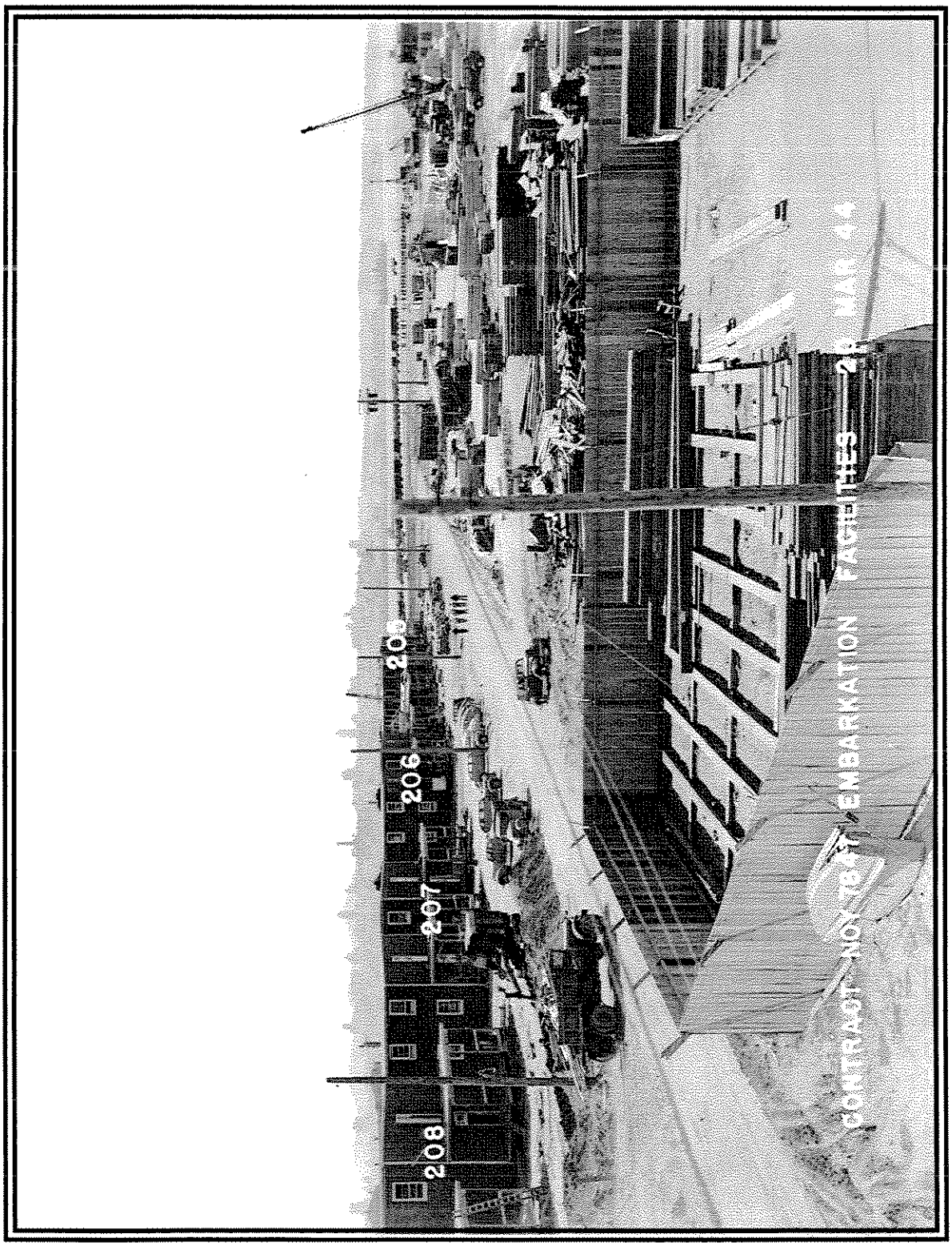


FIGURE 61. ***Treasure Island Embarkation Facilities. March 20, 1944.***
Note: Photograph was taken from mid-island looking southwest, shows continued site excavation and newly constructed Buildings 205, 206, 207, 208.

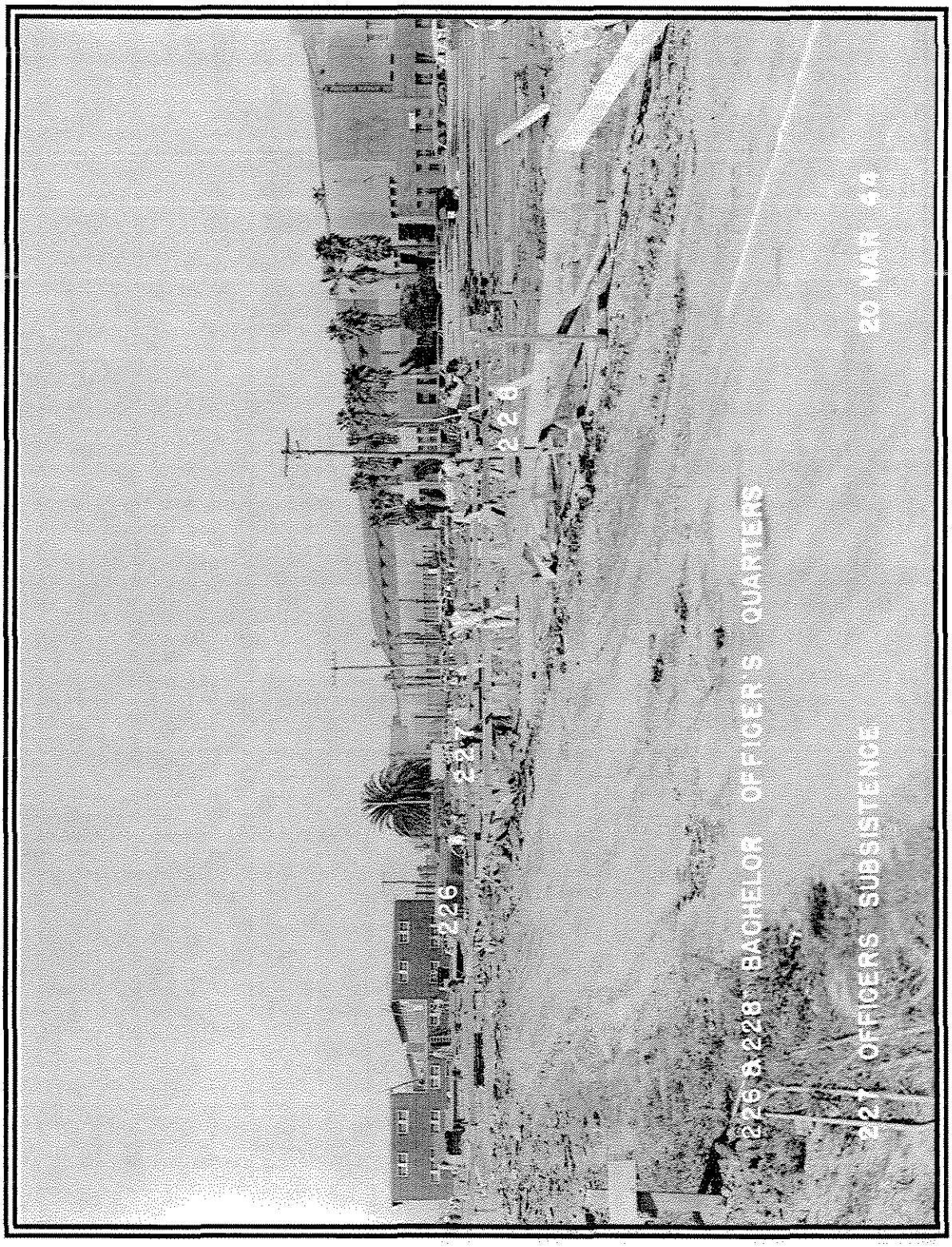


FIGURE 62. ***Treasure Island Embarkation Facilities Bachelor Officer's Quarters. March 20, 1944.***
Note: Photograph, taken from mid-island looking northeast, shows site excavation and new construction for Bachelor Officer's Quarters (Buildings 226 and 228) and Officer's Subsistance (Building 227).

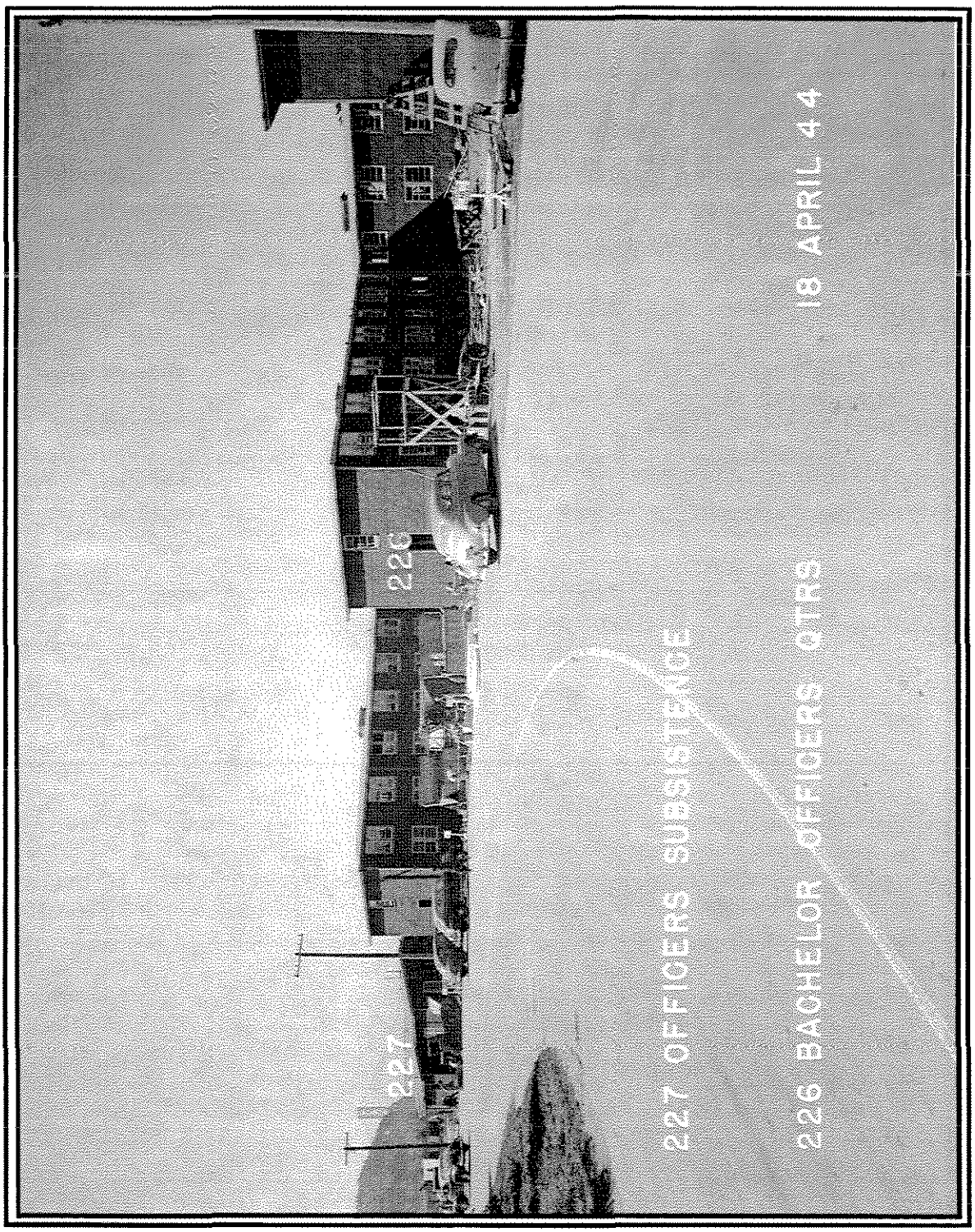


FIGURE 63. ***Treasure Island Embarkation Facilities Bachelor Officer's Quarters. April 18, 1944.***
Note: Photograph, taken from mid-island looking southwest, shows continued site excavation and the newly constructed Bachelor Officer's Quarters (Building 226).and the Officer's Subsitence (Building 227). Bachelor Officer's Quarters (Building 228) is under construction and barely seen to the left of Building 227.

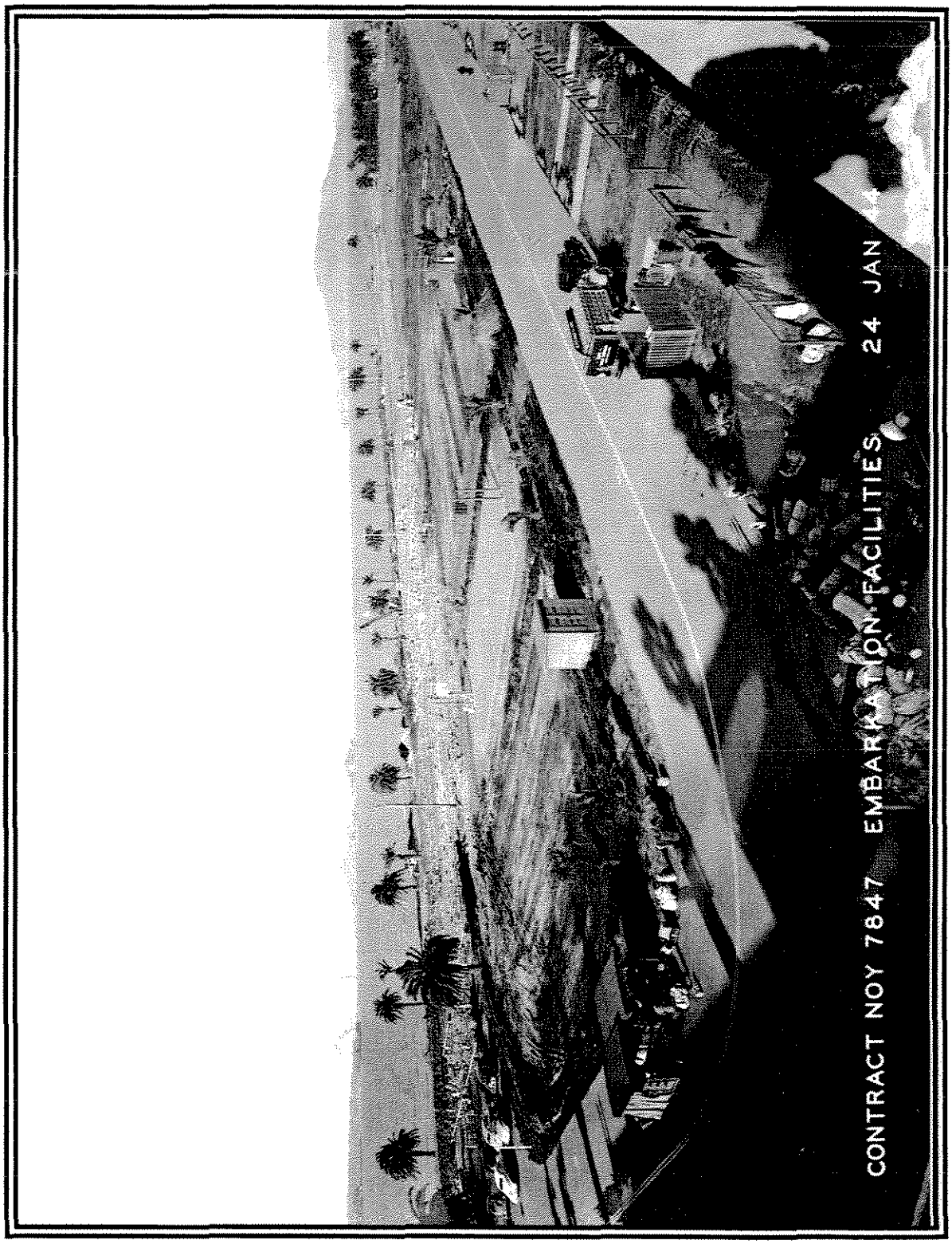


FIGURE 64. ***Treasure Island Embarkation Facilities Designated POW Housing. January 24, 1944***
Note: Photograph, taken from atop "Palace C" looking northwest,. shows the site excavation efforts in progress for soon to be constructed POW Housing (Buildings 188, 189, 190, and 191).

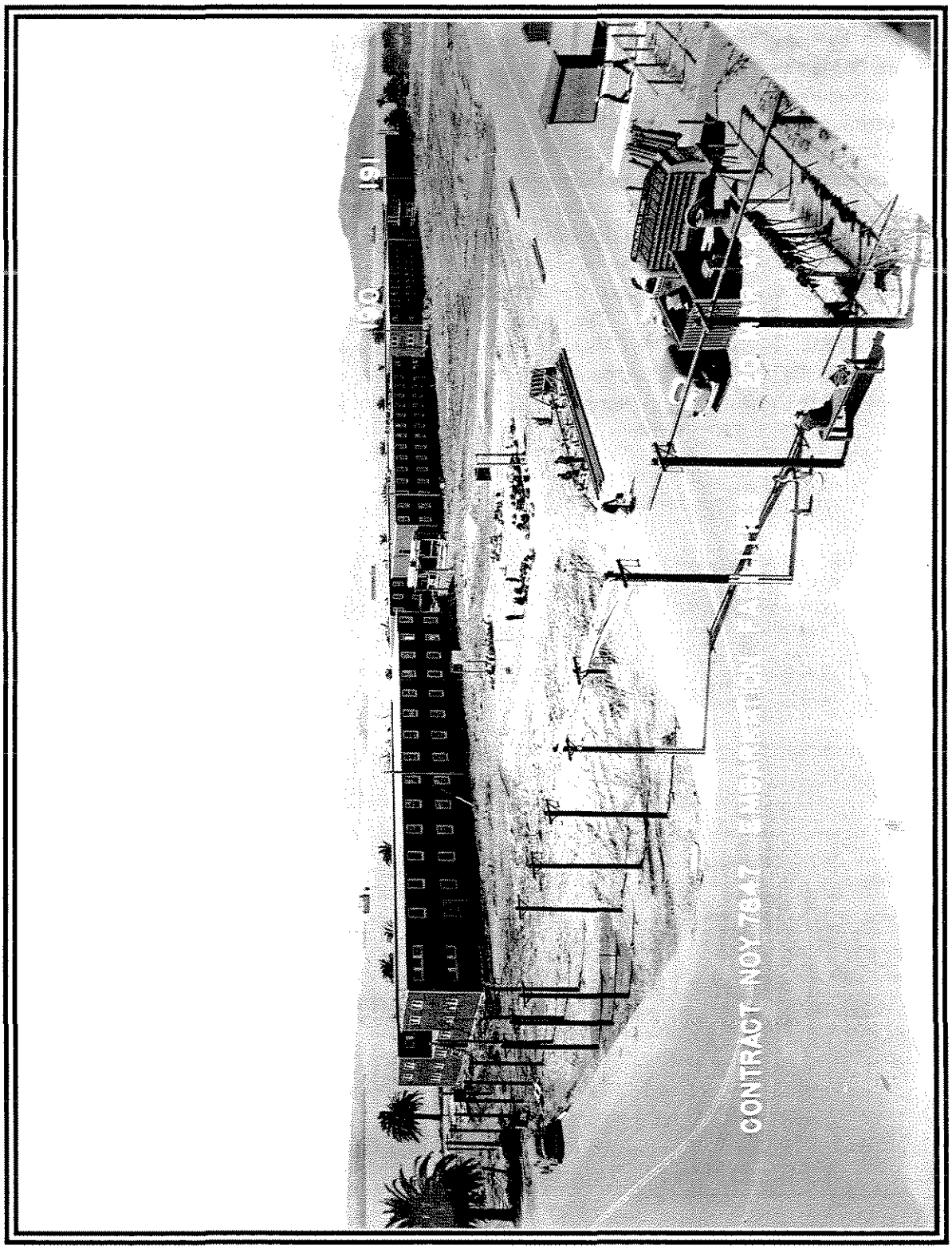
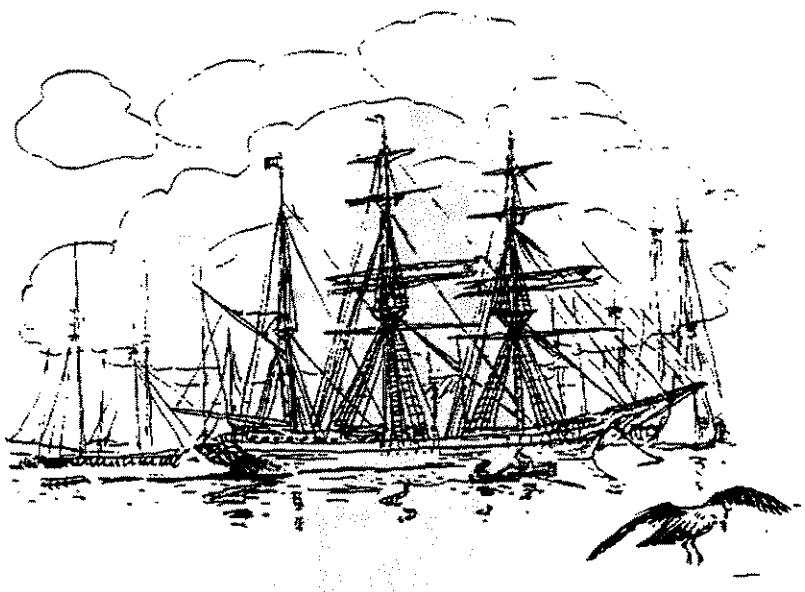


FIGURE 65. ***Treasure Island Embarkation Facilities POW Housing. March 20, 1944.***
Note: Photograph, taken from atop "Palace C" looking northwest, shows continued site excavation efforts and the newly constructed POW Housing (Buildings 188, 189, 190, and 191).

An overall view of the total changes that occurred during World War II on Treasure Island can be seen by comparing the following two maps (Figure 66 and Figure 67). The first map, Figure 66, is the fold-out map provided in the 1939 Official Guide Book of the Golden Gate International Exposition. The second map, Figure 67, was printed in the March 30, 1946 issue of the *Masthead*, the Treasure Island Naval Base newspaper. Neither was intended to be an official map, but rather to convey a view of what the island layout was at that day. The two maps provide an opportunity to compare the island's development over a seven year period.

September 2, 1945 is the official day of victory for the Allies over Japan in World War II and is hence known as "V-J Day", a day of great celebration. To show the San Francisco Bay Area's appreciation of the returning troops from overseas, a large message was erected on the western end of Yerba Buena Island. The message for the returning sailors and marines read "HI MATES — GREAT WORK". A second message reading "WELCOME HOME — JOB WELL DONE" was placed on Angel Island for the returning Army troops. Both messages were visible to the troop ships entering the Bay as they neared each island.



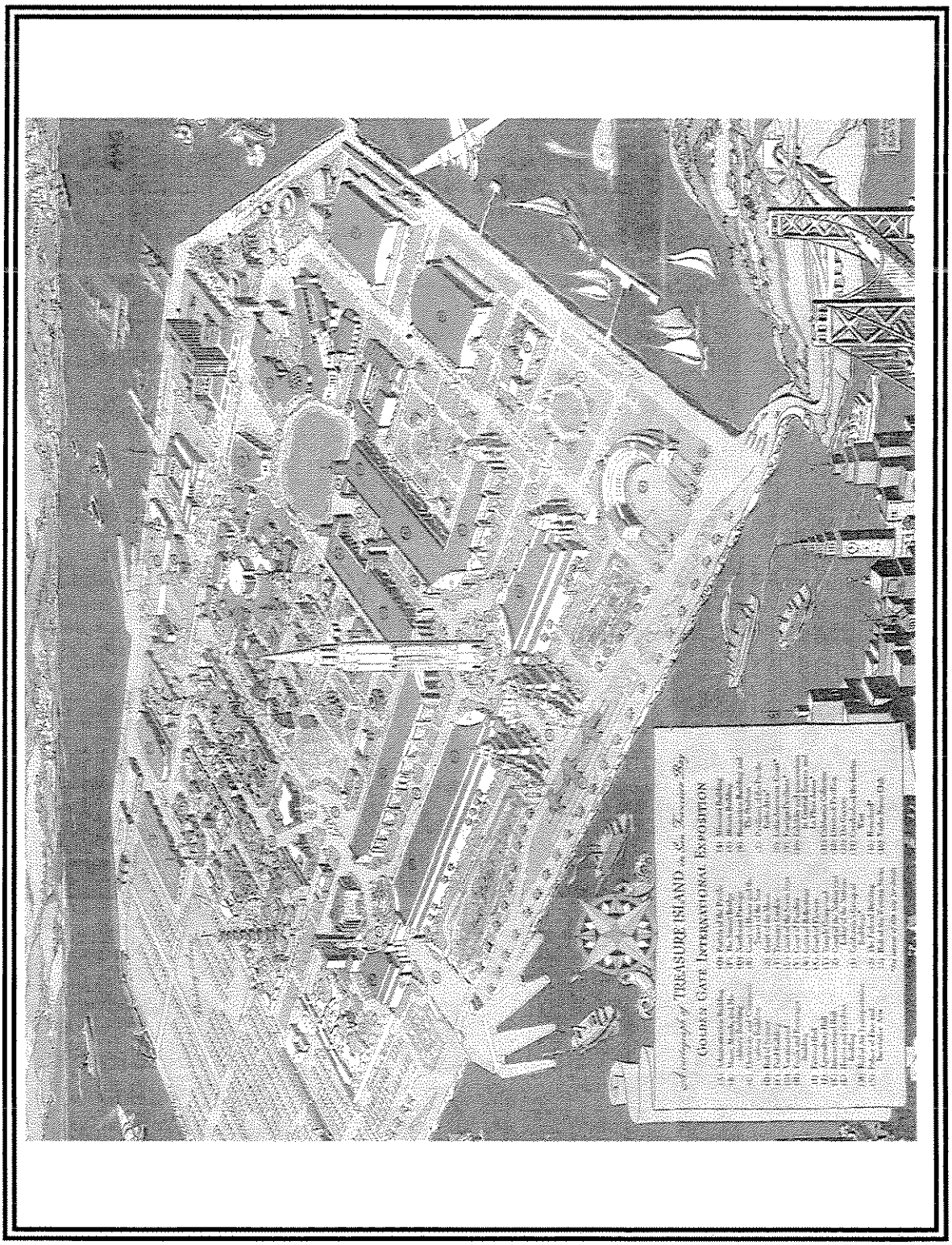


FIGURE 66. ***Cartograph of Treasure Island. Circa 1939.***
Note: The cartograph of Treasure Island presents an overview of the Island during the Golden Gate International Exposition.

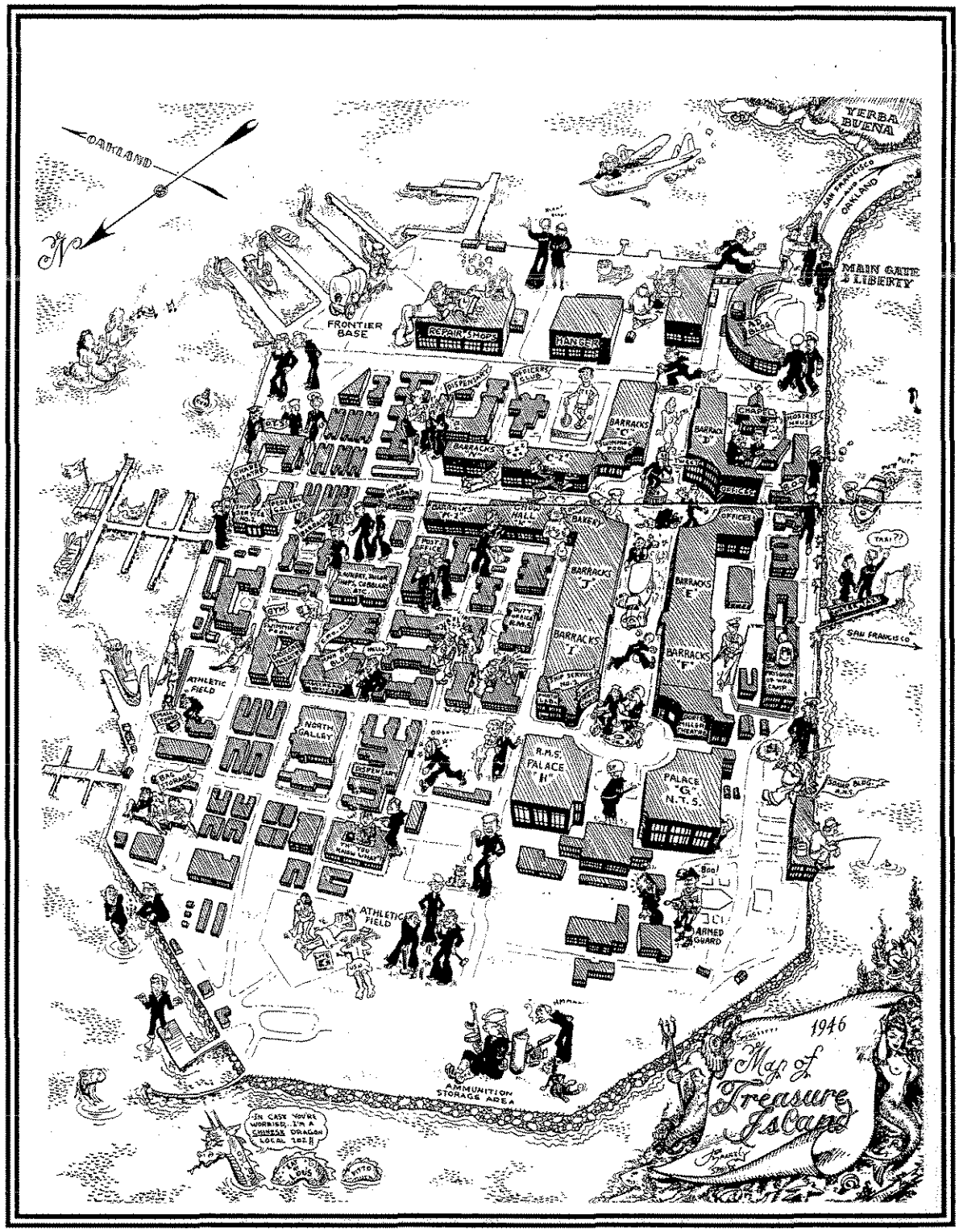


FIGURE 67. ***Cartoon Cartograph of Treasure Island. Circa 1946.***

Note: The cartoon cartograph of Treasure Island presents a comical overview of the Island. The use of a magnifying glass will reveal many examples of 1946 "sailor humor" shown on this map. Notice the union dragon in the lower left corner.

2.3.2 Cold War Era, 1946–Present (1995)

After the end of World War II, the military rapidly downsized. The Treasure Island Frontier Base was disestablished and that portion of the TADCEN was redesignated the US Navy Small Craft Facility. The new organization continued to operate as before, but on a reduced scale. Ships returned from sea with the tens of thousands of men who not too long before had processed through on their way to the war. The highest rate of daily military transfers occurred during this post-war time immediately following "V-J Day" for the Treasure Island TADCEN and the Receiving Ship organizations. Soon the waterfront became crowded with transport ships awaiting decommissioning. The numbers of ships varied daily, as some were towed away to be cut up for scrap metal and others were put to rest in "mothballs". This massive collection of "mothballed" ships which so proudly served their nation, was provided a new place of anchorage located in the Suisun Bay and is called the "Suisun Bay Reserve Fleet".

During the post-WW II period, Treasure Island was redesignated a Naval Station in 1947; however, it continued to operate as a training command. In 1952, the various schools located in facilities through the Bay Area were consolidated to become the Naval Schools Command. The Radio Materiels School eventually became the Electronics Schools. Among the courses offered were the "A" (basic), "B" (intermediate), and "C" (advanced) training levels for Electronics Technicians, Advanced Fire Control Technicians, and Radarmen. These schools were closed circa 1975 when newer facilities became available.

In the post-Vietnam War era, several major training courses were transferred to other military locations. In 1972, the Naval Schools Command at Treasure Island was redesignated the Naval Technical Training Center (NTTC). The NTTC was comprised of thirty seven training courses taught in eight school divisions divided between the following two training departments:

- **The Apprentice and Leadership Training Department** - contained the Damage Controlman "A" School, the Integrated Training Battalion, the Leadership and Management Education and Training Division, the Radioactivity Detection, Indication, and Computation (RADIAC) Division, and the Religious Program Specialist Division..

- **The Fleet Training Department** - contained the Damage Control Division, Underway Replenishment Division, Firefighting Division, and the Electronics Division.

The Damage Control School, built out at the northeast corner of the island, was equipped with a damage control simulator known as the USS *Buttercup*. The simulator duplicated a ships interior compartment and was capable of being flooded with water and steam to simulate battle damage. The students, as their pratical training, were required to the "save the flooding ship" by securing and/or controling all leaks. The students also learned how to repair structural damage to the ship's overheads and decks with the use of shoring, patching and dewatering methods.

The Firefighting School was one of seven in the Navy. The primary function of the school was to teach students how to fight all classes (types) of fires. During the early years of the firefighting school, the fuel fires that were used for training would billow huge black smoke clouds into the sky. The blackened sky could be seen from the Golden Gate to the South Bay.

Finally in the late 1970's, new equipment was installed that controlled the smoke and almost completely ended this unwanted air pollution problem. The original firefighting school at Treasure Island was replaced in 1991 with a new structure; however, the old school was not demolished until 1993. Today, the new school is one of the finest found anywhere. The facility instructs over 12,000 students each year in the proper procedures for fighting all four classes of fires. It is scheduled for closure in 1997.

RADIAC Instrument Maintenance was taught under the auspices of the Navy's Medical Service Corps at Treasure Island. The RADIAC course taught the proper handling, maintenance, and repair of RADIAC instruments. These portable instruments, small in size, have unusually high voltages and are extremely sensitive. Each RADIAC instrument is equipped with a check sources (small, radioactive elements mounted on the instrument) which is used for quick calibration in the field. This course was the only one of its kind taught in the Navy. It was closed in 1993.

The Underway Replenishment School, also a "one-of-a-kind" school, provided instruction specialized courses, such as Cargo Weapons Elevator Systems which included electrical, mechanical, and hydraulic theories combined with advanced troubleshooting. A full-scale Cargo Weapons Elevator was the perfect training aid for students to practice their skills before encountering them aboard ship. The school is scheduled for closure in 1996.

The Religious Program Specialist School provided a curriculum that included communication, program support, financial accounting and office procedures. The courses were divided into two levels; an "A" school for the basics and a "C" school which concentrated on advanced chapel management. Again, this was a one-of-a-kind school, that closed in 1988.

The Leadership and Management Education and Training provided instruction in the most current management theories and definitions, as well as classroom experience to Leading Petty Officers (LPOs), Chief Petty Officers (CPOs), and Division Officers. Additionally, there were two more courses available to the Officers: (1) Drug and Alcohol Program Advisor, and (2) Overseas Deployer Coordinator, whose would be responsible to brief those assigned to their command on cross-cultural communication prior to visits in foreign ports.

From 1969 to 1977, the Twelfth Naval District (12ND) was headquartered at Treasure Island. The concern of the 12ND was the defense of the coast of California. Established originally in 1903, it was administered from Mare Island Naval Shipyard until 1915, when it moved to San Francisco. There the 12ND remained, moving from office building to office building, until 1936, when it moved into the Federal Office Building located in San Francisco. In 1969, the Navy moved the 12ND to Treasure Island where it was administered from Building 257. Then in 1972, the Navy relocated the 12ND into Building 1 at Treasure Island and there the 12ND remained until disestablished in 1977.

US Naval Station Treasure Island was redesignated a US Naval Support Activity in 1975. This was short-lived, as Treasure Island was again designated US Naval Station, Treasure Island in 1980 which remains its designation to this day. Regardless of title, Treasure Island has continued to provide general service to the fleet and has carried on its training mission. In the last few years, the Naval Station had two unusual ships, of interest berthed at her piers, the *Potomac* and the *Hoga*. Their histories are as follows:

- **The *Potomac*** - The *Potomac* was President Franklin Delanor Roosevelt's presidential yacht. The *Potomac*, originally built as an "Argo" class patrol boat by the Manitowoc Shipbuilding Company of Manitowoc, Wisconsin, was commissioned as the Coast Guard Cutter *Electra* in 1934. The steel hulled cutter was 165 feet long, weighed 376 gross tons, and could reach a top speed of 16 knots. In November 1935, The *Electra* was transferred to the US Navy and became the replacement vessel to the then current presidential yacht *Sequoia.* President Roosevelt disliked the *Sequoia* because he considered it to be gaudy and too dandified for deep sea fishing, as well as presenting him great difficulty in moving about the vessel with his weak legs. The *Electra,* converted into a presidential yacht for approximately $60,000, was renamed the *Potomac* in 1936. President Roosevelt obviously loved the yacht because he used it during the following five years on a regular basis. The outbreak of the war in Europe in 1939 gave the the Secret Service cause to worry that at any time a German submarine could destroy the yacht with the President onboard. As a result, in 1941, a panel of US Coast Guard inspectors declared the yacht to be "unseaworthy" and, therefore, withdrew the *Potomac* from presidential service. The vessel was subsequently turned over to the Navy's anti-submarine warfare research center for use as a research ship until the end of the war. The *Potomac* was decommissioned in November 1945. In 1946, the vessel was transferred to the Maryland Tidewaters Fisheries Commission. The Commission used the vessel for research and as the Governor's yacht until 1960, when it sold at auction. It was Purchased by Warren Toone, who sold it to the Hydro Capitol Corporation to ferry passengers between Puerto Rico and the Virgin Islands. By 1964 the *Potomac* had made its way to Long Beach where it was bought by Elvis Presley in January 1964. Mr. Presley donated the yacht to the St. Jude's Hospital of Memphis, Tennessee in February 1964. The St. Jude's Hospital sold the *Potomac* to a Fresno-based real estate developer, whose identiy is unknown. Eventually the ownership of the vessel passed to a Mr. C. Taylor, who leased it to Aubrey Phillips (part-time bail bondsman and private investigator) in 1971. Mr. Phillips, who wanted to display the yacht as a floating museum, relocated the vessel to Stockton where he opened it to the public in January 1980. In August 1980, Mr. Phillips moved to San Francisco and berthed the vessel at San Francisco's Pier 26. A month after his arrival in the City, he was arrested in a major drug raid. Because the *Potomac* was involved in the drug raid, the US Customs Department seized the vessel and towed it to Treasure Island in September 1980. On March 18, 1981, the *Potomac* sank at its mooring from damaged caused by a piling which had punctured its neglected hull. A week after sinking, it was refloated by members of the US Navy Reserves. Later that year, the vessel was again sold. This time, to the Port of Oakland for $15,000. With efforts by the Port of Oakland and eventually the Potomac Preservation Association, the *Potomac* was slowly restored after fourteen years and $5,000,000 in donated funds. The *Potomac* was declared an Historical Landmark in 1990 as the result of these dedicated efforts. In 1993, ownership of the *Potomac* was turned over to The Potomac Preservation Association. The vessel, fully restored and operational, was opened to the public for tours and private

charters in 1995. Today, the vessel is berthed at the Franklin Deleanor Roosevelt Pier (FDR Pier), Jack London Square, Oakland California.

- **The *Hoga*** - The *Hoga*, an ocean-going tugboat, played a dramatic role in the attack on Pearl Harbor. Photographs showed her pushing the burning battleship USS *Nevada* onto the beach, keeping the main channel clear, and then pouring water onto the burning ship. The *Hoga* also did its best to fight the fires on the USS *Arizona* as the doomed ship sank at its moorings. In addition she rescued wounded sailors from the waters of Pearl Harbor. After WW II, the *Hoga* became a fire fighting boat for the Oakland Fire Department. As of December 1994, the vessel is berthed at Treasure Island's Pier 1. The *Hoga* is the last remaining ship from the attack on Pearl Harbor. Attempts are underway by a group in Honolulu to purchase the *Hoga* and return the vessel to the site of its greatest glory.

Like these ships, Treasure Island itself awaits the future with a mixture of hope and concern. The closure of the Naval Station at Treasure Island was announced in 1993 and will occur in September 1997. For the first time in one hundred thirty years, the military will not be the dominant force on the sister islands of Yerba Buena Island and Treasure Island. The lighthouse and Coast Guard will remain on the south side of Yerba Buena Island. Who will claim the rest of the island and how they will use it is still a matter of conjecture. In the meantime, the Navy at both Yerba Buena Island and Treasure Island will gradually close the schools and buildings that have served the people of the United States so well for so long.

2.4 Buildings of Treasure Island, 1937–1994

The buildings of Treasure Island can easily be divided into two categories, those existing and those demolished. Maps used to research the history of Treasure Island buildings were: 1938, 1940, 1943, 1945, 1948, 1950, 1953, 1961, 1970, 1973, 1974, 1976, 1977, 1988, 1992 and 1994. All map quad references are to the current maps. The review of maps for the determination of when a building appeared or disappeared provided the basis for the dating and categorizing buildings. For a few buildings determination was based on photographs. Thus, a building that is described as "Year Demolished: NLT 1948" would have been on the 1945 map but was gone on the 1948 map. Table acrynoms are defined as: "N/A" = "Not Applicable", "NLT" = "No Later Than", and "~" = Approximately. The exception to the acrynoms are those that are of commands, such as "NTTC", where the initials are considered the normal way of identifying and referring to them. When abbreviations are used, reference material has presented the information in this fashion and/or the exact meaning of the abbreviation could not be determined. Building "uses" indicated in "**Bold**" text indicate possible environmental concerns based upon the building use.

2.4.1 Building Index

A numerically sequenced index listing all Treasure Island buildings constructed from 1937 through 1994 is provided as Table 3. This index also provides direction for locating additional building data in Table 4 (Existing Buildings) and Table 5 (Demolished Buildings). Information relative to the Exposition Buildings demolished prior to 1942 is provided in Table 6.

2.4.2 Existing Buildings

The existing buildings of Treasure Island are listed in Table 4. The list contains all buildings still standing on Treasure Island, as of December 1, 1994. The list is presented in numerical sequence by building number.

2.4.3 Demolished Buildings

Buildings which have been demolished or are no longer standing on Treasure Island, as of December 1, 1994, are listed in Table 5. A list of those Golden Gate International Exposition buildings known to be in existance until 1942 is provided in Table 6. Since all Exposition buildings listed in Table 6 were demolished before the first military maps of Treasure Island were generated (approx. 1942), the building list provided is based on the comparison of the civilian 1939 maps to the military 1942 map.

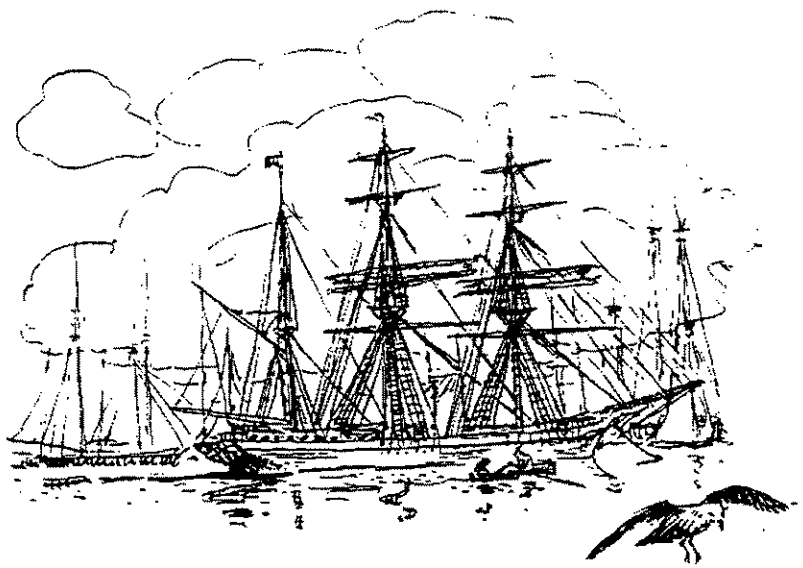


Table 3

Index of Treasure Island Buildings, 1937-1994

Building No.	Table No. 4	5
1	•	
2	•	
3	•	
4	•	
5	•	
6	•	
7	•	
8		•
9		•
10		•
11		•
12		•
12A	•	
12B	•	
12C	•	
13		•
14		•
15		•
16		•
17		•
18		•
19		•
20		•
21		•
22		•
23		•
24		•
25		•
26		•
27		•
28		•
29	•	
30		•
31		•
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33		•
34	•	
35		•
36		•
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38		•
39		•
40	•	
41	•	
42		•
43		•
44		•
45		•
46		•
47		•
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49		•
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51		•
52		•
53		•
54		•
55		•
56		•
57		•
58		•
59		•
60		•
61		•
62	•	
63	•	
64	•	
65		•
* 66		
67		•
68		•
69	•	
70	•	
71		•
72		•
73		•
74		•
75		•
76		•
77		•
78		•
79		•
80		•
81		•
82		•
83		•
84		•
85	•	
86		•
87		•
88		•
89		•
90		•
91	•	
92	•	
93	•	
* 94-95		
96	•	
* 97		
98		•
99	•	
100		•
101		•
102		•
103	•	
104	•	
105	•	
106		•
107	•	
108		•
109		•
110		•
111	•	
112	•	

* - Building number not assigned

Table 3

Index of Treasure Island Buildings, 1937-1994

Building No.	Table No. 4	5
113	•	
114	•	
115		•
116		•
117		•
118		•
119		•
120		•
121		•
122		•
123		•
124		•
125		•
126		•
127		•
128	•	
129	•	
130	•	
131	•	
132		•
133		•
134		•
135	•	
136		•
137		•
* 138		
139		•
140	•	
141	•	
142		•
143	•	
144		•
145		•
146	•	
147		•
148		•
149		•
150		•

Building No.	Table No. 4	5
151		•
152		•
153		•
154		•
155		•
156		•
157	•	
158		•
159		•
160		•
161		•
162		•
163		•
164		•
165		•
166		•
* 167		
168		•
169		•
170		•
171		•
172		•
173		•
174		•
175		•
176		•
177		•
178		•
179		•
180	•	
181		•
182		•
183	•	
184	•	
185		•
186		•
187	•	
188		•

Building No.	Table No. 4	5
189		•
190		•
191		•
192		•
193		•
194		•
195	•	
196		•
197		•
198		•
199		•
200		•
201	•	
202	•	
203		•
204		•
205		•
206		•
207		•
208		•
209		•
210		•
211		•
212		•
213		•
214		•
215	•	
216	•	
217	•	
218		•
219		•
220		•
221		•
222		•
223		•
224		•
225	•	
226		•

* - Building number not assigned

Table 3

Index of Treasure Island Buildings, 1937-1994

Building No.	Table No. 4	5
227	•	
228		•
229	•	
230	•	
231		•
232		•
233	•	
234		•
235		•
236		•
237		•
238		•
239		•
240		•
241		•
242		•
243		•
244		•
245		•
246		•
247		•
248	•	
249		•
250		•
251		•
252		•
253		•
254		•
255		•
256		•
257	•	
258	•	
259		•
260	•	
261	•	
262		•
263		•
264	•	

Building No.	Table No. 4	5
265	•	
266		•
267		•
268		•
269		•
270		•
271	•	
272		•
273		•
274		•
275		•
276		•
277		•
278		•
279		•
280		•
281		•
282		•
283		•
284		•
285		•
286		•
287		•
288		•
289	•	
290	•	
291		•
292	•	
293	•	
294		•
295		•
296		•
297		•
298	•	
299		•
300		•
301		•
302		•

Building No.	Table No. 4	5
303		•
304		•
305		•
306		•
307		•
308		•
309		•
310		•
311		•
312		•
313		•
314		•
315		•
316		•
317		•
318		•
319		•
320		•
321		•
322		•
323		•
324		•
325	•	
326		•
327		•
328	•	
329		•
330	•	
331		•
332		•
333		•
334		•
335	•	
336		•
337		•
338		•
339		•
340		•

* - Building number not assigned

Table 3

Index of Treasure Island Buildings, 1937-1994

	Building No.	Table No. 4	Table No. 5
	341	•	
	342	•	
	343	•	
	344	•	
	345		•
	346	•	
	347	•	
	348		•
	349		•
	350		•
	351		•
	352		•
	353		•
	354		•
	355	•	
	356		•
	357		•
	358	•	
	359		•
	360		•
	361	•	
	362	•	
	363	•	
	364	•	
	365	•	
	366	•	
	367	•	
	368	•	
	369	•	
	370		•
	371	•	
	372		•
	373		•
	374	•	
	375		•
	376		•
	377	•	
	378	•	
	379	•	
	380	•	
	381	•	
	382	•	
	383	•	
	384	•	
	385	•	
	386		•
	387		•
	388		•
	389		•
	390	•	
*	391-392		
	393	•	
	394	•	
	395	•	
	396	•	
	397	•	
	398	•	
	399		•
	400		•
	401	•	
	402	•	
	403		•
	404		•
	405	•	
*	406		
	407	•	
*	408-409		
	410		•
*	411		
	412		•
	413	•	
	414		•
	415	•	
	416	•	
	417	•	
	418		•
*	419-420		
	421	•	
*	422-423		
	424		•
	425		•
	426		•
	427		•
	428		•
	429		•
*	430-436		
	437		•
*	438-439		
	440	•	
	441		•
	442	•	
	443	•	
	444	•	
	445	•	
	446		•
	447	•	
	448	•	
	449	•	
	450	•	
*	451		
	452	•	
	453	•	
	454	•	
	455	•	
	456	•	
	457		•
	458	•	
	459	•	
	460	•	
	461	•	
	462	•	
	463	•	
	464		•
	465	•	

* - Building number not assigned

Table 3

Index of Treasure Island Buildings, 1937-1994

	Building No.	Table No. 4	Table No. 5
	466	•	
	467	•	
	468	•	
	469	•	
	470	•	
	471		•
	472	•	
	473	•	
	474	•	
	475	•	
	476		•
	477		•
	478	•	
	479		•
	480	•	
	481	•	
	482	•	
	483	•	
	484		•
	485	•	
	486		•
	487	•	
	488	•	
	489	•	
*	490		
	491		•
	492	•	
	493	•	
*	494		
	495		•
	496	•	
	497	•	
	498		•
*	499-500		
	501	•	
	502	•	
*	503-504		
	505	•	

	Building No.	Table No. 4	Table No. 5
	506	•	
*	507		
	508	•	
	509	•	
*	510-519		
	520	•	
*	521-529		
	530	•	
*	531-539		
	540	•	
*	541-549		
	550	•	
*	551-564		
	565		•
*	566-569		
	570	•	
	571	•	
	572	•	
	573	•	
	574	•	
*	575-579		
	580	•	
*	581-599		
	600	•	
*	601-604		
	605	•	
	606	•	
	607	•	
	608	•	
	609	•	
	610	•	
	611	•	
	612	•	
	613	•	
	614	•	
	615	•	
	616	•	
	617	•	

	Building No.	Table No. 4	Table No. 5
	618	•	
*	619-669		
	670	•	
	671	•	
*	672-679		
	680	•	
	681-689		•
	690	•	
*	691-1099		
	1100-1129	•	
*	1130		
	1131	•	
*	1132		
	1133	•	
*	1134		
	1135	•	
*	1136		
	1137	•	
*	1138		
	1139	•	
*	1140		
	1141	•	
*	1142		
	1143	•	
*	1144		
	1145	•	
*	1146		
	1147	•	
*	1148		
	1149	•	
*	1150-1200		
	1201-1254	•	
*	1255-1300		
	1301-1319	•	
*	1320		
	1321	•	
	1322	•	
*	1323-1324		

34 28 11+9+30+54+19 = 129

* - Building number not assigned

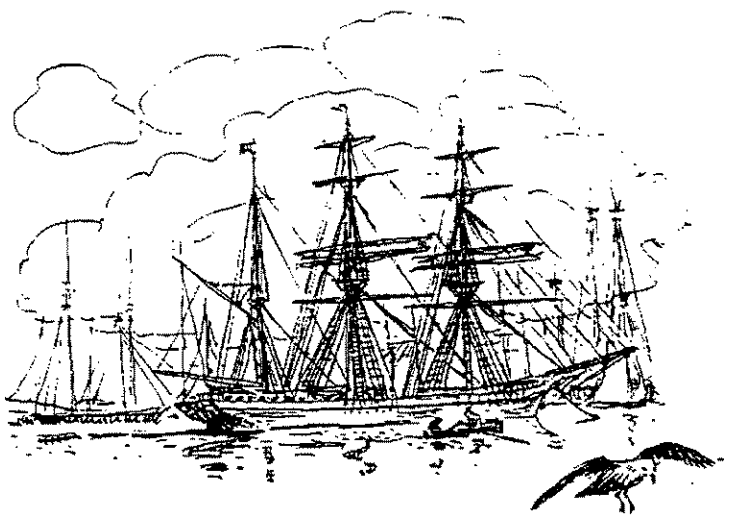
Table 3

Index of Treasure Island Buildings, 1937-1994

	Building No.	Table No. 4	5
	1325	•	
*	1326-1400		
	1401-1406	•	
*	1407		
	1408-1413	•	
*	1414-1417		
	1418-1420	•	
*	1421-1429		
	1430-1445	•	
*	1446		
	1447	•	
*	1448		
	1449	•	
	Pier 1	•	•

Building No.	Table No. 4	5
Pier 2	•	
Pier 3		•
Pier 4		•
Pier 5		•
Pier 6		•
Pier 7		•
Pier 8		•
Pier 9		•
Pier 9A		•
Pier 10		•
Pier 11	•	
Pier 12	•	
Pier 13		•
Pier 14		•

Building No.	Table No. 4	5
Pier 15		•
Pier 16		•
Pier 17		•
Pier 18		•
Pier 19		•
Pier 20		•
Pier 21	•	
Pier 22		•
Pier 23	•	
Pier (unnumbered)	•	
Shed (unnumbered)	•	



* - Building number not assigned

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
1	Map Quad: J15 Year. Built: 1938 Year Demolished: N/A Uses: 1938 - 1946 — Pan Am China Clipper Terminal 1939 - 1940 — Exposition Administrative Building 1941 - 1945 — Patrol Force Section Base Administration 1942 - 1945 — Naval Frontier Base 1945 - 1960 — **District Publications and Printing Office** (Ref. P, page 83) 1945 - 1952 — Naval Training and Central Supply Base 1952 - 1980 — Naval Support Activity, Treasure Island 1948 - 1972 — Command Sea West Frontier 1972 - 1976 — 12th Naval District Headquarters 1976 - Present — Command Naval Base Headquarters 1976 - Present — Museum 1980 - Present — Naval Station, Treasure Island
2	Map Quad: H15 Year. Built: 1938 Year Demolished: N/A Uses: 1938 - 1940 — Aviation Exhibits 1938 - 1946 — **Hangar** 1946 - 1994 — U. S. Naval Reserve and Marine Reserve Center 1994 - Present — General use (Movie set)
3	Map Quad: F15 Year. Built: 1938 Year Demolished: N/A Uses: 1938 - 1940 — Palace of Fine and Liberal Arts 1940 - 1945 — Port Control Office 1945 - 1952 — **Ship Repair Shops** 1952 - Present — Training school, Equipment repair
4	Map Quad: C6 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - Present — **Diesel oil and gas storage tank**
5	Map Quad: C6 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - Present — **Diesel Oil Tank**
6	Map Quad: C6 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - Present — **Gasoline storage tanks** (Originally seven tanks, one additional tank added to total eight tanks by 1966)

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
7	Map Quad: D13 Year. Built: 1938 Year Demolished: N/A Uses: 1938 - 1940 - Federal Building [South half] 1940 - 1952 - Various military schools 1952 - 1994 - Director of Training Facilities (NRTF), Mar. Dist. HQ, NIS, USO, CCPO 1994 - Present - Director of Training Facilities (NRTF), Mar. Dist. HQ, NIS, USO, CCPO, Naval Reserve Center
12A (See #112)	Map Quad: F16 Year. Built: See "Notes" Year Demolished: N/A Uses: 1943 - 1988 — Derrick house 1988 - Present — Port Ops Main office, Ship's pilot office, Port Control storage Notes: Original Building 112 was subdivided and renumbered to Buildings 12A, 12B, and 12C. Date of subdivision and renumbering unknown.
12B (See #12A)	Map Quad: F16 Year. Built: Unknown Year Demolished: N/A Uses: Unknown - Present — Shed for Building 12A Notes: Original Building 112 was subdivided and renumbered to Buildings 12A, 12B, and 12C. Date of subdivision and renumbering unknown.
12C (See #12A)	Map Quad: F16 Year. Built: Unknown Year Demolished: N/A Uses: Unknown - Present — Shed for Building 12A Notes: Original Building 112 was subdivided and renumbered to Buildings 12A, 12B, and 12C. Date of subdivision and renumbering unknown.
29	Map Quad: F10 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1945 - Mess hall 1945 - 1952 - Radio Material School D, Instrument building, Navy Campus, NTTC, and NAVSTA Recreational Services 1952 - Present - Administration building including Boy/Girl Scouts, Columbia College, FTC Det, and MSCPAC
34	Map Quad: E14 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1948 - Subsistence 1948 - Present - Commissary store
40	Map Quad: E13 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1948 - Isolation ward 1948 - Present - Barracks and supply, Marine and Navy Band and "Casual Company"

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
41	Map Quad: G15 Year. Built: 1945 Year Demolished: N/A Uses: 1945 - 1948 — **Small Arms** 1948 - 1952 — **Forge and foundry** 1952 - 1988 — **Paint shop** 1988 - Present — Port Ops
62	Map Quad: D15 Year. Built: 1938 Year Demolished: N/A Uses: 1938 - 1940 — Exposition Warehouse 1940 - 1948 — First Lieutenant's Warehouse and shop 1948 - Present — Naval Reserve C. B. Mobile Battalion 2; Training Aids Center (West Coast)
63	Map Quad: B5 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — Signal Tower at Pier 21
64	Map Quad: C6 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1948 — Dock Master's Office 1948 - Present — Fuel Detail Office (Supply Department)
69	Map Quad: D10 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1948 — **Engineers and Shipfitters Shop** 1948 - Present — Hobby shop, **garage**, storage, public toilets
70	Map Quad: I7 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - Present — Gear locker and storage for the **Fire Department**
85	Map Quad: C6 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - Present — **Diesel Oil Clarifier and Pump Station** (Supply Department) Notes: Building 85 was moved from Map Quad D-14 to Map Quad C-6 in 1945.
91	Map Quad: E14 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - Present — Toilets and self-serve laundry
92	Map Quad: E12 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - 1948 — General Medical Ward #13 1948 - Present — Barracks and Classrooms, Fire Department Inspection Division
93	Map Quad: F14 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - Present — Waiting station, weather shelter

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
96	Map Quad: E11 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1961 — Storage and Reserve Training (Mobile Dive Salvage Unit) 1961 - Present — **Printing plant**
99	Map Quad: F11 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1948 — Laundry 1948 - 1966 — Laundry, cobbler shop, tailor 1966 - 1977 — Laundry and **dry cleaners** 1977 - 1988 — Meat processing facility 1988 - Present — **Government printing shop,** Disaster preparation storage
103	Map Quad: F11 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - Present — **Fuel Oil Tank**
104	Map Quad: F11 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - Present — **Fuel Oil Tank**
105	Map Quad: F11 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - Present — **Oil Pump House**
107	Map Quad: F12 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - 1988 — CPO Barracks and Offices 1988 - Present — Police station
111	Map Quad: F15 Year. Built: 1938 Year Demolished: N/A Uses: 1938 - 1970 — **Fire house #1** 1970 - 1993 — **Fire station #2** 1993 - Present — Port Ops storage
112 (See #12A)	Map Quad: F16 Year. Built: 1943 Year Demolished: See "Notes" Uses: 1943 - 1988 — Derrick house 1988 - Present — Port Ops Main office, Ship's pilot office, Port Control storage Notes: Original Building 112 was subdivided and renumbered to Buildings 12A, 12B, and 12C. Date of subdivision and renumbering unknown.
113	Map Quad: G16 Year. Built: 1942 Year Demolished: N/A Uses: 1945 - Present — Lumber shed, Port Ops Storage

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
114	Map Quad: G16 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1994 — Storage and Reserve Training shops 1994 - Present — Vacant
128	Map Quad: H11 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1948 — Scrub house 1948 - Present — Storage
129	Map Quad: H11 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1948 — Scrub house 1948 - 1961— **Jeep garage** 1961 - Present — Storage
130	Map Quad: H11 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1948 — Scrub house 1948 - Present — Storage
131	Map Quad: H11 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1948 — Scrub house 1948 - Present — **Medical/Dental Storage**
135	Map Quad: H11 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1970 — Garbage house 1970 - 1994 — Launderette 1994 - Present — Sunday School
140	Map Quad: H13 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1944 — Basalt house 1944 - Present — Officer's Mess, Nimitz Conference Center
141	Map Quad: G15 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - 1952 — Explosives office 1952 - 1994 — **Carpenter Shop** and storage 1994 - Present — Vacant
143	Map Quad: H16 Year. Built: 1941 Year Demolished: N/A Uses: 1941 - 1948 — **Gasoline Pump House** 1948 - Present — **Hazardous Material Locker** (contained paints and varnishes, however, now vacant)

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
146	Map Quad: K16 Year. Built: 1941 Year Demolished: N/A Uses: 1941 - Present — Control and dispatch, Security, Main gate
153	Map Quad: K12 Year. Built: NLT 1988 Year Demolished: N/A Uses: NLT 1988 - Present — **Transformer Station and Sump Pump #20** Notes: This is the second use of the number. The original Building 153 was a Garbage House that existed from about 1945 to NLT 1948.
157	Map Quad: I7 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - 1970 — **Fire House #2** 1970 - Present — **Fire Station #1**
180	Map Quad: J15 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - 1946 — Hangar 1946 - Present — 1st Lieutenant ("self help" service), **PWC Transportation Shop**
183	Map Quad: J15 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - 1961 — Office 1961 - Present — Traffic Control Office, Yacht Club MWR
184	Map Quad: K16 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - Present — Sentry house and bus stop Notes: Incorporated into structure of Building 146
187	Map Quad: K14 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - Present — Chapel
195	Map Quad: G6 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - Present — Brig overflow Notes: Building 195 is scheduled for demolition in May 1995.
201	Map Quad: F8 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1948 — Subsistence 1948 - 1961 — Galley and Mess Hall 1961 - Present — Retail store, MWR tickets, MWR warehouse
202	Map Quad: F7 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1948 — Ship's service 1948 - 1952 — Stores and cafeteria 1952 - 1961 — Retail store and restaurant, Credit Union, Laundromat 1961 - Present — NEX storage, Credit Union ATM

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
215	Map Quad: D8 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1948 — Administration 1948 - 1961 — Storage 1961 - 1977 — Hobby shop 1977 - 1994 — Chapel, hobby shop and Special Services 1994 - Present — Vacant
216	Map Quad: D7 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1948 — Assembly shed 1948 - 1952 — Bus pool storage 1952 - 1973 — Draft shed 1973 - Present — **Recreational vehicle storage (MWR)**
217	Map Quad: D7 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1948 — Bachelor officer's quarters 1948 - 1952 — Storage 1952 - 1994 — Post Office, NTTC training, Cable TV 1994 - Present — NTTC training, Cable TV
225	Map Quad: J7 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1952 — **Gun shed** 1952 - 1961 — Storage 1961 - Present — **Auto Hobby Shop garage**
227	Map Quad: K12 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1988 — Officer's Subsistence Building 1988 - Present — Fog Watch Club
229	Map Quad: F9 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1988 — Chief Petty Officer's (CPO) Club 1988 - Present — Teen or Youth Center, Pizza Restaurant
230	Map Quad: E11 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1966 — WAVES Subsistence building 1966 - 1970 — Storage 1970 - Present — **Shop Mobile Ordnance Technical Unit, Nine (MOTU 9)** Notes: This building is on the site of a building that in 1942 was marked as the Brig.
233	Map Quad: D13 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1977 — Classrooms and administration 1977 - 1994 — **Laboratory** 1994 - Present — California National Guard

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
248	Map Quad: E4 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — **Pump House**
257	Map Quad: H8 Year. Built: 1944 Year Demolished: N/A Uses: 1942 - 1944 —There was a **skeet range** at the site prior to constructing Building 257. 1944 - 1991 — Dispensary and ward 1991 - Present — Family services, Red Cross, Youth center, Child Care Center
258	Map Quad: G11 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1948 — Administration 1948 - 1952 — US Post Office 1948 - 1989 — Local bank 1966 - Present — Officer's Wives' Thrift Shop, Drug Testing Facility, Officer's Wives' Club, U.S. Post Office
260	Map Quad: E10 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1994 — Supply offices, warehouse 1994 - Present — Servmart
261	Map Quad: E9 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — Gym, **pool** and bowling alley
264	Map Quad: E5 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — PWC refrigerated storehouse, PWC shops.
265	Map Quad: K13 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1952 — Hostess House 1952 - Present — MWR offices, library
271	Map Quad: K13 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — Officer's Recreation Building, Community Facility (Casa de la Vista)
289	Map Quad: F16 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1948 — Storage 1948 - 1969 — **Shop** 1969 - Present — Port Operations **paint storage**
290	Map Quad: F16 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — Port Operations storage

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
292	Map Quad: E4 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — **Storage shed (Pest Ccontrol Shop)**
293	Map Quad: D12 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — Shed (NTTC training, damage control)
298	Map Quad: J16 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — Marina loading shed (MWR boat house)
325	Map Quad: F16 Year. Built: 1945 Year Demolished: N/A Uses: 1945 - 1970 — **Battery Shop** and storage 1970 - Present — **Pest Control Shop**
328	Map Quad: C6 Year. Built: 1945 Year Demolished: N/A Uses: 1945 - Present — **Transformer House**
330	Map Quad: C5 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1948 — Lucky Bag 1948 - Present — **Navy Exchange Gas Station** 1973 - Present — **Grounds Maintenance Shop**
335	Map Quad: C5 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1948 — Lucky Bag 1948 - Present — **Paint Shop,** grounds maintenance Notes: Welding waste, HazMat, and used oil are on site.
341	Map Quad: D12 Year. Built: 1951 Year Demolished: N/A Uses: 1951 - Present — Instr. USS *Buttercup* (Damage Control Trainer)
342	Map Quad: D11 Year. Built: 1951 Year Demolished: N/A Uses: 1951 - Present — **NTTC Radiac instruction**
343	Map Quad: D11 Year. Built: 1951 Year Demolished: N/A Uses: 1951 - Present — **NTTC Radiac instruction**
344	Map Quad: D11 Year. Built: 1951 Year Demolished: N/A Uses: 1951 - Present — **Radium and Radiac Vault**

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
346	Map Quad: G15 Year. Built: 1950 Year Demolished: N/A Uses: 1950 - 1994 — **Radio Transmitting Station** 1994 - Present — Offices
347	Map Quad: G15 Year. Built: 1951 Year Demolished: N/A Uses: 1951 - Present — **Gun mount**
355	Map Quad: G16 Year. Built: 1946 Year Demolished: N/A Uses: 1946 - 1961 — Naval Station (NAVSTA) Port Operations storage 1961 - Present — **Sandblast Shed**
358	Map Quad: H15 Year. Built: 1953 Year Demolished: N/A Uses: 1953 - Present — Resistor bank building, storage
361	Map Quad: C15 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — Hot Water Tank building
362	Map Quad: F16 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — Port Operations "open storage" shed Notes: Building 362 is scheduled for demolition in May 1995.
363	Map Quad: I9 Year. Built: 1957 Year Demolished: N/A Uses: 1957 - 1994 — Civilian Barracks 1994 - Present — Maritime Cooking School
364	Map Quad: I10 Year. Built: 1957 Year Demolished: N/A Uses: 1957 - Present — Barracks
365	Map Quad: I11 Year. Built: 1957 Year Demolished: N/A Uses: 1957 - Present — Barracks and offices
366	Map Quad: I11 Year. Built: 1956 Year Demolished: N/A Uses: 1956 - Present — Barracks and offices
367	Map Quad: I12 Year. Built: 1957 Year Demolished: N/A Uses: 1957 - Present — Transient Personnel Unit (TPU) Administration, Personnel Support Detachment (PSD) and Barracks

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
368	Map Quad: I10 Year. Built: 1957 Year Demolished: N/A Uses: 1957 - Present — Enlisted Men's Dining Hall
369	Map Quad: I13 Year. Built: 1958 Year Demolished: N/A Uses: 1958 - Present — BOQ, Officer's Club
371	Map Quad: K6 Year. Built: 1957 Year Demolished: N/A Uses: 1957 - Present — USS *Pandemonium* (mock-up trainer)
374	Map Quad: I8 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — **Sump House**
377	Map Quad: E7 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — **Sump House**
378	Map Quad: F10 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — **Sump House**
379	Map Quad: F10 Year. Built: 1956 Year Demolished: N/A Uses: 1956 - Present — **Paint and HazMat Locker**
380	Map Quad: I12 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — **Sump House**
381	Map Quad: D12 Year. Built: 1957 Year Demolished: N/A Uses: 1957 - Present — MWR Baseball field storage
382	Map Quad: D12 Year. Built: 1959 Year Demolished: N/A Uses: 1959 - Present — **Sump House**
383	Map Quad: G15 Year. Built: 1948 Year Demolished: N/A Uses: 1948 - Present — Radio Tower
384	Map Quad: G15 Year. Built: 1958 Year Demolished: N/A Uses: 1958 - Present — Garage - training tanks, NAVRES Storage
385	Map Quad: G15 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - Present — **Skeet Range Building**

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data		
390	Map Quad: E11	Year. Built: 1944	Year Demolished: N/A
	Uses: 1944 - Present — **Sump House**		
393	Map Quad: F9	Year. Built: 1944	Year Demolished: N/A
	Uses: 1944 - Present — **Sump House**		
394	Map Quad: G14	Year. Built: 1944	Year Demolished: N/A
	Uses: 1944 - Present — **Sump House**		
395	Map Quad: G13	Year. Built: 1944	Year Demolished: N/A
	Uses: 1944 - Present — **Sump House**		
396	Map Quad: E14	Year. Built: 1944	Year Demolished: N/A
	Uses: 1944 - Present — **Sump House**		
397	Map Quad: D10	Year. Built: 1950	Year Demolished: N/A
	Uses: 1950 - Present — Tennis courts		
398	Map Quad: H13	Year. Built: 1944	Year Demolished: N/A
	Uses: 1944 - Present — Tennis courts		
401	Map Quad: E9	Year. Built: 1961	Year Demolished: N/A
	Uses: 1961 - Present — Theater		
402	Map Quad: E9	Year. Built: 1961	Year Demolished: N/A
	Uses: 1961 - Present — Gymnasium		
405	Map Quad: K15	Year. Built: 1944	Year Demolished: N/A
	Uses: 1944 - Present — Flag Pole (Building 1)		
407	Map Quad: D8 - 9	Year. Built: 1944	Year Demolished: N/A
	Uses: 1944 - Present — Athletic field		
413	Map Quad: G16	Year. Built: 1950	Year Demolished: N/A
	Uses: 1950 - Present — Storage		
415	Map Quad: Γ 4	Year. Built: 1961	Year Demolished: N/A
	Uses: 1961 - Present — Wastewater treatment facility - Operations		

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
416	Map Quad: D4 Year. Built: 1961 Year Demolished: N/A Uses: 1961 - Present — Wastewater Treatment Facility - **Digester Tank**
417	Map Quad: D4 Year. Built: 1961 Year Demolished: N/A Uses: 1961 - Present — Wastewater Treatment Facility - **Sedimentation Tank**
421	Map Quad: I7 Year. Built: 1958 Year Demolished: N/A Uses: 1958 - Present — Storage (Fire Department)
440	Map Quad: I14 Year. Built: 1942 Year Demolished: N/A Uses: 1942 - Present — **Sump house**
442	Map Quad: G12 Year. Built: 1991 Year Demolished: N/A Uses: 1991 - Present — Medical - Dental Clinic
443	Map Quad: D11 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - Present — **Sump House**
444	Map Quad: G12 Year. Built: 1943 Year Demolished: N/A Uses: 1943 - Present — **Sump House**
445	Map Quad: C5 Year. Built: 1962 Year Demolished: N/A Uses: 1962 - Present — Storage and **Vehicle Maintenance Shop** (MIUW)
447	Map Quad: K16 Year. Built: 1965 Year Demolished: N/A Uses: 1965 - Present — Weather shelter
448	Map Quad: G15 Year. Built: 1965 Year Demolished: N/A Uses: 1965 - Present — Storage
449	Map Quad: J13 Year. Built: 1968 Year Demolished: N/A Uses: 1968 - 1994 — Admin and storage 1994 - Present — Reserve Training Center
450	Map Quad: G13 Year. Built: 1968 Year Demolished: N/A Uses: 1968 - 1972 — 12ND Headquarters 1972 - Present — NLSO, SATO, PSD, Safety offices, MWR

Table 4

Existing Buildings of Treasure Island
(as of December 1, 1994)

Bldg. No.	Building Data
452	Map Quad: J10 Year. Built: 1969 Year Demolished: N/A Uses: 1969 - Present — BEQ
453	Map Quad: J11 Year. Built: 1970 Year Demolished: N/A Uses: 1970 - Present — BEQ
454	Map Quad: H16 Year. Built: 1968 Year Demolished: N/A Uses: 1968 - 1988 — Storage 1988 - Present — **Storage for Armory, Building 501**
455	Map Quad: F11 Year. Built: 1970 Year Demolished: N/A Uses: 1970 - Present — **Boiler Plant**
456	Map Quad: C6 Year. Built: 1898 Year Demolished: N/A Uses: 1898 - Present — **Gasoline storage tanks** Notes: Per PWC Civil Engineering, TI, these tanks were built on Yerba Buena Island in 1898. Moved and rebuilt on Treasure Island in 1968 and improved in the process.
458	Map Quad: C11 Year. Built: 1939 Year Demolished: N/A Uses: 1939 - 1944 — **Pyrotechnics storage** 1994 - Present — **Pyrotechnics storage, Paint storage**
459	Map Quad: H15 Year. Built: 1969 Year Demolished: N/A Uses: 1969 - Present — **Skeet Range**
460	Map Quad: J13 Year. Built: 1968 Year Demolished: N/A Uses: 1968 - Present — Microwave Tower
461	Map Quad: E3 Year. Built: 1970 Year Demolished: N/A Uses: 1970 - Present — DC School Classrooms, MTTC Headquarters, FTC
462	Map Quad: D4 Year. Built: 1970 Year Demolished: N/A Uses: 1970 - Present — **Decontamination building,** FTC
463	Map Quad: D4 Year. Built: 1970 Year Demolished: N/A Uses: 1970 - Present — **Gas Chamber**
465	Map Quad: D5 Year. Built: 1969 Year Demolished: N/A Uses: 1969 - Present — **Trickling filter**

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
466	Map Quad: D4 Year. Built: 1969 Year Demolished: N/A Uses: 1969 - Present — **Secondary sedimentation**
467	Map Quad: D4 Year. Built: 1969 Year Demolished: N/A Uses: 1969 - Present — **Digester #2**
468	Map Quad: D4 Year. Built: 1969 Year Demolished: N/A Uses: 1969 - Present — **Sludge Dewatering Structure**
469	Map Quad: J16 Year. Built: 1969 Year Demolished: N/A Uses: 1969 - Present — **No break Generator Building**
470	Map Quad: K15 Year. Built: 1947 Year Demolished: N/A Uses: 1947 - Present — **Saluting Battery Gun Mount**
472	Map Quad: I7, F14 Year. Built: 1962 Year Demolished: N/A Uses: 1962 - 1988 — Flag Pole (Building 157) 1988 - Present — Flag Pole (Building 30)
473	Map Quad: I15, E3 Year. Built: 1969 Year Demolished: N/A Uses: 1969 - 1977 — Flag Pole (Building 180) 1977 - Present — Flag Pole (Building 461)
474	Map Quad: G12 Year. Built: 1969 Year Demolished: N/A Uses: 1969 - Present — Flag Pole, Building 450
475	Map Quad: H8 Year. Built: 1970 Year Demolished: N/A Uses: 1970 - Present — Flag Pole, Building 257
478	Map Quad: I9 Year. Built: 1967 Year Demolished: N/A Uses: 1967 - Present — Basketball Court for Building 363
480	Map Quad: D12 Year. Built: 1971 Year Demolished: N/A Uses: 1971 - Present — Public toilets at Little League Field
481	Map Quad: J13 Year. Built: 1971 Year Demolished: N/A Uses: 1971 - Present — **Incinerator**

Table 4

Existing Buildings of Treasure Island
(as of December 1, 1994)

Bldg. No.	Building Data
482	Map Quad: H11 Year. Built: NLT 1977 Year Demolished: N/A Uses: NLT 1977 - Present — Antenna tower (Ham radio)
483	Map Quad: D12 Year. Built: NLT 1977 Year Demolished: N/A Uses: ~1977 - Present — Refreshment stand
485	Map Quad: C12 Year. Built: 1971 Year Demolished: N/A Uses: 1971 - Present — Little League Field
487	Map Quad: H12 Year. Built: 1975 Year Demolished: N/A Uses: 1975 - Present — CPO Barracks and Adminstration
488	Map Quad: H12 Year. Built: 1975 Year Demolished: N/A Uses: 1975 - Present — CPO Barracks
489	Map Quad: H12 Year. Built: 1975 Year Demolished: N/A Uses: 1975 - Present — CPO Barracks
492	Map Quad: D10 Year. Built: 1965 Year Demolished: N/A Uses: 1965 - Present — Recreation grounds
493	Map Quad: D14 Year. Built: 1974 Year Demolished: N/A Uses: 1974 - Present — Stormwater Pump
496	Map Quad: J16 Year. Built: 1974 Year Demolished: N/A Uses: 1974 - Present — Harbormaster Office and Boathouse (on unnumbered recreational pier)
497	Map Quad: E8 Year. Built: 1976 Year Demolished: N/A Uses: 1976 - Present — Fitness Center
501	Map Quad: H16 Year. Built: NLT 1988 Year Demolished: N/A Uses: NLT 1988 - Present — **Armory**
502	Map Quad: H7 Year. Built: 1985 Year Demolished: N/A Uses: 1985 - Present — Child care center

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
505	Map Quad: Unknown Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — Training mockup (Property record #2-15110) Notes: The training mockups (Buildings 505, 506, 508 and 509) appear on a list of property. However, they do not appear on any map and may have been either very temporary or perhaps were mobile.
506	Map Quad: Unknown Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — Training mockup (Property record #2-15111) Notes: The training mockups (Buildings 505, 506, 508 and 509) appear on a list of property. However, they do not appear on any map and may have been either very temporary or perhaps were mobile.
508	Map Quad: Unknown Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — Training mockup (Property record #2-15113) Notes: The training mockups (Buildings 505, 506, 508 and 509) appear on a list of property. However, they do not appear on any map and may have been either very temporary or perhaps were mobile.
509	Map Quad: Unknown Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — Training mockup (Property record #2-15114) Notes: The training mockups (Buildings 505, 506, 508 and 509) appear on a list of property. However, they do not appear on any map and may have been either very temporary or perhaps were mobile.
520	Map Quad: G15 Year. Built: 1986 Year Demolished: N/A Uses: 1986 - Present — **Stm / Ht Bld / Shlt**
530	Map Quad: E13 Year. Built: NLT 1988 Year Demolished: N/A Uses: NLT 1988 - Present — **Pier Steam Plant**
540	Map Quad: G7 Year. Built: 1986 Year Demolished: N/A Uses: 1986 - Present — **Stm / Ht Bld / Shlt**
550	Map Quad: D4 Year. Built: 1986 Year Demolished: N/A Uses: 1986 - Present — **Stm / Ht Bld / Shlt**
570	Map Quad: E7 Year. Built: 1988 Year Demolished: N/A Uses: 1988 - Present — Operational Trainer Facility
571	Map Quad: E7 Year. Built: 1988 Year Demolished: N/A Uses: 1988 - Present — Collimation Tower (Kingpost)

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
572	Map Quad: E7 Year. Built: 1988 Year Demolished: N/A Uses: 1988 - Present — RAS Operations Trainer
573	Map Quad: E7 Year. Built: 1988 Year Demolished: N/A Uses: 1988 - Present — Collimation Tower (Kingpost)
574	Map Quad: E7 Year. Built: 1988 Year Demolished: N/A Uses: 1988 - Present — **Electrical Substation**
580	Map Quad: E6 Year. Built: 1988 Year Demolished: N/A Uses: 1988 - Present — NTTC Elevator Trainer
600	Map Quad: D8 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — Administration/Academic Building for Fire Fighting School
605	Map Quad: D8 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **P-250 Pump Trainer Firefighting (F/F)**
606	Map Quad: C8 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **Advanced Shipboard Firefighting (F/F 19F1A)**
607	Map Quad: C8 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **Oxygen Breathing Apparatus (OBA) Locker**
608	Map Quad: C8 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **General Shipboard Firefighting (F/F 19F3 B-1)**
609	Map Quad: C9 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **General Shipboard Firefighting (F/F 19F3 B-4)**
610	Map Quad: D9 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — Equalization Tank #1 (F/F)
611	Map Quad: C9 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — Equalization Tank #2 (F/F)
612	Map Quad: D9 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **Aviation Firefighting (F/F 19F4)**

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
613	Map Quad: D9 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **General Shipboard Firefighting (F/F 19F3 B-3)**
614	Map Quad: D8 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **General Shipboard Galley Firefighting (F/F 19F3 B-2)**
615	Map Quad: D8 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **Utility Building (F/F)**
616	Map Quad: D8 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **Aviation Tower (F/F 19F4)**
617	Map Quad: D8 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **P-250 Tower (F/F)**
618	Map Quad: C9 Year. Built: 1990 Year Demolished: N/A Uses: 1990 - Present — **Propane Farm (F/F)**
670	Map Quad: D6 Year. Built: 1991 Year Demolished: N/A Uses: 1991 - Present — Brig
671	Map Quad: D6 Year. Built: 1991 Year Demolished: N/A Uses: 1991 - Present — **Brig Carpenter Shop**
680	Map Quad: D4, D5 Year. Built: NLT 1992 Year Demolished: N/A Uses: NLT 1992 - Present — **Sewage Processing**
690	Map Quad: K-14 Year. Built: 1972 Year Demolished: N/A Uses: 1972 - Present — NAVSTA Billboard
1100 - 1129	Map Quad: See notes Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
1131	Map Quad: J4 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.
1133	Map Quad: J3 - J4 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.
1135	Map Quad: J3 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.
1137	Map Quad: J4 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.
1139	Map Quad: I3 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.

Table 4

Existing Buildings of Treasure Island
(as of December 1, 1994)

Bldg. No.	Building Data
1141	Map Quad: J3 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.
1143	Map Quad: J3 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.
1145	Map Quad: I3 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.
1147	Map Quad: I3 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.
1149	Map Quad: I3 Year. Built: 1966 Year Demolished: N/A Uses: 1966 - Present — Married Enlisted Men's Quarters Notes: Buildings 1100 through 1125, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149 is a housing complex of 240 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150 through 1200 were not assigned.

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
1201 - 1254	Map Quad: See notes. Year. Built: 1969 Year Demolished: N/A Uses: 1969 - Present — Married Enlisted Men's Quarters Notes: Buildings 1201 through 1254 is a housing complex of 340 units which spans over an area of Treasure Island covering the following Map Quads: I3, I4, I5, H3, H4, H5, J3, J4, J5, G3, G4, G5, E3, F3, F4, and F5. Building numbers 1255 through 1300 were not assigned
1301 - 1319	Map Quad: See notes Year. Built: 1974 Year Demolished: N/A Uses: 1974 - Present — Married Enlisted Men's Quarters Notes: Buildings 1301 through 1319, 1321, 1322, 1325 is a housing complex of 124 units which spans over an area of Treasure Island covering the following Map Quads: J5 and.K5 through J8 and K8. Building numbers 1320, 1323, 1324, 1326 through 1400 were not assigned.
1321	Map Quad: K5 Year. Built: 1974 Year Demolished: N/A Uses: 1974 - Present — Married Enlisted Men's Quarters Notes: Buildings 1301 through 1319, 1321, 1322, 1325 is a housing complex of 124 units which spans over an area of Treasure Island covering the following Map Quads: J5 and.K5 through J8 and K8. Building numbers 1320, 1323, 1324, 1326 through 1400 were not assigned.
1322	Map Quad: K5 Year. Built: 1974 Year Demolished: N/A Uses: 1974 - Present — Married Enlisted Men's Quarters Notes: Buildings 1301 through 1319, 1321, 1322, 1325 is a housing complex of 124 units which spans over an area of Treasure Island covering the following Map Quads: J5 and.K5 through J8 and K8. Building numbers 1320, 1323, 1324, 1326 through 1400 were not assigned.
1325	Map Quad: K6 Year. Built: 1974 Year Demolished: N/A Uses: 1974 - Present — Married Enlisted Men's Quarters Notes: Buildings 1301 through 1319, 1321, 1322, 1325 is a housing complex of 124 units which spans over an area of Treasure Island covering the following Map Quads: J5 and.K5 through J8 and K8. Building numbers 1320, 1323, 1324, 1326 through 1400 were not assigned.
1401 - 1406	Map Quad: I5, J5, J6, J7 Year. Built: 1989 Year Demolished: N/A Uses: 1989 - Present — Married Enlisted Men's Quarters Notes: Buildings 1400 through 1449 is a housing complex of 200 units which spans over an area of Treasure Island covering the following Map Quads: H5, I5, J5 through H8, I8, J8. Building numbers 1407, 1414 through 1417, 1421 through 1429, 1446, and 1448 were not assigned.

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
1408 - 1413	Map Quad: H5, I5, H6, I6 Year. Built: 1989 Year Demolished: N/A Uses: 1989 - Present — Married Enlisted Men's Quarters Notes: Buildings 1400 through 1449 is a housing complex of 200 units which spans over an area of Treasure Island covering the following Map Quads: H5, I5, J5 through H8, I8, J8. Building numbers 1407, 1414 through 1417, 1421 through 1429, 1446, and 1448 were not assigned.
1418 - 1420	Map Quad: H6, I6 Year. Built: 1989 Year Demolished: N/A Uses: 1989 - Present — Married Enlisted Men's Quarters Notes: Buildings 1400 through 1449 is a housing complex of 200 units which spans over an area of Treasure Island covering the following Map Quads: H5, I5, J5 through H8, I8, J8. Building numbers 1407, 1414 through 1417, 1421 through 1429, 1446, and 1448 were not assigned.
1430 - 1445	Map Quad: I7, J7, I8, J8 Year. Built: 1989 Year Demolished: N/A Uses: 1989 - Present — Married Enlisted Men's Quarters Notes: Buildings 1400 through 1449 is a housing complex of 200 units which spans over an area of Treasure Island covering the following Map Quads: H5, I5, J5 through H8, I8, J8. Building numbers 1407, 1414 through 1417, 1421 through 1429, 1446, and 1448 were not assigned.
1447	Map Quad: H8 Year. Built: 1989 Year Demolished: N/A Uses: 1989 - Present — Married Enlisted Men's Quarters Notes: Buildings 1400 through 1449 is a housing complex of 200 units which spans over an area of Treasure Island covering the following Map Quads: H5, I5, J5 through H8, I8, J8. Building numbers 1407, 1414 through 1417, 1421 through 1429, 1446, and 1448 were not assigned.
1449	Map Quad: I8 Year. Built: 1989 Year Demolished: N/A Uses: 1989 - Present — Married Enlisted Men's Quarters Notes: Buildings 1400 through 1449 is a housing complex of 200 units which spans over an area of Treasure Island covering the following Map Quads: H5, I5, J5 through H8, I8, J8. Building numbers 1407, 1414 through 1417, 1421 through 1429, 1446, and 1448 were not assigned.
PIER 1	Map Quad: D15 Year. Built: 1986 Year Demolished: N/A Uses: 1986 - Present — General purpose pier
PIER 2	Map Quad: K16 Year. Built: 1939 Year Demolished: N/A Uses: 1939 - Present — Small boat berthing

Table 4

Existing Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
PIER 11	Map Quad: F16 Year. Built: NLT 1945 Year Demolished: N/A Uses: 1945 - 1948 — Ship's Berthing and Floating Dry Dock Pier 1948 - Present — Ship's Berthing Pier Notes: Pier 11 was drastically shortened NLT 1992.
PIER 12	Map Quad: F16 Year. Built: 1944 Year Demolished: N/A Uses: 1944 - 1993 — **Repair Pier** 1993 - Present — Small Boat Pier
PIER 21	Map Quad: B6 Year. Built: NLT 1942 Year Demolished: N/A Uses: 1945 - 1952 - North pier (general ship's berthing) 1952 - 1968 - Berthing Pier 1968 - 1988 - **Fuel Pier** 1988 - Present - Listed as damaged, slated for demolition Notes: Pier 21 is scheduled for demolition in September 1995.
PIER 23	Map Quad: L11 Year. Built: 1945 Year Demolished: N/A Uses: 1945 - Present — Small boat landing / Recreational, fishing pier
PIER (No Number)	Map Quad: J16 Year. Built: NLT 1968 Year Demolished: N/A Uses: NLT 1968 - Present — Recreational Marina
SHED (No Number)	Map Quad: H16 Year. Built: Unknown Year Demolished: N/A Uses: Unknown - Present — **Bottled gas storage** Notes: Shed, which appears to have been constructed recently, is located inside the fence south east of Building 2.

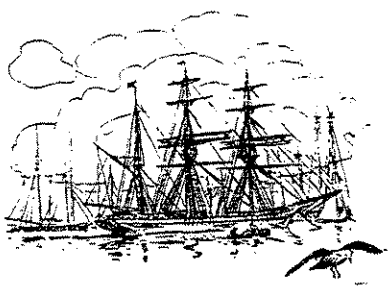


Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
8	Map Quad: D12 Year Built: 1938 Year Demolished: NLT 1961 Uses: 1939 - 1940 — Exposition Building 1940 - 1942 — Federal Building (North Half) 1942 - 1948 — Section Base Building (Theater, General Mess, Ship's Stores) 1948 - 1952 — General Mess CPO 1952 - ~1961 — Administration And Training, Galley And Recreation, Storage
9	Map Quad: G11 Year Built: 1939 Year Demolished: NLT 1961 Uses: 1939 - 1941 — Exposition Building (US Army Camp Hunter Liggett) 1941 - 1948 — US Coast Guard Barracks 1948 - ~1961 — Administrative Offices
10	Map Quad: C10 Year Built: 1939 Year Demolished: NLT 1961 Uses: 1939 - 1941 — Exposition Building (US Army Camp Hunter Liggett) 1941 - ~1961 — Barracks
11	Map Quad: C10 Year Built: 1939 Year Demolished: NLT 1961 Uses: 1939 - 1941 — Exposition Building (US Army Camp Hunter Liggett) 1941 - 1942 — Galley and Mess (Enlisted) 1942 - 1945 — First Lieutenant (US Coast Guard) 1945 - 1948 — Barracks 1948 - ~1961 — Administrative Offices
12	Map Quad: C10 Year Built: 1939 Year Demolished: NLT 1961 Uses: 1939 - 1941 — Exposition Building (US Army Camp Hunter Liggett) 1941 - ~1961 — Administrative Offices
13	Map Quad: D10 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Exposition Building for the Western States Exhibit (Oregon, Idaho, Nevada, Utah, Arizona, Washington And California) 1940 - 1942 — Transition period 1942 - ~1948 — Main Barracks
14	Map Quad: D11 Year Built: 1942 Year Demolished: 1962 Uses: 1942 - 1962 — **Heating Plant #1**
15	Map Quad: G13 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Exposition Building for the Southern Counties Exhibit 1940 - 1942 — Transition period 1942 - ~ 1948 — Dispensary

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
16	Map Quad: G14 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1961 - ~ 1977 — Barracks, US Naval School Command
17	Map Quad: G9 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - ~1961 — Barracks, US Naval School Command
18	Map Quad: G10 Year Built: 1942 Year Demolished: NLT 1970 Uses: 1942 - ~1961 — Barracks, US Naval School Command
19	Map Quad: G10 Year Built: 1942 Year Demolished: NLT 1970 Uses: 1942 - ~1961 — Barracks, US Naval School Command
20	Map Quad: G9 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - ~1961 - General Barracks
21	Map Quad: G10 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - ~1961 - General Barracks
22	Map Quad: G10 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - ~1961 - General Barracks
23	Map Quad: G9 Year Built: 1942 Year Demolished: NLT 1970 Uses: 1942 - ~1970 — Barracks, US Naval School Command
24	Map Quad: G10 Year Built: 1942 Year Demolished: NLT 1988 Uses: 1942 - ~1988 — Barracks, US Naval School Command
25	Map Quad: G10 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - ~1977 — Barracks, US Naval School Command - CPO
26	Map Quad: H11 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - ~1977 — **Heating Plant #2** (Secured)
27	Map Quad: H9 Year Built: 1942 Year Demolished: NLT 1988 Uses: 1942 - 1952 — Radio Materiel School A 1952 - ~1988 — Classrooms, USNSC

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
28	Map Quad: H10 Year Built: 1942 Year Demolished: NLT 1988 Uses: 1945 - 1952 — Radio Material School B 1952 - ~ 1988 — Administration, USNSC
30	Map Quad: F14 Year Built: 1942 Year Demolished: 1988 Uses: 1942 - 1948 — Surgical Operation #2 1948 - 1961 — Barracks 1961 - 1988 — Administration, USNSC
31	Map Quad: F14 Year Built: 1942 Year Demolished: 1991 Uses: 1942 - 1948 — Surgical Ward #3 1948 - 1961 — Barracks 1961 - 1991 — Barracks And Storage (12nd PW)
32	Map Quad: F13 Year Built: 1942 Year Demolished: 1988 Uses: 1942 - 1948 — Surgical Ward #4 1948 - 1952 — Barracks 1952 - 1961 — Administration 1961 - 1988 — Barracks And Storage (12nd PW)
33	Map Quad: F13 Year Built: 1942 Year Demolished: NLT 1991 Uses: 1942 - 1945 — Isolation Ward 1945 - 1948 — Administration And Sick Officers 1948 - ~1991 — Administration, USNSC
35	Map Quad: E13 Year Built: 1942 Year Demolished: NLT 1974 Uses: 1945 - 1948 — Eye, Ear, Nose And Throat #10 1948 - 1961 — Barracks 1961 - ~1974 — Marine Barracks, Casual Co.
36	Map Quad: E13 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - 1946 — General Medical Ward #6 1948 - ~1961 — Barracks
37	Map Quad: E13 Year Built: 1942 Year Demolished: NLT 1970 Uses: 1942 - 1948 — General Medical Ward #9 1948 - 1961 — Barracks 1961 - 1968 —Marine Barracks, Casual Co. 1968 - ~1970 — Storage

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
38	Map Quad: E13 Year Built: 1942 Year Demolished: NLT 1970 Uses: 1942 - 1948 — Urological Ward #11 1948 - 1952 — Barracks 1952 - ~1970 — Classrooms, USNSC
39	Map Quad: E13 Year Built: 1942 Year Demolished: NLT 1961 1942 - 1948 — Urological Ward #12 1948 - ~1961 — Barracks
42	Map Quad: D3 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1942 - 1948 — **Inert Ammunition Storage** 1948 - ~1969 — Storage, USNSC
43	Map Quad: F3 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1942 - 1945 — **Pyrotechnic Ward And Small Arms Magazine** 1945 - 1948 — **Inert Ammunition Storage** 1948 - ~1969 — Storage, Mil. Dept.
44	Map Quad: F3 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1942 - 1945 — **High Explosives Magazine** 1945 - 1948 — **Inert Ammunition Storage** 1948 - ~1969 — Storage, Naval And Marine Corp Reserve Training Center
45	Map Quad: F3 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1942 - 1945 — **High Explosives Magazine** 1945 - 1948 — **Inert Ammunition Storage** 1948 - ~1969 — Storage, Naval And Marine Corp Reserve Training Center
46	Map Quad: F3 Year Built: 1942 Year Demolished: NLT 1969 1942 - 1945 — **High Explosives Magazine** 1945 - 1948 — **Inert Ammunition Storage** 1948 - ~1969 — Storage, Naval And Marine Corp Reserve Training Center
47	Map Quad: G3 Year Built: 1942 Year Demolished: NLT 1969 1942 - 1945 — **High Explosives Magazine** 1945 - 1948 — **Inert Ammunition Storage** 1948 - ~1969 — Storage
48	Map Quad: G3 Year Built: 1942 Year Demolished: NLT 1942 Uses: 1942 - ~1942 — **High Explosives Magazine**

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
49	Map Quad: G3 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1942 - 1945 — **High Explosives Magazine** 1945 - 1948 — **Inert Ammunition Storage** 1948 - ~1969 — Storage, Security Dept.
50	Map Quad: G3 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1942 - 1948 — **Inert Ammunition Storage** 1948 - ~1969 — Storage
51	Map Quad: H3 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1942 - 1945 — **Y-Gun Magazine** 1945 - 1948 — **Inert Ammunition Storage** 1948 - ~1969 — Storage
52	Map Quad: H3 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1942 - 1948 — **Fuse And Detonator Magazine** 1948 - ~1969 — Storage
53	Map Quad: I3 Year Built: 1942 Year Demolished: NLT 1970 Uses: 1942 - 1945 — **Fuse And Detonator Magazine** 1945 - 1948 — **Inert Ammunition Storage** 1948 - ~1970 — Storage
54	Map Quad: I3 Year Built: 1942 Year Demolished: NLT 1945 Uses: 1942 - ~1945 — **Ammunition Magazine**
55	Map Quad: E3 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1945 - 1948 — **Inert Ammunition Storage** 1948 - ~1969— Storage (Foundation Ghost Remains)
56	Map Quad: D4 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1948 - ~1961 — Storage, Training Aids Center (West Coast)
57	Map Quad: D4 Year Built: 1942 Year Demolished: NLT 1969 Uses: 1948 - ~1969 — Storage, Training Aids Center (West Coast)
58	Map Quad: C4 Year Built: 1943 Year Demolished: NLT 1961 Uses: 1943 - 1948 — **Incinerator** and Refuse Building 1948 - ~1961 — **Paint Shop**

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
59	Map Quad: D4 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - 1948 — Office 1948 - ~1961 — Work Improvement Program
60	Map Quad: D4 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1939 - 1940 — **Machine Shop** 1942 - 1948 — Shop 1948 - ~1961 — 12ND Storage
61	Map Quad: K8 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - 1948 — **Carpenter's Shop** 1948 - 1952 — **Paint Spray Shop** 1952 - ~1961 — 12ND Storage
65	Map Quad: C8 Year Built: NLT 1942 Year Demolished: NLT 1961 Uses: 1942 - 1944 — Slip Shed 1944 - ~1961 —Shelter and **Rifle Range**
67	Map Quad: C9 Year Built: 1938 Year Demolished: NLT 1977 Uses: 1938 - 1940 — Bleachers And Gear Locker 1948 - 1952 — Storage 1952 - ~1977 — Recreation
68	Map Quad: C9 Year Built: 1938 Year Demolished: NLT 1961 Uses: 1938 - 1940 — Recreational Athletic Fields 1945 - 1948 — Shops 1948 - ~1961 — Recreation
71	Map Quad: D11 Year Built: 1942 Year Demolished: 1952 Uses: 1942 - 1952 — Scrub House (Building Moved About 1952)
71	Map Quad: F6 Year Built: 1952 Year Demolished: NLT 1970 Uses: 1952 - ~ 1970 — Launderette
72	Map Quad: D11 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - 1966 — Sterilizer Building 1966 - 1969 — Storage 1969 - ~1977 — Paper Disintegrator

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
73	Map Quad: C11 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - ~1961 — Storage and Dock Master's Office
74	Map Quad: D14 Year Built: NLT 1942 Year Demolished: NLT 1944 Uses: ~1942 - 1944 — Office Notes: Building 74 was moved in approximately 1944.
74	Map Quad: C11 Year Built: NLT 1944 Year Demolished: NLT 1966 Uses: ~1944 - ~1966 — Office
75	Map Quad: B11 Year Built: NLT 1942 Year Demolished: NLT 1966 Uses: ~1942 - ~1966 — Signal Tower
76	Map Quad: C11 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - 1952 — Dock Crews Quarters 1952 - ~1961 — Wharf Builders Shop
77	Map Quad: C11 Year Built: 1942 Year Demolished: NLT 1966 Uses: 1942 - ~1966 — **DC Generator House**
78	Map Quad: D12 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Garbage House
79	Map Quad: C13 Year Built: 1943 Year Demolished: NLT 1961 Uses: 1943 - 1952 — **Gun Shed** 1952 - ~1961 — Training
80	Map Quad: C13 Year Built: 1943 Year Demolished: NLT 1961 Uses: 1943 - 1948 — Damage Control School 1948 - ~1961 — Training
81	Map Quad: C13 Year Built: 1943 Year Demolished: NLT 1961 Uses: 1943 - 1948 — **Gasoline Station** 1948 - 1952 — Fireboat Storage 1952 - ~1961 — Storage

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
82	Map Quad: C13 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — **Gasoline Station**
83	Map Quad: D13 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - 1948 — **Gasoline Storage and Lubrication Station** 1948 - 1952 — **Road Striping Detail** 1952 - 1953 — **Paint Shop Annex** 1953 - 1961 — Garage 1961 - ~1977 — Film Exchange
84	Map Quad: D14 Year Built: NLT 1944 Year Demolished: NLT 1945 Uses: ~1944 - ~1945 — Unknown Notes: Extremely small building located in the oil storage area, inside fence of Building 6. Building 84 may have been used as office space.
86	Map Quad: D14 Year Built: NLT 1944 Year Demolished: NLT 1945 Uses: ~1944 - ~1945 — Unknown Notes: Extremely small building located in the oil storage area, inside fence of Building 6. Building 84 may have been used as office space.
87	Map Quad: E15 Year Built: NLT 1945 Year Demolished: NLT 1966 Uses: ~1945 - ~1966 — **Incinerator**
88	Map Quad: E16 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — Storage or Repair Dock #12
89	Map Quad: E14 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - 1969 — Hospital Storehouse 1969 - 1973 — Communications Stc Storage 1973 - ~1977 — Office and Store
90	Map Quad: E14 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - ~1977 — **Garbage House**
98	Map Quad: F9 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Storage

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
100	Map Quad: J7 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~ 1945 - 1948 — **Gun Loading Trainer** 1948 - ~1961 — Portable Office
101	Map Quad: F11 Year Built: 1943 Year Demolished: NLT 1970 Uses: 1943 - ~1970 — **Oil Pump House**
102	Map Quad: F12 Year Built: 1942 Year Demolished: NLT 1970 Uses: 1942 - ~1970 — **Heating Plant #3**
106	Map Quad: F12 Year Built: 1942 Year Demolished: NLT 1948 Uses: 1942 - ~1948 — Water Softener Building
108	Map Quad: F12 Year Built: NLT 1945 Year Demolished: NLT 1977 Uses: ~1945 - ~1977 — Waiting Station (moved To Skids By 1948)
109	Map Quad: F12 Year Built: 1943 Year Demolished: NLT 1991 Uses: 1943 - 1948 — Overflow Pharmacy and Reception 1948 - ~1991 — Barracks
110	Map Quad: F13 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - 1973 — Linen, Bag and Miscellaneous Storage 1973 - ~1977 — **Rod and Gun Locker**
115	Map Quad: G14 Year Built: 1943 Year Demolished: NLT 1977 Uses: 1943 - 1952 — **Garage and Shop** 1952 - 1969 — Storage 1969 - 1973 — Officer's Wives Mess Storage 1973 - ~1977 — Officer's Wives Mess and Wive's Club
116	Map Quad: F14 Year Built: 1943 Year Demolished: NLT 1961 Uses: 1943 - 1945 — **Garage** 1945 - ~1961 — Storage
117	Map Quad: G13 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace N 1942 - ~1948 — Barracks N

Table 5

Demolished Buildings of Treasu e Island

(as of December 1, 1994)

Bldg. No.	Building Da		
118	Map Quad: G12 Year Built: 1938 Uses: 1939 - 1940 — Palace K-1 1942 - ~1948 — Barracks K-1	Year Demolished:	NLT 1948
119	Map Quad: G11 Year Built: 1943 Uses: 1943 - ~1977 — Barracks (Marine)	Year Demolished:	NLT 1977
120	Map Quad: G11 Year Built: 1942 Uses: 1942 - 1948 — Storage 1948 - ~1970 — Office	Year Demolished:	NLT 1970
121	Map Quad: H9 Year Built: NLT 1944 Uses: ~1944 - 1948 — **Electric Shop** 1948 - ~1961 — Classrooms	Year Demolished:	NLT 1961
122	Map Quad: H8 Year Built: 1942 Uses: 1942 - ~1961 — Greenhouse	Year Demolished:	NLT 1961
123	Map Quad: H8 Year Built: 1942 Uses: 1942 - ~1961 — Office, Storage and Tool S ed (Nursery)	Year Demolished:	NLT 1961
124	Map Quad: G9 Year Built: 1943 Uses: 1943 - 1994 — Bus Stop Shelter	Year Demolished:	1994
125	Map Quad: H9 Year Built: 1942 Uses: 1942 - 1948 — **Garage** 1948 - ~1977 — Storage	Year Demolished:	NLT 1977
126	Map Quad: H10 Year Built: 1943 Uses: 1943 - 1948 — Storage 1948 - ~1961 — **Paint Locker**	Year Demolished:	NLT 1961
127	Map Quad: H11 Year Built: 1942 Uses: 1942 - 1948 — Radio Materiel School C 1948 - ~1991 — **Laboratory**	Year Demolished:	NLT 1991
132	Map Quad: H11 Year Built: 1942 Uses: 1942 - ~1970 — Storage	Year Demolished:	NLT 1970

Table 5

Demolished Buildings of Treas re Island

(as of December 1, 1994)

Bldg. No.	Building D a		
133	Map Quad: H11	Year Built: NLT 1945	Year Demolished: NLT 1970
	Uses: ~1945 - ~1970 — **Fuel Oil Tank**		
134	Map Quad: H11	Year Built: NLT 1945	Year Demolished: NLT 1970
	Uses: ~1945 - ~1970 — **Fuel Oil Tank**		
136	Map Quad: H11	Year Built: 1942	Year Demolished: NLT 1961
	Uses: 1942 - 1945 — Storage 1945 - 1952 — **Garbage House** 1952 - ~1961 — Storage		
137	Map Quad: H12	Year Built: 1938	Year Demolished: NLT 1948
	Uses: 1939 - 1940 — Palace K (Foods and Bev ages and Agriculture Building) 1942 - ~1948 — Subsistence K		
139	Map Quad: H13	Year Built: 1938	Year Demolished: NLT 1948
	Uses: 1939 - 1940 — Palace C-2 (Homes and G dens Exhibits) 1942 - ~1948 — Gymnasium		
142	Map Quad: J16	Year Built: 1942	Year Demolished: NLT 1970
	Uses: 1942 - 1952 — **Oil Storage Building** 1952 - ~1970 — **Paint Locker**		
144	Map Quad: H16	Year Built: 1943	Year Demolished: NLT 1970
	Uses: 1943 - 1952 — **Gasoline Storage** 1952 - ~1970 — Salt Water Pumping Sta n		
145	Map Quad: H16	Year Built: NLT 1945	Year Demolished: NLT 1961
	Uses: ~1945 - ~1961 — **Underground Gasolin Storage Tank**		
147	Map Quad: I13	Year Built: 1938	Year Demolished: NLT 1948
	Uses: 1939 - 1940 — Palace C-1 (Homes and C dens Exhibits), Aquacade (East End) 1942 - ~1948 — Barracks C-1		
148	Map Quad: I13	Year Built: 1939	Year Demolished: NLT 1961
	Uses: 1939 - 1940 — Palace C-1 (Aquacade) 1942 - ~1961 — Swimming Pool (Secur by 1952)		

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
149	Map Quad: I12 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Part Of Palace J (Hall of Science) 1942 - ~1948 — Bakery
150	Map Quad: I11 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace J (The Hall of Science) 1942 - ~1948 — Barracks J
151	Map Quad: I10 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace I (Vacationland) 1942 - ~1948 — Barracks I, **Paint Locker**
152	Map Quad: I9 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace I (Vacationland) 1942 - ~1948 — Ships Services
153	Map Quad: I9 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — **Garbage House**
154	Map Quad: I10 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — Storage
155	Map Quad: I8 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace H (Ford Motor Company Building) 1942 - ~1948 — School
156	Map Quad: I8 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - 1961 — **Gun Shed** 1961 - ~1977 — Classroooms
158	Map Quad: I8 Year Built: 1943 Year Demolished: NLT 1961 Uses: ~1943 - 1952 — Air Compressor Building 1952 - ~1961 — Storage
159	Map Quad: I8 Year Built: 1943 Year Demolished: NLT 1973 Uses: 1943 - 1952 — Plotting Room 1952 - ~1973 — Storage

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
160	Map Quad: I8 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - 1952 — Ship Mockup #2 1952 - 1973 — Classrooms 1973 - ~1977 — Vacant
161	Map Quad: I8 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - 1952 — Ship Mockup #1 1952 - 1973 — Classrooms 1973 - ~1977 — Vacant
162	Map Quad: J8 Year Built: 1943 Year Demolished: NLT 1977 Uses: 1943 - 1952 — Acetylene Generator B 1952 - ~1977 — Storage
163	Map Quad: J8 Year Built: 1943 Year Demolished: NLT 1961 Uses: 1943 - 1952 — Diving Tank and Building 1952 - ~1961 — Classrooms
164	Map Quad: J8 Year Built: 1943 Year Demolished: NLT 1977 Uses: 1943 - 1952 — Night Lookout Training Building 1952 - 1968 — Storage 1968 - 1973 — School 1973 - ~1977 — Community Center
165	Map Quad: J8 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - 1961 — Storage 1961 - ~1977 — Navy Exchange Auto Accessory Sales, Storage
166	Map Quad: J8 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace G (General Motors Building) 1942 - ~1948 — School
168	Map Quad: J8 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace G (General Motors) 1942 - ~1948 — Gyro Compass Shop
169	Map Quad: J9 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1938 - ~1948 — Storage

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
170	Map Quad: J9 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace F (Hall of Science, Business Progress) 1940 - 1942 — Transition period 1942 - ~1948 — Theatre Office
171	Map Quad: J9 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace F (Hall of Science, Business Progress) 1940 - 1942 — Transition period 1942 - ~1948 — Theatre
172	Map Quad: J10 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace F (Hall of Science, Business Progress) 1940 - 1942 — Transition period 1942 -~1948 — Barracks F
173	Map Quad: J11 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace E (Electricity and Communications) 1940 - 1942 — Transition period 1942 - ~1948 — Barracks E
174	Map Quad: J12 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace E (Electricity and Communications) 1940 - 1942 — Transition period 1942 - ~1948 — Offices
175	Map Quad: J12 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Palace E (Electricity and Communications, Portals of The Pacific) 1940 - 1942 — Transition period 1942 - ~1948 — Offices
176	Map Quad: I12 Year Built: 1938 Year Demolished: NLT 1961 Uses: 1939 - 1940 — Tower of The Sun 1940 - 1942 — Transition period 1942 - ~1961 — Band Stand
177	Map Quad: J13 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Exposition Building for the Palace D (Mines, Metals and Machinery Exhibit; and the Pantheon Building and Hollywood Show) 1940 - 1942 — Transition period 1942 - ~1948 — Reception

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
178	Map Quad: J13 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Exposition Building for the Palace D (Mines, Metals and Machinery Exhibit; and the Pantheon Building and Hollywood Show) 1940 - 1942 — Transition period 1942 - ~1948 — Offices, Training Building
179	Map Quad: J13 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1939 - 1940 — Exposition Building for the Palace D (Mines, Metals and Machinery Exhibit; and the Pantheon Building and Hollywood Show) 1940 - 1942 — Transition period 1942 - ~1948 — Barracks
181	Map Quad: L18 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - ~1961 — **PAN AM Gasoline Storage Tanks**
182	Map Quad: L18 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - ~1961 — **PAN AM Gasoline Pump House**
185	Map Quad: K16 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — Waiting Station
186	Map Quad: K16 Year Built: 1943 Year Demolished: NLT 1961 Uses: 1943 - ~1961 — Waiting Station
188	Map Quad: K11 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - 1970 — Barracks 1970 - ~1977 — Administration
189	Map Quad: K10 Year Built: 1944 Year Demolished: NLT 1973 Uses: 1944 - 1968 — Barracks 1968 - ~1973 — Administration and Barracks
190	Map Quad: K10 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - 1948 — Barracks 1948 - 1968 — Storage 1968 - ~1977 — Dependent Public School

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
191	Map Quad: K9 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - 1968 — Barracks 1968 - ~1977 — Dependent Public School
192	Map Quad: K6 Year Built: 1943 Year Demolished: NLT 1970 Uses: 1942 - 1945 — **Magnet Channel Range** 1945 - 1952 — **Degaussing Range** 1952 - ~1970 — Radar Bomb Scoring Unit
193	Map Quad: K6 Year Built: 1943 Year Demolished: NLT 1970 Uses: 1942 - 1952 — **Magnet Channel Range Garage** 1952 - ~1970 — Radar Bomb Scoring Unit
194	Map Quad: I6 Year Built: 1944 Year Demolished: NLT 1970 Uses: 1944 - ~1970 — Transportation Building
196	Map Quad: G6 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - 1970 — Barracks 1970 - ~1977 — Public School
197	Map Quad: G8 Year Built: 1944 Year Demolished: NLT 1988 Uses: 1944 - 1948 — Barracks 1948 - ~1988 — Electronics Material School
198	Map Quad: G8 Year Built: 1944 Year Demolished: NLT 1988 Uses: 1944 - 1948 — Barracks 1948 - ~1988 — Electronics Materiel School
199	Map Quad: G8 Year Built: 1944 Year Demolished: NLT 1988 Uses: 1944 - 1948 — Barracks 1948 - ~1988 — Electronics Material School
200	Map Quad: G8 Year Built: 1944 Year Demolished: NLT 1988 Uses: 1944 - 1948 — Barracks 1948 - ~1988 — Electronics Material School
203	Map Quad: F7 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - 1973 — Barracks 1973 - ~1977 — Vacant

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
204	Map Quad: F7 Year Built: 1944 Year Demolished: NLT 1973 Uses: 1944 - ~1973 — Barracks
205	Map Quad: F6 Year Built: 1944 Year Demolished: NLT 1973 Uses: 1944 - ~1973 — Barracks
206	Map Quad: F6 Year Built: 1944 Year Demolished: NLT 1973 Uses: 1944 - ~1973 — Barracks
207	Map Quad: E6 Year Built: 1944 Year Demolished: NLT 1973 Uses: 1944 - ~1973 — Barracks
208	Map Quad: E6 Year Built: 1944 Year Demolished: NLT 1973 Uses: 1944 - ~1973 — Barracks
209	Map Quad: E7 Year Built: 1944 Year Demolished: NLT 1973 Uses: 1944 - ~1973 — Barracks
210	Map Quad: E7 Year Built: 1944 Year Demolished: NLT 1973 Uses: 1944 - ~1973 — Barracks
211	Map Quad: E8 Year Built: 1944 Year Demolished: NLT 1970 Uses: 1944 - ~1970 — Barracks
212	Map Quad: E8 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - ~1977 — Barracks
213	Map Quad: E8 Year Built: NLT 1945 Year Demolished: NLT 1953 Uses: ~1945 - ~1953 — Barracks
214	Map Quad: E8 Year Built: NLT 1945 Year Demolished: NLT 1953 Uses: ~1945 - ~1953 — Barracks

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
218	Map Quad: D6 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - 1952 — Storehouse 1952 - ~1977 — Administration
219	Map Quad: J12 Year Built: 1938 Year Demolished: NLT 1948 Uses: 1938 - ~1948 — **Transformer** and Storage
220	Map Quad: H10 Year Built: 1943 Year Demolished: NLT 1961 Uses: 1943 - 1948 — Shop 1948 - ~1961 — Classrooms
221	Map Quad: G7 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - 1948 — Administration 1948 - ~1977 — Office and Storage
222	Map Quad: G7 Year Built: 1944 Year Demolished: 1993 Uses: 1945 - 1988 — Brigade Guard House 1988 - ~1993 — Correctional Facility
223	Map Quad: I7 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - 1948 — **Paint Shop** 1948 - ~1961 — Bus Washing Shed
224	Map Quad: I7 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Garage and Checking Station
226	Map Quad: K12 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Bachelor Officers' Quarters
228	Map Quad: K13 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Bachelor Officers' Quarters
231	Map Quad: E11 Year Built: 1944 Year Demolished: 1985 Uses: 1944 - 1985 — Wave Officers' Quarters and Religious Education Building
232	Map Quad: E11 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - ~1977 — Wave Barracks (Enlisted)

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
234	Map Quad: E12 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - 1948 — Nurses Quarters 1948 - ~1977 — CPO Quarters
235	Map Quad: E12 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - 1948 — Ward, Blood Bank and **Laboratory** 1948 - ~1961 — Waves Barracks, Jewish Chaplain
236	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1948 — Administration 1948 - 1993 — Classrooms DCTC (FF)
237	Map Quad: E3 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Oil Storage Tank (FF)**
238	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1952 — **Shop and Boiler House** 1952 - 1993 — Repair Shop
239	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Oil Separating Pit and Suction Pump**
240	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — Forecastle Mock Up
241	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1933 — Boiler Room Mock Up
242	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1933 — Engine Room Mock-up
243	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1933 — Flight Deck Mock-up
244	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — Diving Tank and **OBA Storage and Repair**

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
245	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Oil Separating Pit**
246	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Smothering Pit**
247	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Oil Storage**
249	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Gasoline Storage**
250	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Suction Tank**
251	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1933 — **Foam Tank**
252	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Training Tank** (Open)
253	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Christmas Tree Training Tank** (Open)
254	Map Quad: E4 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Christmas Tree Training Tank** (Open)
255	Map Quad: E4(see notes) Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Tank** (Open) Notes: Building 255 was moved in approximately 1969 from Map Quad E4 to Map Quad D9.
256	Map Quad: E3 Year Built: 1944 Year Demolished: 1993 Uses: 1944 - 1993 — **Gasoline Tank**

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
259	Map Quad: J8 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - 1952 — **Gun Mount** 1952 - ~1961 — Classrooms
262	Map Quad: E9 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Theatre
263	Map Quad: F9 Year Built: 1944 Year Demolished: 1977 Uses: 1944 - 1952 — Welfare Building 1952 - 1974 — Recreation 1974 - 1977 — EM Club and Library
266	Map Quad: K8 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 - ~1961 — Sonar School Building
267	Map Quad: I6 Year Built: 1942 Year Demolished: NLT 1977 Uses: 1942 - 1945 — Trans. Storage 1945 - 1961 — Barracks 1961 - 1969 — Training Building 1969 - ~1977 — Teen Club
268	Map Quad: I8 Year Built: 1944 Year Demolished: NLT 1977 1944 - 1952 — **Gun Loading Shed** 1952 - ~1977 — Classrooms
269	Map Quad: K6 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - ~1977 — Chemical Warfare Office
270	Map Quad: E3 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - ~1969 — **Paint and Oil Storage**
272	Map Quad: D14 Year Built: 1944 Year Demolished: 1985 Uses: 1944 - 1952 — Electrical and Mechanical Service 1952 - 1985 — **Air Compressor Station**
273	Map Quad: K6 Year Built: 1944 Year Demolished: NLT 1988 Uses: 1944 - 1952 — **Decontamination Building** 1952 - ~1988 — Classrooms

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
274	Map Quad: E14 Year Built: 1944 Year Demolished: NLT 1961 Uses: 1944 -~1961 — **Dynamometer Shop**, Fallout Shelter
275	Map Quad: E11 Year Built: 1944 Year Demolished: 1985 Uses: 1944 - 1985 — Waves Barracks (Enlisted), Navy Band Barracks
276	Map Quad: E3 Year Built: 1944 Year Demolished: NLT 1988 Uses: 1944 - 1948 — Office 1948 - 1952 — Film Exchange 1952 - ~1988 — Storage
277	Map Quad: F2 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - ~1969 — Storage
278	Map Quad: G2 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - ~1969 — Storage
279	Map Quad: H2 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - 1952 — Small Craft (Ship Group) 1952 - ~1969 — Storage
280	Map Quad: I2 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - ~1969 — **Medical Storage**
281	Map Quad: J3 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - 1952 — Film Storage 1952 - ~1969 — Storage
282	Map Quad: I3 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - ~1969 — Storage

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
283	Map Quad: H3 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - ~1969 — Storage
284	Map Quad: G3 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - 1952 — Electronic Storage 1952 - ~1969 — Storage
285	Map Quad: G4 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - ~1969 — Storage
286	Map Quad: H4 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - 1952 — **Tear Gas Storage** 1952 - ~1969 — Storage
287	Map Quad: I4 Year Built: 1944 Year Demolished: NLT 1969 Uses: 1944 - 1948 — **Magazine, Ammunition** 1948 - 1952 — Film Storage 1952 - ~1969 — Storage
288	Map Quad: K6 Year Built: 1944 Year Demolished: NLT 1970 Uses: 1944 - 1969 — **Gas Chamber (Training)** 1969 - ~1970 — Storage
291	Map Quad: J8 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — **Gun Mount**
294	Map Quad: G5 Year Built: 1944 Year Demolished: NLT 1970 Uses: 1944 - ~1970 — Gear Locker
295	Map Quad: D13 Year Built: 1944 Year Demolished: NLT 1970 Uses: 1944 - 1952 — **Generator Building** 1952 - ~1970 — Training Unit Mock-up

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
296	Map Quad: I11 Year Built: 1944 Year Demolished: NLT 1970 Uses: 1944 - ~1970 — Water Taxi Pier Shelter and Office
297	Map Quad: E16 Year Built: 1944 Year Demolished: NLT 1977 Uses: 1944 - 1952 — **Transformer House** 1952 - ~1977 — Storage
299	Map Quad: J16 Year Built: NLT 1945 Year Demolished: NLT 1950 Uses: ~1945 - ~1950 — Loading Shed
300	Map Quad: K9 Year Built: NLT 1942 Year Demolished: NLT 1961 Uses: ~1942 - 1945 — Army Barracks 1945 - 1948 — Office 1948 - ~1961 — Storage
301	Map Quad: K9 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1948 — Subsistence 1948 - ~1961 — Storage
302	Map Quad: K9 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1948 — Subsistence 1948 - ~1961 — Storage
303	Map Quad: K9 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1948 — Subsistence 1948 - ~1961 — Storage
304	Map Quad: K9 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Toilets (Army)
305	Map Quad: K9 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Toilets (Army)
306	Map Quad: K9 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1948 — Supply Office (Army) 1948 - ~1961 — Storage

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
307	Map Quad: K8 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1948 — Barracks (Army) 1948 - ~1961 — Storage
308	Map Quad: K8 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1948 — Barracks (Army) 1948 - ~1961 — Storage
309	Map Quad: K8 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1948 — Barracks (Army) 1948 - ~1961 — Barracks, Shops, Film Exchange
310	Map Quad: K8 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - 1948 — Barracks (Army) 1948 - ~1961 — Barracks, Shops, Film Exchange
311	Map Quad: K8 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - 1948 — Barracks (Army) 1948 - 1952 — Barracks, Shops, Film Exchange 1952 - ~1961 — Storage
312	Map Quad: K8 Year Built: 1942 Year Demolished: NLT 1961 Uses: 1942 - 1948 — Barracks (Army) 1948 - 1952 — Barracks, Shops, Film Exchange 1952 - ~1961 — Storage
313	Map Quad: J9 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1948 — POW Subsistence Storage 1948 - ~1961 — Storage
314	Map Quad: K8 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — **Gun Mount**
315	Map Quad: J8 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — School
316	Map Quad: K8 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — School

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
317	Map Quad: K8 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — School
318	Map Quad: K7 Year Built: 1938 Year Demolished: NLT 1977 Uses: 1939 - 1940 — **Service Station** 1940 - 1942 — Transition period 1942 - 1952 — **Gun Mount** 1952 - ~1977 — Classrooms
319	Map Quad: K7 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — School (Mock-up)
320	Map Quad: K7 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — School (Mock-up)
321	Map Quad: K7 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — School (Mock-up)
322	Map Quad: J7 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — **Gun Mount**
323	Map Quad: D13 Year Built: 1945 Year Demolished: NLT 1961 Uses: 1945 - 1952 — **Gun Trainer** 1952 - ~1961 — Classrooms
324	Map Quad: K11 Year Built: NTL 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — Assembly Shed
326	Map Quad: K8 Year Built: 1945 Year Demolished: NLT 1970 Uses: 1945 - ~1952 — **Gun Shed** 1952 - ~1970 — Classrooms
327	Map Quad: D4 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Salvage Building

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
329	Map Quad: G11 Year Built: 1945 Year Demolished: NLT 1961 Uses: 1945 - 1948 — Storehouse 1948 - ~1961 — Office and Storehouse
331	Map Quad: H8 Year Built: 1947 Year Demolished: NLT 1961 Uses: 1947 - ~1961 — Greenhouse
332	Map Quad: K8 Year Built: 1945 Year Demolished: NLT 1970 Uses: 1945 - ~1948 — P.O.W. Brig ~1948 - ~1970 — Storage
333	Map Quad: K8 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — Recreation Building
334	Map Quad: D5 Year Built: NLT 1945 Year Demolished: NLT 1948 Uses: ~1945 - ~1948 — **Paint Locker**
336	Map Quad: C5 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1952 — **Linoleum Shop** 1952 - ~1961 — Storage
337	Map Quad: C5 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1952 — **Masons Locker** 1952 - ~1961 — Storage
338	Map Quad: C6 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Duty Barracks
339	Map Quad: C6 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Duty Barracks
340	Map Quad: D14 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Dock Master's Office
345	Map Quad: G2 Year Built: 1951 Year Demolished: NLT 1961 Uses: 1951 - ~1961 — **Incinerator**

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
348	Map Quad: K6 Year Built: 1952 Year Demolished: NLT 1970 Uses: 1952 - ~1970 — Issue Room, Classroom (Chemical Warfare)
349	Map Quad: K6 Year Built: 1952 Year Demolished: NLT 1970 Uses: 1952 - ~1970 — **Field Work Shop, Classroom (Chemical Warfare)**
350	Map Quad: K6 Year Built: 1952 Year Demolished: NLT 1970 Uses: 1952 - ~1970 — **Repair Shop, Classroom (Chemical Warfare)**
351	Map Quad: K6 Year Built: 1952 Year Demolished: NLT 1961 Uses: 1952 - ~1961 — **Repair Shop, Classroom (Chemical Warfare)**
352	Map Quad: E5 Year Built: 1952 Year Demolished: 1993 Uses: 1952 - 1993 — NTTC Training
353	Map Quad: E5 Year Built: 1952 Year Demolished: 1993 Uses: 1952 - 1993 — NTTC Training
354	Map Quad: H13 Year Built: 1951 Year Demolished: NLT 1968 Uses: 1951 - 1968 — Rigger's Shed, Storage Notes: Building moved in approximately 1968 from Map Quad H13 to Map Quad J7.
354	Map Quad: J7 Year Built: NLT 1968 Year Demolished: NLT 1977 Uses: 1968 - 1973 — Instruction 1973 - ~1977 — Instruction (Fire Department) Notes: Building moved in approximately 1968 from Map Quad H13 to Map Quad J7.
356	Map Quad: I16 Year Built: NLT 1953 Year Demolished: NLT 1973 Uses: ~1953 - ~1973 — Steam Clean and Car Wash
357	Map Quad: I16 Year Built: NLT 1953 Year Demolished: NLT 1977 Uses: ~1953 - ~1977 — Bus Wash
359	Map Quad: K6 Year Built: NLT 1961 Year Demolished: NLT 1968 Uses: ~1961 - 1966 — **Mobile Decontamination** 1966 - ~1968 — Classrooms

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
360	Map Quad: K16 Year Built: NLT 1945 Year Demolished: NLT 1991 Uses: ~1945 - ~1991 — Boat House - Pier 24 Notes: The area of Building 360 appears on Maps after 1977, but then the number disappears. Again the area of Building 360 disappears prior to photo of 1991, although it is still shown on the maps.
370	Map Quad: I7 Year Built: NLT 1961 Year Demolished: NLT 1977 Uses: ~1961 - ~1977 — **Gasoline Filling Station**
372	Map Quad: J8 Year Built: NLT 1961 Year Demolished: NLT 1977 Uses: ~1961 - ~1977 — Training Facility - Antenna Tower
373	Map Quad: J8 Year Built: NLT 1961 Year Demolished: NLT 1977 Uses: ~1961 - ~1977 — Training Facility - Antenna Tower
375	Map Quad: C7 Year Built: NLT 1961 Year Demolished: NLT 1988 Uses: ~1961 - ~1988 — Training Facility - Antenna Tower
376	Map Quad: C7 Year Built: NLT 1961 Year Demolished: NLT 1988 Uses: ~1961 - ~1988 — Training Facility - Antenna Tower
386	Map Qaud: G15 Year Built: NLT 1950 Year Demolished: NLT 1973 Uses: ~1950 - ~1973 — Storage
387	Map Quad: E16 Year Built: NLT 1948 Year Demolished: NLT 1966 Uses: ~1948 - ~1966 — Storage
388	Map Quad: E16 Year Built: NLT 1948 Year Demolished: NLT 1966 Uses: ~1948 - ~1966 — Storage
389	Map Quad: E16 Year Built: NLT 1948 Year Demolished: NLT 1966 Uses: ~1948 - ~1966 — Storage
399	Map Quad: H11 Year Built: NLT 1961 Year Demolished: NLT 1991 Uses: ~1961 - ~1991 — Training Facility - Antenna Tower

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
400	Map Quad: H11 Year Built: NLT 1961 Year Demolished: NLT 1991 Uses: ~1961 - ~1991 — Training Facility - Antenna Tower
403	Map Quad: C4 Year Built: NLT 1961 Year Demolished: NLT 1966 Uses: ~1961 - ~1966 — **Incinerator**
404	Map Quad: C4 Year Built: NLT 1961 Year Demolished: NLT 1966 Uses: ~1961 - ~1966 — **Incinerator**
410	Map Quad: H13 Year Built: NLT 1966 Year Demolished: NLT 1969 Uses: ~1966 - ~1969 — Mechanical Equipment
412	Map Quad: J15 Year Built: NLT 1969 Year Demolished: NLT 1977 Uses: ~1969 - ~~1977 — Storage
414	Map Quad: I8 Year Built: NLT 1966 Year Demolished: NLT 1992 Uses: ~1966 - ~1992 — **Transformer House**
418	Map Quad: FG6 & H5 Year Built: NLT 1966 Year Demolished: NLT 1969 Uses: 1942 - 1948 — Airship Field 1948 - 1966 — Vacant 1966 - ~1969 — Athletic Fields (First number designation)
424	Map Quad: G8 Year Built: 1942 Year Demolished: NLT 1991 Uses: 1942 - ~1991 — **Switchgear House**
425	Map Quad: H10 Year Built: 1942 Year Demolished: NLT 1991 Uses: 1942 - ~1991 — **Switchgear House**
426	Map Quad: C14 Year Built: NLT 1966 Year Demolished: NLT 1968 Uses: ~1966 - ~1968 — **Switchgear House**
427	Map Quad: C14 Year Built: NLT 1966 Year Demolished: NLT 1968 Uses: ~1966 - ~1968 — **Switchgear House**

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
428	Map Quad: H10 Year Built: NLT 1966 Year Demolished: NLT 1968 Uses: ~1966 - ~1968 — **Switchgear House**
429	Map Quad: D16 Year Built: NLT 1966 Year Demolished: NLT 1968 Uses: ~1966 - ~1968 — **Switchgear House**
437	Map Quad: SF, CA Year Built: 1961 Year Demolished: 1966 Uses: 1961 - 1966 — Police Station (Located on Clay Street in San Francisco)
441	Map Quad: J12 Year Built: NLT 1961 Year Demolished: NLT 1966 Uses: ~1961 - ~1966 — Sump House #19
446	Map Quad: E4 Year Built: NLT 1966 Year Demolished: 1993 Uses: ~1966 - 1993 — Storage
457	Map Quad: F8 Year Built: NLT 1970 Year Demolished: NLT 1977 Uses: ~1970 - ~1977 — Storage Shed
464	Map Quad: E5 Year Built: 1969 Year Demolished: 1993 Uses: 1969 - 1993 — **Smoke Elimination Structure**
471	Map Quad: E4 Year Built: 1969 Year Demolished: 1993 Uses: 1969 - 1993 — Smoke Elimination Facility Control Building
476	Map Quad: H7 Year Built: NLT 1970 Year Demolished: NLT 1977 Uses: ~1970 - ~1977 — West Guard Tower (Not Shown in 1992 Map)
477	Map Quad: G7 Year Built: NLT 1970 Year Demolished: NLT 1977 Uses: ~1970 - ~1977 — East Guard Tower (not shown in 1992 map).
479	Map Quad: G14 Year Built: 1952 Year Demolished: 1979 Uses: 1952 - 1979 — Basketball Courts (16 total)
484	Map Quad: E4 Year Built: 1973 Year Demolished: 1993 Uses: 1973 - 1993 — Dewater Tower

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
486	Map Quad: F16 Year Built: 1967 Year Demolished: 1984 Uses: 1967 - 1984 — Barge Shelter
491	Map Quad: Unknown Year Built: NLT 1977 Year Demolished: NLT 1993 Uses: ~1977 - ~1993 — **Separating Pit (NTTC)**
495	Map Quad: K15 Year Built: 1976 Year Demolished: 1986 Uses: 1976 - 1986 — Sentry Booth
498	Map Quad: E10 Year Built: 1979 Year Demolished: 1980 Uses: 1979 - 1980 — Wind Generator Tower installed on top of Building 260
565	Map Quad: J22 Year Built: 1988 Year Demolished: Unknown Uses: 1988 - Unknown — P-MUTTS Trailer Notes: Trailer used as a battle simulator. It is no longer in existence
PIER 1	Map Quad: K18 Year Built: 1938 Year Demolished: NLT 1961 Uses: 1938 - ~1961 — **Fueling Pier**
PIER 3	Map Quad: J16 Year Built: 1939 Year Demolished: NLT 1961 Uses: 1939 - ~1961 — Pier and Floats
PIER 4	Map Quad: I16 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Pier and Floats
PIER 5	Map Quad: I16 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — **Marine Railway**
PIER 6	Map Quad: I16 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — Pier and Floats
PIER 7	Map Quad: H16 Year Built: 1939 Year Demolished: NLT 1961 Uses: 1939 - ~1961 — Pier and Floats

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
PIER 8	Map Quad: H16 Year Built: NLT 1942 Year Demolished: NLT 1961 Uses: ~1942 - ~1961 — Pier and Floats
PIER 9	Map Quad: G16 Year Built: NLT 1942 Year Demolished: NLT 1961 Uses: ~1942 - ~1961 — **Marine Railway**
PIER 9A	Map Quad: G16 Year Built: NLT 1945 Year Demolished: NLT 1970 Uses: ~1945 - ~1970 — **Marine Railway - 50 Ton**
PIER 10	Map Quad: F16 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - ~1961 — **Fuel Pier**
PIER 13	Map Quad: E15 Year Built: 1944 Year Demolished: 1991 Uses: 1944 - 1991 — **Maintenance Pier**
PIER 14	Map Quad: D15 Year Built:1944 Year Demolished: 1987 Uses: 1944 - 1987 — **Maintenance Pier**
PIER 15	Map Quad: C14 Year Built: 1944 Year Demolished: 1987 Uses: 1944 - 1987 — **Maintenance Pier**
PIER 16	Map Quad: C14 Year Built: NLT 1945 Year Demolished: NLT 1973 Uses: ~1945 - ~1973 — **Maintenance Pier**
PIER 17	Map Quad: E11 Year Built: NLT 1942 Year Demolished: NLT 1973 Uses: ~1942 - ~1973 — South Pier
PIER 18	Map Quad: C10 Year Built: NLT 1942 Year Demolished: NLT 1945 Uses: ~1942 - ~1945 — Short Pier
PIER 19	Map Quad: C9 Year Built: NLT 1945 Year Demolished: NLT 1961 Uses: ~1945 - 1952 — **Repair Pier** 1952 - ~1961 — **Marine Railway** (Surveyed)

Table 5

Demolished Buildings of Treasure Island

(as of December 1, 1994)

Bldg. No.	Building Data
PIER 20	Map Quad: C8 Year Built: 1938 Year Demolished: NLT 1973 Uses: 1938 - ~1973 — Ferry Slip (Oakland Landing)
PIER 22	Map Quad: E2 Year Built: 1944 Year Demolished: 1987 Uses: 1944 - 1987 — **Ammunition Pier**
PIER 24	Map Quad: K16 Year Built: NLT 1945 Year Demolished: NLT 1977 Uses: ~1945 - ~1977 — Small Boat Pier

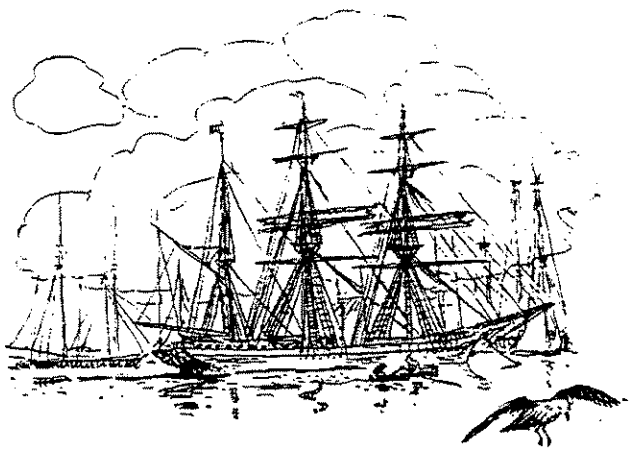


Table 6

Golden Gate Exposition Buildings of Treasure Island

(Demolished by 1942)

Bldg. No.	Building Data
N/A	Map Quad: E11 Year Built: 1938 Year Demolished: NLT 1942 Title: State of California Auditorium Uses: Radio broadcasting of concerts, speeches, comedy shows.
N/A	Map Quad: E13 - E14 Year Built: 1938 Year Demolished: NLT 1942 Title: California State Building Uses: Reception areas and offices.
N/A	Map Quad: F13 Year Built: 1938 Year Demolished: NLT 1942 Title: San Francisco Building Uses: Offices, Mayor's suite, displays of San Francisco wares and services.
N/A	Map Quad: E14 Year Built: 1938 Year Demolished: NLT 1942 Title: Alameda and Contra Costa Counties Uses: Displays promoting Alameda and Contra Costa Counties.
N/A	Map Quad: F14 Year Built: 1938 Year Demolished: NLT 1942 Title: Mission Trails Building Uses: Displays commemorating the missions of California.
N/A	Map Quad: E14 Year Built: 1938 Year Demolished: NLT 1942 Title: Alta California Building Uses: Displays promoting the fourteen Northern California counties.
N/A	Map Quad: E15 Year Built: 1938 Year Demolished: NLT 1942 Title: San Joaquin Valley Building Uses: Displays promoting the agriculture and resources of the San Joaquin Valley. Counties promoted were Merced, Madera, Fresno, and Kern counties.
N/A	Map Quad: E15 Year Built: 1938 Year Demolished: NLT 1942 Title: Sacramento Valley and Lake Tahoe Region Building Uses: Displays promoting gold mining, sugar refineries, canneries, and the Mare Island Naval Shipyard. Counties promoted were Sacramento, El Dorado, Placer, Yolo, and Solano counties.
N/A	Map Quad: D14 - E15 Year Built: 1938 Year Demolished: NLT 1942 Title: Redwood Empire Building Uses: Displays promoting the resources of the San Francisco, Marin, Sonoma, Napa, Lake, Mendocino, Humboldt, and Del Norte counties of California, as well as Josephine county in Oregon.

Table 6

Golden Gate Exposition Buildings of Treasure Island

(Demolished by 1942)

Bldg. No.	Building Data
N/A	Map Quad: D13 - D14 Year Built: 1938 Year Demolished: NLT 1942 Title: Shasta Cascade Building Uses: Displays promoting lumbering, agriculture, fruit growing, and mining in Tehama, Lassen, Modoc, Trinity, Shasta, and Siskiyou counties of California, as well as Lake, Klamath, and Jackson counties in Oregon.
N/A	Map Quad: E10 Year Built: 1938 Year Demolished: NLT 1942 Title: Pacific House Uses: The "Theme Building" of the Exposition. The Pacific House had topographical map of the Pacific Area in the form of a fountain (now demolished and in pieces in a fenced area behind Building 2). The displays were primarily maps of the Pacific area highlighting different aspects, such as flora and fauna, peoples, economics, art, architecture, and transportation.
N/A	Map Quad: E11 Year Built: 1938 Year Demolished: NLT 1942 Title: Hawaii Uses: Displays highlighting both modern and ancient Hawaii.
N/A	Map Quad: E11 Year Built: 1938 Year Demolished: NLT 1942 Title: New Zealand Uses: Displays of the scenic nature of New Zealand and emphasizing the Maori history.
N/A	Map Quad: E11 Year Built: 1938 Year Demolished: NLT 1942 Title: French Indo-China Uses: Displays of the Ruins of Angkor, art in silver work, silk, and fine bronzes.
N/A	Map Quad: E10 Year Built: 1938 Year Demolished: NLT 1942 Title: Australia Uses: Displays of the features of Australia, especially its unusual wildlife.
N/A	Map Quad: E10 Year Built: 1938 Year Demolished: NLT 1942 Title: Life History of Redwoods Uses: Displays of the Coastal Redwoods of California which included their botany, growth, uses, and preservation, as well as a cross-section of the oldest Coastal Redwood harvested which was determined to be 2200 years old.
N/A	Map Quad: E10 Year Built: 1938 Year Demolished: NLT 1942 Title: Philippine Pavilion Uses: Displays of Philippine goods. Copper roof.

Table 6

Golden Gate Exposition Buildings of Treasure Island

(Demolished by 1942)

Bldg. No.	Building Data
N/A	Map Quad: E9 Year Built: 1938 Year Demolished: NLT 1942 Title: Johore State Pavilion Uses: Museum style displays of the agricultural and mineral resources and animals of Johore, as well as the native clothing of its people.
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: Javanese Restaurant Uses: The restuarant, which seated 400 people, was the first to introduce the food "rijstafel" to the United States.
N/A	Map Quad: F10 Year Built: 1938 Year Demolished: NLT 1942 Title: Netherlands East Indies Uses: Displays of the crafts, arts, and dance of Bali, the Celebes, Java, Sumatra, and Dutch Borneo.
N/A	Map Quad: F10 Year Built: 1938 Year Demolished: NLT 1942 Title: Japan Uses: Samauri House and Temple,as well as Japanese garden, drum bridge, lighting (4,000 lanterns) and silk making displays.
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: Mexico Uses: A Mexican restaurant with the side shops of a sandal maker, a silversmith, and leather worker enhanced the Mexico display.
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: El Salvador Uses: A display of the cultivation, picking, milling, and brewing of coffee.
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: Panama Uses: Displays of the steamship routes to and through the Panama Canal, costumes of the country, gold and silver Indian jewelry, and rare Indian pottery.
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: Guatemala Uses: Displays of the arts and products of Guatemala.

Table 6

Golden Gate Exposition Buildings of Treasure Island

(Demolished by 1942)

Bldg. No.	Building Data
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: Peru Uses: Incan gold treasures with emeralds and other precious stones, as well as modern gold and silver pieces, were displayed.
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: Colombia Uses: The centerpiece of this building exhibited a living coffee plantation containing live coffee trees, as well as old gold jewelry from Indian graves and a collection of weapons from the Chichibscha and Pijaos tribes.
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: Chile Uses: The Chilean display centered on tourism and nitrate mining.
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: Ecuador Uses: A display of old Indian art, gold and silver ware, and modern paintings by Ecuadorian artists.
N/A	Map Quad: F9 Year Built: 1938 Year Demolished: NLT 1942 Title: Brazil Uses: Coffee was the theme and centerpiece of the Brazilian displaywhich included a coffee cafe. Paintings by Brazilian artists and displays of mineral oils and raw materials were used to complete the display.
N/A	Map Quad: F10 Year Built: 1938 Year Demolished: NLT 1942 Title: Argentina Uses: Displays of paintings and sculptures by Argentinian artists, products and minerals of the country, books written and published in Argentina, as well as a restaurant serving the food and beverages of Argentina.
N/A	Map Quad: F10 - F11 Year Built: 1938 Year Demolished: NLT 1942 Title: France Uses: Displays of fine arts, fashion and tourism were the focus of the French pavilion. Two statues, "The Shadow" by Rodin and "Carplaux" by Bourdelle were displayed prominently. Paintings, tapestries, and a display of first editions of Seventeenth and Eighteenth Century French authors were also shown. Fashion from the Eighteenth Century to the year 1939 were displayed in a separate salon. The pavilion was unoccupied in 1940 because of France's involvement in World War II.

Table 6

Golden Gate Exposition Buildings of Treasure Island

(Demolished by 1942)

Bldg. No.	Building Data
N/A	Map Quad: F10 - F11 Year Built: 1938 Year Demolished: NLT 1942 Title: Gallery of Elegance Uses: Fifty-eight exhibitors displayed the latest in women's wear and accessories. A French restaurant was also included.
N/A	Map Quad: F10 - F11 Year Built: 1938 Year Demolished: NLT 1942 Title: Italy Uses: The Italian display was centered on tourism with displays of marble, motion pictures, dioramas, and girls dressed in costumes of the eight most important regions of Italy. The Italian pavilion was unoccupied in 1940 because of Italy's involvement in World War II.
N/A	Map Quad: F10 - F11 Year Built: 1938 Year Demolished: NLT 1942 Title: Norway Uses: A Norwegian ski lodge with displays of skis, sleds and toboggans, as well as Finnish baths and a snack bar were included in the Norwegian display.
N/A	Map Quad: G11 Year Built: 1938 Year Demolished: NLT 1942 Title: Press Building Uses: This building was simply a place for members of the press to relax and/or prepare for the next exciting event of the Exposition. It was not open to the public.
N/A	Map Quad: G11 Year Built: 1938 Year Demolished: NLT 1942 Title: Dairy Products Building Uses: A model dairy with a display of milk products.
N/A	Map Quad: G10 Year Built: 1938 Year Demolished: NLT 1942 Title: National Cash Register Building Uses: A giant model of a cash register with windows in the bottom displaying other cash register equipment.
N/A	Map Quad: H11 Year Built: 1938 Year Demolished: NLT 1942 Title: Temple of Religion and the Tower of Peace Uses: Displays emphasizing the contribution of religion to human welfare throughout the world.
N/A	Map Quad: G10 Year Built: 1938 Year Demolished: NLT 1942 Title: Christian Science Activities Building Uses: Displays promoting the Christian Science religion.

Table 6

Golden Gate Exposition Buildings of Treasure Island

(Demolished by 1942)

Bldg. No.	Building Data
N/A	Map Quad: G10 Year Built: 1938 Year Demolished: NLT 1942 Title: Christian Business Men's Building Uses: A display which drew a connection between spiritual truth and applied science.
N/A	Map Quad: G9 Year Built: 1938 Year Demolished: NLT 1942 Title: Ghirardelli Chocolate Building Uses: A display on the manufacture of chocolate and a "soda bar" which specialized in mixing/making chocolate drinks.
N/A	Map Quad: H9 Year Built: 1938 Year Demolished: NLT 1942 Title: Bank of America Building Uses: The Bank of America Building was a windowless air conditioned example of futuristic buildings.
N/A	Map Quad: G9 Year Built: 1938 Year Demolished: NLT 1942 Title: Owl Drug Store Uses: Full service drug store which was decorated with sculptured owls.
N/A	Map Quad: H9 Year Built: 1938 Year Demolished: NLT 1942 Title: Oakwood Barbecue Uses: Restaurant with an outdoor barbecue pit.
N/A	Map Quad: H10 - H11 Year Built: 1938 Year Demolished: NLT 1942 Title: Crillo's Specialty Kitchen Uses: Restaurant and bar
N/A	Map Quad: H10 - H11 Year Built: 1938 Year Demolished: NLT 1942 Title: White Star Tuna Restaurant Uses: Restaurant speciallizing in tuna products.
N/A	Map Quad: I7 & J7 Year Built: 1938 Year Demolished: NLT 1942 Title: Cavalcade of the Golden West Uses: Show set with **narrow gauge railroad.**
N/A	Map Quad: I15 Year Built: 1938 Year Demolished: NLT 1942 Title: Yerba Buena Club Uses: Women's club with beauty shops and a childrens room.

Table 6

Golden Gate Exposition Buildings of Treasure Island

(Demolished by 1942)

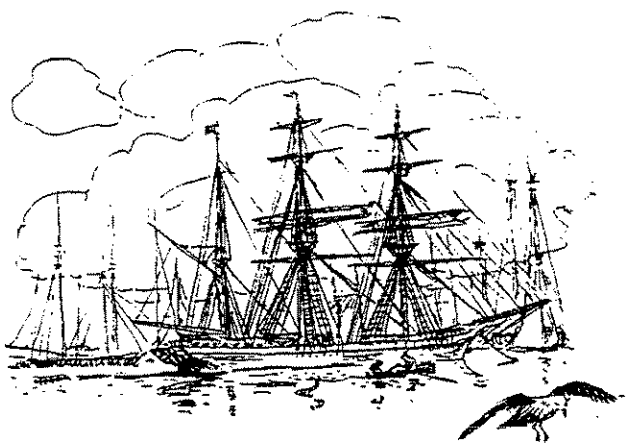
Bldg. No.	Building Data
N/A	Map Quad: H13 Year Built: 1938 Year Demolished: NLT 1942 Title: Compton Metal Home Uses: Partially pre-manufactured home using steel and concrete construction.
N/A	Map Quad: H14 Year Built: 1938 Year Demolished: NLT 1942 Title: Western Pines Home Uses: Cape Cod Colonial house built and decorated in pine wood.
N/A	Map Quad: H14 Year Built: 1938 Year Demolished: NLT 1942 Title: California Nurseries "Old Adobe" Uses: Adobe style house with plants and trees from Niles, CA.
N/A	Map Quad: H14 Year Built: 1938 Year Demolished: NLT 1942 Title: Soule Steel "Unibilt" House Uses: Pre-fabricated, steel frame house with stucco covering.
N/A	Map Quad: D12 - D13 Year Built: 1938 Year Demolished: NLT 1942 Title: Colonnade of States Uses: A spectacular display of flags from each of the forth-eight United States located in the center section of the Federal Building
N/A	Map Quad: D9 Year Built: 1938 Year Demolished: NLT 1942 Title: Missouri Building Uses: Model mountain of the Ozarks, Missouri history, and modern capabilities.
N/A	Map Quad: D8 Year Built: 1938 Year Demolished: NLT 1942 Title: Illinois Building Uses: History of Illinois including New Salem (Lincoln) and Chicago which displayed a Statue of Lincoln.
N/A	Map Quad: D6 - D7 Year Built: 1938 Year Demolished: See "Notes" Title: California Coliseum Uses: Animal shows and indoor athletic competitions. This building was carefully disassembled, moved to Mare Island Naval Shipyard, and reassembeled. There it is known as the Field House, Building 523. Building 523 still stands today.
N/A	Map Quad: C9 - C10 Year Built: 1938 Year Demolished: NLT 1942 Title: Recreation Building Uses: Displays showing and demonstrating different forms of recreation.

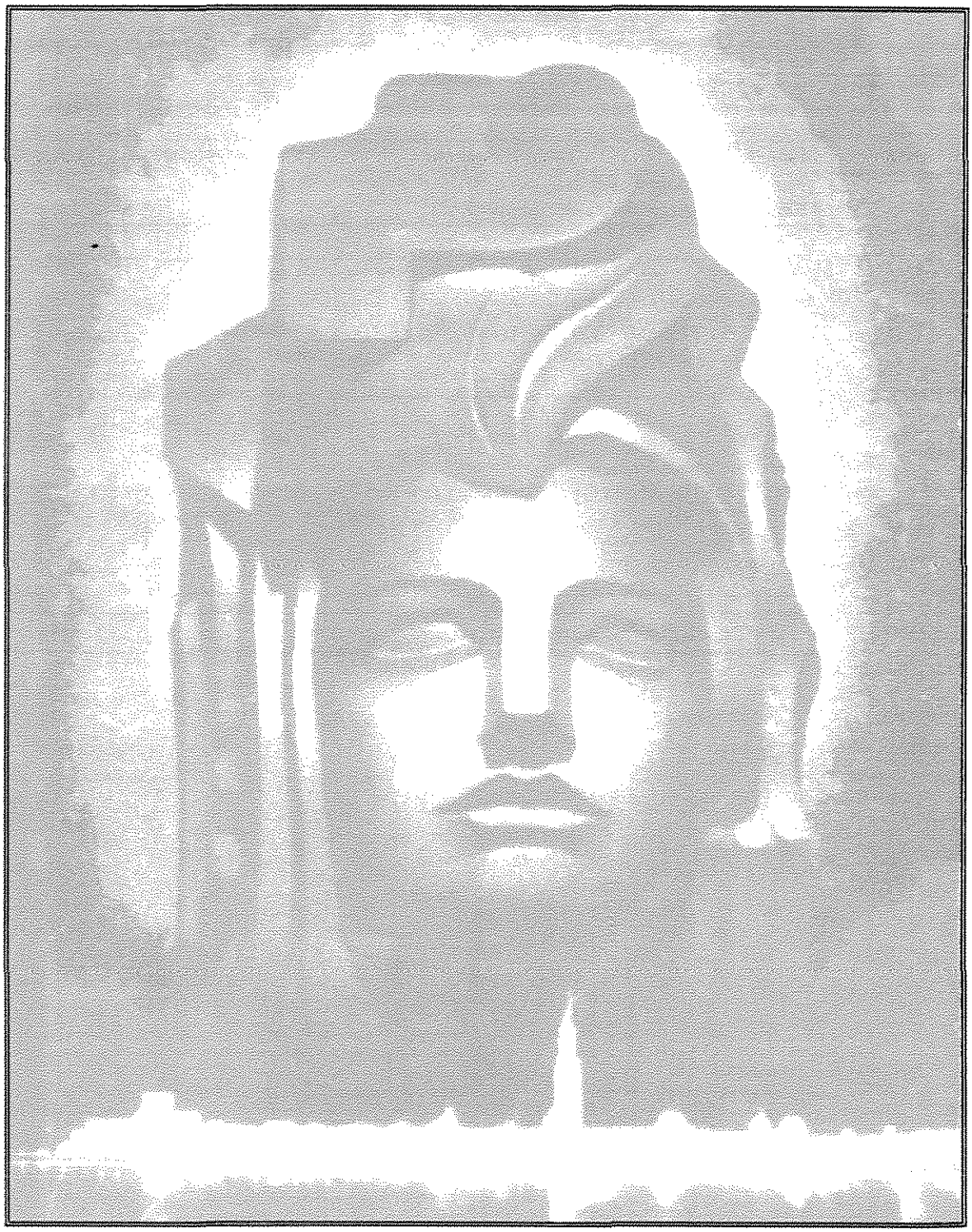
Table 6

Golden Gate Exposition Buildings of Treasure Island

(Demolished by 1942)

Bldg. No.	Building Data
N/A	Map Quad: E5 Year Built: 1938 Year Demolished: NLT 1942 Title: Livestock Pavilion Uses: Livestock shows and competitions
N/A	Map Quad: (See notes) Year Built: 1938 Year Demolished: NLT 1942 Title: Gayway Uses: Carnival rides and shows, including a 4000 foot **roller coaster** Notes: The Gayway spanned over the following Map Quads: E6, 7, 8, 9; F, 6, 7, 8, 9; G6, 7, 8, 9; and H - 6, 7, 8, 9
N/A	Map Quad: H7 Year Built: 1938 Year Demolished: NLT 1942 Title: Chinese Village Uses: Displayed rare art and tapestries, jade and ivory carved pieces, plants of China, classical, acrobatic, and Chinese dance performances, as well as a restaurant with chefs imported from China just for the Exposition.
N/A	Map Quad: L9 Year Built: 1938 Year Demolished: NLT 1942 Title: Ferry Slip (Oakland Landing)





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Resources reviewed in preparation of this historical study include the following categories: books, newspapers, magazine articles, pamphlets and legal briefs, letters, military documents, as well as miscellaneous resources, which could not be categorized in the preceeding groups. Each resourse is identified by a reference index letter(s), resource title, resource information, and source location Not all those listed were actually used in the final report. A number noted in [ ]'s (i.e., [1]) indicates the reference "Source Location" listed below.

Source Locations

1) Bancroft Library, University of California, Berkeley; Berkeley, CA
2) California Historical Society; San Francisco, CA
3) National Archives, Pacific Sierra Branch; San Bruno, CA
4) Personal Library of Jeanne M. Day; Yerba Buena, CA
5) Personal Library of Gordon Turner; Mare Island, CA
6) Personal Library of John Underhill; Richmond, CA
7) San Francisco Public Library, Newspaper and California Rooms; San Francisco, CA
8) Treasure Island Museum Library, Naval Station Treasure Island; San Francisco, CA
9) Treasure Island Library, Naval Station Treasure Island; San Francisco, CA
10) Treasure Island Staff Civil Engineering, Naval Station Treasure Island; San Francisco, CA
11) United States Coast and Geoditic Survey Office; Menlo Park,CA
12) Vallejo Naval and Historical Museum; Vallejo, CA
13) Engineering Field Activity-West, San Bruno, CA

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B) ***Yerba Buena Naval Training Station of the Pacific at San Francisco, California*** – 1902 [2], 1904 [9], 1909 [9] and 1915 [4]

C) ***San Francisco Directory*** – 1861 edition, p. 6 [2]

D) ***San Francisco Bay*** – Harold Gilliam, New York, *Doubleday and Co., Inc.*, 1957 [12]

E) ***The Legend of Yerba Buena Island*** – Marcia Edwards Boyes, 1936, Printed *by The Professional Press* of Berkeley, CA [2, 4, 9]

F) ***The Magic City, Treasure Island*** – Jack James and Earle Weller, 1940, Printed by *Pirani Printing and Publishing Company* of San Francisco, CA [12]

G) ***Naval Station Treasure Island, San Francisco, CA, Unofficial Directory and Guide*** – Published by the Armed Forces Directory Service, Inc., 1098 Harrison St, San Francisco, CA - 1969 [9], 1974 [8], 1976 [8]

H) ***California, A Remarkable State's Life History*** – John W. Caughey, 3rd Edition, 1970, Prentice-Hall, Inc., Englewood Cliffs, New Jersey [5]

I) ***The Creation and Development of Yerba Buena & Treasure Island, the Hub of the Bay*** – Saralyn Borrowman, Tracey Cady, James S. Radkey and David White, 1994 [7]

J) ***Two Years Before the Mast*** – Richard Henry Dana [7]

K) ***Narrative of a Voyage to the Pacific and Beering's Strait*** – Vol. II, pp. 426 - 427, F. W. Beechey [7]

L) ***Seventy-five Years in California*** – pp. 76 - 78, W. H. Davis [7]

M) ***Sixty years in California*** – p. 266, W. H. Davis [7]

N) ***History of California*** – T. H. Hittell [7]

O) ***Mission San Carlos Borromeo (Carmelo), The Father of the Missions*** – Fr. Zephyrin Engelhardt, O. F. M., Ballena Press, P. O. Box 711, Ramona CA, 92065 - 1973 [7]

P) ***The Naval History of Treasure Island*** – Edited by Lt. Comdr. E. A. McDevitt, USNR, Published at Treasure Island, CA - 1946 [8]

Q) ***Treasure Island, San Francisco Exposition Years*** – Richard Reinhardt, Scrimshaw Press, San Francisco, 1973 [8]

R) ***Official Guide Book, Golden Gate International Exposition on San Francisco Bay*** – The Crocker Company, 1939 [6]

S) ***The Islands of San Francisco Bay*** – The National Society of Colonial Dames of America in the State of California [2]

T) ***The California Indians*** – R. F. Heizer and M. A. Whipple, 1951 [12]

U) ***Handbook of Indians of California*** – Alfred L. Kroeber, Dover Publications, New York, 1976, p. 469 [12]

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V) ***San Francisco Call*** – The editions of November 28, 1886 (Arbor Day); March 6, 1887; August 22, 1892; January 21, 1899, March 21, 1899, October 6, 1900, July 9,1901 [7]

W) ***San Francisco Chronicle*** – The editions of March 3, 1889, February 9, 1896; April 23, 1923; August 1, 1923; July 12, 1926; November 5, 1930; January 27, 1934 [7]

X) ***San Francisco Examiner*** – the editions of July 10, 1881; August 22, 1892, January 21, 1899; December 20, 1925 [7]

Y) ***San Francisco Progress*** – Nov. 9, 1974, p.3, column 1 [7]

Z) ***Treasure Island Masthead*** – Feb. 8, 1985, p.4, column 1 [7]

AA) ***San Francisco Union*** – Mar. 21, 1868 [7]

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BB) ***Riptides*** – April 10, 1950 [2]

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- *Annual Reports of the Navy Department for the Year 1900 and 1901: Report to the Secretary of the Navy*, Government Printing Office, 1900 and 1901
- *Federal Owned Real Estate Under Control of the Navy Department, Bureau of Yards and Docks*, Government Printing Office, 1937
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EE) ***FORBES Magazine*** – March, 1991 edition

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FF) ***Yerba Buena Island's History*** – Jeanne M. Day, 1990, 8 pp. [4]

GG) ***Abstract of the Possessory Title to the Island of Yerba Buena in the Harbor of San Francisco*** – dated 1866, provided to Senator Morton during the legal battles over the eviction of Dowling, Judson and Brooks [1]

HH) ***Yerba Buena, or Goat Island; Title by Mexican Prescription*** – A brief filed for J. Polack during the legal battles over the eviction of Dowling, Judson and Brooks [1]

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II) ***Yerba Buena Island, Letter from The Secretary of War in relation to the bill to quiet the title to Yerba Buena Island*** – December 20, 1880 [4]

JJ) ***A Letter to the President about the Title to Yerba Buena Island, Bay of San Francisco, with an Analysis of the Report of the Senate Pacific Railroad Committee upon the Same*** – S. M. Johnson, Printed by M'Gill and Witherow, Printers and Stereotypers, 1870 [4]

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KK) ***Navy Survey Reports*** – 1929 through 1940 [3]

LL) ***Index Maps of Yerba Buena and Treasure Islands*** – PW Dwg. 1672 - 1929, 1935, 1940 [10]

MM) ***Index Maps of Yerba Buena and Treasure Islands*** – 1871, 1919, 1961, 1970, 1994 [10]

NN) ***United States Naval Administration in World War II; Commandant, Twelfth Naval District*** – [3]. The sections within Reference NN which were reviewed for this report are the following:

- *Appendices* Pages 1-68, 1939 - 1946
- *History of Yerba Buena Island, Part I, General*, pages 1-12
- *History of U.S. Naval Section Base, U.S. Naval Frontier Base, S.F., CA*, (60 pages)
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OO) ***Proposal for an Additional Navy Yard on the Pacific Coast*** – Commission on Navy Yards and Naval Stations, 1917 [3]

PP) ***Airport Construction for United States Navy Treasure Island Airport, City and County of San Francisco, California, Master Plan*** – Federal Works Agency, Public Roads Administration, District No. 2, San Francisco, Sheet 2 of 7 dated July 2, 1941 [10]

Miscellaneous

QQ) ***United States Coast and Geoditic Survey Topographical Map of the San Francisco Bay*** – 1905, 1947, 1958 and 1980 [11]

RR) ***Memoirs of Treasure Island*** – A Collection of Photographs of the Golden Gate International Exposition, S. Brown, 1940 [8]

SS) ***Conversation*** – betweem Ms. LeAnne Lindsey-Heathman, great-granddaughter of Captain. Edward F. Lindsey, and Mr.Daniel C. Schierling, Mare Island Naval Shipyard; 2/6/95

TT) ***Recollections of Wayne Piland***, Retired Lighthouse Keeper of Yerba Buena Island; Reference FF [4]

UU) ***Personal log of Gunner William H. Meyers of the sloop of war "Cyane"*** – 1842 [1]

VV) ***Handbook of North American Indians*** – Richard Levy, Smithsonian Institution, Washington, DC, 1976 [13]

Figures

Figures included in this historical study are identified by figure number and title (as listed in table of contents and found in text), as well as and "Source Location", which is the number noted in [ ]'s (i.e., [1]). A listing of source locations is provided at the beginning of this reference section.

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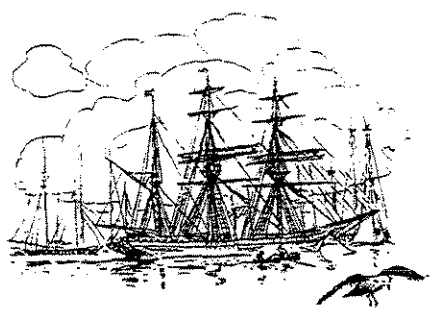
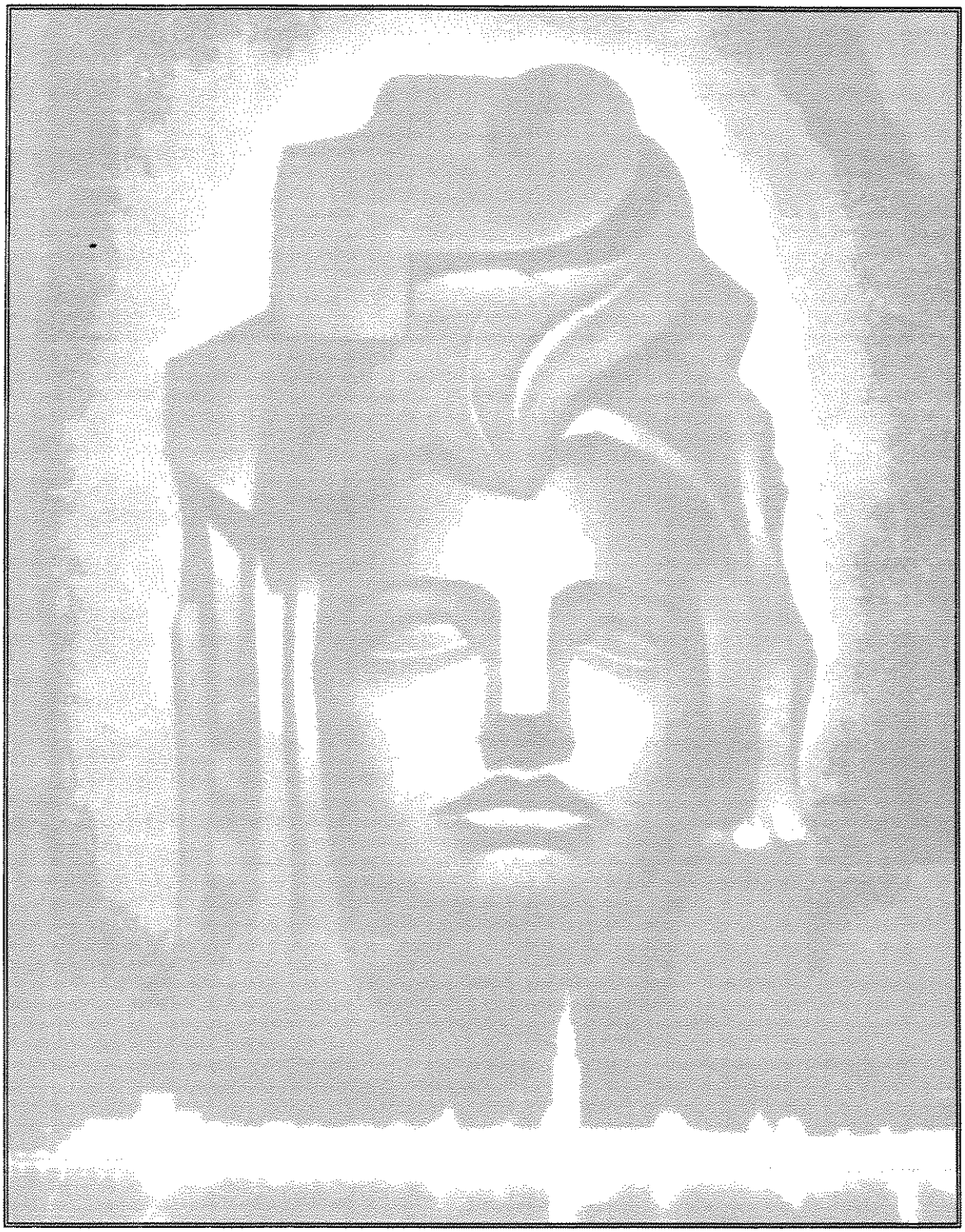
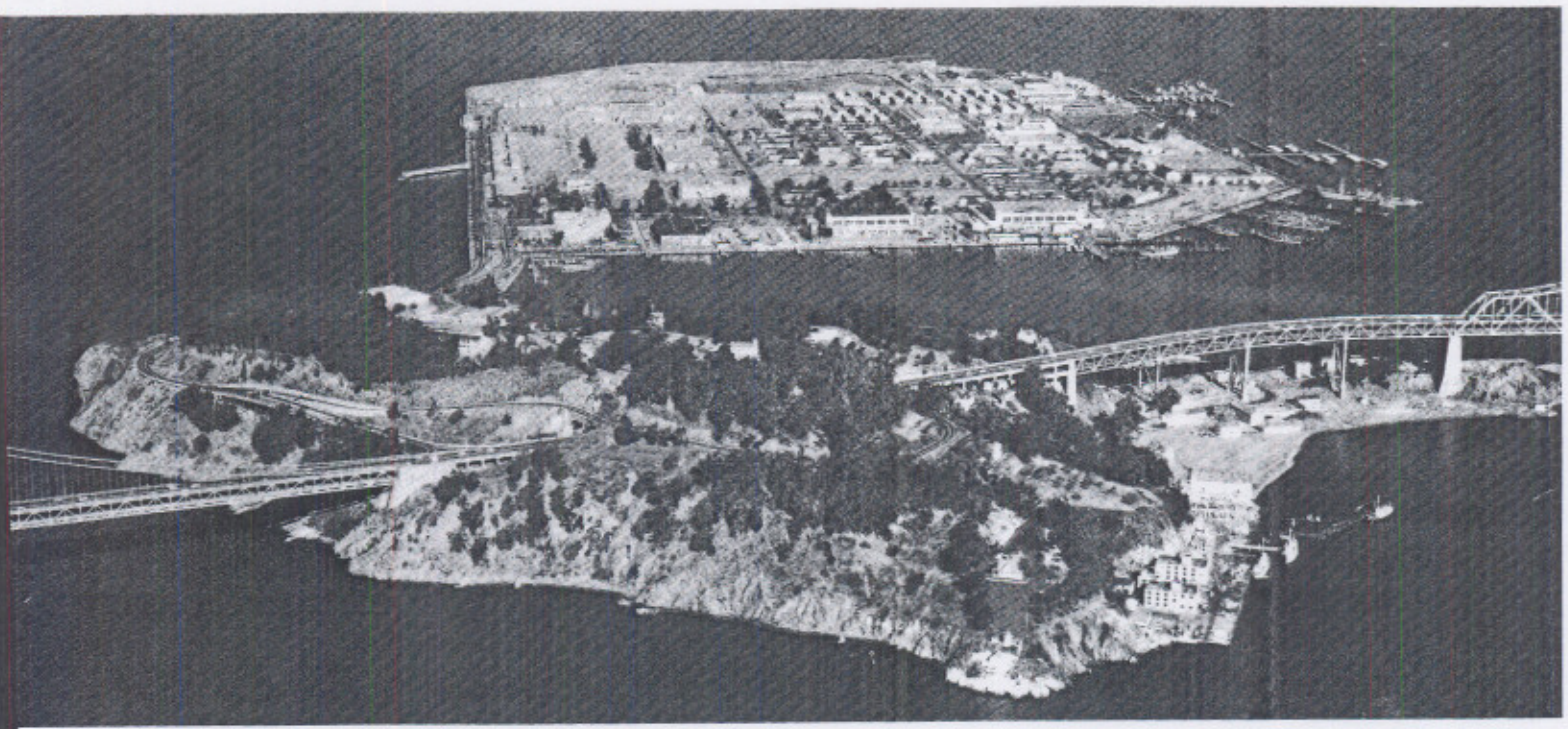




Historical View TI-HRA-1



YERBA BUENA and TREASURE ISLANDS

Yerba Buena and Treasure Island serve the San Francisco Bay area in many ways. Of the two, Yerba Buena is centuries older than its man-made neighbor, Treasure Island which was created in the 1930's. Records reveal that Yerba Buena has had more names and titles through the decades than all other San Francisco Bay islands combined. First seen in 1775 by a band of Spanish explorers, it was christened Isla de Alcatraces because of its large flocks of pelicans. This name was erroneously transferred in 1826 to a big rocky mound in the bay now known as Alcatraz. The island was then named Yerba Buena for the "good herb" or wild mint, a prolific creeper used by the Spanish to flavor tea. The island was subsequently called Wood Island, Bird Island and then, due to the rapidly multiplying herds of goats raised there for food in the 1840's, Goat Island. In 1931 historian Nellie van de Grift Sanchez won a fifteen year crusade when the U.S. Geographic Board officially redesignated the island Yerba Buena.

The New unofficial Seal of the
U. S. Naval Station,
Treasure Island - approved 1966

Legends of pirates and smugglers, graveyards and ghosts intertwine with facts of military occupation and civilian enterprise. Tales of fantastic buried treasures and wrecked schooners have lured fortune seekers and adventurers in endless succession to Yerba Buena's shores.

U. S. NAVAL TRAINING STATION
YERBA BUENA ISLAND
(GOAT ISLAND)

In the early days, Indians operated a fishing station on the island. Archeologists have found skulls in an Indian cemetery in a cove on the southeast side of the island.

After the California gold discovery in 1848, Thomas Dowling occupied the island and developed a sand quarry near the old burial ground. To discourage San Francisco picnickers, he turned loose a bad-tempered bull to patrol the island. Eventually the bull turned on the Dowling family and was destroyed and in 1866 Dowling was ousted as the U.S. Government made Yerba Buena an Army post.

At left is shown the U. S. Naval Training Station, Yerba Buena Island emblem used on the station's "cruise book" of 1909.

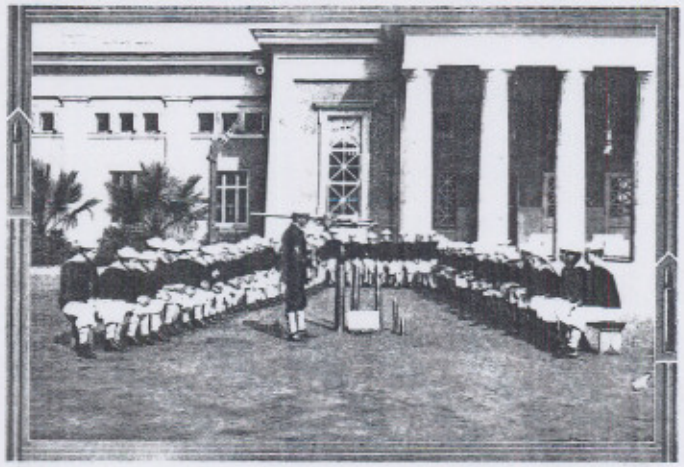
Three years later - 1869 - a bitter political battle was waged over the island. The builders of the Central Pacific Railroad - now Southern Pacific - wanted the island, planning to level the land, fill in the adjoining shoals where Treasure Island now stands, and build a causeway to Oakland. The California State Legislature agreed to grant the railroad the shoals north of Yerba Buena plus a 250 foot strip to the mainland. A bill was introduced in Congress to give the railroad Yerba Buena. However, San Franciscans became alarmed over the thought that the city might become a by-passed suburb of a railroad-owned industrial city in the middle of the bay and sent a high powered committee to Washington where, as a result of its slashing attack, the railroad lost out and constructed its terminal in Oakland.

Many trees had been cut down for firewood and by 1866 the island was rather bare. A California poet captured the public's fancy and on a designated day - the First Arbor Day - thousands of Oakland school children swarmed over Yerba Buena, planting trees in the form of a Greek Cross. The ceremonies featured a concert by the Army band, an address by General Mariano Vallejo and the recitation of an original poem by Joaquin Miller. Most trees were destroyed in a subsequent fire but today on Yerba Buena's upper slopes are eucalyptus and Monterey pine groves which can probably trace their start to that first Arbor Day.

"EASTERN END OF YERBA BUENA ISLAND" - Showing Officers' Quarters and Barracks.

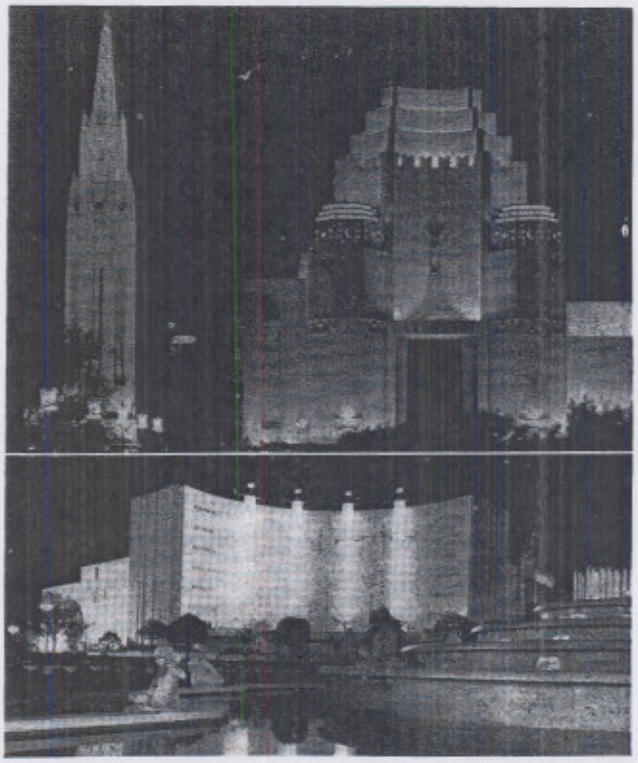
By 1898 the Army had lost interest in the island and the Navy moved in, establishing a training station which was later replaced with a receiving center and transferred to Treasure Island at the beginning of World War II. Since then, Yerba Buena has been serving as a residential suburb for its man-made neighbor, Treasure Island, and as a small Coast Guard Station. Yerba Buena has another claim to distinction today - it has the largest transient population of any island in the world and most of these transients spend their time underground. Their stay averages less than one minute per person as approximately 130,000 cars and buses daily carry them through the tunnel piercing the island's middle and linking the two sections of the San Francisco-Oakland Bay Bridge.

Section of Trail Around Yerba Buena Island used by trainees and visitors in the early days.



U. S. Naval Training Station personnel of 1909 are instructed in ordnance.

The Bay and Golden Gate Bridges spanning San Francisco Bay have brought many changes in the Bay Area. And yet, these changes actually began in the early 30's when construction work on the bridges was starting. The two great spans were hardly begun before there was a movement for a celebration marking their completion. This quickly developed into a movement for an exposition on an international scale.



Shown above are two views of some of the buildings that were on Treasure Island during the Golden Gate International Exposition of 1939-40. Top is a picture of the Tower of the Sun and the Palace of the Moon which were located on 2nd St. looking north on Avenue "C". Bottom: Court of Pacifica, as it was during the fair. The statues and underwater map of the world are still on the island. Location: Avenue "D" and 9th Streets.

A major problem was selecting a suitable site - s were considered: Golden Gate Park, Presidio of S Francisco, China Basin, Filled lands south of Hunte Point, Lake Merced Area and the shoals north of Yer Buena Island. The shoal area was chosen because: was accessible from all parts of the San Francisco B Area, it afforded opportunity for an exposition of uniq beauty and, the island to be created could later become airport for San Francisco.

The island was made from bay bottom carpeted wi silt which had been washed down from the river, much it during the '49 Gold Rush Era. Surely, it was reasone soil of the island must contain particles of gold from t Mother Lode. Gold Island did not sound exactly like t right name but Treasure Island was a natural. On November 1937 dignitaries and civic organizations parti cipated in the dedication of the exposition site and four teen months later the Golden Gate International Exposition a fifty million dollar wonderland dominated by a slim octagonal Tower of the Sun, sparkled in the center San Francisco Bay. This Exposition, hailing completio of the two spans - the San Francisco - Oakland Bay Bridg and the Golden Gate Bridge opened early in 1939 on Trea sure Island. Several of the exposition buildings were permanent construction designed for use as maintenanc and operation buildings of an air terminal and are stil being used by the Navy today.

It was to naval purposes that the man-created sit was converted after the fountains ceased to play in th Enchanted Garden and the lights went out in the Tower of the East. World War II had started shortly after th exposition opened. So, with its closing in late 1940, th island was turned over to the Navy by San Francisco fo emergency use. All airport operations were to be centere

Treasure Island Chapel

by San Francisco on the peninsula airport site. At the maximum, records reveal that Treasure Island processed 12,000 personnel a day. After World War II the Navy acquired the island on a permanent basis, thereby putting an end to the idea of a mid-bay air terminal.

Today Treasure Island houses the U.S. Naval Station, processing Pacific-bound personnel and administering the island itself; a Naval Schools Command and the Headquarters of the Commander Western Sea Frontier. Approximately 7,500 military and 1,700 civilian personnel with a total annual payroll of over twenty-three million dollars comprise the population of Treasure Island.

Treasure Island, due to its location in relation to Navy Department Headquarters in Washington, D.C. and the various naval commands in the Pacific and the Far East, is a focal point in the travel of naval personnel enroute to and from these places and is host to many foreign dignitaries. Thus it is that the legendary rich islands, Yerba Buena Island and Treasure Island, continue serving the San Francisco Bay Area well.

STATISTICS OF INTEREST IN THE CREATION OF TREASURE ISLAND

1. Total of all funds available for the Yerba Buena Shoal Reclamation Project came to $3,803,900.00

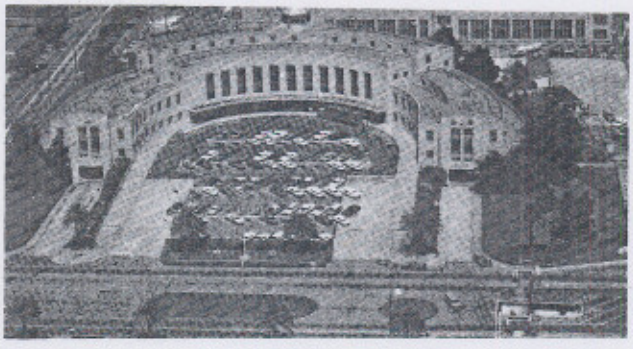
2. The total cubic yardage of sand and gravel necessary to complete the fill was 29,665,152 of which 20,947,000 remained in place.

3. Average cost per cubic yard placed was 11.2 cents.

4. Quantity of rock used was 285,773 tons.

5. Exact area is 17,278,103 square feet or 396.87 acres with the causeway adding 3.81 acres. The area was raised to 13 ft.

6. Man hours of labor were 1,223,374.



Building ONE at Treasure Island Headquarters for Commander Western Sea Frontier.

U.S. NAVY TREASURE ISLAND
SAN FRANCISCO CAL
"GATEWAY TO THE PACIFIC"

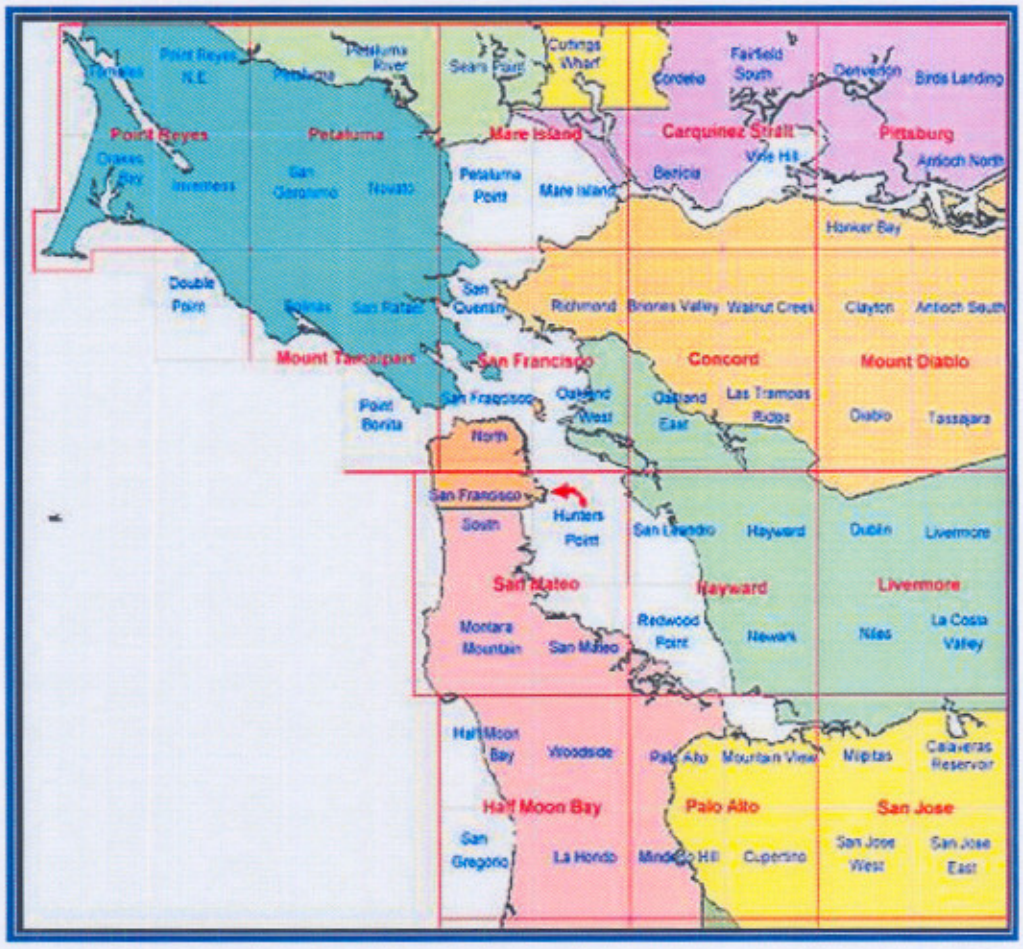


Figure 3-1. San Francisco Bay Area

3.2 GEOLOGICAL SETTING

The Bay was dry land during the ice ages when sea level dropped more than 300 feet as water accumulated in the great continental glaciers. The Sacramento River picked up several tributaries as it flowed through the coastal lowland, and then through the last mountain ridge in a deep canyon that is now the Golden Gate Strait. Coastal lowlands filled with water as sea level rose at the end of the last ice age. The Bay assumed its present form about 10,000 years ago, when sea level returned to its present stand.

Since the rising sea level flooded the Golden Gate Strait and converted the lower part of the river valley into what is now known as San Francisco Bay, the Sacramento and San Joaquin Rivers have been filling the Bay with sediment. This is because early mining operations in the

Sierra Nevada started billions of cubic yards of sediment moving down the rivers. More than a billion cubic yards of that sediment has now reached the Bay. It is estimated about 8 million cubic yards of sediment wash into the Bay every year.

The Bay is about 55 miles long from north to south and 3 to 12 miles wide, an area of about 435 square miles. At its deepest part, the Bay is about 350 feet (58 fathoms) deep, but more than 80 percent is less than 12 feet (2 fathoms) deep. The Bay is made up of brackish water that is about 2.8 percent dissolved salts, 15 percent less than normal seawater, which flows in and out with the tides. An average cycle of rising and ebbing tide moves enough water through the Golden Gate Strait to flood about 1.25 million acres to a depth of 1 foot. Incoming currents reach speeds as great as 4 miles per hour; outgoing flow is much slower.

3.3 GEOLOGY

Geology is the scientific study of the origin, history, and structure of the earth, including the rocks that comprise and underlie the earth's surface features. In most areas, a coherent pattern emerges and geologists can understand the main events that brought the rocks to their present location and condition. However, this approach does not work well in the California Coast Range, where many of the rock formations do not make sense in the traditional way.

Coast Range bedrock beneath the shipyard consisting of sandstone and shale, chert (a flint-like quartz-bearing rock), greenstone (altered volcanic rock), and serpentinite has been assigned to the Franciscan Complex. The Franciscan Complex is one of the world's grandest assortments of rocks, deposited in seawater at many depths and in widely separated parts of the ocean. Rocks in one outcrop often seem unrelated to those in the next. In the late 1960s, geologists finally accepted that large parts of the Franciscan Complex are almost hopelessly scrambled. Geologists coined the term "mélanges" to describe those chaotic jumbles of rock. The bedrock at HPS along the Bay margins is overlain with Bay mud deposits and exposed at the surface at some locations. Bay mud is capped with artificial fill that has been used to build the shipyard's working pad.

HPS lies between two major faults: the San Andreas, 7 miles southwest, and the Hayward, 10 miles to the northeast. Both of these fault systems are considered active and likely

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Spear Street Tower, Suite 717
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(415) 957-9557

GEOMATRIX

August 31, 1990
Project: 1539

Western Division
Naval Facilities Engineering Command
P.O. Box 727
San Bruno, California 94066

Attention: Mr. John deBecker

Gentlemen:

We are pleased to submit the results of our field exploration and laboratory testing programs in this report (Volumes 1 and 2) for the Perimeter Dike Stability Evaluation for Naval Station Treasure Island, San Francisco, California. Comments received from the Navy, dated 3 May 1990, on the draft version of the report have been incorporated into this report. This report is intended to summarize the field and laboratory data only and does not present engineering analysis. The complete results of our evaluation of the stability of the Treasure Island perimeter dikes will be presented in Volume 3. In addition, the results of our analysis of the behavior of the interior of Treasure Island during earthquakes will be reported on separately.

Scott Shewbridge and Zhi-Liang Wang, Senior Staff Engineers, participated extensively in this study.

Please contact us if you have any questions regarding this report.

Sincerely yours,
GEOMATRIX CONSULTANTS, INC.

John A. Egan
Senior Engineer

Maurice S. Power
Principal Engineer

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GEOMATRIX

Results of Field Exploration and Laboratory Testing Program for Perimeter Dike Stability Evaluation Naval Station Treasure Island San Francisco, California

Volume 1

Prepared for

Western Division
Naval Facilities Engineering Command
P.O. Box 727
San Bruno, California 94066

August 31, 1990
Project No. 1539.05

Geomatrix Consultants

GEOMATRIX

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GEOMATRIX

RESULTS OF FIELD EXPLORATION AND LABORATORY TESTING PROGRAM FOR PERIMETER DIKE STABILITY EVALUATION NAVAL STATION TREASURE ISLAND San Francisco, California

INTRODUCTION

This report (Volumes 1 and 2) summarizes the results of our field exploration and laboratory testing program conducted as a part of the Perimeter Dike Stability Evaluation for Naval Station Treasure Island, San Francisco, California, as specified in Contract number N62474-90-C-1057, issued by the United States Department of the Navy, Western Division, Naval Facilities Engineering Command. This report is intended to summarize the field and laboratory data only and does not present engineering analysis. The complete results of our evaluation of the stability of the Treasure Island perimeter dikes will be presented in Volume 3.

The field investigation consisted of a program of onshore and offshore geotechnical borings, onshore Cone Penetration Tests (CPT), and geologic mapping of earthquake related distress. This program was designed to supplement existing boring and CPT test data from geotechnical investigations previously conducted at the Naval Station for a variety of facilities. Locations of the existing borings and Cone Penetration Tests are shown on the Site and Boring Location Plan, Figure 1.

DESCRIPTION OF FIELD INVESTIGATION

Onshore Geotechnical Borings

Twelve geotechnical borings were made onshore. Their locations are shown on Figure 1, the Site and Boring Location Plan. The twelve exploratory borings were drilled in January, 1990 to depths ranging from 56 to 162 feet using truck-mounted, rotary wash drilling rigs outfitted with 4-7/8-inch diameter tricone bits. The drilling was done by Pitcher Drilling Company of East Palo Alto, California and RNL Enterprises of Dillon Beach, California. Scott Shewbridge, Senior Staff Engineer, of our firm observed the drilling and sampling operations and logged the borings in the field.

Samples of the soils encountered in the borings were obtained using three sampling methods: Standard Penetration Test (SPT) sampler (1.375 inch ID, 2 inch OD); Modified California sampler (1.94 inch ID, 2.5 inch OD with liners); and thin wall (Shelby) tubes (3 inch ID). The SPT and Modified California samplers were used in accordance with ASTM standard method designation D 1586-84. Drilling and sampling techniques followed the recommendations of Seed et al (1985). The samplers were driven into the soil with a 140 pound hammer falling 30 inches. The sampler was driven 18 inches, in most cases, and the blow counts for the last 12 inches of driving, or portion thereof, are presented at the corresponding sample locations on the boring logs. The Shelby tube samples were taken in accordance with ASTM standard method designation D 1587-83, being pushed into the soil by the use of hydraulic rams mounted on the drill rig.

Preliminary visual soil classifications were made in the field and were verified by further inspection of the samples in the laboratory. Boring logs were prepared based on the field and laboratory classifications and are shown in Appendix A, Figures A-1 through A-16.

Offshore Geotechnical Borings

Seven geotechnical borings were made offshore at the locations shown in Figure 1. Nine offshore borings were originally scheduled, but two could not be completed due to the combination of weather, currents and large tidal flows on the northern and western sides of the island. The borings were drilled in January and February, 1990 to depths ranging from 8 to 33 feet below the mudline using a barge-mounted, rotary wash drilling rig outfitted with a 3-7/8-inch diameter tricone bit. The drilling was done by MDS Diversified Services Company of Berkeley, California. Scott Shewbridge of our firm observed the drilling and sampling operations and logged the borings in the field. Samples of the soils encountered in the borings were obtained using two sampling methods: SPT sampler (1.375 inch ID, 2 inch OD); and thin wall (Shelby) tubes (3 inch ID). Boring logs of the offshore borings were prepared based on the field and laboratory classifications and are presented along with a boring log explanation sheet in Appendix B on Figures B-1 through B-14.

Cone Penetration Test (CPT) Soundings

Thirty six continuous electric cone penetration test (CPT) soundings were made at the locations shown on the Site and Boring Location Plan, Figure 1. Note that locations for several CPT soundings were initially numbered and laid out in the field but not utilized. Therefore, the CPT soundings are numbered from CPT-1 to CPT-42. The unutilized locations (for example, CPT-2) are not shown in Figure 1. The electric cone penetration testing was performed by VBI In-Situ Testing of Oakland, California, in January, 1990. The cone soundings extended from 58 to 162 feet below the existing ground surface. The cone penetration test consists of pushing a cone tip (10 square centimeters in area) through the soil and measuring individually the resistance against the cone tip, the resistance against the friction sleeve, and the soil pore fluid pressure through a saturated porous stone located directly behind the cone tip. A continuous record of tip resistance, sleeve resistance (local friction) and pore pressure is obtained at each sounding location. In addition, the ratio of sleeve resistance to tip resistance (termed friction ratio) and the ratio of the change in pore pressure to the tip resistance (termed differential pore pressure) are also computed and are used in identifying soil type. Plots of friction ratio, local friction, tip resistance, pore pressure and differential pore pressure recorded for each sounding are presented in Appendix C, Figures C-1 through C-104.

SUBSURFACE CONDITIONS

General

The site of the Naval Station Treasure Island is a relatively flat island, composed of hydraulic sand fill which is contained by perimeter rock and sand dikes. The ground surface of the island inside the dikes varies from approximately Elevation 6.5 to 14.5 feet MLLW (Mean Lower Low Water datum), and the surrounding perimeter dikes vary in Elevation from 10.5 to 16 feet MLLW.

Treasure Island Filling History

Information about the creation of Treasure Island, particularly details of the filling operation, was gathered from several sources including: United States Army Corps of Engineer records stored

at the National Archives and Record Center in San Bruno, California; files of the United States Department of the Navy, Western Division, Naval Facilities Engineering Command, San Bruno; the historical archives of Bancroft Library at the University of California at Berkeley and of the San Francisco Public Library; KQED and KRON television stations' documentary program files; as well as published technical literature. From these sources, a number of written documents, photographs, and plans were obtained that reported on various aspects of Treasure Island's filling history. These mostly addressed the perimeter dike construction, the dredging equipment, fill material borrow sources and type and quantity of materials handled, and the general sequence of filling for the island. Accounts of the construction of Treasure Island reported in Engineering News-Record (1937, 1938), Lee (1969), and Hagwood (1980) provide the basis for the summary of the island filling operation presented in the following paragraphs.

Treasure Island was originally conceived of as a mid-Bay airport facility. The concept quickly evolved into a site for a celebration of the completion of the Golden Gate and Oakland - San Francisco Bay bridges, which took the form of the 1939 Golden Gate International Exposition. The shape and dimensions of the island (approximately 5,500 feet long by 3,400 feet wide) were dictated by requirements for the airport that was still planned to replace the exposition following its closure. Over 29 million cubic yards of dredged material, mostly sand, was handled during filling operations that began in February 1936 and were completed in August 1937. Approximately 21 million cubic yards remained in-place to create the 397-acre island over the shallow Yerba Buena Shoals north of Yerba Buena Island; the remainder was lost to wind and wave erosion, settlement of fill and soft clay, and washing away of fines during deposition. The bay bottom of the Shoals area varied in elevation from -2 feet to -26 feet Mean Lower Low Water (MLLW) across the island footprint. Approximately 75 percent of the bay bottom in this area was composed of sand, with soft clay exposed over the remainder of the site.

The island was constructed under the direction of the U.S. Army Corps of Engineers by hydraulically placing the fill materials using pipeline (suction), hopper, and clam shell dredge equipment. In areas where the shoals were deeper than Elevation -6 feet (MLLW), a bed of hydraulic sand fill was placed. Next, along the island perimeter, a low mound of rock was

placed on either the native soil or fill materials and acted as a retaining dike for subsequently placed sand fill. Fill material was pumped or deposited in place until it approximately reached the top of the low rock mound. Another low rock mound was then placed on the previously constructed rock dike and the filling process continued. This process was repeated until the surface of the fill reached approximately Elevation 13 feet (MLLW). The rock dikes were not constructed to surround the entire island concurrently, but rather they progressed outward as fill was deposited, starting at the southwest corner of the island and worked their way around the west, south and east towards the north. These dikes also acted as backing for a uniformly riprapped slope which extended from Elevation -6 to Elevation +14 feet (MLLW). Configurations of the rock mounds and riprapped slopes are shown on Figure 2. This construction method resulted in an island configuration of hydraulically-placed sand fill retained by a relatively thin rock face founded on either native shoal materials or hydraulically-placed fill.

A failure of the perimeter dike occurred during construction near the north end of the east dike. A 500-foot-long section of dike settled 10 to 14 feet. This area was stabilized by flattening the slope and placing a bed of "heavy" sand beyond the toe of the dike to act as a counter weight (Lee, 1969). As a result of the failure, the north seawall was modified by excavating a trench approximately 400 feet wide and 30 to 40 feet deep along the seawall, backfilling the trench with coarse sand, and then constructing the initial rock dike on that bed of sand.

Dredged material for the filling operations was obtained from various borrow sources located within San Francisco Bay. Material obtained from borrow areas immediately south, east, and north of the island footprint was a blue silty, fine sand. A yellow, well-graded fine to medium sand was obtained from an east bay borrow area, located about 3000 feet east of the island (Lee, 1969). Coarse sand and gravel was hauled to the site in hopper dredges from the Presidio, Alcatraz and Knox Shoals.

A low weir was installed near the center of the north seawall to allow water from the hydraulic dredges and soft mud to escape as the filling proceeded from south to north. However, soft mud became trapped within the island perimeter. A small dredge was set up inside the seawall and

excavated 6 to 12 feet into the mud. The small dredge continued to excavate mud as it was pushed up by the filling operations.

Several projects to protect the riprapped face of the perimeter dikes have occurred since the original construction. This has resulted in the placement of additional rock facing, and in local areas, widening of the perimeter dikes. Where dikes have been widened (e.g., at Cross-Section DD', Figure 1), composition of additional dike materials is presently unknown. Siltation has also resulted in the deposition of materials above the sand spit and fill materials outside of the perimeter dikes, and erosion has apparently removed some sand shoal materials outside of the perimeter dikes at the northwest corner of the island.

Soil Profiles

Eleven representative cross sections, presented on Figures 3 through 13, indicate the subsurface soil conditions through the perimeter dike around the island. The soil conditions are based on the materials encountered in the exploratory borings and cone penetration tests done for this study and on conditions described in the boring logs from the previous studies done on Treasure Island. The boring logs from previous studies that are shown on the cross sections are included in this report in Appendix D.

The location of the preconstruction ground surface shown on the cross sections was determined based on Lee (1969) and Hagwood (1980). The configurations of the original perimeter dike materials are based on the U.S. Engineer Office, San Francisco, California, March 1936 drawing "Retaining Wall, Yerba Buena Shoal, San Francisco Bay, California" found in Hagwood (1980) (Figure 2). Locations of the original perimeter dike are inferred from the site map (Figure 2) and from photos taken during island construction and do not represent surveyed locations. Configurations and locations of the seawall fortification A, B, C, D and E stone are based on the engineering drawings "Repairs to Seawall, Phase 2B, Special Project RCI-83, 1983" and "Repairs to Seawall, Phase 3, Special Project RCI-83, 1985". Locations of the present ground surface are based on the "Topographic and Hydro Survey - Nov.-Dec. 1989". All elevations are based on Mean Lower Low Water (MLLW) datum.

Subsurface materials encountered in the onshore exploratory borings and cone penetration tests can generally be divided into four strata: hydraulic fill; native, Yerba Buena Shoals sands and clays; medium stiff to stiff olive gray silty clay (Bay Mud); and stiff to very stiff or dense brownish and greenish gray sandy, silty and peaty clays and sands (old bay sediments). None of the borings conducted for this study encountered bedrock, but review of data from previous studies indicates that bedrock is 281 feet below ground surface at the location indicated on Figure 1.

Subsurface materials encountered in the offshore exploratory borings can be divided into four strata: recently deposited soft silty clay (Bay Mud siltation accumulated since construction of Treasure Island); hydraulic fill; native, Yerba Buena Shoals sands and clays; and soft to medium stiff olive gray silty clay (Bay Mud).

Description of Soil Strata

Fill and Yerba Buena Shoals Materials - The fill material encountered in the borings matches well with the material described by Lee (1969). The fill is a sand which has gradations ranging from well to poorly graded, and contains different amounts of gravel, silt and clay depending on location. The material can, in some areas, be differentiated from the underlying native Yerba Buena Shoals sands by its density, the fill material being somewhat looser and having lower SPT and CPT resistances and lower shell contents. However, on the average, the fill and shoals materials appear to be very similar in engineering characteristics. In Boring 1, a coarse-grained sand was encountered below the preconstruction ground surface elevation. This material is similar to the material described in Lee (1969) as "Heavy Sand" fill and is assumed to be the back-fill material used as a foundation for the northern perimeter dike.

Silty Clay (Bay Mud) - Onshore, below the fill and shoals materials, there is a layer of medium plastic, olive gray silty clay, commonly referred to as Bay Mud. The Bay Mud has been consolidated by the overlying native shoal and fill materials and is generally medium stiff to stiff in consistency. Offshore, beyond the island fill, the Bay Mud is softer. Thickness of the Bay

Mud varies across the island, being thinnest towards the eastern side of the island and increasing in thickness towards the northwest.

Offshore where currents are weak, there is also a layer of very recently deposited medium plastic, olive gray silty clay, also referred to herein as Bay Mud. This material has been deposited since the construction of Treasure Island on top of the native shoal and fill materials and is very soft to soft in consistency.

Sandy, Silty and Peaty Clays (Older Bay Sediments) - Below the younger Bay Mud, sandy, silty and peaty clay and sand materials were encountered. These materials are commonly referred to as old bay sediments. They are generally stiff to very stiff or dense.

DISTRESS TO PERIMETER OF TREASURE ISLAND ATTRIBUTED TO THE LOMA PRIETA EARTHQUAKE

To document the distress to the perimeter portion of Naval Station Treasure Island due to the Loma Prieta earthquake, field mapping was conducted by Geomatrix geologists, Dennis Wuthrich and John Wesling. The observable features were field mapped on to the 1"=20' plans from the Topographic and Hydro Survey -Nov.-Dec., 1989. These maps are available in our project files. Those features which were deemed most significant were then transferred to the 1"=200' architectural base map, which is shown on Figure 14. Figure 14 also shows additional features mapped by U.S. Geological Survey geologist, Michael Bennett, four weeks after the Loma Prieta earthquake. Generally the majority of the distress occurred on the northeast, east, and southeast portions of the perimeter dikes. Distress features include, but are not limited to, cracking, lateral spreading, horizontal and vertical displacement, settlement, and collapse of paving. Sand boils occurred at numerous locations around the island.

LABORATORY TESTING PROGRAM

A laboratory testing program was performed on selected soil samples recovered from the borings.

These tests included particle size analysis, Atterberg limits, water content, dry density, consolidation, unconsolidated undrained triaxial, and consolidated undrained triaxial tests.

Particle Size Analysis - Twenty particle size analysis tests were made on representative samples to determine their grain size distribution. These tests were performed in accordance with ASTM Test Method D-422, and the results of these tests are presented in Appendix E, Figures E-1 through E-13.

Atterberg Limits - Tests to determine Atterberg Limits (Liquid Limit and Plastic Limit) for clayey soil materials were performed on four representative samples recovered from the borings. These tests were conducted in accordance with ASTM Test Methods D-423 and D-424. The results of these tests are presented on the Logs of Borings in Appendix A.

Water Content and Dry Density - Water content and dry density determinations were made on representative samples recovered from the borings. These tests were conducted in accordance with ASTM Test Methods D-2216 and D-2850. The results of the tests are presented on the boring logs in Appendix A, Figures A-1 through A-16, at the respective locations of the samples.

Consolidation Tests - Consolidation tests were conducted on representative samples of silty clay recovered from the borings in order to determine the consolidation profile of the materials underlying the sand fill. These tests were conducted in accordance with ASTM Test Method D-2435-80. The results of the tests are presented in Appendix E, Figures E-14 through E-49.

Unconsolidated Undrained Triaxial Tests - Unconsolidated Undrained (UU) triaxial tests were conducted on representative samples of silty clay (Bay Mud) from the borings in order to aid in evaluating the strength profile of the materials underlying the sand fill. These tests were conducted in accordance with ASTM Test Method D-2850-70. The results of the tests are presented on the boring logs in Appendix A, Figures A-1 through A-16, at the respective locations of the samples, and in Appendix E, Figures E-50 through E-133.

Consolidated Undrained Triaxial Tests - Consolidated Undrained (CU) triaxial tests were conducted on representative samples of silty clay (Bay Mud) from the borings to aid in evaluating the strength of the materials. These tests were conducted in accordance with U.S. Corp of Engineers Manual EM-1110-1-1906 (30 November 1970, App. X). The samples were consolidated at stresses at least 1.5 times greater than the maximum past consolidation pressure as determined from the consolidation tests. The results of the tests are presented in Appendix E, Figures E-134 through E-157.

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Engineering News-Record (1937), Large Dredging Fleet Assembled for Filling Golden Gate Fair Site: March 18, pp. 412-414.

Engineering News-Record (1938), An Island Built to Order: October 13, pp. 459-461.

Hagwood, J.J. (1980), "Engineers at the Golden Gate, A History of the San Francisco District, U. S. Army Corps of Engineers, 1866-1980", U. S. Army Corps of Engineers, p158-166.

Lee, C. H. (1969), "Bay Mud Developments, Case History 2, Treasure Island Fill" found in Geologic and Engineering Aspects of San Francisco Bay Fill, California Division of Mines and Geology Special Report 97, p. 69-72.

Seed, H. B., K. Tokimatsu, L. F. Harder, R. M. Chung (1985) "Influence of SPT Procedures in Soil Liquefaction Resistance Evaluations", ASCE J. Geot. Eng., Vol. 111, No. 12, pp. 1425-1445.

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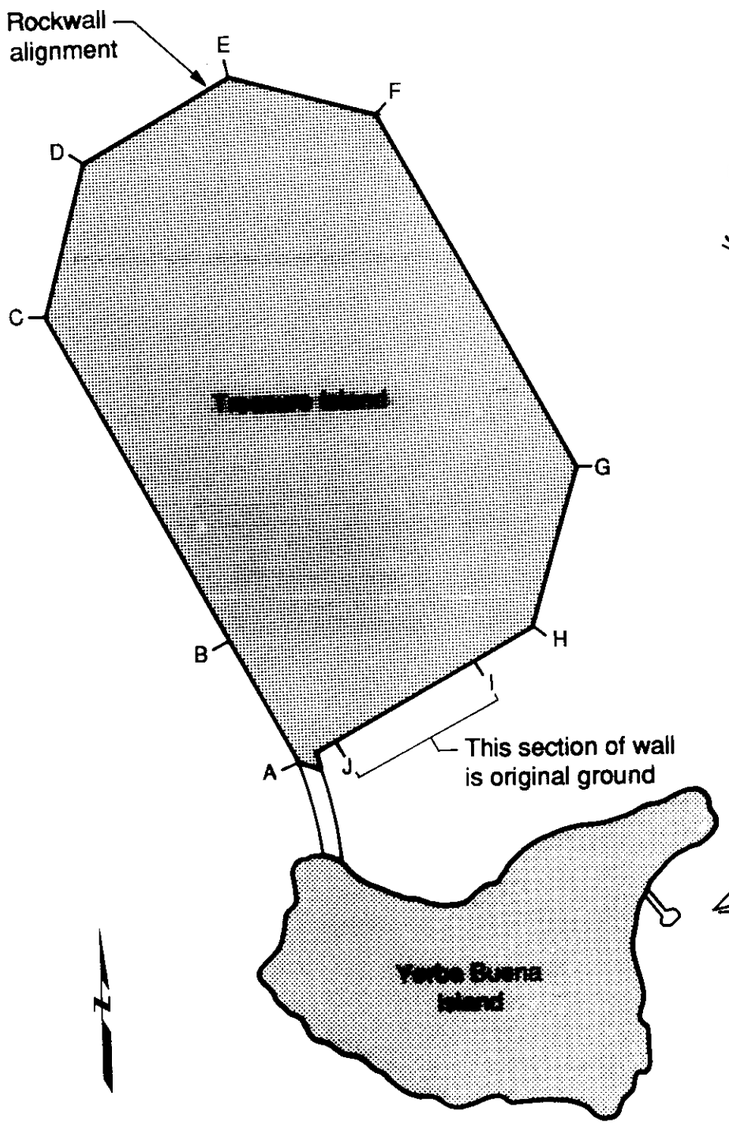

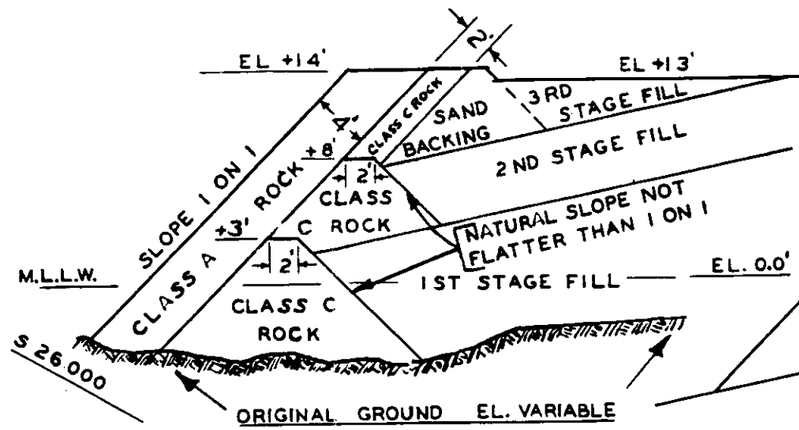

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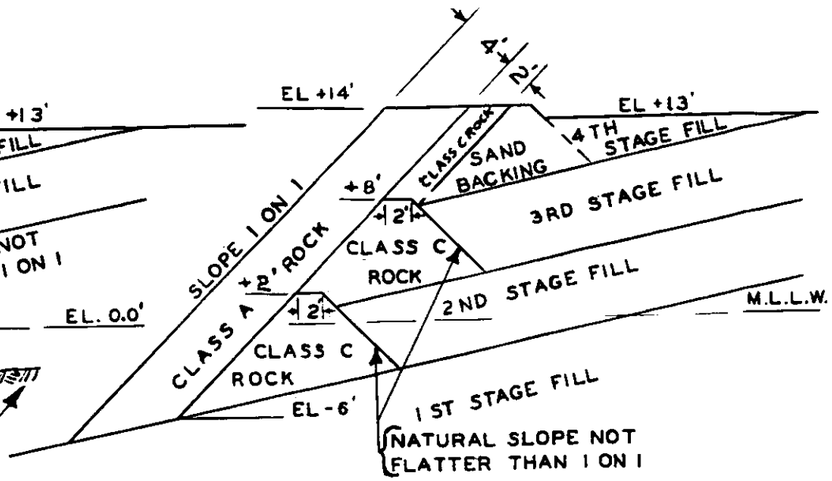

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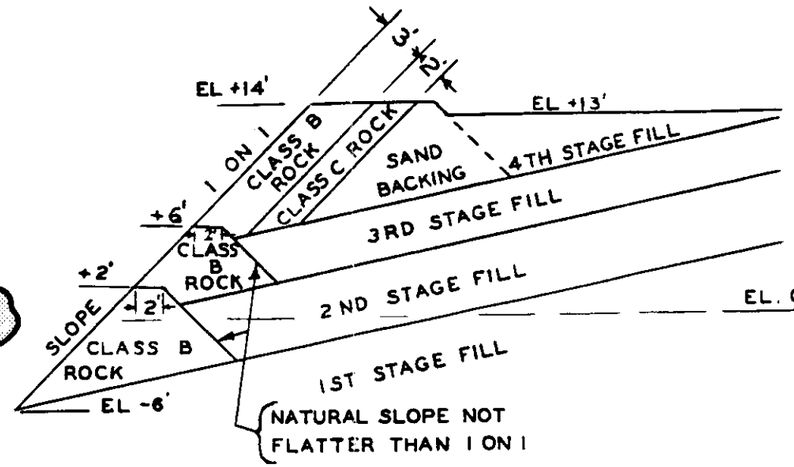
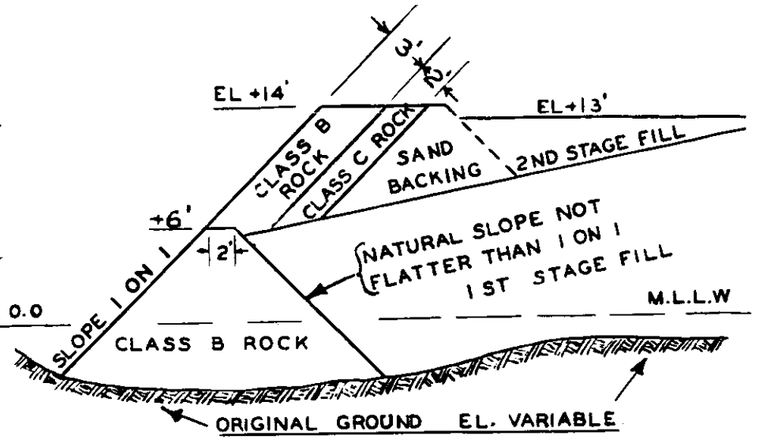


SECTION ON LINE F - G - H - I



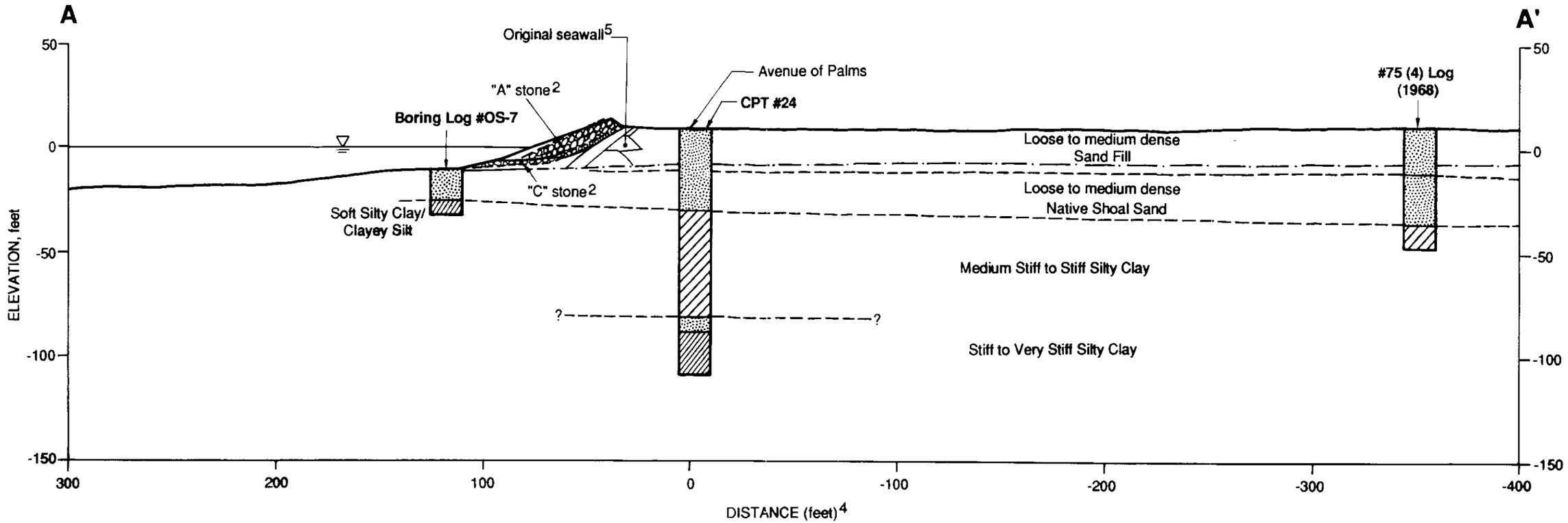
SECTION ON LINE I - J

Note

Drawing adapted from the drawing "Retaining Wall," Yerba Buena Shoal, San Francisco Bay, California, by the U.S. Engineers Office, San Francisco, California, March 1936, found in Hagwood (1980).

CONFIGURATION OF ORIGINAL PERIMETER DIKES
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX	Project No. 1539.05	Figure 2



EXPLANATION

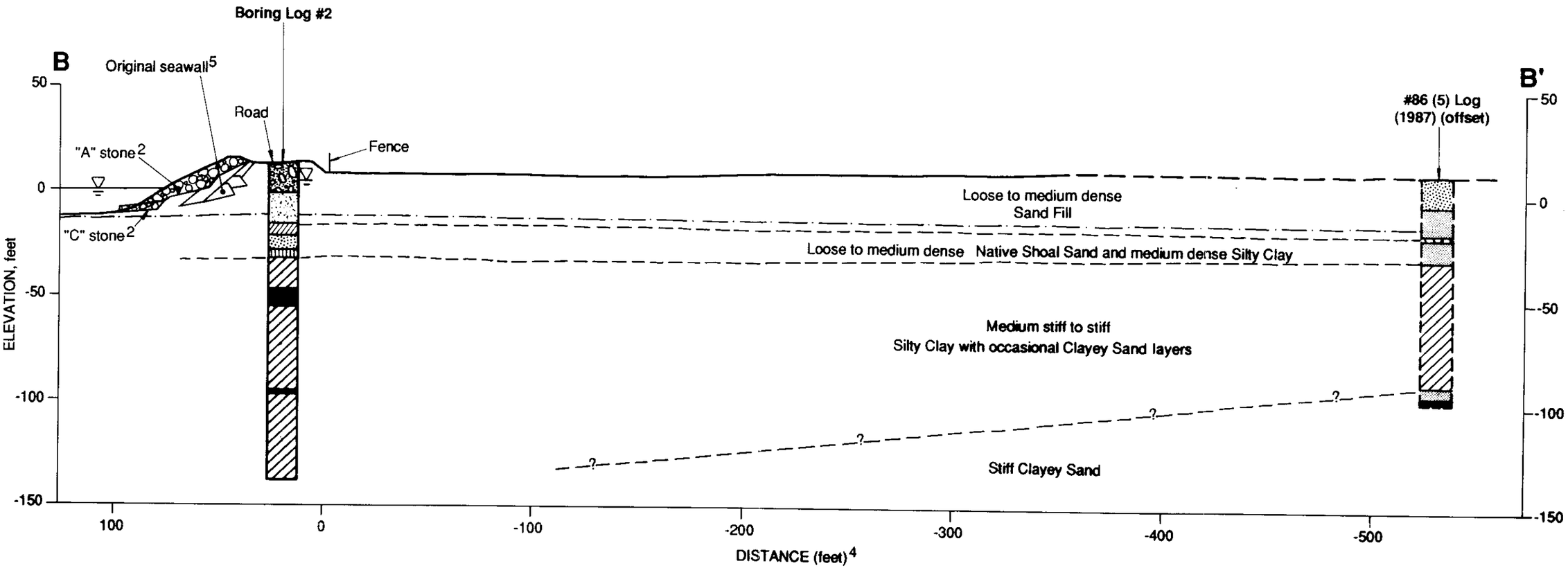
- Poorly graded sand
- Low plasticity clay
- High plasticity clay
- Ground surface[1]
- Lithologic contact
- Lithologic contact - location uncertain
- Original ground surface[3]

Notes

1. Vertical control based on Sheet 6 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of A-stone and C-stone seawall materials based on Sheet C-17 of the "Repairs to Seawall, Phase 2B, Special Project RCI-83, 1983".
3. Original ground surface based on Lee (1969) and Hagwood (1980).
4. Distance measured from survey control line, "Topographic and Hydro Survey , Nov. - Dec. 1989".
5. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and island construction photos.

CROSS SECTION A - A'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX	Project No. 1539.05	Figure 3



EXPLANATION

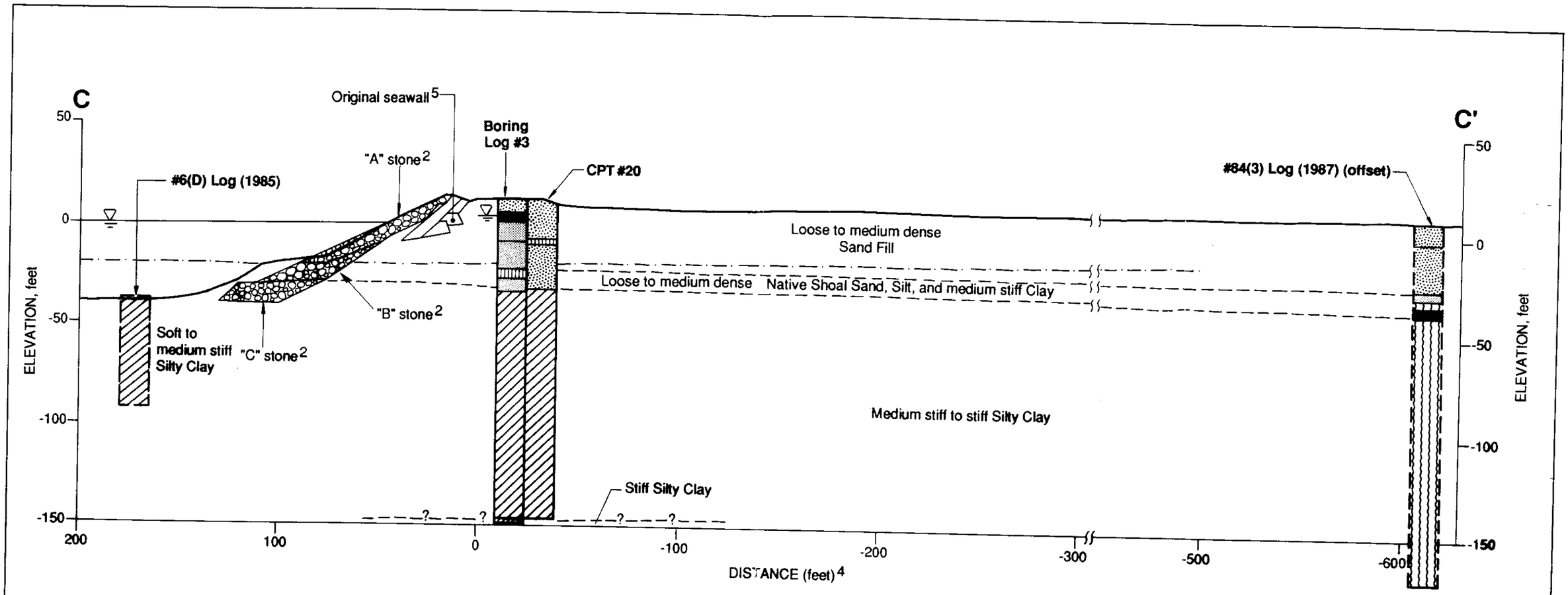
- Well graded gravel
- Well graded sand
- Clayey sand
- High plasticity clay
- Silty sand
- Poorly graded sand
- Low plasticity silt
- Low plasticity clay
- High plasticity organic clay
- Ground surface[1]
- Lithologic contact
- Lithologic contact - location uncertain
- Original ground surface[3]

Notes

1. Vertical control based on Sheets 9 and 10 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of A-stone and C-stone seawall materials based on Sheet C-14 of the "Repairs to Seawall, Phase 2B, Special Project RCI-83, 1983".
3. Original ground surface based on Lee (1969) and Hagwood (1980).
4. Distance measured from survey control line, "Topographic and Hydro Survey , Nov. - Dec. 1989".
5. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and island construction photos.

CROSS SECTION B - B'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX | Project No. 1539.05 | Figure 4



EXPLANATION

- Well graded sand
- Poorly graded sand
- Silty sand
- Clayey sand
- Low plasticity silt
- Low plasticity clay
- High plasticity
- High plasticity organic

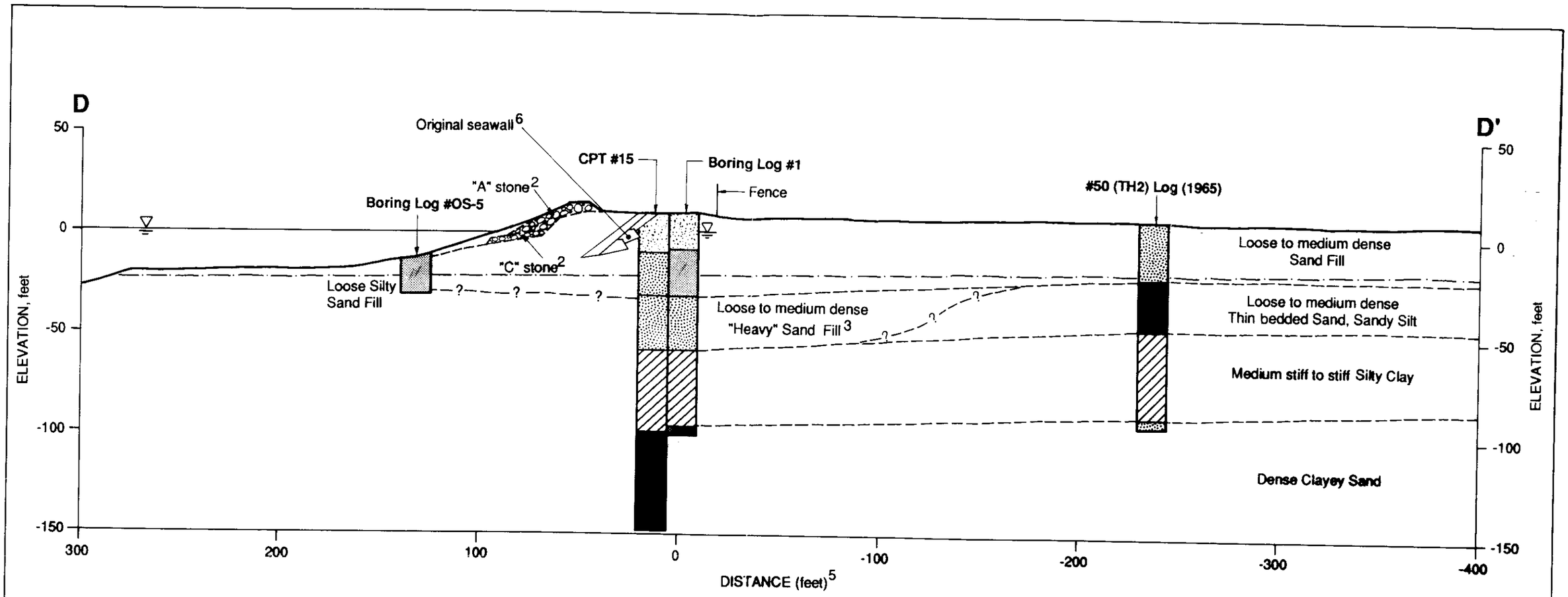
- Ground surface 1
- Lithologic contact
- Lithologic contact - location uncertain
- Original ground surface 3

Notes

1. Vertical control based on Sheets 13 & 14 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of A-, B-, and C-stone seawall materials based on Sheet C-12 of the "Repairs to Seawall, Phase 2B, Special Project RCI-83, 1983".
3. Original ground surface based on Lee (1969) and Hagwood (1980).
4. Distance measured from survey control line, "Topographic and Hydro Survey , Nov. - Dec. 1989".
5. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and island construction photos.

CROSS SECTION C - C'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX | Project No. 1539.05 | Figure 5



EXPLANATION

- Poorly graded sand with gravel
- Poorly graded sand
- Silty sand
- Clayey sand
- High plasticity clay

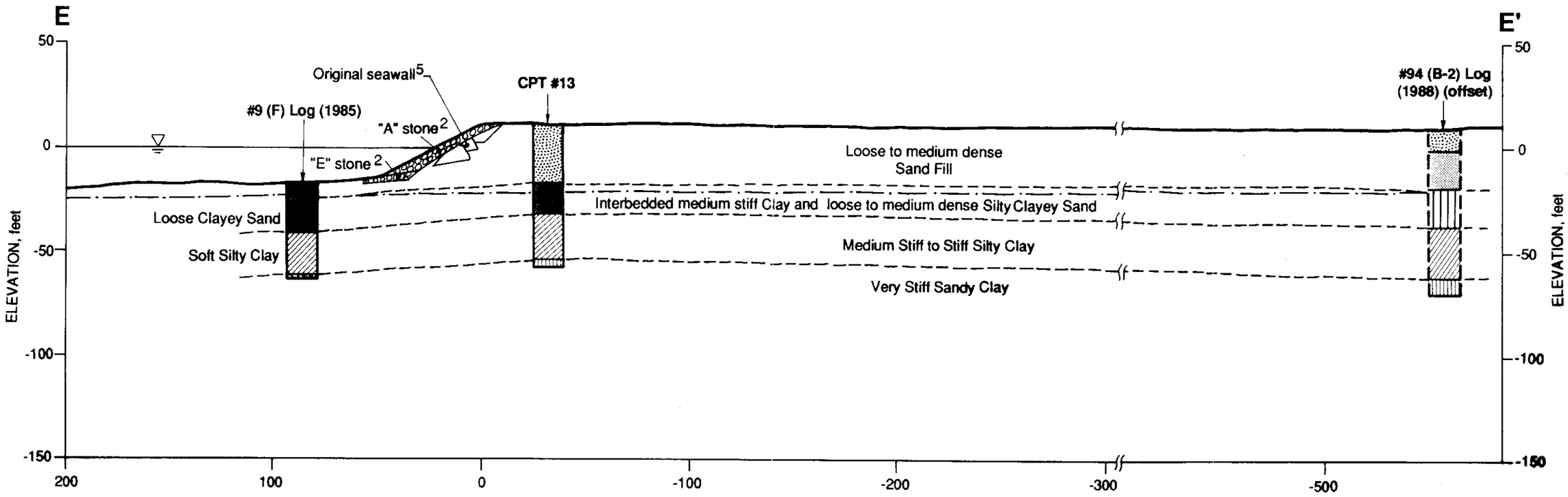
- Ground surface[1]
- Lithologic contact
- Lithologic contact - location uncertain[3]
- Original ground surface[4]

Notes

1. Vertical control based on Sheets 21 & 22 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of A-stone and C-stone seawall materials based on Sheet C-8 of the "Repairs to Seawall, Phase 2B, Special Project RCI-83, 1983".
3. Location of "heavy" sand fill based on boring #1, CPT #15 and a description in "Geologic and Engineering Aspects of San Francisco Bay Fill; Bay Mud Developments" Charles H. Lee, Cal. Div. Mines and Geology Special Report 97, 1969, page 69.
4. Original ground surface based on Lee (1969) and Hagwood (1980).
5. Distance measured from survey control line, "Topographic and Hydro Survey , Nov. - Dec. 1989".
6. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and islanc construction photos.

CROSS SECTION D - D'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX | Project No. 1539.05 | Figure 6



EXPLANATION

- Poorly graded sand
- Silty sand
- Clayey sand
- Low plasticity silt
- High plasticity silt
- Low plasticity clay
- Ground surface[1]
- Lithologic contact
- Original ground surface[3]

Notes

1. Vertical control based on Sheets 28 and 29 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of A-stone and E-stone seawall materials based on Sheet C-48 of the "Repairs to Seawall, Phase 3, Special Project RCI-83, 1985".
3. Original ground surface based on Lee (1969) and Hagwood (1980).
4. Distance measured from survey control line, "Topographic and Hydro Survey , Nov. - Dec. 1989".
5. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and island construction photos.

CROSS SECTION E - E'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX	Project No. 1539.05	Figure 7

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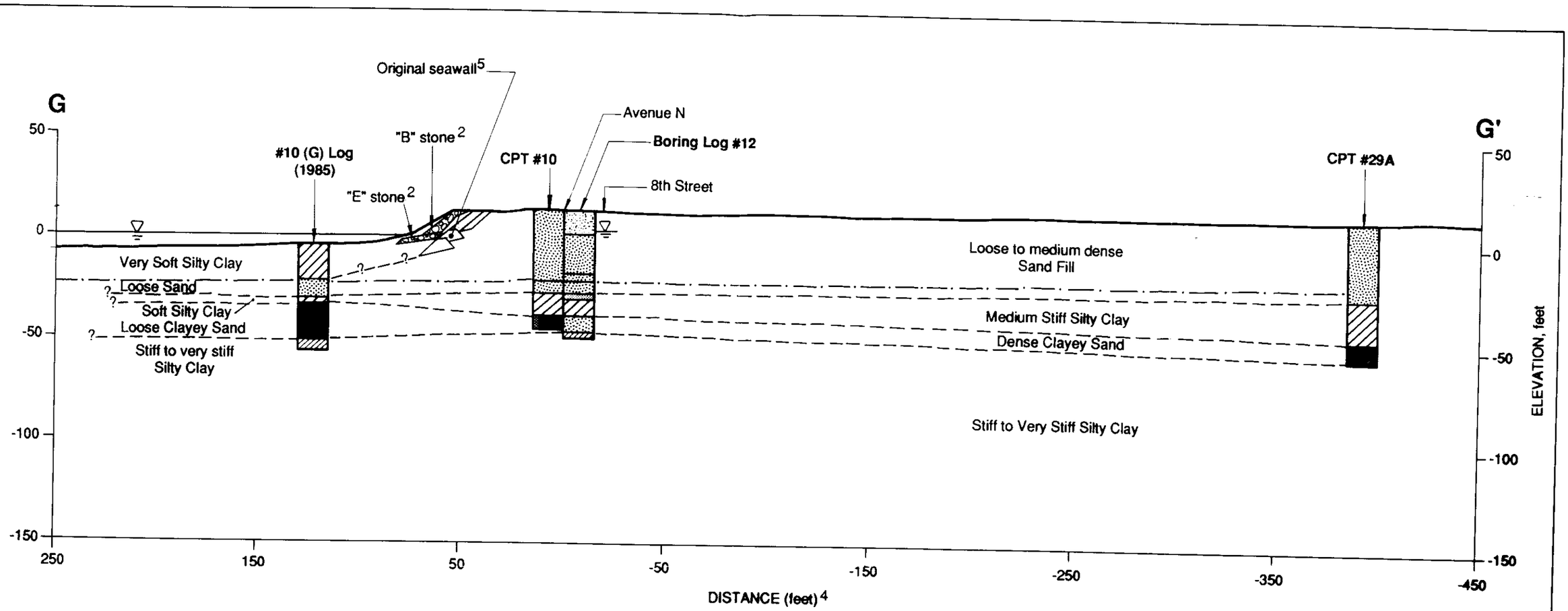


EXPLANATION

- Well graded sand
- Poorly graded sand
- Silty sand
- Clayey sand
- Low plasticity clay
- High plasticity clay

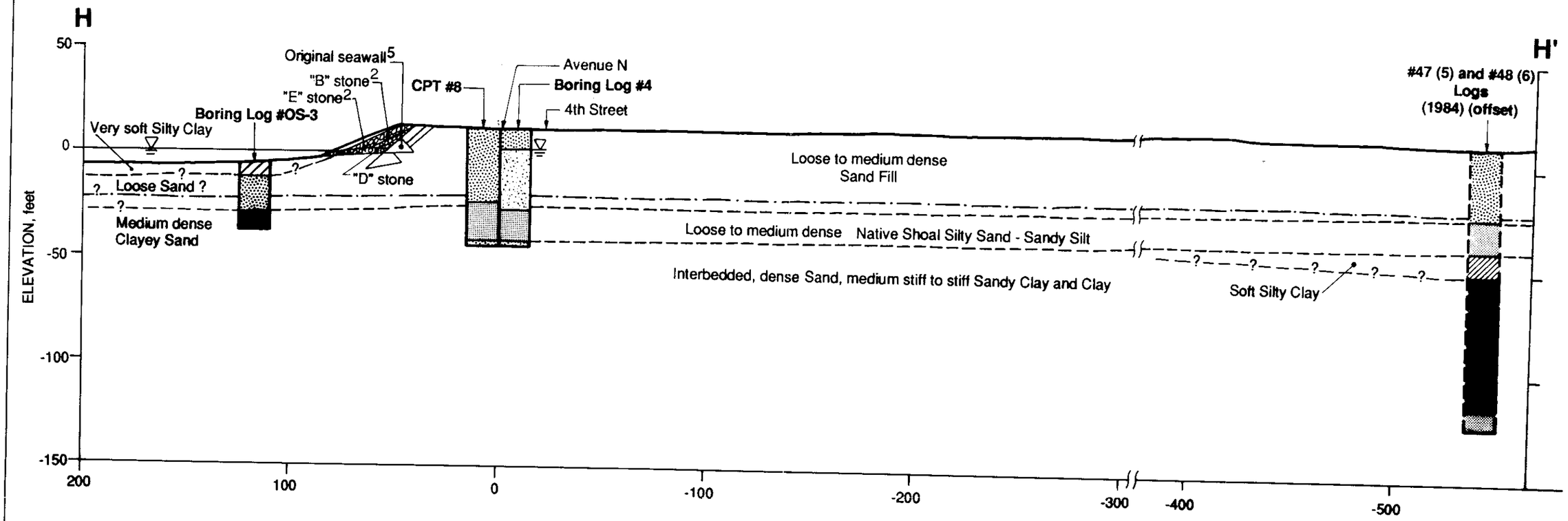
- Ground surface[1]
- Lithologic contact
- Lithologic contact - location uncertain
- Original ground surface[3]

Notes

1. Vertical control based on Sheets 34 and 35 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of B-stone and E-stone seawall materials based on Sheet C-42 of the "Repairs to Seawall, Phase 3, Special Project RCI-83, 1985".
3. Original ground surface based on Lee (1969) and Hagwood (1980).
4. Distance measured from survey control line, "Topographic and Hydro Survey , Nov. - Dec. 1989".
5. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and island construction photos.

CROSS SECTION G - G'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX | Project No. 1539.05 | Figure 9



EXPLANATION

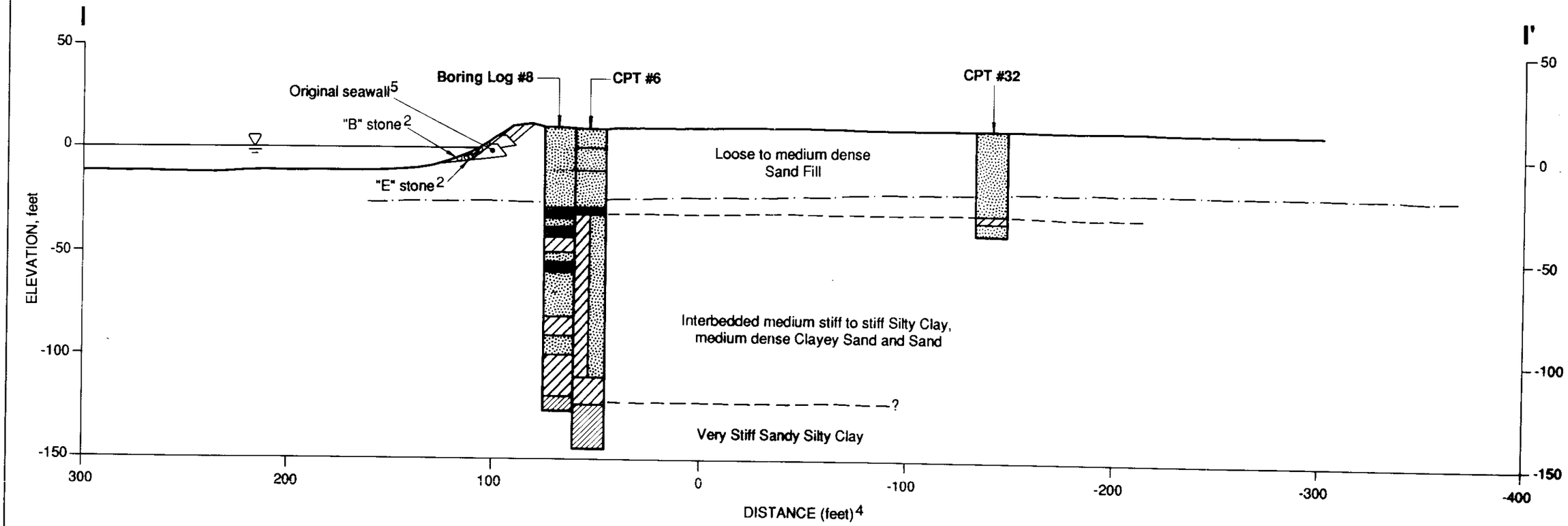
- Poorly graded sand with gravel
- Poorly graded sand
- Silty sand
- Clayey sand
- Low plasticity clay
- High plasticity clay
- Ground surface[1]
- Lithologic contact
- Lithologic contact - location uncertain
- Original ground surface[3]

Notes

1. Vertical control based on Sheets 36 and 37 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of B-, D- and E-stone seawall materials based on Sheet C-38 of the "Repairs to Seawall, Phase 3, Special Project RCI-83, 1985".
3. Original ground surface based on Lee (1969) and Hagwood (1980).
4. Distance measured from survey control line, "Topographic and Hydro Survey , Nov. - Dec. 1989".
5. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and island construction photos.

CROSS SECTION H - H'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX | Project No. 1539.05 | Figure 10



EXPLANATION

- Poorly graded sand
- Clayey sand
- Low plasticity clay
- High plasticity clay
- Ground surface[1]
- Lithologic contact
- Lithologic contact - location uncertain
- Original ground surface[3]

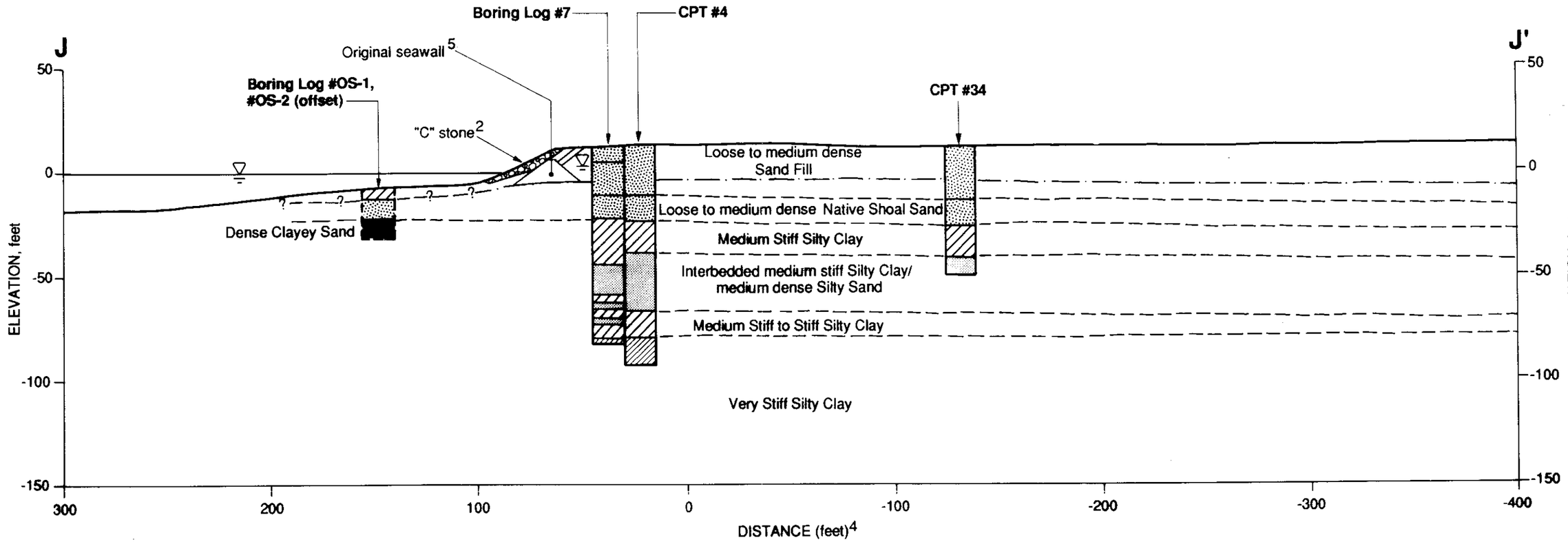
Notes

1. Vertical control based on Sheets 42 and 43 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of B-stone and E-stone seawall materials based on Sheet C-33 of the "Repairs to Seawall, Phase 3, Special Project RCI-83, 1985".
3. Original ground surface based on Lee (1969) and Hagwood (1980).
4. Distance measured from survey control line, "Topographic and Hydro Survey , Nov. - Dec. 1989".
5. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and island construction photos.

CROSS SECTION I - I'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX

Project No.	Figure
1539.05	11



EXPLANATION

- Poorly graded sand
- Silty sand
- Clayey sand
- Low plasticity clays
- High plasticity clays

- Ground surface[1]
- Lithologic contact
- Lithologic contact - location uncertain
- Original ground surface[3]

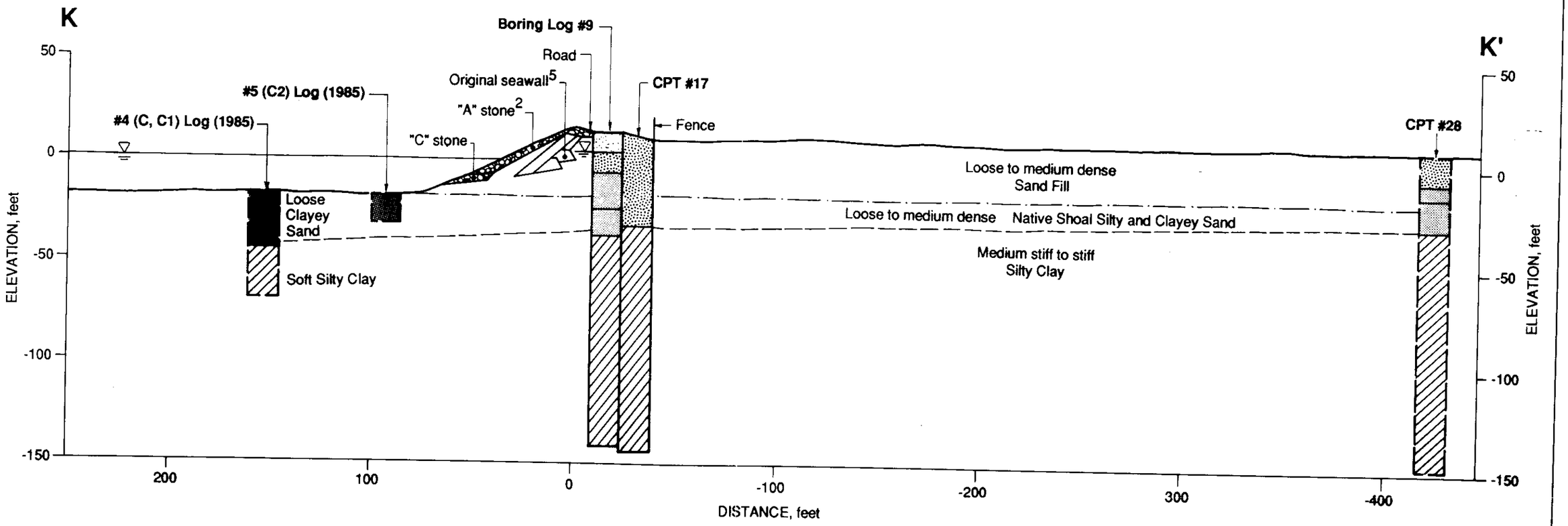
Notes

1. Vertical control based on Sheet 45 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of C-stone seawall materials based on Sheet C-29 of the "Repairs to Seawall, Phase 3, Special Project RCI-83, 1985".
3. Original ground surface based on Lee (1969) and Hagwood (1980).
4. Distance measured from survey control line, "Topographic and Hydro Survey , Nov. - Dec. 1989".
5. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and island construction photos.

CROSS SECTION J- J'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX

Project No.	Figure
1539.05	12



EXPLANATION

- Well graded gravel
- Poorly graded gravel
- Silty sand
- Clayey sand
- High plasticity clay
- Ground surface[1]
- Lithologic contact
- Original ground surface[3]

Notes

1. Vertical control based on Sheets 13 and 14 of the "Topographic and Hydro Survey - Nov. - Dec. 1989". Mean lower low tidal datum.
2. Configuration of A-, B-, and C-stone seawall materials based on Sheet C-9 of the "Repairs to Seawall, Phase 2B, Special Project RCI-83, 1983".
3. Original ground surface based on Lee (1969) and Hagwood (1980).
4. Distance measured from survey control line, "Topographic and Hydro Survey, Nov. - Dec. 1989".
5. Configuration of original seawall based on Hagwood (1980); location inferred from Hagwood (1980) and island construction photos.

CROSS SECTION K - K'
Treasure Island Dike Stability
San Francisco, California

GEOMATRIX	Project No.	Figure
	1539.05	13

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PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 1

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/2/90 | DATE FINISHED: 1/2/90

DRILLING METHOD: 4 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Drilling Co.
Steve Brmalj
John Nederland

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 11.5 feet
	X	1	16	21	GRAVELLY SAND FILL (SP) Poorly graded, medium dense, pale brown, moist, 70% sand, 30% angular gravel ▽
10	X	2	11	16	
	X	3	8	10	
20	X	4	9	10	SILTY to CLAYEY SAND FILL (SM -SC) Well graded, loose, gray, medium grained
	X	5	4	4	Grading very fine, poorly graded olive gray
30	X	6	5	5	
	X	7	7	6	Grading less clayey
40	X	8	13	11	
	X	9	10	8	SAND FILL (SP) Poorly graded, loose to medium dense, olive gray, 80% fine to coarse subrounded sand, 15% gravel (1/2"), 5% seashells ("heavy sand")
50	X	10	17	13	
	X	11	22	16	
60	X	12	21	15	
	X	13	17	11	
70		14	--		SILTY CLAY (CH) Medium stiff to stiff, dark greenish gray/olive gray, medium plasticity
	■	15	11		
80		16	--		
90	■	17	18		
100	■	18	15		
					CLAYEY SAND (SC) Medium dense/stiff, dark olive gray, 60% fine sand, 40% low plastic clay
110	■	19	12		Bottom of boring 111.5 feet
120					

Plastic Limit — Water Content,% — liquid limit
20 40 60 80

PL LL

20 40 60 80

UNDRAINED SHEAR STRENGTH, KSF
2 4 6

(9450)

(12550)

LB-3/90

SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
▲ γ_{dry}

STRENGTH TESTS
- Field torvane
- Field pocket penetrometer
- ● Unconsolidated undrained
- (1300) Confinement pressure
- ■ Remolded unconsolidated undrained

Project No. 1539.05

Geomatrix Consultants

Figure A-1

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 2

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/3/90 | DATE FINISHED: 1/3/90

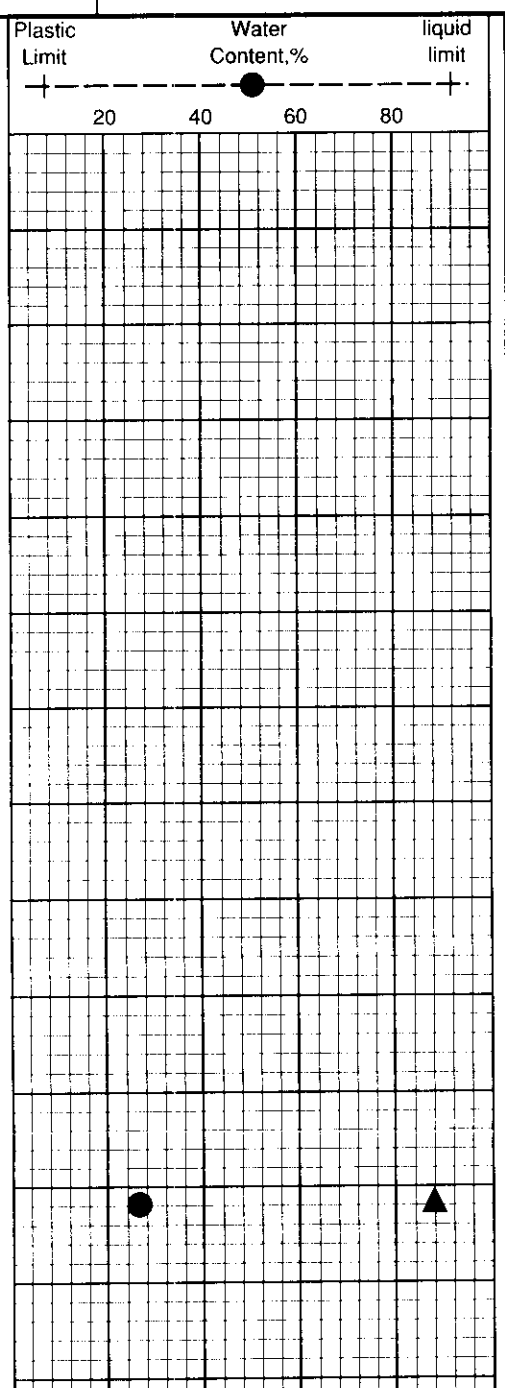
DRILLING METHOD: 4 7/8" tricone rotary wash

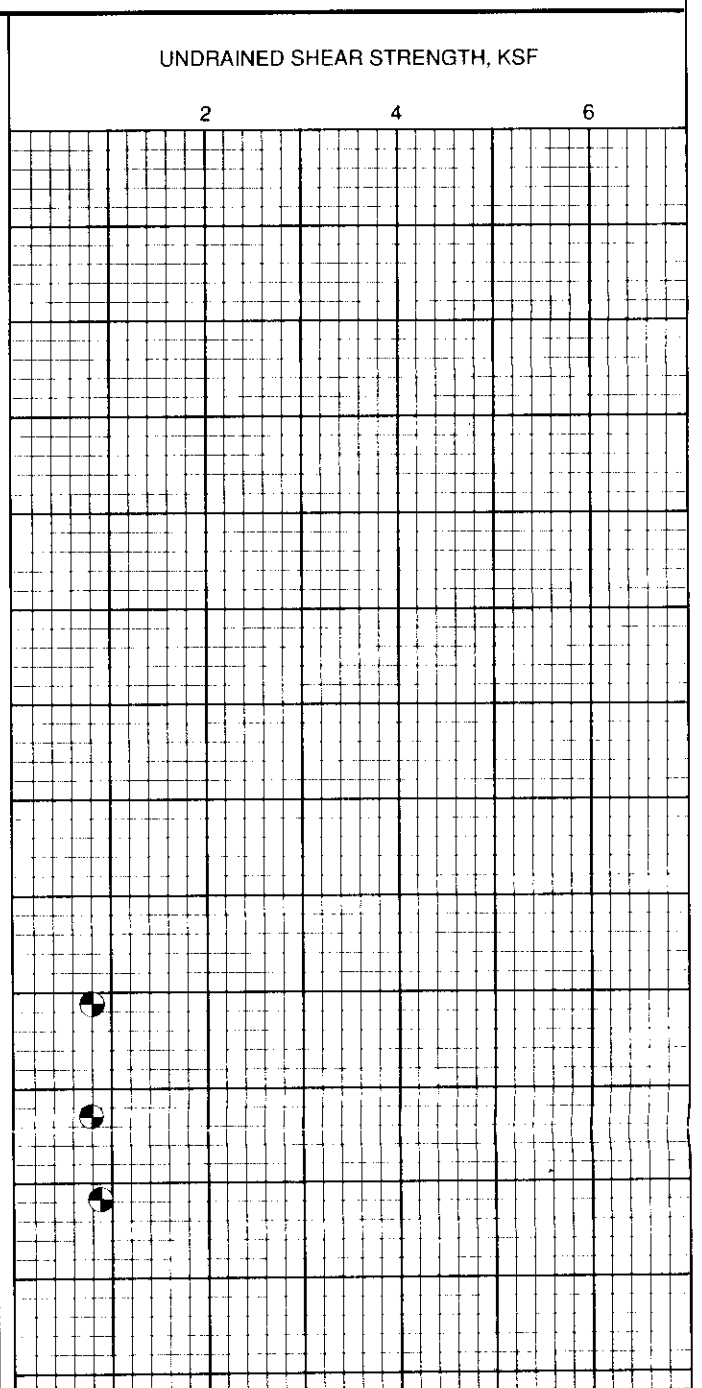
HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Drilling Co.
Steve Brmalj
John Nederland

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 13.0 feet
					GRAVELLY SAND - SANDY GRAVEL FILL (SW - GW) Medium dense, dark brown, wet, 50% sand, 40% gravel (3/4"), 10% silty clay
10	X	1	9	13	
	X	2	15	19	SAND FILL (SP - SW) Poor to well graded, medium dense, olive gray and brownish yellow, fine to coarse, trace of seashells
20	X	3	19	21	
	X	4	12	12	
30	X	5	0	--	SANDY SILTY CLAY (CL) Very soft, greenish gray, low to medium plasticity, trace of clay
	■	6	21	--	SAND (SP) Medium dense, greenish olive gray, fine to medium grained, trace of clay
40	X	7	2	--	SILT (ML) Very soft, dark gray, low plasticity
	■	8	7		SILTY CLAY (CH) Medium stiff, gray - olive gray, medium plasticity
50		9	--		
	■	10	2		
60		11	--		CLAYEY SAND (SC) Loose, olive gray, 80% sand, 20% medium plastic clay
70	■	12	11		SILTY CLAY (CH) Medium stiff to stiff, greenish to olive gray, medium plasticity, trace of seashells
80	■	13	12		
90	■	14	0		
100	■	15	0		
110	■	16	0		Sand lens
120					





SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
▲ γ_{dry}

STRENGTH TESTS
- Field torvane
- Field pocket penetrometer
- ● Unconsolidated undrained
- (1300) Confinement pressure
- ■ Remolded unconsolidated undrained

LB 3/90

Project No. 1539.05

Geomatrix Consultants

Figure A-2

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 2 cont'd.

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
		17	14		Grading silty
130		18	9		
140		19	21		
150		20	20		
					Bottom of boring 151.5 feet

160 170 180 190 200 210 220 230 240 250

Plastic Limit — Water Content,% — liquid limit

20 40 60 80

20 40 60 80

UNDRAINED SHEAR STRENGTH, KSF

2 4 6

LB-2

SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
- ▲ γ_{dry}

STRENGTH TESTS
- Field torvane
- Field pocket penetrometer
- ● Unconsolidated undrained
- (1300) Confinement pressure
- ■ Remolded unconsolidated undrained

Project No. 1539.05 | Geomatrix Consultants | Figure A-3

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 3

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/5/90 | DATE FINISHED: 1/5/90

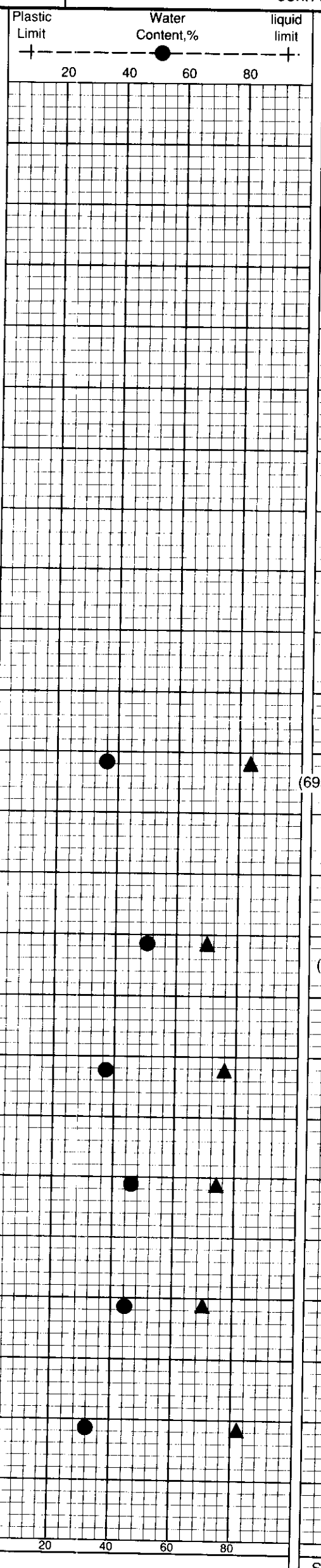
DRILLING METHOD: 4 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

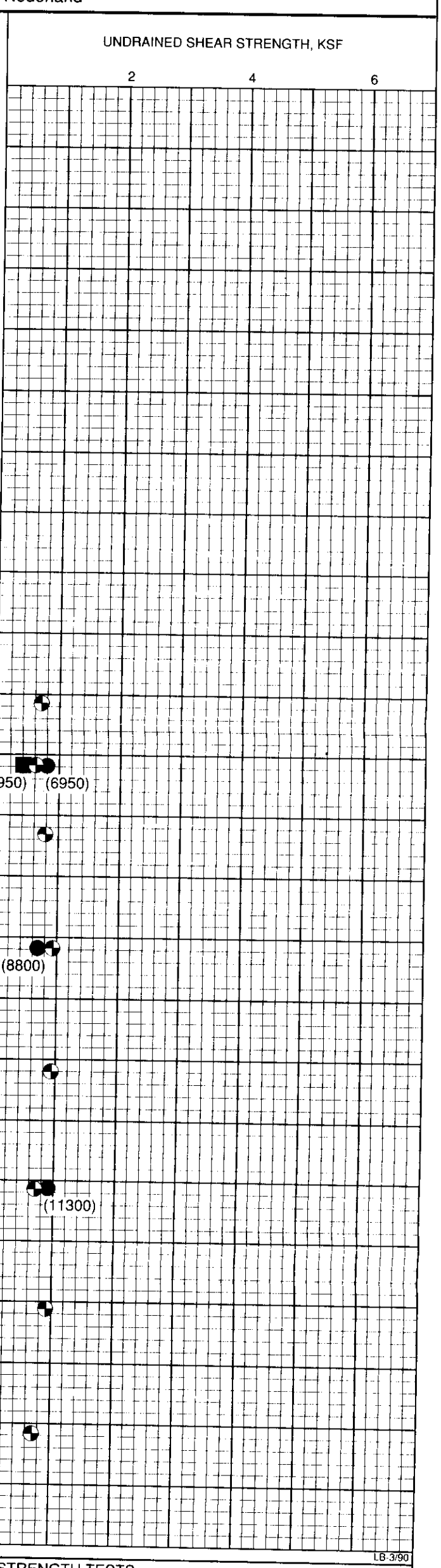
NOTES: Logged by S. Shewbridge
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Drilling Co.
Steve Brmalj
John Nederland

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 13.5 feet
					SAND FILL (SP) Poorly graded, medium dense, pale brown, medium grained
	⊠	1	27	35	CLAYEY SAND FILL (SC) Medium dense to dense, dark brown, 80% medium sand, 10% clay, 10% subangular gravel (1/2")
10	⊠	2	23	31	
	⊠	3	19	23	SAND to SILTY SAND FILL (SP - SM) Poorly graded, medium dense, greenish gray, trace of gravel (1"), trace of seashells
20	⊠	4	7	8	SILTY SAND FILL (SM) Loose, greenish gray, with mica, trace of seashells
	⊠	5	11	11	Grading loose to medium dense
30	⊠	6	41	38	Grading medium dense to dense
	⊠	7	5	4	SANDY SILT (ML) Soft to medium stiff, greenish gray, 80% medium plastic silt, 20% fine sand, trace of seashells
40	■	8	15		SILTY SAND (SP - SM) Medium dense, mottled greenish gray and dark gray, 90% medium angular sand, 10% silt
	⊠	9	0		
50	▯	10	--		SILTY CLAY (CL - CH) Medium stiff to stiff, olive gray, medium plasticity
	■	11	0		
60	▯	12	--		Grading sandy, low plasticity
70	■	13	12		Grading clayey, more plastic
80	■	14	17		
90	■	15	0		
100	■	16	8		
110	■	17	15		Grading silty/sandy
120					



DRY DENSITY (PCF)

▲ γ_{dry}



LB-3/90

SAMPLERS
- ⊠ Standard penetrometer
- ■ 2" ID modified California sampler
- ▯ 3" ID Shelby tube

STRENGTH TESTS
- ● Unconsolidated undrained
- Field torvane
- (1300) Confinement pressure
- Field pocket penetrometer
- ■ Remolded unconsolidated undrained

Project No. 1539.05

Geomatrix Consultants

Figure A-4

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 3 cont'd.

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
		18	12		Varying silty/sandy - silty/clayey layers
130		19	10		
140		20	19		
150		21	12		
160		22	37		SILTY CLAY (CL - OL) Very stiff to hard, mottled dark brown and gray, iron oxides, calcareous nodules, low plasticity
					Bottom of boring 161.5 feet
170					
180					
190					
200					
210					
220					
230					
240					
250					

Plastic Limit — Water Content,% — liquid limit
20 40 60 80

UNDRAINED SHEAR STRENGTH, KSF
2 4 6

(18800)

20 40 60 80

LB-2

SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
- ▲ γ_{dry}

STRENGTH TESTS
- Field torvane
- Field pocket penetrometer
- ● Unconsolidated undrained
- (1300) Confinement pressure
- ■ Remolded unconsolidated undrained

Project No. 1539.05 | Geomatrix Consultants | Figure A-5

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 4

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/9/90 | DATE FINISHED: 1/10/90

DRILLING METHOD: 4 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Drilling Co.
Steve Brmalj
John Nederland

DEPTH (feet)	Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 12.5 feet
					Asphalt
		1	4	5	SAND FILL (SP) Poorly graded, very loose to loose, brownish yellow, dry grading moist, fine angular grained
10		2	12	17	GRAVELLY SAND FILL (SP) Poorly graded, medium dense, olive gray, 70% fine to coarse sand, 30% gravel (3/8"), with trace of seashells
		3	8	10	
20		4	20	22	
		5	15	15	Grading to 70% fine sand, 30% gravel
30		6	21	19	
		7	7	6	
40		8	0		SILTY SAND - SANDY SILT (SM - ML) Very loose, olive gray, 50% fine sand, 50% silt/clay
		9	3		
50		10	3		
		11	45		POORLY GRADED SAND (SP) Dense to very dense, mottled pale brown and brownish yellow, trace of clay, moderate cementation
60					Bottom of boring 56.5 feet
70					
80					
90					
100					
110					
120					

Plastic Limit — Water Content,% — liquid limit
20 40 60 80

UNDRAINED SHEAR STRENGTH, KSF
2 4 6

20 40 60 80

LB 3 90

SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
▲ γ_{dry}

STRENGTH TESTS
- Field torvane
- Field pocket penetrometer
- Unconsolidated undrained
- (1300) Confinement pressure
- Remolded unconsolidated undrained

Project No. 05.01.05 | Geomatrix Consultants | Figure A-6

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 5

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/10/90 | DATE FINISHED: 1/10/90

DRILLING METHOD: 4 7/8" tricone roatary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Drilling Co.
Steve Brmalj
John Nederland

DEPTH (feet)	Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 11.5 feet
					SILTY LOAM TOPSOIL with roots
					SAND FILL (SP) Poorly graded, medium dense, light brown/brownish yellow, fine grained
	X	1	12	16	
10	X	2	22	31	
					SAND FILL (SP) Poorly graded, loose to medium dense, green to olive gray, fine grained
	·	3	11	14	
20	X	4	4	4	SILTY CLAYEY SAND (SM -SC) Loose, olive gray, fine grained, trace of seashells
	X	5	13	13	
30	X	6	4	4	
		7	0		
40		8	0		Grading more silty
		9	6		Grading to a SILTY SAND SANDY SILT (SM - ML), loose/medium stiff, olive gray, 50% fine sand, 50% clayey silt
50		10	0		SILTY CLAY (CH) Medium stiff, olive gray, medium plasticity
		11	--		
60		12	4		With 25% seashells
		13	--		SAND (SP) Medium dense, greenish gray, fine angular sand, trace of clay
70		14	6		SILTY CLAY (CH) with seams of SAND (SP) Clay: medium stiff, olive gray, medium plasticity; Sand: medium dense, greenish gray, fine, trace of clay
80		15	40		POORLY GRADED SAND CLAYEY SAND (SP - SC) Dense, olive/greenish gray, 90% fine angular sand, 10% clay
					SILTY CLAY (CH) Stiff, olive gray, medium plasticity
90		16	12		
					POORLY GRADED SAND (SP)
100		17	18		SILTY CLAY (CL - OL) Stiff, mottled dark brown - olive gray, low plasticity grading to a SANDY CLAY (CL) Very stiff, mottled greenish gray-brownish yellow, 80% low plasticity clay, 20% sand
110		18	37		
					Bottom of boring 111.5 feet
120					

Plastic Limit — Water Content,% — liquid limit
20 40 60 80

UNDRAINED SHEAR STRENGTH, KSF
2 4 6

(6300) (6300)

(12550)

SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
▲ γ_{dry}
20 40 60 80

STRENGTH TESTS
- Field torvane
- Field pocket penetrometer
- Unconsolidated undrained
- (1300) Confinement pressure
- Remolded unconsolidated undrained

LB 190

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 6

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/11/90 | DATE FINISHED: 1/11/90

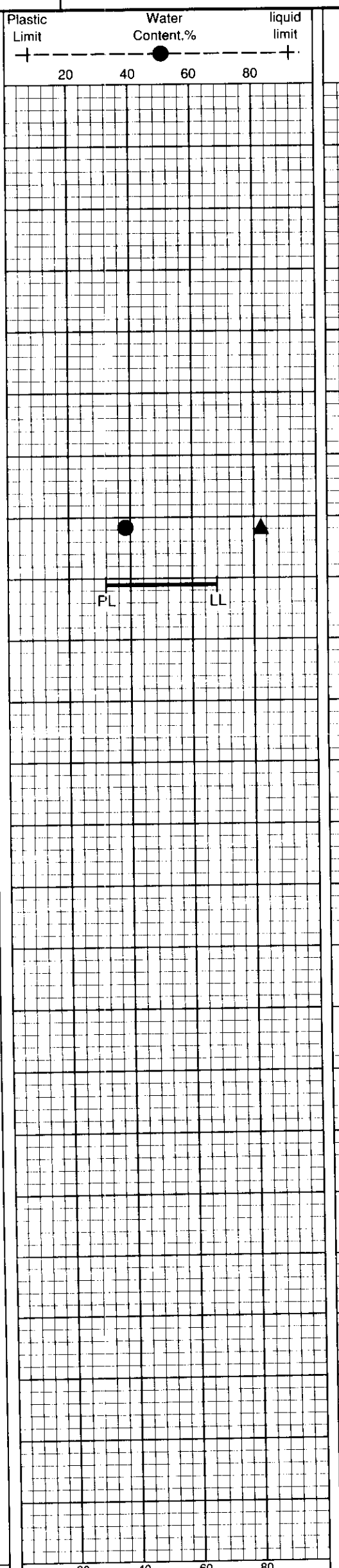
DRILLING METHOD: 4 7/8" tricone rotary wash

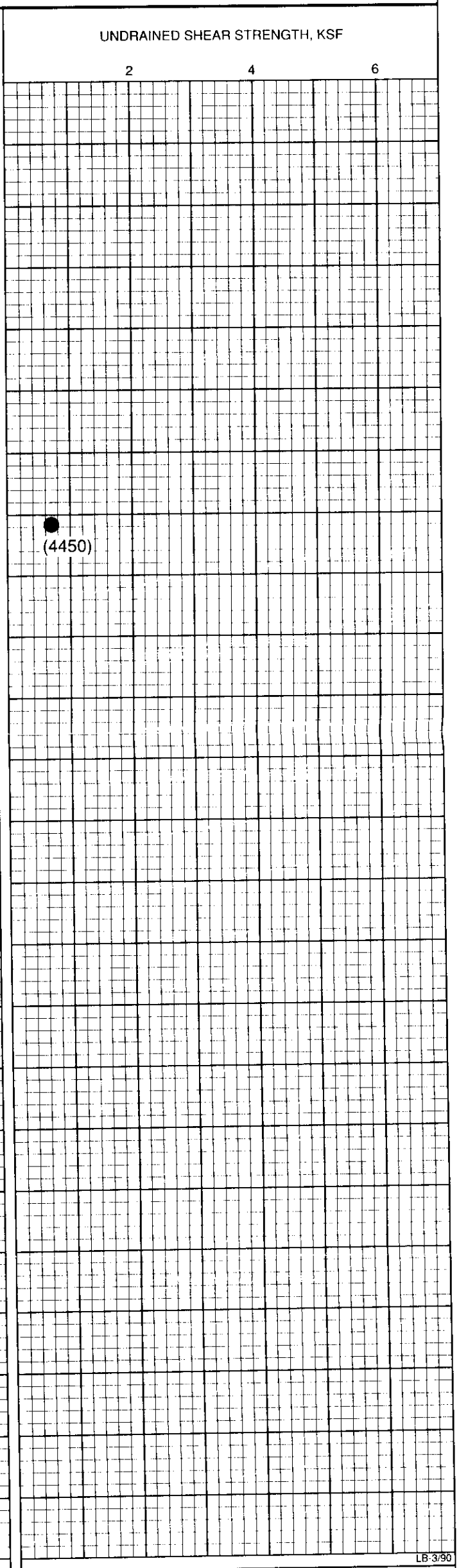
HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by J. Hernandez
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Drilling Co.
SteveBrmalj
John Nederland

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 13.0 feet
					3" asphaltic concrete
					SAND FILL (SP)
					Poorly graded, medium dense, light brown - brownish yellow
	⊠	1	11	15	
10	⊠	2	11	15	Grading very fine, olive gray
	⊠	3	9	11	Grading loose, silty
20	⊠	4	8	9	
	⊠	5	4	4	Grading loose to very loose
30	⊠	6	3	3	Grading very loose
	⊠	7	0		SILTY CLAY (CH) Medium stiff, olive gray, medium plasticity, sandy
40		8	--		
	■	9	0		
50		10	--		SILTY SAND (SM) Loose, gray, fine grained
	■	11	54		Grading very dense
60	■	11	43		SILTY SAND (SP) Dense, green - brown, fine grained
					Bottom of boring 61.5 feet
70					
80					
90					
100					
110					
120					





LB-3/90

SAMPLERS
- ⊠ Standard penetrometer
- ■ 2" ID modified California sampler
- ▯ 3" ID Shelby tube

DRY DENSITY (PCF)
- ▲ γ_{dry}

STRENGTH TESTS
- ◓ Field torvane
- ◩ Field pocket penetrometer
- ● Unconsolidated undrained
- (1300) Confinement pressure
- ■ Remolded unconsolidated undrained

Project No. 1539.05

Geomatrix Consultants

Figure A-8

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 7

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/9/90 | DATE FINISHED: 1/9/90

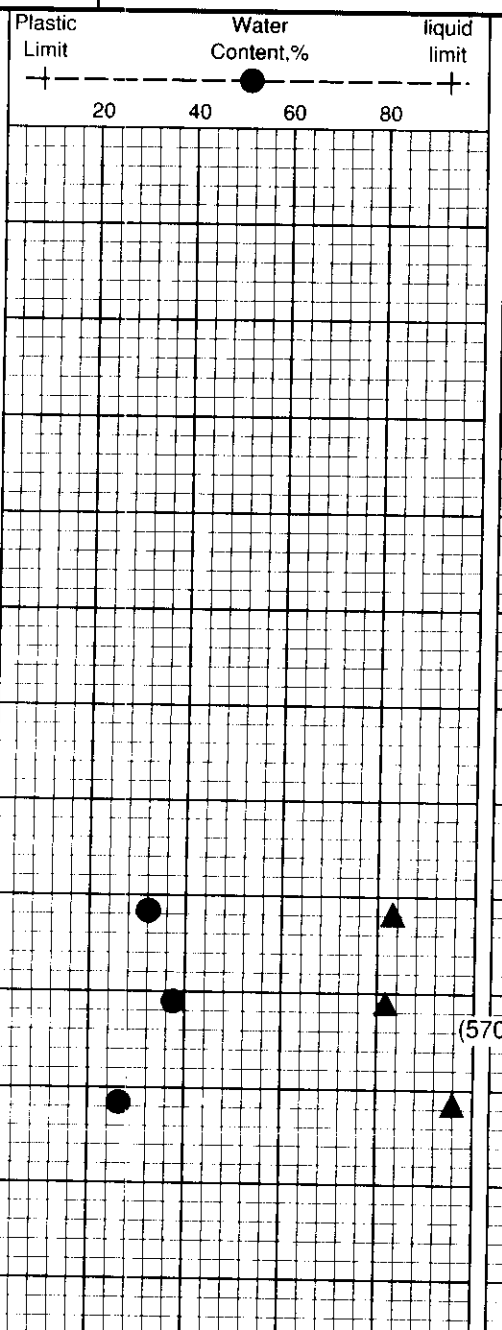
DRILLING METHOD: 4 7/8" tricone rotary wash

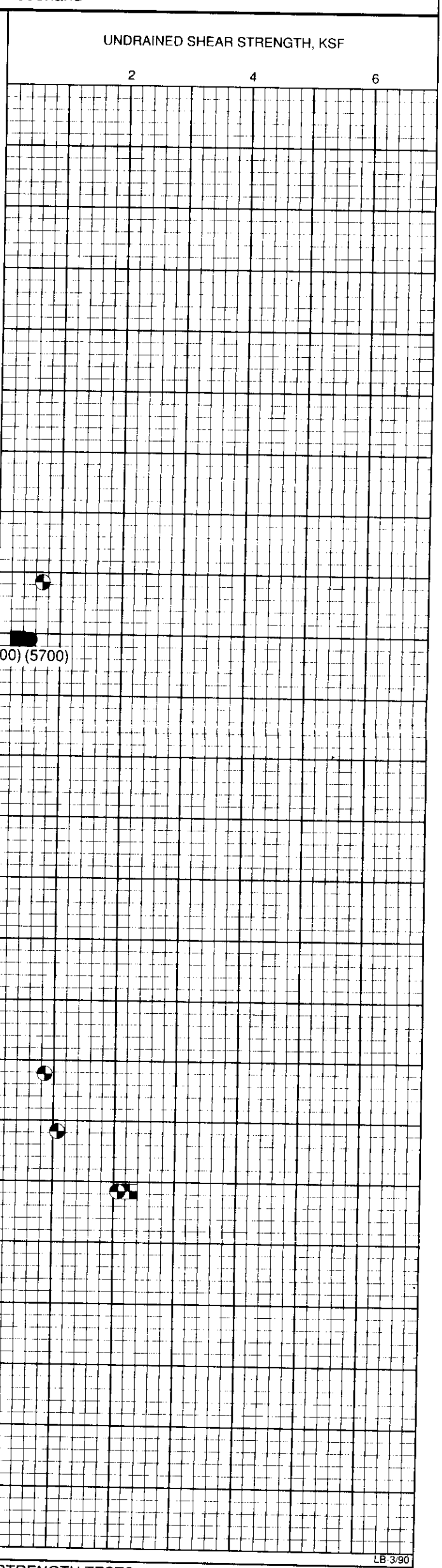
HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Drilling Co.
Steve Brmalj
John Nederland

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 12.0 feet
	⊠	1	6	8	SAND FILL (SP) Loose, brownish yellow, moist, clean, fine, subangular
10	⊠	2	4	5	SAND toSILTY SAND FILL (SP - SM) Poorly graded, very loose to loose, olive gray, fine, subangular
	⊠	3	9	11	Grading loose, gray
20	⊠	4	8	9	Grading with silt and shells
	⊠	5	25	25	SAND (SP) Dense, greenish gray/olive gray
30	⊠	6	44	41	
	⊠	7	3		SILTY CLAY (CH) Medium stiff, olive gray, 80% medium plastic clay, 20% fine sand
40	■	8	6		
	■	9	5		
50	■	10	11		Grading to interlayered silty sand - sandy silt
					Grading with layers of clean sand
	▯	11	--		
60	■	12	30		SILTY SAND - POORLY GRADED SAND (SM - SP) Medium dense to dense, olive gray, 90% sand, 10% medium plastic silt/clay
	■	13	9		Grading loose
70	■	14	2		SILTY CLAY (CL - CH) Medium stiff, gray, medium plastic, trace of sand
	■	15	29		SILTY SAND - POORLY GRADED SAND (SM - SP) Medium dense, olive gray, 90% sand, 10% silt/clay
80	■	16	8		SILTY CLAY (CH) Medium stiff, olive gray, medium plasticity, trace of sand
	■	17	11		SILTY SAND - POORLY GRADED SAND (SM - SP) Medium dense, olive gray, 90% sand, 10% silt/clay
90	■	17	19		SILTY CLAY (CH) Stiff, olive gray, medium plasticity, trace of sand
100					SILTY CLAY (CL - OL) Very stiff, mottled dark brown and olive gray, medium plasticity
110					Bottom of boring 91.5 feet
120					





SAMPLERS
- ⊠ Standard penetrometer
- ■ 2" ID modified California sampler
- ▯ 3" ID Shelby tube

DRY DENSITY (PCF)
▲ γ_{dry}

STRENGTH TESTS
- ◔ Field torvane
- ◪ Field pocket penetrometer
- ● Unconsolidated undrained
- (1300) Confinement pressure
- ■ Remolded unconsolidated undrained

LB-3/90

Project No. 1539.05

Geomatrix Consultants

Figure A-9

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 8

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/11/90 | DATE FINISHED: 1/11/90

DRILLING METHOD: 4 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Drilling Co.
Steve Brmalj
John Nederland

DEPTH (feet)	Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 11.0 feet
	X	1	1	1	SAND FILL (SP) Poorly graded, very loose, brown , fine, subangular sand
10	X	2	7	10	SAND and SILTY SAND FILL (SP and SM) Poorly graded, loose, olive gray, fine
	X	3	4	5	
20	X	4	29	32	Grading medium dense to dense
	X	5	12	12	Grading medium dense
30	X	6	14	13	
	X	7	16	14	
40	X	8	2	2	SANDY CLAY-CLAYEY SAND (SC - CL) Loose/soft, olive gray, 50% sand, 50% medium plastic clay
	X	9	51	40	SILTY SAND - SAND (SM - SP) Dense to very dense olive gray, 90% fine sand, 10% silt/clay
50	X	10	0	0	SANDY CLAY-CLAYEY SAND (CL - SC) Very loose/very soft, olive gray, 50% fine sand, 50% clay
	■	11	3		SILTY CLAY (CH) Medium stiff, olive gray, 90% medium plastic clay, 10% shells
60		12	--		SAND (SP) Medium dense, greenish-olive gray, fine grained, trace of clay
	■	13	7		INTERBEDDED SANDY CLAY (CL - CH) and SILTY SAND (SM - SC) Loose/medium stiff, olive gray, trace of seashells
70	■	14	73		
	■	15	50/6"		SILTY SAND - POORLY GRADED SAND (SM - SP) Dense, olive gray, 90% fine sand, 10% silt/clay
80					Silty clay lens
	■	16	26		Grading silty, 70% sand, 30% silt/clay
90					
	■	17	3		SILTY CLAY (CH) Medium stiff to stiff, olive gray, medium plasticity, mica flakes
100					
	■	18	59		SILTY SAND - POORLY GRADED SAND (SM - SP) Dense to very dense, olive gray, 90% sand, 10% clay
110					
	■	19	13		SANDY CLAY (CL -CH) Medium stiff to stiff, olive gray, 70% medium plastic clay, 30% fine sand
120					

Plastic Limit — Water Content,% — liquid limit
20 40 60 80

UNDRAINED SHEAR STRENGTH, KSF
2 4 6

(6920)

(11950)

LB-3/90

SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
20 40 60 80
▲ γ_{dry}

STRENGTH TESTS
- ● Unconsolidated undrained
- ◔ Field torvane
- (1300) Confinement pressure
- ◪ Field pocket penetrometer
- ■ Remolded unconsolidated undrained

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 8 cont'd.

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
130	■	20	19		Grading to SILTY CLAY (CH) Stiff, olive gray, medium plasticity
					SILTY CLAY (CL) Very stiff, dark olive/brownish gray, low plasticity
140	■	21	56		SANDY CLAY (CL - OL) Very stiff, greenish gray, 60% low plastic clay, 40% fine sand
					Bottom of boring 136.5 feet

Plastic Limit — Water Content,% — liquid limit
20 40 60 80

UNDRAINED SHEAR STRENGTH, KSF
2 4 6

(17000)

20 40 60 80

LB-2

SAMPLERS
- ☒ Standard penetrometer
- ■ 2" ID modified California sampler
- ☐ 3" ID Shelby tube

DRY DENSITY (PCF)
- ▲ γ_{dry}

STRENGTH TESTS
- ◕ Field torvane
- ◪ Field pocket penetrometer
- ● Unconsolidated undrained
- (1300) Confinement pressure
- ■ Remolded unconsolidated undrained

Project No. 1539.05 | Geomatrix Consultants | Figure A-11

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 9

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/8/90 | DATE FINISHED: 1/8/90

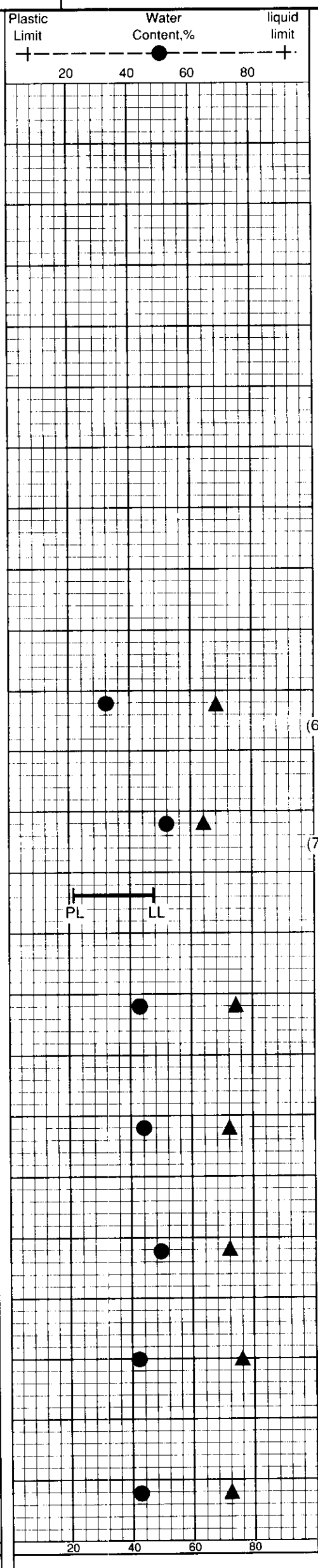
DRILLING METHOD: 4 7/8" tricone rotary wash

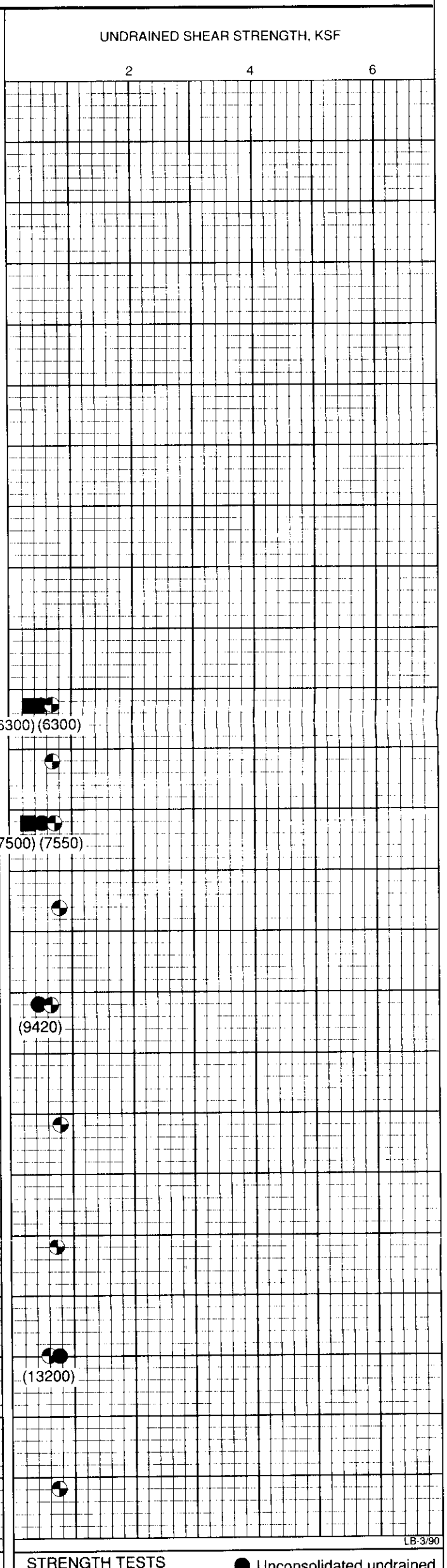
HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Drilling Co.
Steve Brmalj
John Nederland

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 13.0 feet
	X	1	21	28	SANDY GRAVEL FILL (GW) Well graded, medium dense, dark brown, moist, 50% gravel (3/8"), 25% sand, 15% clay, 10% broken glass
10	X	2	10	14	SAND FILL (SP) Poorly graded, loose to medium dense, brown and brownish yellow, fine to coarse subrounded sand
	X	3	15	19	Grading medium dense with trace of seashells
20	X	4	21	23	SILTY SAND FILL (SM) Poorly graded, medium dense, gray-greenish gray, fine grained
	X	5	28	29	Grading medium dense to dense
30	X	6	9	9	Grading loose
	■	7	10		Lens of gray silty clay
40	■	8	17		SILTY SAND (SM) Medium dense, olive gray, 70% fine angular sand, 30% low plastic silt
	■	9	5		Grading more silty - clayey
50	■	10	5		SANDY SILTY CLAY (CL - CH) Medium stiff, olive gray, 60% medium plastic clay, 40% fine sand, trace of seashells
	▯	11	--		Grading to a silty clay, no sand
60	■	12	0		Grading sandy with 25% seashells
	▯	13	--		Graded to a pure silty clay
70					
	■	14	7		
80					
	■	15	12		
90					
	■	16	0		
100					
	■	17	0		
110					
	■	18	0		
120					





SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
▲ γ_{dry}

STRENGTH TESTS
- Field torvane
- Field pocket penetrometer
- Unconsolidated undrained
- (1300) Confinement pressure
- Remolded unconsolidated undrained

LB-3/90

Project No. 1539.05 | Geomatrix Consultants | Figure A-12

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 9 cont'd.

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
130	■	19	0		Grading stiffer
140	■	20	0		
150	■	21	8		
160	■	22	15		PEATY CLAY (CL - OL) Stiff, dark brown and dark gray with brownish yellow stains, low plasticity
					Bottom of boring 156.5 feet
170					
180					
190					
200					
210					
220					
230					
240					
250					

Plastic Limit — Water Content,% — liquid limit

20 40 60 80

P_L — LL

20 40 60 80

UNDRAINED SHEAR STRENGTH, KSF

2 4 6

(17000)

LB 2

SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
- ▲ γ_{dry}

STRENGTH TESTS
- Field torvane
- Field pocket penetrometer
- ● Unconsolidated undrained
- (1300) Confinement pressure
- ■ Remolded unconsolidated undrained

Project No. 1539.05 | Geomatrix Consultants | Figure A-13

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 10

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/14/90 | DATE FINISHED: 1/14/90

DRILLING METHOD: 4 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Mobile Drill B-53
Drilling contractor: RNL Enterprises, Inc.
Ruben Tajeda
Bruce White

DEPTH (feet)	Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 11.0
	X	1	5	7	SAND FILL (SP) Loose, brown and brownish yellow, moist, poorly graded fine sand
10	X	2	7	9	SAND FILL (SP and SP - SM) Poorly graded, loose, olive gray/dark gray, fine sand, trace of silt
	X	3	7	8	Grading with trace of seashells
20	X	4	5	5	Grading olive gray
	X	5	10	10	Grading medium dense, with clay balls and seashells
30	X	6	13	12	Grading silty (20% silt), trace of gravel
	X	7	27	24	SAND (SW) Medium dense to dense, brown/greenish gray, fine to coarse subrounded sand, with shells
40	■	8	4		SILTY CLAY (ML - CL) Medium stiff, olive gray, low plasticity silty clay, trace of shells
		9	--		
50	■	10	4		Grading to a SILTY CLAY (CH), medium stiff, olive gray, medium plasticity, no shells
	■	11	4		
60	■	12	36		SILTY SAND (SM - SC) Hard, very dense, mottled greenish gray - brownish yellow, 60% fine sand, 40% silty clay
					Bottom of boring 61.5 feet
70					
80					
90					
100					
110					
120					

Plastic Limit — Water Content,% — liquid limit
20 40 60 80

UNDRAINED SHEAR STRENGTH, KSF
2 4 6

(6300)
(7550)

20 40 60 80

LB-3/90

SAMPLERS
- Standard penetrometer
- 2" ID modified California sampler
- 3" ID Shelby tube

DRY DENSITY (PCF)
▲ γ_{dry}

STRENGTH TESTS
- Field torvane
- Field pocket penetrometer
- Unconsolidated undrained
- (1300) Confinement pressure
- Remolded unconsolidated undrained

Project No. 1539.05 | Geomatrix Consultants | Figure A-14

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 11

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/10/90 | DATE FINISHED: 1/10/90

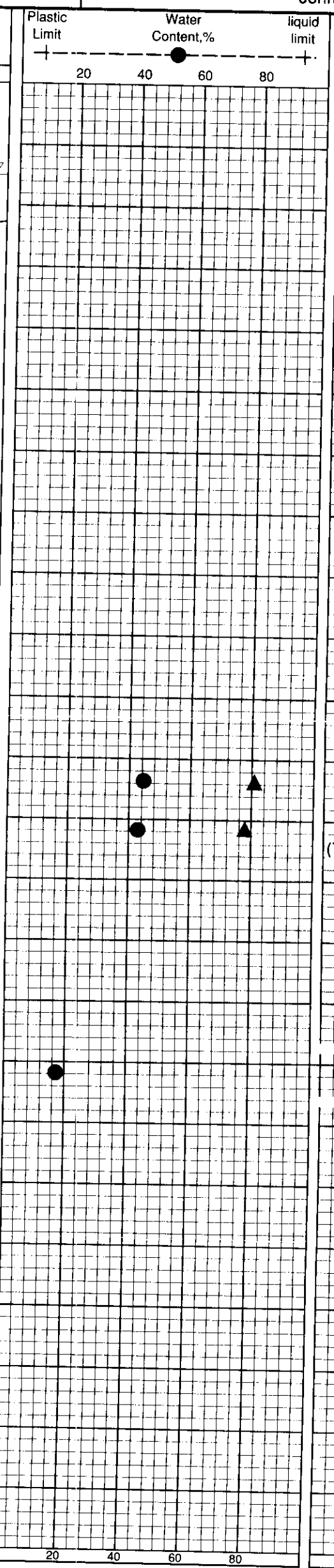
DRILLING METHOD: 4 7/8" tricone rotary wash

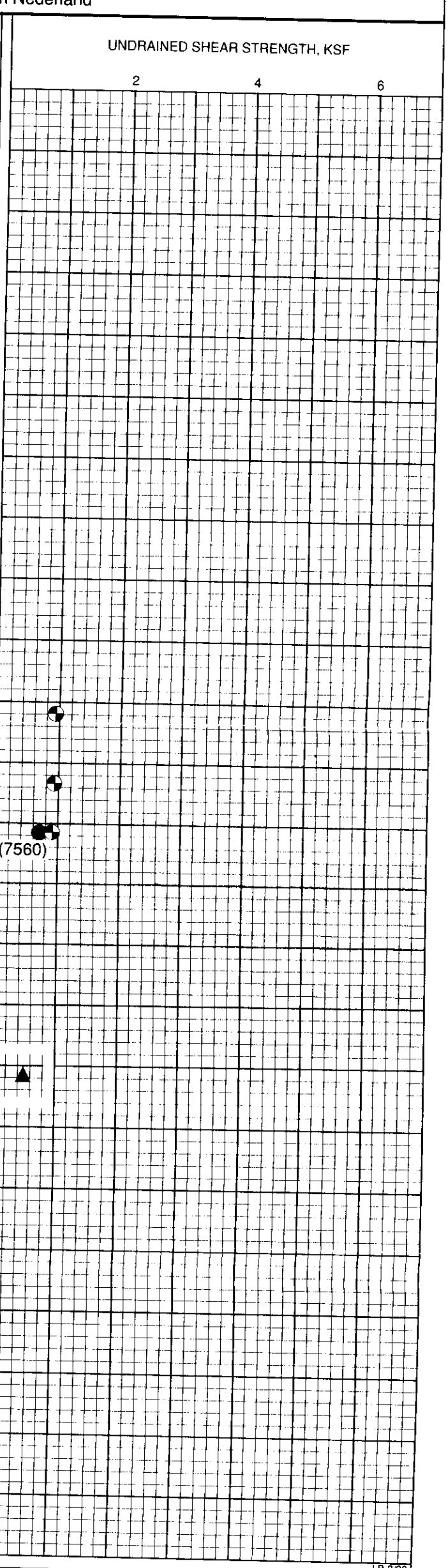
HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Failing Holemaster
Drilling contractor: Pitcher Driller Co.
Steve Brmalj
John Nederland

DEPTH (feet)	SAMPLES: Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 10.5
	⊠	1	10	14	SAND FILL (SP) Poorly graded, loose to medium dense, pale brown, moist, medium grained
10	⊠	2	14	20	Grading well graded with seashells
	⊠	3	9	11	SAND FILL (SW - SM) Well graded, loose to medium dense, olive gray, with trace of gravel (1/2") and seashells
20	⊠	4	11	12	
	⊠	5	8	8	Grading to 25% seashells
30	⊠	6	7	6	
	⊠	7	24	21	Grading to a SAND FILL (SP - SM) Poorly graded - silty, medium dense, greenish olive gray, trace of seashells
40	■	8	2		SILTY SAND (SM) Very loose, olive gray, 60% fine sand, 35% silt, 5% shells
	■	9	3		SILTY CLAY (CH) Medium stiff, olive gray, 80% medium plastic clay, 20% mussel shells grading with no shells
50	▯	10	--		
	■	11	5		
60	■	12	6		Grading more plastic
70	■	13	50/4"		SAND (SP) Very dense, greenish gray, fine angular sand
80	■	14	29		SANDY SILTY CLAY (CL) Very stiff to hard, greenish gray, 60% clay, 40% sand, calcareous nodules
					Bottom of boring 81.5 feet
90					
100					
110					
120					





SAMPLERS
- ⊠ Standard penetrometer
- ■ 2" ID modified California sampler
- ▯ 3" ID Shelby tube

DRY DENSITY (PCF)
- ▲ γ_{dry}

STRENGTH TESTS
- ◔ Field torvane
- ◪ Field pocket penetrometer
- ● Unconsolidated undrained
- (1300) Confinement pressure
- ■ Remolded unconsolidated undrained

LB-3/90

Project No. 1539.05

Geomatrix Consultants

Figure A-15

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island, San Francisco, California

Log of Boring No. 12

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/13/90 | DATE FINISHED: 1/13/90

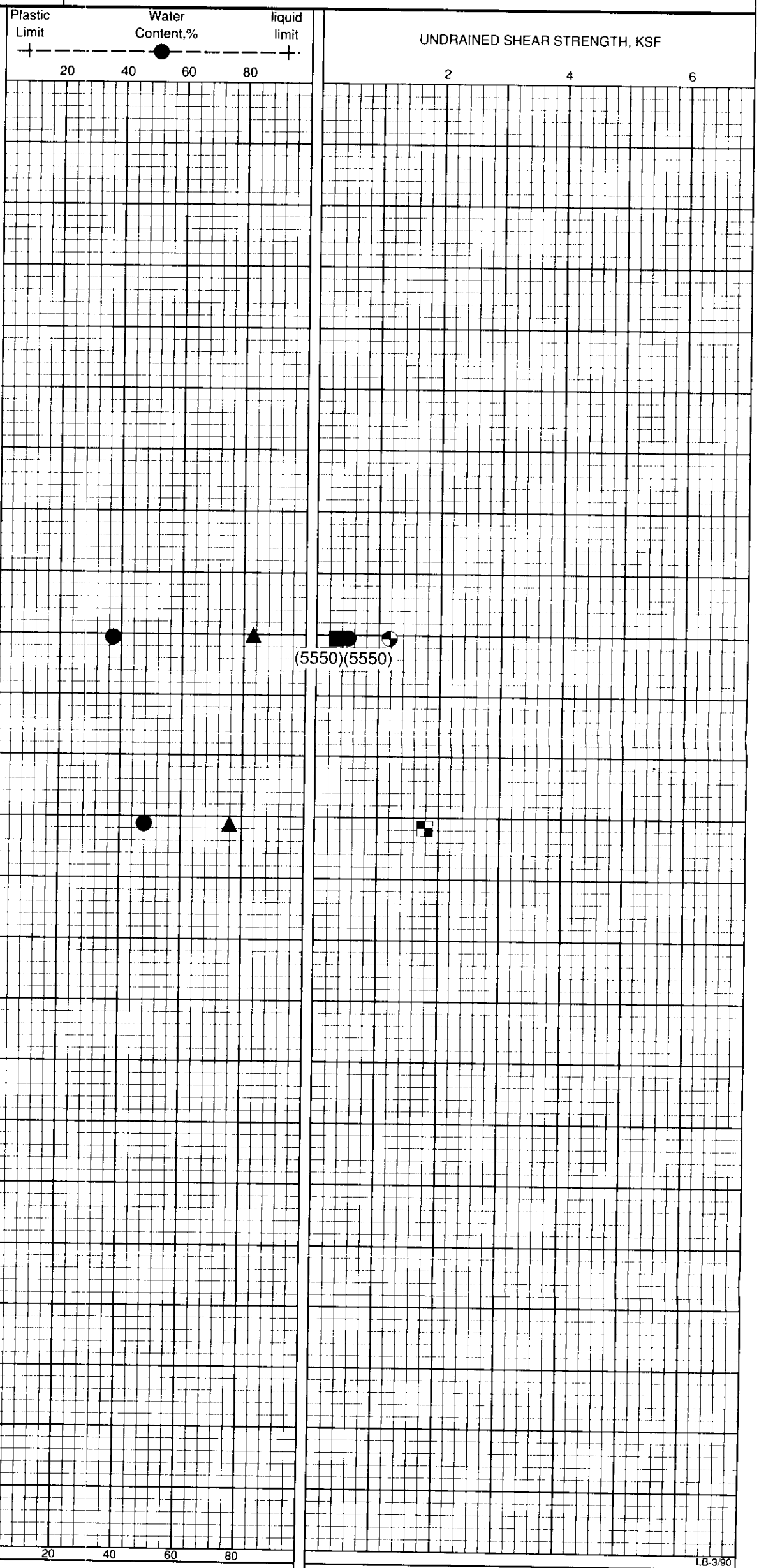
DRILLING METHOD: 4 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30"

SAMPLER: See below

NOTES: Logged by S. Shewbridge
Drilling equipment: Mobil Drill B53
Drilling contractor: RNL Enterprises, Inc.
Ruben Tajeda
Bruce White

DEPTH (feet)	Sample	Sample No.	Blows/ Foot	Calculated $(N_1)_{60}$	MATERIAL DESCRIPTION
					Surface Elevation: 13.0
	☒	1	9	12	SAND FILL (SW) Well graded, loose, brown and brownish yellow, moist, with seashells
10	☒	2	4	5	SAND FILL (SP) Poorly graded, loose, olive gray, fine angular sand with seashells
	☒	3	3	4	Grading very loose to loose
20	☒	4	4	4	
	☒	5	12	12	Grading medium dense
					SAND FILL (SP - SM) Poorly graded, medium dense, pale brown, fine sand with trace shells and silt
30	☒	6	16	15	
					SAND FILL (SP) Poorly graded, loose to medium dense, olive gray, fine sand with seashells
	☒	7	10	9	
40	☒	8	1	1	SILTY SAND - SANDY SILT (SM - ML) Very loose/very soft, dark greenish gray, 50% fine sand, 50% silt, trace shells
	■	9	4		SILTY SANDY CLAY (CH) Medium stiff, olive gray, 80% medium plastic clay, 20% fine sand, trace of seashells, occasional clean sand veins
50		10	--		
					SILTY SAND (SP) Medium dense, olive gray, fine sand
		11	--		
60	■	12	10		SILTY CLAY (CL) Stiff to very stiff, mottled light olive brown and brownish yellow, low plastic clay with trace of gravel (1/4")
					Bottom of boring 61.5 feet
70					
80					
90					
100					
110					
120					



SAMPLERS
☒ Standard penetrometer
■ 2" ID modified California sampler
[ ] 3" ID Shelby tube

DRY DENSITY (PCF)
▲ γ_{dry}

STRENGTH TESTS
● Unconsolidated undrained
◔ Field torvane
(1300) Confinement pressure
◪ Field pocket penetrometer
■ Remolded unconsolidated undrained

LB-3/90

Project No. 1539.05

Geomatrix Consultants

Figure A-16

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-1

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 2/1/90 | DATE FINISHED: 2/1/90

DRILLING METHOD: 3 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30 inches

SAMPLER: See boring log explanation page

NOTES:
Logged by: S. Shewbridge
Drilling equipment: Barge mounted skid rig
Drilling contractor: McDaniel Smith
Leon Smith, Andre Stewart

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
				Surface Elevation: 8 ' to mudline at 12:55 PM			
1				SILTY CLAY (CL - CH) Very soft, olive gray, medium plasticity			
2							
3							
4							
5				SAND (SP) Very loose to loose, greenish olive gray, fine grained, trace of silt			
6	1		4				
7							
8							
9				Silt lens			
10							
11	2		19	Grading medium dense			
12							
13							
14				CLAYEY SAND (SC) Dense, greenish olive gray, 60% fine sand, 40% medium plastic clay			
15							

gt-1-88

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-1 cont.

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
16	3		Push	CLAYEY SAND (SC) Dense, greenish olive gray, 60% fine sand, 40% medium plastic clay			
17							
18				Bottom of boring 18 feet			
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							

gt-2-88

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-2

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 2/1/90 | DATE FINISHED: 2/1/90

DRILLING METHOD: 3 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30 inches

SAMPLER: See boring log explanation page

NOTES:
Logged by: S. Shewbridge
Drilling equipment: Barge mounted skid rig
Drilling contractor: McDaniel Smith
Leon Smith, Andre Stewart

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
				Surface Elevation: 8 1/2' to mudline at 9:30 AM			
1				SILTY CLAY (CL - CH) Very soft, mottled olive gray and dark gray, medium plasticity			
2							
3							
4							
5							
6	1		Push				
7							
8							
9							
10				SAND FILL (SP) Poorly graded, very loose, olive gray, medium grained, trace of seashells			
11	2		Push				
12							
13							
14							
15							

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-2 cont.

DEPTH (feet)	SAMPLES Sample No.	SAMPLES Sample	SAMPLES Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS Moisture Content (%)	LABORATORY TESTS Dry Density (pcf)	LABORATORY TESTS Unconf. Comp. Str. (psf)
16	3		6	Grading to a poorly graded sand with 10% sea shells			
17				Silty layer			
18				SILTY CLAY (CL - CH) Soft, olive gray, medium plasticity			
19							
20							
21	4		Push				
22							
23				Bottom of boring 23 feet			
24							
25							
26							
27							
28							
29							
30							
31							
32							

gt-2-88

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-3

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/31/90 | DATE FINISHED: 1/31/90

DRILLING METHOD: 3 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30 inches

SAMPLER: See boring log explanation page

NOTES:
Logged by: S. Shewbridge
Drilling equipment: Barge mounted skid rig
Drilling contractor: McDaniel Smith
Leon Smith, Andre Stewart

DEPTH (feet)	SAMPLES Sample No.	SAMPLES Sample	SAMPLES Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS Moisture Content (%)	LABORATORY TESTS Dry Density (pcf)	LABORATORY TESTS Unconf. Comp. Str. (psf)
				Surface Elevation: 5 1/5' of water at 9:25 AM			
0				SILTY CLAY (CL - CH) Very soft, olive gray, medium plasticity			
6				SAND FILL (SP) Poorly graded, loose, olive gray, fine to medium grained, trace of seashells			
7	1		Push				
10	2		3	Grading fine grained, trace of silt			
15							

gt-1-88

Project No. 1539.05 | Geomatrix Consultants | Figure B-5

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-3 cont.

DEPTH (feet)	SAMPLES Sample No.	SAMPLES Sample	SAMPLES Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS Moisture Content (%)	LABORATORY TESTS Dry Density (pcf)	LABORATORY TESTS Unconf. Comp. Str. (psf)
16	3		4				
17							
18							
19							
20							
21	4		1	Grading well graded, very loose, trace of gravel (3/8")			
22							
23							
24							
25				SILTY CLAYEY SAND (SC) Medium dense, olive gray/gray, 60% fine sand, 40% low plastic clay			
26							
27	5		Push				
28							
29							
30							
31	6		Push	Grading to an interbedded sand and clay			
32							

gt-2-88

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-3 cont.

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
33				Bottom of boring 33 feet			
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							
49							

gt-2-88

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-4

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 1/29/90 | DATE FINISHED: 1/29/90

DRILLING METHOD: 3 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30 inches

SAMPLER: See boring log explanation page

NOTES:
Logged by: S. Shewbridge
Drilling equipment: Barge mounted skid rig
Drilling contractor: McDaniel Smith
Leon Smith, Andre Stewart

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
				Surface Elevation: 6' to mudline at 12:00 PM			
0				SILTY CLAY (CH) Very soft, olive gray, highly plastic			
5	1		Push				
10	2		Push	As above, grading olive gray			
14				SAND FILL (SP) Poorly graded, loose, olive gray, fine sand, trace of silt and seashells			

gt-1-88

Project No. 1539.05 | Geomatrix Consultants | Figure B-8

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-4 cont.

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
16				Coarse grained sand			
17							
18							
19							
20							
21	3		15	SAND (SP) Medium dense to dense, olive gray, fine sand, trace of silt and seashells			
22							
23							
24				SILTY CLAY (CL) [Bay Mud] Medium stiff, olive gray, low plasticity			
25							
26							
27	4		Push				
28							
29							
30				Bottom of boring 30 feet			
31							
32							

gt-2-88

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-5

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 2/5/90 | DATE FINISHED: 2/5/90

DRILLING METHOD: 3 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30 inches

SAMPLER: See boring log explanation page

NOTES:
Logged by: S. Shewbridge
Drilling equipment: Barge mounted skid rig
Drilling contractor: McDaniel Smith
Andre Stewart

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
				Surface Elevation: -23 feet to mudline at 9:10 am			
1				GRAVELLY SILTY SAND FILL (SP) Poorly graded, loose, olive gray, 80% sand, 10% silty clay, 10% gravel (3/8")			
2							
3							
4							
5							
6							
7	1		6				
8							
9							
10	2		6	Grading with trace of shells			
11							
12							
13							
14				Bay Mud?			
15				Bottom of boring 15 feet			

gt-1-88

Project No. 1539.05 | Geomatrix Consultants | Figure B-10

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-7

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 2/7/90 | DATE FINISHED: 2/7/90

DRILLING METHOD: 3 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30 inches

SAMPLER: See boring log explanation page

NOTES: Logged by: S. Shewbridge
Drilling equipment: Barge mounted skid rig
Drilling contractor: McDaniel Smith
Andre Stewart

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
				Surface Elevation: 18 feet to mudline at 10:00			
0				SAND (SP) Poorly graded, loose, olive/greenish gray, fine sand, trace of seashells			
5	1		8				
10				Silty layer			
12	2		Push				
14				Silty layer			
15							

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-7 cont.

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
16	Lost		Push	SILTY CLAY to CLAYEY SILT (CL - ML) Soft, mottled olive gray and gray, 60% silt and clay, 40% sand			
17							
18							
19							
20							
21	3		Push				
22							
23				Bottom of boring 23 feet			
24							
25							
26							
27							
28							
29							
30							
31							
32							

gt-2-88

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Log of Boring No. OS-9

BORING LOCATION: See site and boring location plan, Figure 1

DATE STARTED: 2/8/90 | DATE FINISHED: 2/8/90

DRILLING METHOD: 3 7/8" tricone rotary wash

HAMMER WEIGHT: 140 lbs. | DROP: 30 inches

SAMPLER: See boring log explanation page

NOTES:
Logged by: S. Shewbridge
Drilling equipment: Barge mounted skid rig
Drilling contractor: McDaniel Smith
Andre Stewart

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
				Surface Elevation: 11 feet to mudline at 12:30			
0				SAND FILL (SP) Poorly graded, loose, olive/greenish gray, trace of seashells			
8				Bottom of boring 8 feet			
15				Bottom of boring 15 feet			

gt-1-88

PROJECT: TREASURE ISLAND DIKE STABILITY
Treasure Island
San Francisco, California

Boring Log Explanation Page

BORING LOCATION:

DATE STARTED: | DATE FINISHED: | NOTES:

DRILLING METHOD:

HAMMER WEIGHT: | DROP:

SAMPLER:

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/Foot	MATERIAL DESCRIPTION	LABORATORY TESTS: Moisture Content (%)	LABORATORY TESTS: Dry Density (pcf)	LABORATORY TESTS: Unconf. Comp. Str. (psf)
				Surface Elevation			
1	1		4	Standard penetration sample (SPT)			
2							
3	2		Push	Thin walled (Shelby) tube sampler			
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

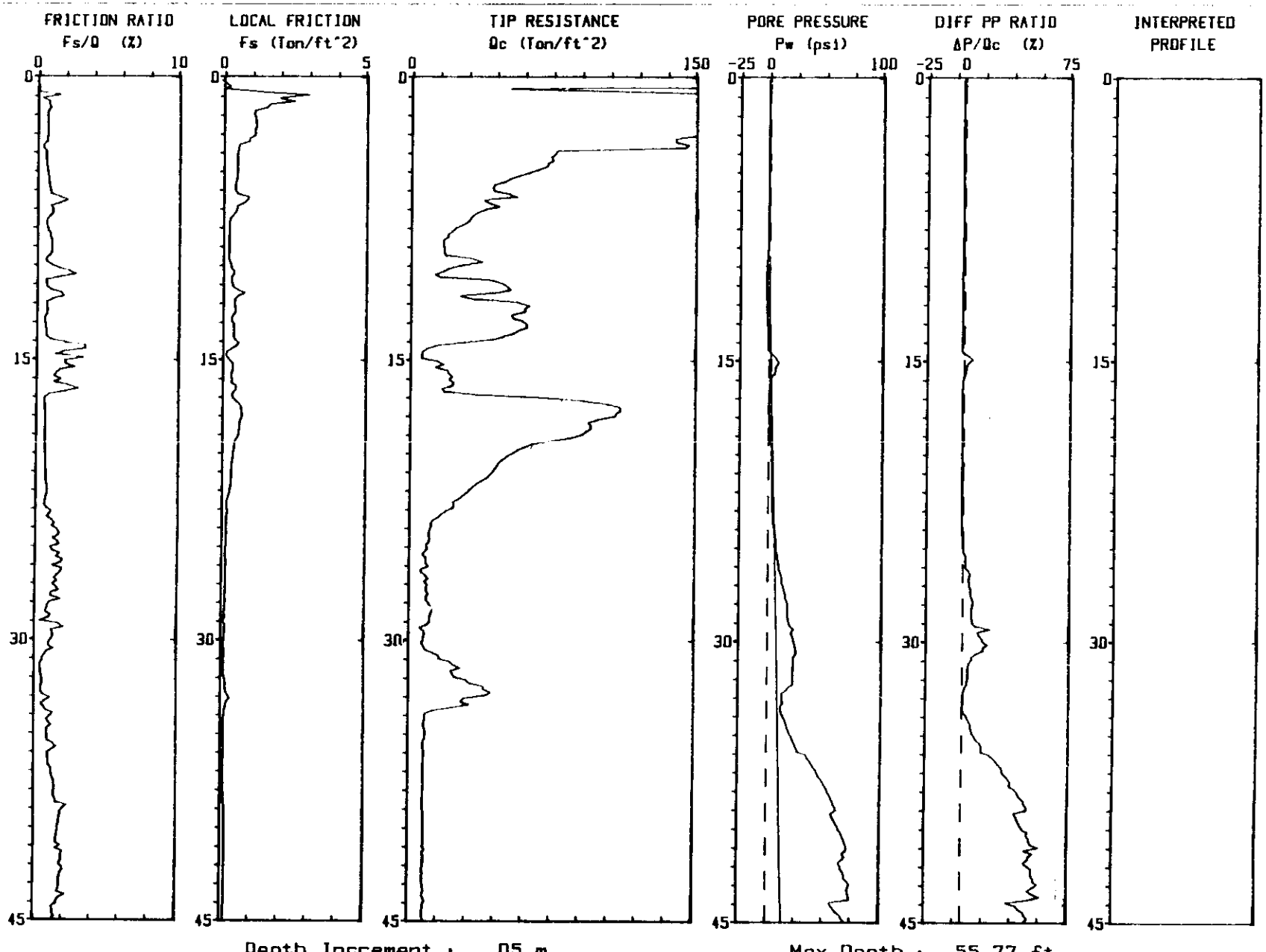
gt-1-88

V B I

Ground surface elevation: 12.0 ft.

Operator : VIRGIL A. BAKER CPT Date : 01/31/90 07:53 Sounding : 5 Pg 1 / 2

Location : CPT-1 Cone Used : 322 Job No. : 1539



Depth Increment : .05 m Max Depth : 55.77 ft

Figure C-1

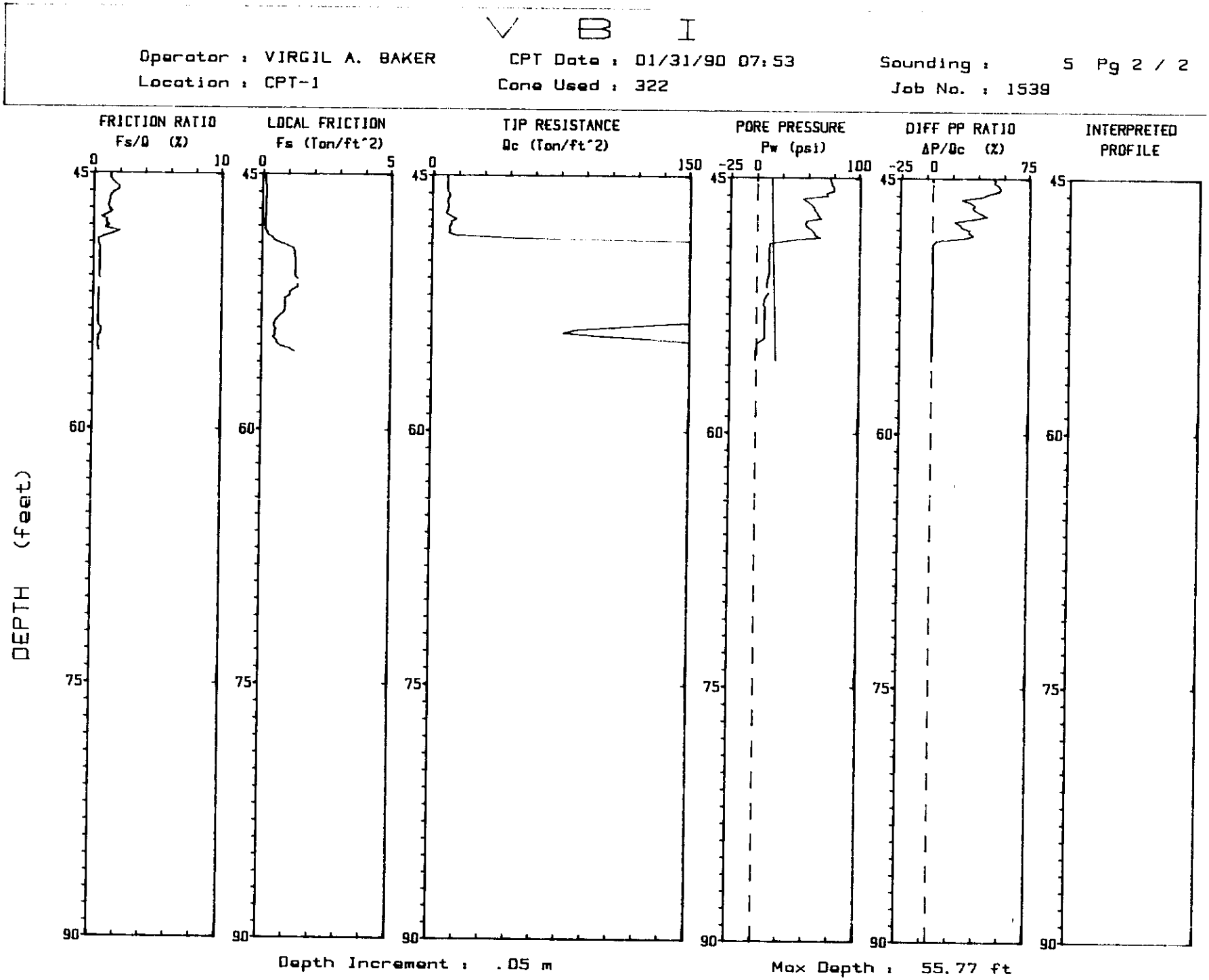

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/31/90 07:53
Sounding : 5 Pg 2 / 2
Location : CPT-1
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 55.77 ft

Figure C-2

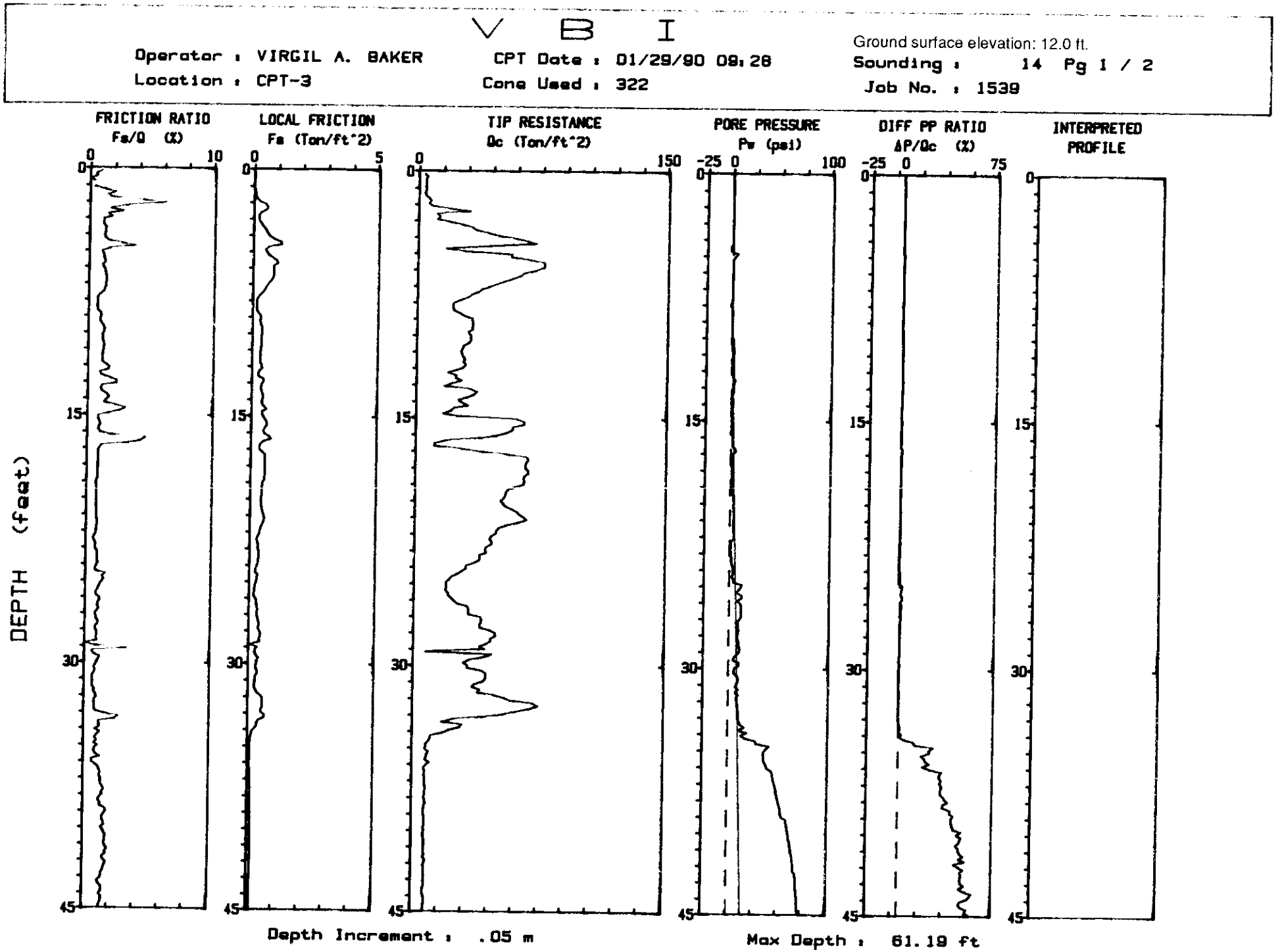

V B I
Operator : VIRGIL A. BAKER
Location : CPT-3
CPT Date : 01/29/90 09:28
Cone Used : 322
Ground surface elevation: 12.0 ft.
Sounding : 14 Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 61.19 ft

Figure C-3

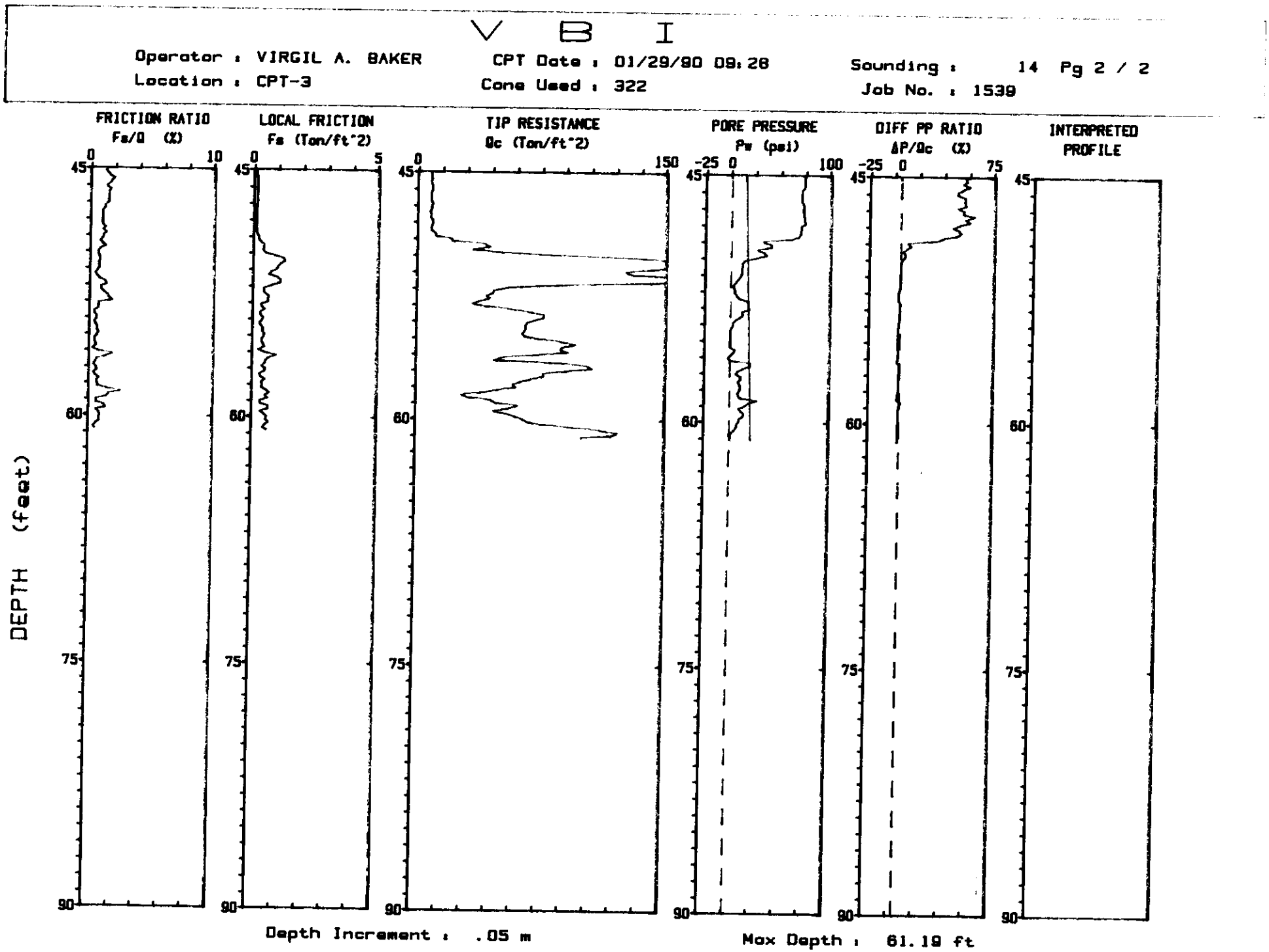

V B I
Operator : VIRGIL A. BAKER
Location : CPT-3
CPT Date : 01/29/90 09:28
Cone Used : 322
Sounding : 14 Pg 2 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 61.19 ft

Figure C-4

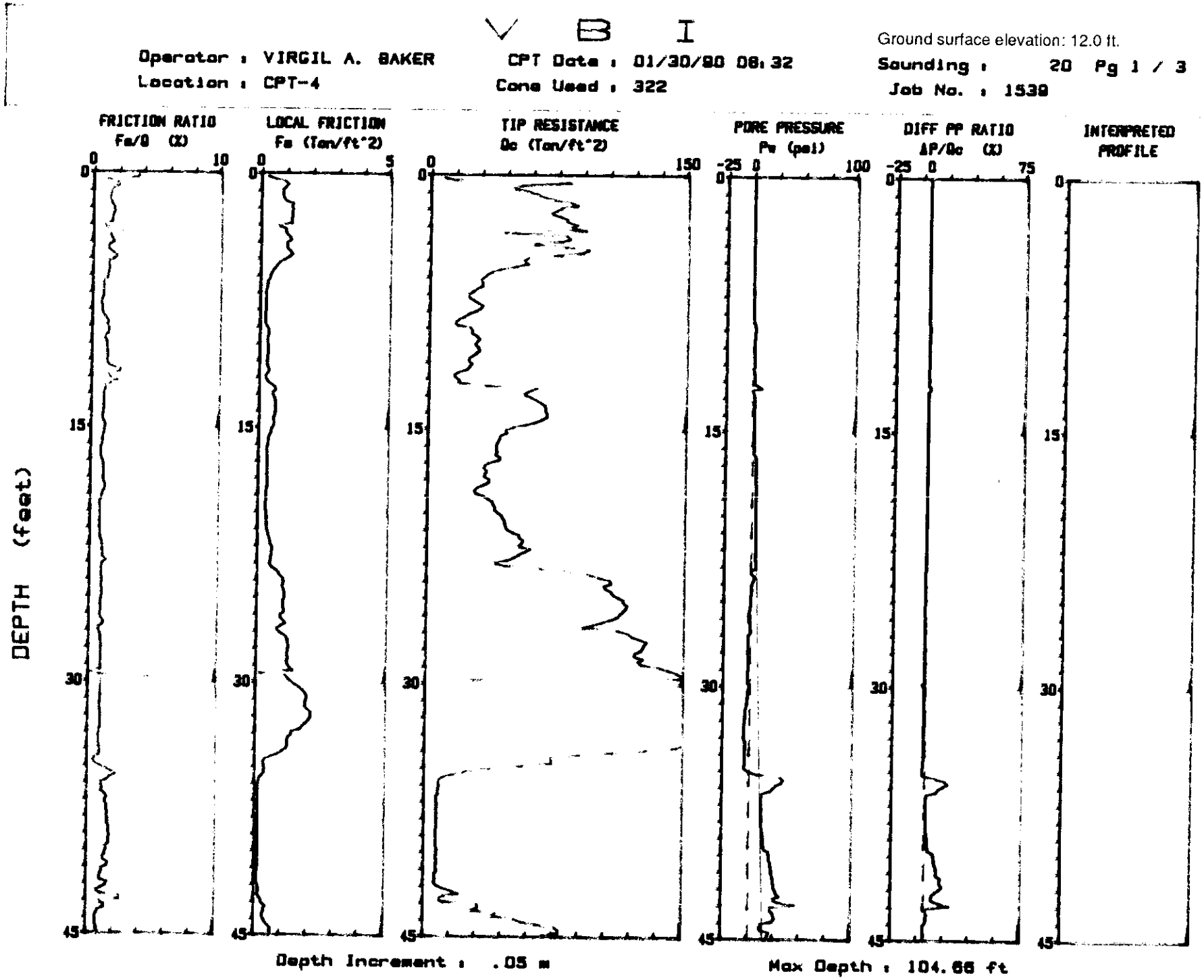

V B I
Operator : VIRGIL A. BAKER
Location : CPT-4
CPT Date : 01/30/90 08:32
Cone Used : 322
Ground surface elevation: 12.0 ft.
Sounding : 20 Pg 1 / 3
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 104.66 ft

Figure C-5

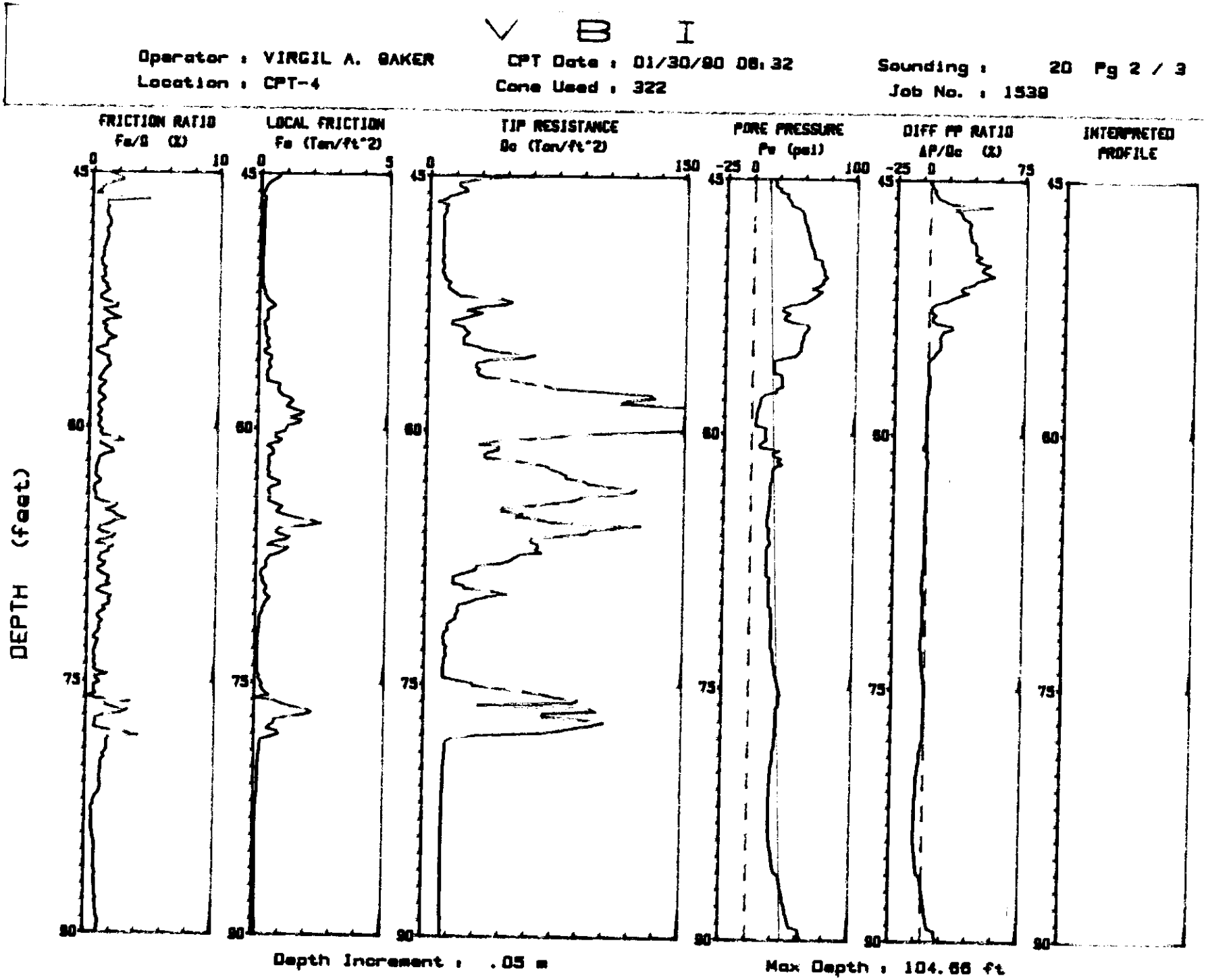

V B I
Operator : VIRGIL A. BAKER
Location : CPT-4
CPT Date : 01/30/90 08:32
Cone Used : 322
Sounding : 20 Pg 2 / 3
Job No. : 1539
FRICTION RATIO
Fa/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 104.66 ft

Figure C-6

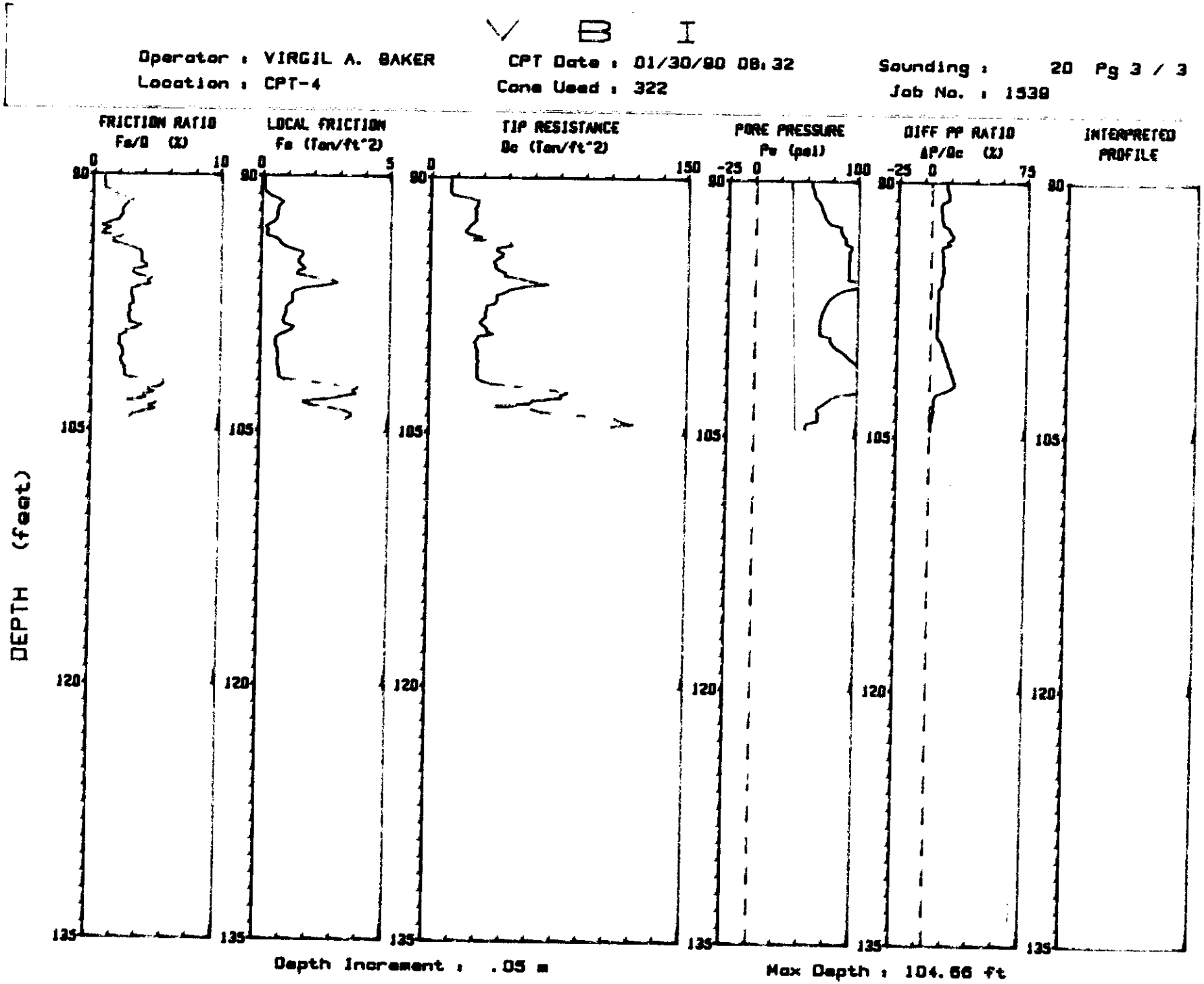

V B I
Operator : VIRGIL A. BAKER
Location : CPT-4
CPT Date : 01/30/90 08:32
Cone Used : 322
Sounding : 20 Pg 3 / 3
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 104.66 ft

Figure C-7

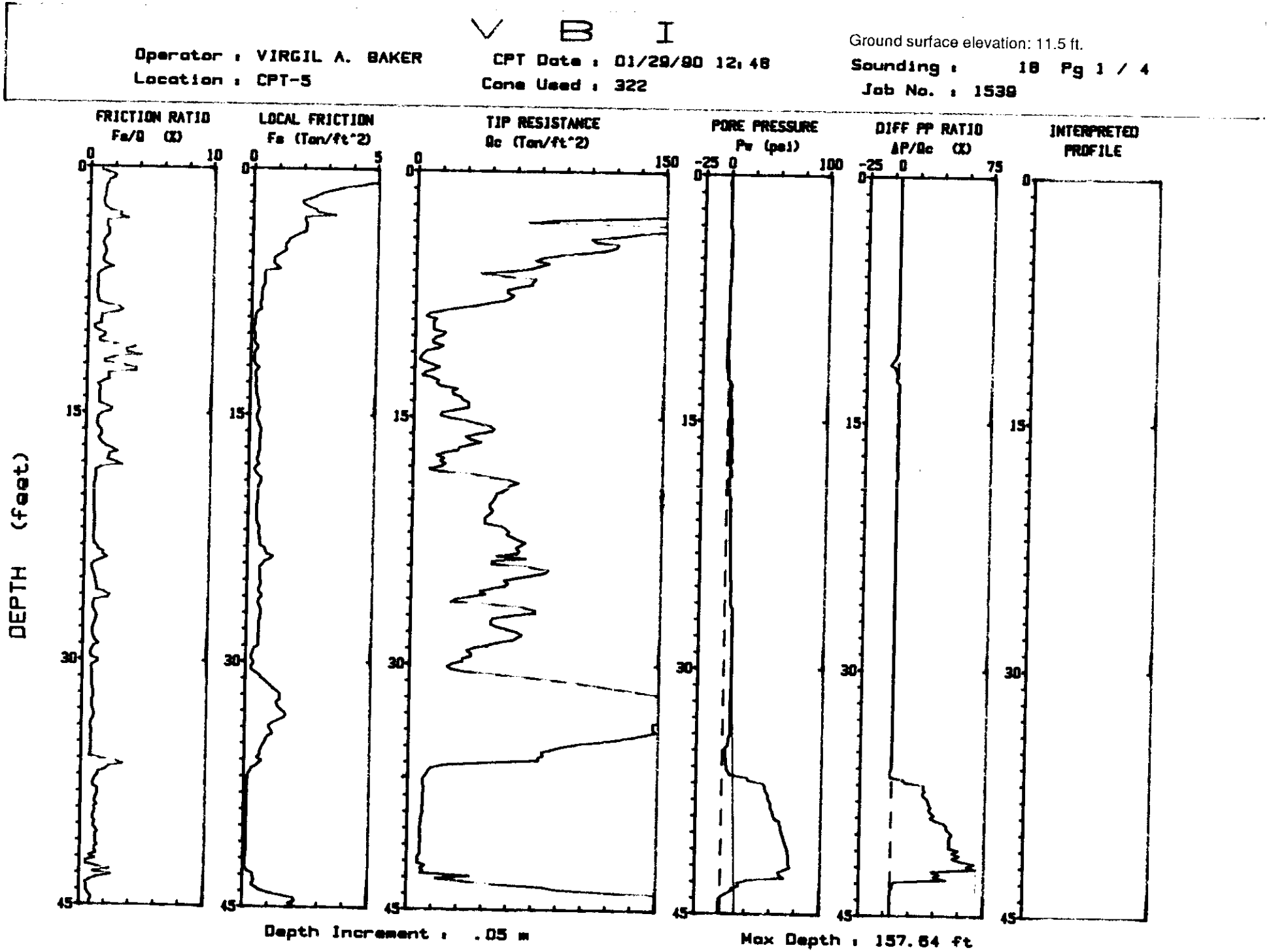
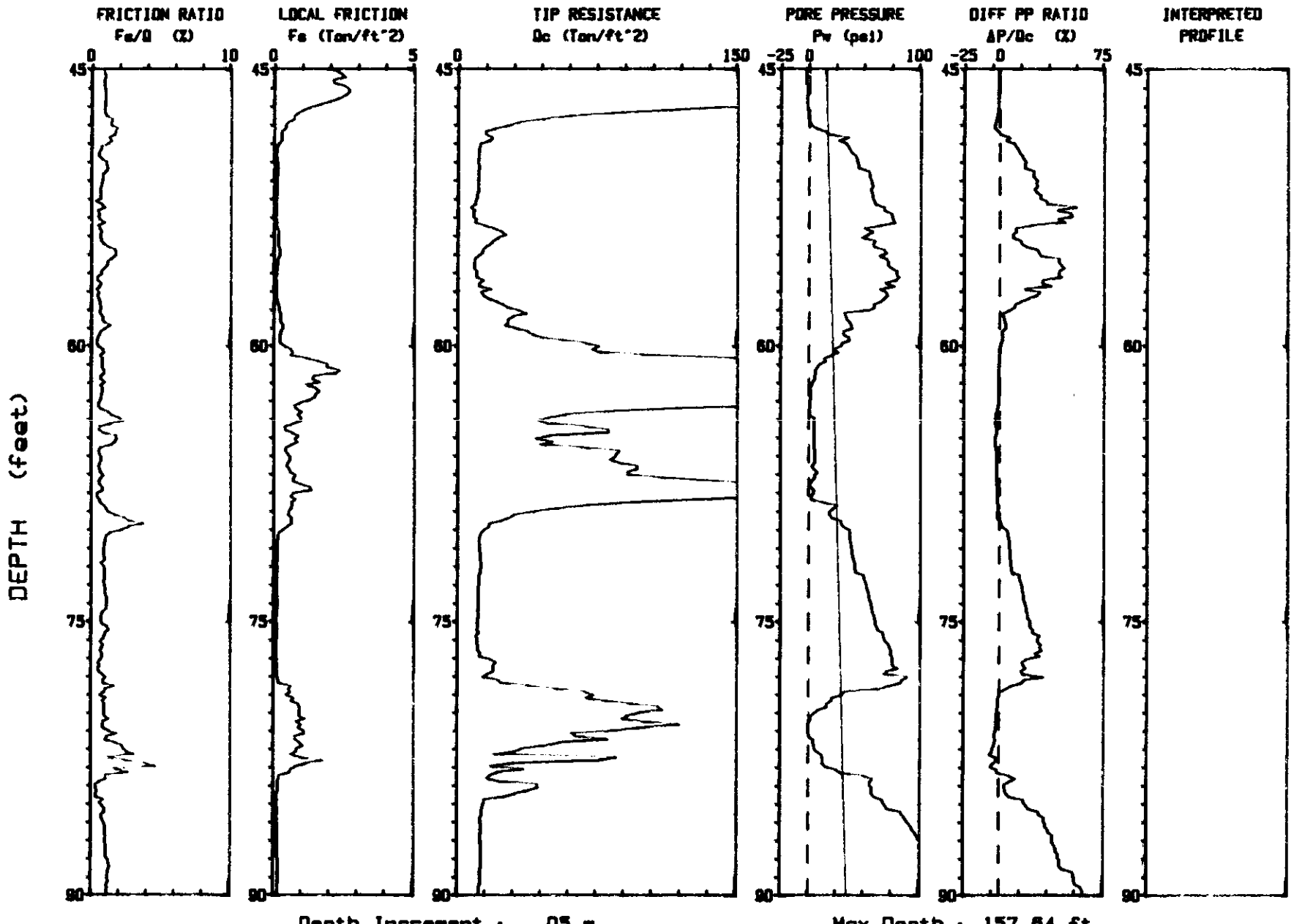

V B I
Operator : VIRGIL A. BAKER
Location : CPT-5
CPT Date : 01/29/90 12:48
Cone Used : 322
Ground surface elevation: 11.5 ft.
Sounding : 18 Pg 1 / 4
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.64 ft

Figure C-8

V B I

Operator : VIRGIL A. BAKER CPT Date : 01/29/90 12:48 Sounding : 18 Pg 2 / 4

Location : CPT-5 Cone Used : 322 Job No. : 1539



Depth Increment : .05 m Max Depth : 157.64 ft

Figure C-9

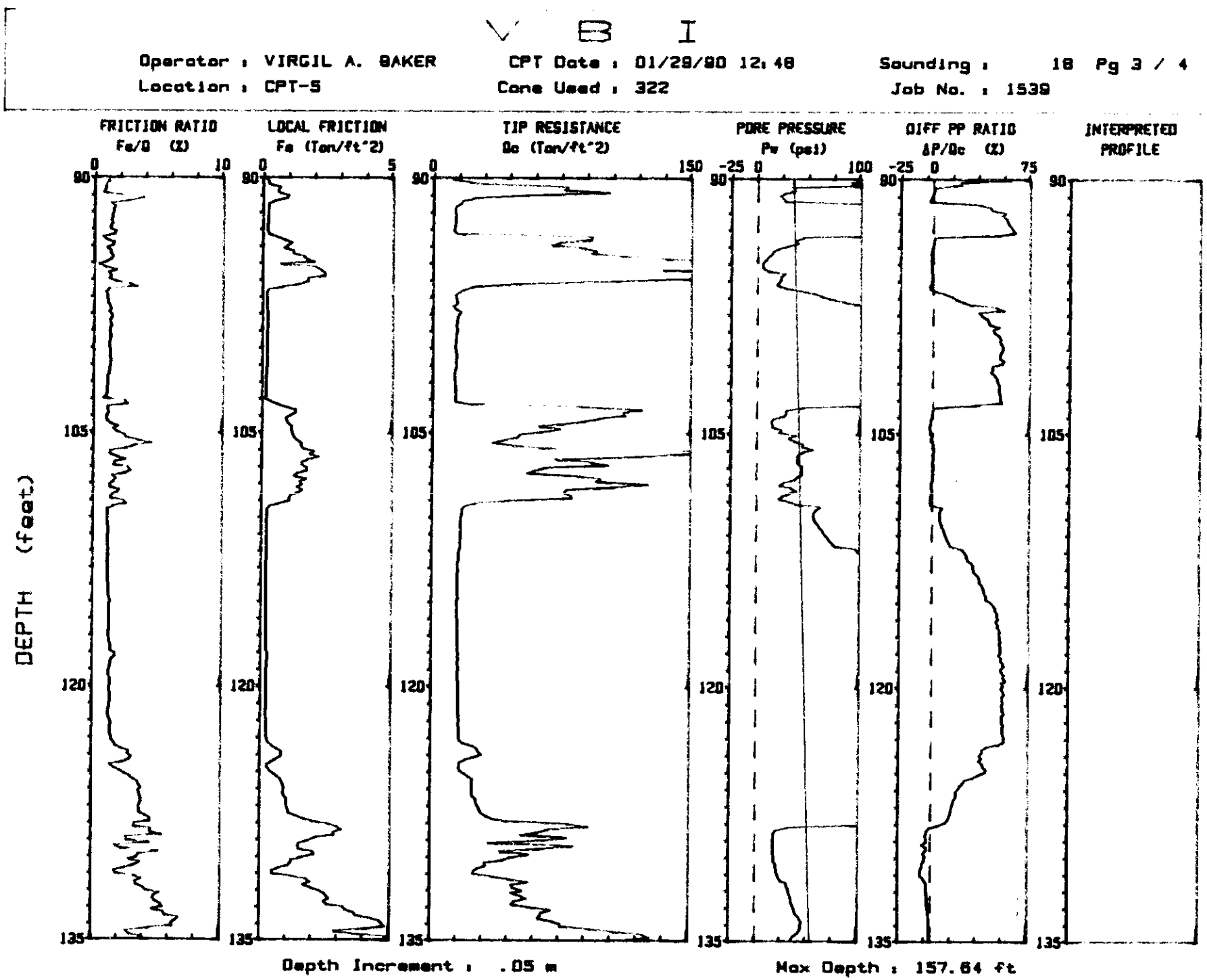

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/29/90 12:48
Sounding : 18 Pg 3 / 4
Location : CPT-5
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.64 ft

Figure C-10

V B I

Operator : VIRGIL A. BAKER CPT Date : 01/29/90 12:48 Sounding : 18 Pg 4 / 4

Location : CPT-5 Cone Used : 322 Job No. : 1538

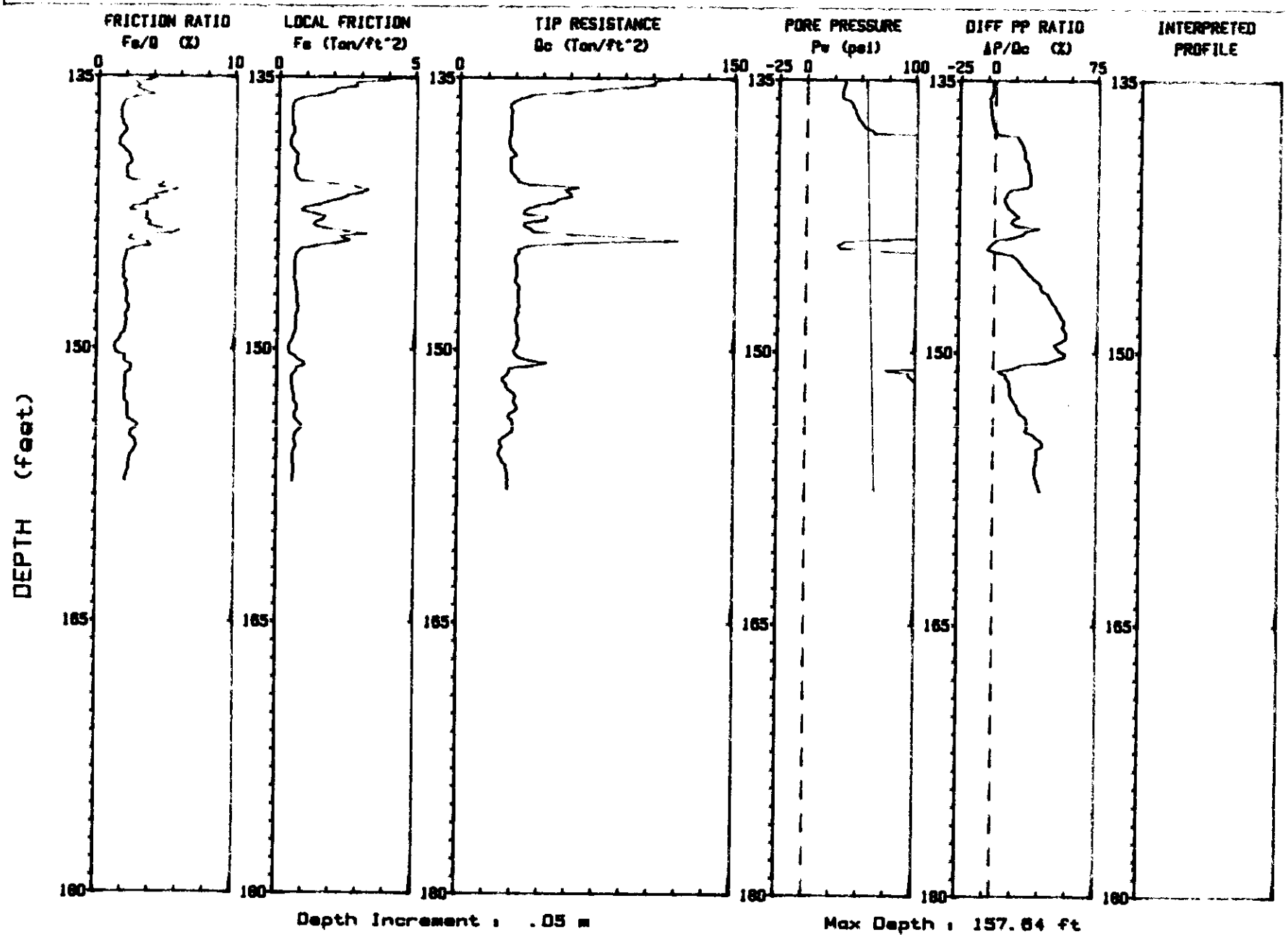


Figure C-11

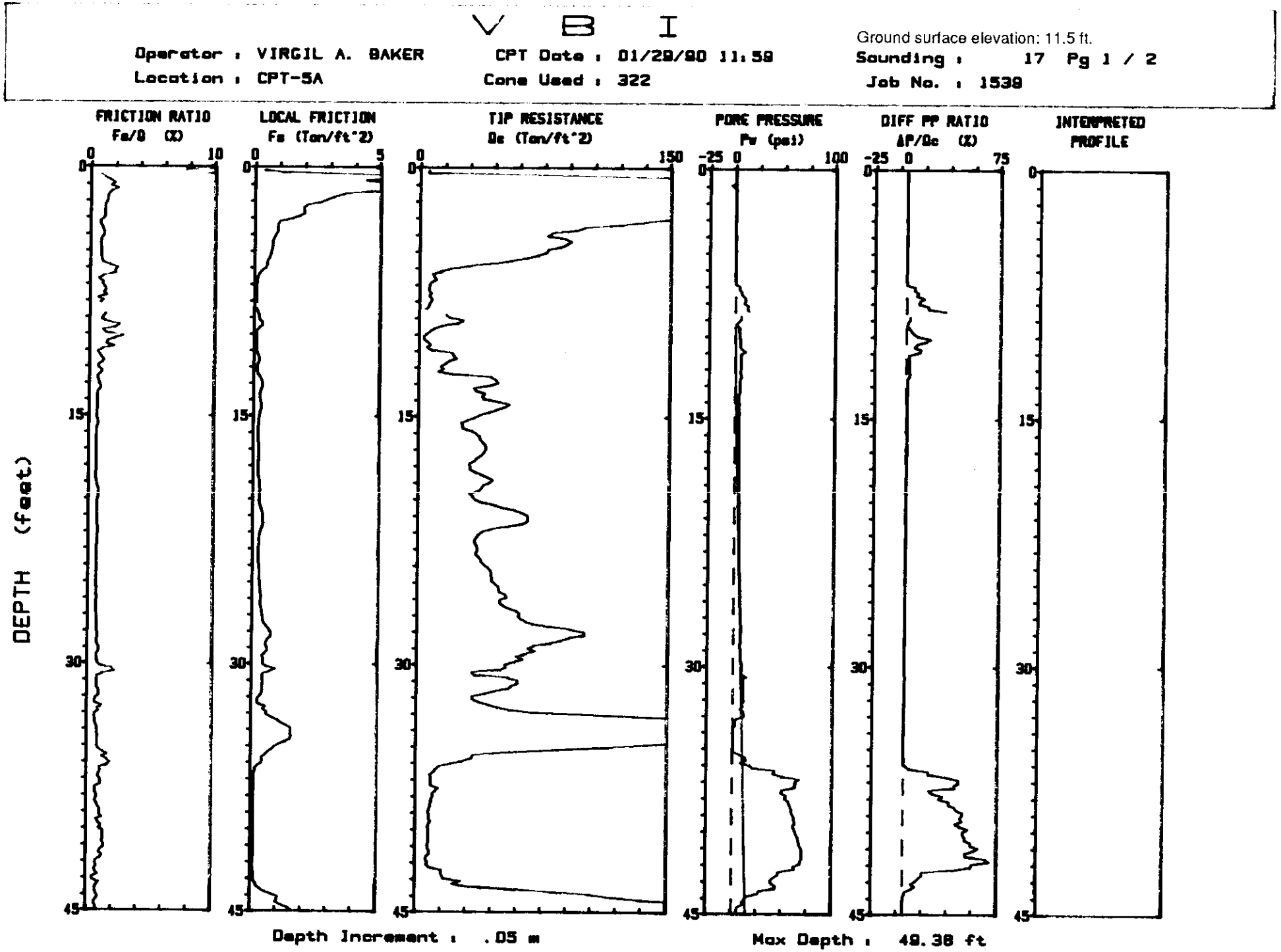
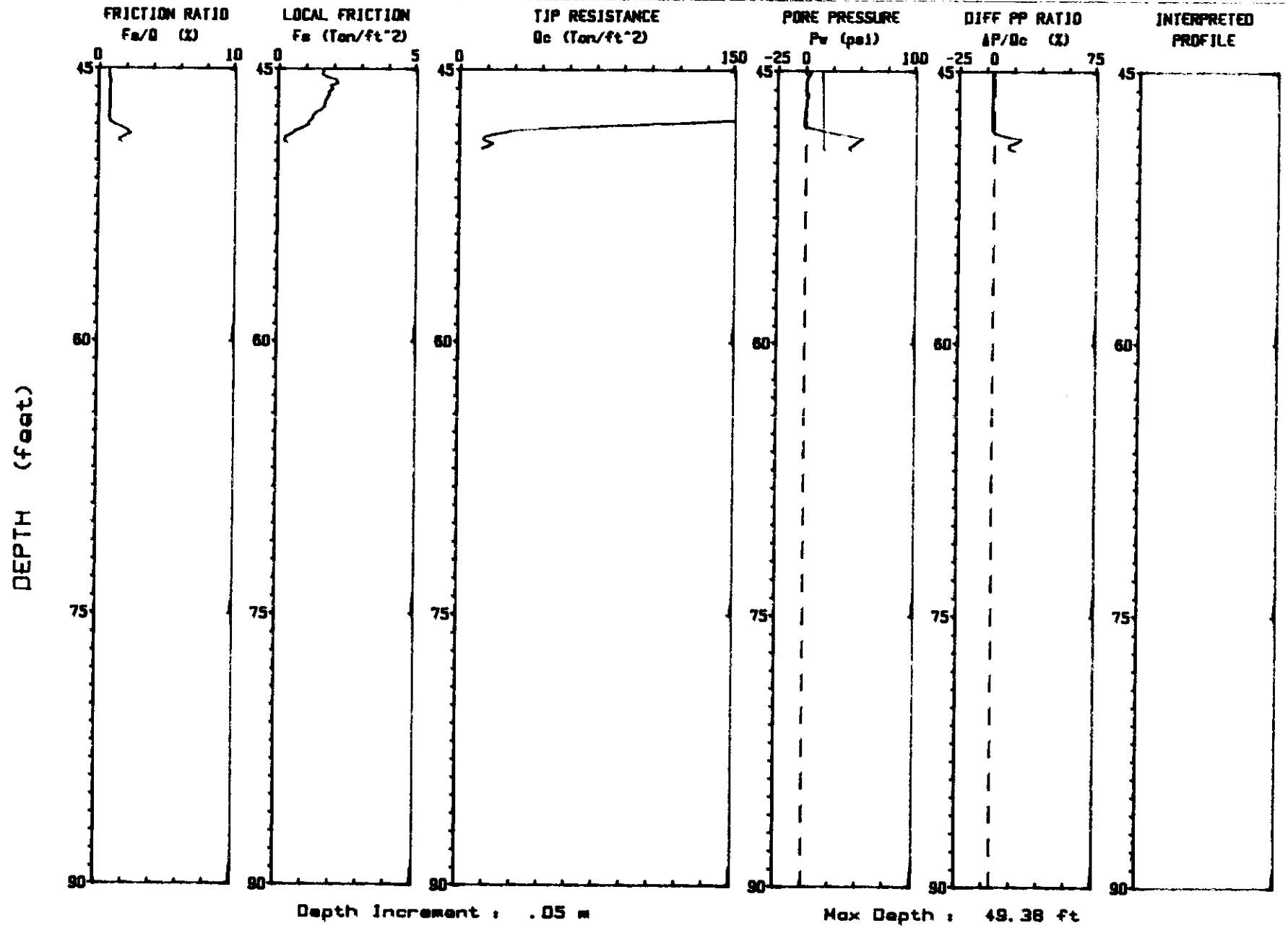

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/29/90 11:58
Ground surface elevation: 11.5 ft.
Sounding : 17 Pg 1 / 2
Location : CPT-5A
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 49.38 ft

Figure C-12

V B I

Operator : VIRGIL A. BAKER CPT Date : 01/29/90 11:59 Sounding : 17 Pg 2 / 2

Location : CPT-5A Cone Used : 322 Job No. : 1539



Depth Increment : .05 m Max Depth : 49.38 ft

Figure C-13

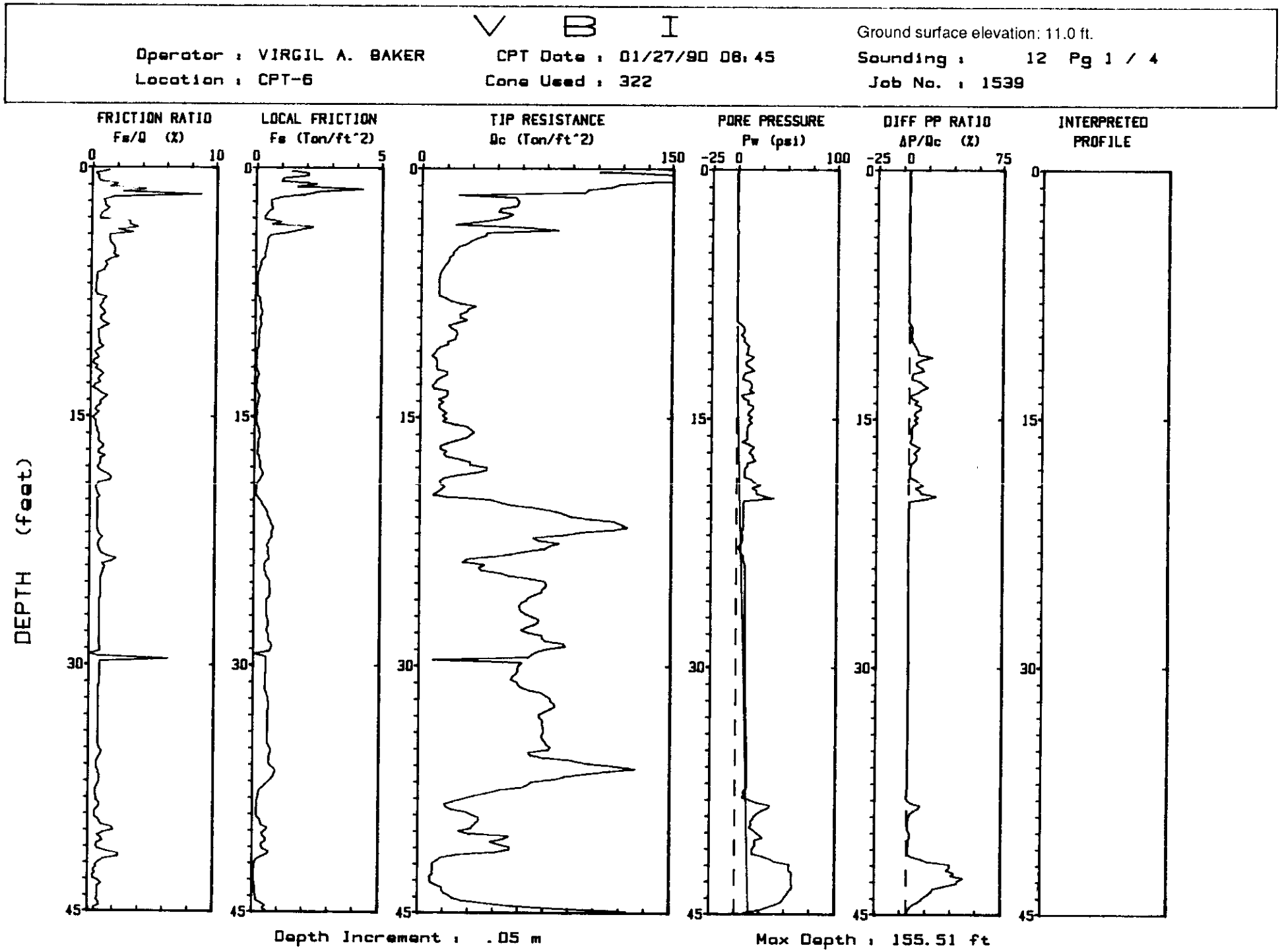

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/27/90 08:45
Ground surface elevation: 11.0 ft.
Location : CPT-6
Cone Used : 322
Sounding : 12 Pg 1 / 4
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 155.51 ft

Figure C-14

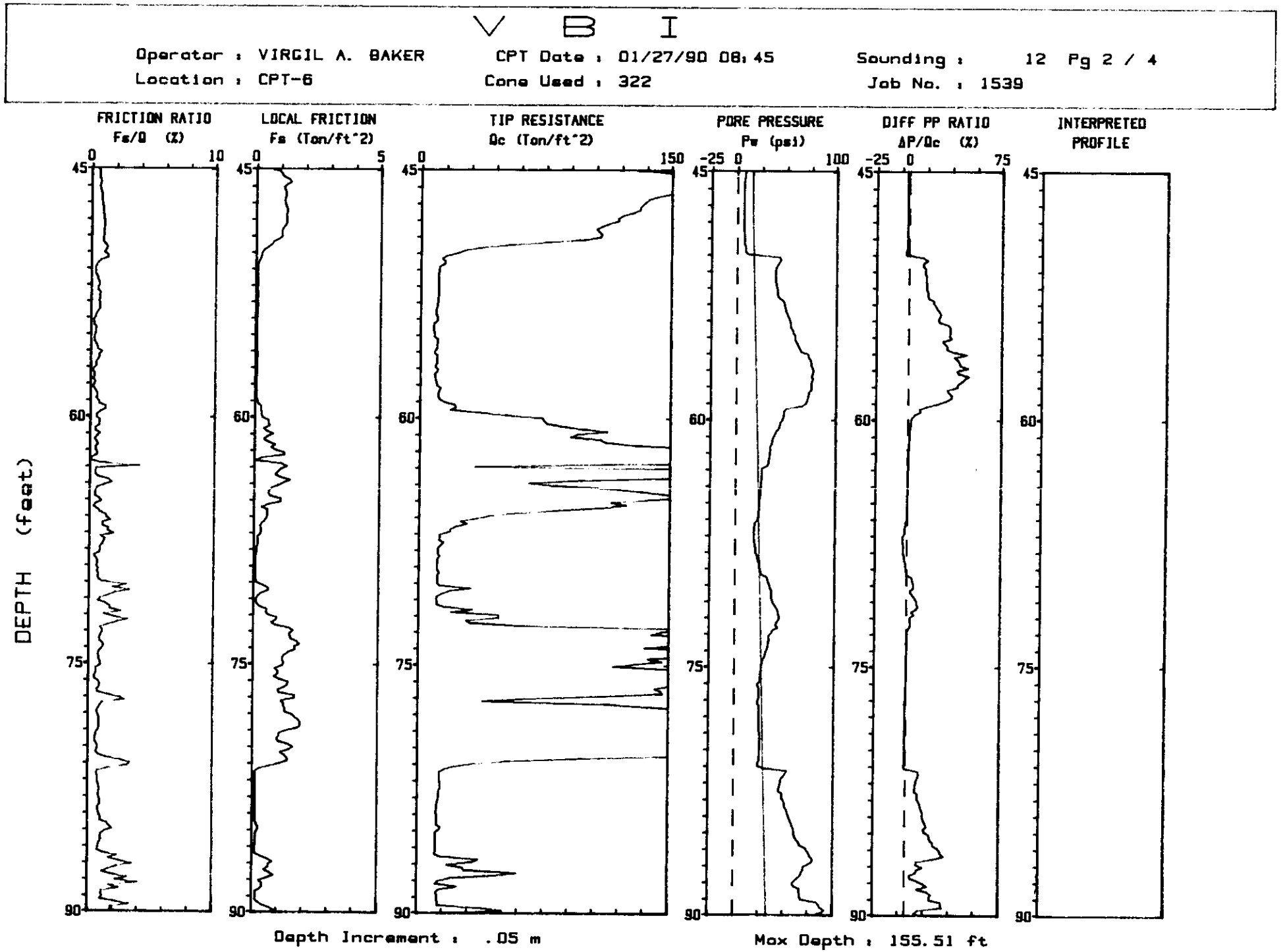

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/27/90 08:45
Sounding : 12 Pg 2 / 4
Location : CPT-6
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 155.51 ft

Figure C-15

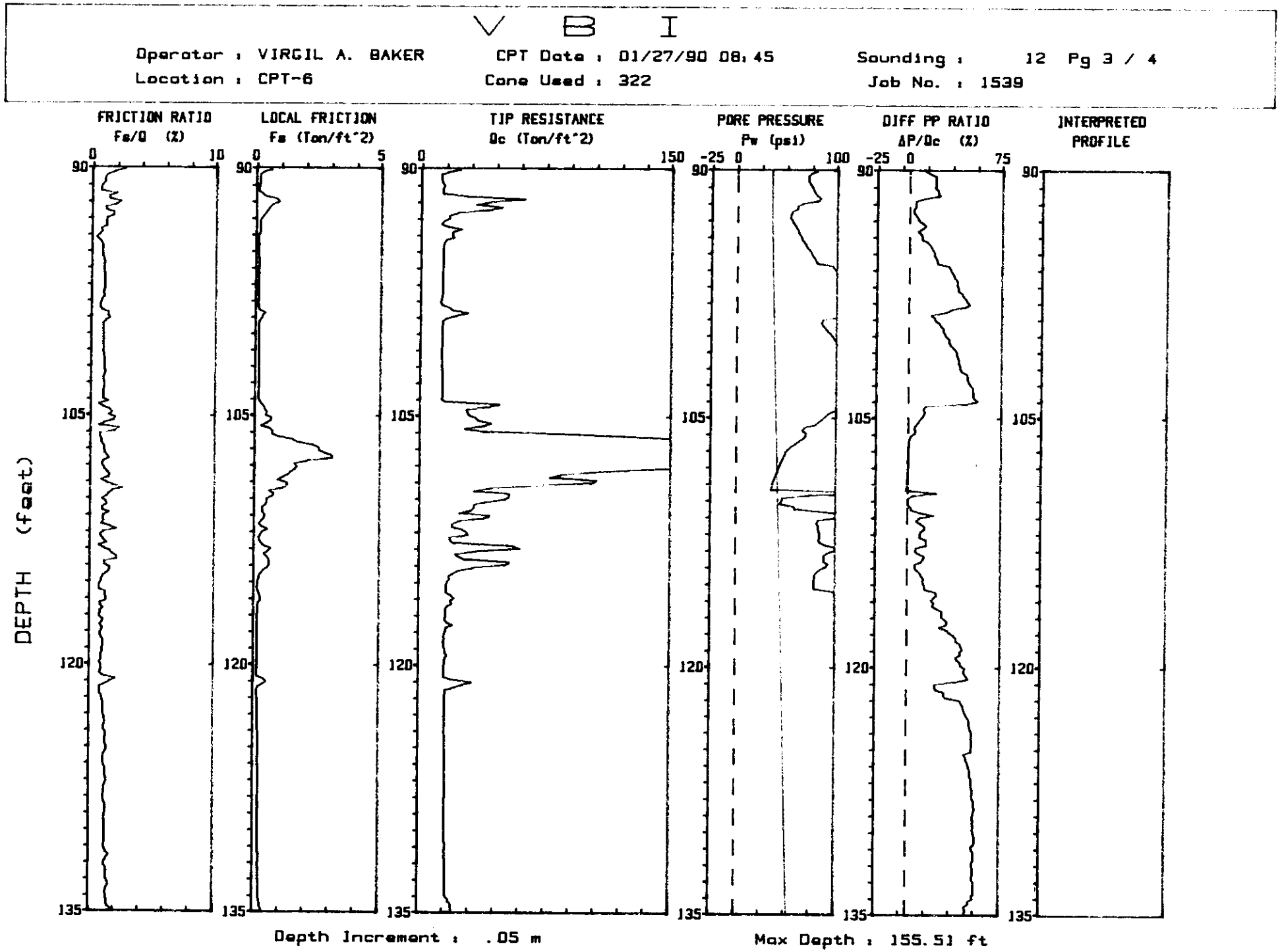

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/27/90 08:45
Sounding : 12 Pg 3 / 4
Location : CPT-6
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 155.51 ft

Figure C-16

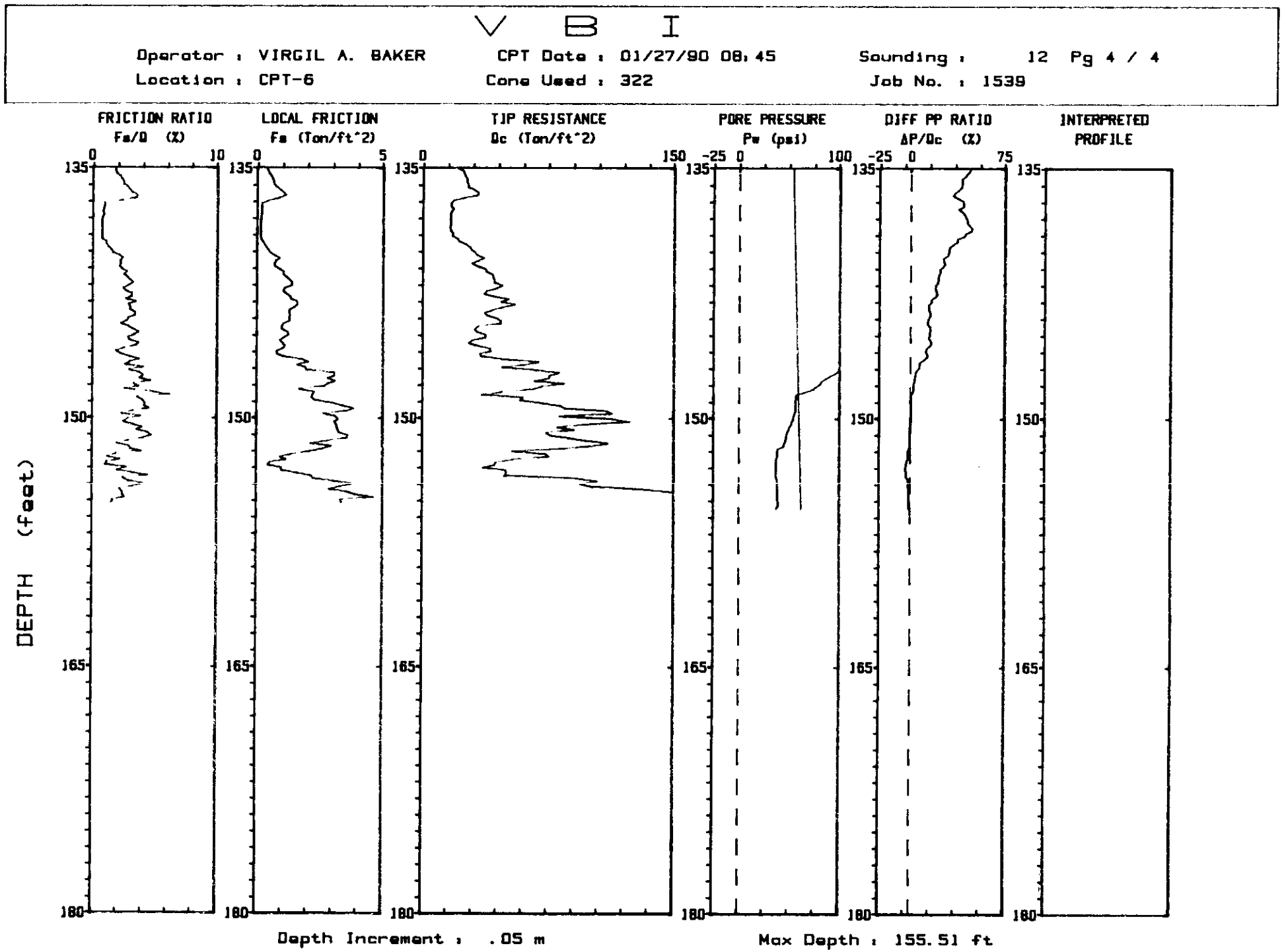

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/27/90 08:45
Sounding : 12 Pg 4 / 4
Location : CPT-6
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 155.51 ft

Figure C-17

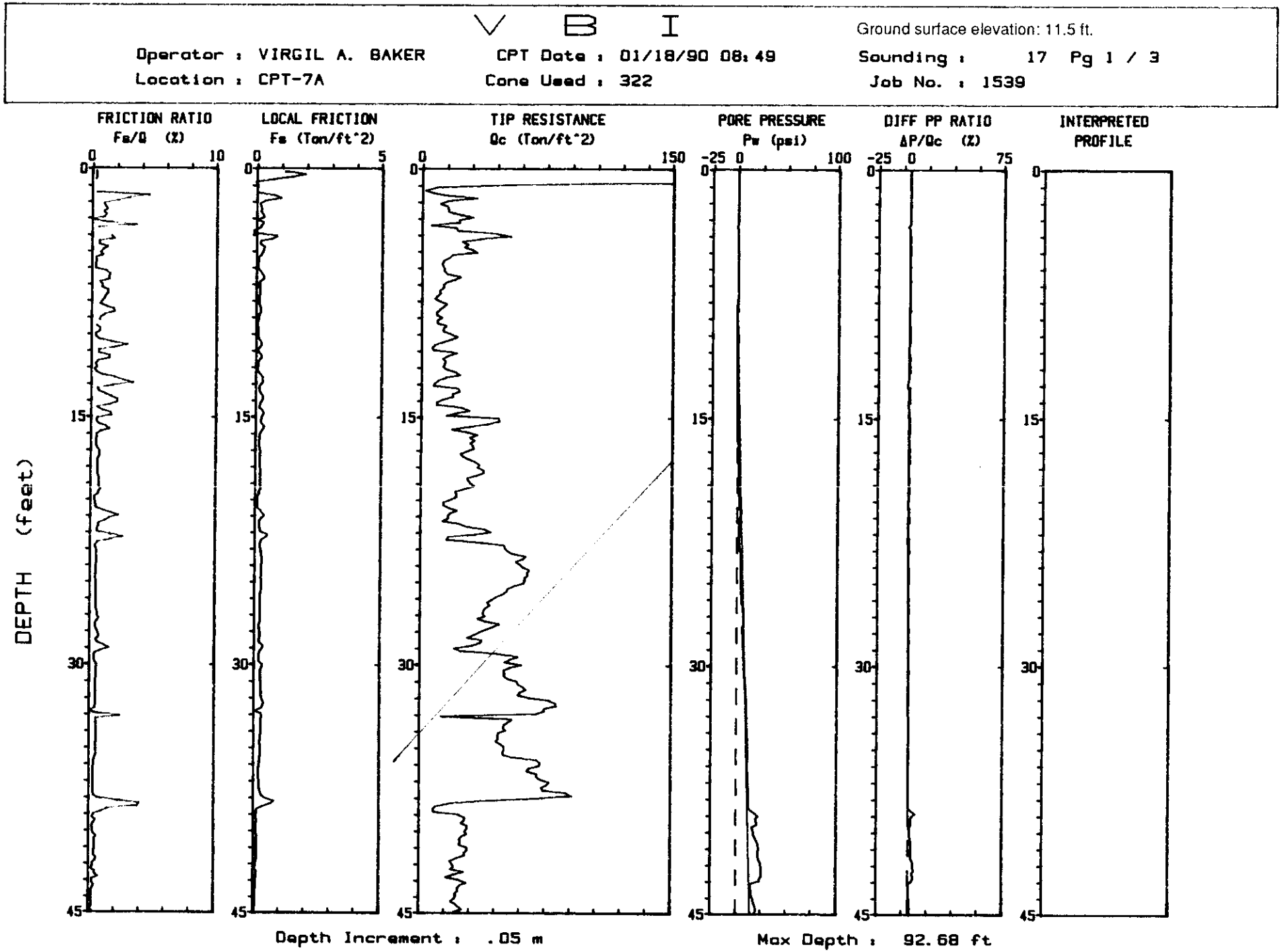

V B I
Ground surface elevation: 11.5 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 08:49
Sounding : 17 Pg 1 / 3
Location : CPT-7A
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 92.68 ft

Figure C-18

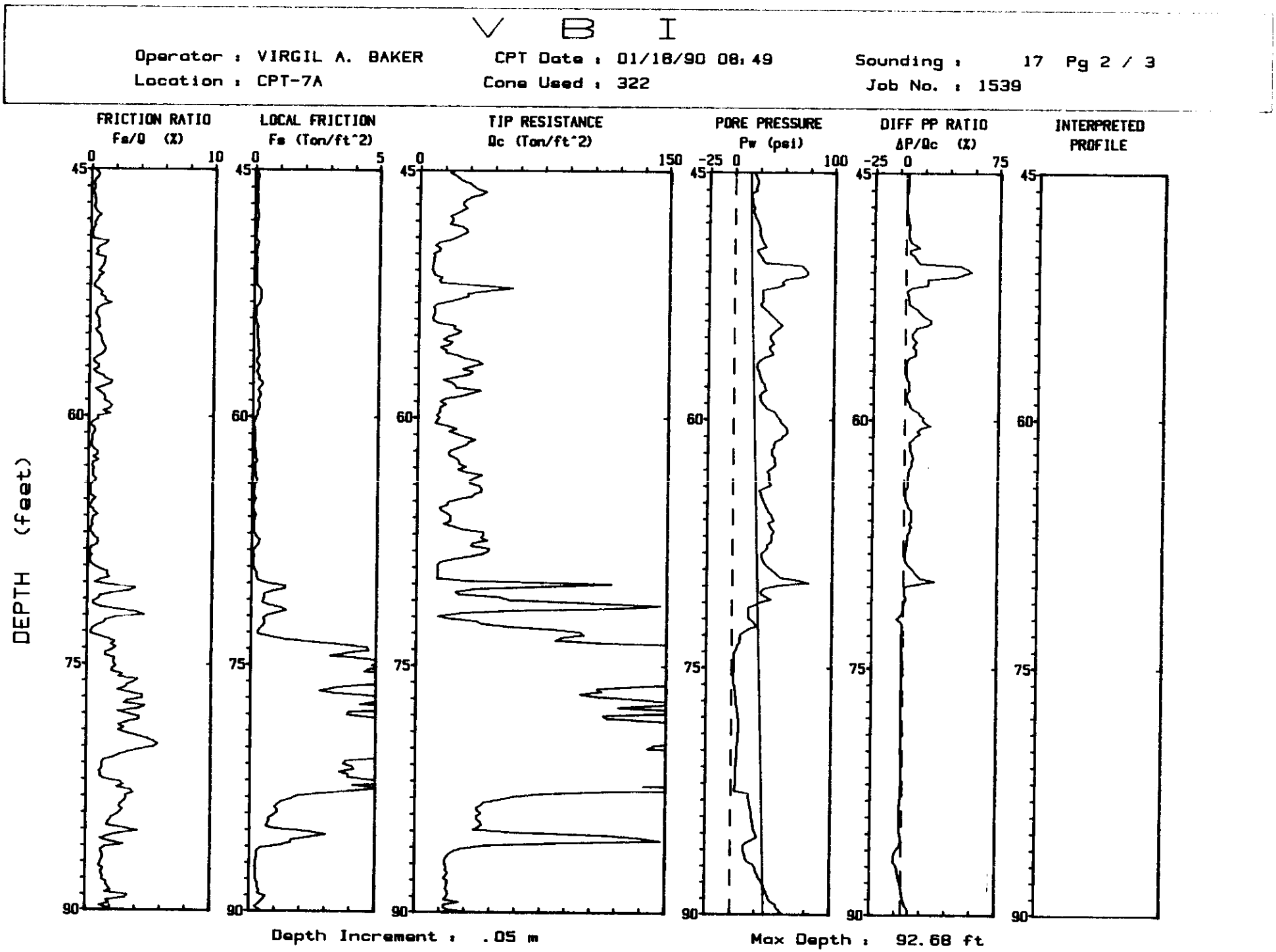

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 08:49
Sounding : 17 Pg 2 / 3
Location : CPT-7A
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 92.68 ft

Figure C-19

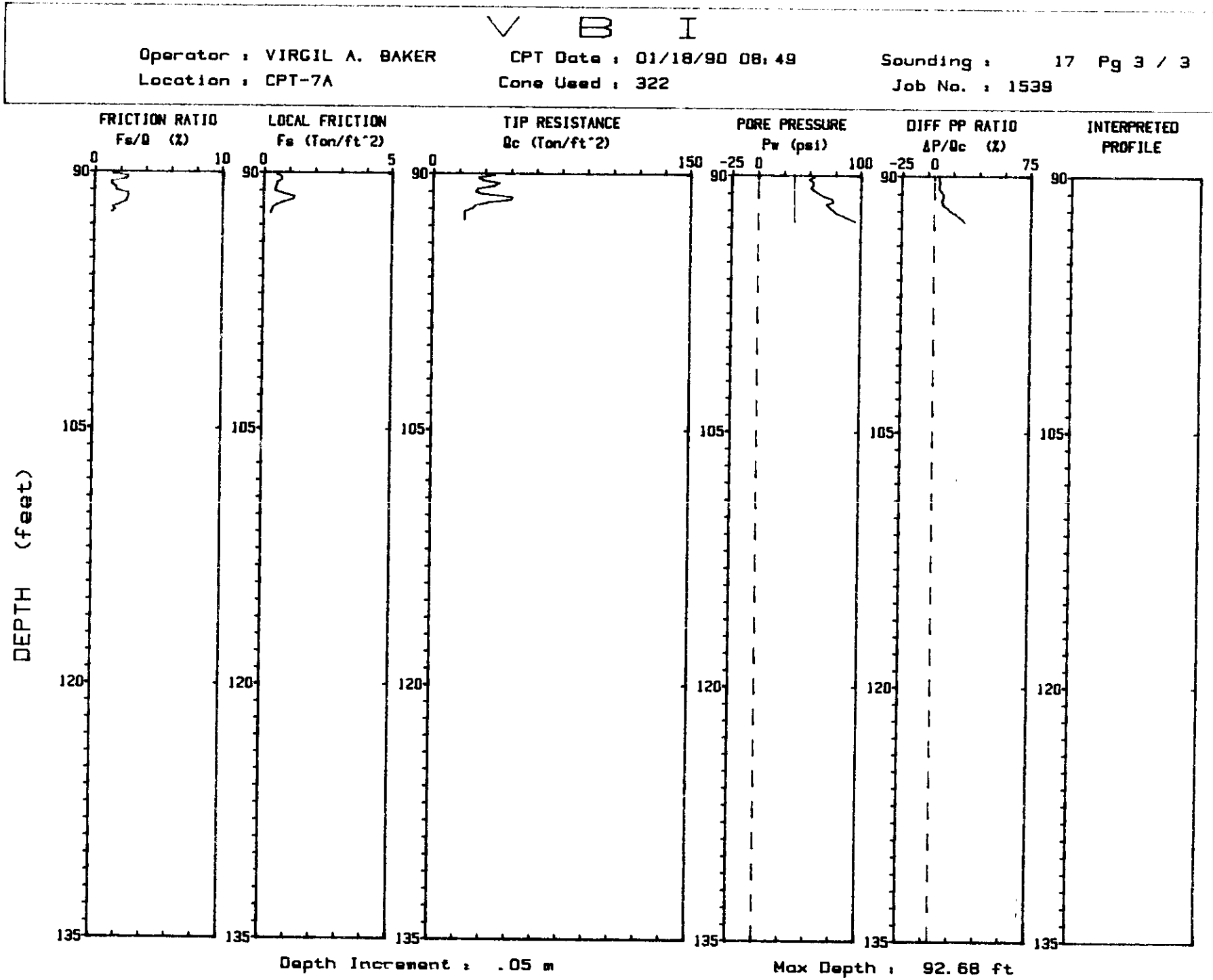

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 08:49
Sounding : 17 Pg 3 / 3
Location : CPT-7A
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 92.68 ft

Figure C-20

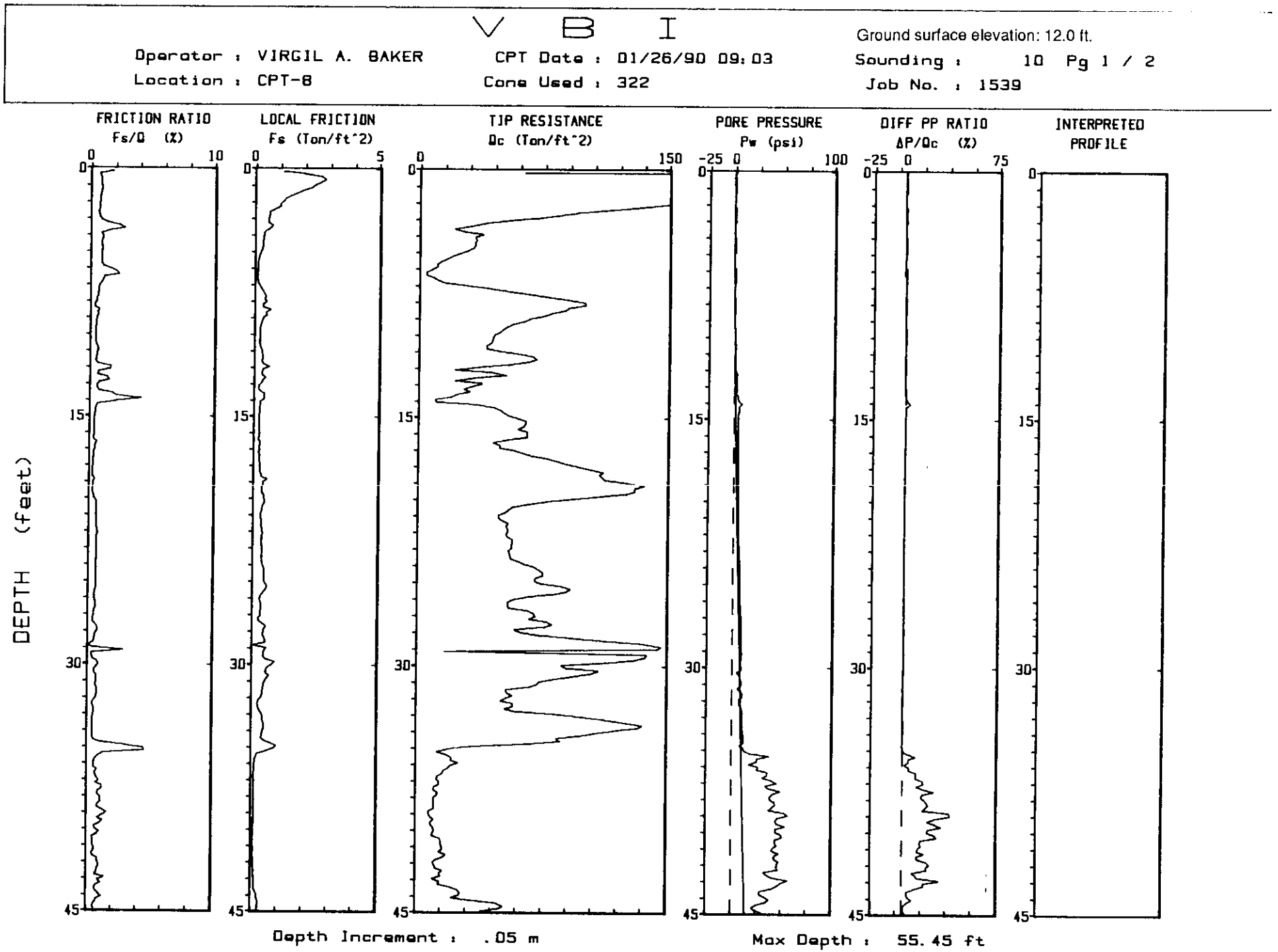

V B I
Operator : VIRGIL A. BAKER
Location : CPT-8
CPT Date : 01/26/90 09:03
Cone Used : 322
Ground surface elevation: 12.0 ft.
Sounding : 10 Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 55.45 ft

Figure C-21

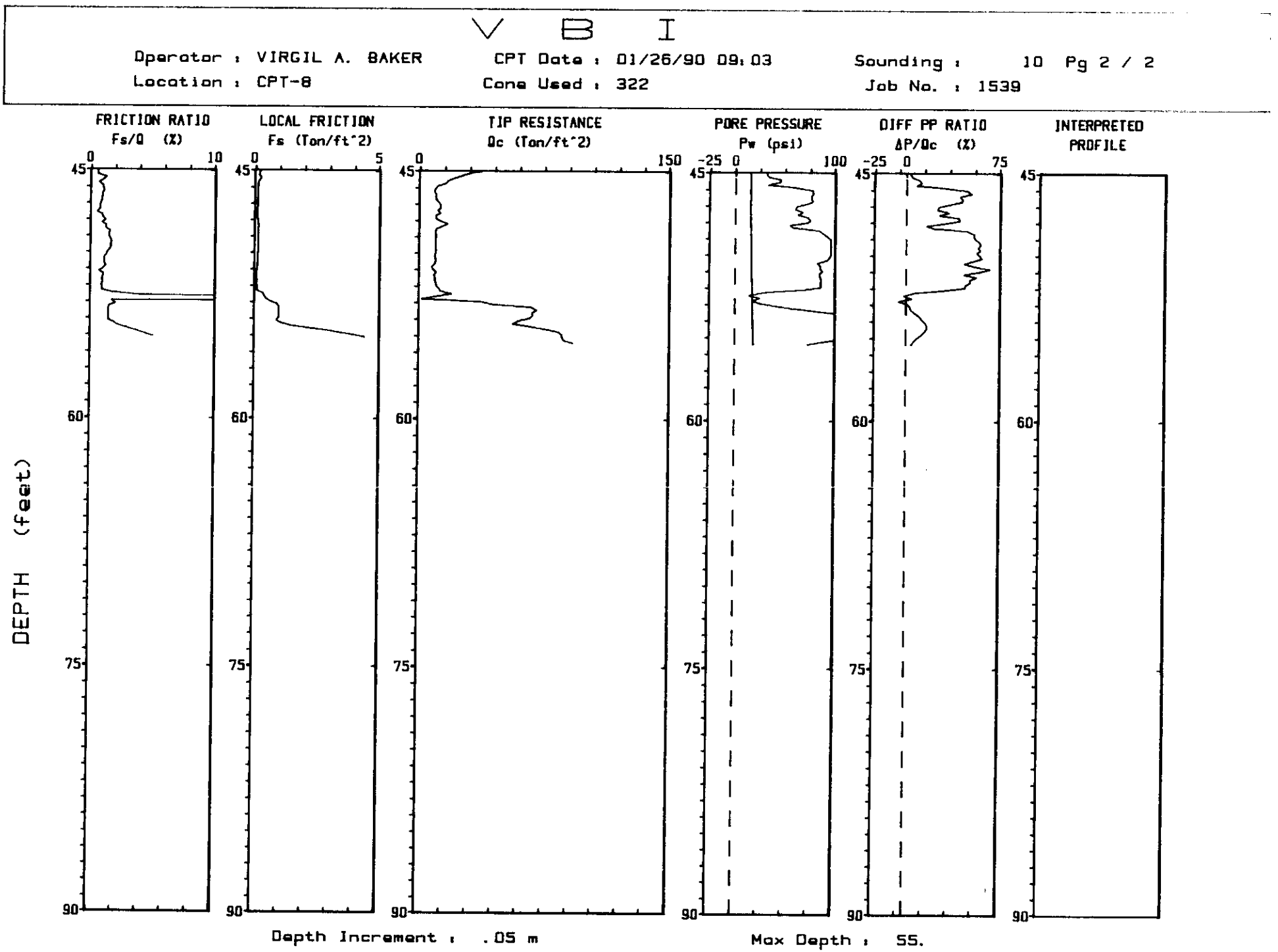

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/26/90 09:03
Sounding : 10 Pg 2 / 2
Location : CPT-8
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 55.

Figure C-22

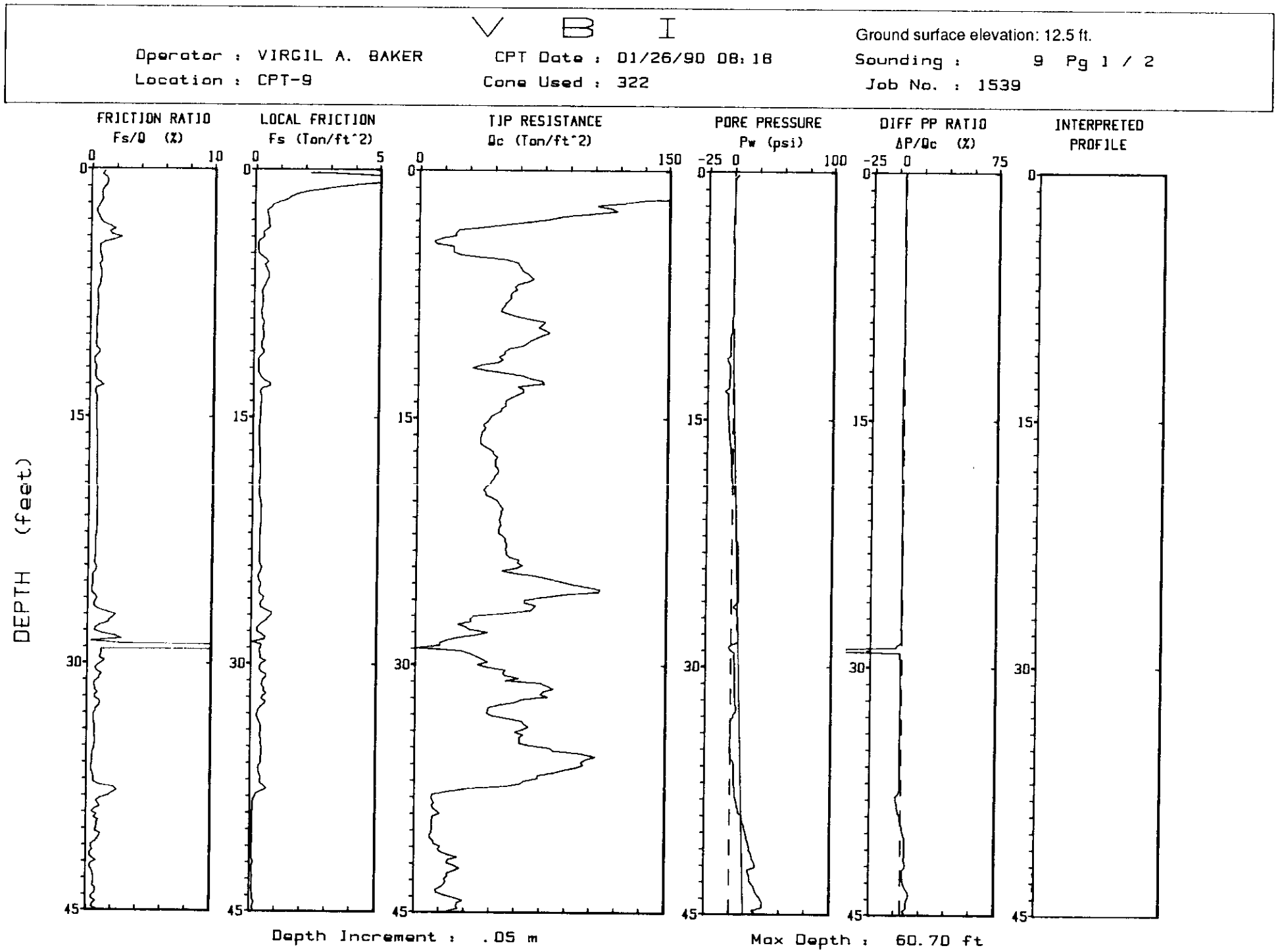

V B I
Operator : VIRGIL A. BAKER
Location : CPT-9
CPT Date : 01/26/90 08:18
Cone Used : 322
Ground surface elevation: 12.5 ft.
Sounding : 9 Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED
PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 60.70 ft

Figure C-23

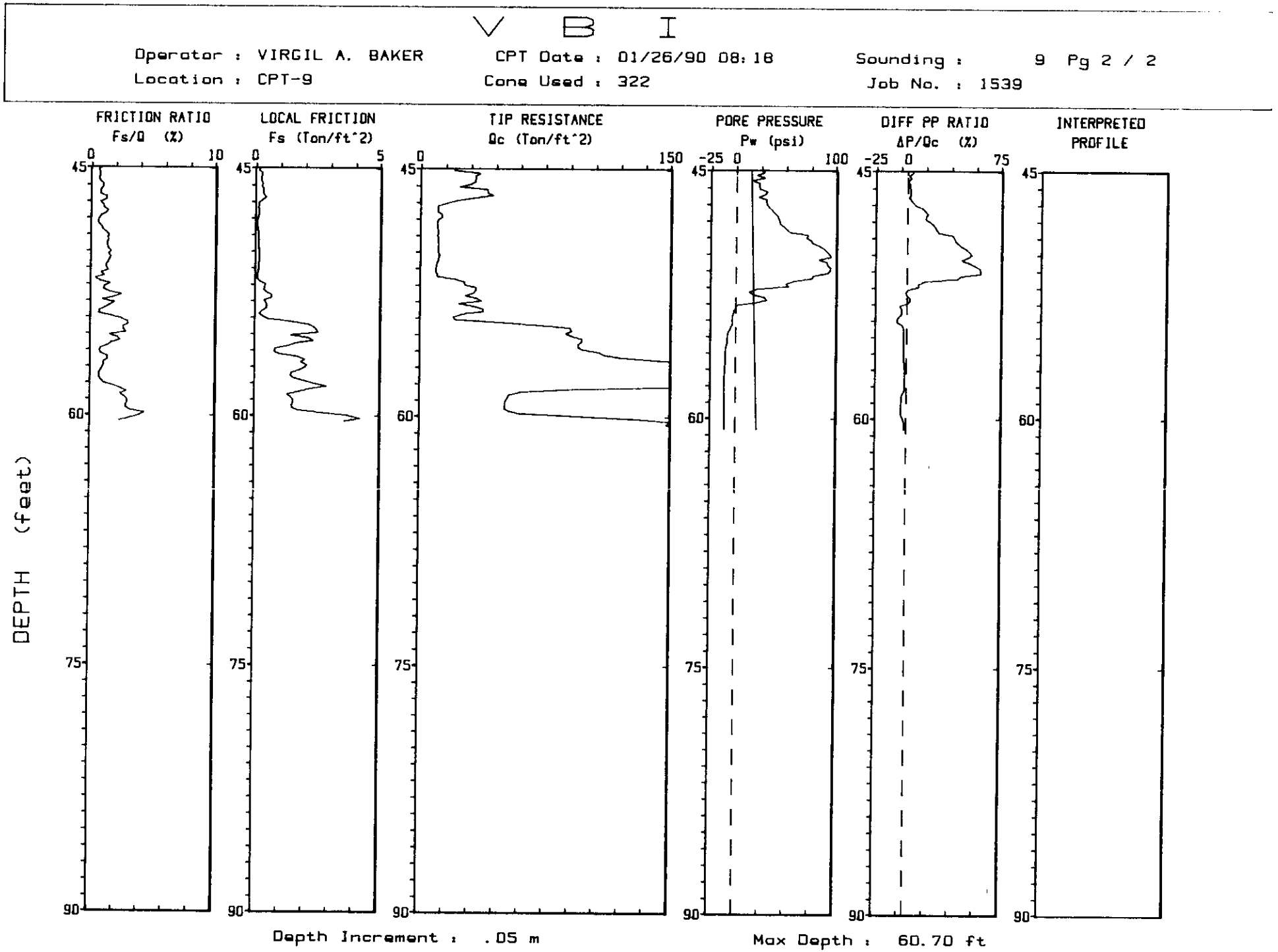

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/26/90 08:18
Sounding : 9 Pg 2 / 2
Location : CPT-9
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 60.70 ft

Figure C-24

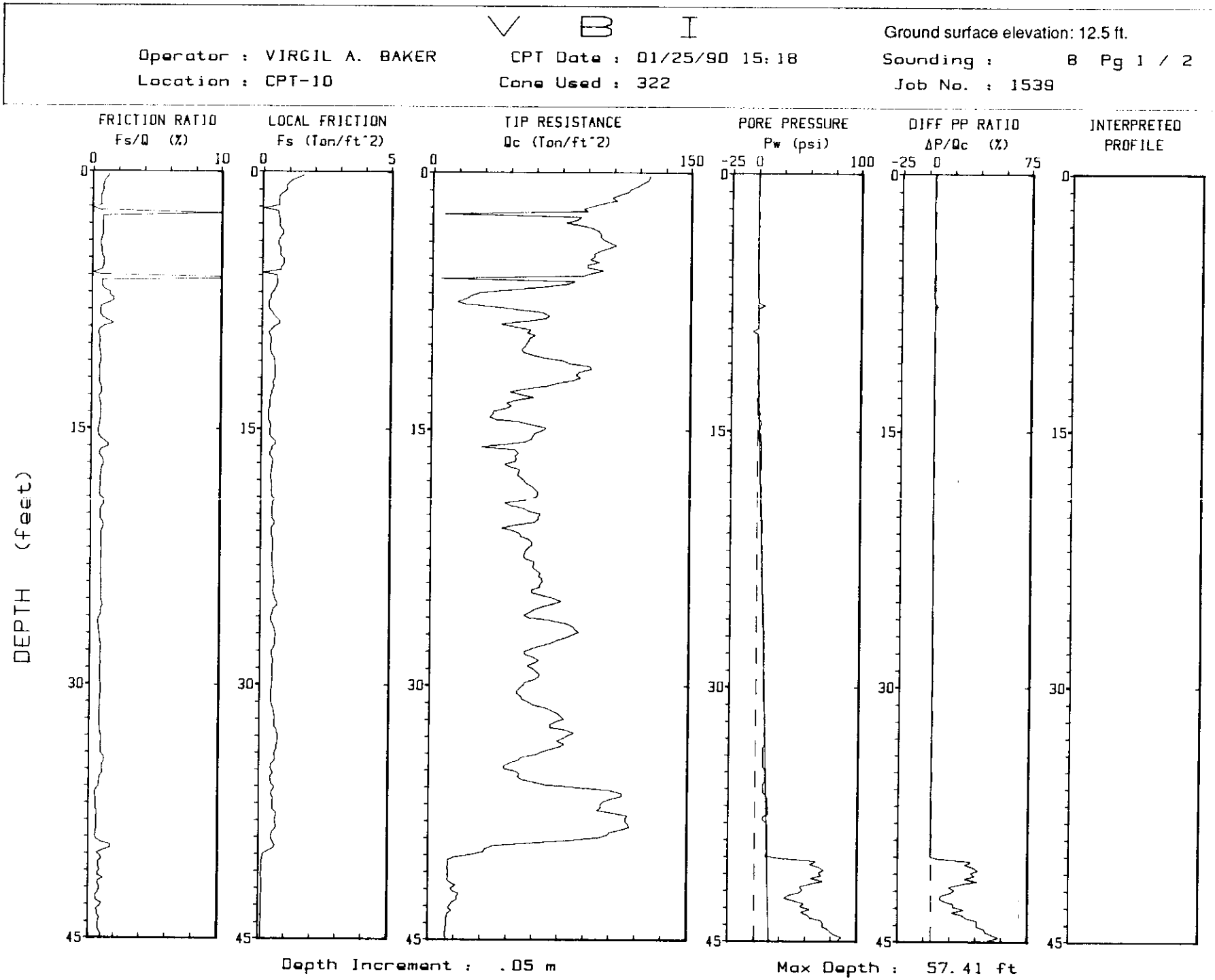

V B I
Operator : VIRGIL A. BAKER
Location : CPT-10
CPT Date : 01/25/90 15:18
Cone Used : 322
Ground surface elevation: 12.5 ft.
Sounding : B Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 57.41 ft

Figure C-25

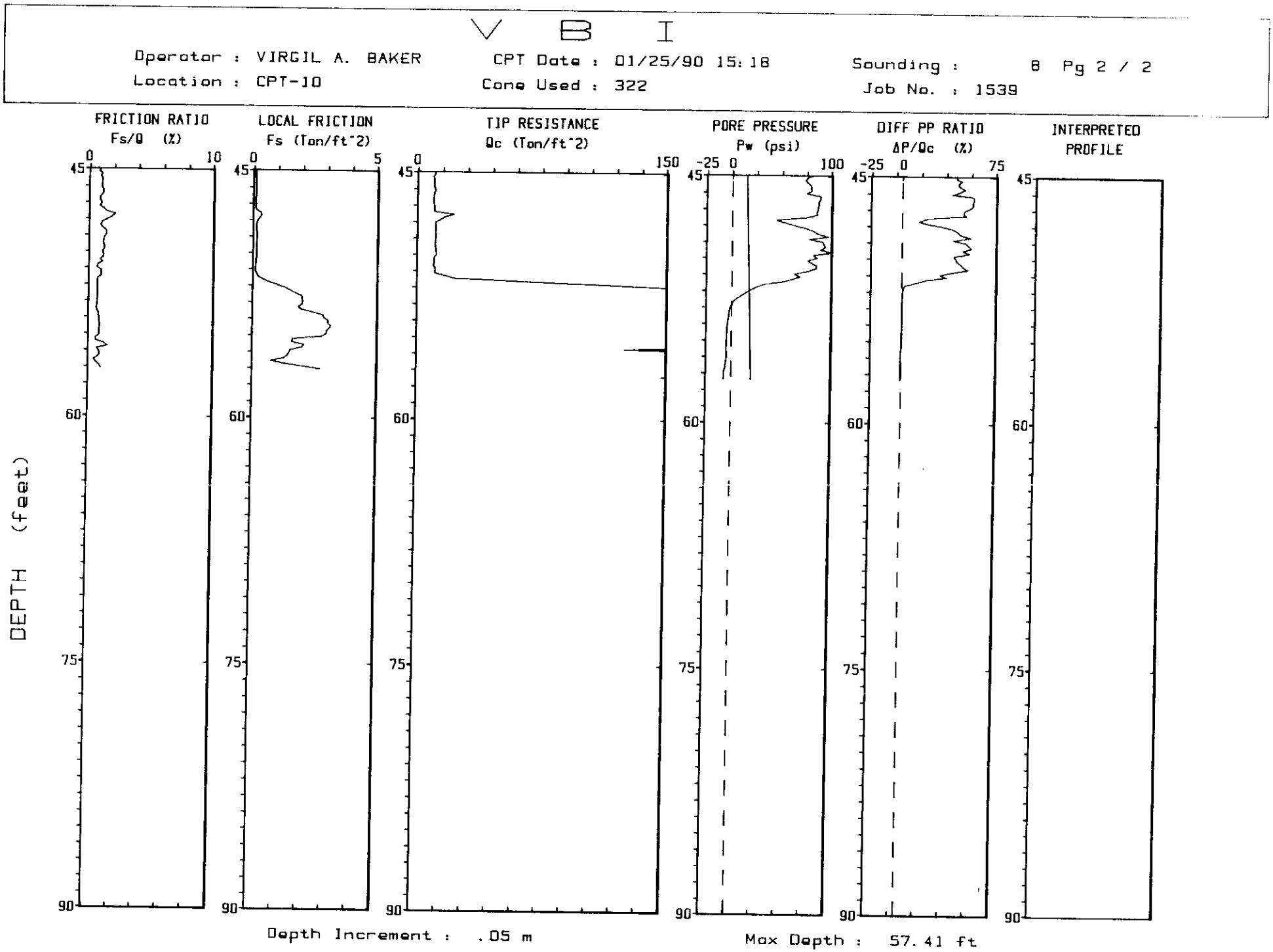

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/25/90 15:18
Sounding : 8 Pg 2 / 2
Location : CPT-10
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 57.41 ft

Figure C-26

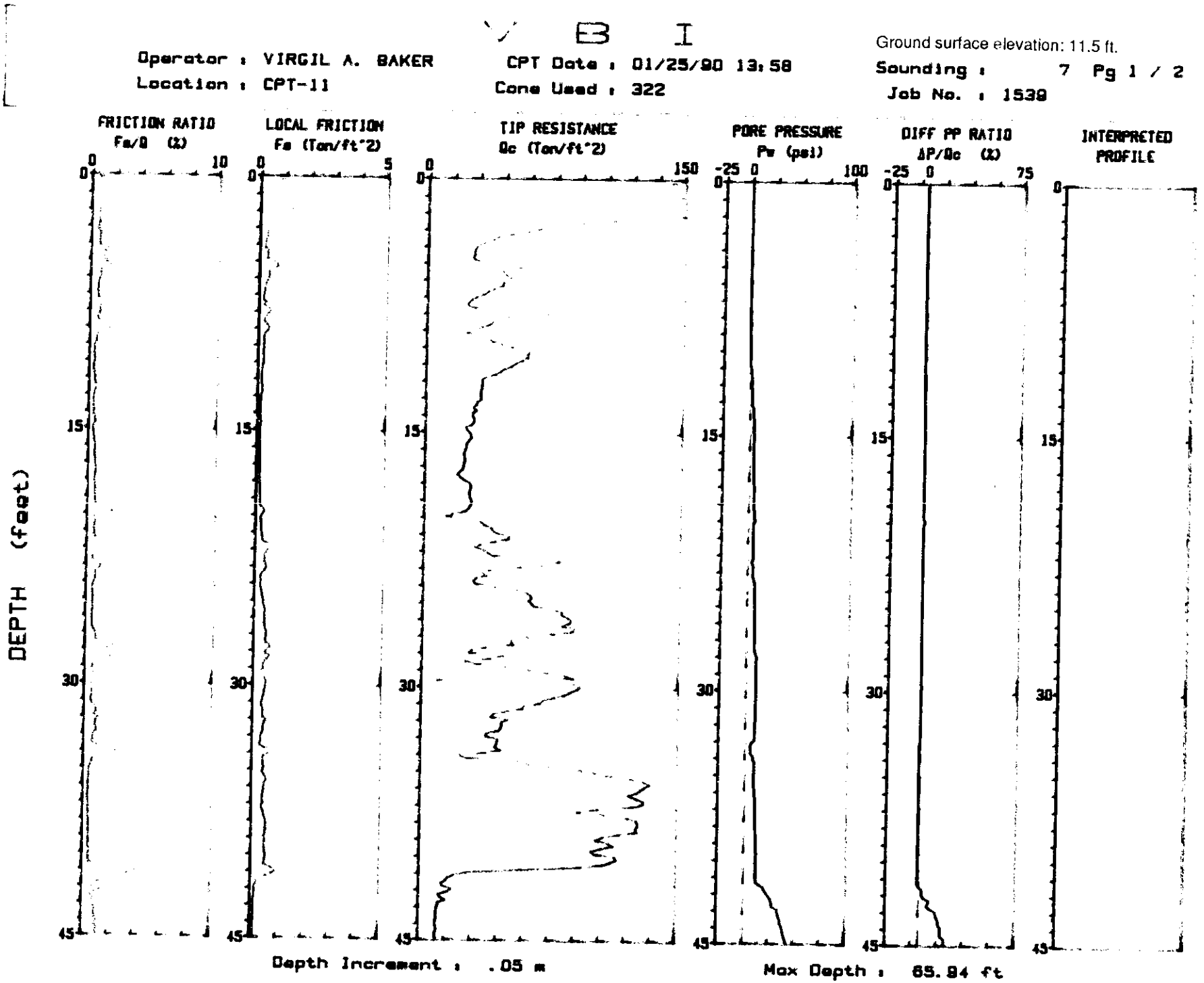

B I
Operator : VIRGIL A. BAKER
Location : CPT-11
CPT Date : 01/25/90 13:58
Cone Used : 322
Ground surface elevation: 11.5 ft.
Sounding : 7 Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 65.84 ft

Figure C-27

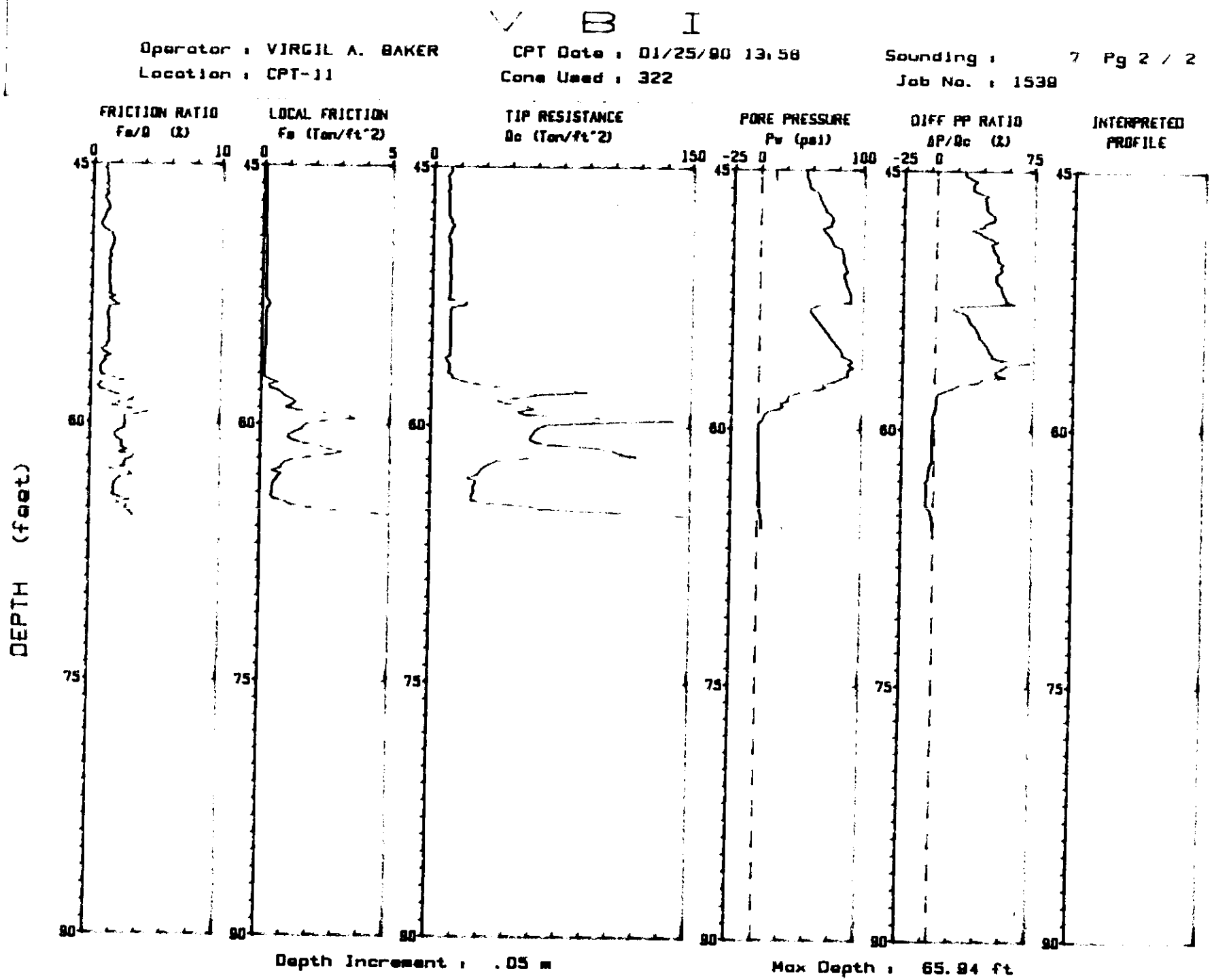

V B I
Operator : VIRGIL A. BAKER
Location : CPT-11
CPT Date : 01/25/90 13:58
Cone Used : 322
Sounding : 7 Pg 2 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 65.94 ft

Figure C-28

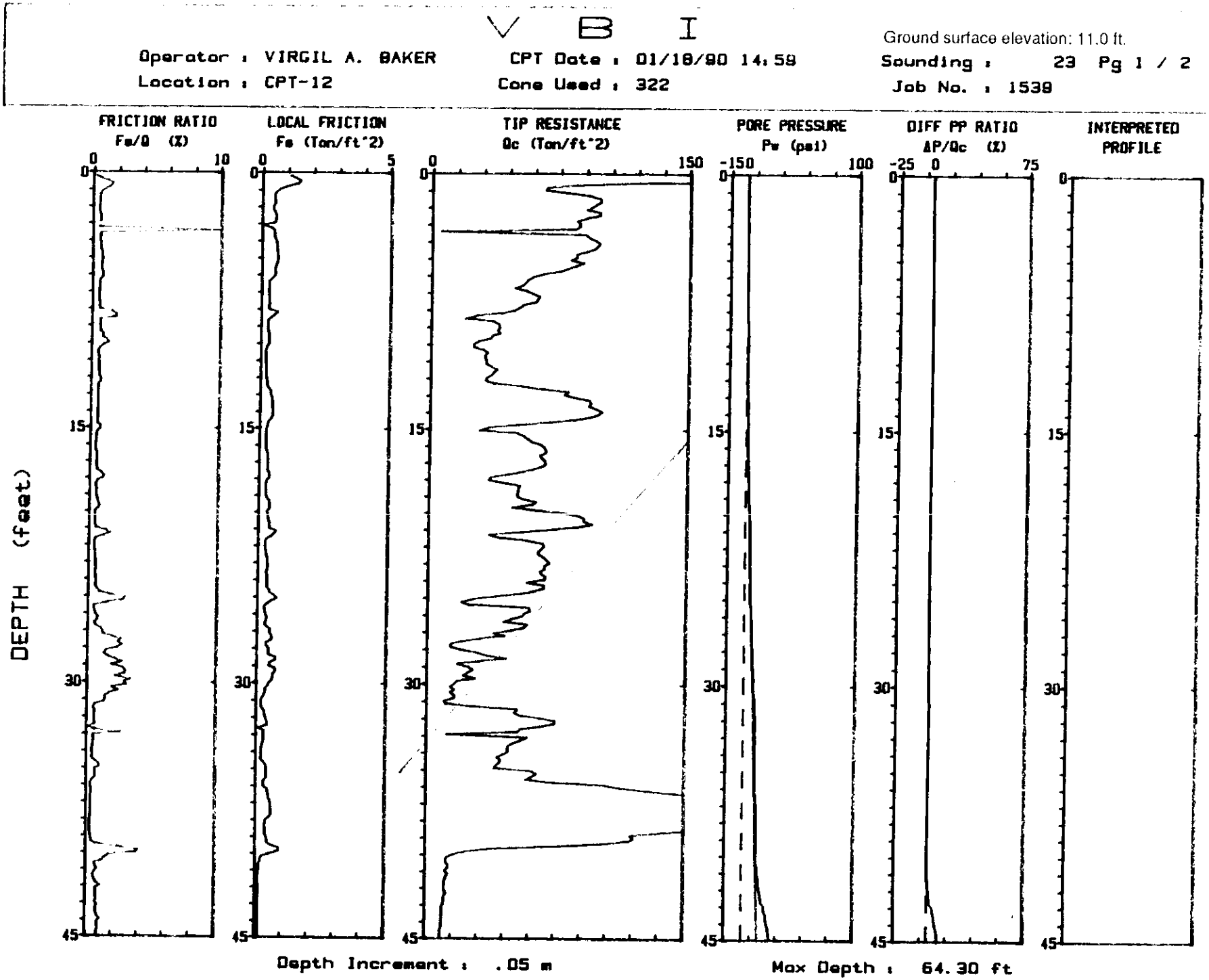
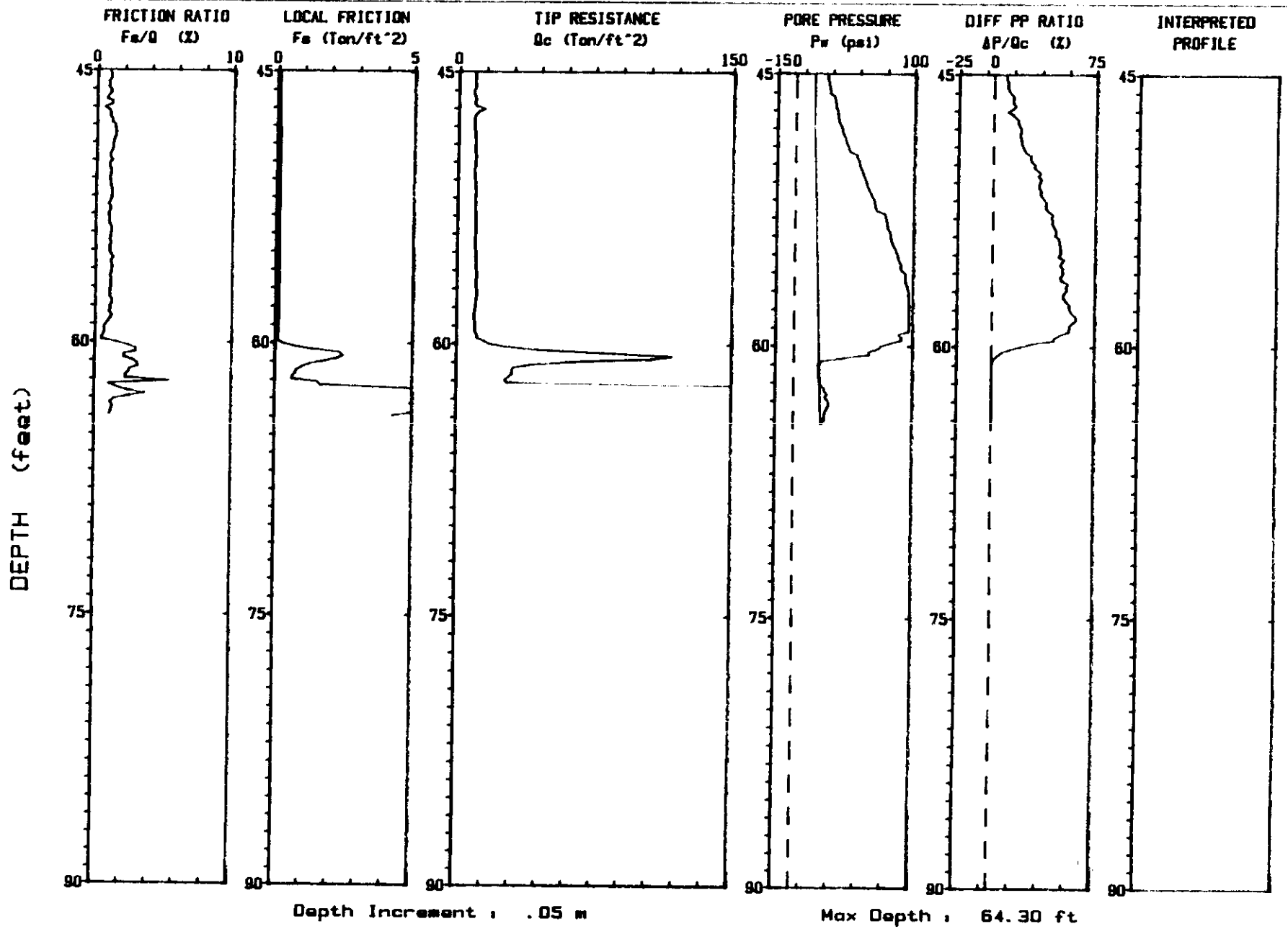

V B I
Operator : VIRGIL A. BAKER
Location : CPT-12
CPT Date : 01/18/90 14:59
Cone Used : 322
Ground surface elevation: 11.0 ft.
Sounding : 23 Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 64.30 ft

Figure C-29

V B I

Operator : VIRGIL A. BAKER CPT Date : 01/18/90 14:59 Sounding : 23 Pg 2 / 2

Location : CPT-12 Cone Used : 322 Job No. : 1538



Depth Increment : .05 m Max Depth : 64.30 ft

Figure C-30

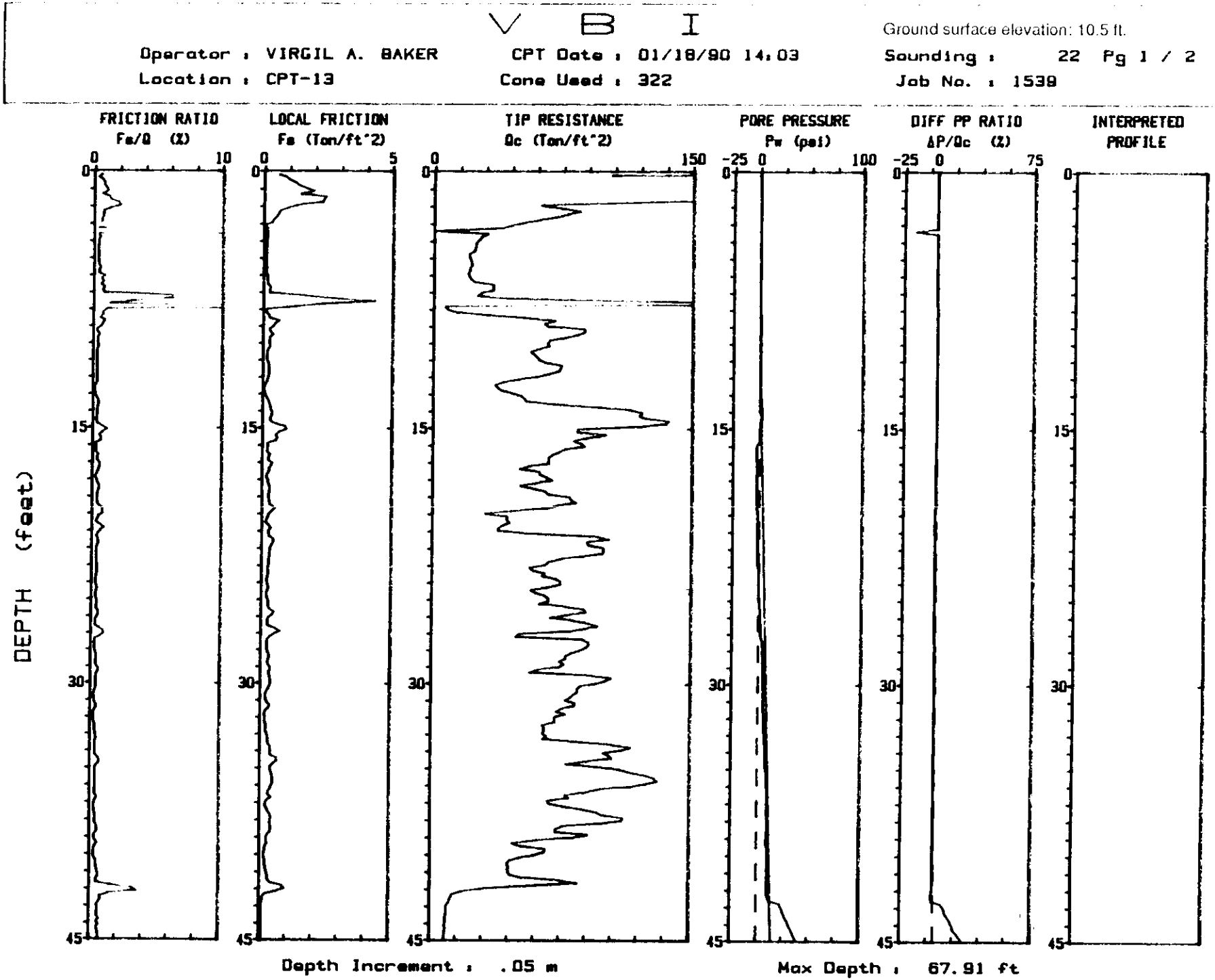

V B I
Ground surface elevation: 10.5 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 14:03
Sounding : 22 Pg 1 / 2
Location : CPT-13
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 67.91 ft

Figure C-31

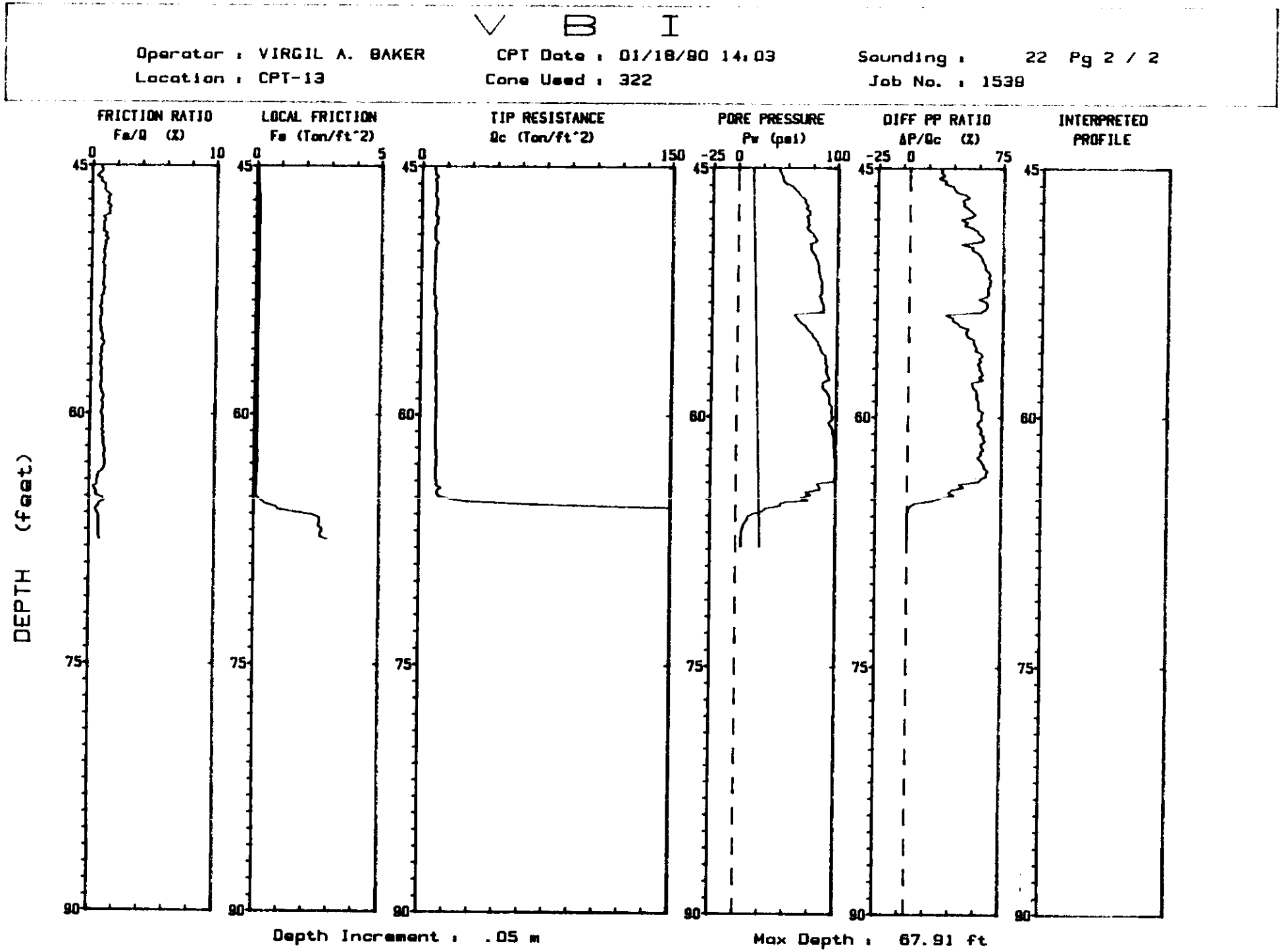

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 14:03
Sounding : 22 Pg 2 / 2
Location : CPT-13
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 67.91 ft

Figure C-32

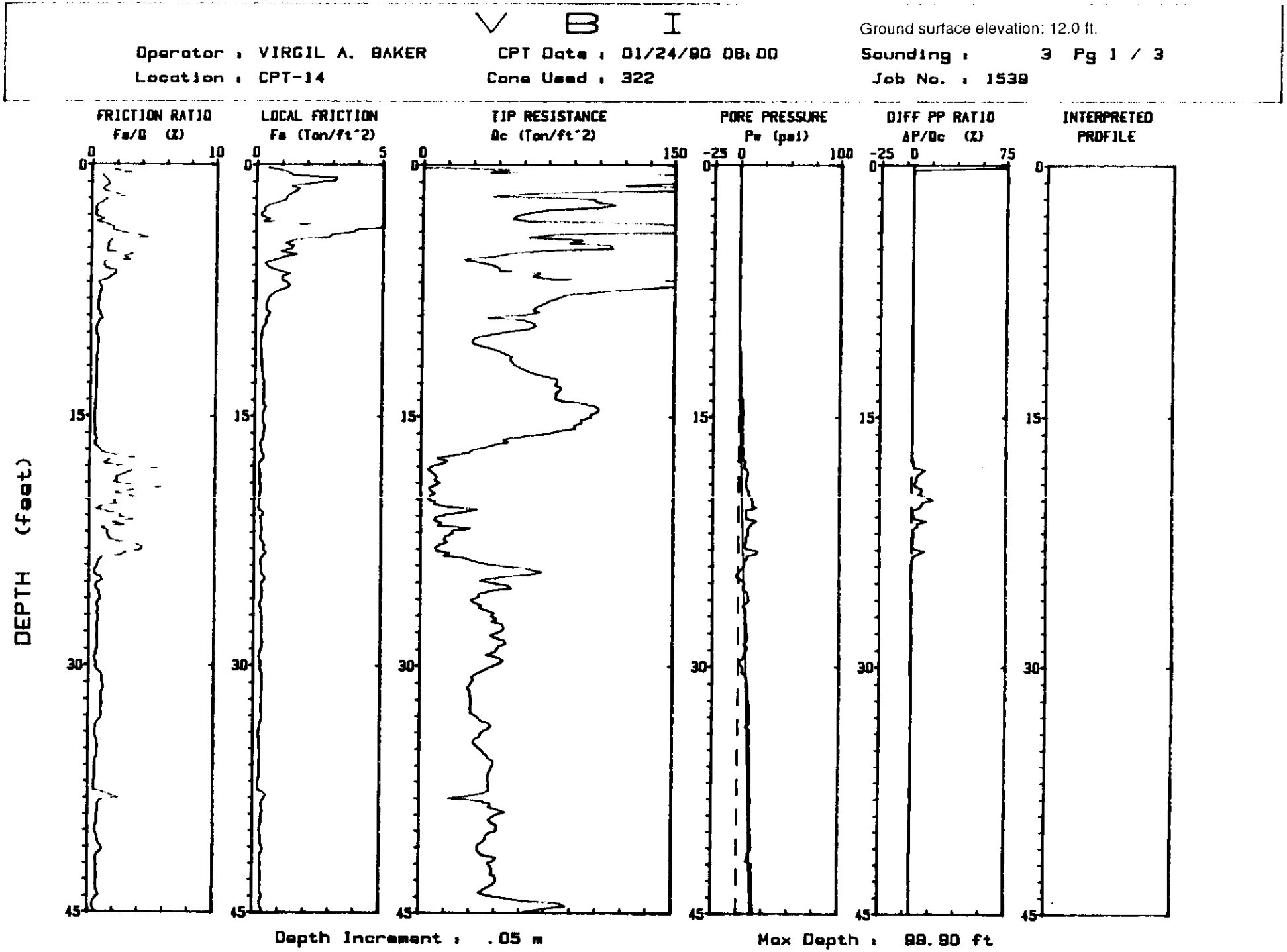

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/24/90 08:00
Ground surface elevation: 12.0 ft.
Sounding : 3 Pg 1 / 3
Location : CPT-14
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 99.90 ft

Figure C-33

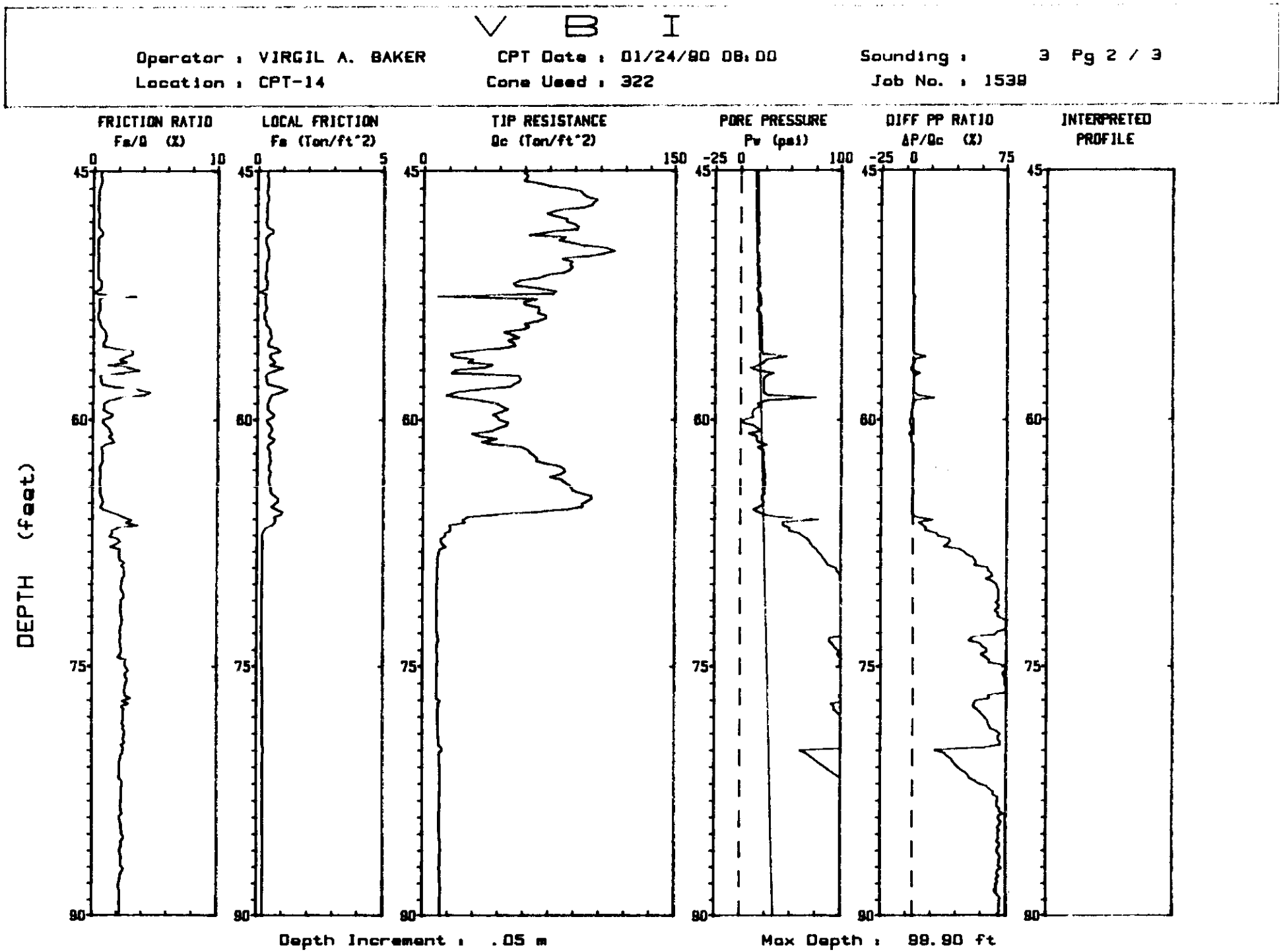

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/24/90 08:00
Sounding : 3 Pg 2 / 3
Location : CPT-14
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 99.90 ft

Figure C-34

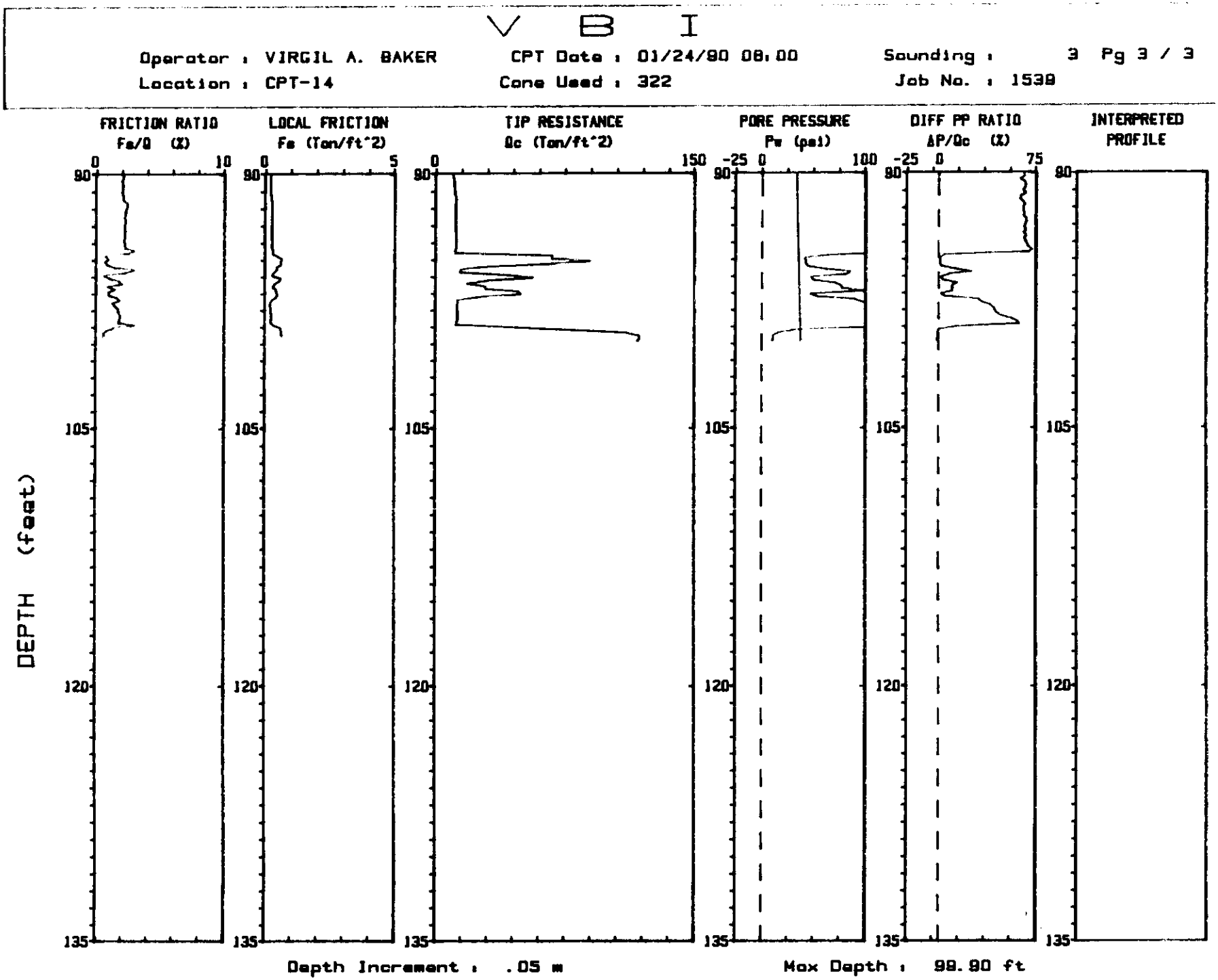

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/24/90 08:00
Sounding : 3 Pg 3 / 3
Location : CPT-14
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 99.90 ft

Figure C-35

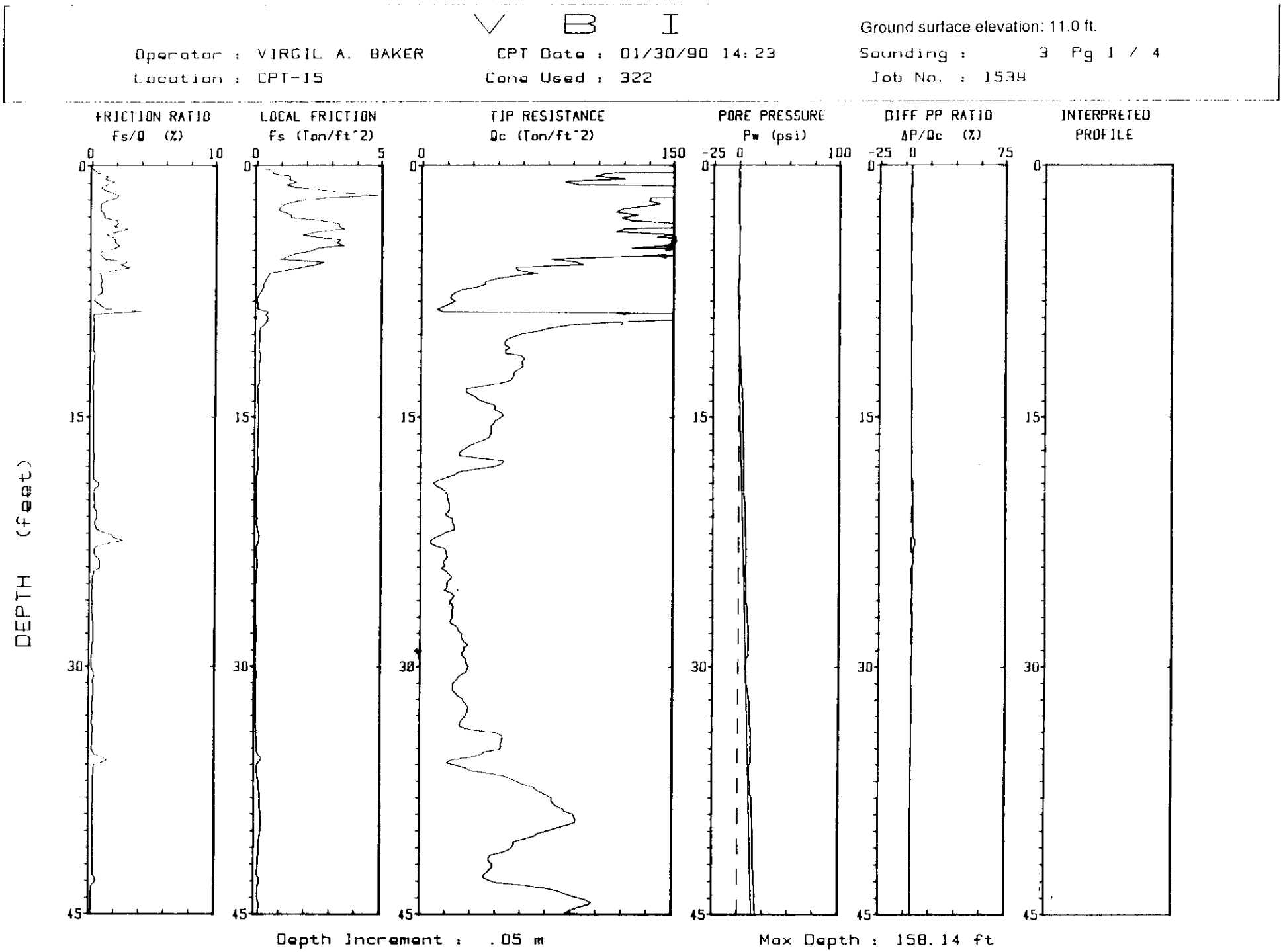

V B I
Ground surface elevation: 11.0 ft.
Operator : VIRGIL A. BAKER
CPT Data : 01/30/90 14:23
Sounding : 3 Pg 1 / 4
Location : CPT-15
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 158.14 ft

Figure C-36

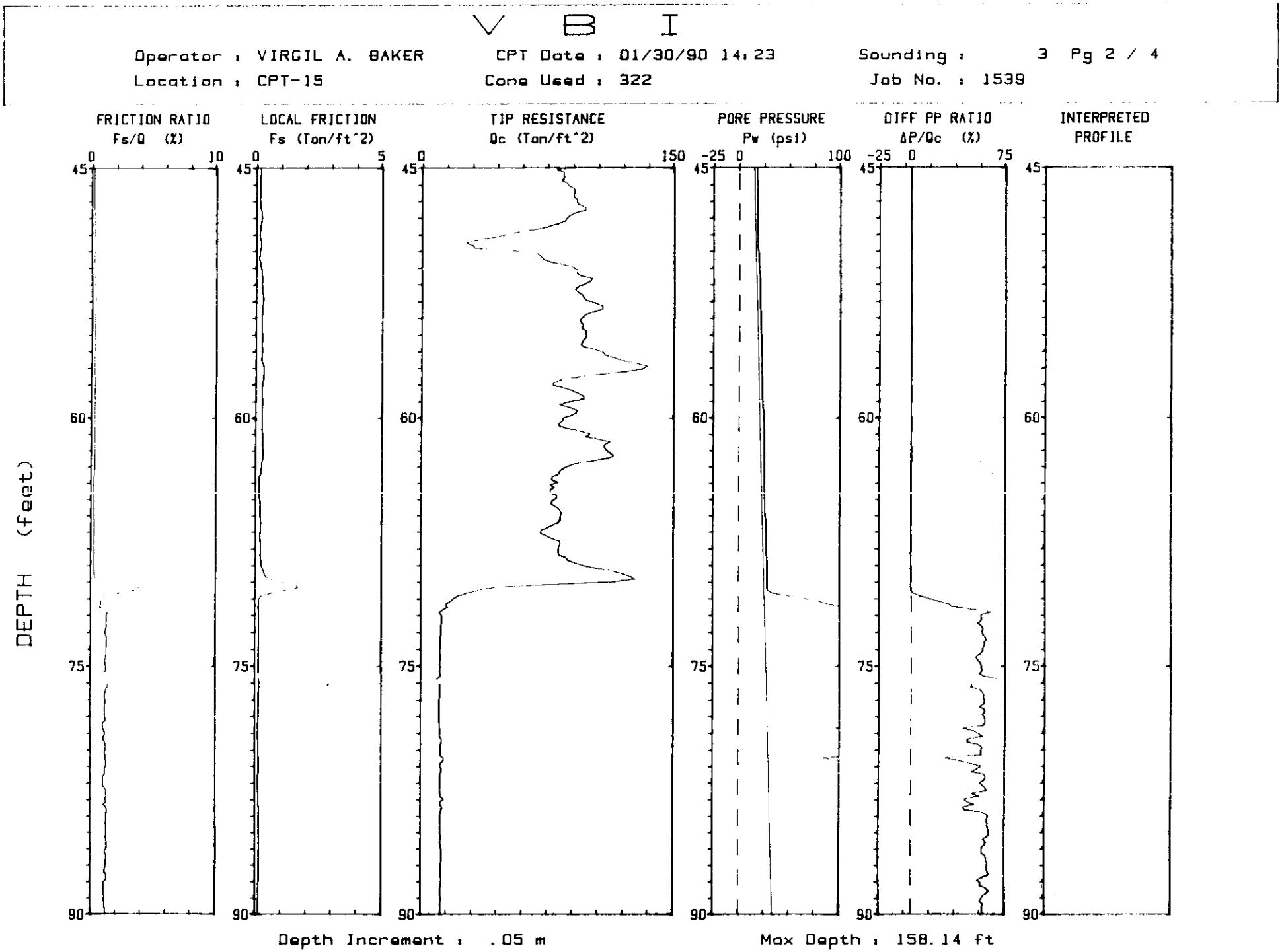

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/30/90 14:23
Sounding : 3 Pg 2 / 4
Location : CPT-15
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 158.14 ft

Figure C-37

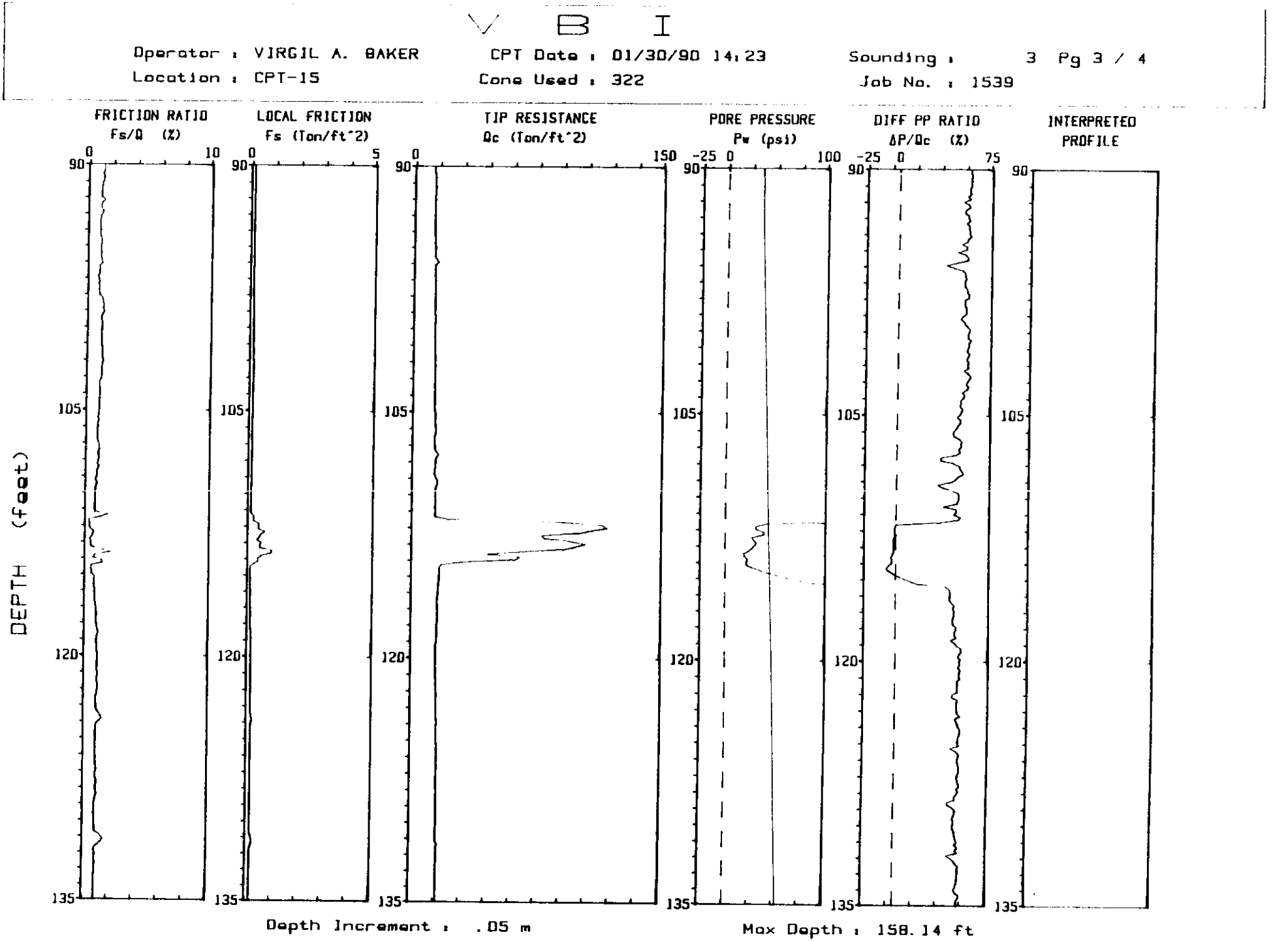

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/30/90 14:23
Sounding : 3 Pg 3 / 4
Location : CPT-15
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 158.14 ft

Figure C-38

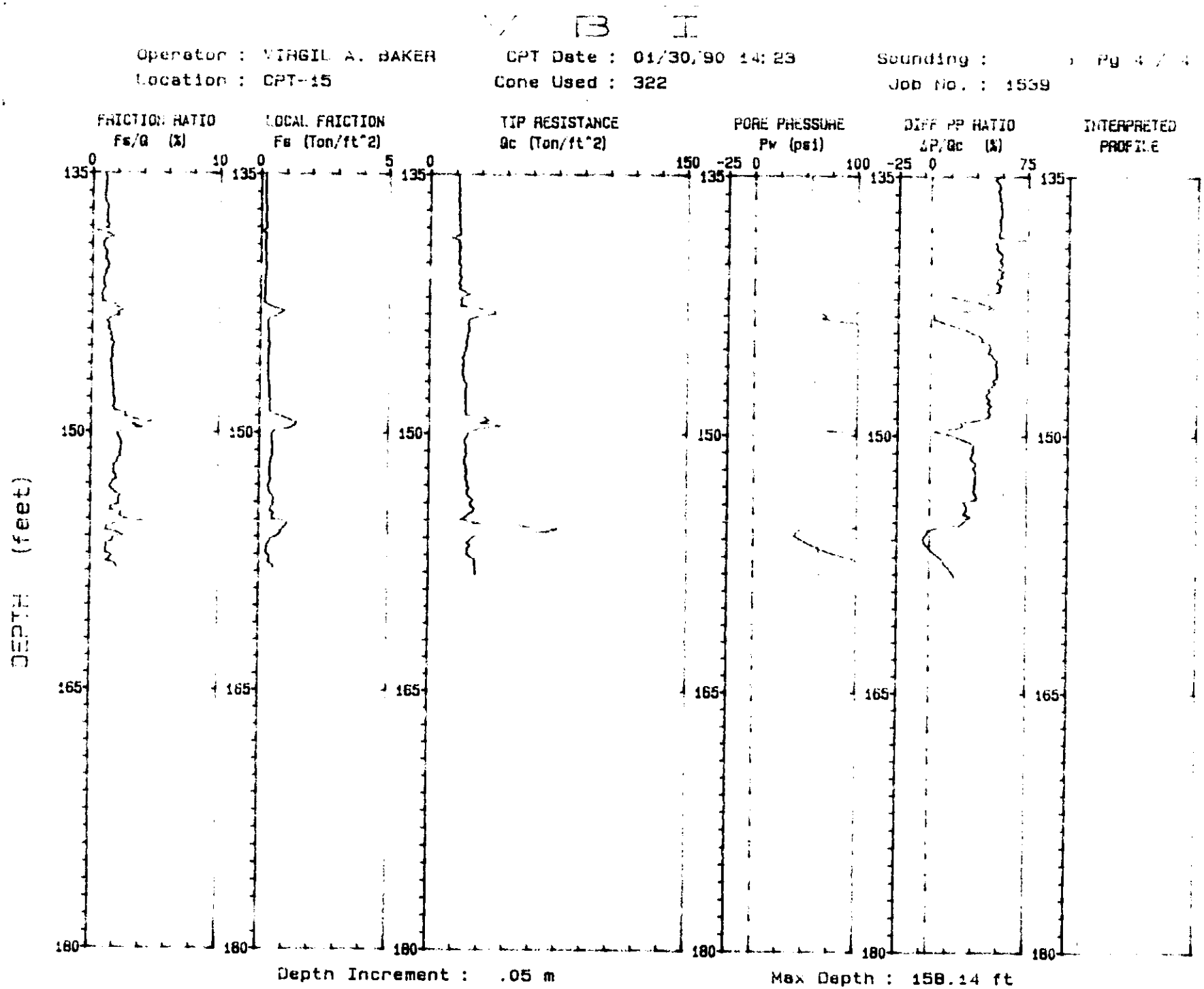

Operator : VIRGIL A. BAKER
CPT Date : 01/30/90 14:23
Sounding :
Location : CPT-15
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED
PROFILE
DEPTH (feet)
Deptn Increment : .05 m
Max Depth : 158.14 ft

Figure C-39

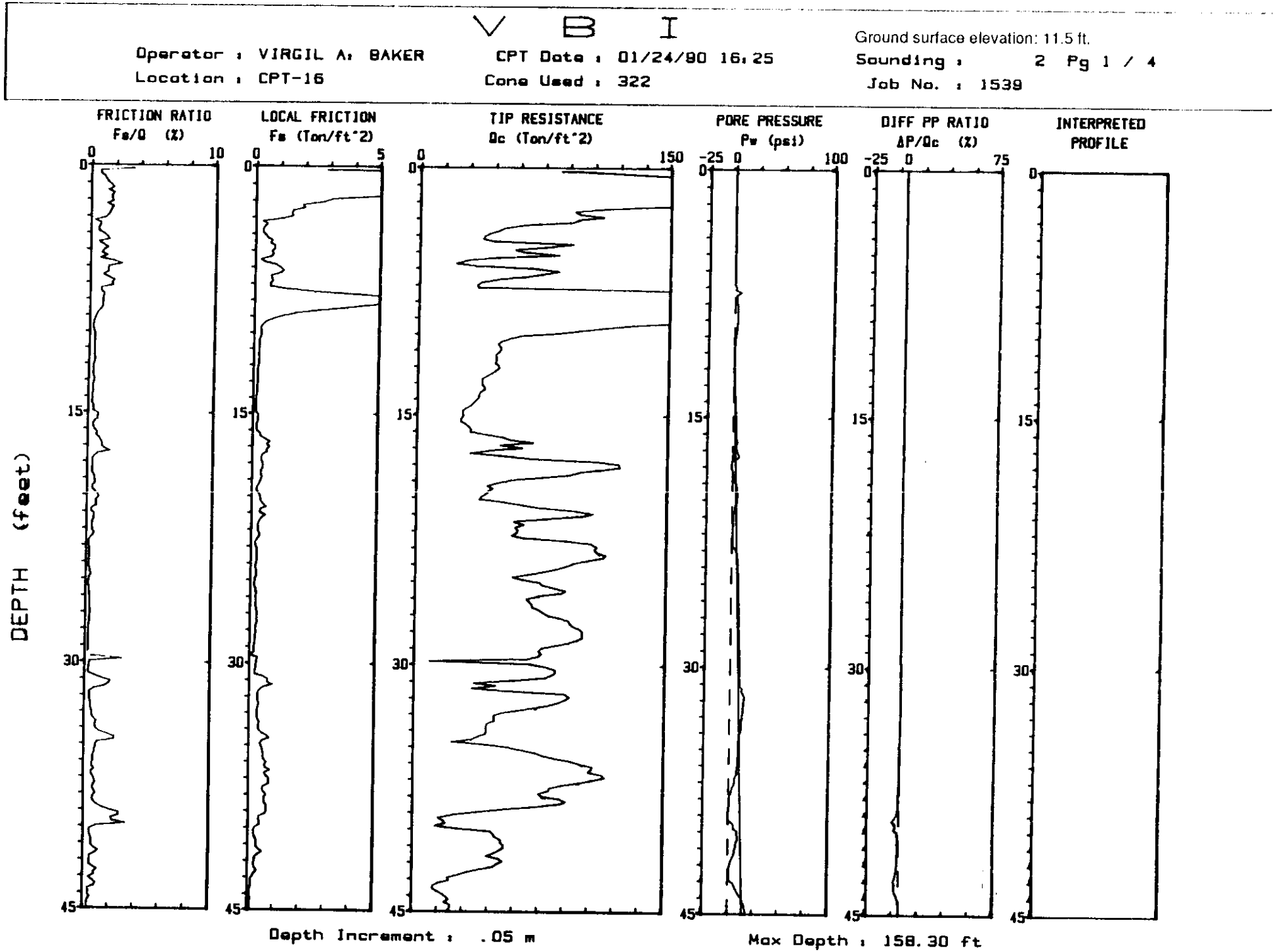

V B I
Operator : VIRGIL A. BAKER
Location : CPT-16
CPT Date : 01/24/90 16:25
Cone Used : 322
Ground surface elevation: 11.5 ft.
Sounding : 2 Pg 1 / 4
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 158.30 ft

Figure C-40

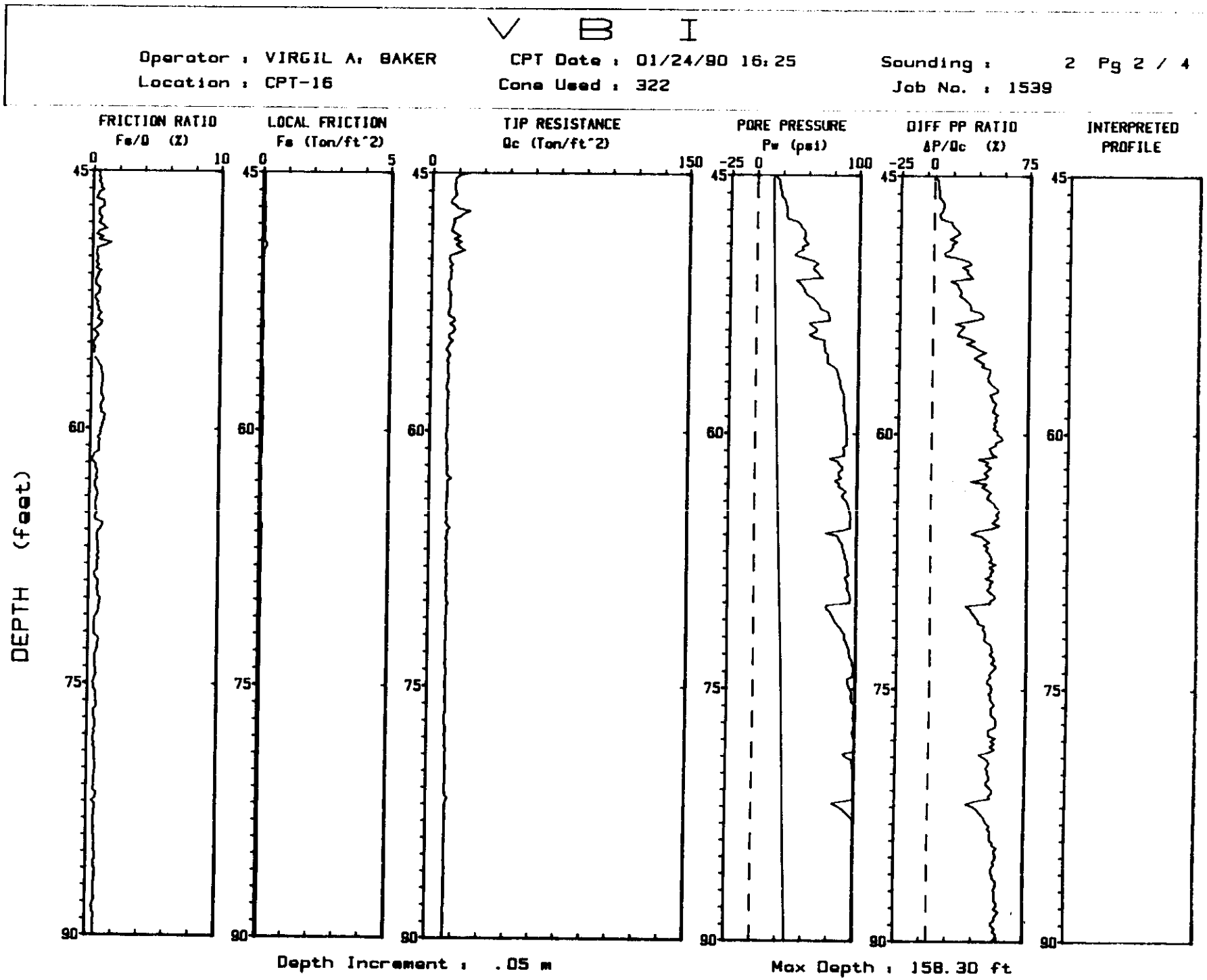

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/24/90 16:25
Sounding : 2 Pg 2 / 4
Location : CPT-16
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 158.30 ft

Figure C-41

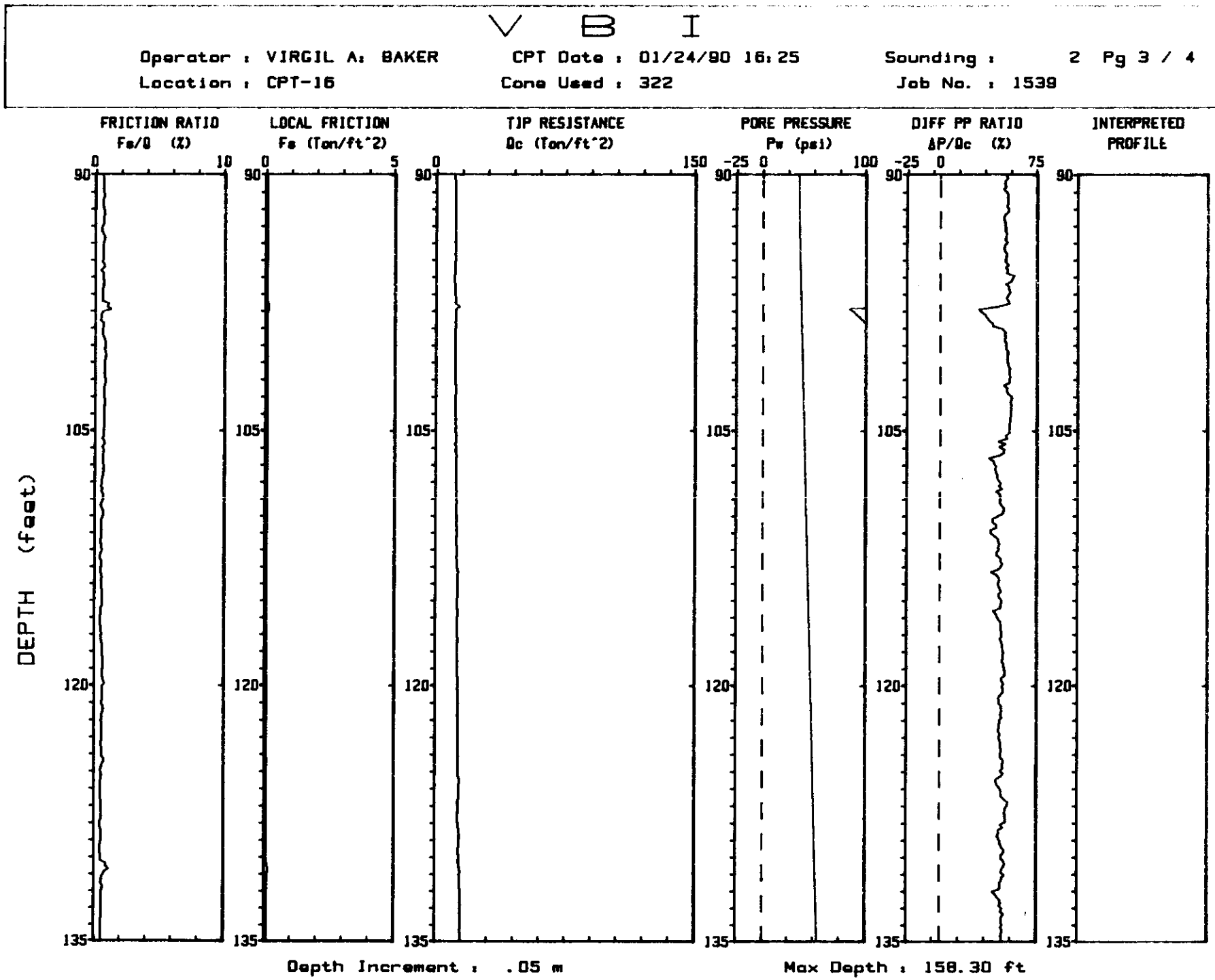

V B I
Operator : VIRGIL A: BAKER
CPT Date : 01/24/90 16:25
Sounding : 2 Pg 3 / 4
Location : CPT-16
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 158.30 ft

Figure C-42

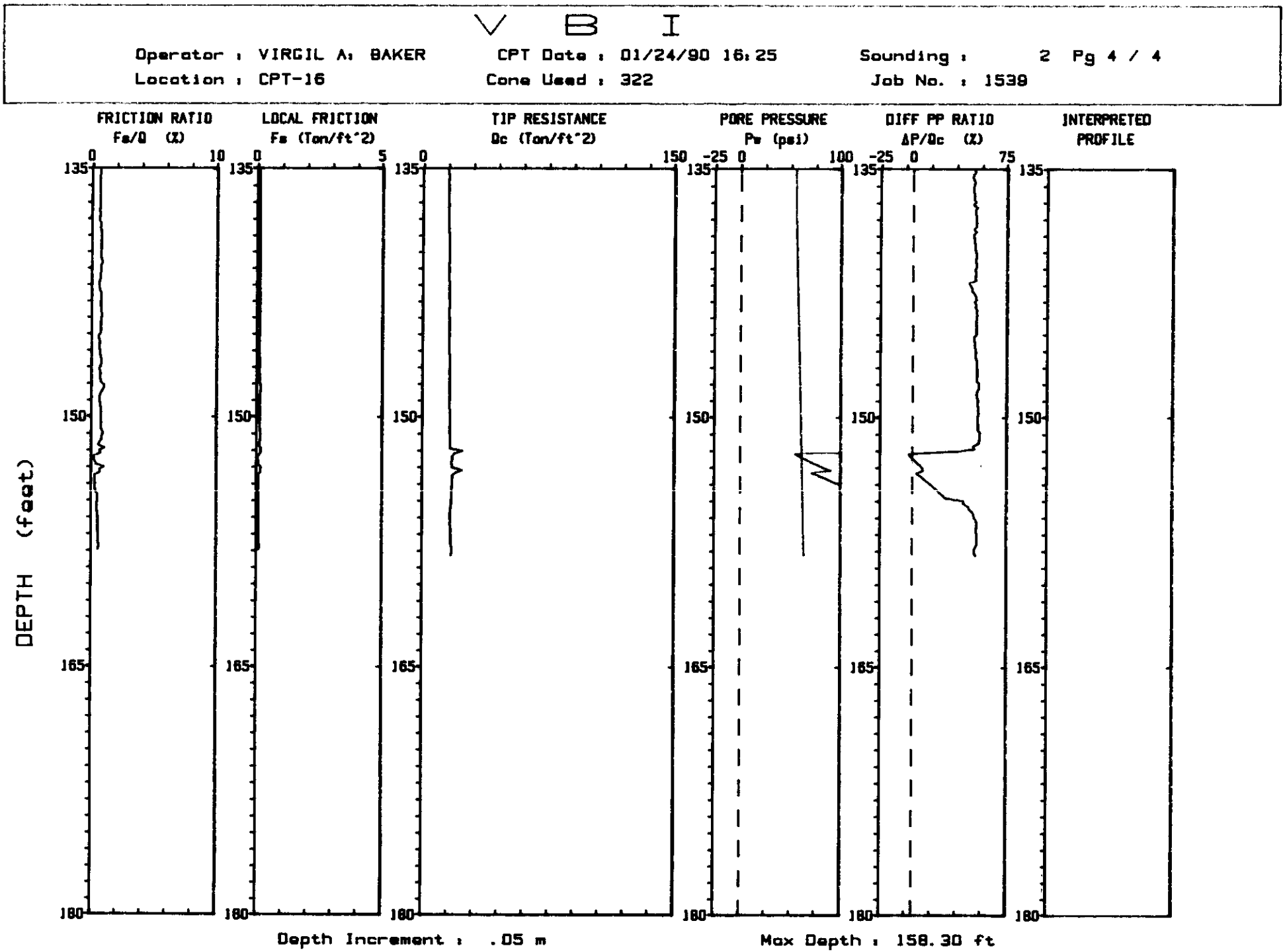

V B I
Operator : VIRGIL A: BAKER
CPT Date : 01/24/90 16:25
Sounding : 2 Pg 4 / 4
Location : CPT-16
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
0
10
LOCAL FRICTION
Fs (Tsf/ft^2)
0
5
TIP RESISTANCE
Qc (Tsf/ft^2)
0
150
PORE PRESSURE
Pw (psi)
-25
0
100
DIFF PP RATIO
ΔP/Qc (%)
-25
0
75
INTERPRETED PROFILE
DEPTH (feet)
135
150
165
180
Depth Increment : .05 m
Max Depth : 158.30 ft

Figure C-43

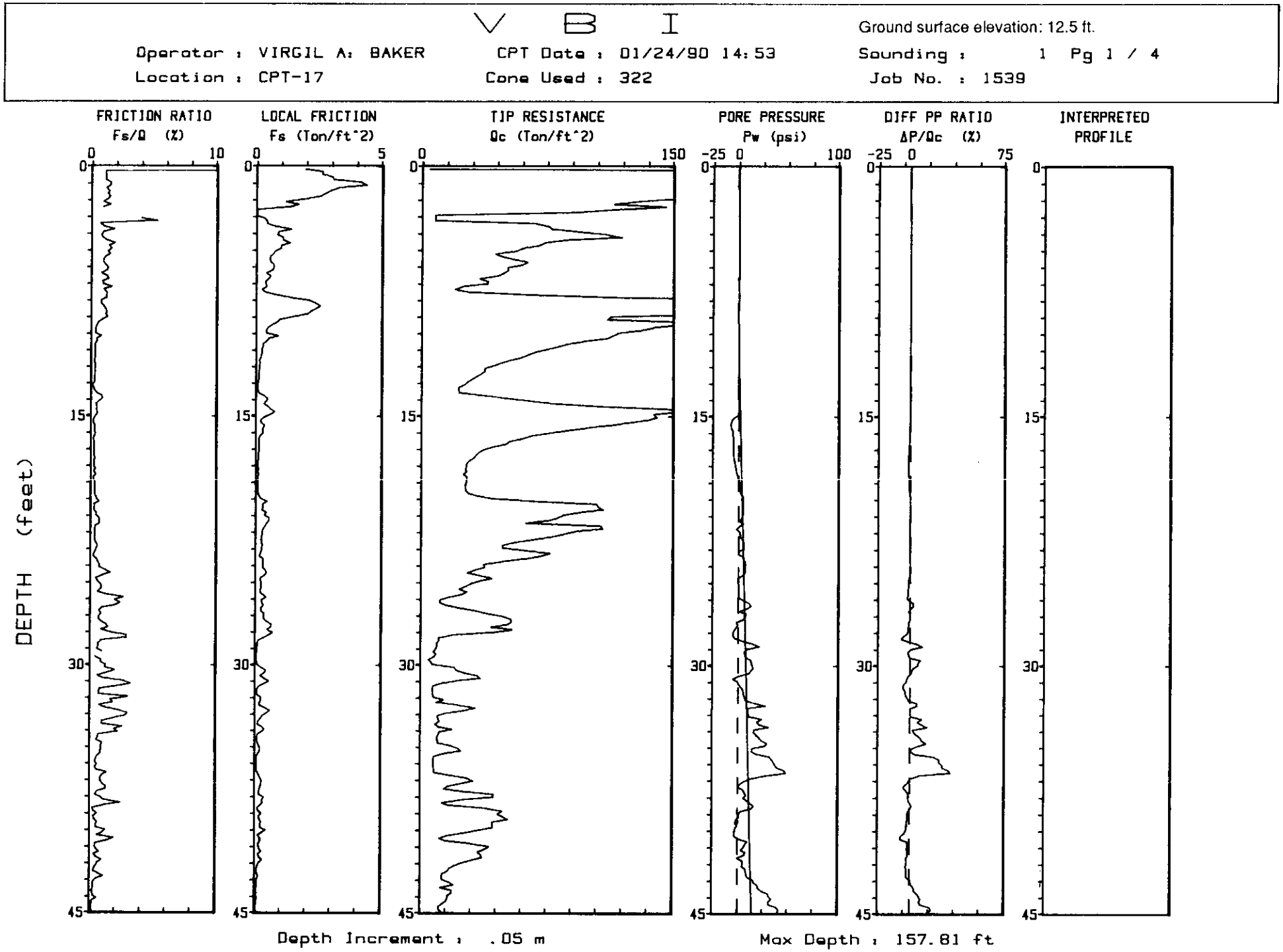

V B I
Ground surface elevation: 12.5 ft.
Operator : VIRGIL A: BAKER
CPT Date : 01/24/90 14:53
Sounding : 1 Pg 1 / 4
Location : CPT-17
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.81 ft

Figure C-44

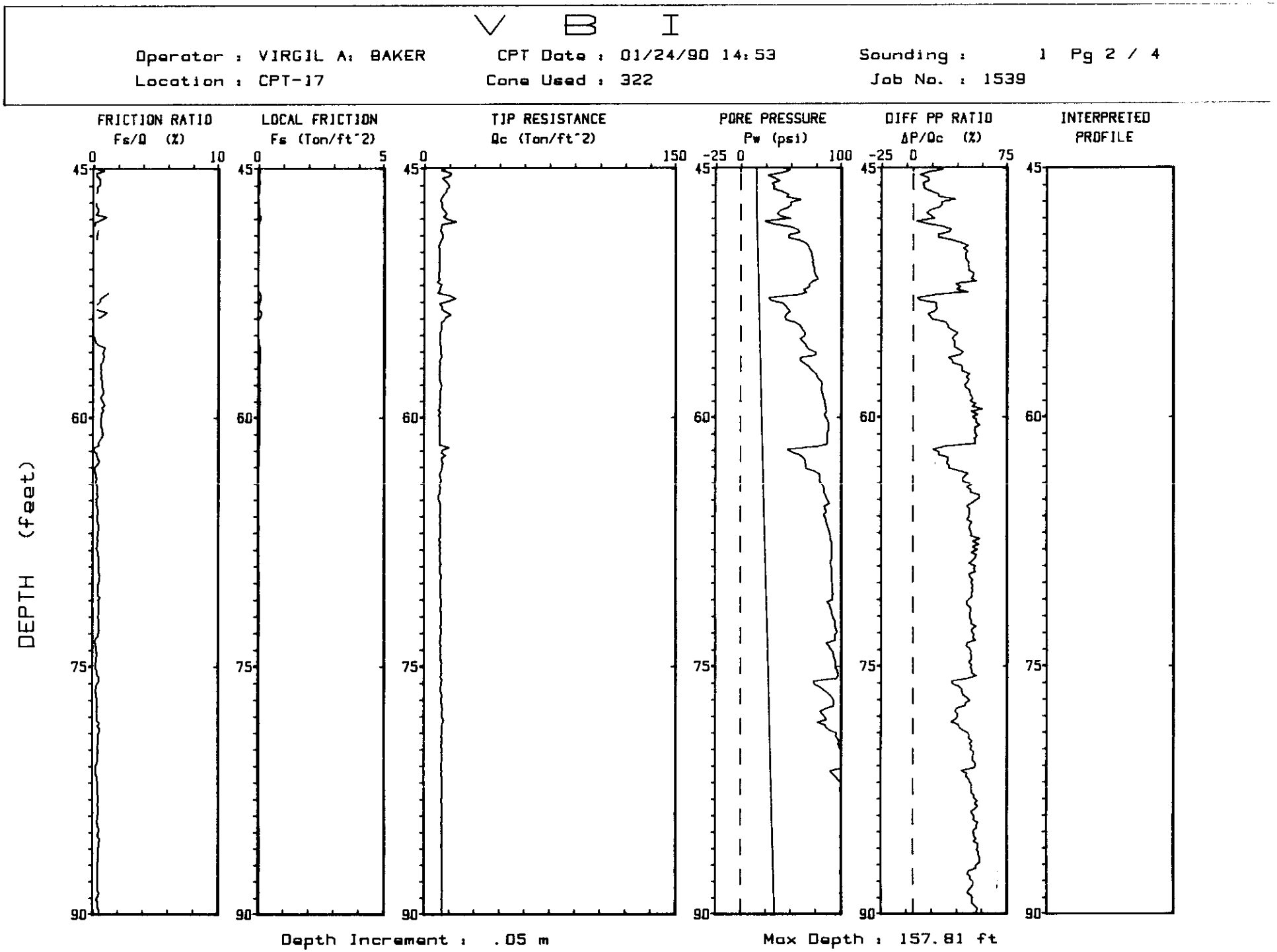

V B I
Operator : VIRGIL A: BAKER
CPT Date : 01/24/90 14:53
Sounding : 1 Pg 2 / 4
Location : CPT-17
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.81 ft

Figure C-45

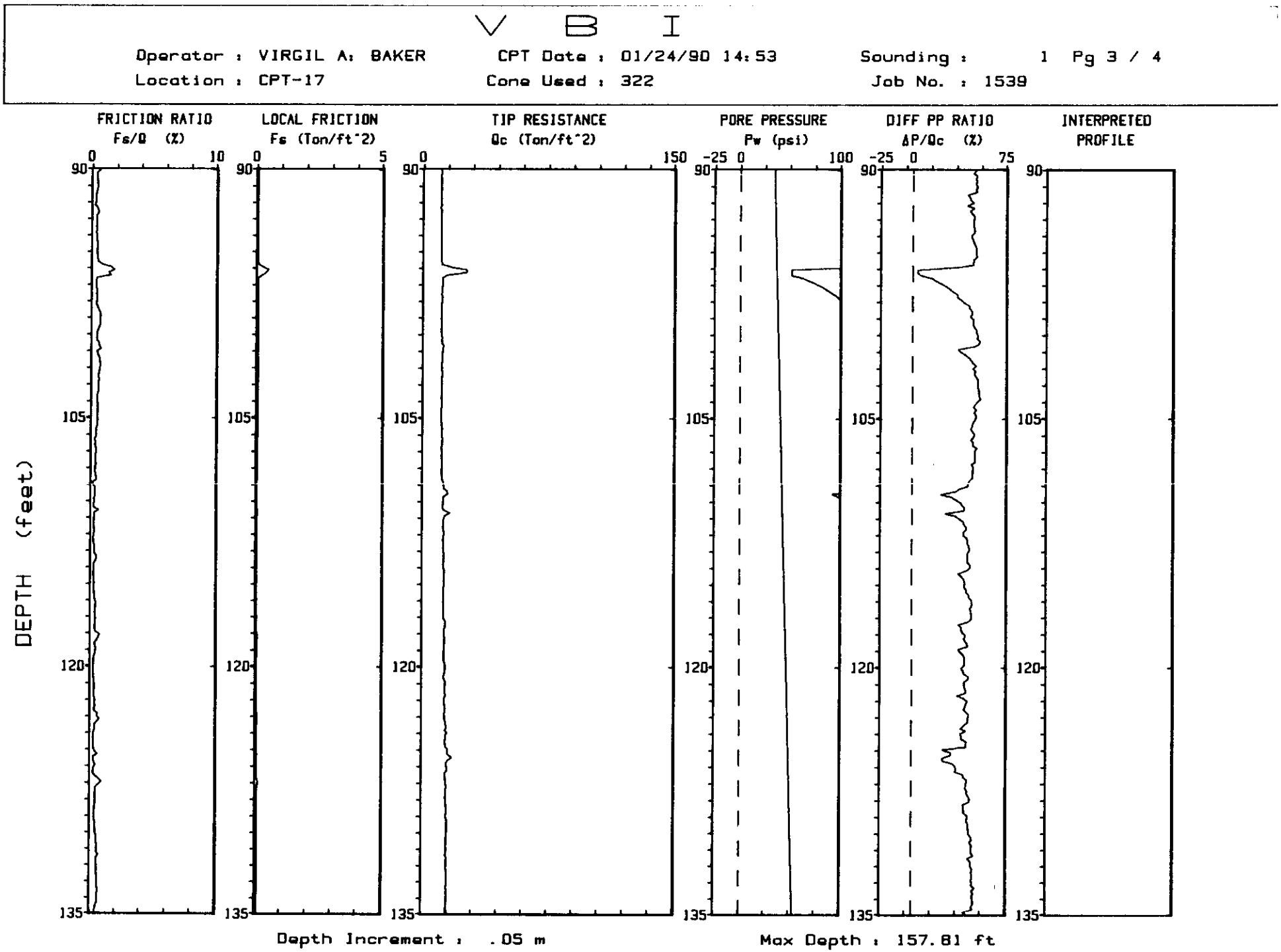

V B I
Operator : VIRGIL A: BAKER
CPT Date : 01/24/90 14:53
Sounding : 1 Pg 3 / 4
Location : CPT-17
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.81 ft

Figure C-46

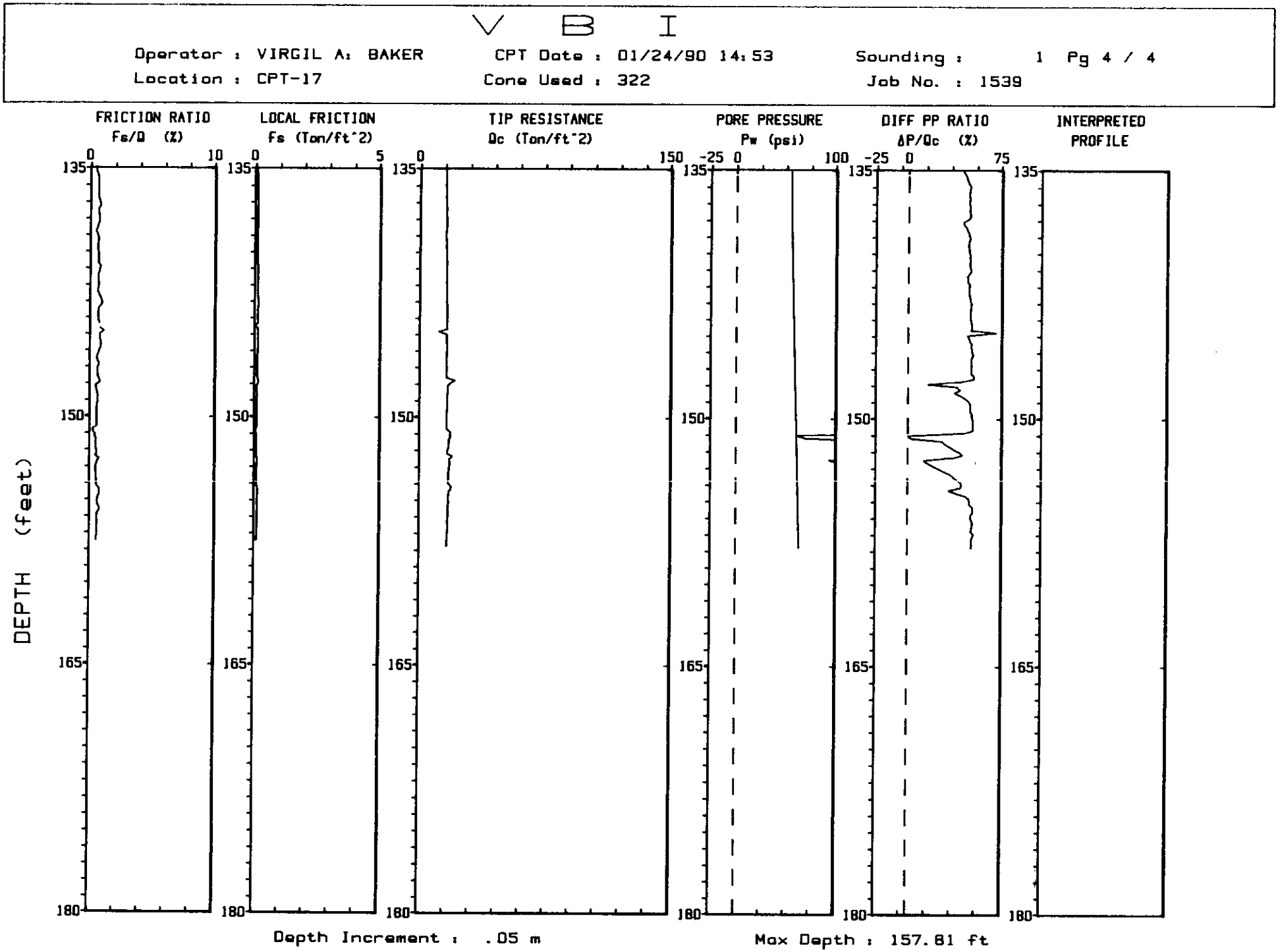

V B I
Operator : VIRGIL A: BAKER
CPT Date : 01/24/90 14:53
Sounding : 1 Pg 4 / 4
Location : CPT-17
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.81 ft

Figure C-47

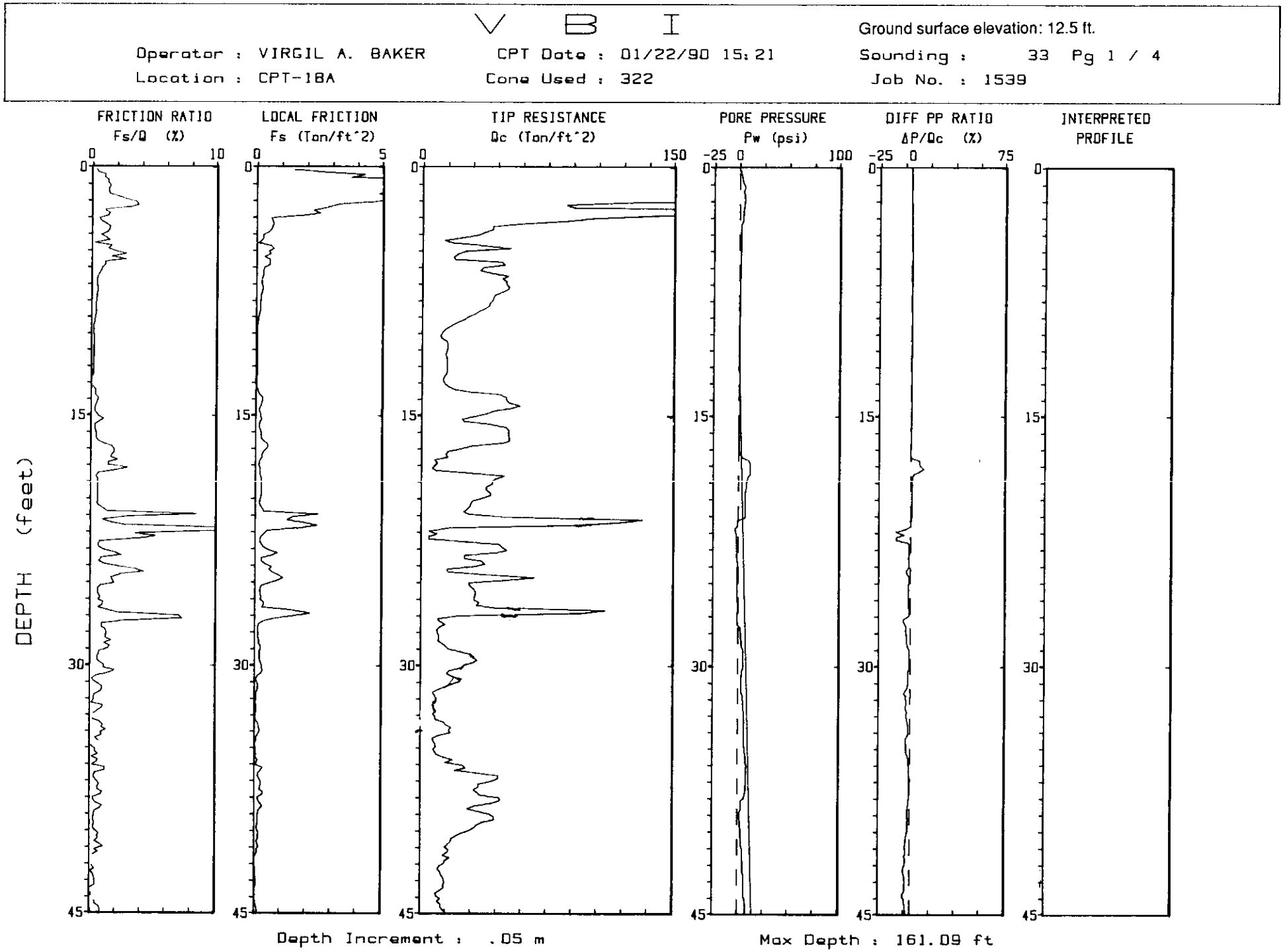

V B I
Ground surface elevation: 12.5 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 15:21
Sounding : 33 Pg 1 / 4
Location : CPT-18A
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED
PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 161.09 ft

Figure C-48

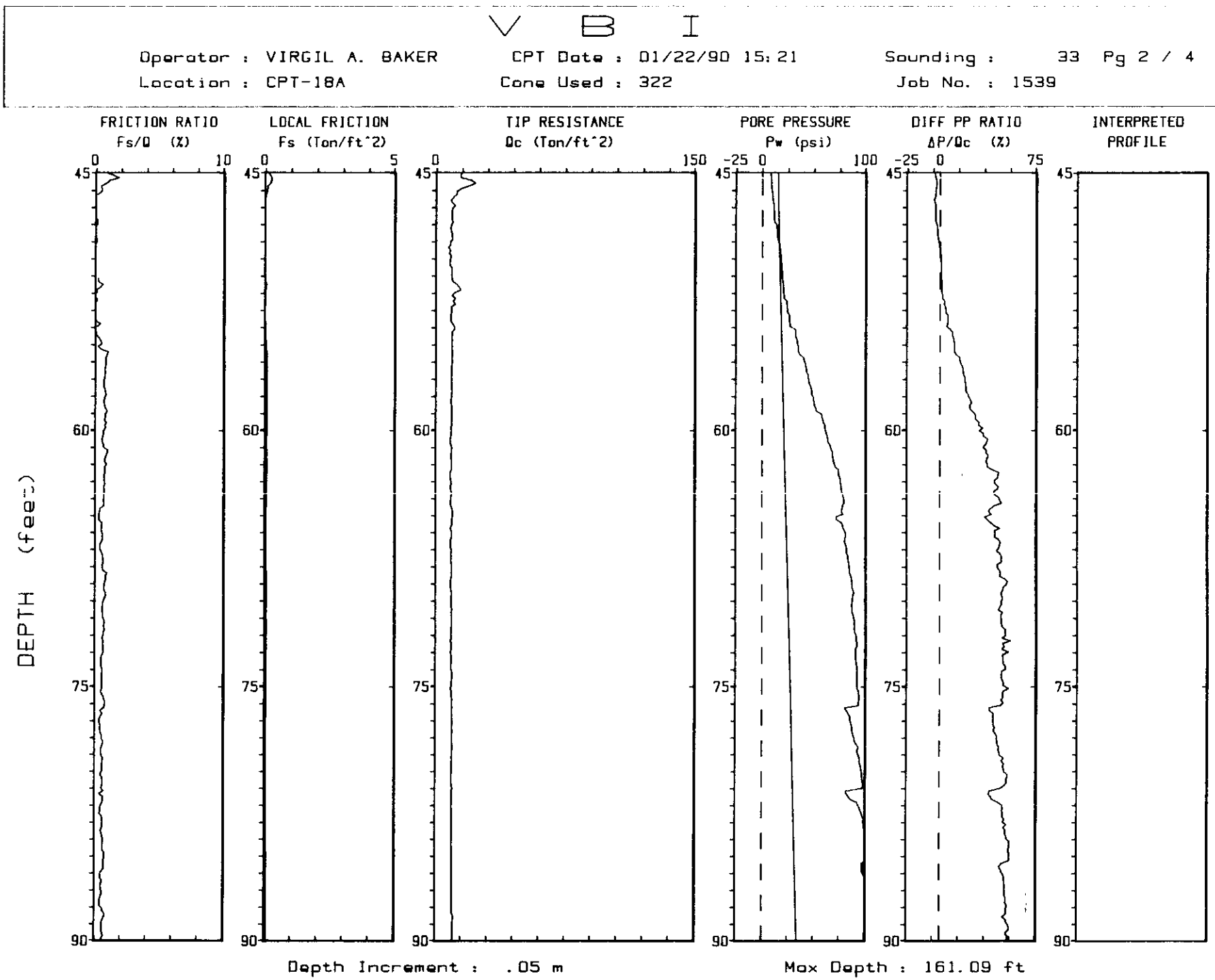

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 15:21
Sounding : 33 Pg 2 / 4
Location : CPT-18A
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 161.09 ft

Figure C-49

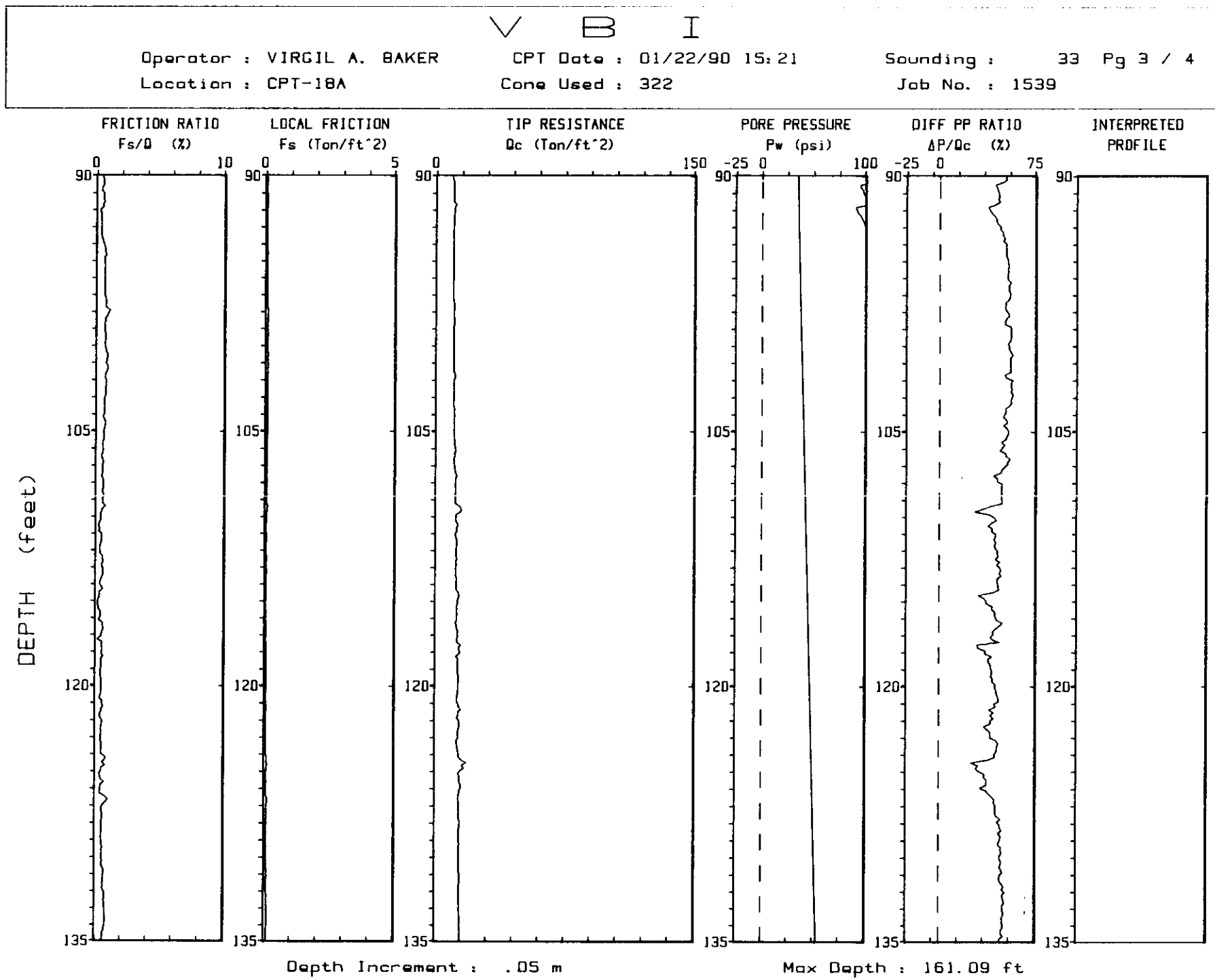

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 15:21
Sounding : 33 Pg 3 / 4
Location : CPT-18A
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 161.09 ft

Figure C-50

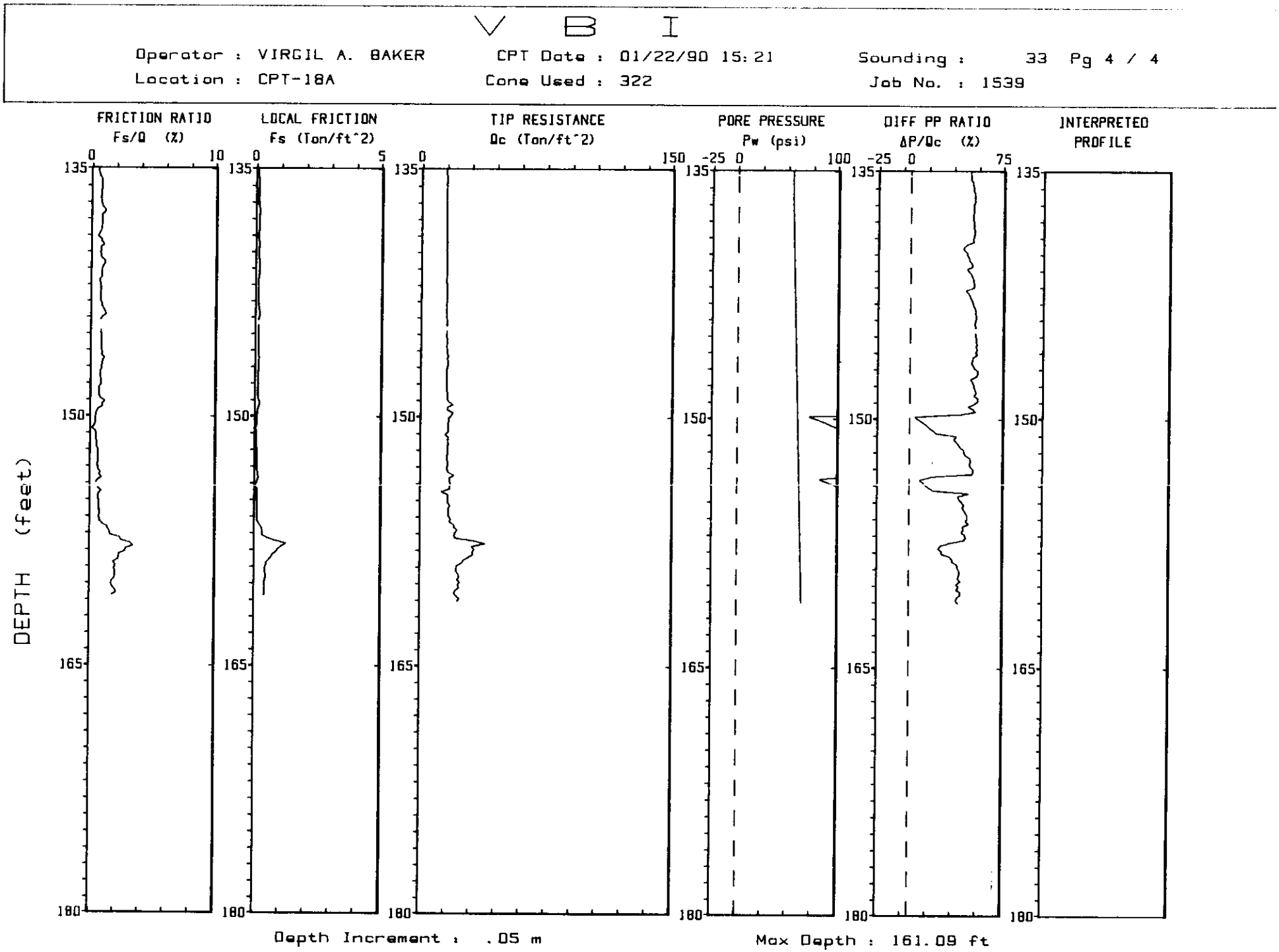

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 15:21
Sounding : 33 Pg 4 / 4
Location : CPT-18A
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 161.09 ft

Figure C-51

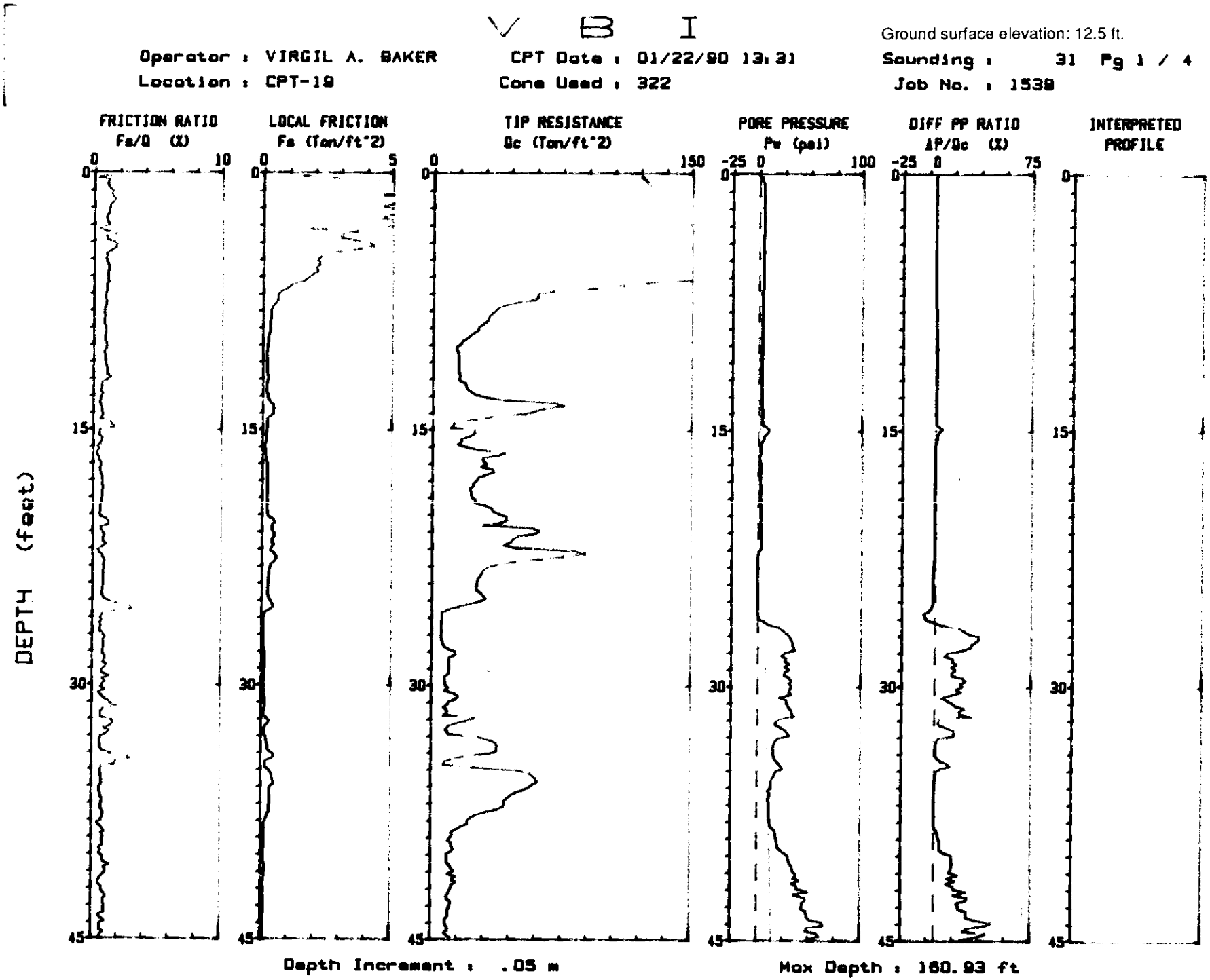

V B I
Ground surface elevation: 12.5 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 13:31
Sounding : 31 Pg 1 / 4
Location : CPT-19
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 160.93 ft

Figure C-52

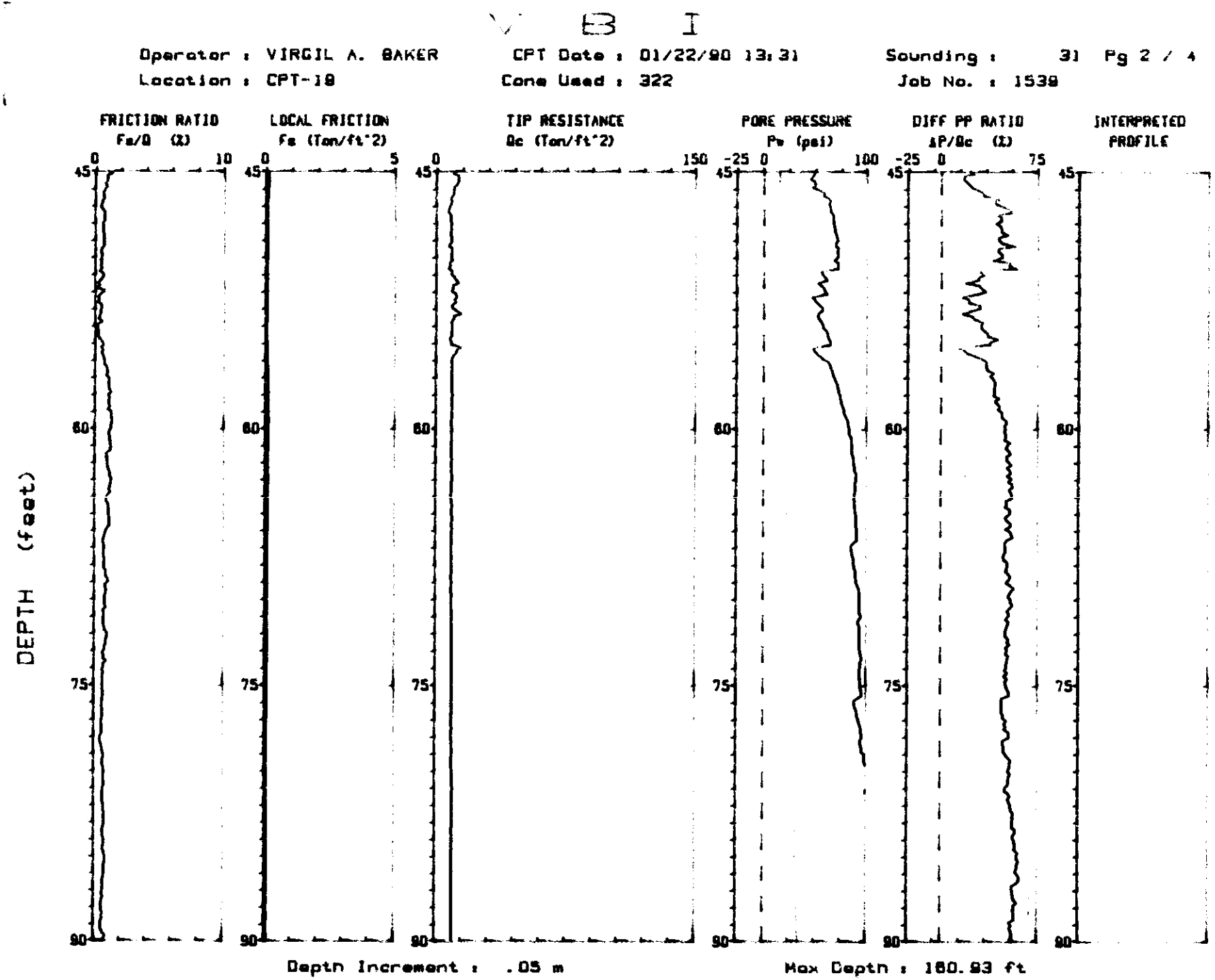

Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 13:31
Sounding : 31 Pg 2 / 4
Location : CPT-18
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Deptn Increment : .05 m
Max Deptn : 180.93 ft

Figure C-53

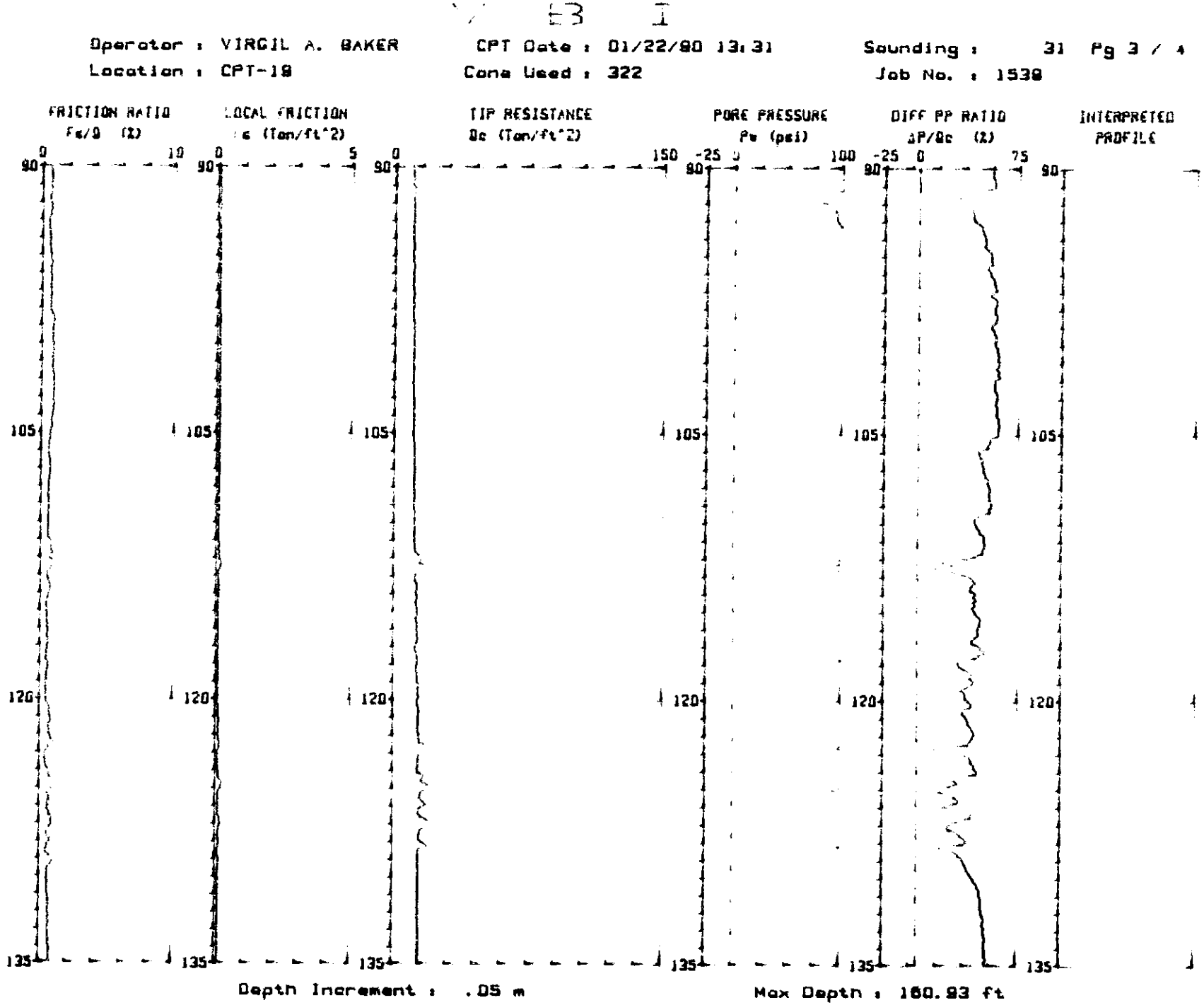

Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 13:31
Sounding : 31 Pg 3 / 4
Location : CPT-18
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED
PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 160.93 ft

Figure C-54

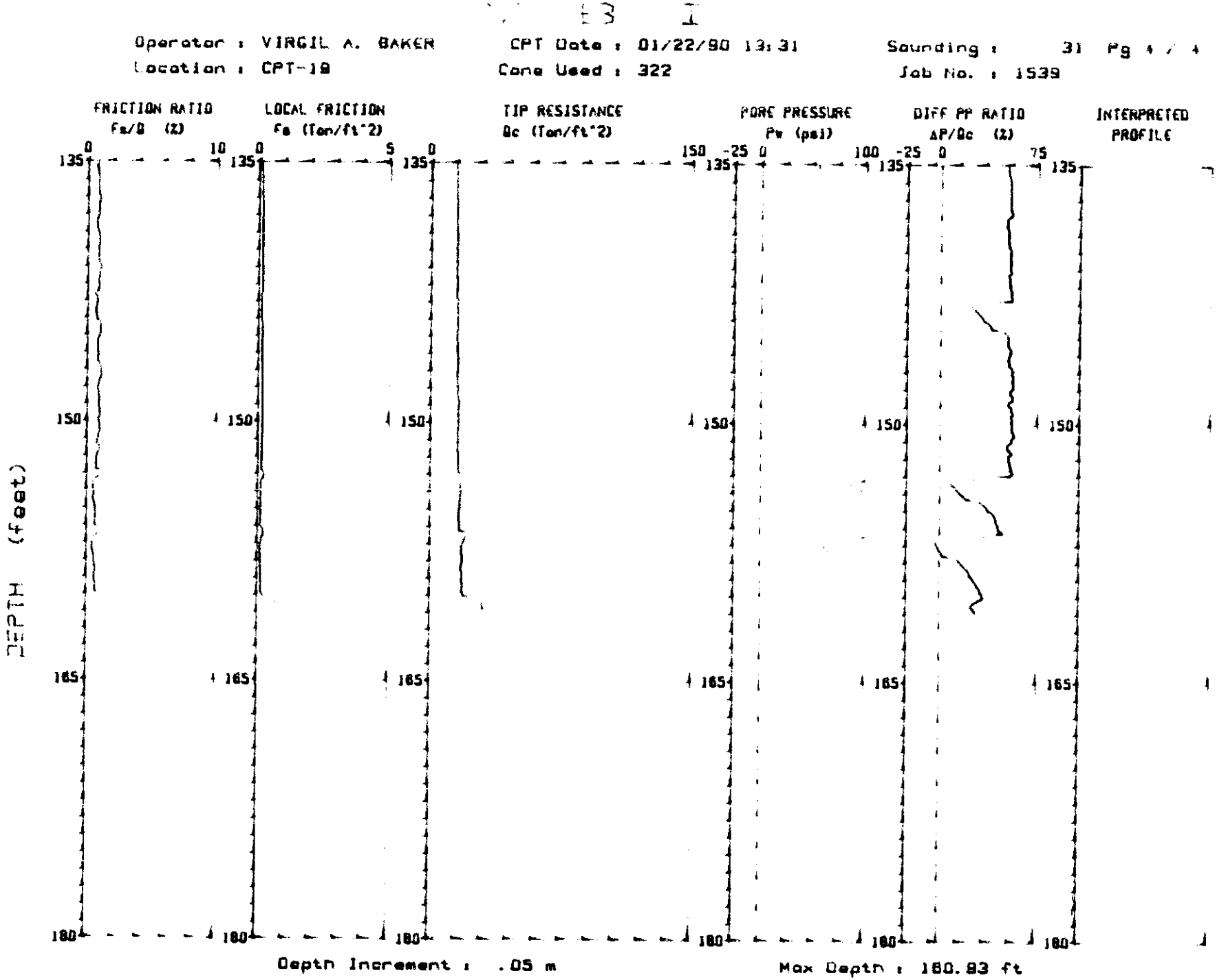

Operator : VIRGIL A. BAKER
Location : CPT-18
CPT Date : 01/22/90 13:31
Cone Used : 322
Sounding : 31 Pg 4 / 4
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 180.83 ft

Figure C-55

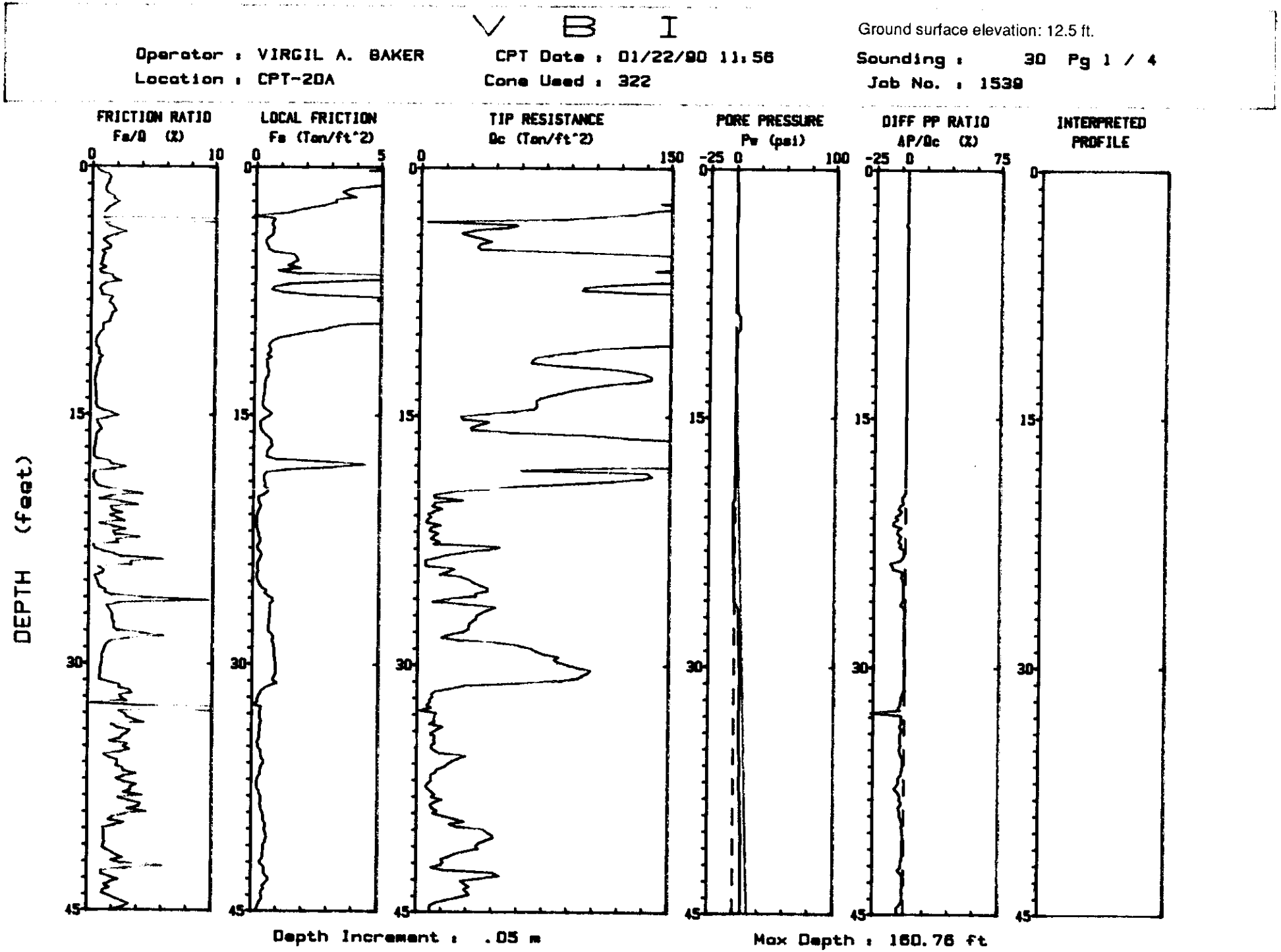

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 11:56
Location : CPT-20A
Cone Used : 322
Ground surface elevation: 12.5 ft.
Sounding : 30 Pg 1 / 4
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 160.76 ft

Figure C-56

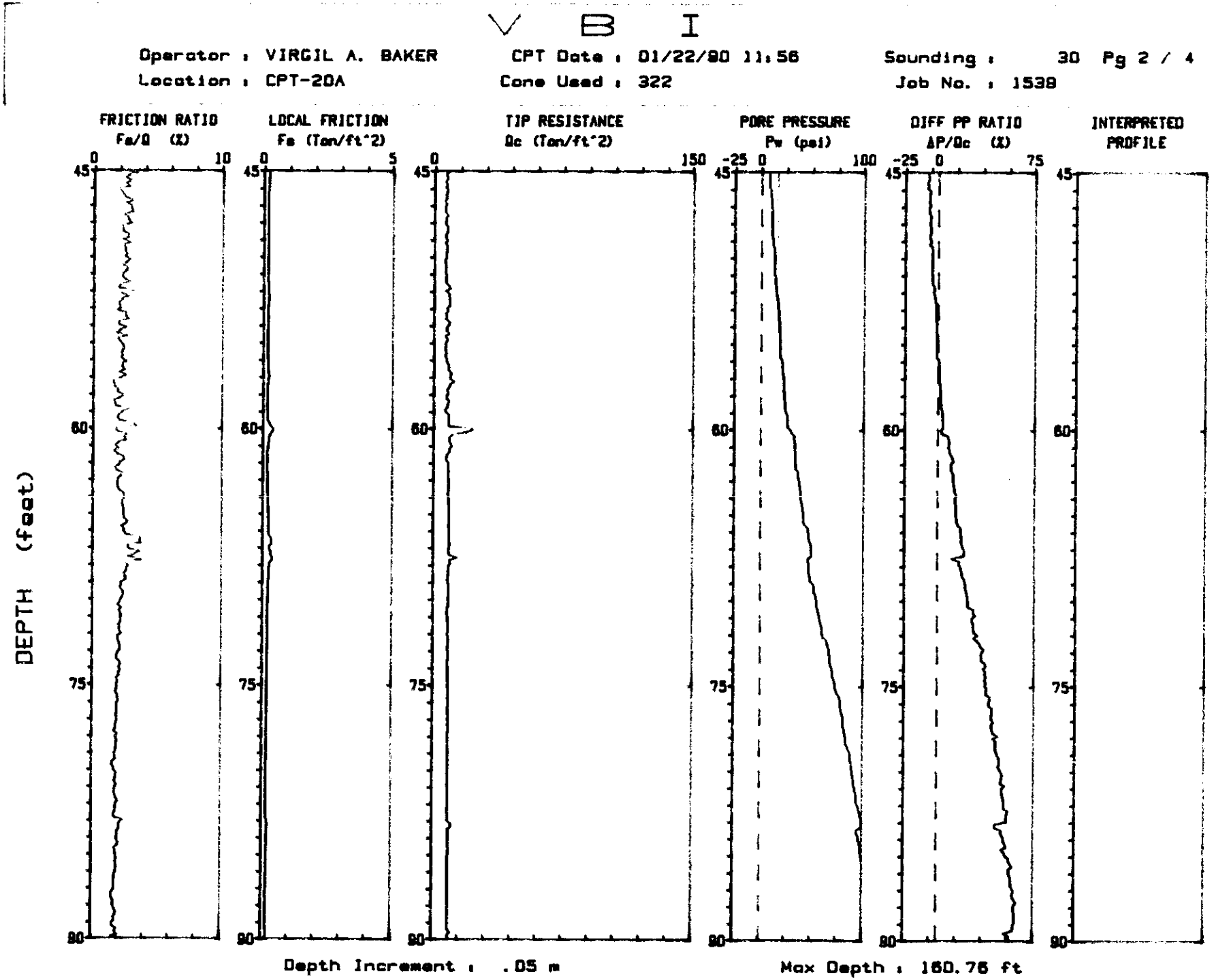

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 11:56
Sounding : 30 Pg 2 / 4
Location : CPT-20A
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 160.76 ft

Figure C-57

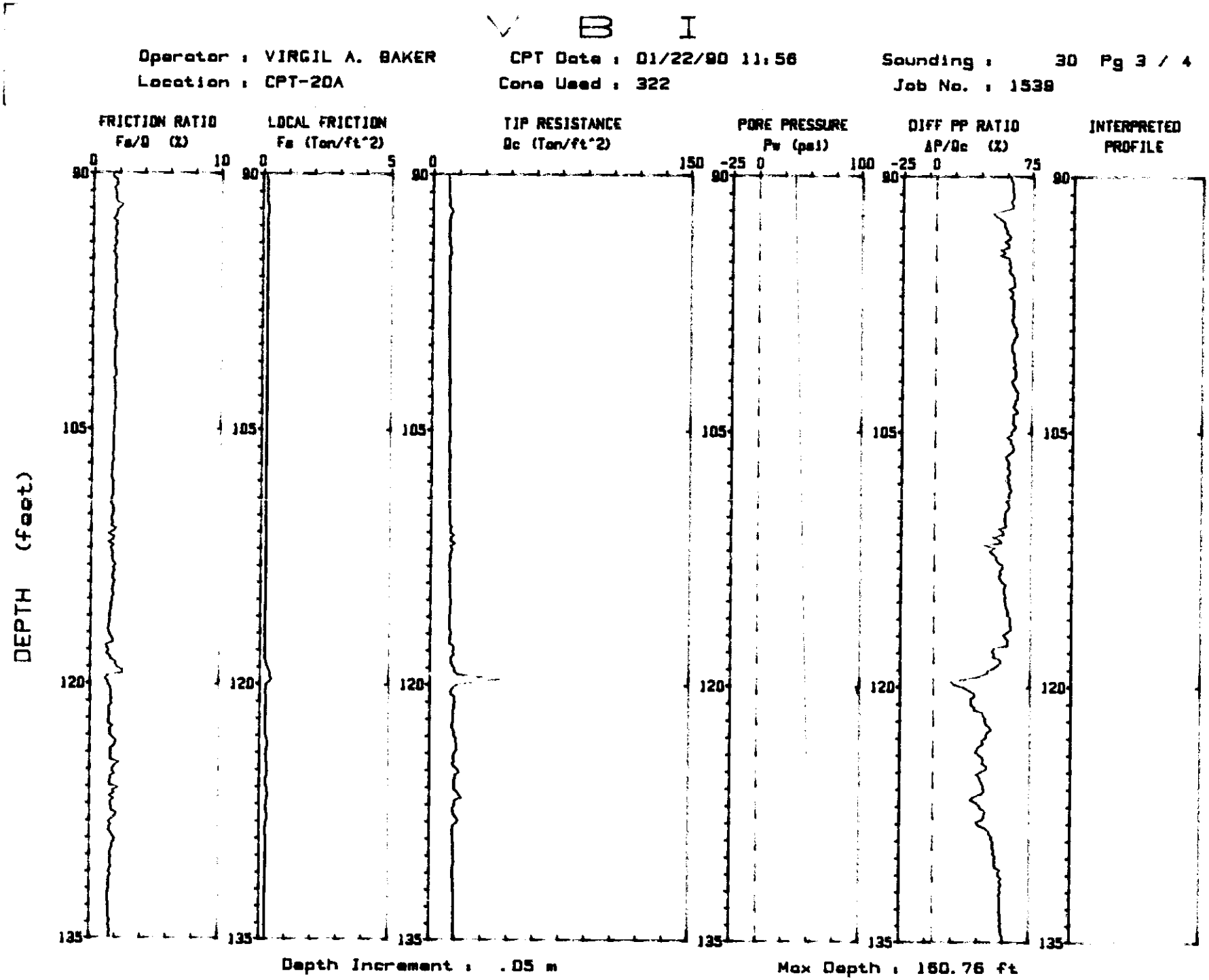

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 11:56
Sounding : 30 Pg 3 / 4
Location : CPT-20A
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 160.76 ft

Figure C-58

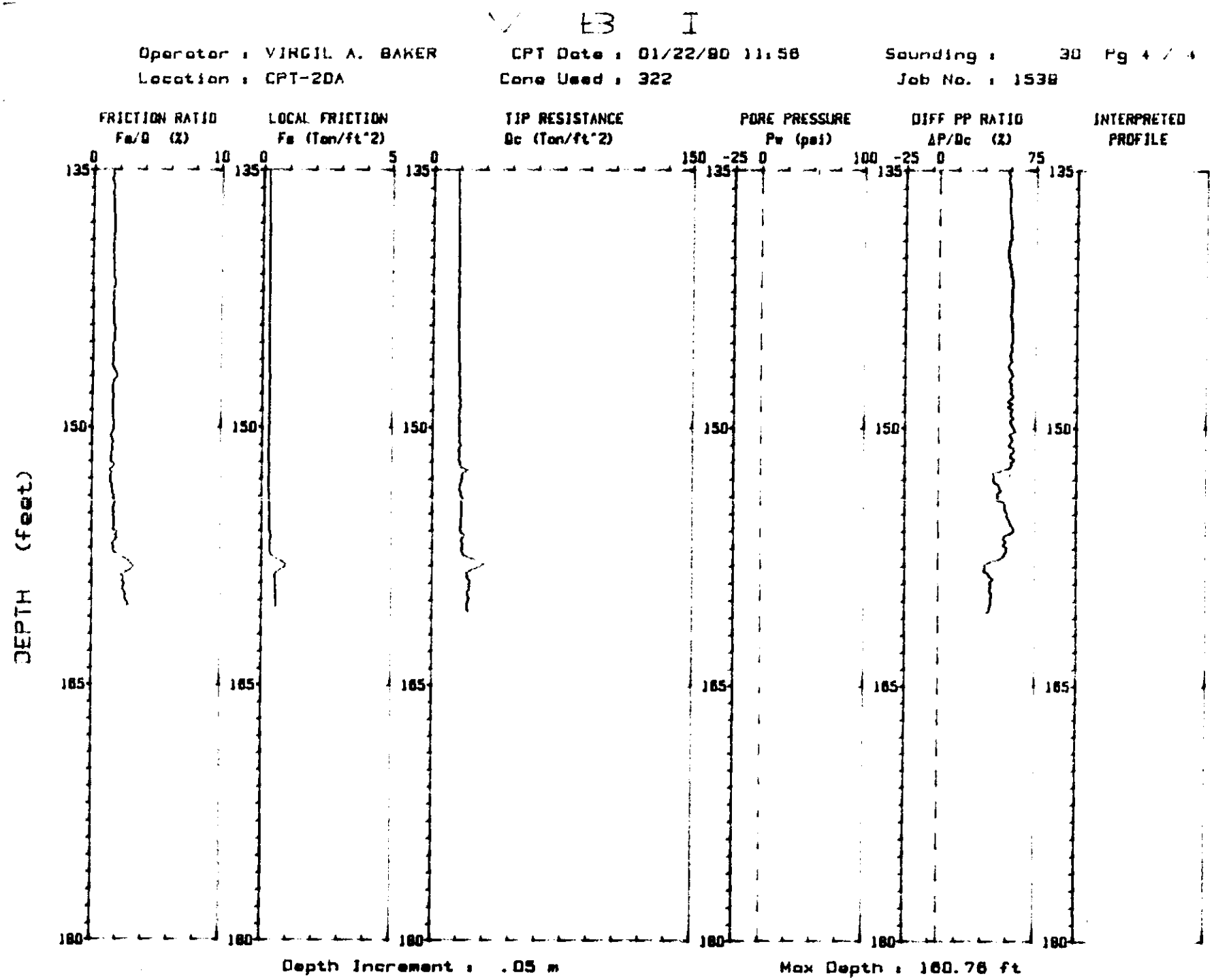

EB I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 11:58
Sounding : 30 Pg 4 / 4
Location : CPT-20A
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
135
150
165
180
Depth Increment : .05 m
Max Depth : 160.76 ft

Figure C-59

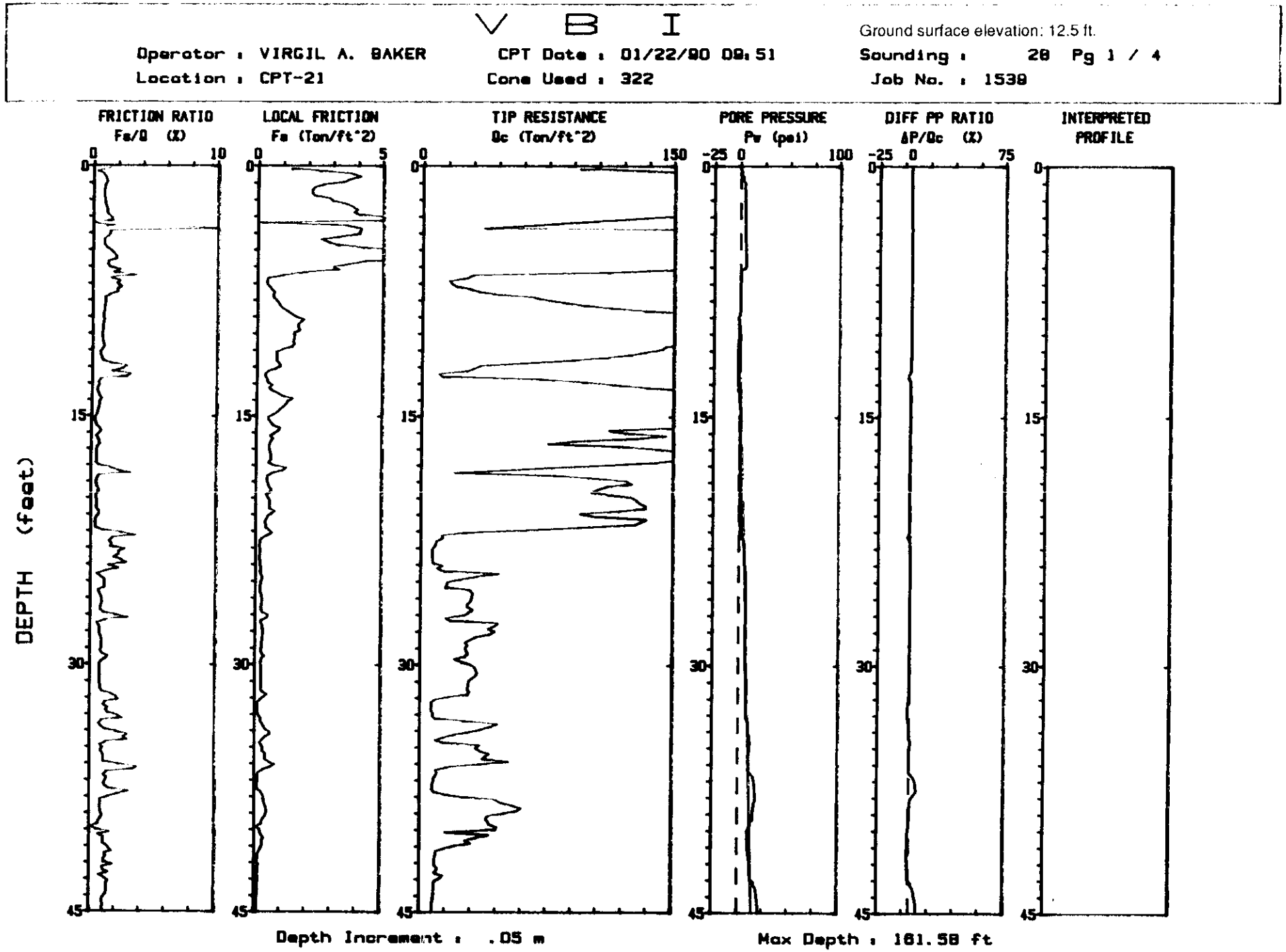

V B I
Ground surface elevation: 12.5 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 09:51
Sounding : 28 Pg 1 / 4
Location : CPT-21
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 161.58 ft

Figure C-60

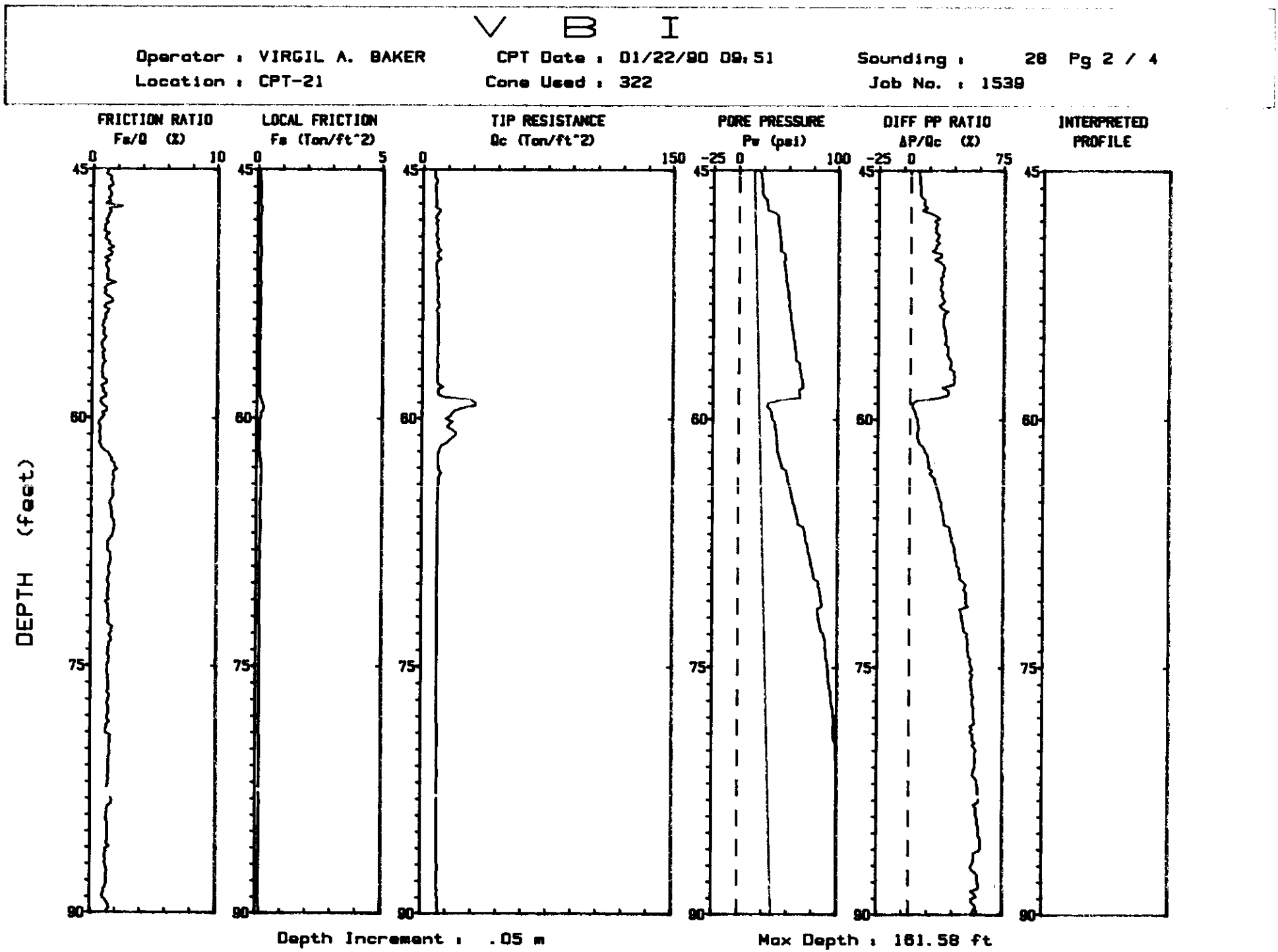

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 09:51
Sounding : 28 Pg 2 / 4
Location : CPT-21
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 161.58 ft

Figure C-61

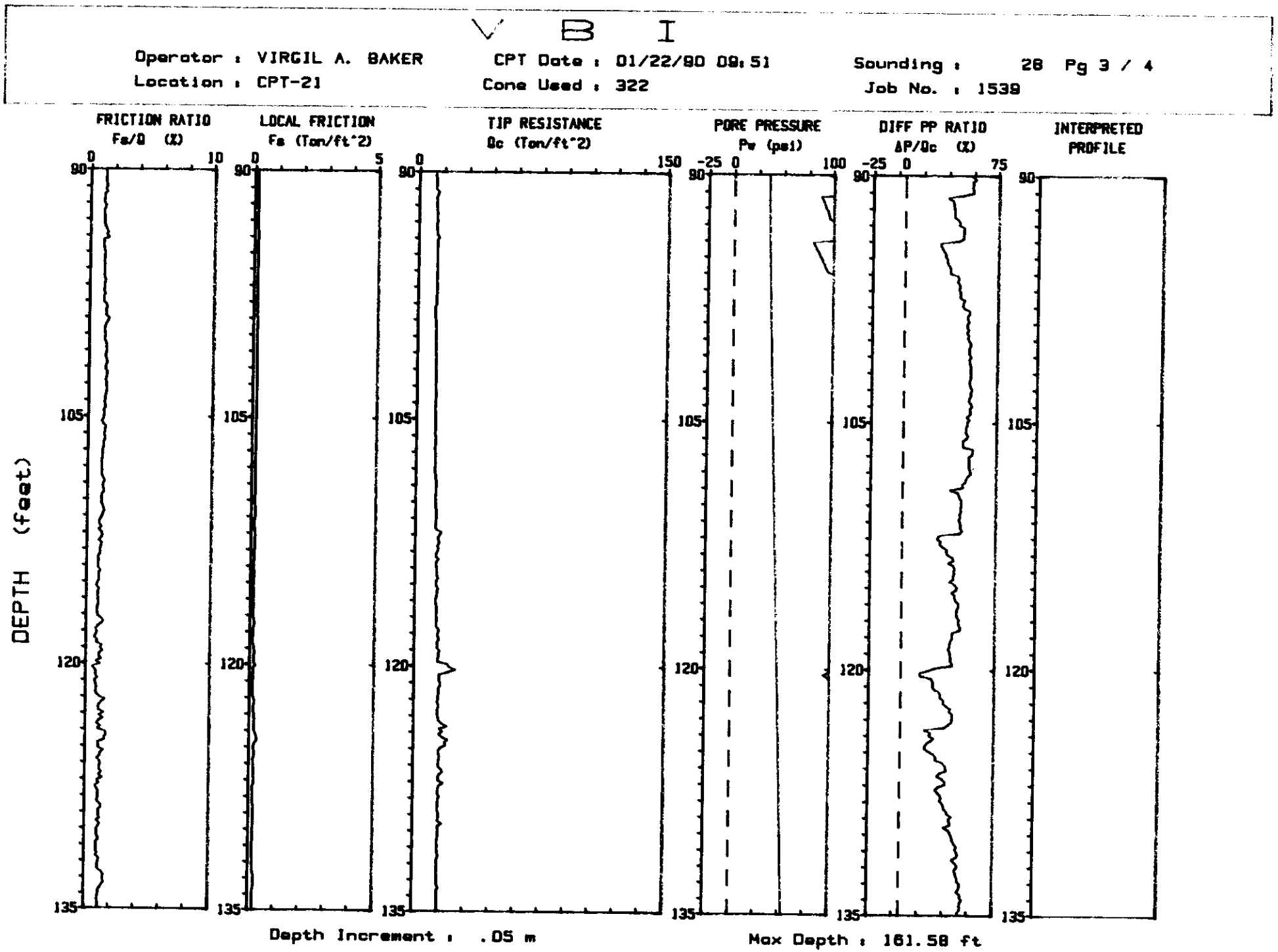

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 09:51
Sounding : 28 Pg 3 / 4
Location : CPT-21
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 161.58 ft

Figure C-62

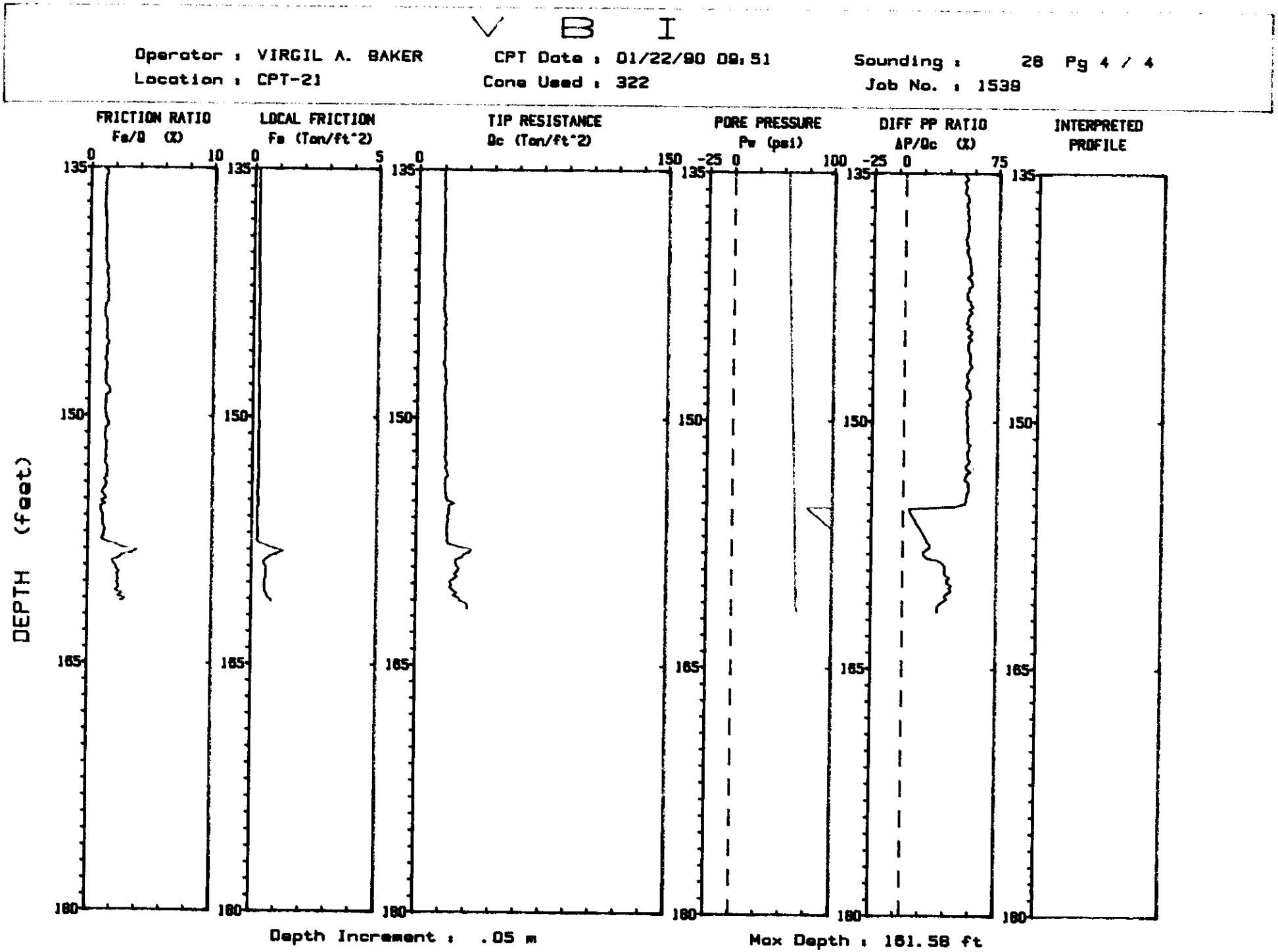

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/22/90 09:51
Sounding : 28 Pg 4 / 4
Location : CPT-21
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 181.58 ft

Figure C-63

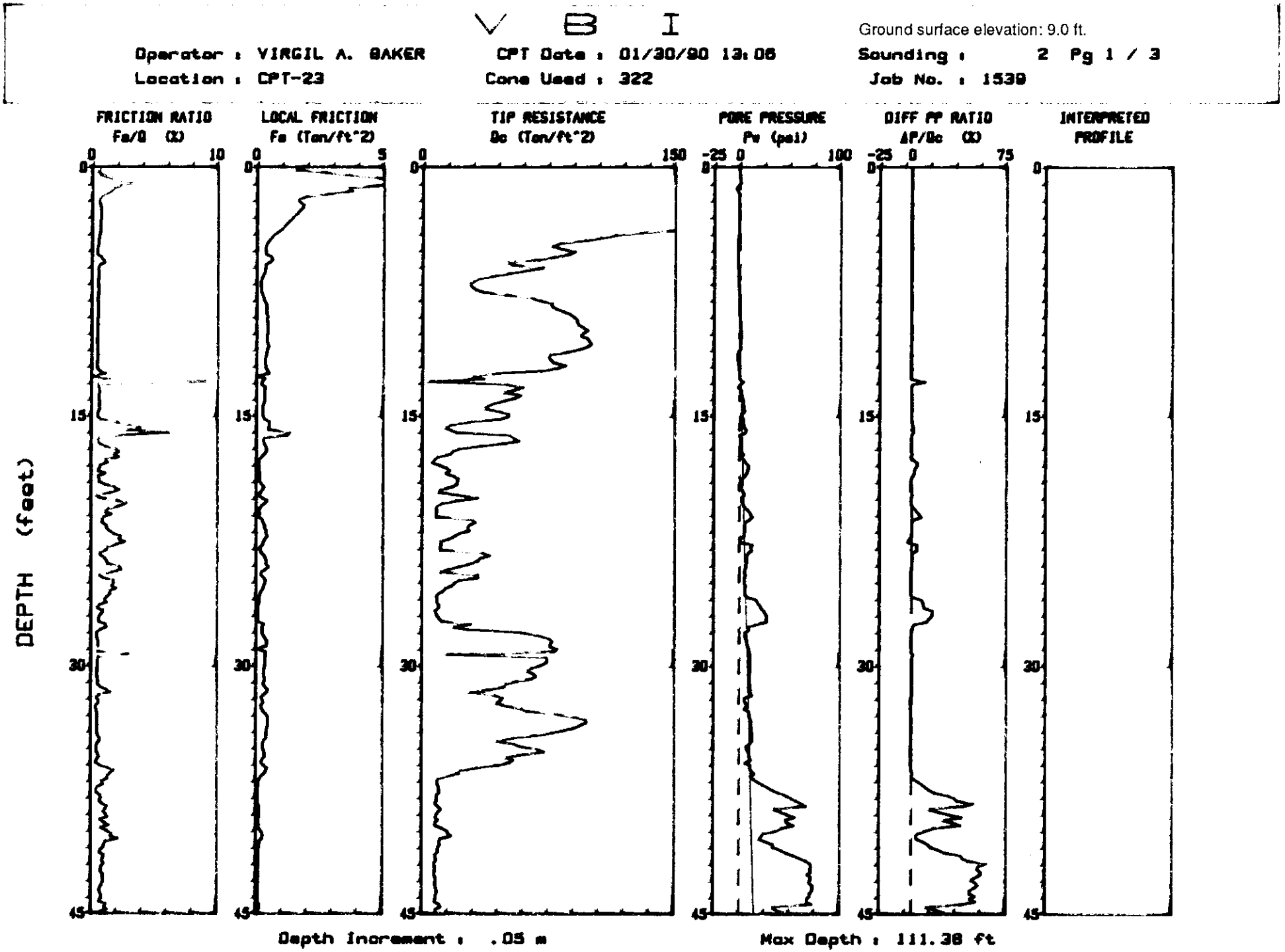

V B I
Ground surface elevation: 9.0 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/30/90 13:06
Sounding : 2 Pg 1 / 3
Location : CPT-23
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 111.38 ft

Figure C-64

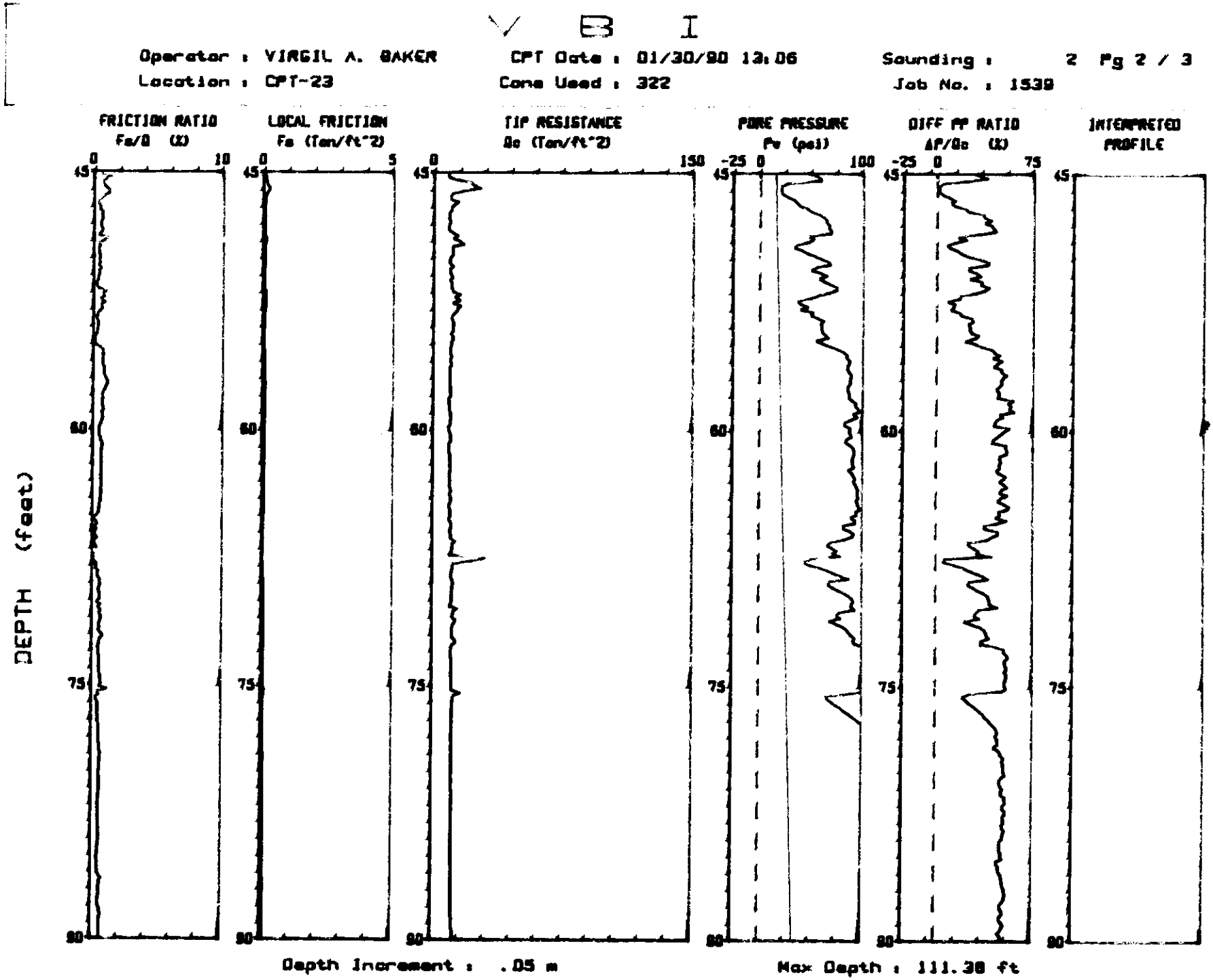

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/30/90 13:06
Sounding : 2 Pg 2 / 3
Location : CPT-23
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 111.38 ft

Figure C-65

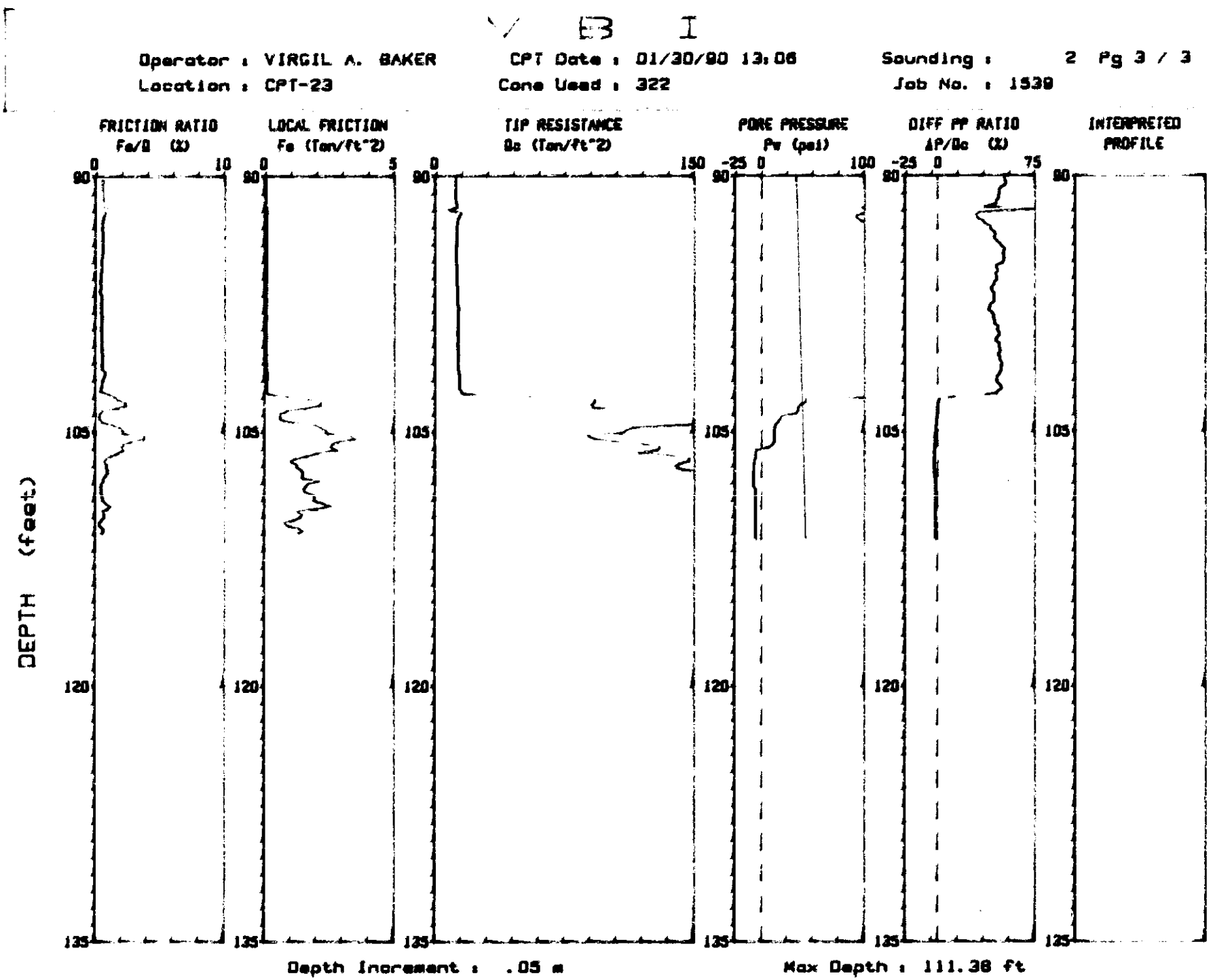

Operator : VIRGIL A. BAKER
CPT Date : 01/30/90 13:06
Sounding : 2 Pg 3 / 3
Location : CPT-23
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fe/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED
PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 111.38 ft

Figure C-66

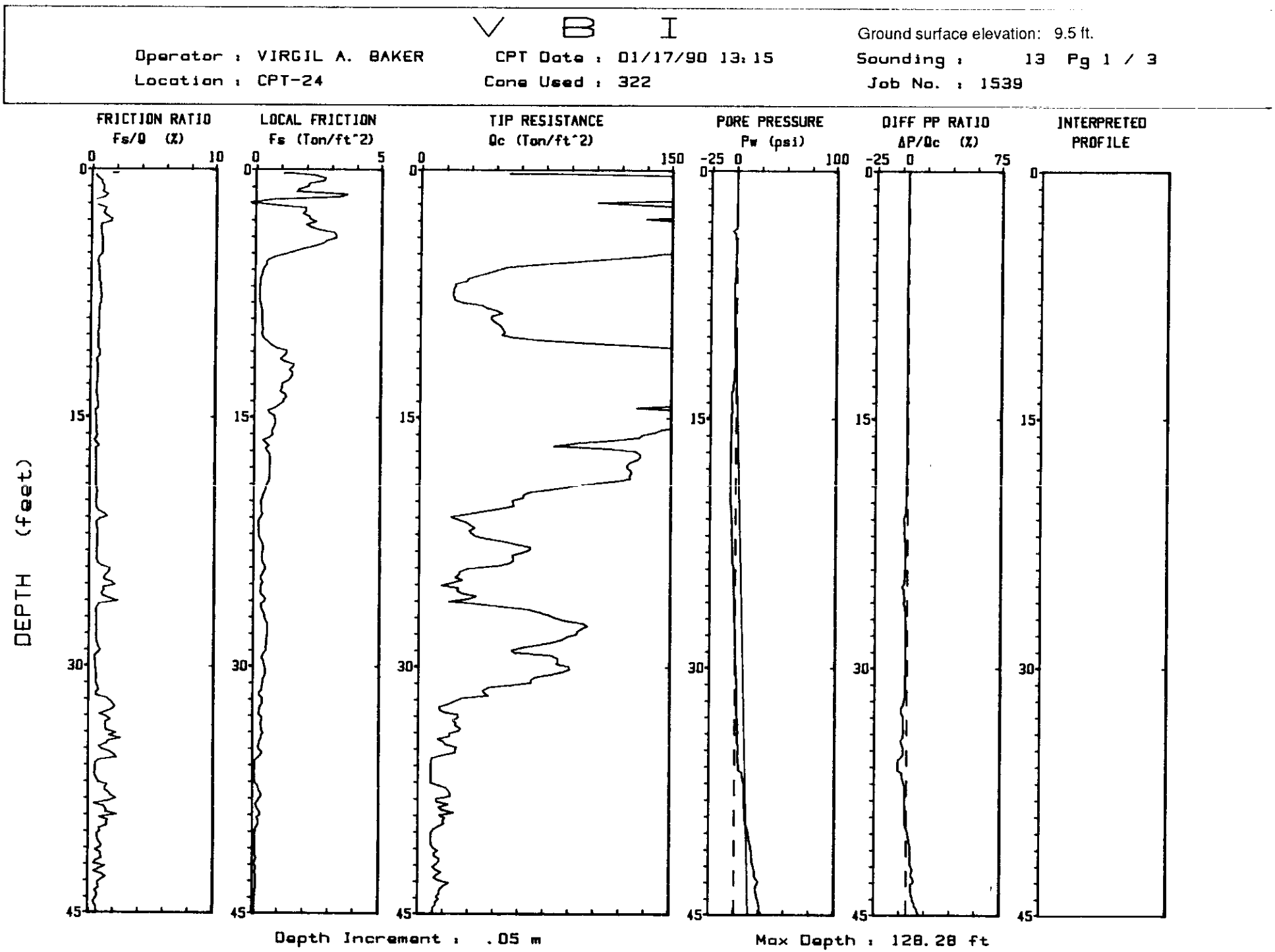

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/17/90 13:15
Ground surface elevation: 9.5 ft.
Location : CPT-24
Cone Used : 322
Sounding : 13 Pg 1 / 3
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 128.28 ft

Figure C-67

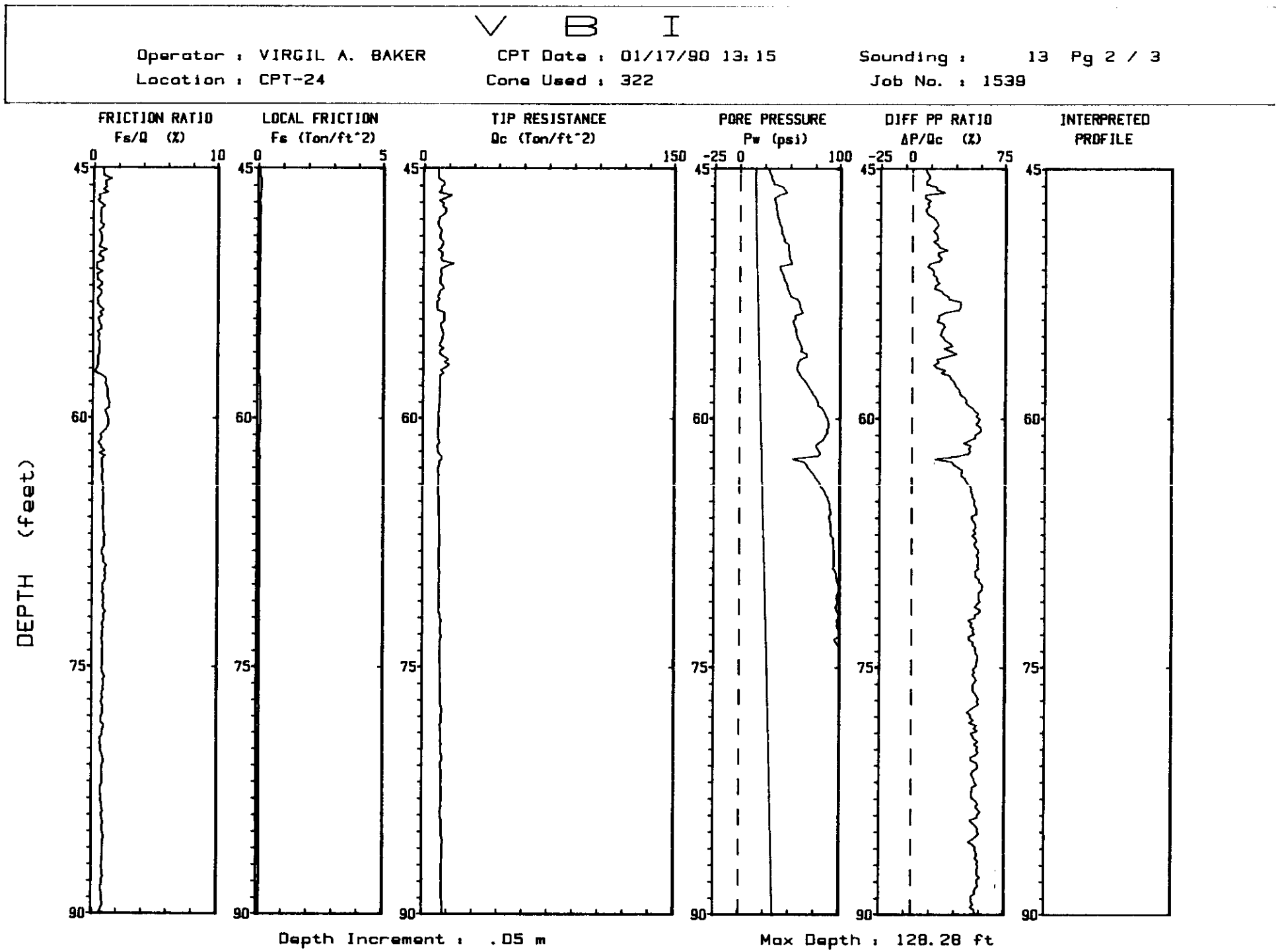

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/17/90 13:15
Sounding : 13 Pg 2 / 3
Location : CPT-24
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 128.28 ft

Figure C-68

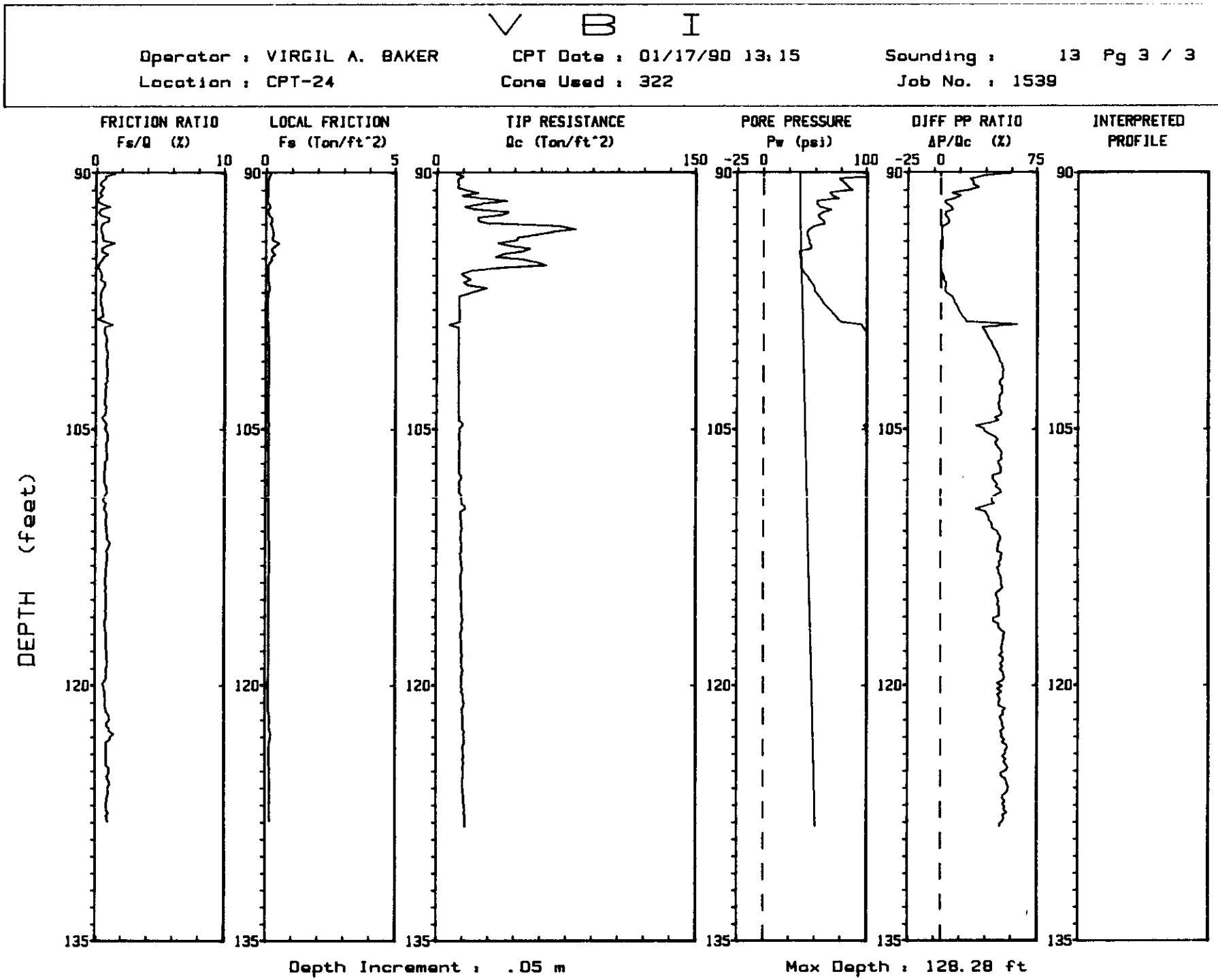

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/17/90 13:15
Sounding : 13 Pg 3 / 3
Location : CPT-24
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 128.28 ft

Figure C-69

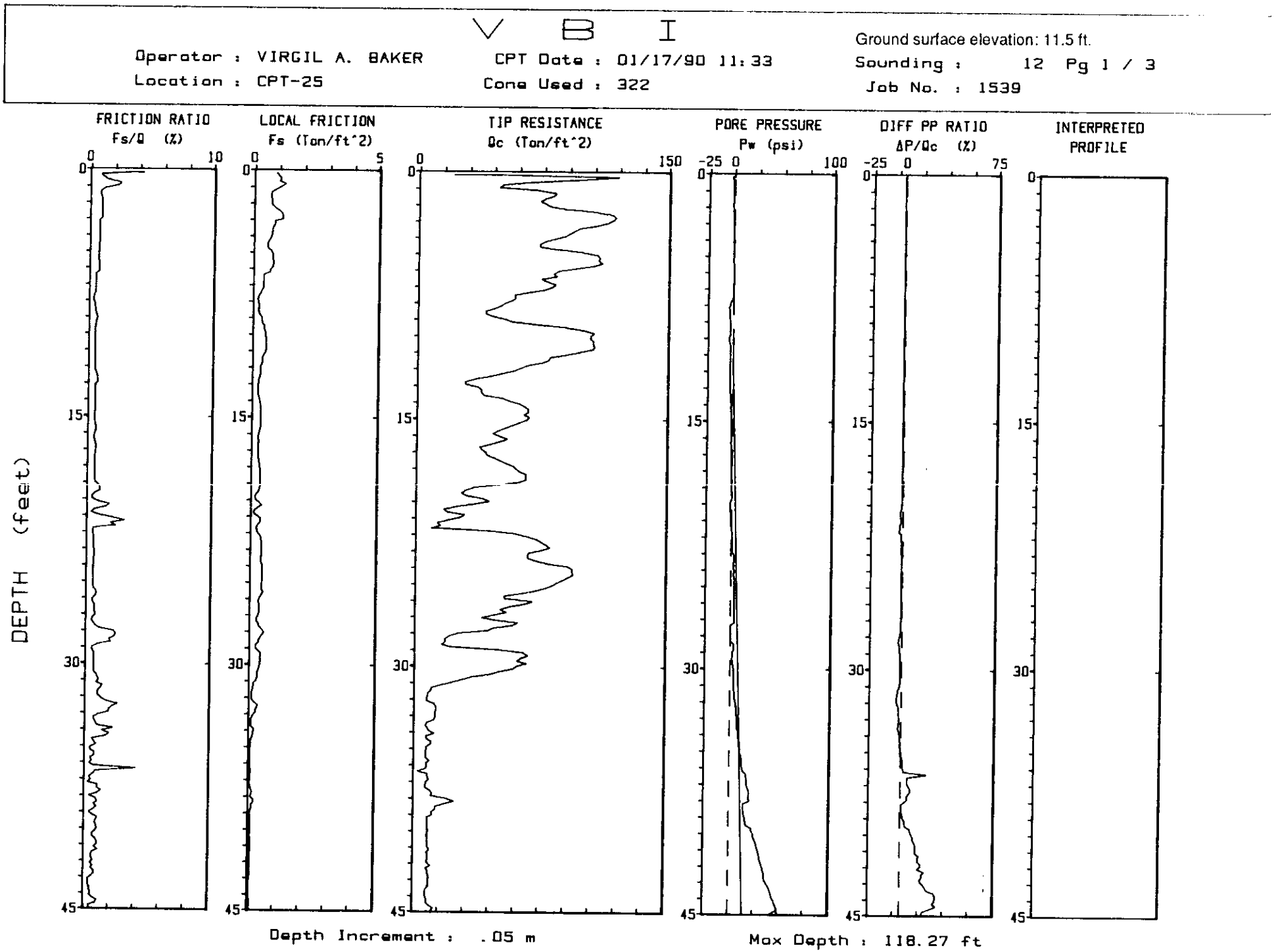

V B I
Operator : VIRGIL A. BAKER
Location : CPT-25
CPT Date : 01/17/90 11:33
Cone Used : 322
Ground surface elevation: 11.5 ft.
Sounding : 12 Pg 1 / 3
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 118.27 ft

Figure C-70

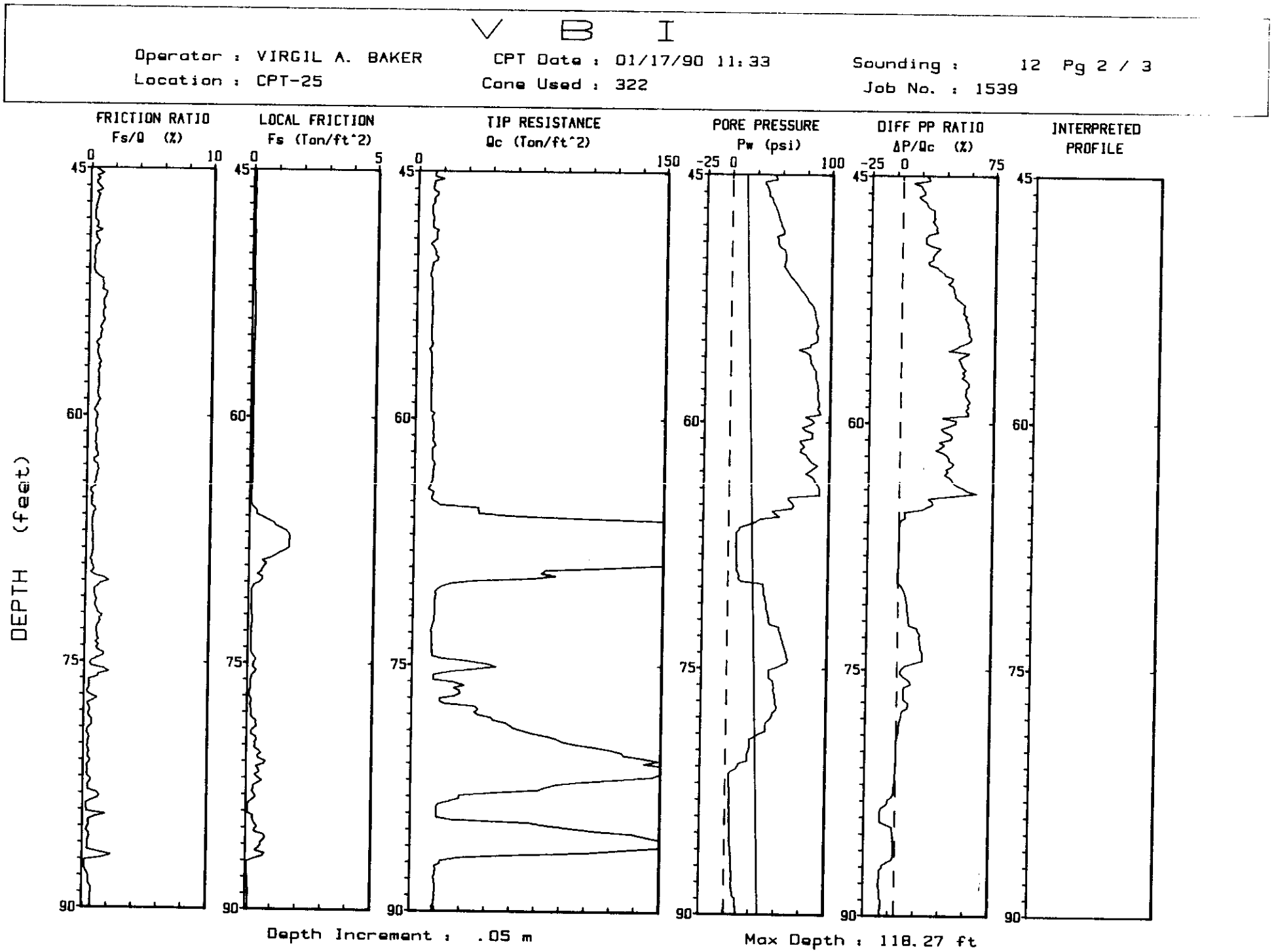

V B I
Operator : VIRGIL A. BAKER
CPT Data : 01/17/90 11:33
Sounding : 12 Pg 2 / 3
Location : CPT-25
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 118.27 ft

Figure C-71

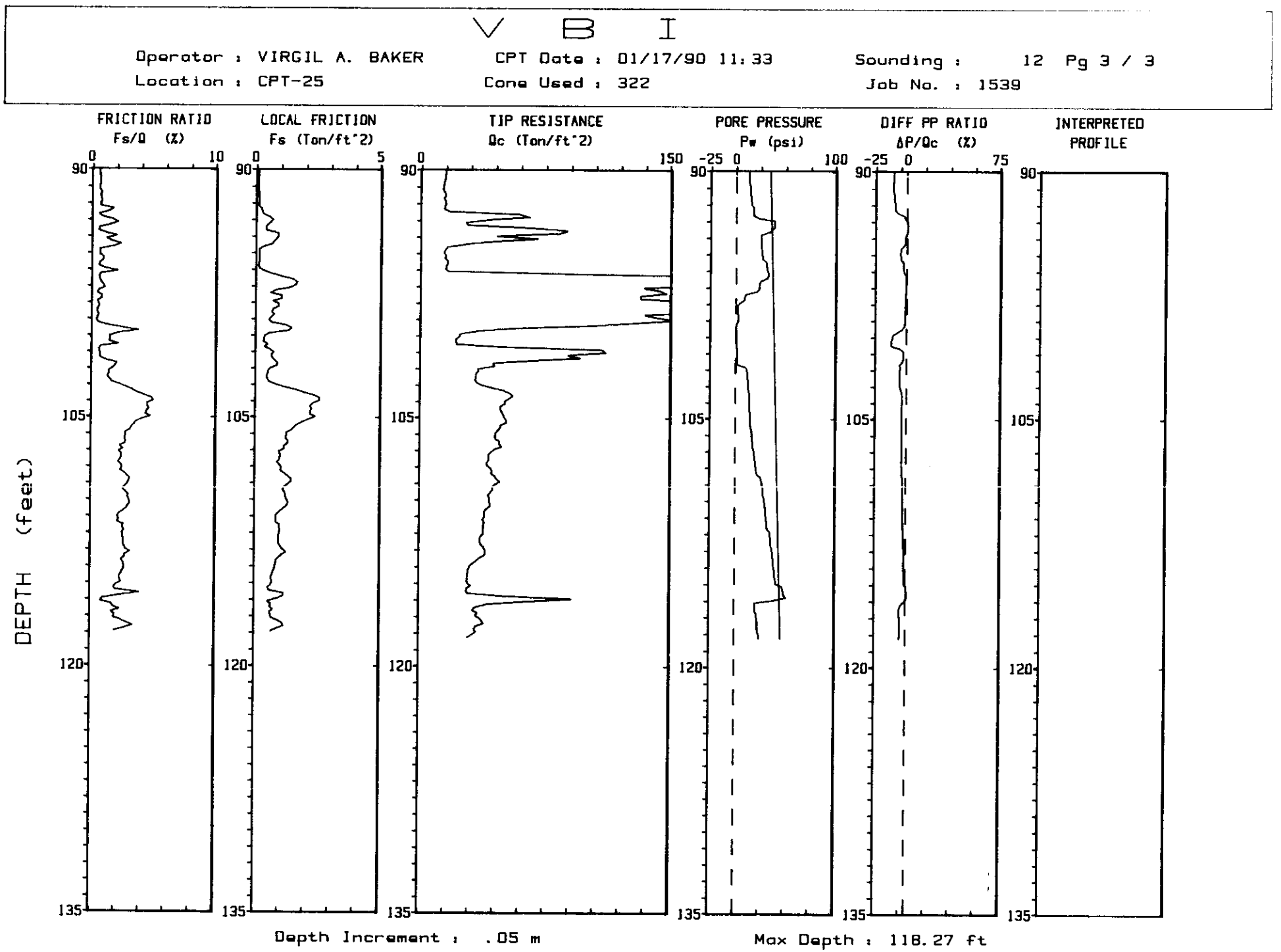

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/17/90 11:33
Sounding : 12 Pg 3 / 3
Location : CPT-25
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 118.27 ft

Figure C-72

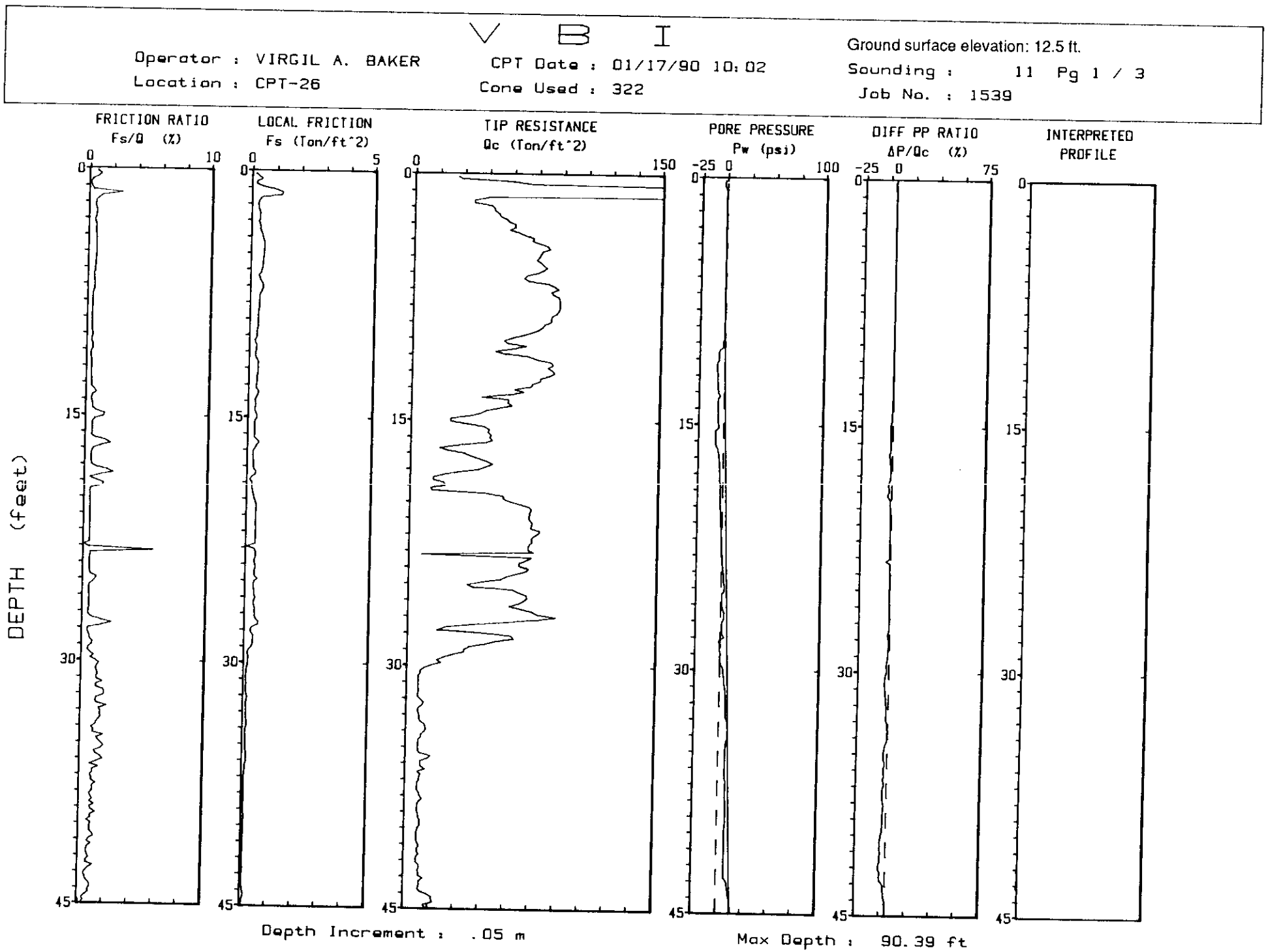

V B I
Operator : VIRGIL A. BAKER
Location : CPT-26
CPT Date : 01/17/90 10:02
Cone Used : 322
Ground surface elevation: 12.5 ft.
Sounding : 11 Pg 1 / 3
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 90.39 ft

Figure C-73

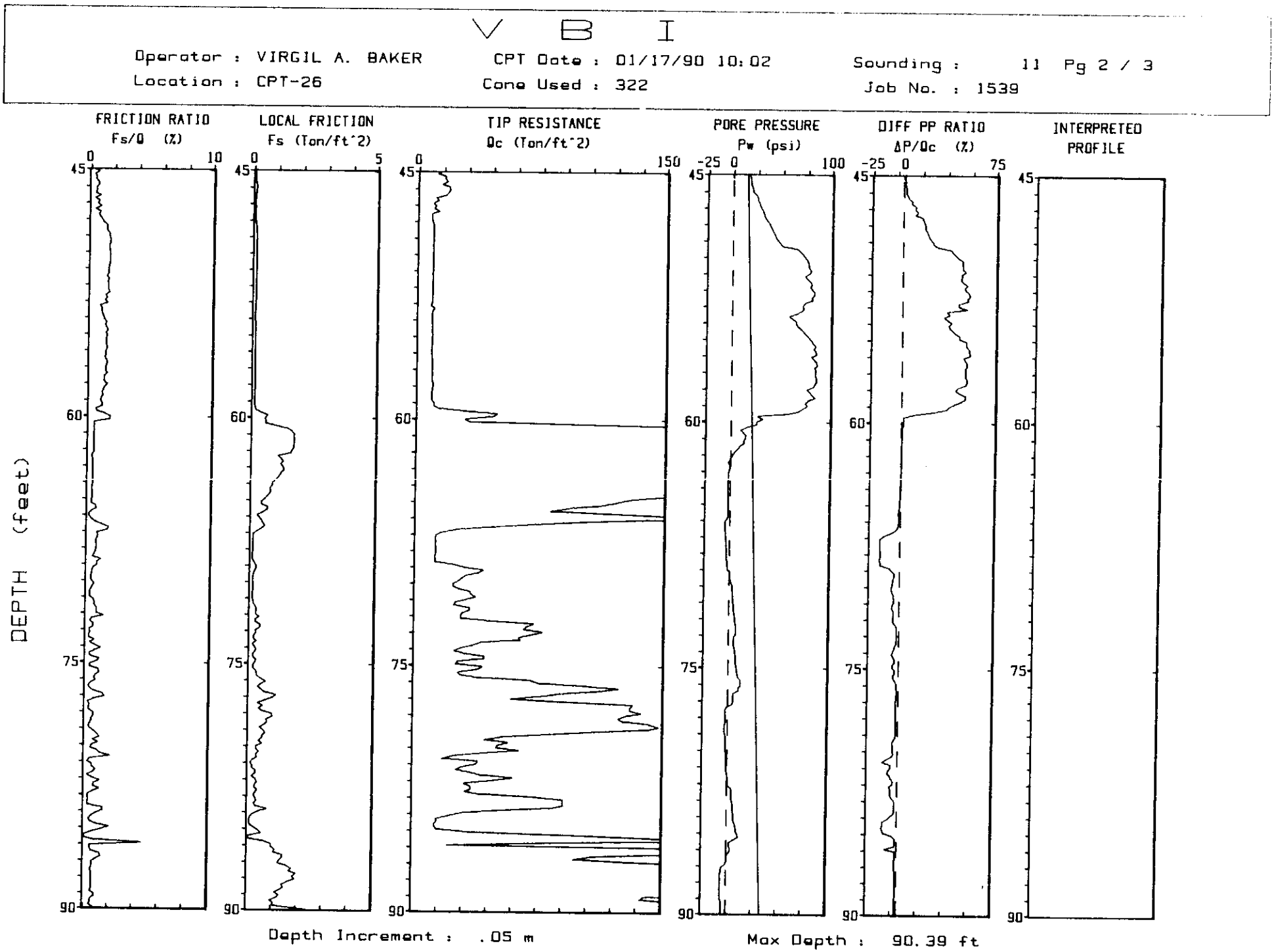

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/17/90 10:02
Sounding : 11 Pg 2 / 3
Location : CPT-26
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 90.39 ft

Figure C-74

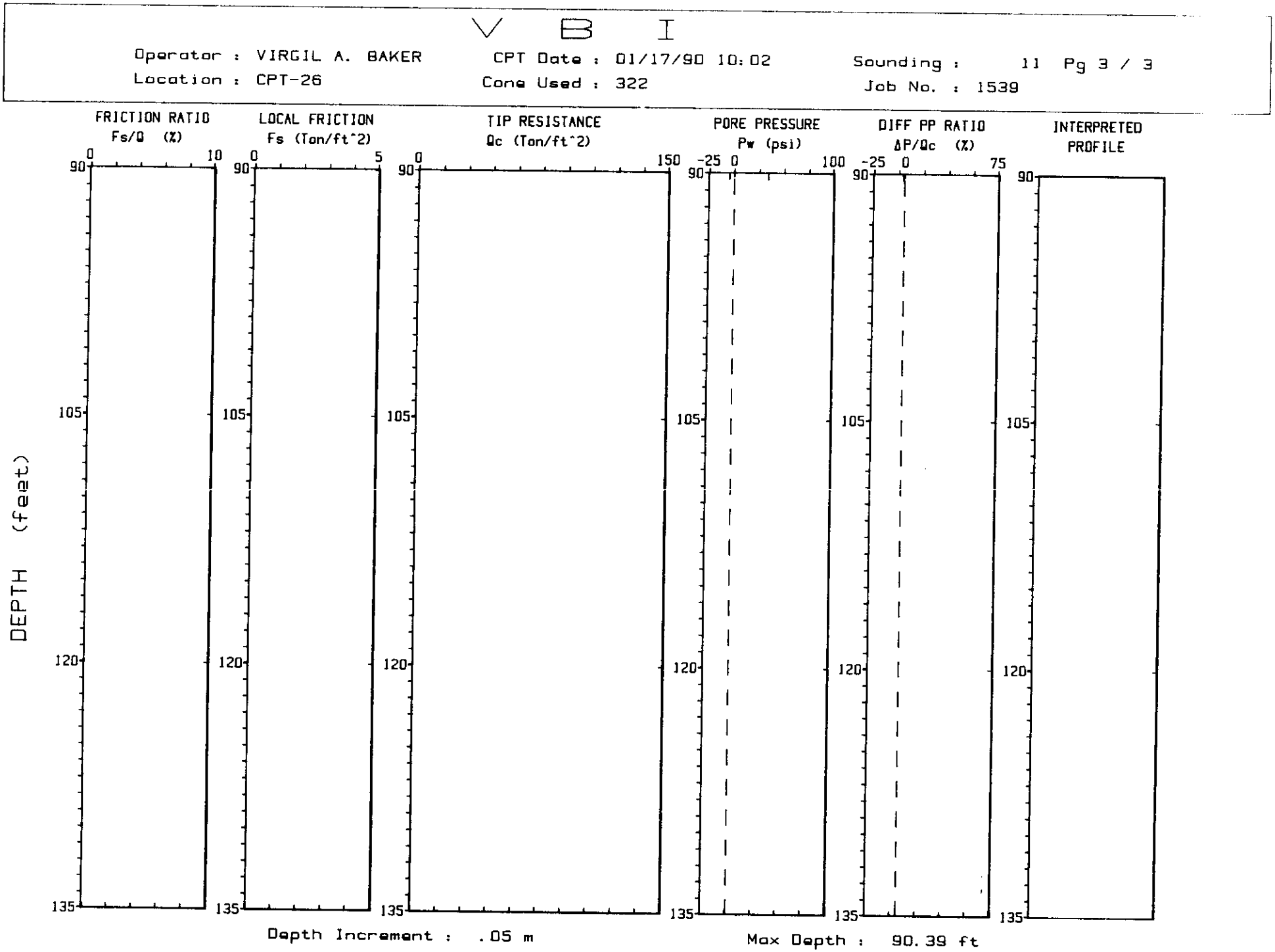

V B I
Operator : VIRGIL A. BAKER
Location : CPT-26
CPT Date : 01/17/90 10:02
Cone Used : 322
Sounding : 11 Pg 3 / 3
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED
PROFILE
DEPTH (feet)
90
105
120
135
Depth Increment : .05 m
Max Depth : 90.39 ft

Figure C-75

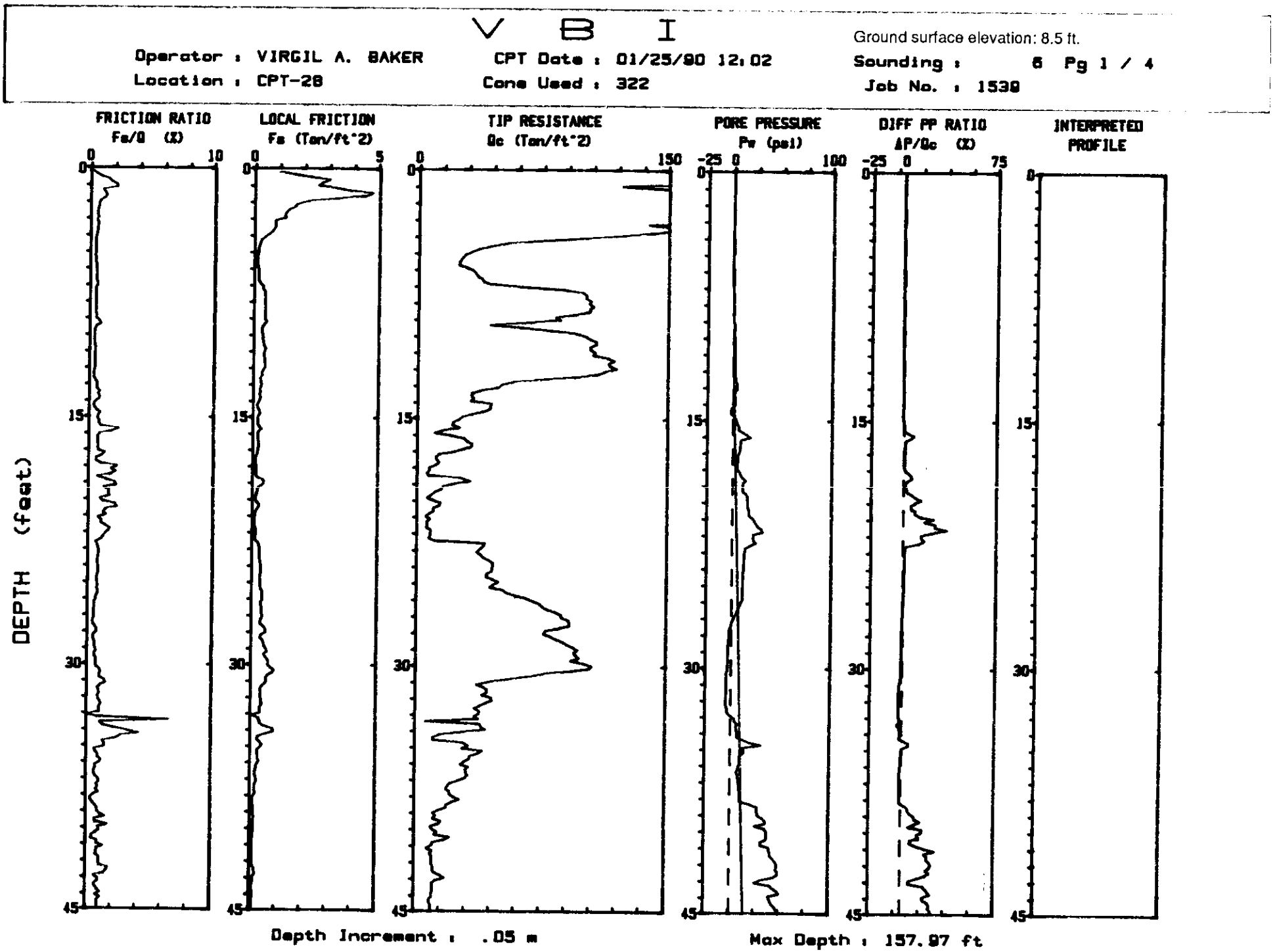

V B I
Operator : VIRGIL A. BAKER
Location : CPT-28
CPT Date : 01/25/90 12:02
Cone Used : 322
Ground surface elevation: 8.5 ft.
Sounding : 6 Pg 1 / 4
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.97 ft

Figure C-76

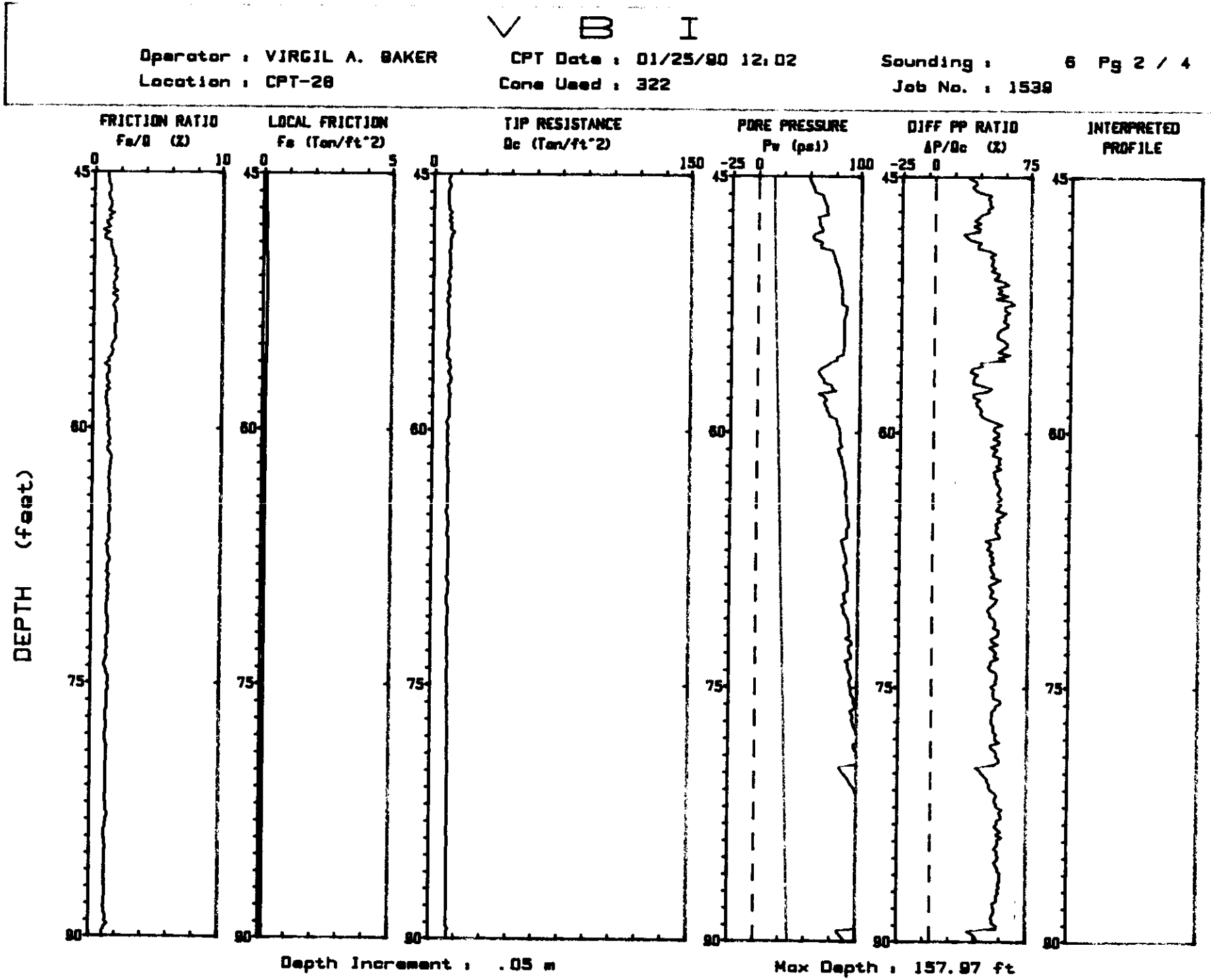

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/25/90 12:02
Sounding : 6 Pg 2 / 4
Location : CPT-28
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.97 ft

Figure C-77

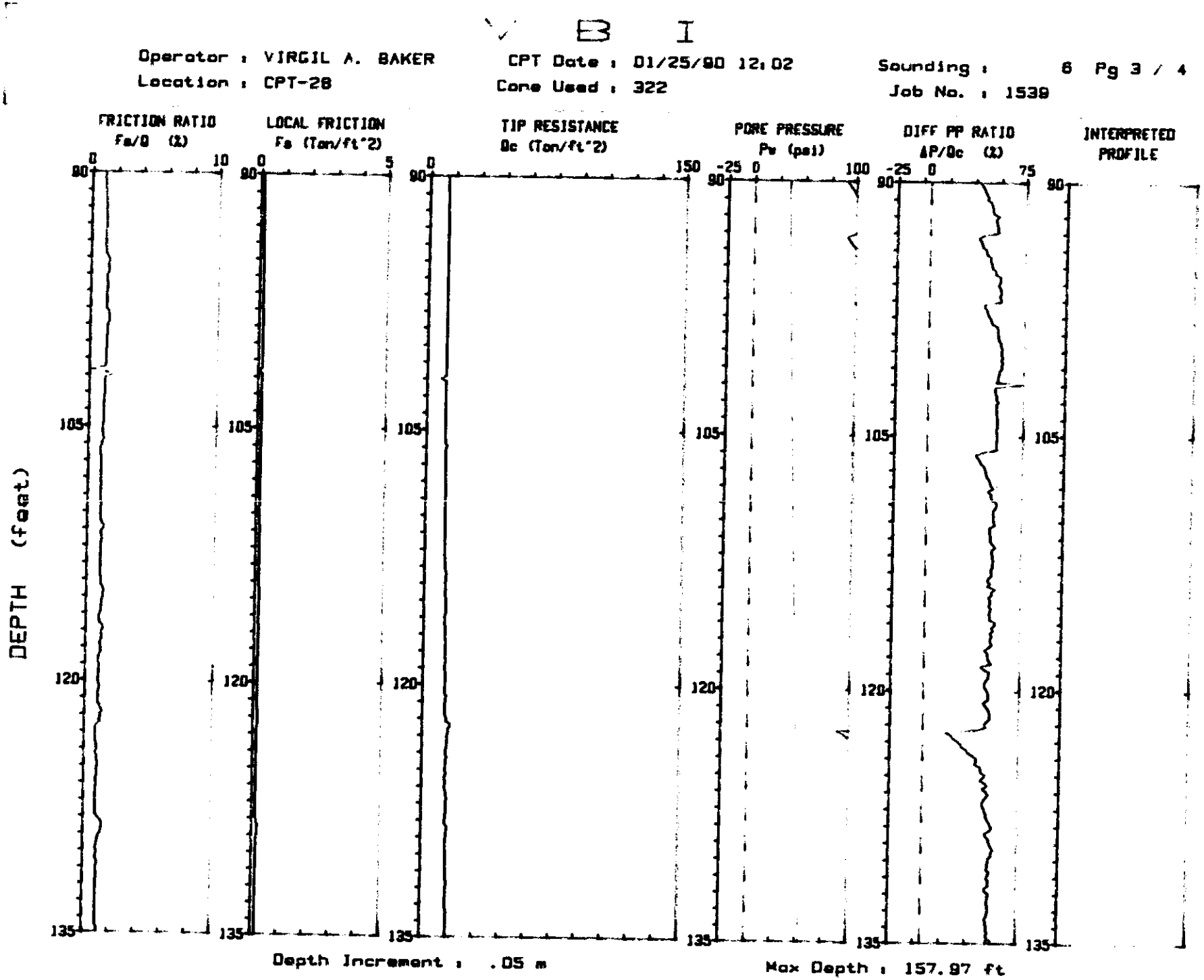

B I
Operator : VIRGIL A. BAKER
Location : CPT-28
CPT Date : 01/25/90 12:02
Cone Used : 322
Sounding : 6 Pg 3 / 4
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.87 ft

Figure C-78

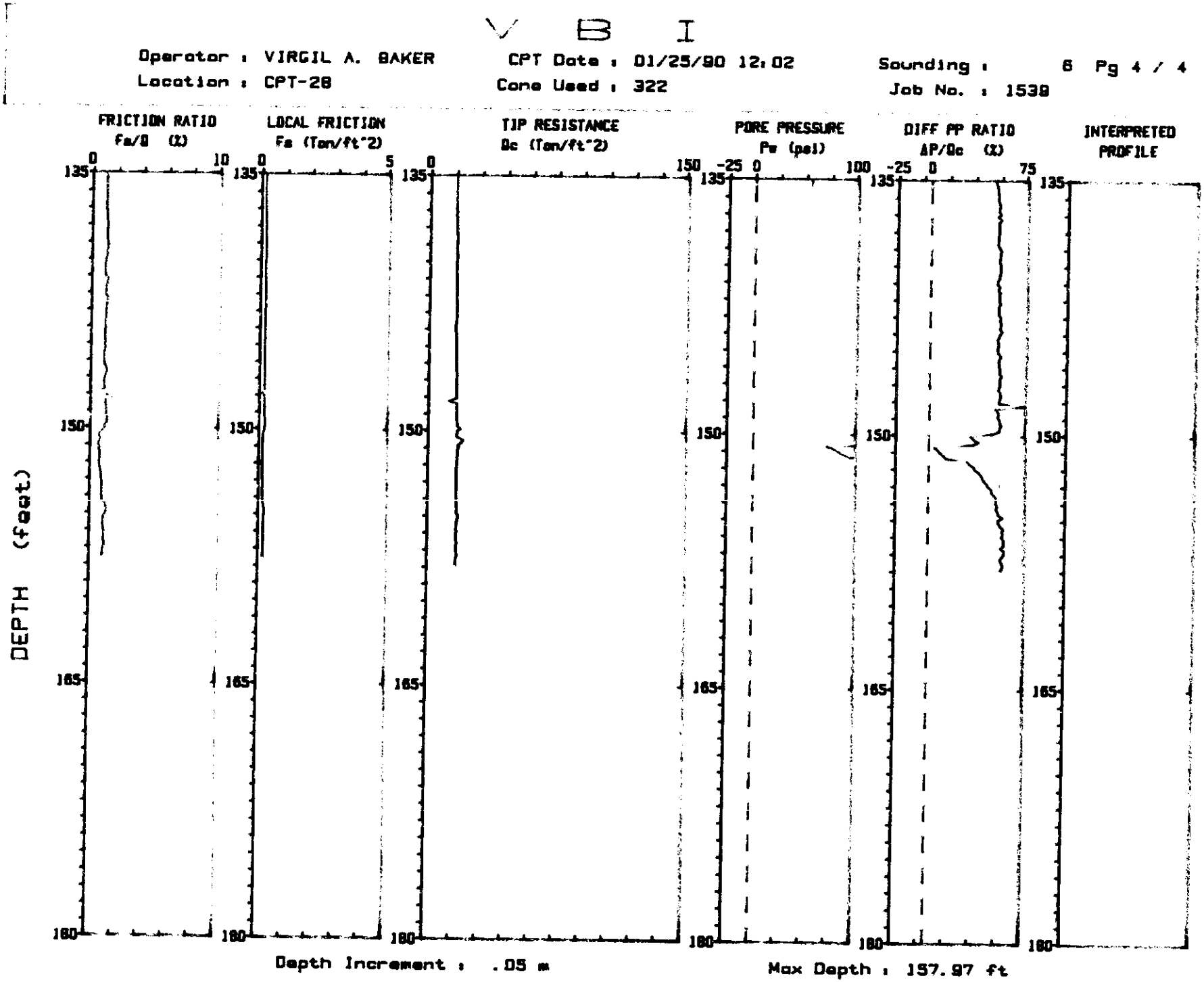

V B I
Operator : VIRGIL A. BAKER
Location : CPT-28
CPT Date : 01/25/90 12:02
Cone Used : 322
Sounding : 6 Pg 4 / 4
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED
PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 157.97 ft

Figure C-79

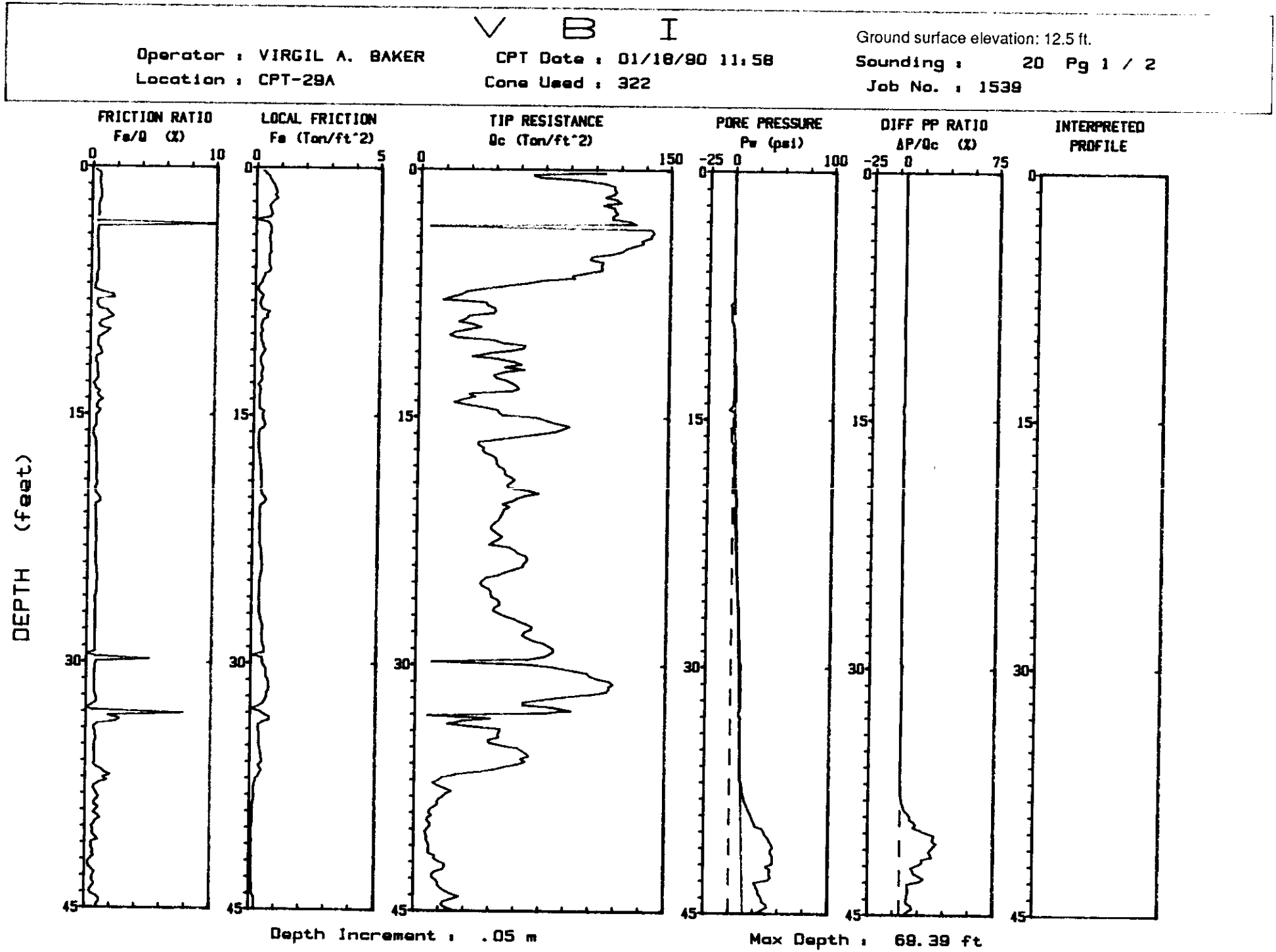

V B I
Operator : VIRGIL A. BAKER
Location : CPT-29A
CPT Date : 01/18/90 11:58
Cone Used : 322
Ground surface elevation: 12.5 ft.
Sounding : 20 Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 68.39 ft

Figure C-80

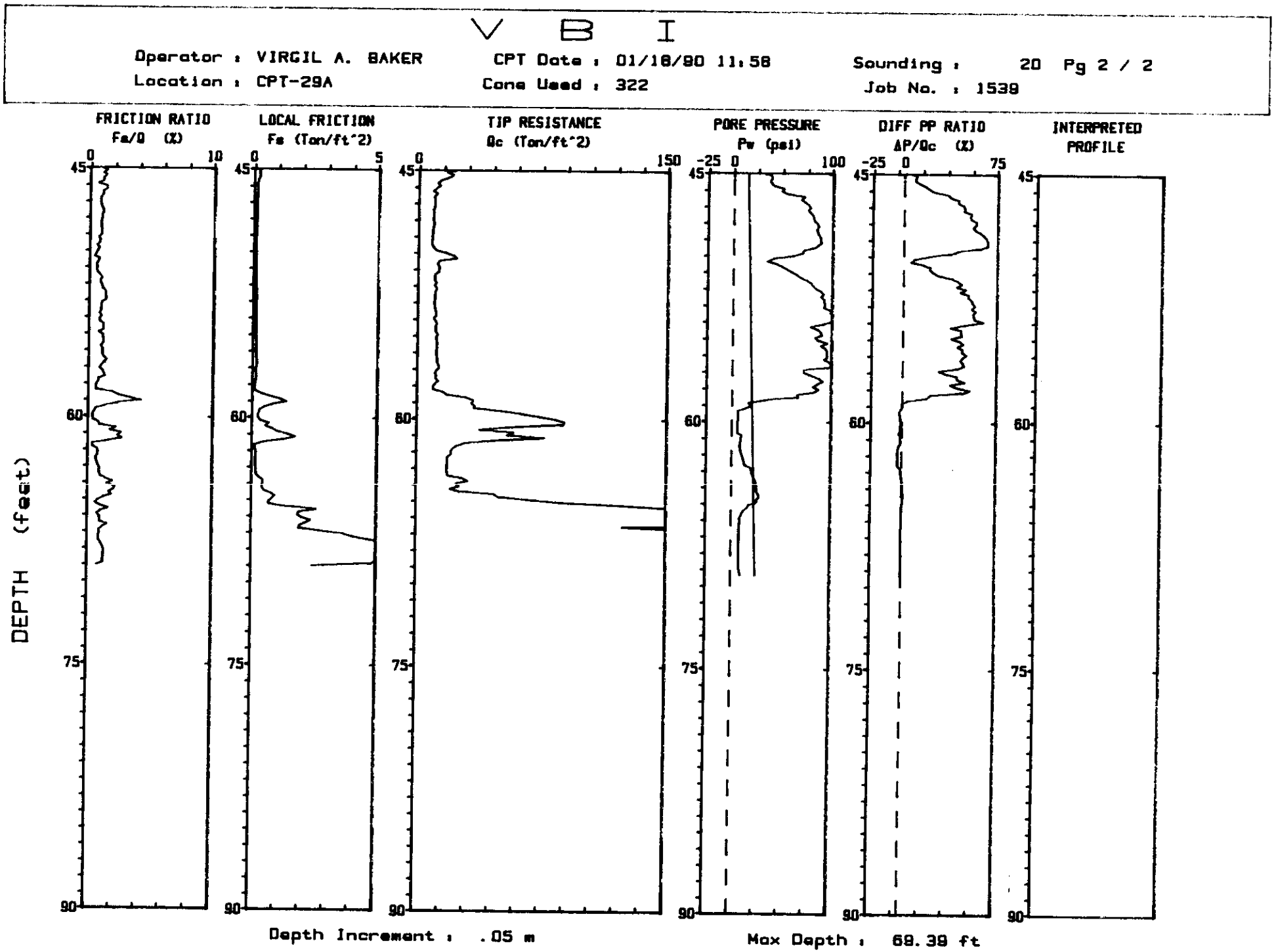

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 11:58
Sounding : 20 Pg 2 / 2
Location : CPT-29A
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 68.39 ft

Figure C-81

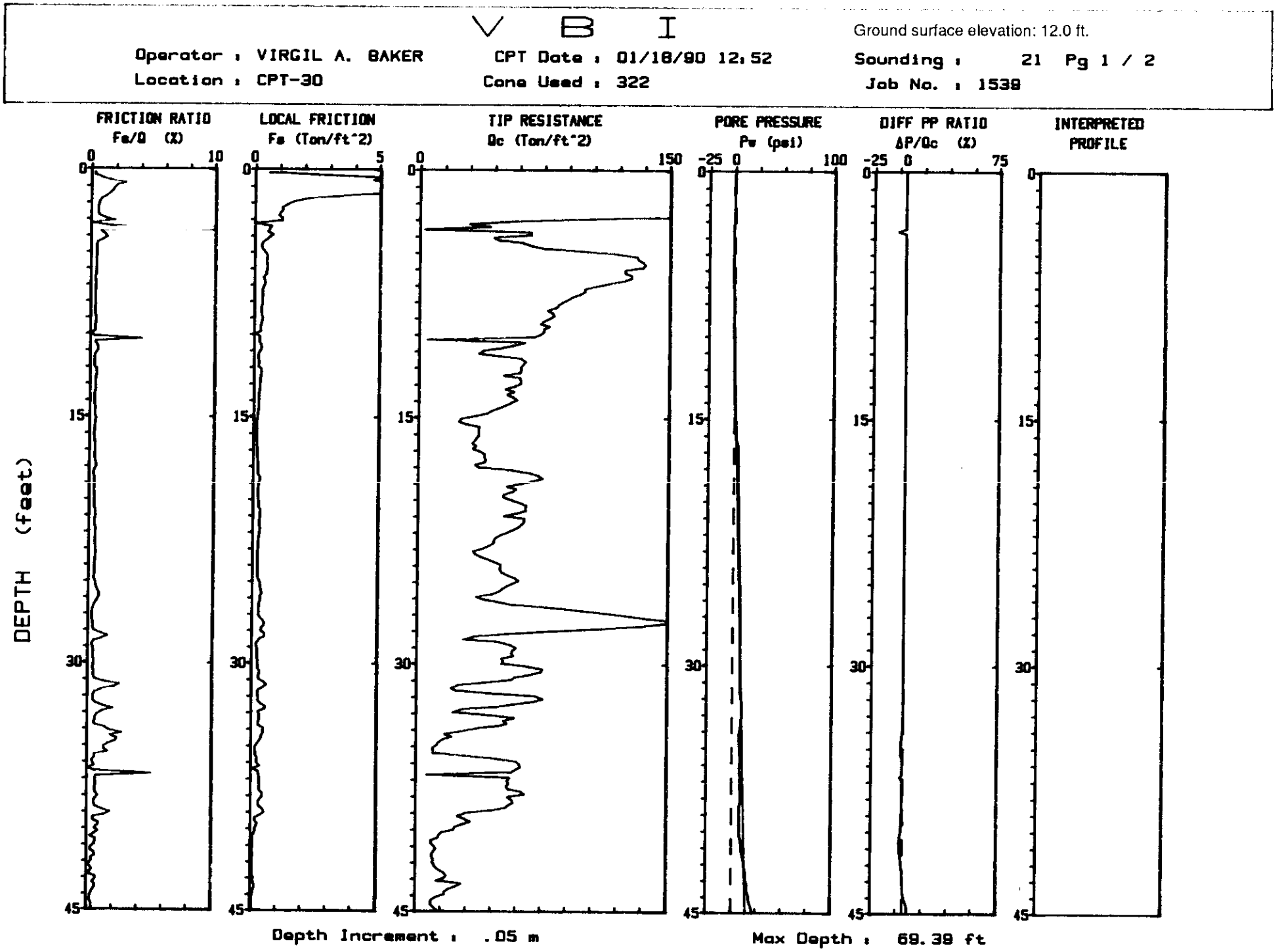

V B I
Ground surface elevation: 12.0 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 12:52
Sounding : 21 Pg 1 / 2
Location : CPT-30
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 69.39 ft

Figure C-82

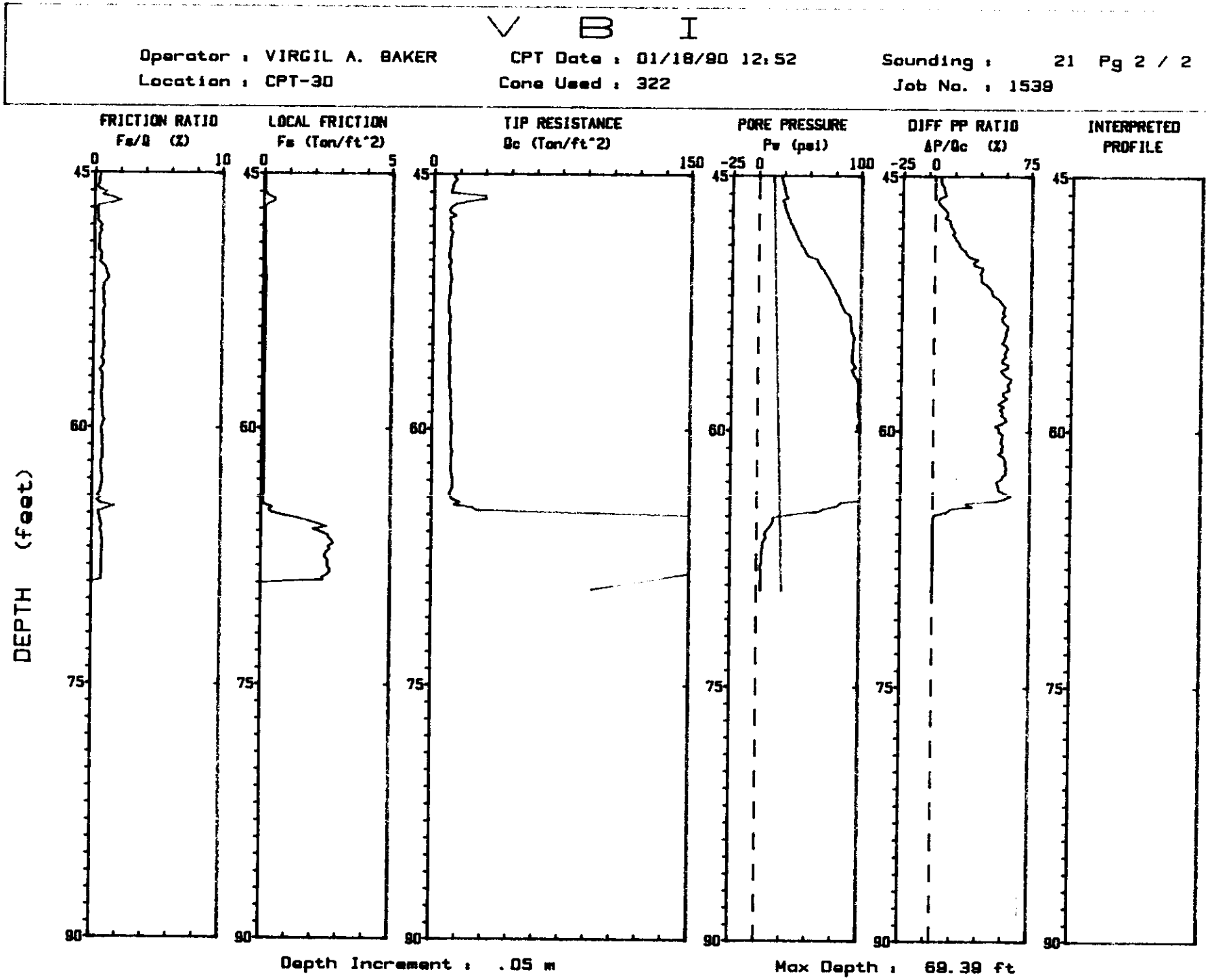

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 12:52
Sounding : 21 Pg 2 / 2
Location : CPT-30
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 69.39 ft

Figure C-83

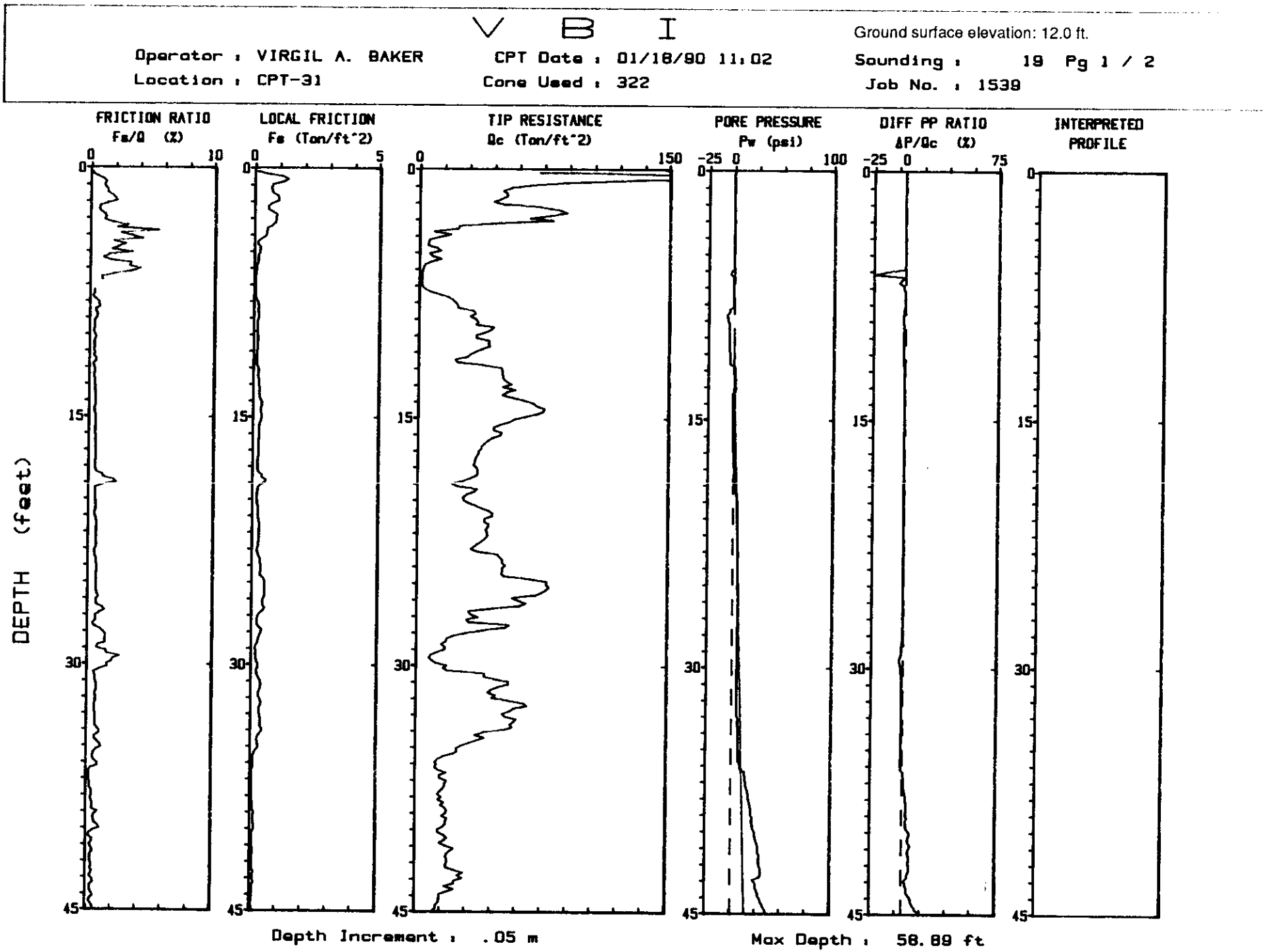

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 11:02
Ground surface elevation: 12.0 ft.
Location : CPT-31
Cone Used : 322
Sounding : 19 Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 58.89 ft

Figure C-84

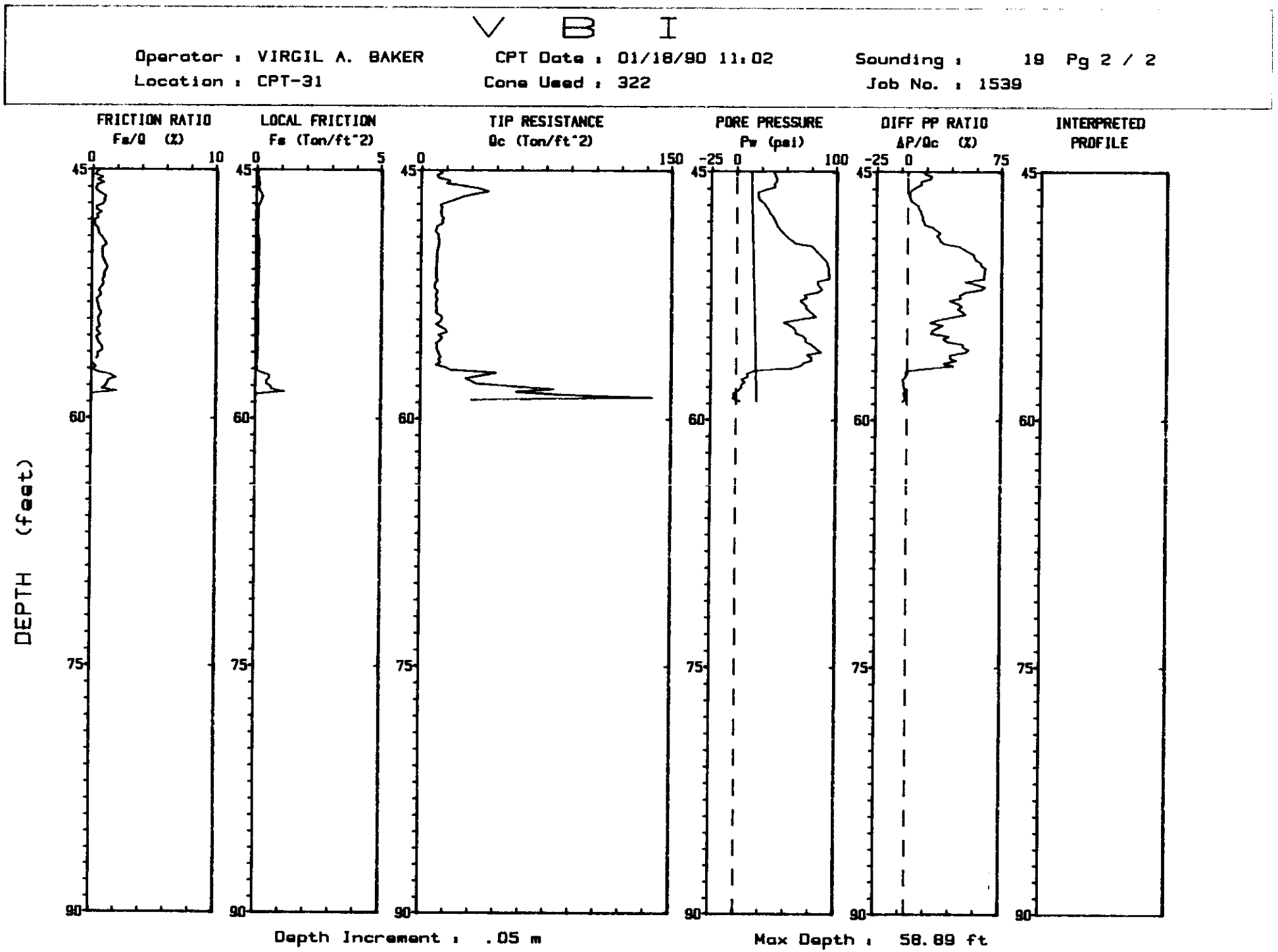

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/18/90 11:02
Sounding : 19 Pg 2 / 2
Location : CPT-31
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 58.89 ft

Figure C-85

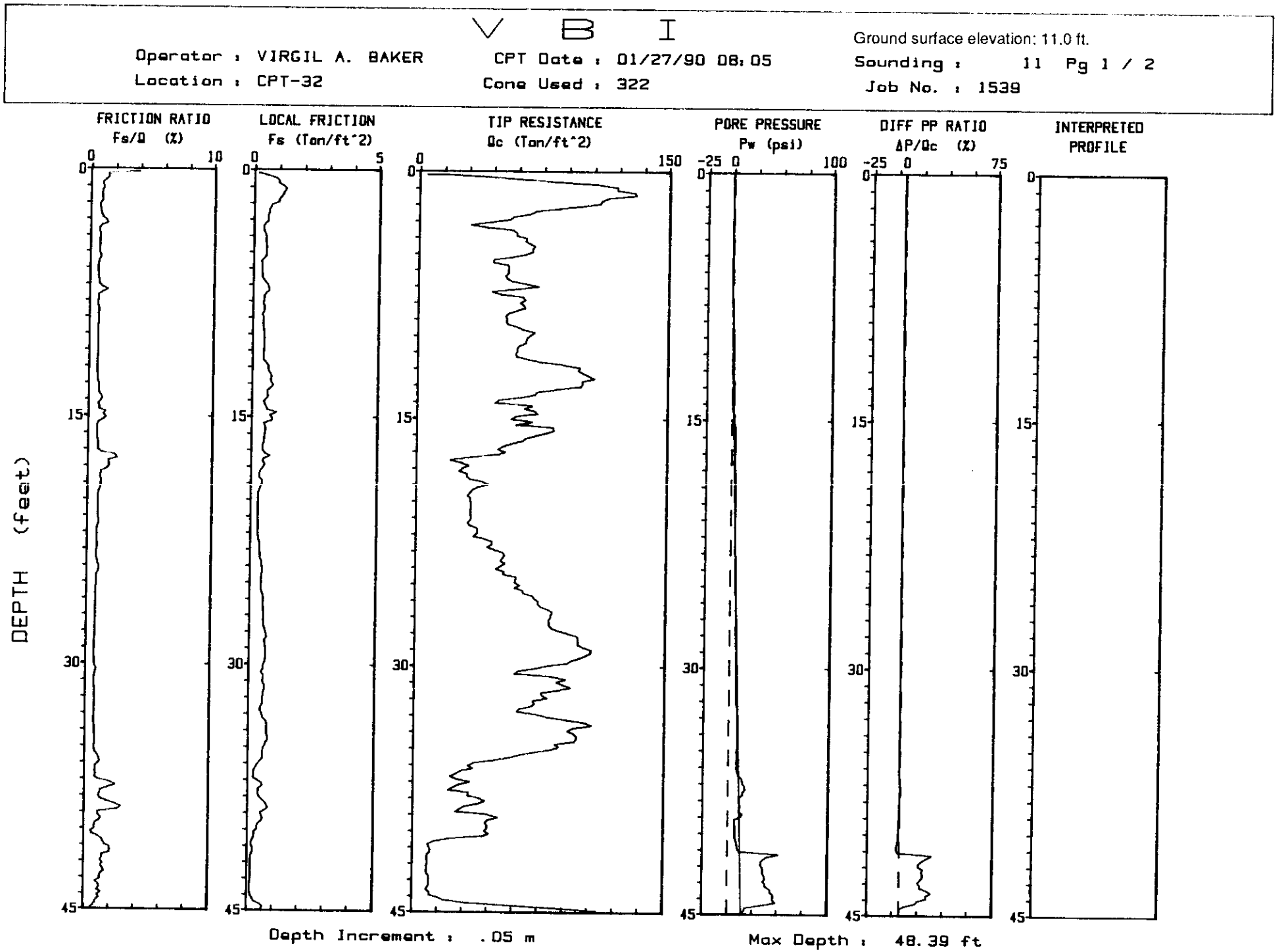

V B I
Operator : VIRGIL A. BAKER
Location : CPT-32
CPT Date : 01/27/90 08:05
Cone Used : 322
Ground surface elevation: 11.0 ft.
Sounding : 11 Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED
PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 48.39 ft

Figure C-86

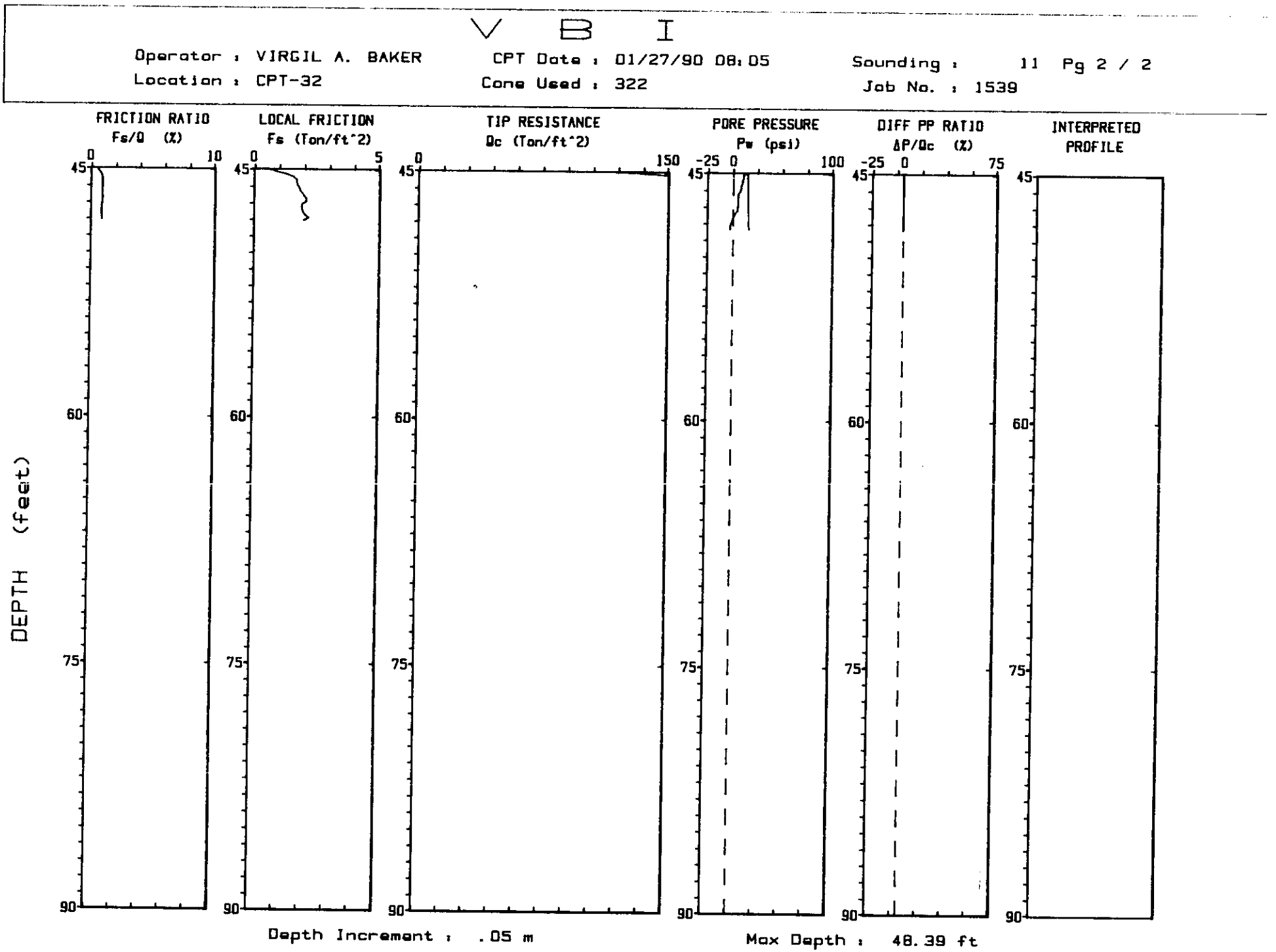

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/27/90 08:05
Sounding : 11 Pg 2 / 2
Location : CPT-32
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 48.39 ft

Figure C-87

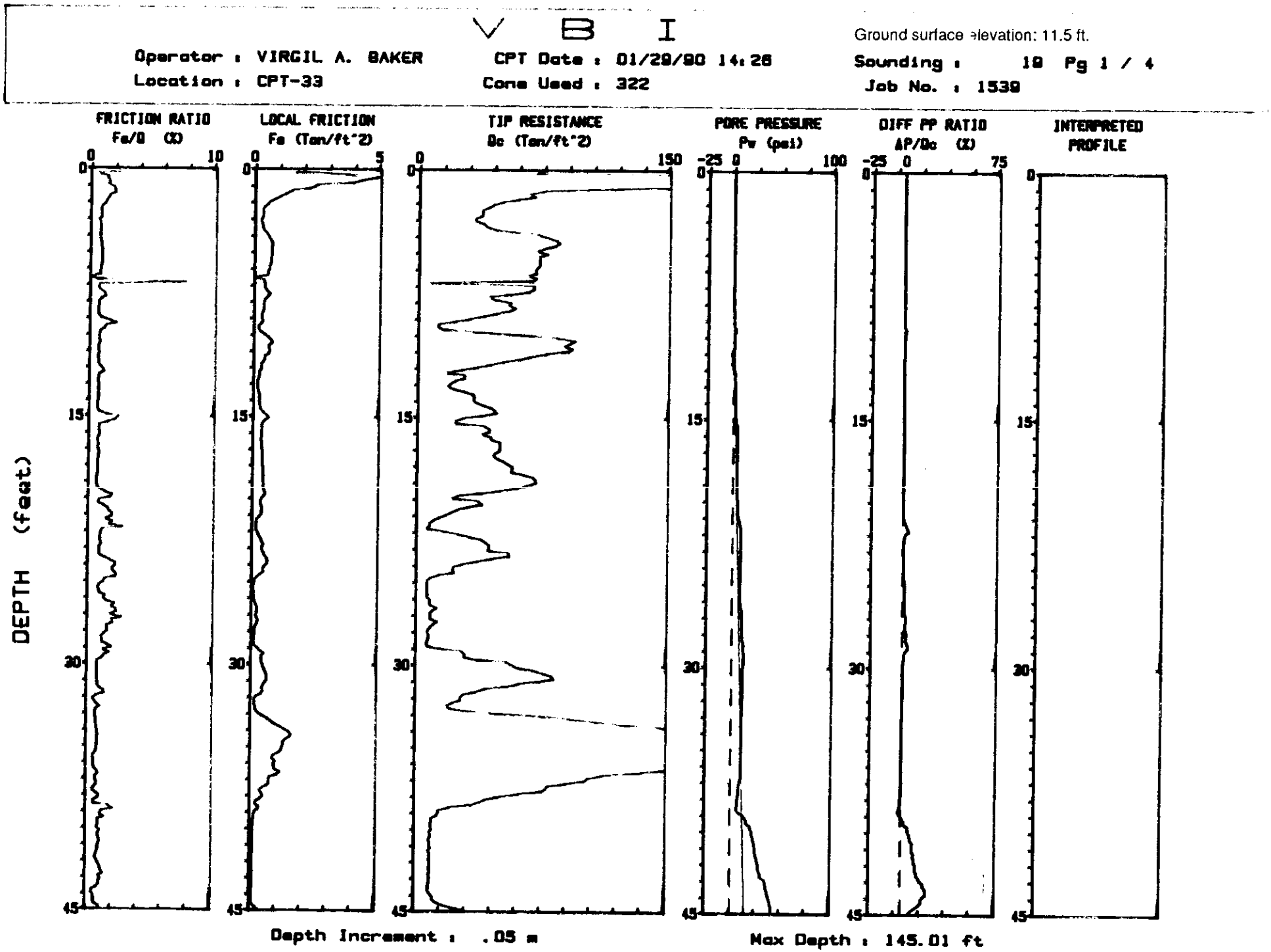

V B I
Operator : VIRGIL A. BAKER
Location : CPT-33
CPT Date : 01/29/90 14:28
Cone Used : 322
Ground surface elevation: 11.5 ft.
Sounding : 18 Pg 1 / 4
Job No. : 1539
FRICTION RATIO
Fa/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 145.01 ft

Figure C-88

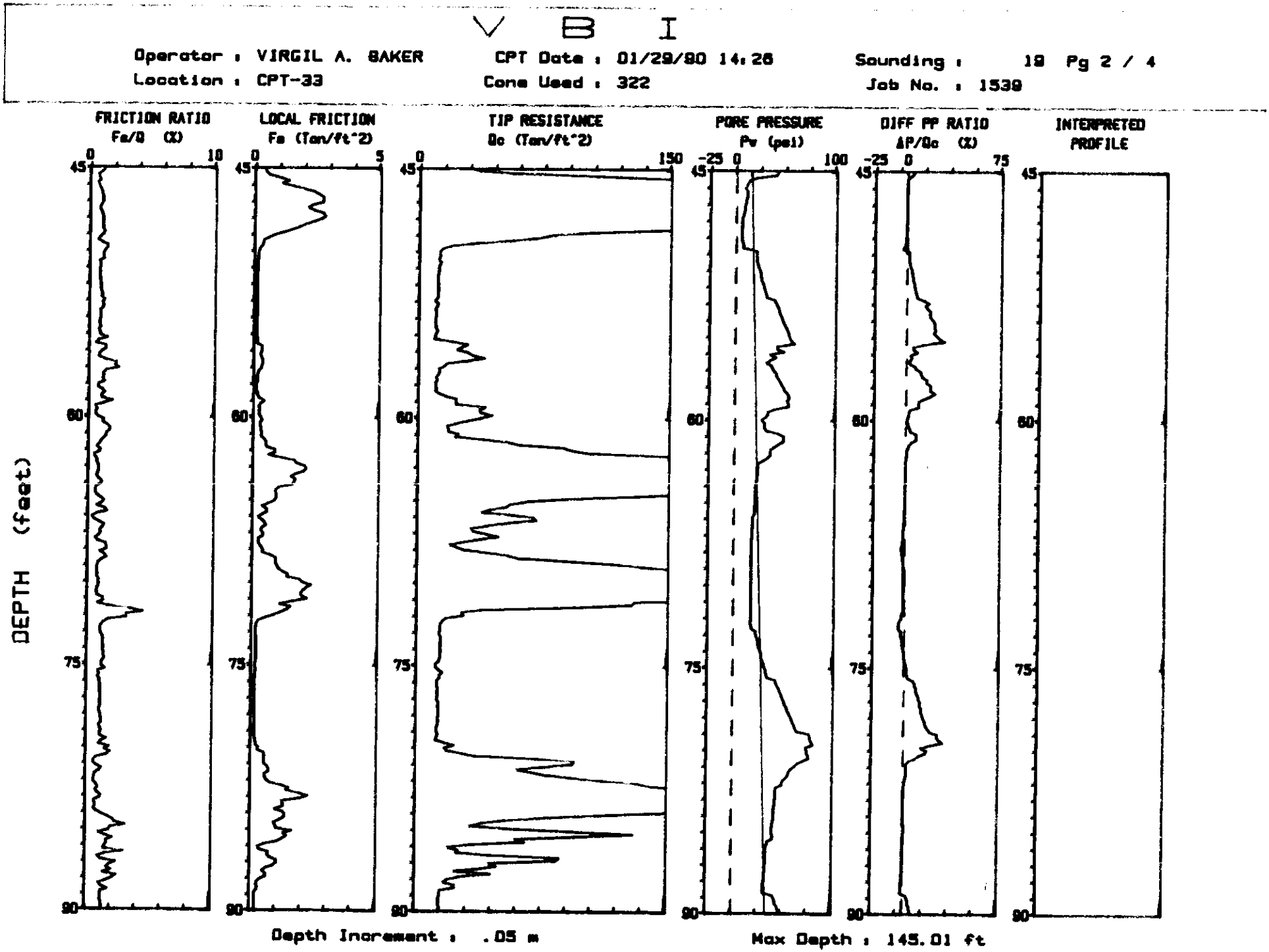

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/29/90 14:26
Sounding : 18 Pg 2 / 4
Location : CPT-33
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 145.01 ft

Figure C-89

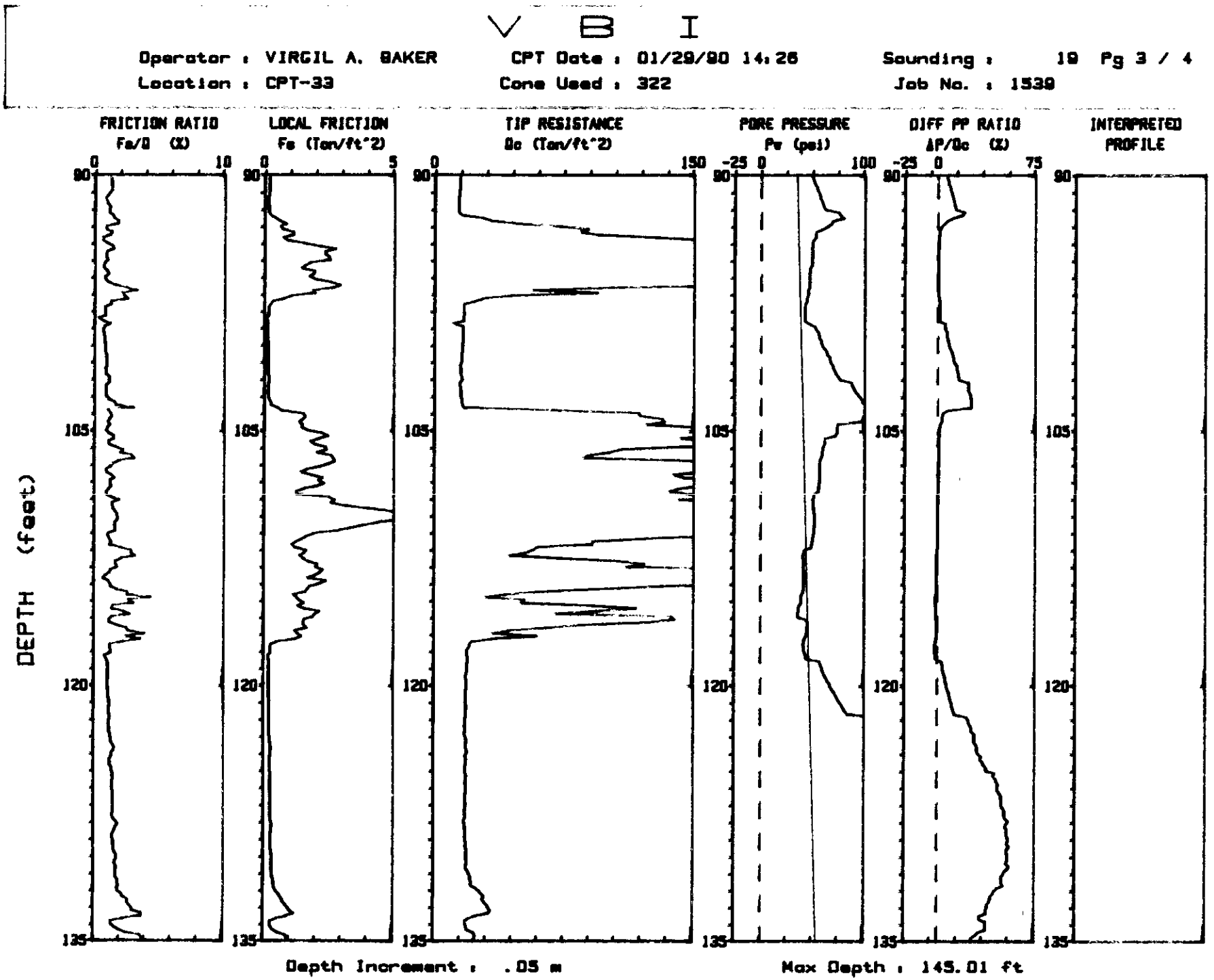

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/29/90 14:26
Sounding : 19 Pg 3 / 4
Location : CPT-33
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 145.01 ft

Figure C-90

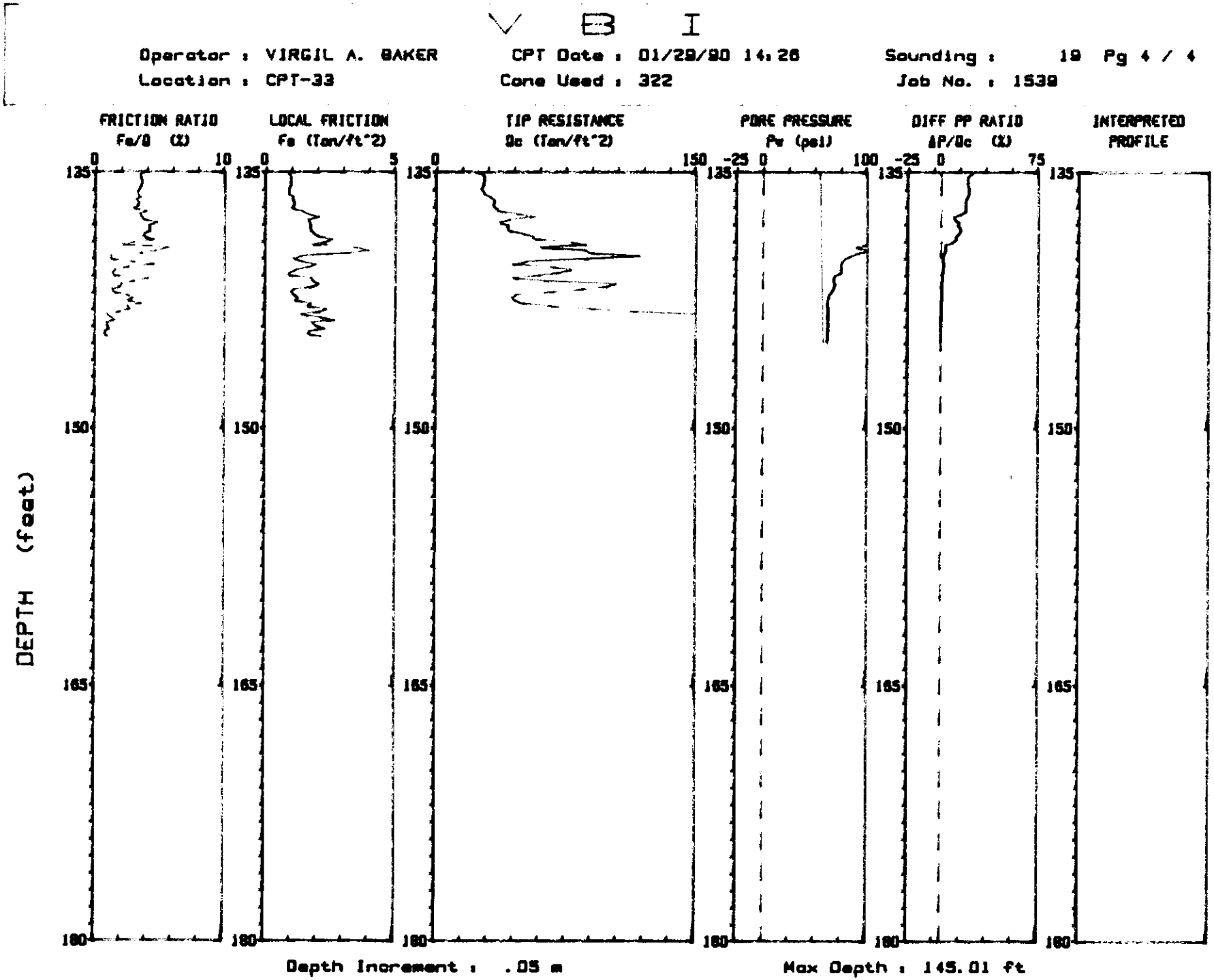

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/29/90 14:26
Sounding : 19 Pg 4 / 4
Location : CPT-33
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fe/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 145.01 ft

Figure C-91

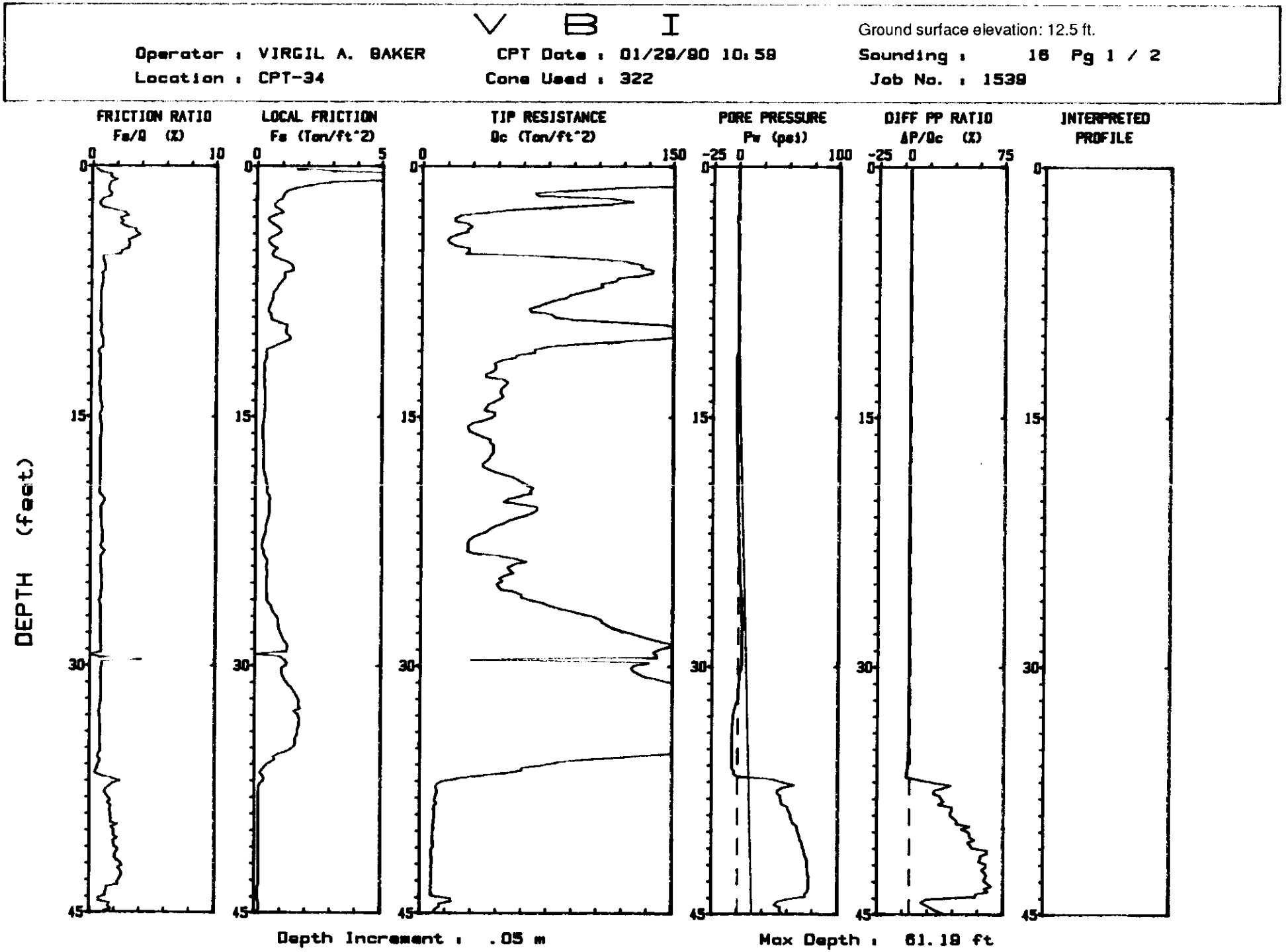

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/29/90 10:58
Location : CPT-34
Cone Used : 322
Ground surface elevation: 12.5 ft.
Sounding : 16 Pg 1 / 2
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 61.19 ft

Figure C-92

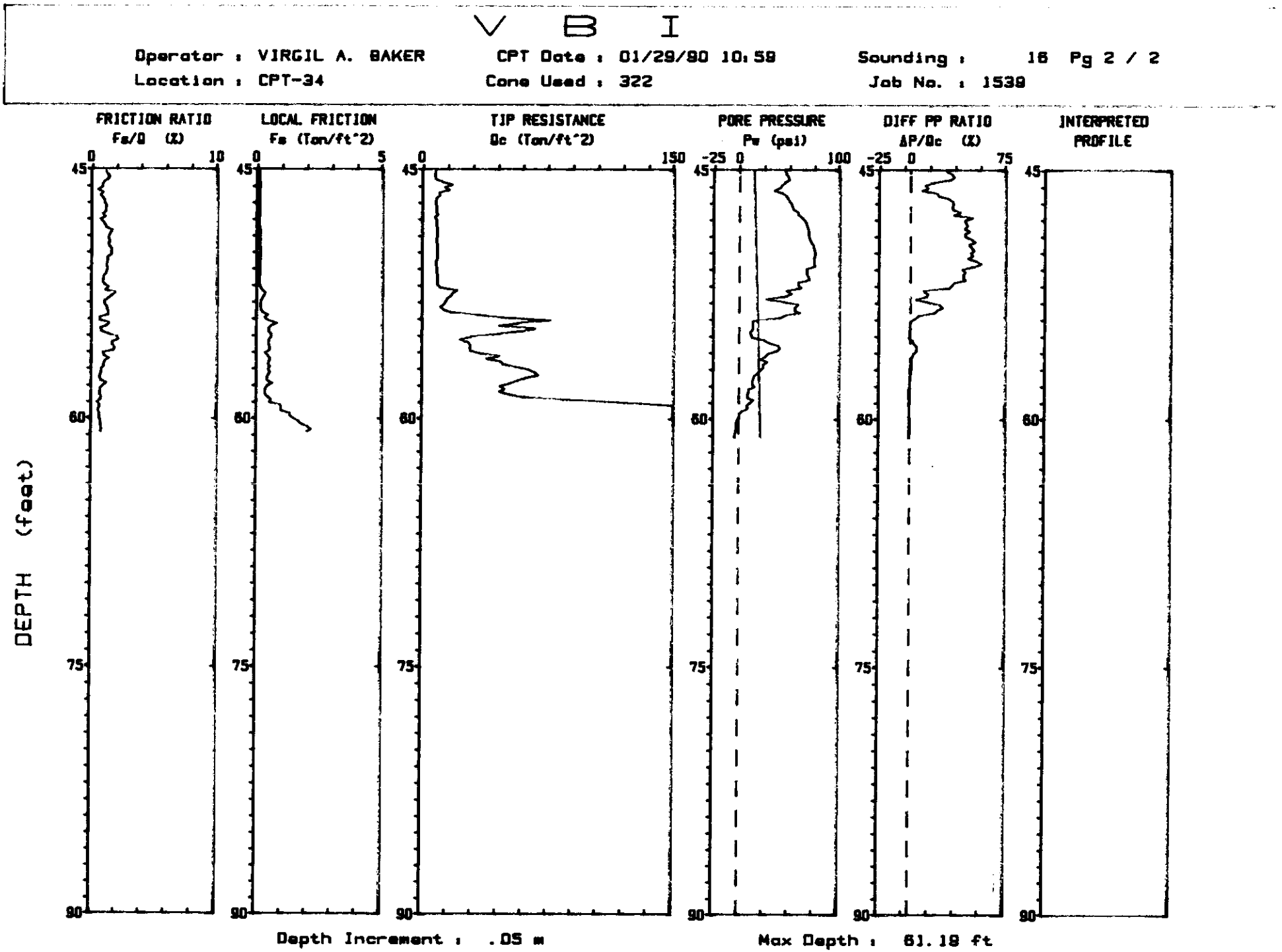

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/29/90 10:59
Sounding : 16 Pg 2 / 2
Location : CPT-34
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
0
10
LOCAL FRICTION
Fs (Tsf)
0
5
TIP RESISTANCE
Qc (Tsf)
0
150
PORE PRESSURE
Pw (psi)
-25
0
100
DIFF PP RATIO
ΔP/Qc (%)
-25
0
75
INTERPRETED PROFILE
DEPTH (feet)
45
60
75
90
Depth Increment : .05 m
Max Depth : 61.19 ft

Figure C-93

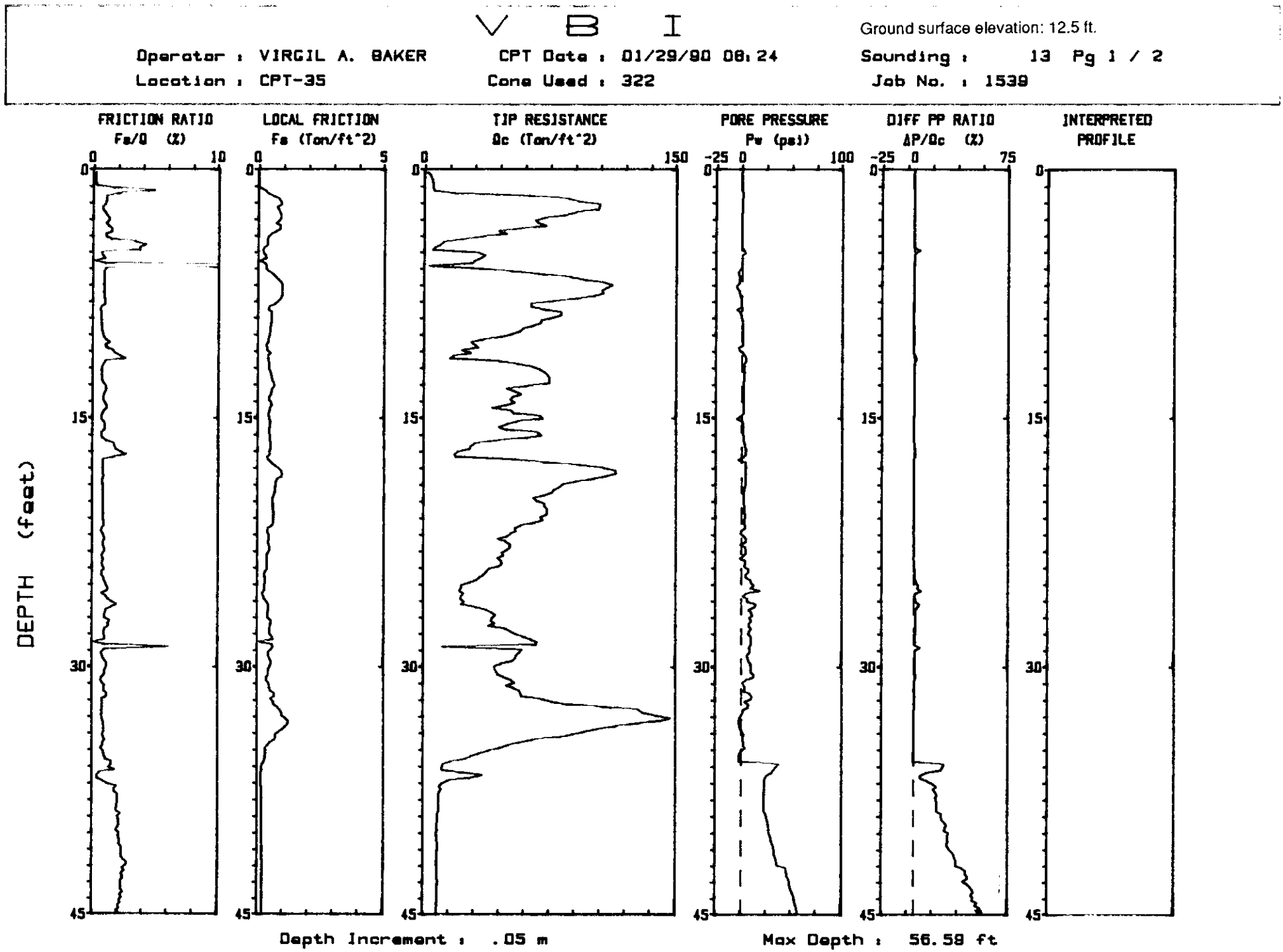

V B I
Ground surface elevation: 12.5 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/29/90 08:24
Sounding : 13 Pg 1 / 2
Location : CPT-35
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 56.59 ft

Figure C-94

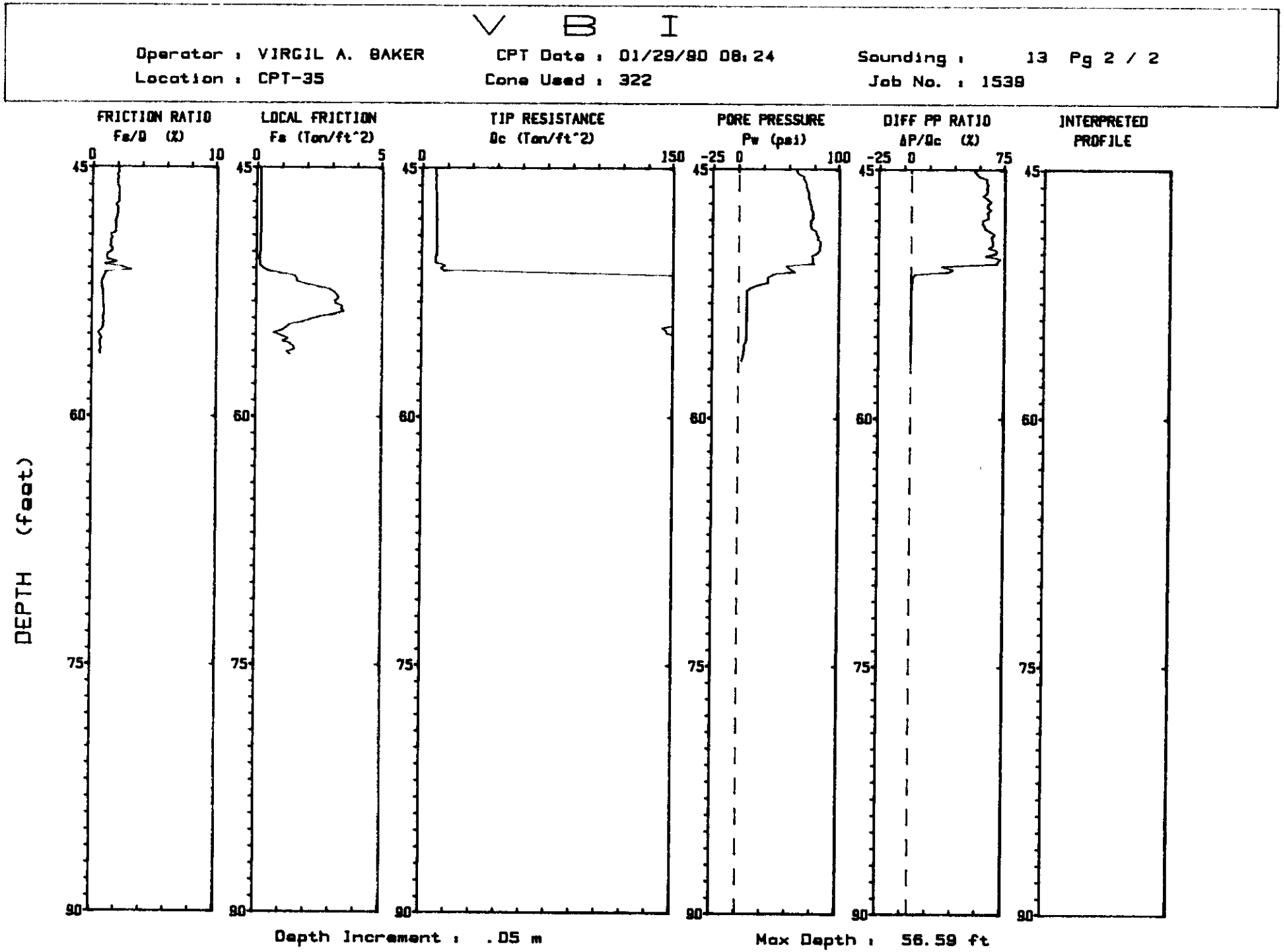

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/29/90 08:24
Sounding : 13 Pg 2 / 2
Location : CPT-35
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 56.59 ft

Figure C-95

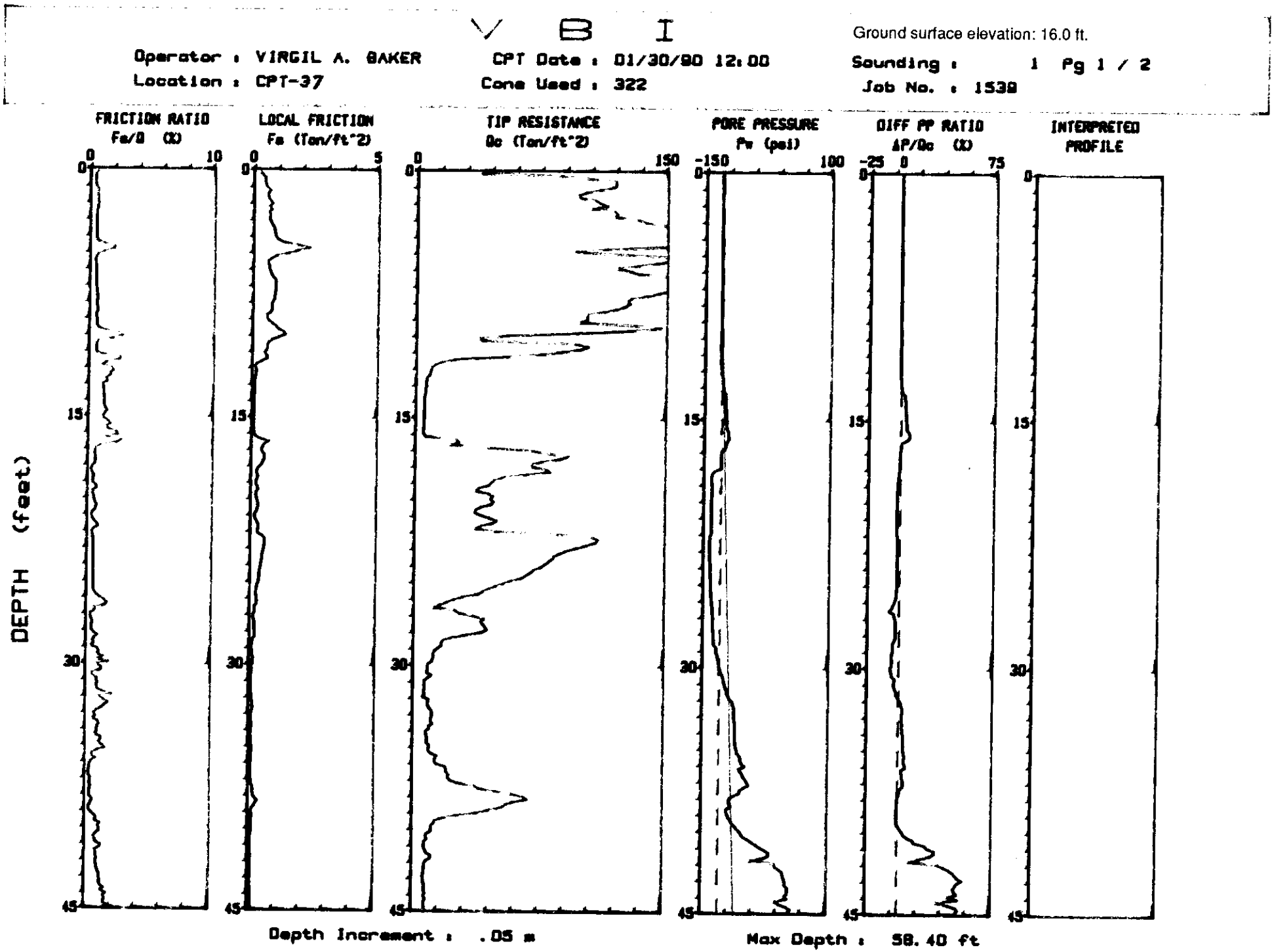

V B I
Ground surface elevation: 16.0 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/30/90 12:00
Sounding : 1 Pg 1 / 2
Location : CPT-37
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 58.40 ft

Figure C-96

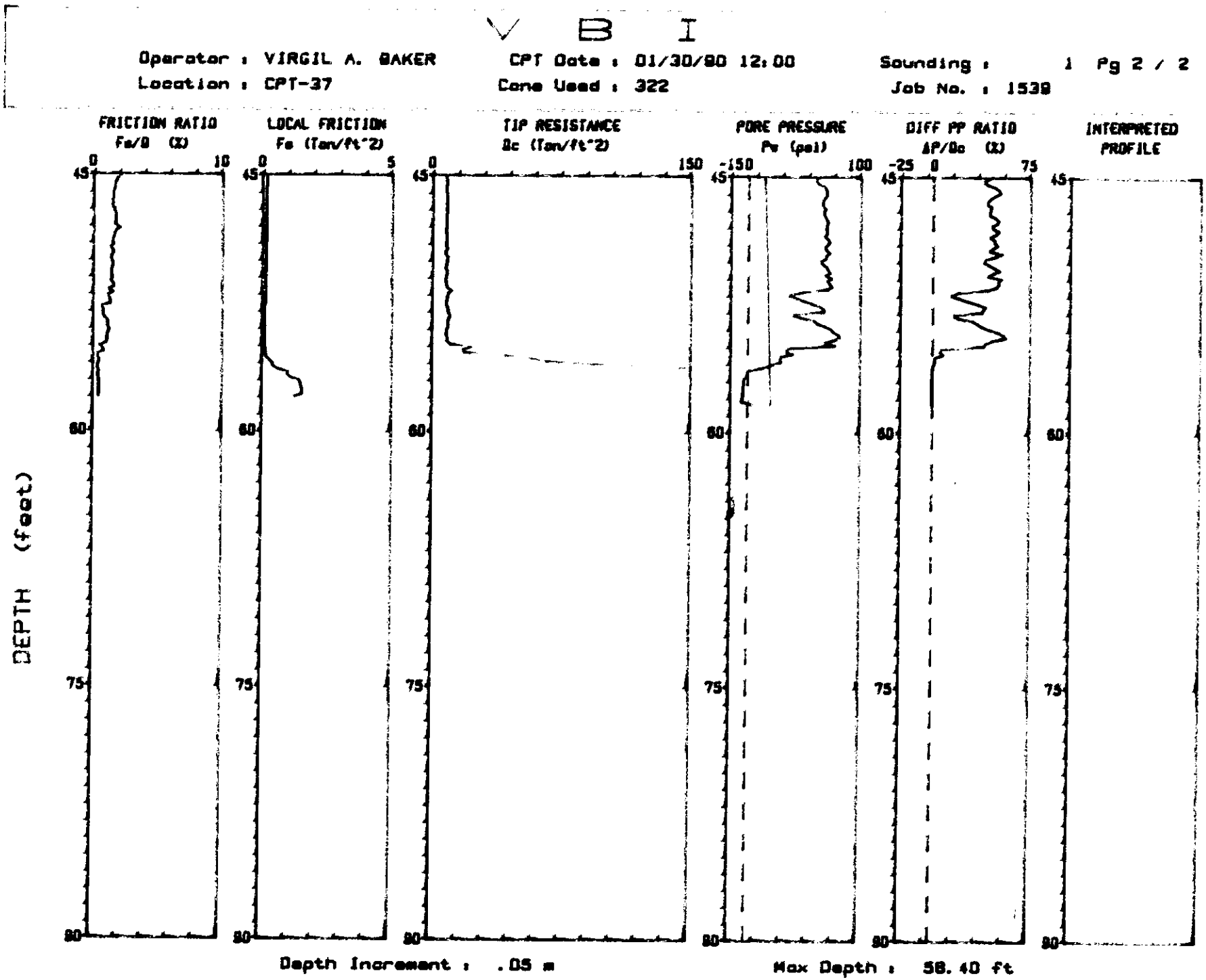

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/30/90 12:00
Sounding : 1 Pg 2 / 2
Location : CPT-37
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf/ft^2)
TIP RESISTANCE
Qc (Tsf/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 58.40 ft

Figure C-97

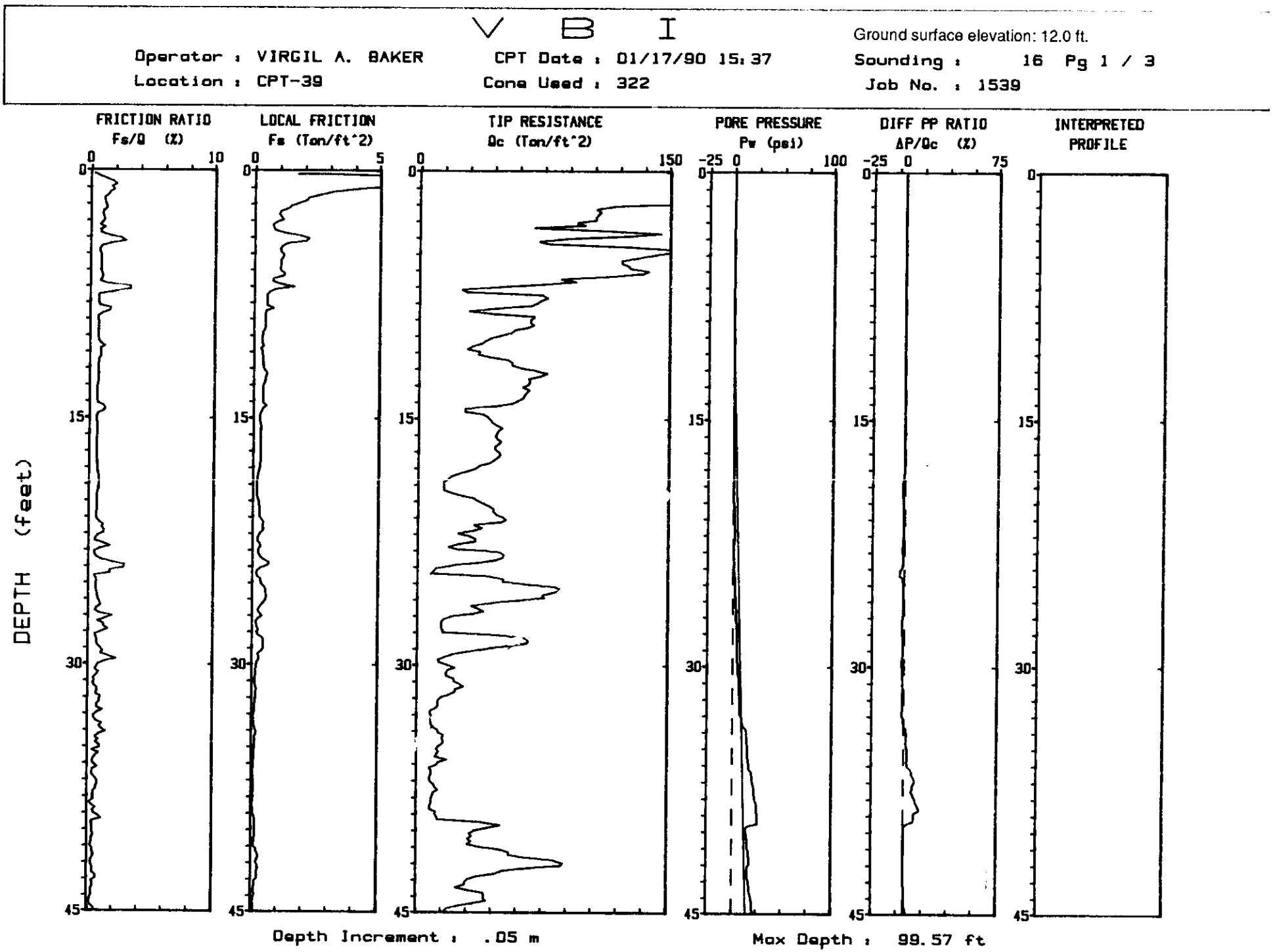

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/17/90 15:37
Ground surface elevation: 12.0 ft.
Location : CPT-39
Cone Used : 322
Sounding : 16 Pg 1 / 3
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 99.57 ft

Figure C-98

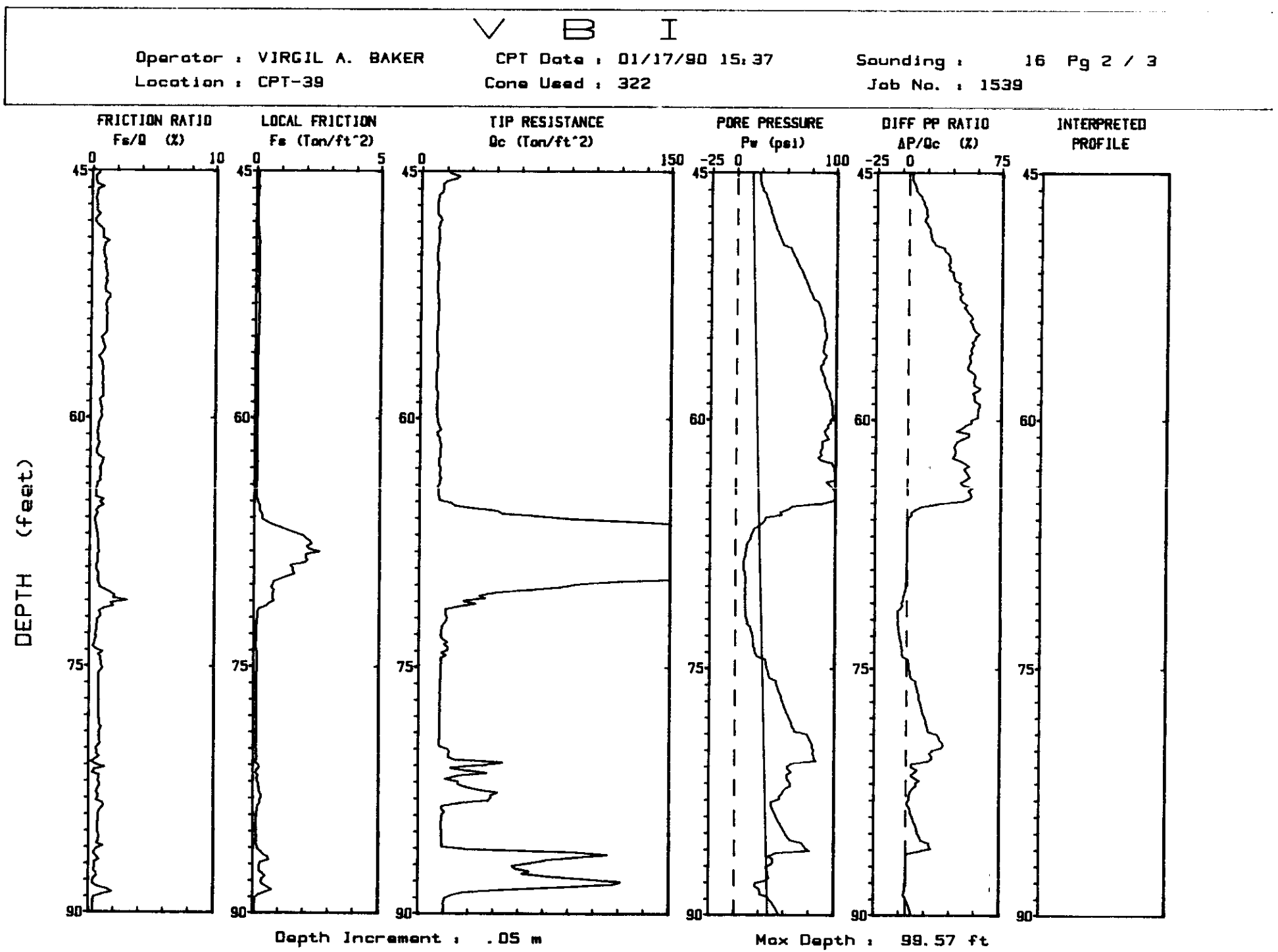

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/17/90 15:37
Sounding : 16 Pg 2 / 3
Location : CPT-39
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 99.57 ft

Figure C-99

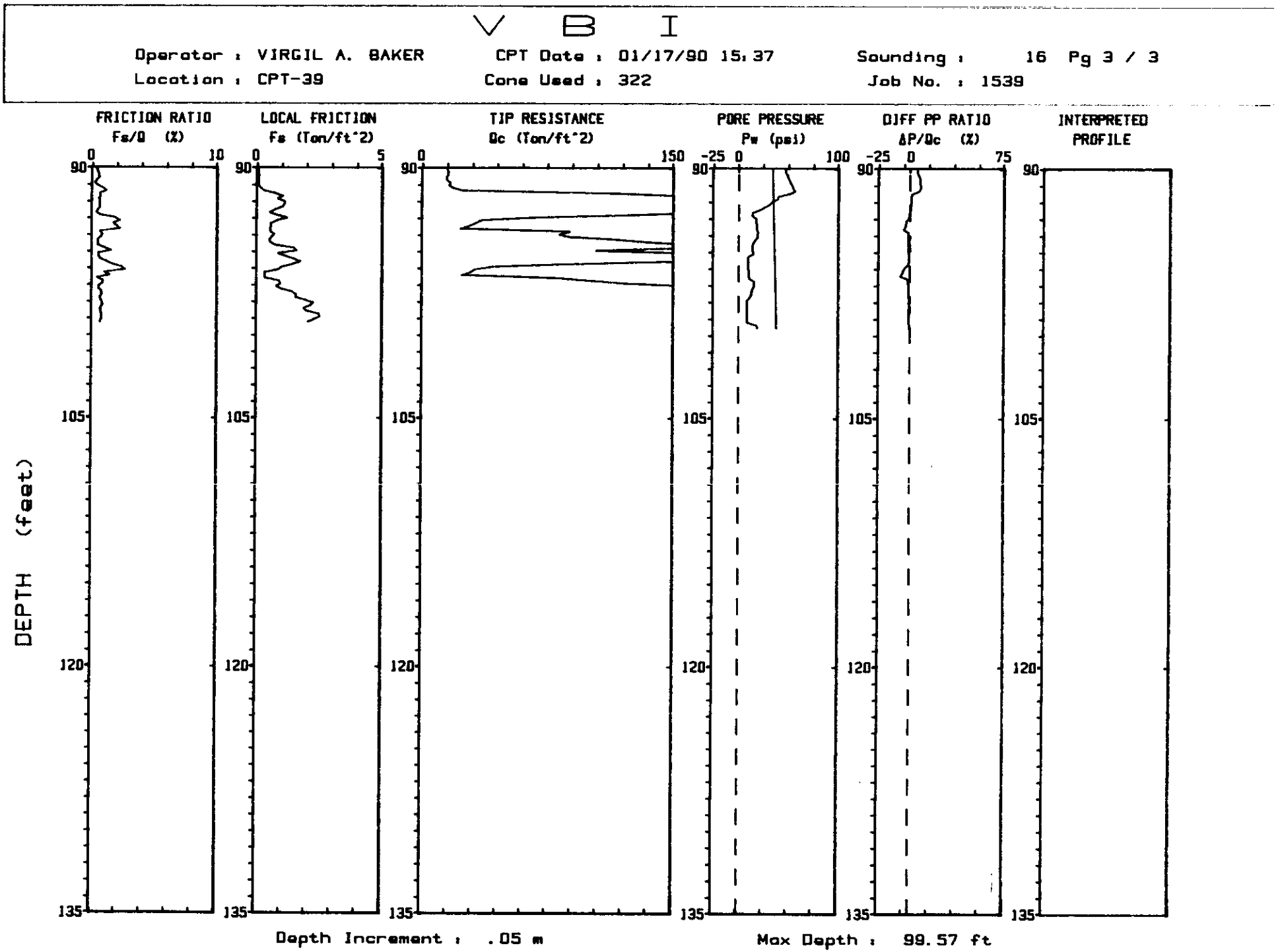

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/17/90 15:37
Sounding : 16 Pg 3 / 3
Location : CPT-39
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Ton/ft^2)
TIP RESISTANCE
Qc (Ton/ft^2)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 99.57 ft

Figure C-100

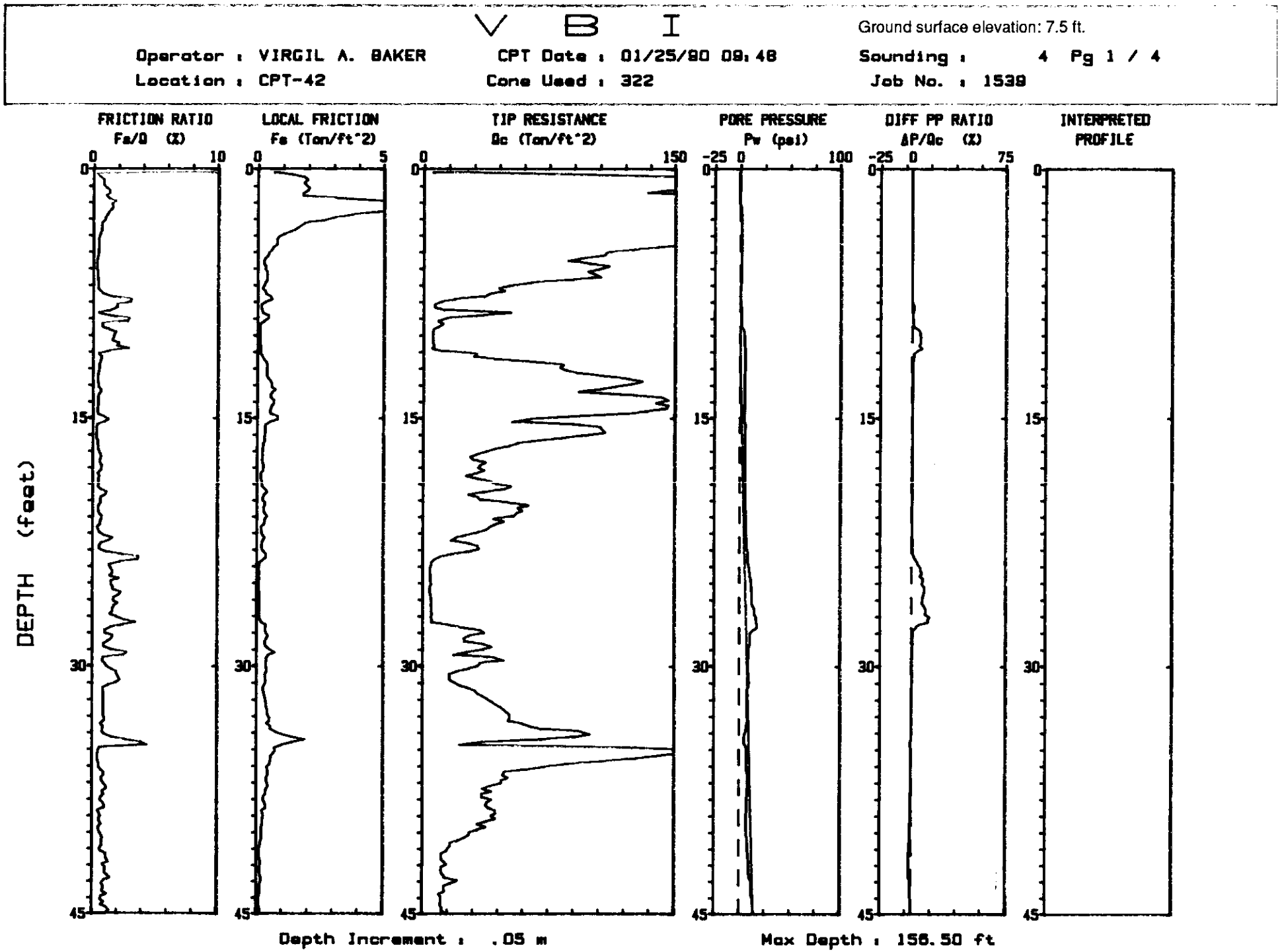

V B I
Ground surface elevation: 7.5 ft.
Operator : VIRGIL A. BAKER
CPT Date : 01/25/90 09:48
Sounding : 4 Pg 1 / 4
Location : CPT-42
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 156.50 ft

Figure C-101

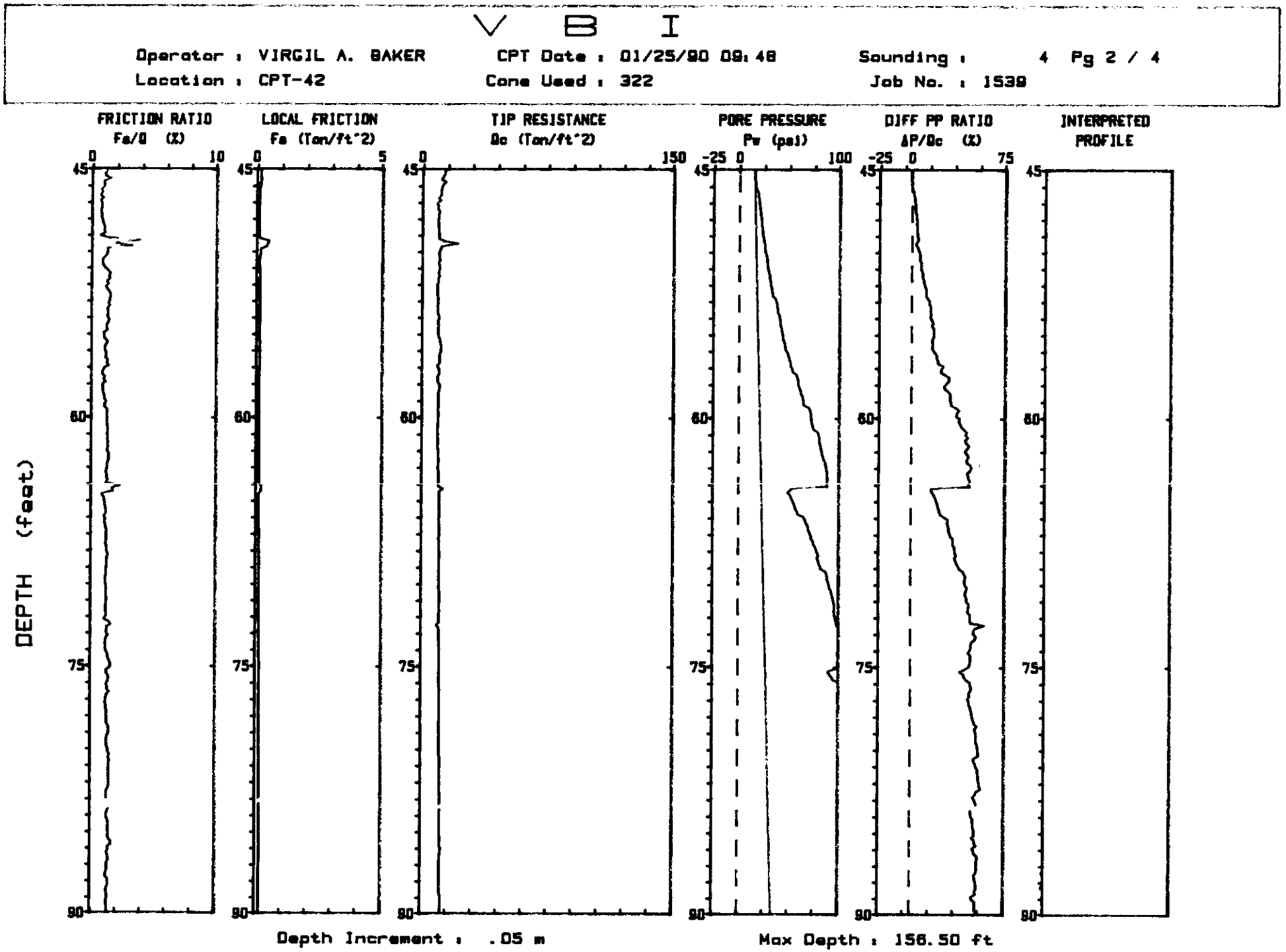

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/25/90 09:48
Sounding : 4 Pg 2 / 4
Location : CPT-42
Cone Used : 322
Job No. : 1538
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 156.50 ft

Figure C-102

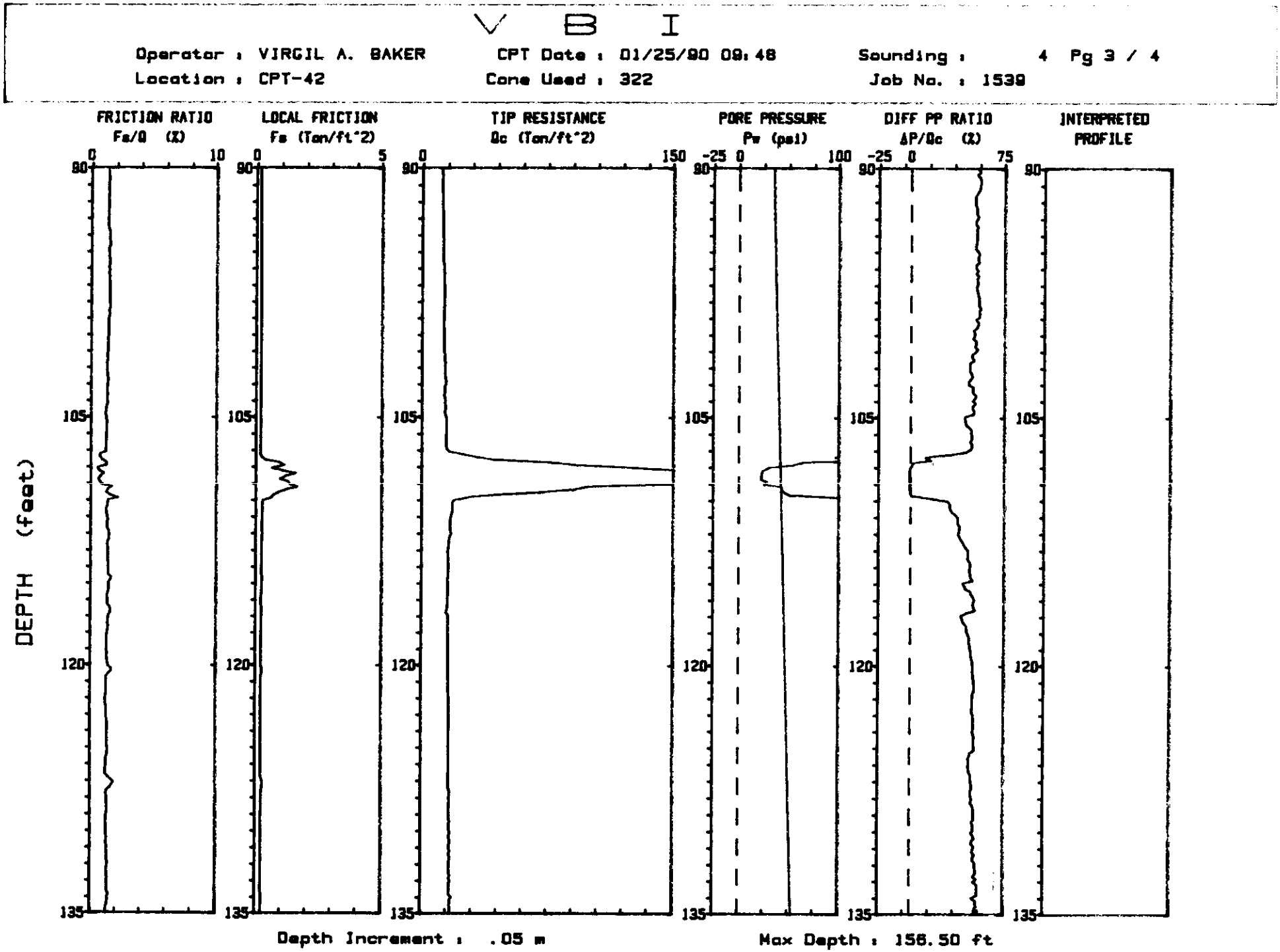

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/25/90 09:48
Sounding : 4 Pg 3 / 4
Location : CPT-42
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 156.50 ft

Figure C-103

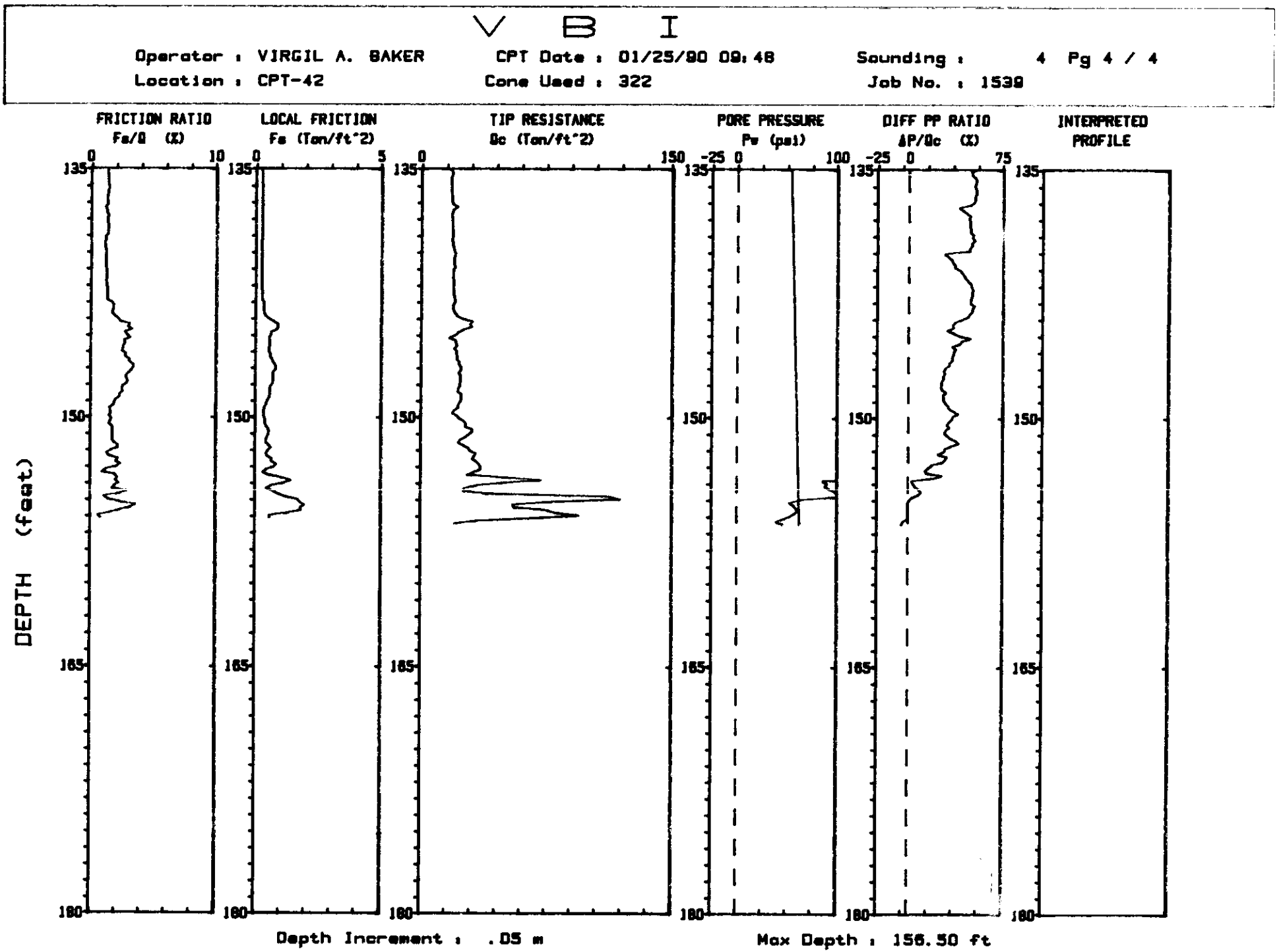

V B I
Operator : VIRGIL A. BAKER
CPT Date : 01/25/90 09:48
Sounding : 4 Pg 4 / 4
Location : CPT-42
Cone Used : 322
Job No. : 1539
FRICTION RATIO
Fs/Q (%)
LOCAL FRICTION
Fs (Tsf)
TIP RESISTANCE
Qc (Tsf)
PORE PRESSURE
Pw (psi)
DIFF PP RATIO
ΔP/Qc (%)
INTERPRETED PROFILE
DEPTH (feet)
Depth Increment : .05 m
Max Depth : 156.50 ft

Figure C-104

BORING LOCATION, ELEVATION AND DATE DRILLED: See Site Plan, Plate 1 — 5/8/85

DRILLING METHOD: Truck-mounted rotary drill rig; Failing 1500

BORING C

SAMPLING METHOD: 200# down-hole hammer with 24-inch drop; Modified California Sampler w/2.42" I.D. rings

SHEET 1 OF 1

TORVANE KSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U.S.C.S.	
								Mudline
					0		SC	Greenish Gray fine Clayey Sand, very loose, saturated; no shells.
	0	88	34	C-1	1			
					2			
					3			
					4			CURRENT STRONG OFF SHORE. TAKING SOME SAMPLES TO SET OFF HOLE BEFORE CASING DRIVEN.
					5			
					6			
					7			
					8			
					9		SC/CL	Grading to gray clayey sand to sandy clay, very soft to loose, saturated
					10			
	0	83	36	C-2	11 *			* Unconsolidated Undrained Triaxial = 351 psf with 200 psf confining pressure
					12			Boring terminated at 11-1/2 feet SWELLS TOO BIG FOR CASING.
					13			Depth of water, above boring, measured at 17 feet at 7:30 am on 5/8/85.
					14			
					15			Note: Drilling stopped due to increase in current.
					16			WS ELEV. -1' MLLW
					17			
					18			LOCATION: WEST OF T.I. ~100' OFFSHORE
					19			
					20			

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 4

LOG OF BORING

PAL CONSULTANTS, INC.

• GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC 1-83
Navsta Treasure Island, San Francisco, CA

DATE: June 1985 | JOB NO: PC110/85002

PLATE A-10

BORING LOCATION, ELEVATION AND DATE DRILLED | DRILLING METHOD | BORING NUMBER

See Site Plan, Plate 1 | Truck-mounted rotary drill rig; Failing 1500 | C1

5/10/85

SAMPLING METHOD: 200# down-hole hammer with 24-inch drop; Modified California sampler w/2.42" I.D. rings

TORVANE TSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U.S.C.S.	
					20		SC/CL	(Continuation of Boring C) Gray Clayey Sand to Sandy Clay, saturated See Boring C Shell lense at 20 feet.
					21			
					22			
					23			
					24			
					25			
					26			
					27			
					28		CL	Gray Silty Clay, very soft, saturated, no shells, trace fine sand.
					29			
					30			
					31			
	2	68	52	C1-1	* 32			* Plasticity Index = 13.3 Liquid Limit = 36.8% Unconsolidated undrained triaxial = 330 psf with 600 psf confining pressure
					33			
					34			
					35			
					36			
					37			
					38			
					39			
					40			

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 4 continued

LOG OF BORING

PAL CONSULTANTS, INC.

• GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1995 | JOB NO : PC110/85002

PLATE A-11

TORVANE KSF	NUMBER OF BLOWS/FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	USCS	BORING NUMBER	SHEET OF
					40		CL/ ML	Gray Silty Clay to Clayey Silt, very soft, saturated, no shells, trace fine sand.	
					41				
					42				
					43				
					44				
					45				
					46				
					47				
					48			* Plasticity Index = 13.8 Liquid Limit = 40.1% Unconsolidated Undrained Triaxial = 412 psf with 1000 psf confining pressure	
					49				
					50			Occasional small shells	
	4	67.9	51.3	C1-2	50 *				
					51			Boring terminated at 51-1/2 feet.	
					52			Depth of water, above boring, measured at 20 feet at 8 am on 5/10/85.	

IVS FLEW O' MCCW

ENTERED "C" TO 10' WID., BUT SHUT DOWN DUE TO WIND & CURRENT. THEREFORE, WILL MARINE & TRY TO GET SAMPLES @ 30' & TO' BEFORE TIDE & WIND PICKS UP!

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 4 continued

LOG OF BORING

PAL CONSULTANTS, INC.

GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC 1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | JOB NO : PC110/85002

PLATE A-12

BORING LOCATION, ELEVATION AND DATE DRILLED: See Site Plan, Plate 1; 5/15/85

DRILLING METHOD: Truck-mounting rotary drill rig; Failing 1500

BORING NUMBER: C2

SAMPLING METHOD: 200# down-hole hammer with 24-inch drop; Modified California Sampler w/2.42" I.D. rings

SHEET 1 OF 1

TORVANE KSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	USCS	
								Mudline
					0		SC	Gray, fine Clayey Sand, very loose, saturated; occasional small shells, few mica flakes.
	0	89	32	C2-1	1			
					2			
					3			
					4			
					5			
					6			
					7			
					8			
					9			
					10			
					11			
					12			Very fine to fine grained; increasing silt content
	0	79	40	C2-2	13			Boring terminated at 12-1/2 feet.
					14			Depth of water, above boring, measured at 23 feet at 11 am on 5/15/85.
					15			
					16			WS FLUSH + 3' AVG W
					17			
					18			40-45' OFF SHORE (RIPRAP IS CLOSER)
					19			
					20			

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 5

LOG OF BORING

PAL CONSULTANTS, INC.
• GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE: June 1985 | JOB NO: PC110/85002

PLATE A-13

BORING LOCATION, ELEVATION AND DATE DRILLED	DRILLING METHOD	BORING NUMBER
See Site Plan, Plate 1 5/9/85	Truck-mounted rotary drill rig; Failing 1500	D

TORVANE KSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U.S.C.S.	SAMPLING METHOD: 200# down-hole hammer with 24-inch drop; Modified California Sampler w/2.42" I.D. rings	SHEET 1 OF 3
								Mudline	
					0				
					1		CL	Gray fine Sandy Silty Clay, very soft, saturated no shells, occasional very few finy mica flakes.	
0.15	0	78	42	D-1	2				
					3				
					4				
					5				
					6			Grading to	
					7		ML / CL	Gray Clayey Silt to Silty Clay, very soft, saturated, trace of fine sand, shells	
					8				
					9				
					10				
					11				
	0	64	56	D-2	* 12			* Plasticity Index = 14.1 Liquid Limit= 41.3 Unconsolidated Undrained Triaxial = 379 psf with 200 psf confining pressure	
					13				
					14				
					15				
					16				
					17				
					18				
					19				
					20				

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 6

LOG OF BORING

PAL CONSULTANTS, INC.

• GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | JOB NO : PC110/85002

PLATE A-14

TORVANE KSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U S C S	BORING NUMBER D	SHEET 2 OF 2
					20		ML/CL	Gray Clayey Silt, to Silty Clay, very soft, saturated; trace fine sand, no shells.
					21			
					22			
					23			
					24			
					25			
					26			
					27			
					28			
					29			
					30			
	4	67	52	D-3	31 *			Increasing Silt Content
					32			
					33			* Plasticity Index = 11.4 Liquid Limit = 39.8% Unconsolidated Undrained Triaxial = 421 psf with 600 psf confining pressure
					34			
					35			
					36			
					37			
					38			
					39			
					40			
					41			
					42			
					43			
					44			
					45			

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 6

LOG OF BORING

PAL CONSULTANTS, INC.

• GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | JOB NO : PC110/85002

PLATE A-15

BORING NUMBER D

SHEET 2 OF 3

TORVANE TSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U S C S	
					45		CL/ ML	Gray Silty Clay to Clayey Silt, very soft, saturated; no sand or shells
					46			
					47			
					48			
					49			* Plasticity Index =13.0 Liquid Limit = 37.6% Unconsolidated Undrained triaxial = 349 psf with 1000 psf confining pressure
					50			
					51			
	1	74	45	D-4	*			
					52			Boring terminated at 51-1/2 feet.
					53			Depth of water, above boring, measured at 40 feet at 745 am on 5/9/85.
					54			
					55			

WAS ECHO O' . . N

~ 75' FROM SHORE,

HAD TO MOVE IN DUE TO

CURRENTS & WATER DEPTH

(TAKING FEWER SAMPLES -

HURRYING TO GET BORING

DONE BEFORE TIDES PICKING

& WIND PICKING UP)

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 6 continued

LOG OF BORING

PAL CONSULTANTS, INC.

• GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | JOB NO : PC110/8500

PLATE A-16

ING LOCATION, ELEVATION AND DATE DRILLED	DRILLING METHOD	BORING NUMBER
ee Site Plan, Plate 1 5/9/85	Truck-mounting rotary drill rig; Failing 1500	F

TORVANE KSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U.S.C.S.	SAMPLING METHOD: 200# down-hole hammer with 24-inch drop; Modified California Sampler w/2.42" I.D. rings — SHEET 1 OF 3
								Mudline
	0	109	18	F-1	0–7		SC	Gray fine to medium grained Clayey Sand with shell fragments, very loose, saturated; organic smell
					8		SP	Brown medium Sand with abundant shells and occasional small gravels, saturated
	1	85	35	F-2	9–20		CL/SC	Gray Sandy Clay to Clayey Sand; very soft to very loose, saturated; very few mica flakes

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 9

LOG OF BORING

PAL CONSULTANTS, INC.

• GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | JOB NO : PC110/85003

PLATE A-22

TORVANE KSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U.S.C.S.	BORING NUMBER F	SHEET 2 OF 3
					20		CL/ SC	Gray Sandy Clay to Clayey Sand; very soft to very loose, saturated; trace very fine sand, very few mica flakes	
					21				
					22				
					23				
					24				
					25		CL	Gray Silty Clay, very soft, saturated; no sand; occasional small shell fragments	
					26				
					27				
					28				
					29				
					30				
	0	67	55	F-3	31 *			* Plasticity Index = 17.9 Liquid Limit = 40.6%	
					32				
					33				
					34				
					35				
					36				
					37				
					38				
					39				
					40				
					41				
					42				
					43				
					44				
					45				

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 9 continued

LOG OF BORING

PAL CONSULTANTS, INC.

· GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | **JOB NO** : PC110/85002

PLATE A-23

TORVANE KSF	NUMBER OF BLOWS / FT.	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U.S.C.S.	BORING NUMBER F	SHEET 3 OF 5
					45		SP	Greenish Gray fine Sand, dense, saturated	
					46				
					47				
					48				
					49				
					50				
					51				
	77	99	23	F-4	52			Boring terminated at 51-1/2 feet	
					53			Depth of water, above boring, measured at 16 feet at 12:15 pm on 5/9/85	
					54				
					55				
					56				
					57				
					58				
					59				
					60				
					61				
					62				
					63				
					64				
					65				
					66				
					67				
					68				
					69				
					70				

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 9 continued

LOG OF BORING

PAL CONSULTANTS, INC.

GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | JOB NO : PC110/85002

PLATE A-24

BORING LOCATION, ELEVATION AND DATE DRILLED: See Site Plan, Plate 1 — 5/7/85

DRILLING METHOD: Truck-mounted rotary drill rig; Failing 1500

BORING NUMBER: 3

SAMPLING METHOD: 200# down-hole hammer with 24-inch drop; Modified California Sampler w/2.42" I.D. rings

SHEET 1 OF 3

TORVANE KSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U S C S	
								Mudline
					0		OH	Dark gray Silty Clay, very soft, saturated; few shell fragments, organic smell
1.8	0	52	81	G-1	1			
					2			
					3			
					4			
					5			
					6			
					7			
					8			
					9			
					10			
--	0	-	83	G-2	11 *			No shells; small pieces of decaying wood fragments
					12			
					13			
					14			* Plasticity Index = 22.7 Liquid Limit = 56.6%
					15			
					16			
					17		SP	Brown Sand, medium grained, saturated
					18			
					19			
					20			

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 10

LOG OF BORING

PAL CONSULTANTS, INC.
• GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | JOB NO : PC110/85002

PLATE A-25

TORVANE KSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U S C S	BORING NUMBER C	SHEET 2 OF 3
					20		SP	Brown Sand, medium grained, saturated	
					21				
					22				
					23				
					24				
					25				
					26				
					27		CH	Dark gray Silty Clay, saturated	
					28				
					29			Increasing sand	
					30		SC	Gray fine Clayey Sand, very loose, saturated; few small shells	
					31				
	0	89	31	G-3	32				
					33				
					34				
					35				
					36				
					37				
					38				
					39				
					40				
					41				
					42				
					43				
					44				
					45				

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 10 continued

LOG OF BORING

PAL CONSULTANTS, INC.

• GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | **JOB NO :** PC110/85002

PLATE A-26

BORING NUMBER G

SHEET 3 OF 3

TORVANE KSF	NUMBER OF BLOWS / FT	DRY DENSITY PCF	MOISTURE CONTENT % DRY WT	SAMPLE NUMBER	DEPTH IN FEET	SOIL GRAPH	U.S.C.S.	
					45		SC	Gray fine Clayey Sand, saturated
					46		CL	Light Brown and Gray mottled Silty Clay with very small patches of iron staining, stiff to very stiff, saturated.
					47			
					48			
					49			
					50			
					51			
1.60	31	86	40	G-4	52			Boring terminated at 51-1/2 feet
					53			Depth of water, above boring, measured at 6 feet at 11:30 am on 5/7/85
					54			
					55			

WS ELEV. +1' MLLW

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 10 continued

LOG OF BORING

PAL CONSULTANTS, INC.

· GEOTECHNICAL ENGINEERING DIVISION

Repairs to Seawall, Phase 3
Special Project RC1-83
Navsta Treasure Island, San Francisco, CA

DATE : June 1985 | JOB NO : PC110/85002

PLATE A-27

LOCATION 5

TEST BORING

EL. 9.9 — B-5

5'		SEMI-COMPACT, BROWN VERY FINE TO FINE SILTY SAND. (FILL)
16.7	1 1.4 5 6	
	2 1.4 22 11	VERY LOOSE TO COMPACT, GRAY VERY FINE SAND WITH NUMEROUS SILTY SAND, SANDY SILT AND VERY SOFT TO SOFT SILTY CLAY LAYERS, AN OCCASIONAL SEMI-COMPACT SILTY SAND LAYER OCCURS THEOUGHOUT. (FILL)
26.5	3 1.4 10 11	
	4 1.4 10 21	
41.0	5 1.4 P 21	
40.9	6 1.4 7 31	
28.2	7 1.4 5 16	
25.3	8 1.4 P 41	(SAND SPIT MATERIALS)
	9 1.4 10 46	
58.4 35.7	10 1.4 P 51	
5.5 M.9 21.2	11 2.7 76	VERY SOFT, GRAY SILTY CLAY AND CLAYEY SILT WITH SHELL FRAGMENTS.
1 12.7 6.1	12 1.4 61 66	HARD, GREEN & BROWN MOTTLED SANDY CLAY.
12.1 4 70.0	13 1.4 76	DENSE, GRAY AND BROWN-GRAY VERY FINE TO FINE SILTY SAND WITH SEVERAL CLAYEY SAND AND CLAYEY SILT LAYERS.
3 19.1 19.0	14 1.4 39 81	
96.1	15 1.4 23 96	INTERBEDDED SEMI-COMPACT TO DENSE, GRAY AND GRAY-GREEN SILT AND STIFF TO HARD CLAYEY SILT AND SILTY CLAY.
19.2	17 1.4 44 106	
49.1	18 1.4 13 111	
20.3	19 1.4 89 126	DENSE TO VERY DENSE, DARK GREEN VERY FINE TO FINE SILTY SAND WITH DISSEMINATED SHELL FRAGMENTS AND OCCASIONAL CLAYEY SILT LAMINATIONS.
24.9	20 1.4 71 141	

11-7-04

CPT

TIP RESISTANCE (TON/FT.²)	LOCAL FRICTION (TON/FT.²)	FRICTION RATIO (PERCENT)
0 200 400	0 2.5 5.0	4

LOCATION 6

TEST BORING

EL. 10.1 — B-6

5'		SEMI-COMPACT, BROWN VERY FINE TO FINE SILTY SAND W/FEW SILTY CLAY LAYERS. (FILL)
107.9 10.3	1 1.4 5 6	
22.3	2 1.4 8 11	
23.1	3 1.4 12 16	SEMI-COMPACT GRADING TO VERY LOOSE, GRAY VERY FINE TO FINE SAND GRADING TO SILTY SAND, SILT AND VERY SOFT CLAYEY SILT. (FILL)
25.6	4 1.4 9 21	
47.7 44.2	5 1.4 P 31	
5.4 67.2 44.7	6 2.7 38	
46.1	7 1.4 5 41	(SAND SPIT MATERIALS)
	8 1.4 P 51	
6.7 65.9 45.5	9 2.7 58	VERY SOFT TO SOFT, GRAY SILTY CLAY AND CLAYEY SILT WITH SHELL FRAGMENTS.
5.1 M.7 19.2	10 1.4 5 61	
29.4 33.4	11 1.4 21 71	DENSE, GRAY AND GRAY-BROWN VERY FINE TO FINE SILTY SAND WITH A FEW THIN STIFF TO HARD SANDY CLAY LAYERS.
1.0 10.4 44.5	12 1.4 39 81	
2.9 106.3 52.2	13 1.4 25 91	INTERBEDDED SEMI-COMPACT TO COMPACT, GRAY AND GRAY-GREEN VERY FINE TO FINE SILTY SAND, SILT, CLAYEY SAND AND STIFF TO VERY STIFF SANDY CLAY AND CLAYEY SILT.
33.5 41.5	14 1.4 13 101	
1.8 81.1 49.0	15 1.4 12 111	
1.6 87.2 53.6	16 2.5 12 121	
20.1	17 1.4 82 131	VERY DENSE, DARK GREEN-GRAY VERY FINE TO FINE SILTY SAND WITH DISSEMINATED SHELL FRAGMENTS.

11-8-04

CPT

TIP RESISTANCE (TON/FT.²)	LOCAL FRICTION (TON/FT.²)	FRICTION RATIO (PERCENT)
0 200 400	0 2.5 5.0	4

REFER TO NOTE 6

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539 09 | Index No. 47

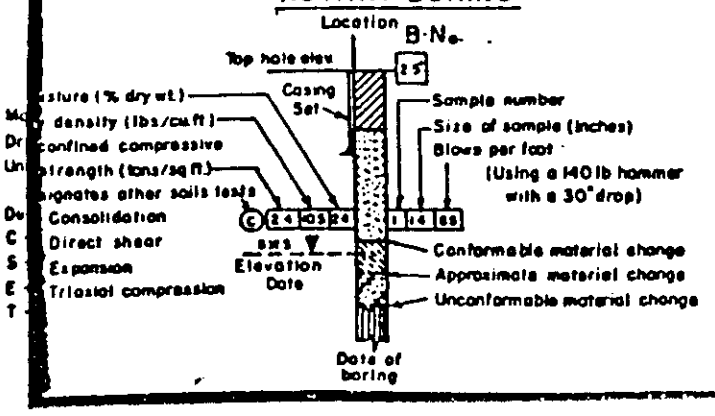
BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

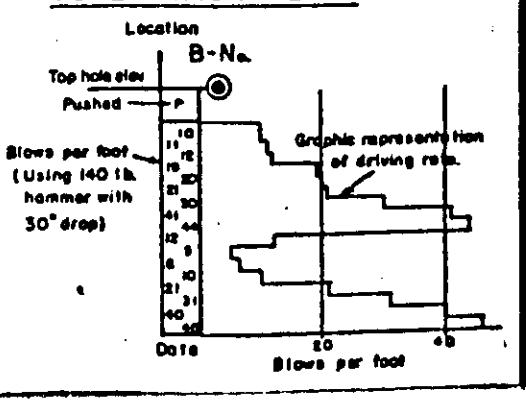
GEOMATRIX | Project No. 1539.09 | Index No. 48

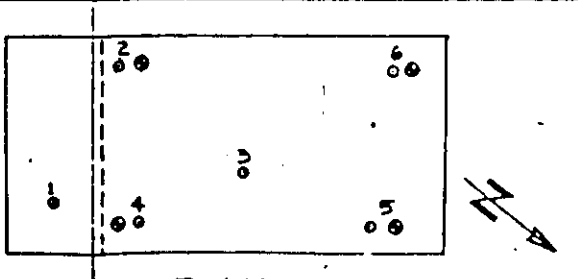
LEGEND OF BORING OPERATIONS

ROTARY BORING



PENETRATION TEST





PLAN
(NOT TO SCALE)

LEGEND
- CPT LOCATION
- TEST BORING LOCATION

NOTES: DUE TO A MALFUNCTION OF THE TIP RESISTANCE AND FRICTION RATIO RECORDED IN THE UPPER 55 FT OF CPT-6 RANGE FROM 50% TO 80% THE CORRESPONDING VALUES FOR THE UNCORRECTED CASE

McCREARY KORETSKY ENGINEERS

BORING LOG

PROJECT	Treasure Island - Quarters	Project No. 2498	Boring No. TH2
LOCATION OF BORING	See Plate 1		Sheet No. 1/2
			Date Drilled 11/19-20/64

DEPTH FT.	ELEV. FT.	DRIVE NO.	Blows per Foot	Dry Unit Weight P.C.F	Natural Moist %	Compr. Str. T.S.F	LOG OF MATERIAL
0	4						
		1	3				Sand, with thin layers of clay, dense. SW-SP CH
-10		2	2	-	15.4	-	
		3	4	-	30.0	-	
-20		4	2	-	25.9	-	
		5	1	81	41.2	0.46	
				-	38.1	-	
-30		6	Os	89	35.4	0.39	Thin-bedded: sand, silty fine sand, sandy silt, medium silty clay. SC SP SW SM ML CL
				-	49.7	-	
		7	-	69	53.9	0.84	
-40		8	Os				
		9	Os				
-50		10	Os				Many shells.
		11	Os	75	46.0	C	
				72	49.0	1.01	
-60							(cont'd)

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 50

PLATE No. 6

McCREARY KORETSKY ENGINEERS

BORING LOG

PROJECT	Treasure Island - Quarters	Project No. 2498	Boring No. TH2
LOCATION OF BORING			Sheet No. 2/2
			Date Drilled

DEPTH FT.	ELEV. FT.	DRIVE NO.	Blows per Foot	Dry Unit Weight P.C.F	Natural Moist %	Compr. Str. T.S.F	LOG OF MATERIAL
60		12	Os	74	46.5	C	
				75	46.7	0.98	Medium to stiff silty clay and clayey silt.
		13	Os	78	42.7	1.03	CH-MH
70		14	Os	77	42.5	C	
				76	45.2	-	
				80	40.7	1.09	
		15	Os	71	51.5	1.21	
80		16	Os	78	43.3	1.76	
				70	52.2	C	
		17	Os	77	44.1	1.33	
90		18	Os	-	56.4	-	
				69	52.7	C	
				69	53.8	1.22	
		19		77	43.3	1.43	
100		20					Dense sand. SP
							Bottom of boring.
110							

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 50 continued

PLATE No. 7

RATION TEST
ring)
ot

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 75

LOG OF BORING 4

Equipment 4 3/4" Rotary Wash

Elevation 111.1 Date 12/4/67

Percent Passing #200 Sieve	Equivalent Blows/Foot Standard Penetration Test	Moisture Content (%)	Dry Density (pcf)	Depth (feet)	Sample
				0	
8.6	13	5.3	103		
	15	19.9	103	5	
	15				
7.2	push	19.0	.101	10	
7.2	push	23.0	98		
	push			15	
4.7	push	25.1	96		
	push			20	
16.2	push	24.0	100		
	push			25	
	push	27.2	96		
	push			30	
				35	
	push			40	
	push			45	
	push				
	push	56.3	67	50	

1" ASPHALT PAVING
BROWN GRAVELLY SAND (SP)
medium, moist
GRAY BROWN FINE SAND (SP-SM)
medium, wet, with occasional clay inclusions and shell and rock fragment
water level 12/5/67
with occasional shell fragments
grading to (SP)
DARK GRAY SILTY SAND (SP-SM)
medium, saturated
with occasional shell fragments
with occasional mica flakes
(lost sample - loose zone)
DARK BLUE GRAY SANDY CLAY (CH)
soft, saturated, with occasional shells

SOFT BAY MUD

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 75

LOG OF BORING 5

Equipment 4 3/4" Rotary Wash

Percent Passing #200 Sieve	Equivalent Blows/Foot Standard Penetration Test	Moisture Content (%)	Dry Density (pcf)	Depth (feet)	Sample
				0	
8.6	13	5.3	103		
	15	19.9	103	5	
	15				
7.2	push	19.0	.101	10	
7.2	push	23.0	98		
	push			15	
4.7	push	25.1	96		
	push			20	
16.2	push	24.0	100		
	push			25	
	push	27.2	96		
	push			30	
				35	
	push			40	
	push			45	
	push				
	push	56.3	67	50	

BORING 3
DATE DRILLED 3/11/87
ELEVATION (ft) 9

DEPTH IN FEET	SAMPLE	SYMBOLS	DESCRIPTION
0			Brown silty fine to mediun sand (SM) (dense, damp)
			Grayish brown fine sand with trace of shell fragments (SP) (medium dense, damp) (grading coarse sand, loose)
5			encountered water 3/11/87 (clay lens)
			(gravelly lens)
10			Grayish green fine sand with some shell fragments (SP) (very loose)
15			(clay layer)
			Fill
20			
25			(grading thin interbedded sand and clay)
30			
			(gravelly lens) Grayish green silty fine sand (SM) (very loose)
35			
40			Gray silty clay with sand and some shell fragments (OH) (medium stiff, bay mud)
45			Grayish green clayey fine sand (SC) (medium stiff)
			(sand layer) Gray organic silty clay (OH) (stiff, bay mud)
50			
55			(continue to Plate A-1I)

LABORATORY TEST DATA

CLASSIFICATION TEST DATA				STRENGTH TEST DATA				MOISTURE & DENSITY TEST DATA		
SIEVE ANALYSIS (% Passing #200)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX		TYPE OF STRENGTH TEST	TEST NORMAL PRESSURE, psf	TEST MOISTURE CONTENT	SHEAR STRENGTH psf	NATURAL MOISTURE CONTENT, %	DRY DENSITY pcf	SAMPLING RESISTANCE Blows / Foot
										25
3								15.2	115	9
								17.7		13
								22.6	102	6
12								30.8		2
								32.0	90	4
8								31.9		2
								27.3	98	3
20								29.2		2
				PEN	-	N	300			
				TV	-	N	400	34.3	87	5
				TR	1395	N	750			
				PEN	-	N	400			
				TV	-	N	560	27.4	96	9
				TR	1495	N	890			

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX

Project No.	Index No.
1539.09	84

LOG OF BORING

BORING 3 (continued)
DATE DRILLED 3/11/87
ELEVATION (ft) 9

DEPTH IN FEET	LABORATORY TEST DATA: SIEVE ANALYSIS (% Passing #200)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	STRENGTH TEST DATA: TYPE OF STRENGTH TEST	STRENGTH TEST DATA: TEST NORMAL PRESSURE, psf	STRENGTH TEST DATA: TEST MOISTURE CONTENT	STRENGTH TEST DATA: SHEAR STRENGTH psf	MOISTURE & DENSITY TEST DATA: NATURAL MOISTURE CONTENT, %	MOISTURE & DENSITY TEST DATA: DRY DENSITY pcf	SAMPLING RESISTANCE Blows / Foot	SAMPLE	SYMBOLS	DESCRIPTION
55				PEN TV	- -	N N	700 1020	54.2	68	P			
60													
65				PEN TV	- -	N N	550 940	44.6	75	P			(grading medium stiff)
70													
75				PEN TV	- -	N N	650 1040	40.0	77	P			(grading stiff)
80													
85				PEN TV TR	- - 2300	N N -	350 300 845	51.8	71	P			(grading medium stiff)
90													
95				PEN TV	- -	N N	700 1020	51.6	70	P			(grading stiff)
100													
105				PEN TV	- -	N N	750 920	53.4	72	P			(grading more silty, medium stiff)
110													

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 84 continued

(continue to Plate A-1J)

LOG OF BORING

BORING 4
DATE DRILLED 3/12/87
ELEVATION (M) 10'±

DEPTH IN FEET	SAMPLE	SYMBOLS	DESCRIPTION	SIEVE ANALYSIS (% Passing #200)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	STRENGTH TEST DATA: TYPE OF STRENGTH TEST	STRENGTH TEST DATA: TEST NORMAL PRESSURE, psi	STRENGTH TEST DATA: TEST MOISTURE CONTENT	STRENGTH TEST DATA: SHEAR STRENGTH psi	MOISTURE & DENSITY TEST DATA: NATURAL MOISTURE CONTENT, %	MOISTURE & DENSITY TEST DATA: DRY DENSITY pcf	SAMPLING RESISTANCE - Blows / Foot
0			Grayish brown silty fine sand (SM) (dense, damp)										33
			Light brown silty sand with shell fragments and clay balls (SP) (dense)	9							16.9	99	16
5			(grading medium dense) encountered water 3/12/87								22.5		12
10			(grading graish brown, very loose)								22.8	99	4
15			Grayish green fine sand (SP) (very loose)	9							30.5		2
20			(grading loose)								30.1	98	8
25			(grading grayish brown, medium dense)	5							22.5		16
30			Gray organic silty clay with shell fragments (OH) (medium stiff, bay mud)								23.4	105	8
			Grayish green fine sand with thin clay lenses (SP) (loose)										
35			(grading medium dense)	10									23
40			Grayish green clayey sand with shell fragments (SC) (stiff)				PEN TR	- 1395	N N	550 1385	22.7	102	P
45			(grading more clayey)				PEN TV	- -	N N	1000 560	38.2	85	P
			Grayish green organic silty clay with sand (OH) (medium stiff, bay mud)										
50			(grading gray, no sand)				PEN TV	- -	N N	500 860	54.6	69	P
55													

Fill

(continue to Plate A-1M)

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX

Project No.	Index No.
1539.09	85

LOG OF BORING

BORING 4 (continued)
DATE DRILLED 3/12/87
ELEVATION (ft) 10±

DEPTH IN FEET	SAMPLE	SYMBOLS	DESCRIPTION
55			
60			(lenses of shell fragments)
65			Gray clayey sand with shell fragments (SC) (stiff)
70			Gray organic silty clay (OH) (stiff, bay mud)
75			
80			
85			Grayish green silty fine sand (SM) (medium dense)
90			Gray organic silty clay (OH) (stiff, bay mud)
95			Grayish green silty fine sand (SM) (medium dense)
100			Grayish green silty clay with trace of decayed vegetation (CH) (stiff)

LABORATORY TEST DATA

CLASSIFICATION TEST DATA					STRENGTH TEST DATA				MOISTURE & DENSITY TEST DATA		
		SIEVE ANALYSIS (% Passing #200)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	TYPE OF STRENGTH TEST	TEST NORMAL PRESSURE, psf	TEST MOISTURE CONTENT	SHEAR STRENGTH psf	NATURAL MOISTURE CONTENT, %	DRY DENSITY pcf	SAMPLING RESISTANCE Blows / Foot
60					PEN TV	- -	N N	250 760	53.7	70	p
65									17.4	100	p
75					PEN TV TR	- - 2085	N N N	850 1320 1180	46.5	74	p
85					PEN TV	- -	N N	700 980	47.9 20.4	.78 106	p
95					PEN TV	- -	N N	2300 2000	46.5	74	22

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX

Project No.	Index No.
1539.09	85 continued

LOG OF BORING

LOG OF BORING B-2

Equipment: Rotary Wash

Elevation: ~111.2 ft Date: 3/24/88

Laboratory Analyses	Moisture Content (%)	Dry Density (pcf)	Blows/ft	Depth (ft)	Sample pnts.	
				0		ORANGE BROWN MEDIUM GRAINED SAND (SP) moist, loose to medium dense with gravels up to 1/2" in diameter with trace of shell fragments
			27*	5		
.5% passing #200 sieve			9	10		
				15		DARK GRAY SILTY SAND (SM) saturated, loose fine to coarse with abundant shell fragments
Sieve analysis	28.1	99	10*	20		
				25		Less silty at 25 feet
6.4% passing #200 sieve			9			
				30		GRAY SILT (MH) saturated, very stiff
			41*	35		contains interbedded layers of medium dense brown sand and silts from 35 feet to 40 feet
				40		

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

Project No. 1539.09

Index No. 94

GEOMATRIX

Geo/Resource Consultants, Inc.
Consulting Engineers, Geologists, Geophysicists

Job No. 1338-00-00 Appr. ST Date 4/14/88

LOG OF BORING B-2

NAVAL STATION, TREASURE ISLAND
SEWAGE SYSTEM IMPROVEMENTS (P-054)
PROPOSED PLANT EXPANSION

FIGURE

A-2a

LOG OF BORING B-2 (cont)

Equipment: Rotary Wash

Elevation: _____ Date: 3/24/88

Laboratory Analyses	Moisture Content (%)	Dry Density (pcf)	Blows/ft	Depth (ft)	Sample pnts.	
			2	40		soft gray silt with abundant shells at 40 feet
			8*	45		dark gray and sandy at 45 feet with less shell
			run	50		GRAY CLAY (CL)-"Bay Mud" saturated, soft with traces of shells
			push	55		(no recovery from pitcher barrel)
			8*	60		interlayered sand , silt and clay from 58 to 65 feet
				65		
				70		
				75		DARK GRAY SANDY SILT (ML) saturated, very stiff with very fine sand
				80		

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

Project No. 1539.09

Index No. 94 continued

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Consulting Engineers, Geologists, Geophysicists

Job No. 1338-00-00 Appr. ST Date 4/14/88

LOG OF BORING B-2 (cont)

NAVAL STATION, TREASURE ISLAND
SEWAGE SYSTEM IMPROVEMENTS (P-054)
PROPOSED PLANT EXPANSION

FIGURE A-2b

LOG OF BORING B-2 (cont)

Equipment Rotary Wash

Elevation _____ Date 3/24/88

Laboratory Analyses	Moisture Content (%)	Dry Density (pcf)	Blows/ft	Depth (ft)	Sample pnts.	
			37*	80		DARK GRAY SANDY SILT (ML) continued
						Boring terminated at 81.5 feet
				85		
				90		
				95		
				100		
				105		
				110		
				115		
				120		

BORING LOG FROM PRIOR STUDY

Naval Station Treasure Island
San Francisco, California

GEOMATRIX | Project No. 1539.09 | Index No. 94 continued

Geo/Resource Consultants, Inc.
Consulting Engineers, Geologists, Geophysicists

Job No. 1338-00-00 Appr. ST Date 4/14/88

LOG OF BORING B-2 (cont)

NAVAL STATION, TREASURE ISLAND
SEWAGE SYSTEM IMPROVEMENTS (P-054)
PROPOSED PLANT EXPANSION

FIGURE A-2c

A-E CERCLA/RCRA/UST Contract Number N68711-03-D-5104
Contract Task Order 024

FINAL
REMEDIAL INVESTIGATION REPORT FOR
INSTALLATION RESTORATION SITES 09 AND 10
NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA

March 2005

Prepared for

DEPARTMENT OF THE NAVY

Naval Facilities Engineering Command
Southwest Division
San Diego, California

Prepared by

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DS.B024.14080

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ACRONYMS AND ABBREVIATIONS

atm m^3/mol	Atmosphere meter cubed per mole
ARAR	Applicable or Relevant and Appropriate Requirements
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient water quality criterion
Bay	San Francisco Bay
BCF	Bioconcentration factor
BCT	BRAC Cleanup Team
bgs	Below ground surface
BRAC	Base Realignment and Closure
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
°C	Degrees Celsius
Cal/EPA	California Environmental Protection Agency
CAL-modified	California-modified
CCSF	City and County of San Francisco
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract laboratory program
COEC	Chemical of Ecological Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CTE	Central tendency exposure
CTO	Contract task order
2,4-DB	2,4-dichlorophenoxy butanoic acid
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DoD	U.S. Department of Defense
DQO	Data quality objective
DTSC	Department of Toxic Substances Control
EBS	Environmental Baseline Study
Eh	Redox potential
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration

ACRONYMS AND ABBREVIATIONS (CONTINUED)

ERA	Ecological Risk Assessment
FFSRA	Federal Facility Site Remediation Agreement
FS	Feasibility Study
ft/d	Feet per day
HEAST	Health Effects Assessment Summary Tables
HHRA	Human health risk assessment
IDW	Investigation-derived waste
IR	Installation restoration
IRP	Installation Restoration Program
IRIS	Integrated risk information system
m^3	Cubic meter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
MINS	Mare Island Naval Shipyard
MLLW	Mean lowest low water
mm Hg	Millimeters of mercury
MTBE	Methyl-tertiary-butyl-ether
NAVSTA TI	Naval Station Treasure Island
Navy	U.S. Department of the Navy
NCEA	National Center for Environmental Assessment
NFA	No Further Action
OEHHA	Cal/EPA Office of Environmental Health Hazard Assessment
PAH	Polycyclic aromatic hydrocarbon
PAH-i	PAHs using immunoassay methods
PA/SI	Preliminary assessment and site inspection
PCB	Polychlorinated biphenyl
PCB-i	PCBs using immunoassay methods
ppm	Parts per million
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal

QC	Quality control
RA	Remedial actions
RAGS	Risk Assessment Guidance for Superfund
Redox	Oxidation reduction
RfD	Reference dose
RI	Remedial investigation
RME	Reasonable maximum exposure
RPD	Relative percent difference
RPM	Remedial project manager
RWQCB	California Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SDG	Sample delivery group
SF	Slope factor
SG	Silica gel
SLERA	Screening level ecological risk assessment
SVOC	Semivolatile organic compound
SWDIV	Naval Facilities Engineering Command Southwest Division
SWRCB	State Water Resources Control Board
TCLP	Toxicity characteristic leaching procedure
TDS	Total dissolved solid
TPH	Total petroleum hydrocarbons
TPH-d	Total petroleum hydrocarbons as diesel
TPH-e	Total petroleum hydrocarbons as extractable
TPH-i	Total petroleum hydrocarbons as immunoassay
TPH-m	Total petroleum hydrocarbons as motor oil
TPH-p	Total petroleum hydrocarbons as purgeable
Tetra Tech	Tetra Tech EM Inc.
UCL_{95}	95 percent upper confidence limit
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
Uribe	Uribe and Associates

USC	United States Code
UST	Underground Storage Tank
VOC	Volatile organic compound
YBI	Yerba Buena Island

EXECUTIVE SUMMARY

SulTech, a joint venture of Sullivan Consulting Group and Tetra Tech EM Inc., received Contract Task Order (CTO) 024 from the U.S. Department of Navy (Navy), Naval Facilities Engineering Command, under the A-E CERCLA/RCRA/UST/Studies and Remedial Design Contract Number N68711-03-D-5104, CTO 024, to complete this remedial investigation (RI) report for IR Sites 09 and 10. The Navy submitted the draft RI report for IR Sites 09 and 10 to the regulatory agencies and the Base Realignment and Closure (BRAC) Cleanup Team (BCT) on July 31, 2003. The draft RI report for Sites 09 and 10 presented the geologic, hydrogeologic, and chemical data collected during the phase I, phase IIA, phase IIB, quarterly groundwater sampling, the environmental baseline study (EBS), and additional RI field efforts conducted under the Navy Installation Restoration Program (IRP) at Naval Station Treasure Island (NAVSTA TI) from June 1992 through November 2002. All RI data collected at Sites 09 and 10 were incorporated into the draft RI report. These data were used to prepare the human health risk assessment (HHRA) and ecological risk assessment (ERA) included in the draft RI report.

As part of the draft RI report, the human health risk assessment (HHRA) was completed following Navy and the U.S. Environmental Protection Agency (US EPA) regulatory guidelines. However, comments received by the California Department of Toxic Substances and Control (DTSC) requested that the risk assessment be revised to follow new (September 2003) agreements in principle between the Navy and State of California. In order to meet the regulatory requests from the DTSC, and still meet the regulatory requirements of the US EPA and the Navy guidance, the Navy agreed to revise the HHRA. The Navy developed a second HHRA using DTSC's guidelines and the Navy's new September 2003 dual-tracking risk assessment guidance, which also was issued after the first draft of the Sites 09 and 10 HHRA was in review.

A revised draft HHRA was completed under this SulTech CTO and submitted to the BCT in September 2004. This HHRA strategy is based upon a technical conference call with the Navy on December 5, 2003 and a meeting with the Department of Toxic Substances and Control (DTSC) and the Regional Water Quality Control Board (RWQCB) on March 8, 2004 to outline the dual tracking risk assessment approach. This final RI report incorporates the revised draft HHRA, and consensus reached in December 2004 on the responses to comments on the draft RI report and the revised draft HHRA.

Site History

NAVSTA TI is located in San Francisco Bay (Bay), midway between San Francisco and Oakland, California. The facility consists of two contiguous islands: Treasure Island, which is approximately 403 acres, and Yerba Buena Island, which is approximately 147 acres. Treasure Island is a manmade island constructed of materials dredged from the Bay. Military activities at the former NAVSTA TI date back to 1866. In 1993, NAVSTA TI was designated for closure under the Base Closure and Realignment Act of 1990. The base was closed on September 30, 1997, and is currently in the transfer process.

Site 09 includes approximately 11,000 square feet in the central portion of the southern end of NAVSTA TI and includes Building 41 (the former foundry) and the paved area immediately adjacent to the northwest, west, and south sides of the building. Building 41 has been used for multiple purposes since the early 1940s, including a forge and foundry, a paint shop, a vehicle maintenance shop, a welding training school, a small boat maintenance shop, a wood shop for building movie sets, and a storage building for oil spill containment equipment. The building is currently vacant.

Site 10 includes approximately 32,000 square feet in the northeastern section of NAVSTA TI, north of 13th Street, between Avenue N and the island shoreline. Site 10 includes Building 335 (the former bus painting shop) and the area immediately surrounding the building. Building 335 was built during the mid-1940s. It was used throughout the years as a bus painting shop, a paint mixing facility, and a building where pesticides and chlorinated herbicides were mixed and handled. At one time it reportedly contained a self-service steam rack used to clean vehicles, drums, garbage cans, and related equipment. Currently, the building and surrounding area are leased by a local landscaping contractor for use as equipment storage and staging area, as well as a wood-chipping area.

Geology and Groundwater Hydrology

With the exception of the area covered by Building 41, all of Site 09 is paved with asphalt and underlain by sandy dredge fill. The sandy fill consists of tan to grayish-brown, fine- to coarse-grained, angular sand with some pea-size gravel. Minor silt and clay lenses are scattered throughout the sand, and locally, shell fragments can range from minor to abundant. Native formations such as the Bay Mud were not encountered in the shallow borings. Groundwater at Site 09 was encountered at approximately 7 feet below ground surface (bgs) during the 2002 sampling event. Based on general NAVSTA TI hydrogeology and basewide groundwater monitoring data, groundwater at Site 09 flows to the south and southeast, toward the shoreline.

The geology of Site 10 is similar to Site 09 except that the surface material varies throughout the site. The western and southern sides of Building 335 are mostly covered by asphalt. The asphalt is underlain by sandy dredge fill. The surface material on the northern and eastern sides of the building consists of a combination of soil, gravel, and wood chips because of the landscaping activities presently taking place at the site. The sandy fill consists of relatively permeable sands with interbedded clays and silts. Native formations such as the Bay Mud were not encountered in the shallow borings. Groundwater at Site 10 was encountered at approximately 7 feet bgs during the 2002 sampling event. Based on general Treasure Island hydrogeology and basewide groundwater monitoring and flow data, groundwater at Site 10 likely flows to the northeast, toward the shoreline.

Future Land Use

According to the draft 1996 reuse plan, the reuse for the area that includes Site 09 is designated as a Film Production/Conference Center. This includes land that could be used for publicly oriented recreation/cultural/entertainment and specifically as a film/events district. The reuse for

the area that includes Site 10 is designated as Residential/Open Space/Publicly Oriented Uses. This includes land designated for institutional use, specifically as a public facilities district. Residential housing may be associated with the proposed reuse at both Sites 09 and 10.

Nature and Extent of Contamination - Soil and Groundwater

Chemical data sets from past efforts (including the phase I and phase II RIs as well as basewide groundwater monitoring) and the recent additional RI were used to characterize the nature and extent of contamination at Sites 09 and 10. No major sources of organic or inorganic contamination were identified to remain in soil at either Site 09 or Site 10. Small and isolated amounts of contamination in soil were identified at various locations. Only soil contamination that remains at the IR sites was evaluated during the HHRA and ERA.

Two areas of soil contamination were identified at Site 09. The former hydraulic lift system was considered a potential source of total petroleum hydrocarbon (TPH) contamination. The hydraulic lift and associated UST were removed prior to the initial RI work. No records were found to describe the removal. The exact data of removal is not known. TPH as diesel (TPH-d) and TPH as motor oil (TPH-m) contamination was reported in soil from a sample collected immediately adjacent to the former lift system during the phase II RI. TPH-d was reported at a concentration of 38,000 milligrams per kilogram (mg/kg), and TPH-m was reported at a concentration of 12,000 mg/kg. Results from samples collected during the additional RI reported the highest concentration of TPH-d at 1,300 mg/kg and TPH-m at 430 mg/kg from the same area. Both TPH-d and TPH-m concentrations from samples collected during the additional RI are below TPH screening criteria. The screening criteria used are from the Final Preliminary Remediation Criteria for Petroleum and Petroleum Constituents, Technical Memorandum (Tetra Tech 2001b).

During the additional RI associated with sampling downgradient of the hydraulic lift system, elevated concentrations of TPH-d at 7,600 mg/kg and 7,100 mg/kg were identified near the southeast corner of the IR Site 09 boundary. Additional sampling was completed in the area. The contamination appears localized and does not impact groundwater.

Similar to soil, no major sources of groundwater contamination were identified at either Site 09 or 10. Pesticide contamination reported north of Building 335 at Site 10 during the phase II RI appears to have been associated with sediment entrained in the groundwater sample. Follow-up sampling during the additional RI did not identify pesticide concentrations in groundwater at this area. The basewide groundwater monitoring program continues to collect groundwater data at Sites 09 and 10, and no anomalous results have been reported.

Human Health Risk Assessment

A quantitative baseline HHRA completed as part of this RI is based on phase I and phase II RI basewide groundwater monitoring data as well as additional RI data collected from IR sites from 1994 through 2002. Because groundwater at Sites 09 and 10 is not a source of drinking water,

potential exposure to chemicals in groundwater would occur only through the inhalation of volatiles migrating upward into in the air (breathing zone). For this reason, only volatile organic compounds (VOC) were evaluated as possible chemicals of potential concern (COPC) in groundwater.

No groundwater COPCs were identified for either Sites 09 or 10. COPCs identified in soil at IR Site 09 and 10 included iron, benzo(a)pyrene, and dibenz(a,h)anthracene.

Incremental Risk

The following risks to human health were calculated for Site 09:

- The current industrial worker reasonable maximum exposure (RME) multipathway cancer risk was 5×10^{-7}.
- The future industrial worker RME multipathway cancer risk was 1×10^{-6}.
- The future construction worker RME multipathway cancer risk was 1×10^{-7}.
- The future resident (adult + child) multipathway cancer risk was 2×10^{-6}.
- The future intrusive resident (adult + child) multipathway cancer risk was 4×10^{-6}.
- The noncancer HI for the same risk scenarios was less than one.

The following risks were calculated for Site 10:

- The current industrial worker RME multipathway cancer risk was 3×10^{-7}.
- The future industrial worker RME multipathway cancer risk was 1×10^{-6}.
- The future construction worker RME multipathway cancer risk was 1×10^{-7}.
- The future resident (adult + child) multipathway cancer risk was 1×10^{-6}.
- The future intrusive resident (adult + child) multipathway cancer risk was 5×10^{-6}.
- The noncancer HI for the same risk scenarios was less than one.

The most significant exposure pathway at Sites 09 and 10 is dermal contact and soil ingestion for the future resident scenario. Multiple pathway risk results fall within the target risk range for this scenario and for the industrial worker scenario as well.

Total Risk

The following risks were calculated for Site 09 surface soil. The industrial worker RME multipathway total cancer risk was estimated at 7×10^{-6} (associated with all detects); 6×10^{-6} is attributable to ambient inorganics. The resident (adult + child) RME multipathway total cancer risk was estimated at 3×10^{-5} (associated with all detects); 2×10^{-5} is attributable to ambient inorganics. The industrial worker surface soil RME multipathway total noncancer hazard was estimated below . 0.1 (associated with all detects); 0.08 is attributable to ambient inorganics. The resident (adult + child) RME multipathway total noncancer hazard was estimated at 2 (associated with all detects); 0.9 is attributable to ambient inorganics. None of the target organ HIs for a residential scenario at Site 9 surface soil were estimated over 1.

The following risks were calculated for Site 09 subsurface soil. The industrial worker RME multipathway total cancer risk was estimated at 5×10^{-6} (associated with all detects); 3×10^{-6} is attributable to ambient inorganics. The resident (adult + child) RME multipathway total cancer risk was estimated at 2×10^{-5} (associated with all detects); 1×10^{-5} is attributable to ambient inorganics. The industrial worker RME multipathway total noncancer hazard was estimated at 0.1 (associated with all detects); 0.05 is attributable to ambient inorganics. The resident (adult + child) RME multipathway total noncancer hazard was estimated at 1 (associated with all detects); 0.6 is attributable to ambient inorganics. None of the target organ HIs for a residential scenario at Site 9 subsurface soil were estimated over 1.

The following risks were calculated for Site 10 surface soil. The industrial worker RME multipathway total cancer risk was estimated at 5×10^{-6} (associated with all detects); 4×10^{-6} is attributable to ambient inorganics. The resident (adult + child) RME multipathway total cancer risk was estimated at 2×10^{-5} (associated with all detects); 2×10^{-5} is attributable to ambient inorganics. The industrial worker RME multipathway total noncancer hazard was estimated below 1 at 0.1 (associated with all detects); 0.07 is attributable to ambient inorganics. The resident (adult + child) RME multipathway total noncancer hazard was estimated at 2(associated with all detects); 0.8 is attributable to ambient inorganics. None of the target HIs for a residential scenario at Site 10 surface soil were estimated over 1.

The following risks were calculated for Site 10 subsurface soil. The industrial worker RME multipathway total cancer risk was estimated at 6×10^{-6} (associated with all detects); 4×10^{-6} was attributable to ambient inorganics. The resident (adult + child) RME multipathway total cancer risk was estimated at 2×10^{-5} for total risks (all detects); 2×10^{-5} was attributable to ambient inorganics. The subsurface soil industrial worker RME multipathway total noncancer hazard was estimated at 0.1 (associated with all detects); 0.08 was attributable to ambient inorganics. The resident (adult + child) RME multipathway total noncancer hazard was estimated at 2 (associated with all detects); 0.9 is attributable to ambient inorganics. None of the target HIs for a residential scenario at Site 10 subsurface soil were estimated over 1.

Ecological Risk Assessment

A screening level ERA for Sites 09 and 10 at NAVSTA TI was conducted following Navy policy and U.S. Environmental Protection Agency (EPA) guidance. The terrestrial habitat of NAVSTA TI is of poor quality for wildlife species because it is predominantly covered with urbanized areas. The Navy and federal and state regulators have agreed that NAVSTA TI did not contain significant habitat and should not be considered for a detailed ERA for terrestrial receptors. Groundwater discharge to the Bay is a potential concern because marine ecological receptors could be affected. The Sites 09 and 10 screening level ERA addressed chemicals identified in groundwater at each site and the potential risk to aquatic receptors associated with chemical groundwater migration to the offshore surface waters of the Bay.

Contaminants reported in groundwater were screened against NAVSTA TI screening criteria. Chemicals of potential ecological concern (COPEC) identified for Site 09 included nickel, alpha-chlordane, and endosulfan II. No COPECs were identified for Site 10. Groundwater is not of ecological concern at NAVSTA TI until it meets or becomes surface water or when it can transport dissolved chemicals into the offshore environment. The Sites 09 and 10 screening level ERA focused on groundwater chemicals that have migrated to the offshore environment and are bioavailable or potentially bioavailable to aquatic receptors.

COECs were evaluated by simulating the fate and transport of COPECs (nickel, alpha-chlordane, and endosulfan II) in groundwater to the ecological point of exposure in an analytical model. For this assessment, "conservative model results" are defined as those results that would yield reasonable worst-case concentrations of COPECs at the ecological point of exposure. COPECs identified at Site 09 were not determined to be COECs. Additionally, because no COPECs existed at Site 10, none was identified. In summary, groundwater at Sites 09 and 10 does not pose an unacceptable risk to aquatic biota offshore of NAVSTA TI.

Recommendations

The following recommendations are provided for Sites 09 and 10 at NAVSTA TI:

- No additional soil or groundwater data are needed at Sites 09 and 10. The current level of site characterization is adequate to complete the human health and ecological risk assessments.
- Based on the results of the human health risk assessment, remedial action is not required for soil or groundwater at Sites 09 and 10.
- Based on the results of the ecological risk assessment, remedial action is not required for soil or groundwater at Sites 09 and 10.
- The IRP effort for soil and groundwater at Sites 09 and 10 should be to pursue site closure through a No Action Record of Decision.

1.0 INTRODUCTION

SulTech, a joint venture of Sullivan Consulting Group and Tetra Tech EM Inc., received Contract Task Order (CTO) 024 from the U.S. Department of Navy (Navy), Naval Facilities Engineering Command, under the A-E CERCLA/RCRA/UST/Studies and Remedial Design Contract Number N68711-03-D-5104, CTO 024, to complete this remedial investigation (RI) report for IR Sites 09 and 10. The Navy submitted the draft RI report for IR Sites 09 and 10 to the regulatory agencies and the Base Realignment and Closure (BRAC) Cleanup Team (BCT) on July 31, 2003. The draft RI report for Sites 09 and 10 presented the geologic, hydrogeologic, and chemical data collected during the phase I, phase IIA, phase IIB, quarterly groundwater sampling, the environmental baseline study (EBS), and additional RI field efforts conducted under the Navy Installation Restoration Program (IRP) at Naval Station Treasure Island (NAVSTA TI) from June 1992 through November 2002. All RI data collected at Sites 09 and 10 were incorporated into the draft RI report. These data were used to prepare the human health risk assessment (HHRA) and ecological risk assessment (ERA) included in the draft RI report.

As part of the draft RI report, the human health risk assessment (HHRA) was completed following Navy and the U.S. Environmental Protection Agency (US EPA) regulatory guidelines. However, comments received by the California Department of Toxic Substances and Control (DTSC) requested that the risk assessment be revised to follow new (September 2003) agreements in principle between the Navy and State of California. In order to meet the regulatory requests from the DTSC, and still meet the regulatory requirements of the US EPA and the Navy guidance, the Navy agreed to revise the HHRA. The Navy developed a second HHRA using DTSC's guidelines and the Navy's new September 2003 dual-tracking risk assessment guidance, which also was issued after the first draft of the Sites 09 and 10 HHRA was in review.

A revised draft HHRA was completed under this SulTech CTO and submitted to the BCT in September 2004. This HHRA strategy is based upon a technical conference call with the Navy on December 5, 2003 and a meeting with the Department of Toxic Substances and Control (DTSC) and the Regional Water Quality Control Board (RWQCB) on March 8, 2004 to outline the dual tracking risk assessment approach. This final RI report incorporates the revised draft HHRA, and consensus reached in December 2004 on the responses to comments on the draft RI report and the revised draft HHRA.

1.1 PURPOSE OF THE REMEDIAL INVESTIGATION

The purpose of this report is to present the RI results for Sites 09 and 10, in partial fulfillment of the ongoing activities and responsibilities required under the Installation Restoration Program (IRP). These activities are governed by all applicable Federal and state laws and regulations as cited in the Federal Facility Site Remediation Agreement (FFSRA) for NAVSTA TI (Navy 1992). This agreement, made in 1992 between the State of California and the Navy, provides the operational framework for remediation work conducted at NAVSTA TI. Applicable regulations require the completion of a preliminary assessment and site inspection (PA/SI), an RI and feasibility study (FS), and selected remedial actions (RA), if necessary.

This RI presents the geologic, hydrogeologic, and chemical data collected during the phase I, phase IIA, phase IIB, quarterly groundwater sampling, the EBS, and additional investigation RI field efforts conducted under the Navy IRP at NAVSTA TI from June 1992 through November 2002. Data generated during these investigations were used to complete the final characterization of soil and groundwater conditions at Sites 09 and 10 and to support risk calculations for human health and ecological receptors.

The following sections describe in greater detail the history of the Navy IRP, the governing FFSRA, the RI/FS objectives, and the scope of this RI report for NAVSTA TI.

1.1.1 Installation Restoration Program

In 1975, the U.S. Department of Defense (DoD) initiated a program to identify and investigate potential hazardous waste sites at military installations. The program was the result of increasing public and government concern over the potential impacts of past hazardous waste disposal methods. This program began on a pilot scale and expanded in 1980 as the DoD IRP.

Concurrent with the formation of the IRP, the U.S. Congress directed the U.S. Environmental Protection Agency (EPA) to develop a comprehensive national program to manage past disposal sites. The basis for this program is the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or "Superfund") as amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). In 1988, DoD adopted EPA's terminology for the investigation and remediation of past hazardous waste disposal sites for use in its IRP.

In response to the DoD IRP, the Navy instituted its own program for implementation of the DoD IRP at naval facilities. This program, the Navy IRP, is conducted in the following three phases:

- PA/SI: identification of potential disposal or contaminated sites and evaluation of these sites with respect to potential threat to human health and the environment
- RI/FS: verification and characterization of the extent of contamination, definition of potential migration pathways, evaluation of human health and ecological risks, and evaluation of the feasibility of potential remedial measures
- RA: design and implementation of the required corrective measures to mitigate or eliminate confirmed problems

The PA/SI and associated assessments conducted at NAVSTA TI identified 25 sites requiring RI/FS activities. The actual number of sites that were identified during the RI, and that are subsequently discussed in this RI report, differs somewhat from the PA/SI investigation. The RI process was initially conducted in two phases. Phase I RI results identified contaminated areas that required additional investigation to fully characterize the majority of the sites. The phase IIA and phase IIB RIs were completed to address data gaps identified during the phase I RI. Because new information was discovered during the phase IIA and phase IIB RIs, additional follow-up work was necessary at Sites 09 and 10 to address the new information. These RI

activities were conducted in the fall of 2002. All RI data collected at Sites 09 and 10 are incorporated into this RI report, which can be considered a "stand-alone" document. The results of all phases of the RI are presented in Section 5.0 of this report.

1.1.2 Federal Facility Site Remediation Agreement

The FFSRA is an agreement that was made between the State of California and the Navy that stipulates the type, scope, and schedule of environmental work to be conducted at NAVSTA TI (Navy 1992). Specifically, the purposes of the FFSRA are as follows:

- Establish requirements for the performance of preremedial work and RI as well as for the performance of an FS for the site
- Identify the nature, objective, and schedule of response actions to be taken at the site
- Implement the selected RAs in accordance with applicable state and Federal laws
- Ensure compliance with applicable state and Federal laws and regulations
- Coordinate response actions at the site
- Expedite the cleanup process
- Provide for initiation, development, selection, and implementation by the Navy of response actions
- Provide for State of California oversight of and participation in the initiation, development, selection, and implementation of response actions
- Provide for operation and maintenance of any RA selected and implemented
- Identify operable unit (OU) alternatives that are appropriate at the site before the implementation of final RAs at the site

In addition, the FFSRA identifies the regulatory agencies responsible for oversight of all related work at NAVSTA TI. These include the California Environmental Protection Agency's (Cal/EPA) Department of Toxic Substances Control (DTSC), Region 2, and the California Regional Water Quality Control Board (RWQCB) San Francisco Bay Region. These parties entered into this FFSRA pursuant to the following authorities:

- Chapters 6.5 and 6.8 of Divisions 20, 102, and 25355.5(a)(1)(C) of the California Health and Safety Code
- Division 7 of the California Water Code
- CERCLA 120(a)(4), 120(f), 121
- Title 42 United States Code (USC) 9620(a)(4), 9620(f), and 9621
- National Environmental Policy Act (NEPA), Title 42 USC 4321

- Defense Environmental Restoration Program (DERP), Title 10 USC 2701 et seq.

All remediation efforts on NAVSTA TI are governed by this FFSRA.

A NAVSTA TI project team has been established and is led by the Base Realignment and Closure (BRAC) environmental coordinator. Monthly project team meetings are conducted to perform periodic program reviews and reach consensus on decisions with federal and state regulators. The BRAC cleanup team (BCT) includes the BRAC environmental coordinator, the Navy remedial project manager (RPM), other representatives from the Navy, representatives of DTSC, representatives of EPA Region IX, and representatives of RWQCB. Although not official members of the BCT, representatives from the City of San Francisco and their technical consultants also attend the BCT meetings.

1.1.3 Remedial Investigation Objectives

An RI under CERCLA is an iterative process beginning with project scoping and work plan preparation activities. The process defines data quality objectives (DQO) that include a review of available information, the development of a conceptual model for each site, and the identification of data needs. Project management plans are then prepared on the basis of these activities, and work is initiated at the site.

EPA generally recommends that data be collected in several stages. As a basic understanding of site characteristics is achieved, subsequent efforts focus on filling gaps in the understanding of site characteristics and gathering information necessary to evaluate potential risk and any necessary remedial alternatives (EPA 1988).

The objective of the RI is to characterize the nature and extent of risks to human health and the environment posed by uncontrolled release of hazardous substances. This includes the following steps:

- Establish the nature and extent of contamination
- Characterize the geology, hydrogeology, and physical features
- Identify potential contaminant migration pathways and receptors
- Evaluate the fate and transport potential of contaminants
- Conduct a baseline human health risk assessment (HHRA) and ecological risk assessment (ERA)
- If necessary, the RI would support an FS, including screening and evaluation of remedial alternatives

Data gathered during the RI are used to support the HHRA and ERA and to evaluate remedial alternatives developed in the FS, if an FS is determined to be necessary.

1.2 TREASURE ISLAND LOCATION, HISTORY, CURRENT OPERATIONS, AND FUTURE USE

NAVSTA TI information, including location, history, and current operations, is presented in the following sections. Most of the information was obtained from the draft final onshore RI (PRC Environmental Management, Inc. [PRC] 1997b). This report comprised information from the following: (1) "Preliminary Assessment/Site Inspection of Naval Station Treasure Island" (Dames and Moore, 1988), (2) "Master Plan for the Naval Station Treasure Island" (Navy 1988), and (3) "Historical Study of Yerba Buena Island, Treasure Island, and their Buildings" (Mare Island Naval Shipyard [MINS] 1996). Specific information pertaining to Sites 09 and 10 is provided in Section 2.0.

1.2.1 Location

NAVSTA TI is located in San Francisco Bay (Bay), midway between San Francisco and Oakland, California (see Figure 1-1). The facility consists of two contiguous islands: Treasure Island, which is approximately 403 acres (Figure 1-2), and Yerba Buena Island (YBI), which is approximately 147 acres. The U.S. Coast Guard owns 30 of the 147 acres on YBI. Treasure Island is a manmade island constructed of materials dredged from the Bay; YBI is a natural island. All vehicular transportation to and from Treasure Island and YBI must use the San Francisco-Oakland Bay Bridge (Interstate 80), which passes through YBI by way of a tunnel.

Beyond the waters of the Bay, the facility is surrounded by the extensively developed, mixed-use lands of the Bay Area. The Bay Area, with a population that exceeds 6.6 million, is a major metropolitan center of business, industry, and government.

1.2.2 History

Military activities at the former NAVSTA TI date back to 1866, before the construction of Treasure Island, when the U.S. Government took possession of YBI for defensive fortifications. YBI was occupied by the U.S. Department of the Army until 1896, when the Navy assumed operations. The Navy operated the first West Coast naval training station on YBI until 1923, when these activities were transferred to and alternate location in San Diego. YBI continued to function as a naval receiving station until World War II, when naval operations were transferred to NAVSTA TI.

NAVSTA TI was built on Yerba Buena Shoals and a sand spit extending from the northwest point of YBI. Dredging and construction of the island began in 1936 and were completed in 1937. Approximately 29 million cubic yards of fill was used for construction of the island. Additional information about the fill used at NAVSTA is provided in Section 4.2.2.1. The island was developed to be the site for the 1939 Golden Gate International Exposition and then San Francisco's proposed commercial airport.

In response to a Navy request, the City of San Francisco leased Treasure Island to the Navy in 1941 for the duration of World War II. The island became a major naval facility, processing approximately 12,000 military personnel per day for service overseas and upon their return to the United States. After the war, the City of San Francisco agreed to trade the deed for Treasure Island to the Navy in exchange for government-owned land south of San Francisco where the San Francisco International Airport was eventually built.

Many changes to NAVSTA TI have occurred over the last 45 years. Figure 1-3, prepared based on a 1945 aerial photograph, depicts NAVSTA TI as it appeared at that time. When compared with the 2000 aerial photograph of NAVSTA TI (Figure 1-4), several changes since 1945 are apparent, including the removal of buildings and piers and the replacement of structures. The original exposition center and barracks no longer exist. The exposition center was replaced by numerous other buildings, and the barracks were replaced by parking areas and open space. Family housing replaced the ammunition storage area. Numerous piers were demolished, especially along the east side of NAVSTA TI. Only one major pier, at the southeast corner of NAVSTA TI, is still in use.

1.2.3 Current Operations

In 1993, NAVSTA TI was designated for closure under the Base Closure and Realignment Act of 1990. The base was closed on September 30, 1997, and is currently in the transfer process. Potential future land use is discussed in the following section.

1.2.4 Future Land Use

According to the draft 1996 reuse plan (City and County of San Francisco [CCSF] 1996), the reuse for the area that includes Site 09 is designated as a "Film Production/Conference Center." This includes land that could be used for "publicly-oriented recreation/cultural/entertainment" and specifically as a film/events district. According to the plan, the following activities may be undertaken in the area:

- Theme parks
- Destination entertainment
- Hotel and resort
- Conference and meeting rooms
- Spectator sports and recreation areas (including golf)
- Community recreation
- Specialty restaurant and retail
- Performance, exposition, and display
- Festivals, markets, and fairs
- Film production and associated offices
- Museums and cultural institutions
- Neighborhood retail
- Employee housing for publicly-oriented uses

According to the draft 1996 reuse plan (CCSF 1996), the reuse for the area that includes Site 10 is designated as "Residential/Open Space/Publicly Oriented Uses." This includes land designated for institutional use, specifically as a public facilities district. According to the plan, the following activities may be undertaken in the area:

- Schools, day care, and other public and nonprofit uses
- Job corps
- Fire and police
- Transportation facilities
- Other service and support facilities
- Medical and health facilities and services
- Water reservoirs
- Sewage treatment plant
- Employee or trainee housing for institutional facilities

1.3 REPORT CONTENTS AND ORGANIZATION

This RI report is divided into two volumes, Volume One includes the following sections and the associated figures and tables:

- Executive Summary
- Section 1.0, Introduction, includes the purpose of the RI, NAVSTA TI information, and this section, Report Contents and Organization.
- Section 2.0, Background and Approach for the Remedial Investigation, includes site descriptions and previous investigation information.
- Section 3.0, Investigation Procedures and Field Methods, includes information on all IR work performed at Sites 09 and 10. The field work described includes utilities survey, direct push probe soil sampling, monitoring well installation, monitoring well development and sampling, decontamination, management of investigation-derived waste (IDW), and a description of the deviations to the SAPs.
- Section 4.0, Physical Characteristics and Environmental Setting, includes both regional and site-specific (Sites 09 and 10) information on climate, geology, and hydrogeology.
- Section 5.0, Nature and Extent of Contamination, describes all analytical results for Sites 09 and 10.
- Section 6.0, Principles of Environmental Fate and Transport, describes the persistence and migration potential of contaminants.
- Section 7.0, Human Health Risk Assessment, evaluates potential health risks associated with a site under current and future land use conditions.

- Section 8.0, Screening Level Ecological Risk Assessment, provides a screening-level ecological risk assessment (SLERA) for Sites 09 and 10 at NAVSTA TI.
- Section 9.0, Summary, Conclusions, and Recommendations, summarizes the conclusions and recommendations for the sites.

Volume Two includes the following Appendices:

- Appendix A, Borehole Logs and Well Construction Details
- Appendix B, Well Development Data
- Appendix C, Site 09 Analytical Data
- Appendix D, Site 10 Analytical Data
- Appendix E, Quality Control Summary Reports
- Appendix F, Estimation of Background and Ambient Metal Concentrations in Soils
- Appendix G, Estimation of Ambient Concentrations of Metals in Groundwater
- Appendix H, Contaminant Fate and Transport Modeling
- Appendix I, Human Health Risk Assessment
- Appendix J, Ecological Risk Assessment
- Appendix K, Chemical Characteristics and Transport Mechanisms
- Appendix L, Petroleum Screening Levels
- Appendix M, Response to Comments on the Draft RI Report
- Appendix N, Response to Comments on the Revised Draft HHRA

FIGURES

Not To Scale

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 1-1
Installation Location Map

Not To Scale

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 1-2
Oblique Air Photo of Treasure Island
Showing Locations of Sites 09 and 10

Not To Scale

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 1-3
Installation 1945 Aerial Photograph

Not To Scale

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 1-4
Installation 2000 Aerial Photograph

2.0 BACKGROUND AND APPROACH FOR THE REMEDIAL INVESTIGATION

Previous investigations identified soil and groundwater contamination at Sites 09 and 10. At Site 09, petroleum and lead concentrations in soil exceeded screening criteria. At Site 10, pesticide and polycyclic aromatic hydrocarbon (PAH) concentrations in soil and groundwater exceeded screening criteria. Based on available data, the horizontal and vertical extent of soil and groundwater contamination at each site was not fully known. In addition, groundwater flow gradients and water quality impacts to the Bay required further evaluation. To address these data gaps, a SAP was prepared (Tetra Tech 2002e), and the additional RI was conducted by Tetra Tech in the fall of 2002.

The overall approach to this RI includes compilation and analysis of (1) site history and background information, including soils and groundwater data collected before the fall of 2002, and (2) recent data collected by Tetra Tech during the fall 2002 sampling event. Data from all investigations are combined and presented together in this RI report; the combined data set was used to conduct the HHRA and ERA. Site descriptions and historical background information for Sites 09 and 10 are presented in Section 2.1. The data collected during previous investigations conducted before October 2002 is summarized in Section 2.2. A summary of the Sites 09 and 10 RI field activities conducted in the fall of 2002 is provided in Section 2.3. Site conceptual models for Sites 09 and 10 are presented in Section 2.4.

2.1 SITE DESCRIPTIONS AND HISTORICAL BACKGROUND INFORMATION

Site descriptions and historical background information for Sites 09 and 10, including site location, site history, and current operations, are presented in the following sections. Most of the historical information presented in the following sections was obtained from previously existing reports referenced in Section 1.2.

2.1.1 Site 09

Site 09 is located in the central portion of the southern end of NAVSTA TI and includes Building 41 (the former foundry) and the paved area immediately adjacent to the northwest, west, and south sides of the building. Site 09 encompasses approximately 11,000 square feet (see Figure 2-1). The site terrain is generally flat. The Bay is located approximately 300 feet to the southeast of Site 09.

Building 41 has been used for multiple purposes since the early 1940s. According to a review of historical documentation, Building 41 was listed as a forge and foundry from 1943 to 1947; therefore, metals are the most likely contaminant sources. From approximately 1952 to 1981, Building 41 was listed as a paint shop. One floor drain or sump was observed next to the paint booth upon inspection of Building 41 during the phase I RI. Paints used at this building are likely to have contained lead and zinc-chromium based pigments. In addition, two former trenches, now filled in with concrete, in the large middle room are apparently the remaining structures associated with a former hydraulic lift system. These trenches, along with the

presence of the former hydraulic lift system, suggest that vehicle maintenance may have been performed at this location. A 30-gallon underground storage tank (UST), previously used as a hydraulic oil reservoir for use with the former hydraulic lift, has been removed. No records were found to describe the removal of the former hydraulic lift system; however, site inspections indicate that this lift has been removed. From 1981 to 1987, the building was used as a welding training school by the Navy Technical Training Center. In 1994, the building was used for small boat maintenance, primarily bodywork. In 1997, the building was being used as a wood shop for movie sets and to store oil spill containment equipment. The building is currently vacant.

The outdoor area around Building 41 has apparently been paved for most of the building's existence. The building is a two-story structure and appears in good condition. The interior floor is slab on grade construction and several rooms are finished with linoleum flooring. The roof appears sound and no obvious leaks were observed in the interior of the building. A paint booth was previously located in the northeast corner of Building 41 and a floor drain was adjacent to the paint booth. Two storm drain catch basins are located just outside the IR site boundary. The actual locations of utility lines within the footprint of Building 41 were not included on the utility maps obtained for NAVSTA TI.

2.1.2 Site 10

Site 10 is located in the northeastern section of NAVSTA TI, north of 13th Street, between Avenue N and the island shoreline. Site 10 comprises Building 335 (the former bus painting shop) and the area immediately surrounding the building, and encompasses approximately 32,000 square feet (see Figure 2-2). The area surrounding the building is covered primarily by asphalt pavement and compacted bare ground, with small areas of grass and shrubbery.

Building 335 was constructed during the mid-1940s and operated as a bus painting shop through the 1950s. For an unspecified period of time, the building may have also been used for paint mixing. Handling practices reported at similar facilities on NAVSTA TI indicate that waste paints, thinners, and solvents may have been released onto the ground near Building 335. Building 335 was also reportedly used for storing, mixing, and handling pesticides and chlorinated herbicides during an unspecified time period. Solution residues were reportedly washed from containers and spraying equipment. It was also reported that Building 335 housed a self-service steam rack used to clean vehicles, drums, garbage cans, and related equipment. A floor drain was reportedly used in the building and connected to the storm water sewer system. Inspections of the building in March 1994 and September 2001 revealed a cement-patched area that may have been the former location of the floor drain. Currently, the building and surrounding area are leased by a local landscaping contractor for use as equipment storage and staging area, as well as a wood-chipping area.

The outdoor area around Building 335 has been partly paved for most of the building's existence. The building is a one-story structure and appears to be in good condition. It currently is used to store landscaping equipment and materials. The interior floor is slab on grade construction. The roof appears to be in good condition. A large "L"-shaped floor drain was present at one time in the northern half of the building, but has been filled in with concrete. Drainage from this floor

drain is unknown. The actual locations of utility lines within the footprint of Building 335 were not included on the utility maps obtained for NAVSTA TI except for a portion of two storm drain lines at the south side of the building. These lines pass into the catch basins immediately outside Building 335 and beneath the overhang, and intersect an east-west storm drain line that flows into the Bay.

2.2 PREVIOUS INVESTIGATIONS

A number of investigations have been conducted at Sites 09 and 10 including a PA/SI, a phase I and phase II RI, an environmental baseline study (EBS), and groundwater monitoring under the basewide groundwater monitoring program. This section summarizes investigation activities previously performed at Sites 09 and 10. Table 2-1 provides a summary of the reports and investigations that provide background information or historical information related to NAVSTA TI. Table 2-2 summarizes the field activities previously completed at Sites 09 and 10. Tables 2-3 and 2-4 provide the type of analysis performed on each sample collected at Site 09 and Site 10, respectively. Figures 2-3 and 2-4 show the locations of all samples taken at Sites 09 and 10, respectively.

2.2.1 Preliminary Assessment (Dames & Moore)

In 1988, Dames and Moore conducted a PA/SI (Dames and Moore 1988) at Site 09. A PA/SI was not conducted at Site 10. Although no environmental sampling was conducted at Site 09, the PA/SI report included a site inspection, personnel interviews, and a review of historical records and aerial photographs. The PA/SI report concluded that the site warranted further investigation because of the potential for contamination of soil and groundwater from past site operations.

2.2.2 Draft Final Onshore RI and Associated RI Field Efforts

A draft final onshore RI report (PRC 1997b) was prepared in 1997. This report summarized the information gathered during the phase I, phase IIA, and phase IIB RI field efforts conducted under the Navy IRP at NAVSTA TI from June 1992 through September 1996. The draft final onshore RI report evaluated Site 09 as an individual IR site but combined Site 07 and Site 10 because of similar operational histories. The activities conducted during the phase I, phase IIA, and phase IIB RI field efforts are summarized in Sections 2.2.2.1 through 2.2.2.5.

2.2.2.1 Tidal Influence Studies

In August 1995, as part of the phase IIA RI, a 72-hour tidal influence study was performed at 11 monitoring wells at NAVSTA TI and one Bay monitoring station (PRC 1995). The purpose of the study was to evaluate tidal effects on the groundwater, which were expected to be most significant near the shoreline. The results of water level measurements were used to calculate a mean groundwater elevation by removing tidal fluctuations from groundwater level measurements and to estimate the amount of tidal mixing of freshwater and brackish Bay water

in the groundwater aquifer. The data collection procedures and results of the study are presented in the 1996 groundwater status report (PRC 1996a). The results are summarized as part of the NAVSTA TI hydrogeology presented in Section 4.3.

In December 2000 and January 2001, a tidal mixing zone study was conducted at NAVSTA TI (Tetra Tech 2002d). The purpose of the study was to collect sufficient data to understand the extent and degree of physical mixing that occurs within the nearshore areas of NAVSTA TI as a result of tidal fluctuations. Although study areas were not specifically located at either Sites 09 or 10, results may be applicable to other nearshore areas at NAVSTA TI. The results of the tidal mixing zone study are summarized in Section 4.3.1.3.

2.2.2.2 Aquifer Testing

In January 1995, as part of the phase IIA RI, rising head slug tests were performed at 13 wells at NAVSTA TI. Two wells from YBI were also tested. The purpose of the slug tests was to estimate the hydraulic conductivity in the aquifer in different areas of NAVSTA TI and YBI. The procedures and results of aquifer testing are presented in the groundwater status report (PRC 1996a) and are summarized in Section 4.3.

Additional aquifer testing was performed at NAVSTA TI in September 2001 as part of the Site 21 RI/FS. Although aquifer testing was not conducted on monitoring wells at Sites 09 or 10, aquifer testing was conducted at Site 21, immediately west of Site 09. Hydrogeologic conditions at Sites 09 and 21 are similar, based on well logs and geologic sampling. Pumping tests were conducted on two monitoring wells, and slug tests were conducted on nine monitoring wells at Site 21. The results are summarized in Section 4.3.1.1.

2.2.2.3 Ambient Metals Study

Ambient metals concentrations in soil and groundwater have been established at NAVSTA TI. Ambient concentrations of metals in soil were estimated during the phase I RI; the ambient groundwater concentration study was completed in 2001 as part of a separate investigation. These studies are included in Appendices F and G, respectively. The purpose of establishing ambient concentrations is to assess whether the presence of a chemical constituent is the result of a site-specific release or if it is from naturally occurring or regional anthropogenic sources. The concentrations of inorganic chemicals present in soil altered by human activities, as is the case with land made of dredged fill, are referred to as "ambient," and this term is applied to conditions at Treasure Island. The concentrations of inorganic chemicals present in soil as part of the undisturbed natural conditions of the area are referred to as "background," and this term is applied to conditions at YBI. Both terms relate to concentrations of inorganic constituents that are not site related. Because Sites 09 and 10 are both located on Treasure Island, only ambient levels of metals are further discussed in this RI report.

Ambient Concentrations of Metals in Soil at Treasure Island

Ambient concentrations of metals in soil were evaluated at NAVSTA TI in 2001 (PRC 1996b) Metals data from 200 soil samples collected at NAVSTA TI were used to determine the ambient concentrations of 19 metals present in soil altered by human activities, as is the case with land made of dredged fill. For NAVSTA TI, site-specific soil metals data collected during the phase IIB RI were used to determine ambient metal concentrations.

Statistical procedures consistent with EPA and Cal/EPA guidance documents (EPA 1989; Cal/EPA1992, 1994) and current practices in the environmental industry were used to establish ambient concentrations of metals in soil. A one-sided tolerance limit was used to determine reasonable upper levels of ambient concentrations of metals at a site. A tolerance limit is a value for which only a small probability exists that a portion of the population exceeds a specific limit.

Before upper limits of the ambient metal concentrations could be calculated, most of the data sets required special preparation. Nondetectable results were replaced by values equal to one-half the detection limit for that sample. Exploratory data analysis was performed using probability plots and histograms to identify any outliers. Outliers are data points with concentrations significantly greater or lower than the main population. The outliers were removed from the data sets to reduce their impact on the estimates of background or ambient levels.

The ambient concentrations of metals in soil were estimated using distribution-dependent formulae to find the strict 95th percentile. The calculated ambient concentrations of metals in dredged fill at NAVSTA TI are listed in Table 2-5. A more detailed description of the methodologies used to establish ambient and background concentrations in soil is presented in Appendix F.

Ambient Concentrations of Metals in Groundwater at Treasure Island

Ambient concentrations of metals in groundwater were evaluated at NAVSTA TI in 2001 (Tetra Tech 2001a). The approach used in this study included the following steps:

1. Identify monitoring wells not affected by contamination originating from sites, collect four quarters of groundwater samples using low-flow techniques, analyze the samples, and compile new data
2. Compare newly collected groundwater data for metals with previously collected groundwater data
3. Evaluate variability and trends in metal concentrations and compile the ambient data set
4. Conduct statistical data analysis and estimate the upper limits of the ambient concentrations of metals in NAVSTA TI groundwater

Because limited historic data were available to evaluate concentrations, an additional four quarters of basewide metals data were collected from the existing monitoring wells. The number of monitoring wells and sampling frequency were determined using the DQO process developed for the study. The number of required samples was estimated based on the coefficient of variation calculated using previous metals data and statistical performance objectives to achieve a specified precision and confidence level at a defined minimum detectable relative difference (EPA 1989). Approximately 100 samples collected from 26 monitoring wells were found to be sufficient for meeting the study goals.

A single value (the 95th percentile of ambient concentrations) was derived for simple screening purposes. These values calculated ambient concentrations for metals in groundwater at NAVSTA TI and are provided in Table 2-6. A copy of the complete study is provided in Appendix G.

2.2.2.4 Sampling and Analyses – Site 09

The objective of the phase I RI soil sampling at Site 09 was to determine whether subsurface soil surrounding Building 41 had been contaminated. Phase I RI soil boring locations were selected based on the findings of the PA/SI. The PA/SI identified areas adjacent to the building where disposal of hazardous wastes most likely occurred.

Based on the analytical results from the phase I RI samples, soil and groundwater samples were collected as part of the phase IIB RI to assess the extent of lead contamination in the south-central region of Site 09. Also as part of the phase IIB RI, soil, groundwater, oily waste, and wastewater samples were collected to determine the nature and extent of contamination in and around the former concrete lift system trenches and floor drain/sump inside Building 41.

Soil Sampling

During the phase I RI, 12 soil samples from four soil borings (09-SB01 to 09-SB04) were analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides/polychlorinated biphenyls (PCB), and metals. Five additional soil samples were reanalyzed for SVOCs in December 1992 because the original sample results were not usable (PRC 1997b). Fifteen soil samples from six hydraulic punch borings (09-HP001 to 09-HP006) were collected during the phase IIB RI; the soil samples were analyzed for specific analytes (see Table 2-3) according to the phase IIB RI sampling plan.

Two sludge samples were collected from the former hydraulic lift trench. One sample was analyzed for PCBs, and a fuel fingerprint was performed on the other (see Table 2-3).

Results of soil sampling conducted at Site 09 are presented in Section 5.1.1.

Groundwater Sampling

Groundwater samples were not collected at Site 09 during the phase I RI. The phase IIB RI approach called for the collection of groundwater samples to determine whether groundwater contamination was present at the site. Groundwater samples were obtained from one monitoring well (09-MW01) and eight direct push borings (09-HP001 through 09-HP008) at Site 09 during the phase IIB RI. Table 2-3 provides the type of analysis performed on each of these samples.

One water sample was collected from the floor drain located next to the paint booth in Building 41. It was analyzed for SVOCs and metals (see Table 2-3). Results of groundwater sampling conducted at Site 09 are presented in Section 5.1.2.

2.2.2.5 Sampling and Analyses – Site 10

The main objective of the phase I RI at Site 10 was to assess the nature and extent of possible contamination in the soils around Building 335.

The purpose of the phase IIB RI was to investigate data gaps remaining after completion of the phase I RI. One objective was to determine the extent of potential diesel and PAH contamination in soil and groundwater near Building 335 and to determine the source of the petroleum. Additionally, the phase IIB RI evaluated the potential contamination in storm drain catch basins.

Soil Sampling

To investigate the potential contamination, 12 soil samples were collected from 4 soil borings (10-SB01 to 10-SB04). One soil boring (10-SB01) was drilled to a depth of 20 feet below ground surface (bgs) to examine the site stratigraphy, and the remaining three soil borings were hand-augered to a depth of 6.5 feet bgs because of access problems. All four soil borings were located in visibly stained areas surrounding three small former aboveground storage tanks (AST) previously located east of Building 335. The samples were analyzed for VOCs, SVOCs, metals, pesticides/PCBs, chlorinated herbicides, and extractable total petroleum hydrocarbons (TPH-e).

During the phase IIB RI, 24 samples from nine direct push borings (07/10HP001, 002, 004, 006, 007, 008, 009, 010, and 011) were collected and analyzed for total petroleum hydrocarbons (TPH) and total PAHs using immunoassay test kits. Samples were collected from the surface down to depths of 7 to 10 feet bgs. Based on the field screening, 21 soil samples from 10 direct push borings (07/10HP001, 002, 004, 006, 007, 008, 010, 011, 012, and 013) were selected for analysis at an off-site laboratory for VOCs, SVOCs, pesticides, chlorinated herbicides, metals, and TPH-e (see Table 2-4).

Two sediment samples were collected from two catch basins located southeast and northwest of Building 335. These samples were analyzed for VOCs, TPH-e, purgeable TPH (TPH-p), SVOCs, PCBs, pesticides, lead, and herbicides (see Table 2-4).

Figure 2-4 shows the locations of all phase I and phase IIB RI samples collected at Site 10. Results of soil sampling conducted at Site 10 are presented in Section 5.2.1.

Groundwater Sampling

Groundwater samples were not collected at Site 10 during the phase I RI. During the phase IIB RI, eight additional direct push locations were selected based on contamination detected at primary sampling locations. One groundwater sample was collected from each of the direct push locations (07/10HP001, 002, 004, 006, 007, 008, 009, 010, 011, 012, 013, 014, 015, 016, 017, 018, and 019) to determine the extent of contamination in the groundwater. Thirteen groundwater samples were field screened for TPH, and 11 samples were analyzed by an off-site laboratory for VOCs, TPH-e, SVOCs, PCBs, pesticides, metals (sometimes only lead), and herbicides.

One surface water grab sample was collected from the catch basin located north west of Building 335 and analyzed for VOCs, TPH-e, TPH-p, SVOCs, PCBs, pesticides, lead, and herbicides.

Table 2-4 summarizes the groundwater and surface water grab samples collected and the analyses performed during the phase IIB RI. Figure 2-4 shows the locations of all phase IIB RI samples. Results of groundwater sampling conducted at Site 10 are presented in Section 5.2.2.

2.2.3 Environmental Baseline Study

An EBS was conducted in November of 1997 (Tetra Tech and Uribe and Associates [Uribe] 1997). The samples that were collected are described below.

Site 09

One groundwater sample collected from monitoring well 09-MW01 during the EBS was analyzed for TPH-p and benzene, toluene, ethylbenzene, and xylene (BTEX) as well as methyl-tert-butyl-ether (MTBE). No soil samples were collected.

Site 10

Three soil samples were collected during the EBS at Site 10. These samples were analyzed for BTEX, TPH-e, TPH-p, SVOC, PCB, pesticides, and metals. No groundwater samples were collected.

2.2.4 Basewide Groundwater Monitoring Program

Groundwater monitoring activities are conducted by the Navy at NAVSTA TI in support of two ongoing environmental restoration efforts. The first restoration effort includes sites where substances defined as hazardous under CERCLA have been detected (IR sites). The second

comprises an investigation and RA in accordance with California underground storage tank (UST) regulations at sites where petroleum constituents have been identified. Accordingly, information collected from groundwater monitoring is being used, as appropriate, to (1) complete an RI/FS for CERCLA sites and (2) complete corrective action plans, interim action plans, construction summary reports, and closure reports for petroleum program sites.

The most recent groundwater status report (Tetra Tech 2003a) presents analytical and water level data for groundwater samples collected from numerous monitoring wells during quarterly groundwater monitoring events conducted between May 2001 and August 2002 at NAVSTA TI. Data from groundwater sampling events conducted before May 2001 are also included in this report and have been analyzed in three previous NAVSTA TI groundwater status reports (PRC 1997a, Tetra Tech 1999a, and Tetra Tech 2002c). These previous reports discuss data gathered during quarterly groundwater monitoring events conducted from November 1995 to September 1996, January to November 1998, and March to October 2000. Only those reports providing information of quarterly groundwater sampling conducted at Sites 09 and 10 are referenced and discussed in this report.

The following sections provide an overview of the analytical results and groundwater monitoring status for Sites 09 and 10 at NAVSTA TI. Tables 2-3 and 2-4 provide the type of analysis performed on each sample collected at Site 09 and Site 10, respectively.

2.2.4.1 Site 09 Groundwater Monitoring Program

Only one monitoring well at Site 09 has been sampled during the groundwater monitoring program. Monitoring well 09-MW01 was installed during the phase IIB RI in November 1995, and six samples were collected over time. Samples were collected in February, June, and September of 1996, November of 1998, and April and October of 2000. Because of the absence of elevated concentrations of analytes of concern in groundwater samples from this well, groundwater monitoring at Site 09 was suspended in 2001 with regulatory agency concurrence (Tetra Tech 2003a).

2.2.4.2 Site 10 Groundwater Monitoring Program

Monitoring well 07/10-MW01, which was previously installed during the phase IIB RI, was sampled four times during the groundwater monitoring program. This well was sampled in February, June, and September 1996 and again in November 1998. Six groundwater samples were analyzed for VOCs, TPH-e, SVOCs, PCBs, pesticides, metals, and herbicides. In November 1998, the sample was analyzed for VOCs, TPH-e with a silica gel cleanup (SG), and dissolved metals. This well was abandoned in December 2001 after it was damaged beyond repair (Tetra Tech 2002a).

In addition, groundwater data for monitoring well 14-MW03, which is located within the boundary of Site 10, are included in this RI report. Monitoring well 14-MW03 was installed during the phase IIB RI and was sampled seven times during the groundwater monitoring

program. This well was sampled in February, June, and September of 1996, May and November of 1998, May 2000, and October 2001. The samples collected in 1996 were analyzed for VOCs, TPH-e, TPH-p, SVOCs, and metals. The sample collected in May 1998 was analyzed for VOCs only. The sample collected in November of 1998 was analyzed for VOCs, TPH-e (SG), TPH-p, and dissolved metals. The samples collected in 2000 and 2001 were analyzed for VOCs, TPH-e (SG), TPH-p, SVOCs, and metals.

2.3 ADDITIONAL REMEDIAL INVESTIGATION, FALL 2002

Before October 2002, previous investigations identified soil and groundwater contamination at Sites 09 and 10. At Site 09, petroleum and lead concentrations in soil exceeded human health or ecological screening criteria. At Site 10, pesticide in groundwater and PAH concentrations in soil exceeded human health or ecological screening criteria. In addition, data gaps at each site were identified during a basewide historical data gaps review that required sampling. An additional RI was conducted at Sites 09 and 10 in the fall of 2002. The RI was conducted to (1) determine the horizontal and vertical extent of soil and groundwater contamination at each site and (2) evaluate groundwater flow gradients and water quality impacts to the Bay. Because additional investigations at Sites 09 and 10 conducted in the fall of 2002 have not been previously reported, this RI report presents details of the investigations, including sampling objectives, sample matrix, location of samples, and chemical analyses performed. Tables 2-3 and 2-4 provide the type of analysis performed on each sample collected at Sites 09 and 10. Figures 2-3 and 2-4 show the locations of all samples collected at Sites 09 and 10.

Details related to the RI objectives and sampling conducted for Site 09 and Site 10 are discussed in Section 2.3.1 and 2.3.2, respectively. Analytical results are provided in Section 5.0.

2.3.1 Remedial Investigation Objectives and Sampling - Site 09

The objectives of soil and groundwater sampling at Site 09 during the fall 2002 RI were as follows:

- Collect additional soil and groundwater samples to evaluate the horizontal and vertical extent of contamination previously detected in the former hydraulic lift area.
- Collect additional soil samples to evaluate lead contamination previously detected in soil boring 09SB03.
- Collect soil and groundwater samples adjacent to the paint booth catch basin to evaluate the catch basin as a potential contaminant source.
- Use soil data to estimate the volume of petroleum-contaminated soil that may require excavation and removal.
- Refine estimates of groundwater flow gradients and evaluate potential migration of contaminants to the Bay.

- Use soil and groundwater data to evaluate human health and ecological risks.

The samples described in the following two sections were collected to meet the previous objectives.

Soil Sampling

Twenty-one soil borings (09-SB05 through 09-SB25) were drilled during the fall 2002 RI. Three soil samples were collected from each borehole except for soil boring 09-SB09, where a building footing was encountered preventing sample collection. All samples were analyzed for VOCs, SVOCs, pesticides, PCBs, TPH-e, TPH-p, and metals. An additional three samples were collected from boring 09-SB05 and analyzed for lead only.

Results of soil sampling conducted at Site 09 are presented in Section 5.1.1.

Groundwater Sampling

Six new monitoring wells (09-MW02 through 09-MW07) were installed at Site 09 during the fall 2002 RI. The six new monitoring wells along with the previously installed monitoring well 09-MW01 were sampled during the additional RI. All groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, TPH-e, TPH-p, and metals.

Results of groundwater sampling conducted at Site 09 are presented in Section 5.1.2.

2.3.2 Remedial Investigation Objectives and Sampling - Site 10

The objectives of soil and groundwater sampling at Site 10 during the fall 2002 RI were as follows:

- Collect additional soil samples to evaluate the horizontal and vertical extent of PAH contamination previously detected in soil boring 10SB03.
- Collect additional soil and groundwater samples to evaluate the horizontal and vertical extent of pesticide contamination previously detected in soil and groundwater at soil boring 07/10-HP006.
- Collect soil samples to evaluate the former floor drain inside Building 335.
- Collect soil samples to evaluate the discolored soil area south of Building 335 that was identified in a 1968 aerial photograph. (The Navy and DTSC agreed that this area would be included as part of the Site 10 additional investigation to evaluate whether or not the discoloration was due to soil contamination).

- Use soil data to estimate the volume of contaminated soil that may require excavation and removal.
- Refine estimates of groundwater flow gradients and evaluate potential migration of contaminants to the Bay.
- Use soil and groundwater data to evaluate human health and ecological risks.

The samples described in the following two sections were collected to meet the previous objectives.

Soil Sampling

Twenty-five borings (10-SB05 through 10-SB29) were drilled at Site 10 during the additional RI. Three soil samples were collected from each borehole. Samples from nine of the boreholes centered around previously drilled boring 10-SB03 were analyzed for SVOCs only. Samples from 12 of the boreholes centered around previously drilled boring 07/10-HP006 were analyzed for pesticides only. Samples from two boreholes drilled inside Building 335 and two boreholes drilled on the south side of the building were analyzed for VOCs, SVOCs, pesticides, PCBs, TPH-e, TPH-p, and metals.

Results of soil sampling conducted at Site 10 are presented in Section 5.2.1.

Groundwater Sampling

Groundwater monitoring wells 10-MW02 and 10-MW03 were installed and sampled during the additional RI. Samples from monitoring well 10-MW02 were analyzed for pesticides only. Samples from monitoring well 10-MW03 were analyzed for VOCs, SVOCs, pesticides, PCBs, TPH-e, TPH-p, and metals.

Results of groundwater sampling conducted at Site 10 are presented in Section 5.2.2.

2.4 GENERAL SITE CONCEPTUAL MODELS

Conceptual model block-diagrams for Site 09 and Site 10, identifying known surface and subsurface features and areas of potential contamination at each site, are included as Figure 2-5 and 2-6, respectively. The areas identified on the figures were based on an evaluation of all available data collected prior to the additional investigation completed in 2002. Available data were used to help develop the DQOs for each site.

TABLES

TABLE 2-1: SUMMARY OF PREVIOUS REPORTS OR INVESTIGATIONS

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Report or Investigation	Author or Contractor	Date	Summary of Investigation activities
Final Preliminary Assessment/Site Inspection of Naval Station Treasure Island	Dames and Moore	1988	No samples were collected during the PA/SI.
Draft Final Onshore Remedial Investigation Report	PRC Environmental Management, Inc.	September 1997	This RI presents the geologic, hydrogeologic, and chemical data gathered during the phase I, phase IIA, and phase IIB RI field efforts conducted under the IRP at NAVSTA TI, San Francisco, California, from June 1992 through September 1996. Sites 09 and 10 were included in this report.
EBS Sampling and Analysis Summary Report	Tetra Tech EM Inc.	November 1997	The EBS process is used to assess the environmental concerns associated with closing Navy installations. The original EBS consisted of nonintrusive data-gathering activities including document review, visual inspections, and employee interviews. One groundwater sample was collected at Site 09 and three soil samples collected Site 10 during this EBS, and these data were used in the RI.
Draft Facility-wide Underground Storage Tank Summary Report	Tetra Tech EM Inc.	April 2003	This report summarizes the current status and available information for all USTs at NAVSTA TI. No USTs have been located on Sites 09 or 10. According to this report, three ASTs used to exist at Site 10 and one AST used to exist at Site 09.
Additional Investigation of Onshore Installation Restoration Sites 09 and 10, Fall 2002	Tetra Tech EM Inc.	October 2002	In the summer of 2001, the Navy requested TtEMI to further evaluate Sites 09 and 10. Results of the additional characterization at Sites 09 and 10 are incorporated into the final RI report for NAVSTA TI.

Notes:

AST	Aboveground storage tank
EBS	Environmental Baseline Study
IRP	Installation Restoration Program
NAVSTA TI	Naval Station Treasure Island
PA/SI	Preliminary assessment and site inspection
RI	Remedial investigation
TtEMI	Tetra Tech EM Inc.
UST	Underground storage tank

TABLE 2-2: FIELD ACTIVITY SUMMARY TABLE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Investigation	Site	Field Activity	Number of Samples[a]	Analyses[b]
I	09	Install and sample four soil borings[c]	Three soil samples per boring (12 samples)	VOCs, SVOCs, PCBs, pesticides, and metals
	10	Install and sample four soil borings	Two to three soil samples per boring (12 samples)	VOCs, TPH-e, SVOCs, PCBs, pesticides, metals, and herbicides
IIB	09	Install and sample six hydraulic punch borings	Two to three soil samples per boring (15 samples)	TPH-e, SVOCs, metals (or lead and chromium), and hexavalent chromium
		Install and sample eight hydraulic punch borings	One groundwater sample per boring (8 samples)	TPH-e, SVOCs, metals (or lead), and immunoassay
		Install and sample one monitoring well	One groundwater sample	TPH-e, SVOCs, and metals
		Sample hydraulic lift trench	Two oil samples	PCBs or fuel fingerprint
		Sample floor drain	One water sample	SVOCs and metals
	10	Install eleven hydraulic punch borings	Two to three soil samples per boring (31 samples)	VOCs, TPH-e, TPH-p, SVOCs, PCBs, pesticides, metals, (lead only sometimes), herbicides, and immunoassay
		Sample catch basin	Two sediment samples	VOCs, TPH-e, TPH-p, SVOC, pesticides, lead, and herbicides
		Install seventeen hydraulic punch borings	One groundwater sample per boring	VOCs, TPH-e, SVOCs, PCBs, pesticides, metals, (lead only sometimes), herbicides, and immunoassay
		Install two monitoring wells	One groundwater sample per well (2 samples)	VOC, TPH-e, TPH-p, SVOC, pesticides, metals, and herbicides
		Sample catch basin	One water sample	VOCs, TPH-e, TPH-p, SVOCs, pesticides, lead, and herbicides
EBS	09	Sample one previously installed monitoring well	One groundwater sample	BTEX and TPH-p
	10	Install and sample three soil borings	Three soil samples	BTEX, TPH-e, TPH-p, SVOC, pesticides, and metals

TABLE 2-3: SAMPLES COLLECTED AND LABORATORY ANALYSES PERFORMED AT SITE 09

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample No.	Matrix	Sample Date	Sampling Location	Sample Type	Depth	VOC	TPH-e	TPH-e (SG)	TPH-p	SVOC	PCB	PEST	METL	DMETL	CR	TCLP METL	IM-PAH	IM-PCB	IM-TPH	TDS
199HH511	PRODUCT	08/15/95	TRENCH OIL	ORIG	0.00 - 0.00						✓									
199HH001	SOIL	08/03/95	09-HP001	ORIG	1.25 - 1.75		✓			✓		✓+P	✓Pb		✓		✓	✓	✓	
199HH005	SOIL	08/03/95	09-HP001	ORIG	5.50 - 6.00												✓	✓	✓	
199HH002	SOIL	08/03/95	09-HP002	ORIG	1.00 - 1.50												✓	✓	✓	
199HH003	SOIL	08/03/95	09-HP002	ORIG	5.50 - 6.00												✓	✓	✓	
199HH004	SOIL	08/03/95	09-HP002	ORIG	6.50 - 7.00		✓			✓		✓+P	✓Pb		✓					
199HH006	SOIL	08/03/95	09-HP003	ORIG	1.00 - 1.50							✓+P	✓Pb				✓	✓	✓	
199HH007	SOIL	08/03/95	09-HP003	ORIG	3.25 - 3.75								✓Pb							
199HH008	SOIL	08/03/95	09-HP003	ORIG	5.50 - 6.00								✓Pb		✓					
199HH009	SOIL	08/03/95	09-HP004	ORIG	0.75 - 1.25								✓Pb							
199HH010	SOIL	08/03/95	09-HP004	ORIG	3.25 - 3.75								✓Pb							
199HH011	SOIL	08/03/95	09-HP004	ORIG	5.50 - 6.00								✓Pb							
199HH012	SOIL	08/03/95	09-HP005	ORIG	0.75 - 1.25								✓Pb							
199HH013	SOIL	08/03/95	09-HP005	ORIG	3.25 - 3.75								✓Pb							
199HH014	SOIL	08/03/95	09-HP005	ORIG	5.50 - 6.00								✓Pb							
199HH015	SOIL	08/08/95	09-HP006	ORIG	0.50 - 1.00								✓Pb			✓Pb				
09SB01A	SOIL	07/16/92	09-SB01	ORIG	0.50 - 1.00	✓				✓		✓+P	✓							
09SB01B	SOIL	07/16/92	09-SB01	ORIG	2.00 - 2.50	✓				✓		✓+P	✓							
09SB01C	SOIL	07/16/92	09-SB01	ORIG	4.50 - 5.00	✓				✓		✓+P	✓							
09SB02A	SOIL	07/16/92	09-SB02	ORIG	0.80 - 1.30	✓				✓		✓+P	✓							
09SB02B	SOIL	07/16/92	09-SB02	ORIG	2.50 - 3.00	✓						✓+P	✓							
09SB02C	SOIL	07/16/92	09-SB02	ORIG	4.50 - 5.00	✓						✓+P	✓							
09SB02BA	SOIL	12/15/92	09-SB02	ORIG	2.50 - 3.00					✓										
09SB02CA	SOIL	12/15/92	09-SB02	ORIG	4.50 - 5.00					✓										
09SB03A	SOIL	07/16/92	09-SB03	ORIG	1.00 - 1.50	✓						✓+P	✓							

TABLE 2-4: SAMPLES COLLECTED AND LABORATORY ANALYSES PERFORMED AT SITE 10

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample No.	Matrix	Sample Date	Sampling Location	Sample Type	Depth	VOC	TPH-e	TPH-e (SG)	TPH-p	SVOC	PCB	PEST	METL	DMETL	CR	HERB	ANION	MEE	SUL-FIDE	IM-PAH	IM-TPH	TDS
199AA566	SEDIMENT	07/05/95	CATCH BASIN	ORIG	0.00 - 0.00	✓	✓		✓	✓		✓+P	✓Pb			✓						
199AA567	SEDIMENT	07/05/95	CATCH BASIN	ORIG	0.00 - 0.00	✓	✓		✓	✓		✓+P	✓Pb			✓						
199AA082	SOIL	06/09/95	07/10-HP001	ORIG	1.25 - 1.75	✓						✓+P	✓Pb			✓				✓	✓	
199AA083	SOIL	06/09/95	07/10-HP001	ORIG	7.00 - 7.50	✓						✓+P	✓Pb			✓				✓	✓	
199AA084	SOIL	06/09/95	07/10-HP002	ORIG	1.25 - 1.50	✓						✓+P	✓Pb			✓				✓	✓	
199AA085	SOIL	06/09/95	07/10-HP002	ORIG	7.25 - 7.75	✓	✓			✓		✓+P	✓Pb			✓						
199AA089	SOIL	06/13/95	07/10-HP004	ORIG	1.30 - 2.00	✓						✓+P	✓Pb			✓				✓	✓	
199AA090	SOIL	06/13/95	07/10-HP004	ORIG	3.30 - 4.00	✓						✓+P	✓Pb			✓				✓	✓	
199AA091	SOIL	06/13/95	07/10-HP004	ORIG	6.30 - 7.00	✓	✓			✓		✓+P	✓Pb			✓				✓	✓	
199AA095	SOIL	06/13/95	07/10-HP006	ORIG	1.00 - 2.00	✓						✓+P	✓Pb			✓				✓	✓	
199AA096	SOIL	06/13/95	07/10-HP006	ORIG	3.00 - 4.00	✓						✓+P	✓Pb			✓				✓		
199AA097	SOIL	06/13/95	07/10-HP006	ORIG	6.00 - 7.00	✓						✓+P	✓Pb			✓				✓	✓	
199AA098	SOIL	06/13/95	07/10-HP007	ORIG	1.30 - 2.00	✓	✓			✓			✓							✓	✓	
199AA099	SOIL	06/13/95	07/10-HP007	ORIG	3.30 - 4.00															✓	✓	
199AA100	SOIL	06/13/95	07/10-HP007	ORIG	6.30 - 7.00															✓	✓	
199AA101	SOIL	06/14/95	07/10-HP008	ORIG	1.00 - 1.50															✓	✓	
199AA102	SOIL	06/14/95	07/10-HP008	ORIG	4.50 - 5.00															✓	✓	
199AA103	SOIL	06/14/95	07/10-HP008	ORIG	7.25 - 7.75	✓	✓			✓			✓							✓	✓	
199AA104	SOIL	06/14/95	07/10-HP009	ORIG	1.00 - 1.50															✓	✓	
199AA105	SOIL	06/14/95	07/10-HP009	ORIG	3.75 - 4.00															✓	✓	
199AA106	SOIL	06/14/95	07/10-HP009	ORIG	7.00 - 7.50															✓	✓	
199AA107	SOIL	06/14/95	07/10-HP010	ORIG	1.00 - 1.50	✓	✓			✓			✓							✓	✓	
199AA108	SOIL	06/14/95	07/10-HP010	ORIG	3.75 - 4.00															✓	✓	
199AA109	SOIL	06/14/95	07/10-HP010	ORIG	7.00 - 7.50															✓	✓	
199AA110	SOIL	06/14/95	07/10-HP011	ORIG	1.25 - 1.75	✓	✓			✓			✓							✓	✓	

TABLE 2-5: AMBIENT METAL CONCENTRATIONS IN DREDGE FILL

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

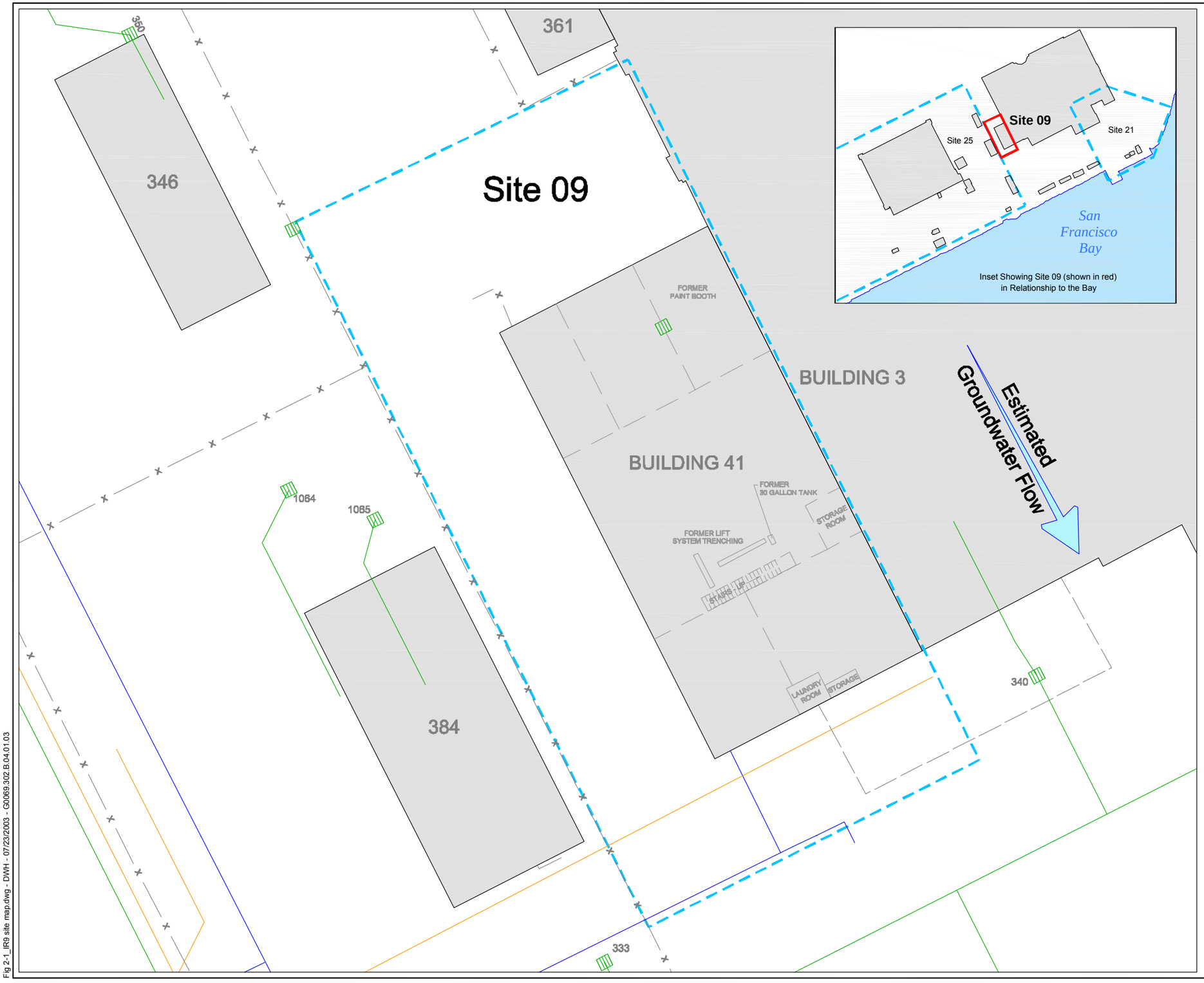
Metal	Number of detections/ Samples Analyzed	Values Excluded		Ambient Data Set Size[a]	Ambient Data Set Distribution	Soil Metal Concentration Statistics for Ambient Data Sets (mg/kg)						U.S. EPA PRG[f] (mg/kg)
		Too Low	Too high			Minimum Detected[b]	Maximum Detected[c]	Mean/50th Percentile[d]	Standard Deviation	Coefficient of Variance	95th percentile[e] (Ambient Level)	
Aluminum	241/241	0	0	241	Unknown	1190.0	18,600.0	4,230.18	N/A	N/A	**9,900**	77,000
Antimony	53/237	0	5	232	Unknown	0.45	18.2	0.27	N/A	N/A	**2.9**	31
Arsenic	207/241	5	5	231	Unknown	1.1	14.0	5.60	N/A	N/A	**10**[*]	0.38
Barium	238/241	0	0	241	Unknown	3.6	1,090.0	17.71	N/A	N/A	**260**	5,300
Beryllium	12/241	0	0	241	Unknown	0.02	0.77	0.01	N/A	N/A	**0.12**	0.14
Cadmium	24/241	0	0	241	Unknown	0.07	9.2	0.02	N/A	N/A	**1.4**	9.0[g]/38
Chromium	247/247	2	2	243	Unknown	10.7	191.0	29.31	N/A	N/A	**75**	210[h]
Cobalt	241/241	2	2	237	Unknown	4.0	26.7	6.80	N/A	N/A	**16**	4,600
Copper	214/241	1	1	239	Unknown	1.9	1,260.0	5.60	N/A	N/A	**85**	2,800
Lead	221/234	0	7	227	Unknown	1.2	51.4	3.90	N/A	N/A	**21**[i]	130[g]/400
Manganese	241/241	1	1	239	Lognormal	58.9	1,070.0	246.66	153.13	0.11	**550**	3,200
Mercury	51/246	1	1	244	Unknown	0.03	2.4	0.03	N/A	N/A	**0.51**	23[j]
Molybdenum	27/241	0	0	241	Unknown	0.21	37.4	0.10	N/A	N/A	**2.0**	380
Nickel	241/241	6	6	229	Unknown	18.0	275.0	29.61	N/A	N/A	**133**	150[g]/1,500
Selenium	5/241	0	0	241	Unknown	0.85	1.2	0.37	N/A	N/A	**0.5**[k]	380
Silver	20/241	0	7	234	Unknown	0.28	2.4	0.07	N/A	N/A	**0.45**	380
Thallium	24/241	0	1	240	Unknown	0.44	1.1	0.22	N/A	N/A	**0.71**	5.4[l]
Vanadium	241/241	4	4	233	Lognormal	11.4	47.3	22.01	5.97	0.08	**33**	540
Zinc	209/241	0	19	222	Unknown	11.2	147.0	23.81	N/A	N/A	**94**	23,000

TABLE 2-6: AMBIENT METAL CONCENTRATIONS IN GROUNDWATER

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Metal	Number of Samples		Outlier Vaues Excluded	Detection Frequency %	Size of Ambient Data Set[a]	Distribution of Ambient Data Set	Summary Statistics for Ambient Data Set (µg/L)					Screening Level[d] (µg/L)
	Detected	Analyzed					Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration[b]	95th percentile[c] (Ambient Level)	
Aluminum	4	112	0	4	112	Lognormal	12.4	304	31.3	300	**27**	N/A
Antimony	0	112	0	0	112	NE	1.7	60	N/A	N/A	**1.7 (DL[e])**	4,300[1]
Arsenic	77	112	0	69	112	Normal	2.5	13.9	2.5	18.5	**15**	0.14[1]
Barium	74	112	0	66	112	Normal	4.1	12.8	2	160	**120**	N/A
Beryllium	5	112	0	4	112	Normal	0.1	2	0.11	0.55	**0.04 (DL[e])**	N/A
Cadmium	3	112	0	3	112	Normal	0.3	5	0.69	1.4	**0.27 (DL[e])**	9.3[1]
Calcium	112	112	0	100	112	Lognormal	N/A	N/A	11,800	162,000	**120,000**	N/A
Chromium	5	112	0	4	112	Normal	0.7	10	1.1	5.4	**0.13 (DL[e])**	50[1]
Cobalt	7	112	0	6	112	Normal	0.54	20	1	4	**1.4**	N/A
Copper	22	112	1	19	111	Lognormal	1.1	10	1.5	32.7	**6.6**	3.1[1]
Iron	23	112	0	21	112	Lognormal	12.5	186	32.6	510	**200**	N/A
Lead	3	112	0	3	112	Normal	0.6	3	3	5	**2.0**	5.6[2]
Magnesium	112	112	11	100	101	Lognormal	N/A	N/A	5,240	55,500	**43,000**	N/A
Manganese	104	112	0	93	112	Lognormal	1.5	21.7	2.3	1,450	**900**	100[1]
Mercury	2	112	1	2	112	NE	0.1	0.2	0.1	0.13	**0.1 (DL[e])**	0.025[2]
Molybdenum	54	112	2	48	110	Normal	0.9	20	1.2	8.7	**6.5**	N/A
Nickel	21	112	0	19	112	Normal	1	20	1	10.6	**5.8**	8.2[1]
Potassium	112	112	10	100	102	Normal	N/A	N/A	2,700	45,200	**37,000**	N/A
Selenium	3	111	0	3	111	Normal	1.7	5	2.9	5.3	**1.8 (DL[e])**	71[1]
Silver	6	104	0	6	104	Normal	0.6	5.0	2.0	4.0	**2.2**	0.38[3]
Sodium	112	112	13	100	99	Nonparam.	N/A	N/A	7,000	361,000	**240,000**	N/A
Thallium	4	112	0	4	112	Normal	1.1	7.9	3.8	6.2	**3.4**	6.3[1]
Vanadium	23	112	0	20	112	Normal	0.7	10	0.77	7.2	**4.2**	N/A
Zinc	18	112	3	16	112	Normal	0.6	20	1.4	8.4	**4.4**	81[1]

FIGURES



AREA OF INTEREST

LEGEND

- FRESHWATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- STORM DRAIN CATCH BASIN
- FENCE
- 384 BUILDING
- SITE BOUNDARY

N

10 0 10 20

SCALE IN FEET

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 2-1
Site 09 - Foundry
Detailed Site Map

Fig 2-1_IR9 site map.dwg - DWH - 07/23/2003 - G0069.302.B.04.01.03

San Francisco Bay

Site 10

445

BUILDING 335

SHED

OVERHANG

FORMER FLOOR DRAIN

335R

2640

2641

2670

GATE

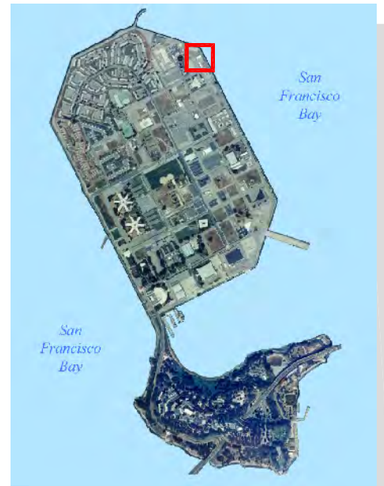
Site 07

62

Site 14

Estimated Groundwater Flow

AREA OF INTEREST



LEGEND

- FRESHWATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- STORM DRAIN CATCH BASIN
- x FENCE
- 445 BUILDING
- SITE BOUNDARY

N

15 0 15 30

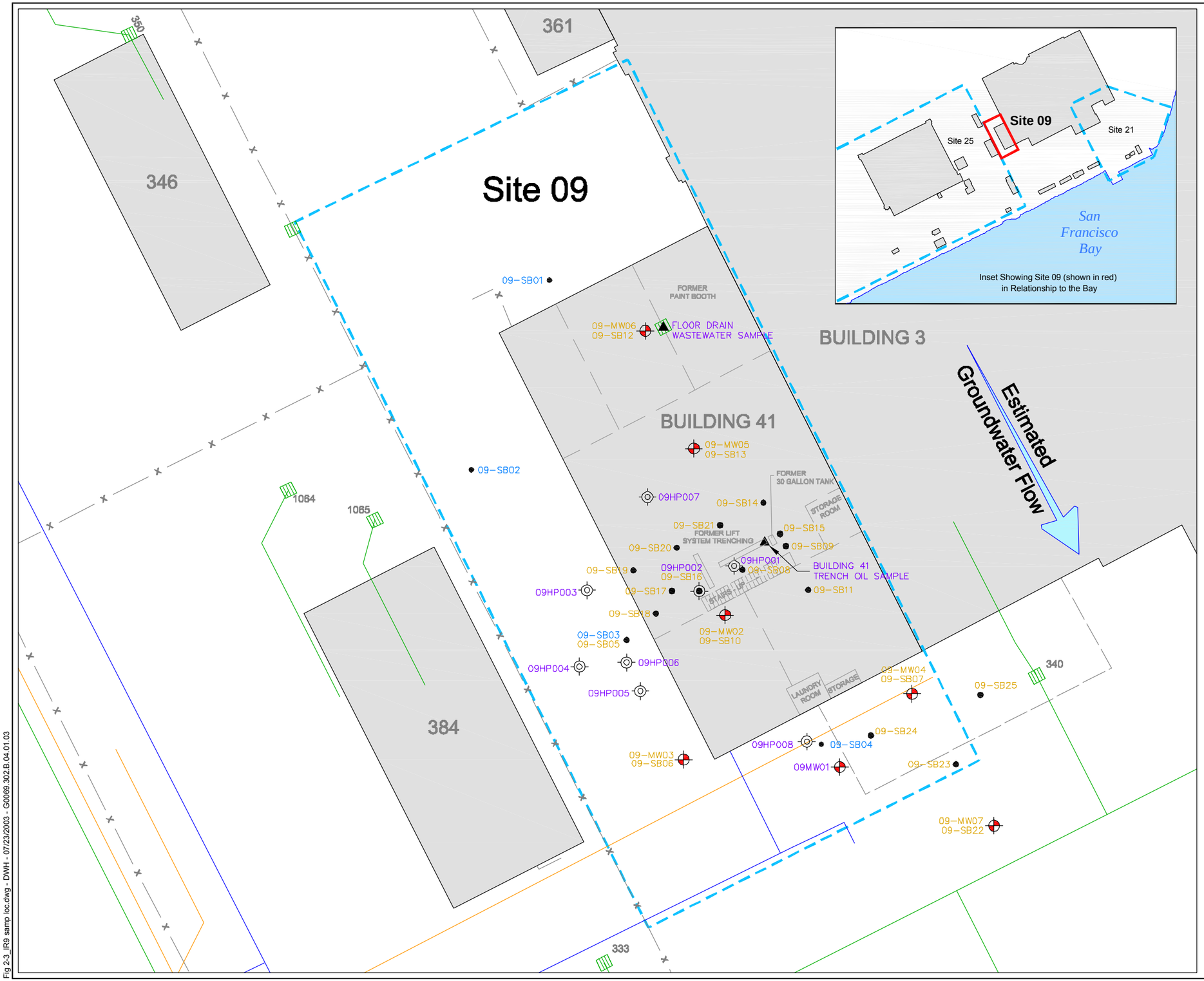
SCALE IN FEET

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 2-2
Site 10 - Bus Painting Shop
Detailed Site Map

Fig 2-2_IR10 site map.dwg - DWH - 07/24/2003 - G0069.302.B.04.01.03



AREA OF INTEREST

LEGEND

- MONITORING WELL LOCATION
- GEOPROBE SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- GRAB SAMPLE
- FRESHWATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- 1066 STORM DRAIN CATCH BASIN AND I.D. NUMBER
- FENCE
- 384 BUILDING
- SITE BOUNDARY
- 09-SB01 PHASE I REMEDIAL INVESTIGATION - 1992
- 09-HP01 PHASE IIB REMEDIAL INVESTIGATION - 1995
- 09-SB05 ADDITIONAL INVESTIGATION - 2002

N

10 0 10 20

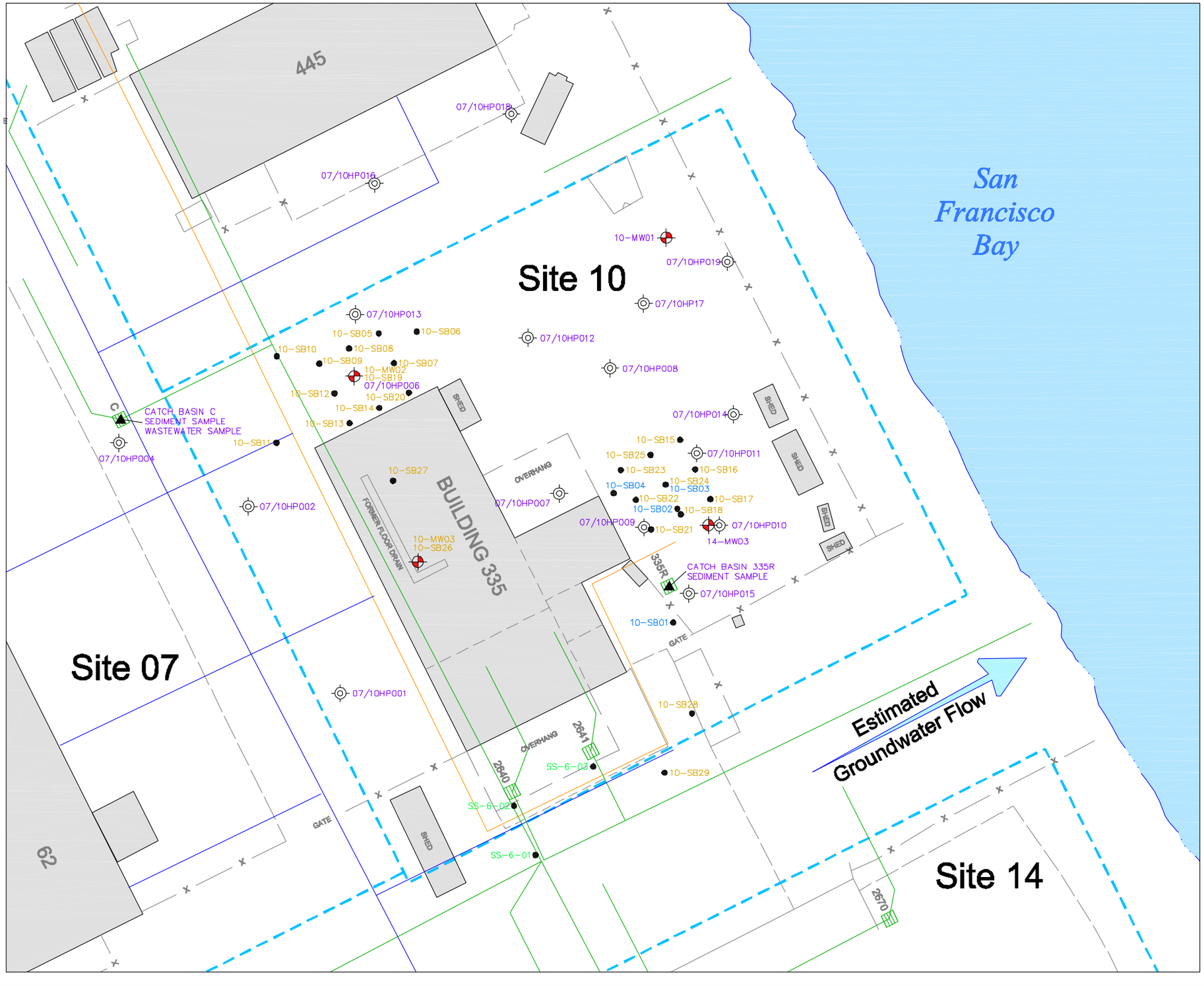
SCALE IN FEET

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 2-3
Site 09 - Foundry
Sample Location History

Fig 2-3_IR9 samp loc.dwg - DWH - 07/23/2003 - G0069.302.B.04.01.03



AREA OF INTEREST

LEGEND

- MONITORING WELL LOCATION
- GEOPROBE SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- GRAB SAMPLE
- FRESHWATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- 2641 — STORM DRAIN CATCH BASIN AND I.D. NUMBER
- FENCE
- 384 — BUILDING
- SITE BOUNDARY
- 10-SB01 — PHASE I REMEDIAL INVESTIGATION - 1992
- 07/10HP001 — PHASE IIB REMEDIAL INVESTIGATION - 1995
- SS-6-01 — ENVIRONMENTAL BASELINE SURVEY - 1997
- 10-SB05 — ADDITIONAL INVESTIGATION - 2002

N

15 0 15 30

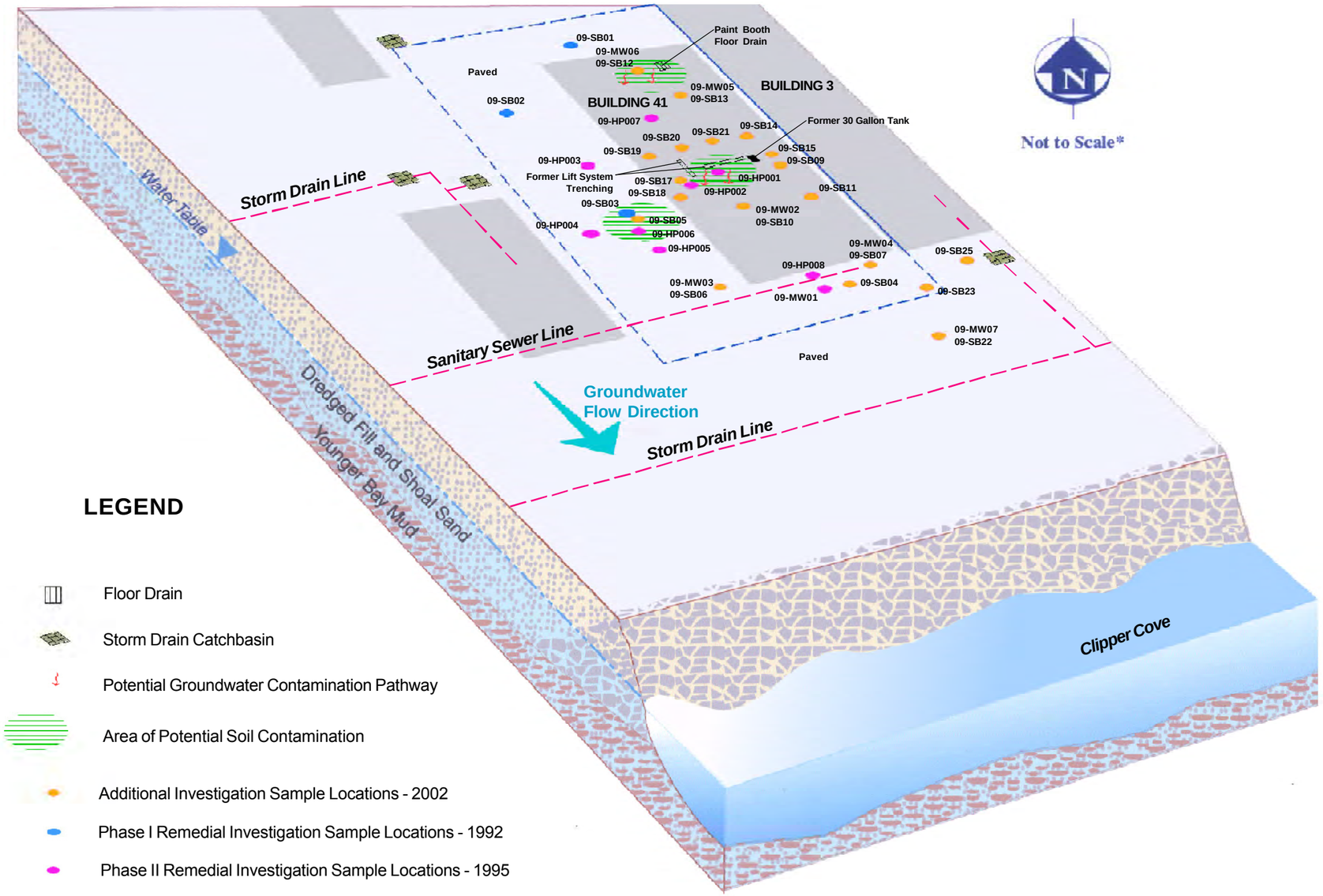
SCALE IN FEET

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 2-4
Site 10 - Bus Painting Shop
Sample Location History

Fig 2-4_IR10 samp loc.dwg - DWH - 07/24/2003 - G0069.302.B.04.01.03



Site 09 - Looking Southeast at Building 41

Site 09 - Looking North at Building 41

LEGEND

- Floor Drain
- Storm Drain Catchbasin
- Potential Groundwater Contamination Pathway
- Area of Potential Soil Contamination
- Additional Investigation Sample Locations - 2002
- Phase I Remedial Investigation Sample Locations - 1992
- Phase II Remedial Investigation Sample Locations - 1995
- IR Site Boundary

SB = Soil Boring
MW = Monitoring Well
HP = Hydropunch

NOT TO SCALE
NOTE: Schematic Horizontally and Vertically Exaggerated

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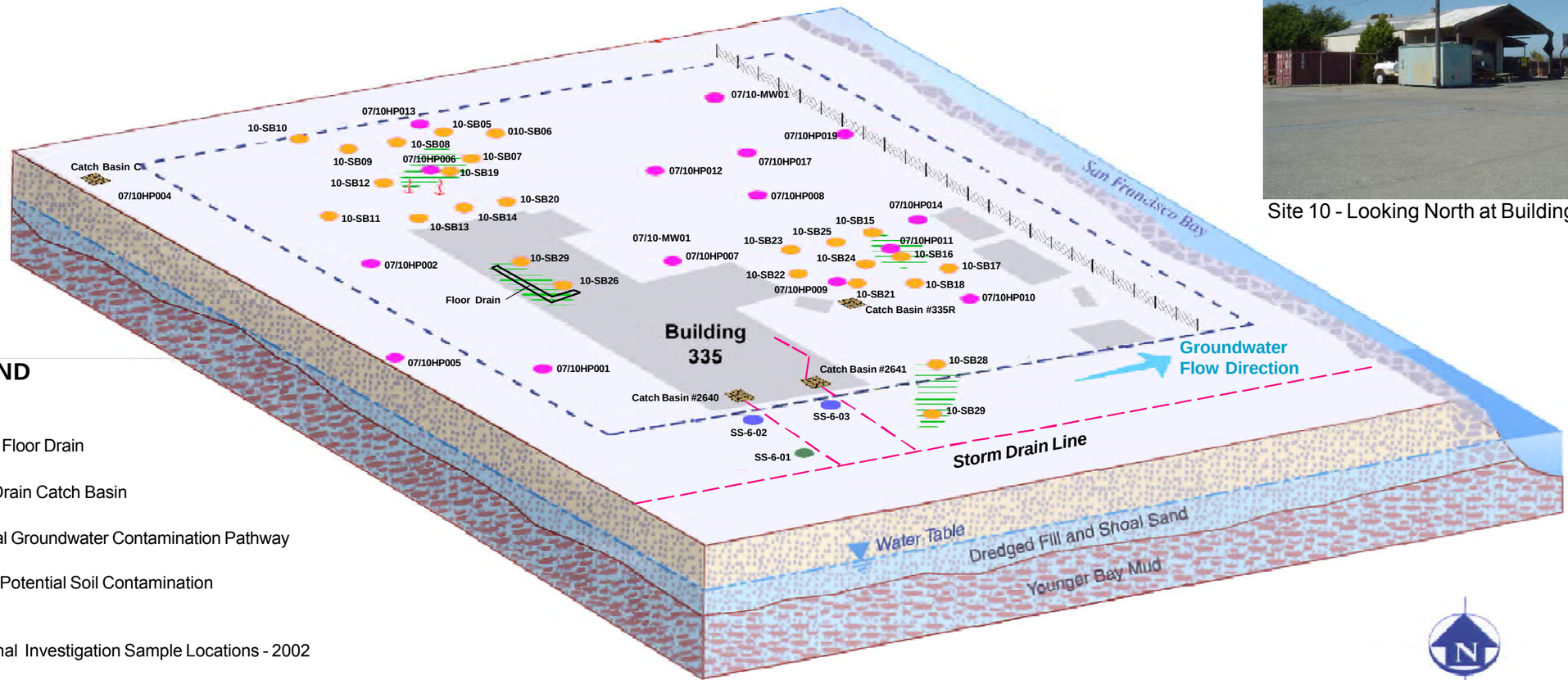
NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 2-5
Site 09 - Foundry
Conceptual Model Block Diagram



Site 10 - Looking North at Building 335

LEGEND

- Former Floor Drain
- Storm Drain Catch Basin
- Potential Groundwater Contamination Pathway
- Area of Potential Soil Contamination
- Additional Investigation Sample Locations - 2002
- Phase I Remedial Investigation Sample Locations - 1992
- Phase II Remedial Investigation Sample Locations - 1995
- IR Site Boundary

SB = Soil Boring
MW = Monitoring Well
HP = Hydropunch

Site 10 - Looking Southeast at Building 335

N

NOT TO SCALE
NOTE: Schematic Horizontally and Vertically Exaggerated

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 2-6
Site 10 - Bus Painting Shop
Conceptual Model Block Diagram

3.0 INVESTIGATION PROCEDURES AND FIELD METHODS

Because procedures and field methods for phase I and phase II RI activities were previously presented in the draft final onshore RI report (PRC 1997b), the following sections only describe the additional RI field activities.

To address data gaps at Sites 09 and 10, additional field activities were conducted at these sites during the fall of 2002. Field activities included the drilling of soil borings, soil sampling, the installation of groundwater monitoring wells, and groundwater sampling, as outlined in the final SAP for additional RI of onshore Sites 09 and 10 (Tetra Tech 2002e). Tables 2-3 and 2-4 summarize the samples collected and analyses performed on each sample at Sites 09 and 10 during the additional investigation in 2002. In addition, Figures 2-3 and 2-4 identify sampling locations from the additional RI. Appendix A contains borehole logs and well construction details, and Appendix B contains well development data.

3.1 UTILITIES SURVEY AND CLEARANCE

Before field activities began, an underground utility survey and clearance was conducted at Sites 09 and 10 to clear all soil boring and monitoring well locations before any intrusive activities began. The utility clearance located various underground utilities, including water distribution piping, telecommunications lines, storm sewer lines, sanitary sewer lines, fire water lines, and electrical lines. The utility survey was conducted by a local, private utility locating company and utility company representatives.

3.2 SOIL SAMPLING

Soil borings were installed using a truck-mounted direct-push rig to the depth of the water table (approximately 8 feet bgs). At soil boring locations where monitoring wells were installed, soil borings were extended to 15 feet bgs.

Soil samples were collected using the methods described in the SAP (Tetra Tech 2002e). To collect the soil samples, the direct-push rig used a hydraulic hammer probe to drive a 1.5-inch-diameter open tube core barrel sampler. To obtain a continuous lithologic sample, the barrel sampler was fitted with a clear polymer liner. A new liner was installed into the sampler before each drive. During open tube sampling, the lined sampler was fitted with a drive shoe and driven to the desired depth. The barrel sampler was then retracted, the sample liner removed from the sample barrel, and the soil sample was visually logged. To collect representative samples at depth, a closed piston sampler was used. Using this method, the sample barrel was equipped with a piston and a drive point that locked into the cutting shoe, allowing the sealed barrel sampler to pass through the previously sampled interval and any sloughed material and opened at the desired depth. The sample barrel was then driven to the starting depth of the drive with the piston assembly locked. The piston assembly was then released from the cutting shoe, allowing it to move to the top of the sampler as the liner filled during the drive.

To minimize exposure of the soil samples to the atmosphere, the soil samples were collected in accordance with SW-846, EPA method 5035, for the collection of representative and precise data for VOCs in soils (EPA 1996b). Soil samples were collected using an EnCore® soil sampler (EPA 1999). The soil sample was collected by using a coring body and push plunger assembly with a T-handle. The coring body was readied for use by placing it into the open end of the T-handle and twisting it clockwise until locked. The T-handle was pushed and twisted into the soil until the coring body was completely full. The core body was removed, the excess soil wiped from the exterior, and then capped while still on the T-handle. Three core body samples were collected from each sample depth interval in each borehole. The three collocated samples were placed into one zip lock bag and immediately placed in a chilled cooler for temporary on-site storage and shipment. Samples were shipped to the laboratory within the recommended holding time between sampling and preservation by the laboratory of 48 hours.

Three soil samples were collected from each borehole above the water table and sent for laboratory analysis. Soil samples at Site 09 were collected from 0.5 to 2.0 feet bgs, 2.5 to 5.0 feet bgs, and 5.0 to 7.5 feet bgs in each borehole. In total, 21 boreholes were drilled at Site 09, and six of those were converted to monitoring wells. Soil samples at Site 10 were collected from 0.5 to 2.0 feet bgs, 3.5 to 5.0 feet bgs, and 6.0 to 7.0 feet bgs in each borehole. In total, 25 borings were drilled at Site 10, and two of those were converted to monitoring wells. Sampling did not start at the surface because of the existence of surface gravel, wood chips, or pavement at Sites 09 and 10. All soil samples were sent to a Navy CLEAN II contract laboratory for analysis. After borehole soil sampling was completed, boreholes that were not converted to monitoring wells were grouted using hydrated granular bentonite.

A photoionization detector was used to detect organic vapors in the soil by placing a portion of the soil sample in a plastic bag, inserting the intake tube of the instrument in the bag, sealing the bag allowing for an approximately equal volume of headspace, and taking an instrument reading of the headspace after a period of at least 15 minutes.

3.3 MONITORING WELL INSTALLATIONS

Six soil borings from Site 09 and two soil borings from Site 10 were converted to small-diameter monitoring wells to evaluate the nature and extent of groundwater contamination at each site.

Monitoring wells were installed using methods described in the SAP (Tetra Tech 2002e). The monitoring wells were installed using a truck-mounted, direct-push rig that uses a hydraulic hammer probe. The dual-tube system was used for monitoring well installation, which allowed for continuous core sample collection while providing a sealed borehole at a diameter sufficient for casing installation. A 2.1-inch-outside-diameter probe rod equipped with a cutting shoe was driven as the outer casing.

The 1-inch-diameter monitoring well casing was installed within the 2.1-inch outer drive pipe. Monitoring well casing consisted of schedule 40 polyvinyl chloride with a screen slot size of 0.020-inch. Prepacked filter packs were used. Shallow monitoring wells were screened from approximately 5 to 15 feet bgs (based on groundwater levels). The top of the screened section in

each well extended above the observed water level in the borehole. Grouting material consisted of granular bentonite grout and was placed above the sand filter pack and screened portion after the 2.1-inch outer drive pipe was pulled back. All monitoring wells were completed with flush-mount monitoring well boxes inserted into a concrete surface seal.

3.4 MONITORING WELL DEVELOPMENT AND SAMPLING

The new monitoring wells were developed following the procedures outlined in the SAP (Tetra Tech 2002e). The monitoring wells were developed to remove sediment from the monitoring well casing and to remove finer-grained material from the monitoring well screen and filter pack. Developing the monitoring wells allowed groundwater to flow efficiently from the formation, through the screen, and into the monitoring well. The monitoring wells were developed no sooner than 24 hours after they were completed to allow the grout in the annular spacing to hydrolyze completely and the surface seal cement to harden. Water levels were measured before development began. The newly installed monitoring wells were developed using a surging device, bailer, and peristaltic pump. When the turbidity of the water had visibly decreased, a submersible or peristaltic pump was used for the remaining development until the groundwater was sufficiently clear for sampling.

The water level, flow rate, and the quantity and clarity of the water withdrawn were monitored visually during this process; observations were recorded on water quality sheets during monitoring well development and while purging for sampling. During purging, field parameters were measured using a closed flow-through cell system. Field parameters measured included temperature, pH, conductivity, dissolved oxygen, and turbidity. Parameters were considered stabilized when three or more sequential measurements are within plus or minus 0.2 °C for temperature, plus or minus 3 percent for conductivity, and plus or minus 0.1 unit for pH (EPA 1996). Purging continued until temperature, conductivity, pH, and water clarity had stabilized. A groundwater sample was then collected.

The low-flow groundwater sampling method using a peristaltic pump was used to collect groundwater samples from all small-diameter monitoring wells. The low-flow method was implemented to collect data that were representative of field conditions while minimizing sample contamination. The discharge tube was placed in the approximate center of the well screen interval or in the approximate center of the water column if the screen extended above the water level. The monitoring wells were purged at a pump rate between 0.5 liter per minute (0.13 gallon per minute) and 1.0 liter per minute (0.25 gallon per minute). Purging continued until measured water quality parameters were stable or three well casing volumes had been purged.

3.5 MONITORING WELL SURVEY

The locations of all new monitoring wells were surveyed to an accuracy of plus or minus 0.1 foot horizontally and plus or minus 0.01 foot vertically. Horizontal coordinates are reported in accordance with the California State Planar Coordinate System. Vertical coordinates were reported as feet above Treasure Island mean lowest low water (MLLW) level.

3.6 DECONTAMINATION

Drilling equipment, including drill rods and bits as well as the back end of the drill rig, were steam cleaned before work began and between boring locations and sampling. Decontamination of the drilling equipment followed general practices listed in the SAP (Tetra Tech 2002e). A portable steam cleaner and an on-site source of potable water were used for decontamination, and all water derived from decontamination was collected and temporarily stored on site. Disposable trowels, dedicated bailers, and tubing for peristaltic pumps were used to collect samples. Because the soil sampling core barrel was the only piece of sampling equipment to be reused, equipment rinsate samples were collected from the core barrel after it has been steam cleaned. One rinsate sample was collected for each day soil sampling was performed.

3.7 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

IDW generated during this RI includes soil cuttings from soil borings and monitoring well installations and wastewater from decontamination and purging procedures. Soil cuttings and wastewater were containerized in drums and then transported to the NAVSTA TI IDW storage facility for temporary storage before disposal.

One composite IDW soil sample was collected and analyzed for VOCs, SVOCs, pesticides, PCBs, TPH-e, TPH-p, and metals for characterization before disposal. Approximately one drum of soil cuttings was generated during the drilling.

One composite IDW water sample was collected and analyzed for VOCs, SVOCs, pesticides, PCBs, TPH-e, TPH-p, and metals for characterization before disposal. Approximately 500 gallons of purge and decontamination water was generated during drilling, well installation, and sampling activities.

Although soil and wastewater IDW analyses did not report any elevated levels of contamination, the drummed IDW was disposed of at Kettleman Hills Facility, located in Kettleman City, California. The drummed IDW was picked up and disposed of on March 13, 2003. The Baker tank containing the approximately 500 gallons of purge and decontamination water was discharged on site at a nearby publicly owned treatment works. This was disposed of in late March.

3.8 DEVIATIONS

The following deviations occurred during the additional field activities for Sites 09 and 10:

- Because of the observation of petroleum contamination in soil samples collected from soil boring 09-SB07 at Site 09, four additional borings and one additional small-diameter monitoring well were installed downgradient of 09-SB07 (09-SB22, 09-SB23, 09-SB24, 09-SB25 and 09-MW07). See Figure 2-3. The additional borings and well were not part of the original SAP for the additional RI.

- At boring 09-SB05, the SAP indicated that three near surface soil samples would be collected and analyzed for lead only. After observing dark, possibly stained soil in the near surface soil it was decided to collect additional samples for VOCs, SVOCs, TPH-e, TPH-p, pesticides, PCBs and metals. In total, 6 soil samples were collected from boring 09-SB05.

- While drilling soil boring 09-SB09, coarse construction gravel was encountered from below the surface pavement to approximately 3 feet bgs and no sample was recovered. Below 3 feet bgs, a cement footing was encountered, and the boring could not be advanced any further. The boring location was moved, but the same conditions were encountered. The fact that 09-SB09 was located in a corner limited attempts to relocate it further. As such, no soil samples were collected from proposed soil boring 09-SB09.

- At Site 10, the location of monitoring well 10-MW02 was changed from the proposed location in the SAP because of the location of underground utilities.

4.0 PHYSICAL CHARACTERISTICS AND ENVIRONMENTAL SETTING

The physical characteristics and environmental settings presented in this section are based on historical data for the Bay area and site-specific information collected during the RI completed at NAVSTA TI.

4.1 CLIMATE

The description of climate includes an evaluation of winds, temperature, precipitation, and humidity at NAVSTA TI.

4.1.1 Winds

The prevailing wind direction for the Bay Area is from the northwest. Wind speed is less than 6 miles per hour for more than 50 percent of the time and exceeds 12 miles per hour for only approximately 10 percent of the time. The strongest winds are associated with winter storms. In the winter, winds from the north and east sometimes bring low temperatures to the Bay Area. Westerly winds predominate during the summer when cool, marine air flows east toward the warm Central Valley region of California. These winds are strongest in the late afternoon and early evening (Navy 1987).

4.1.2 Temperature

The climate at NAVSTA TI is dominated by the Pacific Ocean, producing a maritime climate characterized by little temperature variation. The average annual temperature is 56 to 58 degrees Fahrenheit, with an annual frost-free period ranging from 300 to 330 days (Navy 1987).

4.1.3 Precipitation

The average annual precipitation is approximately 25 to 30 inches. Approximately 90 percent of the annual precipitation occurs from November to April. Localized showers are infrequent, and storms are moderate in duration and intensity. Mean annual evaporation is 48 inches. The greatest evaporation occurs during July (Navy 1987).

4.1.4 Humidity

Relative humidity during the winter is approximately 50 to 60 percent during the day, increasing to approximately 80 to 90 percent at night. Humidity decreases in spring; however, by summer, it increases, particularly at night or in the morning when frequent fogs occur. Humidity is lowest in the fall, ranging from approximately 50 percent during the day to 70 percent at night (Navy 1987).

4.2 LOCAL GEOLOGY

The following section describes the local geology and is divided into two sections. Section 4.2.1 describes the general geology of the Bay Area and Section 4.2.2 describes the local geology of NAVSTA TI.

4.2.1 San Francisco Bay Area Geology

The Bay Area, which is along the contact between the North American and Pacific crustal plates, is a tectonically active region. This seismic regime is characterized by southeast to northwest trending faults exhibiting primarily right lateral strike-slip movement. The major active faults in the vicinity of the site are all part of the San Andreas fault system. These faults include the Hayward fault, approximately 3 miles to the east; the San Andreas fault, approximately 9 miles to the west; the San Gregorio-Seal Cove fault, approximately 25 miles to the west; and the Calaveras fault, approximately 50 miles to the southeast (Dames and Moore 1988). A general geologic map of the greater Bay Area that shows the location of these faults, with the exception of the San Gregorio-Seal Cove Fault, is provided in Figure 4-1.

Basement rocks in the Bay Area consist primarily of the fractured and sheared rocks of the Late Jurassic to Early Cretaceous Franciscan Assemblage. The Bay is a drowned river valley developed within a southeast to northwest trending structural trough in the Franciscan Assemblage bedrock. Material eroded from the Berkeley/Oakland hills forms the broad, gently sloping coastal plain that borders the eastern shoreline of the Bay. Extensive areas of fill material are found at locations along the western shoreline of the Bay, primarily along the San Francisco waterfront and in San Mateo County. This fill material generally consists of variable amounts of soil, gravel, broken concrete and asphalt, rock, bay muds, alluvial and estuarine sediments, and other solid material. Soil characteristics are highly variable because of the different kinds and amounts of fill material in the profile (Dames and Moore 1988).

4.2.2 Treasure Island Geology

Treasure Island is a relatively flat, manmade island, approximately 403 acres, consisting primarily of sand dredged from the Bay and retained by a perimeter of rock and sand dikes. Dredging and construction of Treasure Island, directed by the U.S. Army Corps of Engineers (USACE), began in 1936 and was completed in 1937. Treasure Island was constructed on the Yerba Buena Shoals, a sand spit extending north and northwest of YBI. Treasure Island ranges in elevation from 9 to 12 feet above mean sea level based on national geodetic vertical datum of 1929. Subsurface materials at Treasure Island can be divided into the following five units, listed from youngest to oldest:

- Fill (Dredged Sand Fill)
- Shoal Sands (Yerba Buena Shoal Sands)
- Younger Bay Mud

- Older Bay Mud
- Franciscan Assemblage

The following sections describe each unit. A generalized geologic cross section of Treasure Island is provided in Figure 4-2.

4.2.2.1 Fill and Shoal Sands

The dredged sediments used for construction of Treasure Island consisted primarily of fine- to coarse-grained sand with lesser amounts of silt, clay, and gravel. Commonly included in the dredged sand were shell fragments and occasional clay nodules (clay balls formed as dredged clay passed through the delivery pipe line). Within the layered sand fill are occasional thin beds of clay that settled out during dredging operations.

Over 29,360,000 cubic yards of material was dredged. Of that amount, approximately 21,000,000 cubic yards was retained within the sea wall of Treasure Island. The remainder of the dredge material was lost during construction by tidal current erosion and flotation of fine-grained material. Fill material was obtained from the following Bay sediment sources (Lee 1969):

- **Heavy sand**: coarse and well-graded sand and gravel from Presidio, Alcatraz, and Knox Shoals, transported by hopper dredges (approximately 1,261,000 cubic yards).
- **Soft blue marine sand**: very fine to fine sand, 70 to 80 percent held by 200 mesh screen, obtained from the channel south of Treasure Island and transported by pipeline from dredges (approximately 6,349,000 cubic yards).
- **Soft blue marine sand**: fine textured, 50 to 60 percent held by 200 mesh screen, lying east and north of Treasure Island, transported by pipeline from dredges (approximately 14,356,000 cubic yards).
- **Yellow alluvial sand**: cohesive, well-graded, fine to medium sand, 98 percent held by 150 mesh sieve, from East Bay area transported by pipeline dredge (approximately 7,142,000 cubic yards). Contained lenses of clayey sand that were discharged as clay nodules.
- **Miscellaneous material**: principally black sandy mud, handled by clamshell dredge over the sea wall of Treasure Island (approximately 252,000 cubic yards).

The underlying shoal sands (Quaternary Period) consist of sand deposits similar in lithology to the overlying dredged sand sediments of Treasure Island. The dredged sand fill and the underlying shoal sands range in combined thickness of approximately 30 to 50 feet (Geomatrix 1990).

4.2.2.2 Younger Bay Mud

Underlying the Yerba Buena Shoal sands are Younger Bay Mud sediments of marine origin (Quaternary Period) that consist of soft to stiff, olive gray, silty clay and clay with interbedded sand and silt layers in some areas. The Younger Bay Mud sediments range in thickness from approximately 10 to 120 feet and are thinnest on the eastern portion of the island and thicken towards the northwestern portion of the island (Geomatrix 1990).

4.2.2.3 Older Bay Mud

Underlying the Younger Bay Mud sediments is the Older Bay Mud sediments (Quaternary Period) that consist of stiff to very stiff, sandy, silty, and peaty clays and extend to the Franciscan bedrock. The Older Bay Mud sediments range in thickness from approximately 20 to 170 feet and are thinnest on the southern portion of the island and thicken towards the northern portion of the island (Geomatrix 1990).

4.2.2.4 Franciscan Assemblage

Underlying the Older Bay Mud sediments is bedrock of the Franciscan Assemblage (Late Jurassic to Early Cretaceous) that consists of interbedded shales and sandstone. Based on borings at NAVSTA TI that penetrated bedrock, the estimated depth to the Franciscan Assemblage ranges from 150 to 320 feet bgs and is shallowest on the southern portion of the island and deepest towards the northern portion of the island (Geomatrix 1990).

4.2.2.5 Soils

The soil types on the island reflect the underlying geology. According to an unpublished U.S. Department of Agriculture (USDA) soil survey (Dames and Moore 1988), the soils at NAVSTA TI consist primarily of urban land and fill material. Urban land comprises those areas that are more than 85 percent covered by asphalt, concrete, buildings, or other impervious manmade material. The soil under these structures is generally similar to the fill material. In general, the soils found at NAVSTA TI are poorly graded, fine sand with occasional discontinuous lenses of silt and clay.

4.3 LOCAL HYDROGEOLOGY

The hydrogeology for the Bay Area and the local NAVSTA TI hydrogeology are described in the following sections.

4.3.1 Treasure Island Hydrogeology

The following sections summarize the aquifer testing, groundwater gradients and flow direction, the tidal influence, and the quality and beneficial uses of groundwater at NAVSTA TI.

4.3.1.1 Treasure Island Aquifer Testing

In January 1995, rising head slug tests were performed at 13 wells across NAVSTA TI. Data for the slug tests were presented in the draft final RI (PRC 1997b). Data from the rising head slug tests were analyzed using the Bouwer and Rice method (Bouwer and Rice 1976; Bouwer 1989). Excluding an anomalous value from well 24-MW03, hydraulic conductivity values for the NAVSTA TI wells tested ranged from 5.0 feet per day (ft/d) (well 4/19-MW01) to 16 ft/d (well 12-MW01) and averaged 10.12 ft/d. In general, the calculated hydraulic conductivities agree with published hydraulic conductivities (Todd 1980) for the lithologies present in the saturated screened interval.

In September 2001, slug tests and pump tests were also performed on existing monitoring wells at Site 21, located on the south side of NAVSTA TI and immediately east of Site 09 (Tetra Tech 2002e). The average hydraulic conductivity of the shallow water-bearing zone based on several test solutions for one pump test was 108 ft/d. The average hydraulic conductivity based on slug testing from wells completed in the shallow and intermediate water-bearing zones was 22.0 ft/d and 32.1 ft/d, respectively. The hydraulic conductivities used for Site 09 were derived from base wide data since no site specific data were available for Site 09. Hydraulic conductivities used for Site 10 were derived from site specific data from Site 14 due to its proximity to Site 10 and similar lithology. These base wide data are incorporated in the fate and transport modeling presented in Appendix H.

4.3.1.2 Treasure Island Groundwater Gradients and Flow Direction

A water table aquifer is present at NAVSTA TI at an average depth of approximately 7 feet bgs. The groundwater elevation contour map for December 2002 sampling event is shown in Figure 4-3. The map shows that groundwater flow is radial from the center of the island toward the shoreline at average gradients ranging from 0.0015 to 0.005. The average groundwater gradients measured during the quarterly sampling events do not include potential tidal effects on the groundwater gradient near the shoreline.

Groundwater recharge at NAVSTA TI occurs primarily from infiltration of precipitation with some contribution from landscape irrigation. Perched groundwater conditions above the shallow water table may exist locally because of the presence of relatively impermeable silt and clay lenses.

4.3.1.3 Treasure Island Tidal Influence

In August 1995, a 72-hour tidal influence study was performed at 11 monitoring wells at NAVSTA TI and one bay monitoring station (PRC 1995). Between high and low tides, groundwater table fluctuations ranged from 1.81 feet at near shore locations (30 feet from the Bay) to 0.12 foot at inland locations (250 feet from the Bay). Temporary tidal effects on groundwater within 200 to 250 feet of the shoreline produce a steeper groundwater gradient after low tide and a flattening of the groundwater gradient and flow reversal after high tide.

As part of the 72-hour tidal influence study, mean groundwater elevations were determined for all tidal monitoring stations using a geostatistical filtering method to remove all daily and semidaily lunar and solar induced fluctuations from groundwater level measurements. The mean elevations are used to determine the mean groundwater gradient and flow direction. Mean groundwater elevations also showed a radial groundwater flow towards the shoreline at a mean groundwater gradient ranging from 0.001 to 0.002. Since the mean groundwater gradient filters tidal effects, it provides a higher degree of accuracy than quarterly groundwater gradients (PRC 1995).

The study also estimated tidal mixing of fresh groundwater and brackish Bay water based on analysis for total dissolved solids (TDS), conductivity, and salinity. At NAVSTA TI, the tidal mixing estimates show a 13 percent tidal mixing (13 percent brackish Bay water mixed with 87 percent fresh groundwater) in areas within 30 feet of the shoreline and up to 2 percent tidal mixing in areas 44 to 250 feet from the shoreline. Tidal mixing was not observed at wells farther than 250 feet from the shoreline (PRC 1995). TDS and salinity of the Bay water collected during the tidal influence study was 28,400 milligrams per liter (mg/L) and 2.67 percent, respectively.

Between December 2000 and March 2001, Tetra Tech conducted an investigation that focused on estimating the extent and degree of the physical mixing of surface water and groundwater within the tidal mixing zone at Treasure Island. The 2001 tidal mixing zone study measured tidal influence on water levels within approximately 100 feet of the shoreline to help understand the physical mixing processes but was not intended to duplicate the results of the 1995 study that measured the inland extent of pressure wave propagation caused by tidal influence at distances beyond the tidal mixing zone. The 2001 tidal mixing zone study estimated that physical mixing of surface water and groundwater took place over distances that ranged from 60 to 150 feet inland from the NAVSTA TI MLLW shoreline (Tetra Tech 2002d). Estimates of the degree of tidal mixing of surface water and groundwater for Treasure Island ranged from 10 to 17 percent, with the exception of a transect in the southeastern portion of Treasure Island. The transect is located on Site 21 which is located east of site 09 approximately 500 feet. Tidal mixing was conservatively estimated at 43 percent within this southeastern portion of Treasure Island; however, conditions encountered in this transect are considered unusual and representative only of the area immediately surrounding that transect.

4.3.1.4 Treasure Island Groundwater Quality and Beneficial Uses

As part of the November 1995 groundwater sampling event, groundwater samples from all 86 wells at NAVSTA TI were analyzed for TDS. Using the TDS criteria of 3,000 mg/L to define potential sources of drinking water as defined by the State Water Resources Control Board (SWRCB), Resolution No. 88-63, potentially suitable drinking water at NAVSTA TI exists from the water table surface to an estimated depth of 33 feet bgs.

The minimum production criteria to define potential sources of drinking water (SWRCB 1988) are well yields of more than 200 gallons per day. Pump tests, well development rates, and hydraulic conductivity values from slug testing (5 to 16 ft/d) indicate NAVSTA TI wells can yield more than 200 gallons per day.

Under the Bay Basin water quality control plan (basin plan), all groundwater within the Bay Basin that meets the criteria of SWRCB Resolution No. 88-63 has a potential beneficial use for municipal or domestic supply (SWRCB 1988). The RWQCB, however, completed a Pilot Beneficial Use Designation Project for several groundwater basins in San Francisco and northern San Mateo Counties, including NAVSTA TI and YBI (RWQCB 1996). The report indicated that the use of groundwater for municipal and domestic supply at NAVSTA TI would be limited by (1) the small volume of fresh groundwater available, (2) the likelihood of saltwater intrusion, and (3) potential future ground improvements for stability (stone columns and dynamic compaction). Consequently, the report recommended that the basin plan be revised to no longer designate groundwater at NAVSTA TI as a potential municipal or domestic water supply but retain designation for potential agricultural, process, and industrial supply.

4.4 SITE 09

The geology for Site 09 was evaluated based on review of boring logs from all soil borings, hydropunch borings, and monitoring wells located within the site boundaries. In total, 25 soil borings, eight hydropunch borings, and seven groundwater monitoring wells have been installed at Site 09. Hydrogeology for Site 09 is based on groundwater monitoring data from site wells and NAVSTA TI site-wide hydrogeology.

4.4.1 Geology

Asphalt and concrete provide surface cover at Site 09 and is underlain by sandy dredge fill. The sandy fill consists of tan to grayish-brown, fine- to coarse-grained, angular sand with some pea-size gravel. Minor silt and clay lenses are scattered throughout the sand, and locally, shell fragments can range from minor to abundant. Native formations such as the Bay Mud were not encountered in the shallow borings. A hydrogeologic cross section of Site 09 is presented in Figure 4-4.

4.4.2 Hydrogeology

Groundwater at Site 09 was encountered at approximately 7 feet bgs during the 2002 sampling event. Groundwater elevation may fluctuate based on tidal influence with greater fluctuation occurring closer to the shoreline. During seasonal precipitation increases, groundwater elevations will rise corresponding to increased water levels throughout NAVSTA TI. Near surface groundwater is encountered in the unconfined, homogeneous dredge sand that makes up the island.

During the 2002 sampling event, groundwater levels varied only 0.15 foot across the site, and no consistent groundwater direction could be derived from the data (Table 4-1). Based on general NAVSTA TI hydrogeology and basewide groundwater monitoring data, groundwater at Site 09 probably flows to the south and southeast, toward the shoreline.

Since no site-specific aquifer tests were completed at Site 09, the hydraulic conductivity and hydraulic gradient were estimated based on the average value for Treasure Island. A hydraulic conductivity of 10.12 ft/d was used for Site 09. The hydraulic gradient was estimated to be 0.0048 foot per foot (ft/ft). Assuming an effective porosity of 0.28 (unitless) for medium-grained sands (Todd 1980), the groundwater seepage velocity is equal to 0.17 ft/d. These estimates are calculated using Darcy's Law (Fetter 1980) and site-specific values of the hydraulic conductivity, hydraulic gradient, and an effective porosity listed above as follows:

$$v = (k \times i) / n_e$$

where

v = seepage velocity, or pore water velocity (ft/d)
k = hydraulic conductivity (ft/d)
i = hydraulic gradient (ft/ft)
n_e = effective porosity (unitless)

4.5 SITE 10

The geology for Site 10 was evaluated based on review of boring logs from the soil borings, hydropunch borings, and monitoring wells located within the site boundaries. In total, 30 soil borings, 14 hydropunch borings, and four groundwater monitoring wells have been installed within the site boundaries. Additional soil borings and hydropunch borings have been installed adjacent to the site. Hydrogeology for Site 10 is based on groundwater monitoring data from site wells and NAVSTA TI site-wide hydrogeology.

4.5.1 Geology

Site 10 surface cover includes asphalt on the western and southern sides of Building 335; soil, gravel, and wood chips resulting from landscaping activities on the eastern side of the building; and concrete flooring in Building 335. Surface cover is underlain by sandy dredge fill. The sandy fill consists of tan to grayish-brown, fine- to coarse-grained, angular sand with some pea-size gravel. Minor silt and clay lenses are scattered throughout the sand, and shell fragments found locally range from minor to abundant. Native formations such as the Bay Mud were not encountered in the shallow borings. A hydrogeologic cross section of Site 10 is presented as Figure 4-5.

4.5.2 Hydrogeology

Groundwater at Site 10 was encountered at approximately 7 feet bgs during the 2002 sampling event. Groundwater elevations may fluctuate based on tidal influence with greater fluctuation occurring closer to the shoreline. During seasonal precipitation increases, groundwater elevations will rise, corresponding to increased water levels throughout NAVSTA TI.

Near-surface groundwater is encountered in the unconfined, homogeneous dredged sand fill that makes up Treasure Island

Only two monitoring wells, 10-MW02 and 10-MW03, are present at Site 10, and water level data were insufficient to prepare a groundwater elevation contour map during the 2002 sampling event. Based on general NAVSTA TI hydrogeology and basewide groundwater monitoring and flow data, groundwater at Site 10 likely flows to the northeast, toward the shoreline.

Since no site-specific aquifer tests were completed at Site 10, the hydraulic conductivity and hydraulic gradient was estimated based on the average value of two slug test results available for adjacent Site 14/22 (Tetra Tech 2002b). A hydraulic conductivity of 12.47 ft/d was used for Site 10. The hydraulic gradient was estimated to be 0.0036 ft/ft. Assuming an effective porosity of 0.28 (unitless) for medium-grained sands (Todd 1980), the groundwater seepage velocity is equal to 0.16 ft/d, based on Darcy's Law described in Section 4.4.2.

TABLES

TABLE 4-1: SITE 09 GROUNDWATER ELEVATION AND SAMPLING DATA - OCTOBER/NOVEMBER 2002

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

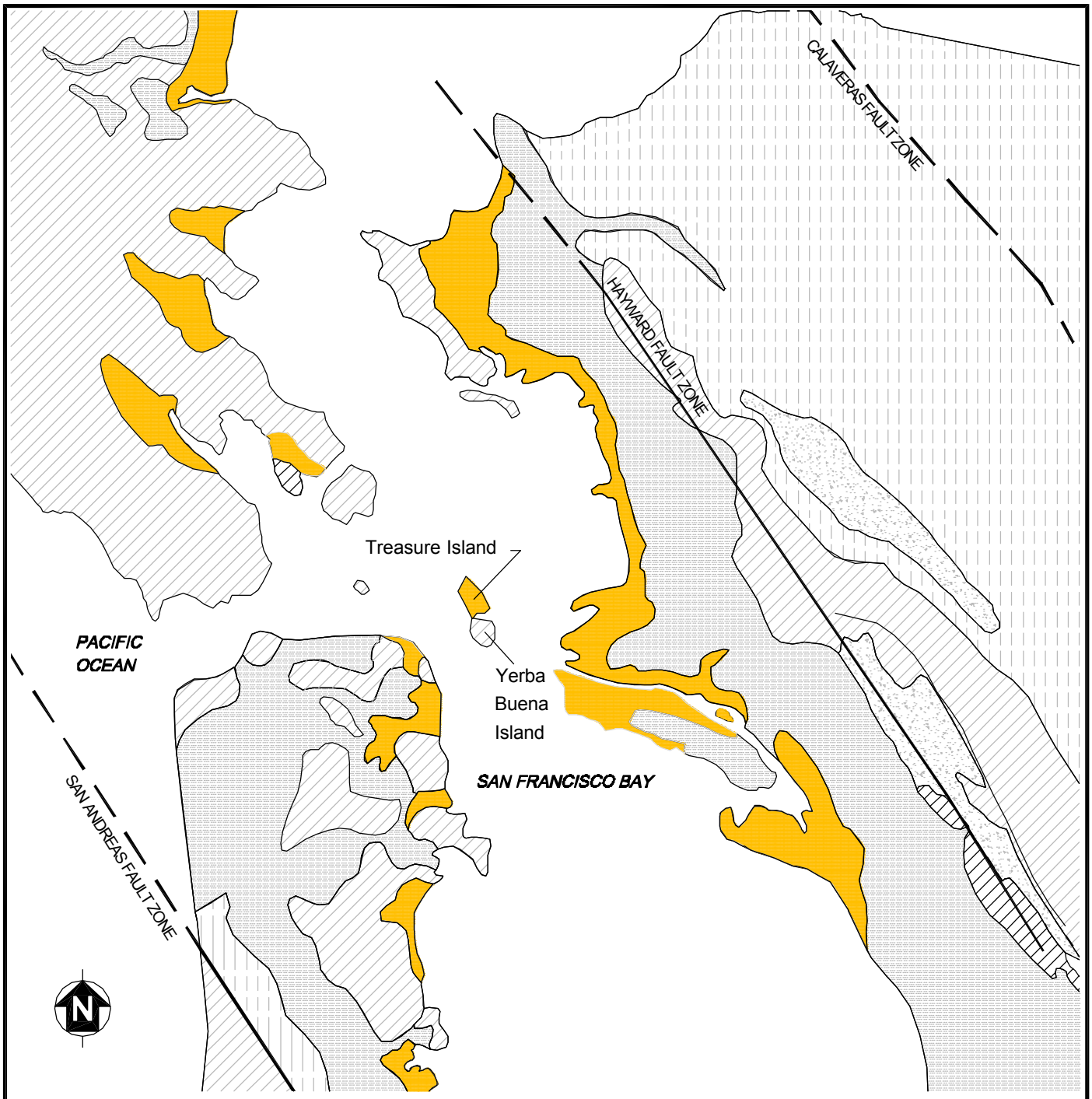
Sample Date	Point ID	Northing	Easting	TOC Elevation (MLLW)	Sample Depth ft BTOC	Sample Depth Elevation (MLLW)	Sample Method	Depth to GW ft BTOC	Groundwater Elevation (MLLW)
10/31/2002	09-MW01	2125947.6	6022598.9	11.30	9.5	1.80	Peristaltic	6.80	4.50
10/31/2002	09-MW02	2125978.7	6022575.4	11.28	10	1.28	Peristaltic	6.81	4.47
10/31/2002	09-MW03	2125949.1	6022566.9	11.10	10	1.10	Peristaltic	6.50	4.60
10/30/2002	09-MW04	2125962.6	6022613.7	11.16	10	1.16	Peristaltic	6.65	4.51
10/31/2002	09-MW05	2126012.8	6022569.0	11.00	10	1.00	Peristaltic	6.52	4.48
10/31/2002	09-MW06	2126036.9	6022559.1	11.15	10	1.15	Peristaltic	6.63	4.52
11/14/2002	09-MW07	2125935.6	6022630.5	11.29	10	1.29	Peristaltic	6.84	4.45
10/30/2002	10-MW02	2130194.3	6022038.8	11.30	10	1.30	Peristaltic	7.00	4.30
10/30/2002	10-MW03	2130138.6	6022057.9	11.44	10	1.44	Peristaltic	7.90	3.54

Notes:

All survey data is referenced to feet above mean lower low water for Treasure Island

ft BTOC	feet below top of casing
GW	groundwater
ID	Identification
MLLW	mean lower low water
Peristaltic	peristaltic pump with tubing
TI	Treasure Island
TOC	top of casing referenced to TI MLLW

FIGURES



LEGEND

QUATERNARY		ESTUARINE SEDIMENTS/MUD/FILL
		ALLUVIUM
TERTIARY		SEDIMENTARY ROCKS
		VOLCANIC ROCKS
JURASSIC AND CRETACEOUS		SEDIMENTARY AND ULTRAMAFIC ROCKS

MODIFIED FROM SCHLOKER (1971)

4 0 4

SCALE IN MILES - 1 inch = 4 miles

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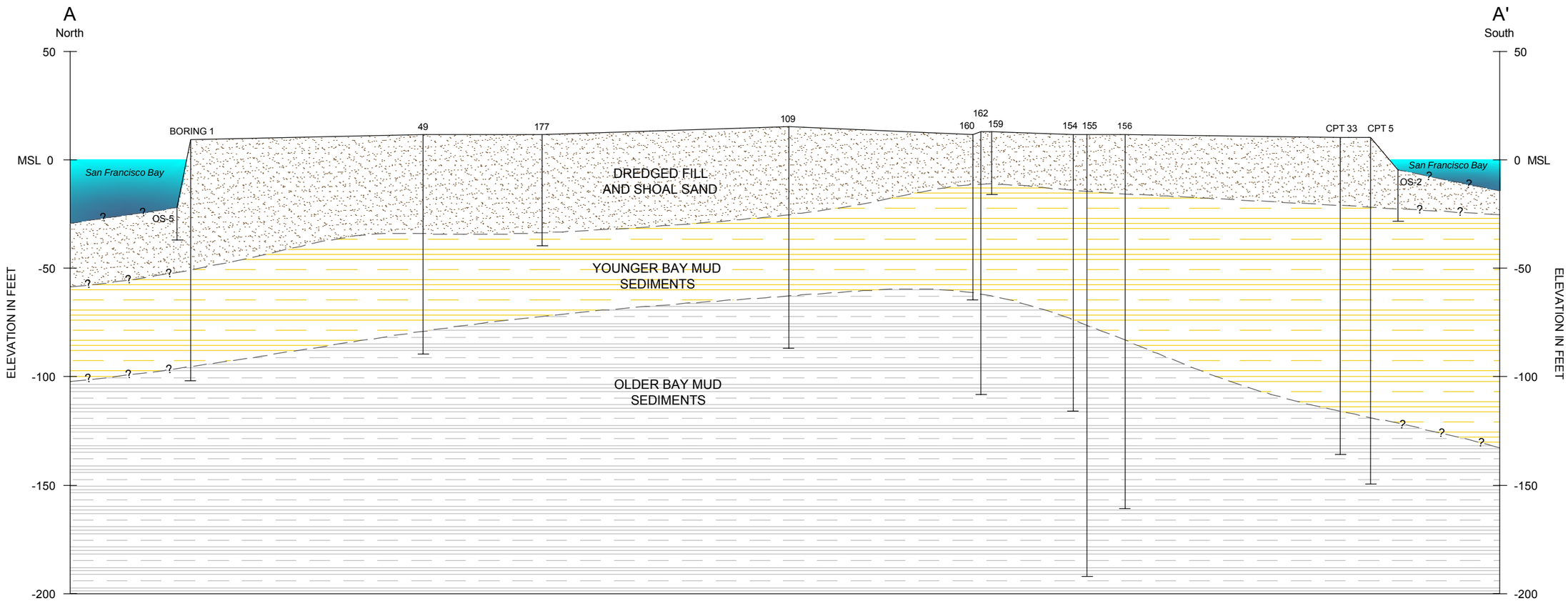
FIGURE 4-1
GENERAL REGIONAL GEOLOGY

Fig 4-1_gen reg geo.dwg - 07/23/2003 - G0069.302.B.04.01.03



LEGEND:

- DREDGED FILL AND SHOAL SANDS (Predominantly fine- to medium-grained sands and silty sands)
- YOUNGER BAY MUD SEDIMENTS (Predominantly soft to stiff clay, silty clay, or sandy clay with some silty sands and clayey sands)
- OLDER BAY MUD SEDIMENTS (Predominantly stiff to very stiff clay, silty clay, or sandy clay with some silty sands and clayey sands)
- LITHOLOGIC CONTACT (dashed where inferred, queried where uncertain)
- 49 — SOIL BORING OR CONE PENETROMETER TEST (CPT)

NOTES:

1. Cross section modified from cross section M-M' (Geomatrix 1990).
2. The number over each soil boring/CPT corresponds to a specific boring index number (Geomatrix 1990)
3. This cross section represents one interpretation based on available data; other interpretations are possible.
4. Soil Borings shown on cross section were compiled from previous investigations and are used for reference only.

LOCATOR MAP

500 0 500

SCALE IN FEET - 1 inch = 500 feet
VERTICAL EXAGGERATION = 10X

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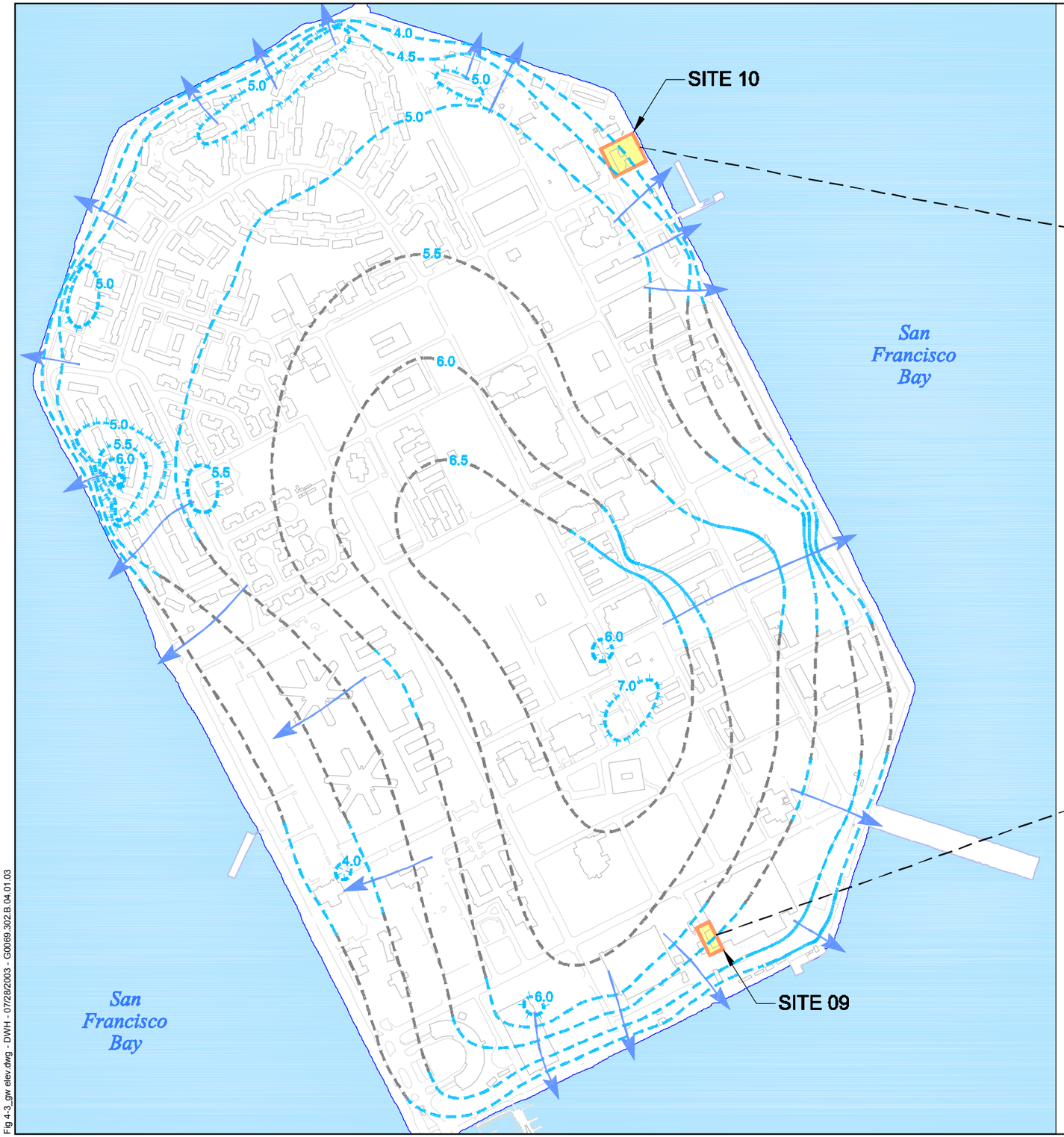
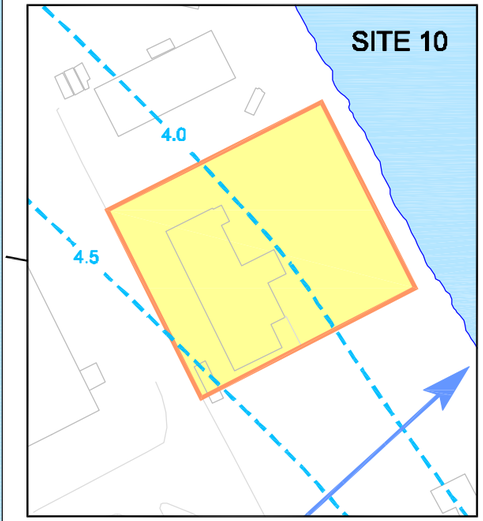
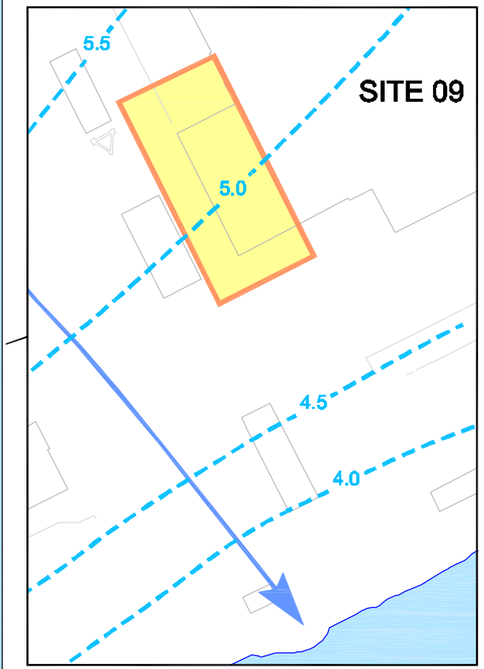
FIGURE 4-2
Generalized Treasure Island
Geologic Cross Section A-A'

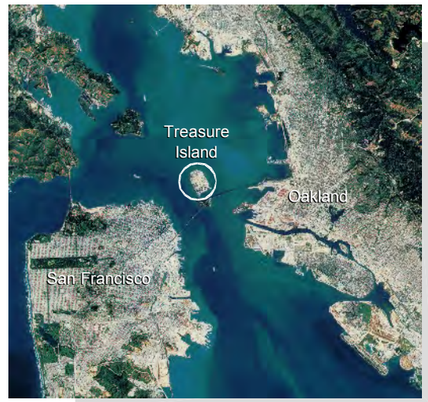
Fig 4-2_gen x-sect.dwg – 07/29/2003 – G0069.302.B.04.01.03







AREA OF INTEREST



LEGEND

- 4.0 — ESTIMATED GROUNDWATER ELEVATION CONTOUR (Dashed where inferred, shown in gray where inference based on limited groundwater elevation data, tick marked where localized groundwater mound or depression inferred.)
- INFERRED GROUNDWATER FLOW DIRECTION
- ROAD
- BUILDING
- SITES 09 & 10 BOUNDARY

NOTES

Elevations in feet above the Treasure Island mean lower low water datum.

Contour Interval = 0.5 feet.

Shoreline is approximate.

Water level measurements collected during an intense winter storm on December 13, 2002; anomalous groundwater mounds may be associated with variable infiltration rates in recharge areas.

This map represents one interpretation based on the available data; other interpretations are possible.

N

300 0 300 600

SCALE IN FEET

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FIGURE 4-3
Groundwater Elevation
Contour Map
December 13, 2002

Fig 4-3_gw elev.dwg - DWH - 07/28/2003 - G0069.302.B.04.01.03

A
North - Northwest

A'
South - Southeast

Building 41

15'
10'
5'
0'
-5'

09-SB01 Elevation = 11.30'
09-MW06 Elevation = 11.30'
09-MW05 Elevation = 11.00'
Former 30 Gallon Tank
09-SB11 Elevation = 11.00'
09-MW04 Elevation = 11.16'
09-MW07 Elevation = 11.29'

Fill
Fill
Fill

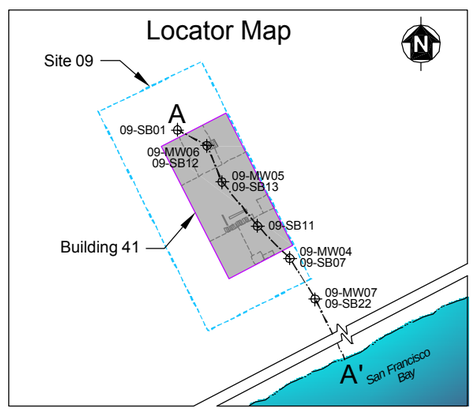
?

San Francisco Bay

230'

NOTE: This cross section represents one interpretation based on available data; other interpretations are possible.

Locator Map



20 0 20
SCALE IN FEET - 1 inch = 20 feet
VERTICAL EXAGGERATION = 5X

Legend

- Dark Brown to Black Sand
- Golden Brown Coarse-Grained Sand With Gravel and Shell Fragments
- Grey Coarse Grained Sand With Shell Fragments
- Riprap Sea Wall
- Groundwater Level - Dashed Where Inferred
- ? — - Soil Transition - Inferred Line

Top of Casing Elevations Listed in Feet Above Mean Lower Low Water Level

Well Detail

Riser
Screened Interval

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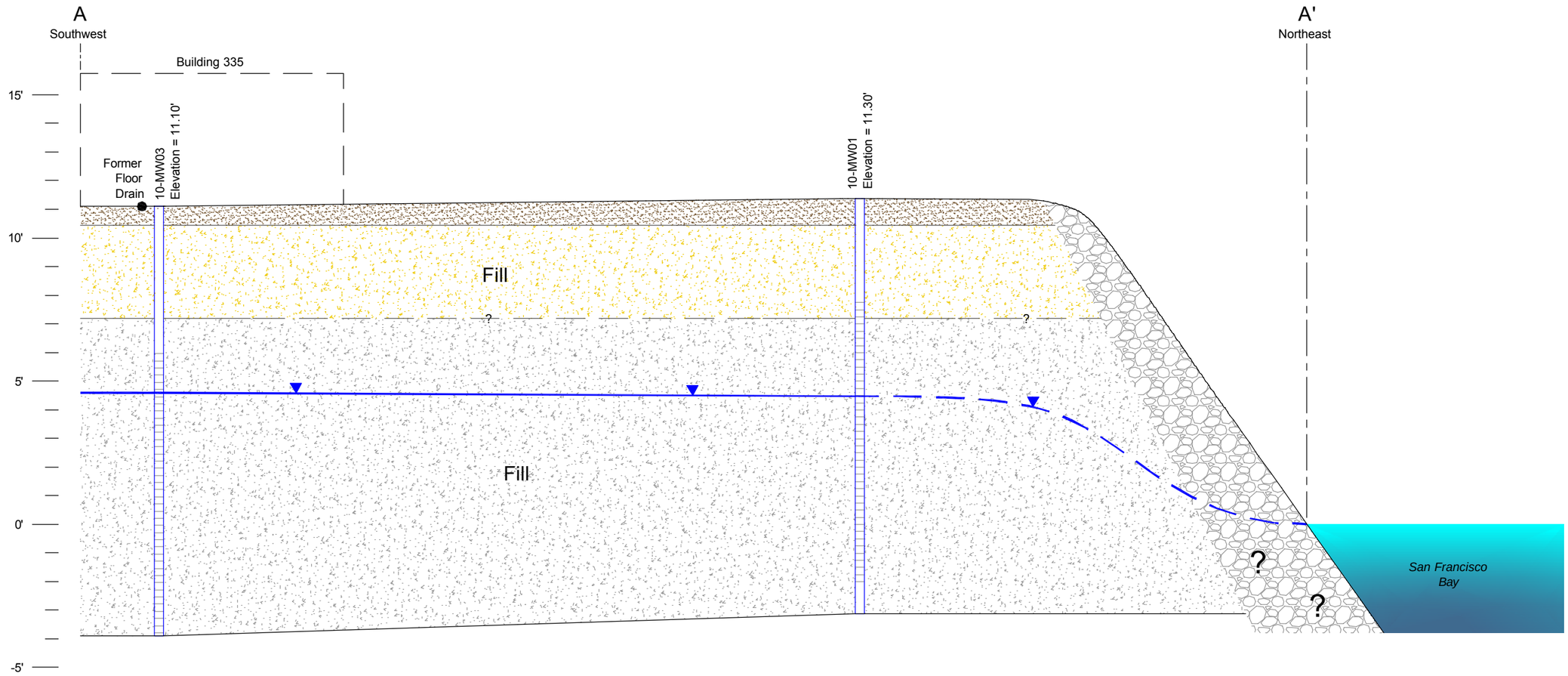
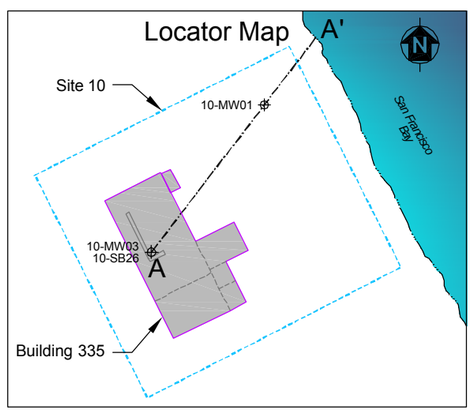
FIGURE 4-4
Site 09 - Foundry
Hydrogeological Cross Section

Fig 4-4_IR9 x-sect.dwg - DWH - 07/24/2003 - G0069.302.B.04.01.03



NOTE: This cross section represents one interpretation based on available data; other interpretations are possible.



20 0 20

SCALE IN FEET - 1 inch = 20 feet
VERTICAL EXAGGERATION = 5X

Legend

- Dark Brown Sand
- Light Brown Sand With Gravel and Shell Fragments
- Grey Coarse-Grained Sand With Gravel, Shell Fragments, and Scattered Silt and Clay
- Riprap Sea Wall
- Groundwater Level - Dashed Where Inferred
- ? - Soil Transition - Inferred Line

Elevations Listed in Feet Above Mean Lower Low Water Level

Well Detail

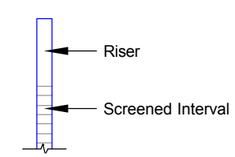


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FIGURE 4-5
Site 10
Hydrogeological Cross Section

Fig 4-5 IR10 x-sect.dwg - DWH - 07/23/2003 - G0069.302.B.04.01.03

5.0 NATURE AND EXTENT OF CONTAMINATION

The following sections present the analytical results of the investigations completed at Sites 09 and 10, including the PA/SI (Dames and Moore 1988), the phase I and phase II RIs (PRC 1997b), the EBS sampling performed in 1997 (Tetra Tech and Uribe 1997), basewide quarterly groundwater monitoring from 1996 to 2002 (PRC 1997a, Tetra Tech 1999a, Tetra Tech 2002c, Tetra Tech 2003a), and the additional RI conducted in the fall of 2002 (Tetra Tech 2002e). Data collected during these investigations were used to evaluate site conditions in the HHRA and the ERA. Unlike the previous draft final RI report (PRC 1997b), data in this section are not compared to EPA Region IX preliminary remediation goals (PRG) or NAVSTA TI screening criteria. Instead, data in the HHRA (Section 7.0) and ERA (Section 8.0) portions of the document are used to evaluate the relative risk at Sites 09 and 10 and support a remedial decision, as necessary.

As part of this section, figures and tables have been prepared to present sampling locations and reported concentrations for each site. Boring and monitoring well locations for Site 09 are shown in Figure 2-3. Boring and monitoring well locations for Site 10 are shown in Figure 2-4. Figures 5-1 through 5-16 present the analytical data for all chemical constituents reported in samples collected at each site. Laboratory analytical results for all samples collected are included in Section 5.0 tables. Laboratory analytical results for samples collected during all investigations are included in Appendices C and D. A report describing the results of the additional RI data validation summary is included in Appendix E. The following sections describe the results of soil and groundwater sampling conducted at Sites 09 and 10 and pertinent background and historical data.

5.1 SITE 09

Areas adjacent to Building 41 where disposal of hazardous wastes most likely occurred were identified in the PA/SI. Phase I soil boring locations were selected based on the findings of the PA/SI. Four soil borings (09-SB01 through 09-SB04) were drilled along the northern, western, and southern sides of Building 41. Three soil samples were collected from each boring at depths ranging from 0.5 foot bgs to 5.0 feet bgs. Soil samples were analyzed for VOCs, SVOCs, metals and pesticides/PCBs. No groundwater samples were collected during the phase I RI.

During the phase II RI eight hydropunch soil borings (09-HP001 through 09-HP008) were drilled, and one groundwater monitoring well (09-MW01) was installed.

Soil samples were collected from six of the hydropunch soil borings (09-HP001 through 09-HP006) at depths ranging from 0.5 to 7.0 feet bgs. Various analyses were performed in the laboratory on soil samples from the hydropunch borings including chromium, hexavalent chromium, lead, toxicity characteristic leaching procedure (TCLP) lead, pesticides/PCBs, SVOCs, and TPH-e. Field immunoassay analysis were completed for PAHs, PCBs, and TPH. Groundwater samples were collected from hydropunch locations 09-HP001, 09-HP006, 09-HP007, and 09-HP008 and monitoring well 09-MW01. Groundwater samples were analyzed for SVOCs, lead, and TPH-e. Groundwater samples from monitoring well 09-MW01 were also

analyzed for metals. Field immunoassays for TPH were also performed on select samples. In addition to soil and groundwater samples, waste oil samples were collected from a trench inside Building 41 in the vicinity of the former hydraulic lift and analyzed for fuel fingerprint and PCBs. A wastewater sample was also collected from the paint booth catch basin inside Building 41 and analyzed for metals and SVOCs.

Quarterly groundwater sampling was also performed on monitoring well 09-MW01 from February 1996 to October 2000. Quarterly groundwater samples were analyzed for SVOCs, TPH-e, and metals. Groundwater was also analyzed for MTBE during the last two quarterly sampling events.

Twenty-one soil borings and six small-diameter monitoring wells were installed at Site 09 as part of the additional RI activities. Three soil samples were collected from each soil boring at depths of 0.5 to 2.0 feet bgs, 2.5 to 5.0 feet bgs, and 5.0 to 7.5 feet bgs. Groundwater samples were collected from all on-site monitoring wells (09-MW01 through 09-MW07). All soil and groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, TPH-e, TPH-p, and metals.

No soil samples were collected at Site 09 as part of the EBS. One groundwater sample collected from monitoring well 09-MW01 during the EBS was analyzed for TPH-p and BTEX/MTBE.

5.1.1 Soil Sample Results

Soil and oil/drain analytical results for Site 09 along with the distribution of contaminants are discussed in this section. Analytical results for soil samples collected at Site 09 are included in Tables 5-1 and 5-4 and presented in Figures 5-1 through 5-4. Oil and drain results are included in Table 5-3.

5.1.1.1 Volatile Organic Compounds

Analytical results for VOCs in soil at Site 09 are summarized in the following sections (Figure 5-1).

Phase I Remedial Investigation

Acetone and toluene were the only VOCs reported in samples from the phase I RI. Acetone was reported in a sample from soil boring 09-SB02 at a depth of 0.8 to 1.3 feet bgs at a concentration of 0.3 milligrams per kilogram (mg/kg). Toluene was reported in the same sample at a concentration of 0.003J mg/kg. The detections of methylene chloride, acetone and toluene in field blanks indicates the possibility of laboratory introduced contamination, as noted in Appendix E. .No other VOCs were reported.

Phase II Remedial Investigation

Samples were not analyzed for VOCs during the phase II RI. Data collected during the phase I RI did not suggest additional VOC sampling was necessary.

Additional Remedial Investigation 2002

The phase II RI found that fluids contained in the former hydraulic lift UST inside Building 41 would be considered waste oils. Phase II soil samples also contained elevated TPH concentrations in the vicinity of the hydraulic lift. As such, samples collected during the 2002 additional RI were analyzed for a suite of analytes, including VOCs.

VOCs were detected in soil samples collected from seven soil borings during the additional RI activities. VOCs were reported in soil samples from soil borings 09-SB05, 09-SB06, 09-SB07, 09-SB16, 09-SB18, 09-SB20, and 09-SB23. All reported concentrations except one, were qualified as estimated values. Methylene chloride was identified in soil boring 09-SB05 at a depth of 5.0 to 7.5 feet bgs at a concentration of 0.16 mg/kg. VOCs were detected in samples collected from the 0.5- to 2.0-foot interval in three soil borings, from the 2.5- to 5.0-foot interval in one soil boring, and from the 5.0- to 7.5-foot interval in six soil borings. No lateral or vertical pattern to the VOC concentrations was observed.

5.1.1.2 Total Petroleum Hydrocarbon

Analytical results for TPHs in soil at Site 09 are summarized in the following sections (Figure 5-1). Petroleum screening levels for NAVSTA TI are included in Appendix L.

Phase I Remedial Investigation

No soil samples were analyzed for TPH constituents during the phase I RI. The hydraulic lift and 30-gallon storage tank inside Building 41 were identified during the phase I RI, which led to sampling for TPH in this area during the phase II RI.

Phase II Remedial Investigation

Soil samples collected from two hydropunch borings (09-HP001 and 09-HP002) near the hydraulic lift and storage tank inside Building 41 were sent to a laboratory for TPH-e analysis. Soil samples from borings 09-HP001, 09-HP002, and 09-HP003 were analyzed in the field by the TPH immunoassay method (TPH-i). A fuel fingerprint was also run on an oily waste sample from a trench at the former hydraulic lift.

All off-site laboratory samples were analyzed for TPH-e and quantitated as TPH-diesel (TPH-d) and TPH-motor oil (TPH-m). Field-screening samples were analyzed for TPH-i. Table 2-3 identifies the type of TPH analyses performed for each sample. All detected TPH concentrations appeared to be associated with hydraulic oil, based on interpretation of the chromatograms for

the off-site laboratory analyses and the fuel fingerprint analysis performed for the oily waste in the lift trench.

In boring 09-HP001, TPH-d was reported at 21 mg/kg, and TPH-m was reported at 85 mg/kg in the sample collected from 1.25 to 1.75 feet bgs. In soil boring 09-HP002, TPH-d was reported at 38,000 mg/kg, and TPH-m was reported at 12,000 mg/kg in the sample collected from 6.5 to 7.0 feet bgs. Both borings were located adjacent to the hydraulic lift.

TPH-i was detected at concentrations less than 15 mg/kg in all of the field screened soil samples. The TPH-i result from the 1.25- to 1.75-foot bgs sample in boring 09-HP001 was compared to the laboratory TPH results. The off-site laboratory detected a greater concentration of TPH in boring 09-HP001 than was identified during the TPH-i. The TPH-i analysis is generally more sensitive to light-end hydrocarbon contamination, while the samples in question contained heavier hydrocarbon contamination, which may explain the lower TPH-i results. TPH contamination reported in samples from borings 09-HP001 and 09-HP002 is likely to have originated from oily waste observed in the former lift system trench.

Additional Remedial Investigation 2002

TPH constituents were reported in samples from 15 out 21 soil borings drilled during the additional RI. Soil borings 09-SB23 and 09-SB07, located on the southeast side of Building 41, contained the highest two TPH concentrations at a depth of 5.0 to 7.5 feet bgs. A TPH-d concentration of 7,600 mg/kg was identified in boring 09-SB23, and 7,100 mg/kg was identified in boring 09-SB07. Both concentrations exceed the NAVSTA TI residential screening criteria for TPH-d of 1,400 mg/kg. Samples from soil borings both upgradient and downgradient of borings 09-SB23 and 09-SB07 reported low to nondetectable contaminant concentrations at that depth. Although soil samples collected from boring 09-SB16 (located immediately adjacent to former boring 09-HP002) contained elevated concentrations of TPH-d at 1,300 mg/kg and TPH-m at 430 mg/kg, the concentrations were still much lower than the phase II RI concentrations reported in boring 09-HP002 (TPH-d of 38,000 mg/kg and TPH-m of 12,000 mg/kg). Soil boring 09-SB16 was the only boring with relatively continuous contamination from 2.5 feet bgs to groundwater.

TPH contamination data previously reported during the phase II RI sampling in the vicinity of the hydraulic lift (38,000 mg/kg) was not detected at similarly elevated levels during the additional RI. Samples from nine of the ten boreholes drilled around the hydraulic lift did not detect elevated TPH concentrations. Sample 09-SB16 had the only reported elevated TPH concentration but still below the NAVSTA TI TPH screening criteria. In general, TPH contamination at Site 09 appears to be localized near the former hydraulic lift and in the vicinity of the southeast corner of Building 41. Risk associated with TPH constituents are assessed in the HHRA (Section 7.0) and ERA (Section 8.0).

5.1.1.3 Semivolatile Organic Compounds

Analytical results for SVOCs in soil at Site 09 are summarized in the following sections (Figure 5-2).

Phase I Remedial Investigation

Soil samples from all four phase I RI soil borings were analyzed for SVOCs. No SVOCs were reported in any of the samples.

Phase II Remedial Investigation

Samples from two of the hydropunch borings drilled during the phase II RI were analyzed for SVOCs. Phenol was detected in soil samples from borings 09-HP001 and 09-HP002, near the lift system trenches. Phenol was detected at a concentration of 1.1 mg/kg in the sample collected from 1.25 to 1.75 feet bgs at boring 09-HP001 and at a concentration of 16 mg/kg in the sample collected from 6.50 to 7.0 feet bgs at boring 09-HP002.

Soil samples from borings 09-HP001 through 09-HP003 were also field screened for total PAHs using immunoassay methods (PAH-i). PAH-i was not detected in field screened samples with a detection limit of 1.0 mg/kg. To confirm the PAH-i results, the 1.25- to 1.75-foot bgs sample from boring 09-HP001 was analyzed for SVOCs by an off-site analytical laboratory. Laboratory analyses reported no PAHs at detection limits of 0.38 mg/kg.

Additional Remedial Investigation 2002

SVOCs were reported in 17 soil borings during the additional RI. The highest reported PAH values were from soil boring 09-SB07, and those concentrations were qualified as estimated. The highest nonestimated SVOC concentrations were also from 09-SB07; 2-methylnapthalene was reported at 1.8 mg/kg, flourene was reported at 5.7 mg/kg, phenanthrene was reported at 4.6 mg/kg, benzo(g,h,i)perylene was reported at 0.32 mg/kg and benzo(a)pyrene was reported at 0.07 mg/kg. SVOC concentrations in samples collected from boring 09-SB23 were also elevated in comparison to the other soil borings. Of the 25 samples with reported SVOCs, 14 were from the 0.5- to 2.0-foot bgs interval, 6 were from the 2.5- to 5.0-foot bgs interval, and 5 were from the 5.0- to 7.5-foot bgs interval. While the majority of reported SVOCs were identified in the near-surface samples, there appears to be no pattern to the low-level contamination. The comparatively elevated concentrations reported in borings 09-SB07 and 09-SB23 may be associated with the source of the TPH contamination reported at those same borings.

5.1.1.4 Pesticides and Polychlorinated Biphenyls

Soil and groundwater samples collected during the phase I RI, phase II RI, and the 1995 and 1996 quarterly groundwater sampling for pesticides/PCBs were analyzed using the EPA Contract Laboratory Program (CLP) method for pesticides in which PCBs were included in the pesticide

analysis (EPA 1986). Samples collected during the 2002 additional RI were analyzed for pesticides using EPA method 8081; PCBs were analyzed using EPA method 8082. The PCB analyte list for the CLP and 8082 methods is the same (EPA 1996).

Reported PCB and pesticide concentrations for Site 09 soil samples are shown in Figure 5-3.

Phase I Remedial Investigation

Samples from all four soil borings collected during the phase I RI were analyzed for pesticides. Pesticides and PCBs were not reported in any sample.

Phase II Remedial Investigation

Immunoassay field screening methods were used to test soil samples from borings 09-HP001, 09-HP002, and 09-HP003 for total PCBs using immunoassay method (PCB-i). PCB-i was not reported at concentrations above 0.5 mg/kg in the soil samples from borings 09-HP001 and 09-HP002. The sample collected at a depth of 0.5 to 1.0 foot bgs from boring 09-HP003 contained PCB-i within a reported concentration range of 0.5 to 1.0 mg/kg; however, no PCBs were reported in the off-site laboratory confirmation analysis for this sample. Soil samples from borings 09-HP001, 09-HP002, and 09-HP003 were also sent for laboratory analysis for pesticides. Pesticides were not reported in any sample.

In addition to soil samples, one oily waste sample was collected from the hydraulic lift trench and analyzed for PCBs. No PCBs were reported in the sample.

Additional Remedial Investigation 2002

Aroclor 1260 was the only PCB reported in analyses of soil samples collected at Site 09. Three samples with reported Aroclor 1260 were collected from the 0.5- to 2.0-foot bgs interval in borings 09-SB06 (0.0015 mg/kg), 09-SB05 (0.032 mg/kg), and 09-SB12 (0.058 mg/kg). A fourth sample with reported Aroclor 1260 was also collected from boring 09-SB12 at a depth of 2.5 to 5.0 feet bgs (0.016 mg/kg).

Pesticides were also reported in samples collected from four soil borings (09-SB07, 09-SB12, 09-SB15 and 09-SB16). 4,4-dichlorodiphenyltrichloroethane (DDT) was identified in samples from borings 09-SB12 at concentrations of 0.037 mg/kg and 0.0092 mg/kg; endosulfan I was identified in samples from boring 09-SB15 at a concentration of 0.0013 mg/kg. Alpha-chlordane was reported in boring 09-SB12 at an estimated concentration of 0.0018 mg/kg. No vertical or horizontal pattern was evident from the reported pesticides and PCBs.

5.1.1.5 Metals

Analytical results for metals in soil at Site 09 are summarized in the following sections (Figure 5-4). Ambient metals concentrations in dredged fill at NAVSTA TI are listed in Table 2-5 and Appendix F.

Phase I Remedial Investigation

Soil samples from all four borings drilled during the phase I RI were analyzed for metals. Lead was detected at an elevated concentration of 974 mg/kg in the 1.0- to 1.5-foot bgs interval from boring 09-SB03 during the phase I RI. Soil samples below that level in the same boring did not contain elevated lead concentrations.

In addition to lead; aluminum, arsenic, beryllium, chromium, cobalt, silver, vanadium, and zinc were reported above their respective ambient concentrations. Beryllium was the only metal consistently reported at concentrations above the ambient level of 0.12 mg/kg with a maximum concentration of 0.96 mg/kg. Arsenic exceeded the ambient concentration of 10 mg/kg in one sample from boring 09-SB03 at a concentration of 14.8 mg/kg; the sample was collected at a depth of 1.0 to 1.5 feet bgs.

Phase II Remedial Investigation

Soil samples from borings 09-HP001 through 09-HP006 were analyzed for lead during the phase II RI to investigate the elevated lead concentrations reported in the sample from 09-SB03. Chromium and hexavalent chromium were also analyzed in samples from borings 09-HP001, 09-HP002, and 09-HP003 in an effort to speciate the different forms of chromium.

The highest reported lead concentration, 40 mg/kg, was identified in boring 09-HP006 at a depth of 0.5 to 1.0 feet bgs. The sample was also analyzed for TCLP leachate concentrations of lead with no reported leachable lead. The highest reported chromium concentration, 38.6 mg/kg, was identified in boring 09-HP001 at a depth of 1.25 to 1.75 feet bgs. The ambient chromium concentration is 75 mg/kg. No hexavalent chromium was reported.

Additional Remedial Investigation 2002

Soil boring 09-SB05 was drilled to investigate the elevated lead concentration of 947 mg/kg reported in boring 09-SB03 during the phase I RI. The highest lead value reported from 09-SB05 was 76.2 mg/kg, identified in samples collected at a depth of 0.5 to 1.0 foot bgs. All other samples collected from soil boring 09-SB05 reported lead values below 10 mg/kg. Elevated arsenic concentrations were reported in three soil borings at a depth of 0.5 to 2.0 feet bgs. Soil boring 09-SB10 contained a concentration of 15.4 mg/kg; boring 09-SB12 contained a concentration of 16.9 mg/kg, and boring 09-SB18 contained a concentration of 17.7 mg/kg.

5.1.2 Groundwater Sample Results

Groundwater and wastewater analytical results generated at Site 09 are discussed in the following sections. Monitoring well 09-MW01 was the only monitoring well sampled during pre-2002 phases of the RI. Monitoring wells 09-MW02 through 09-MW07 were installed in 2002 and sampled once. All groundwater analytical results for Site 09 are presented in Tables 5-2 and 5-4 and Figures 5-5 through 5-8. Oil and drain results are provided in Table 5-3.

5.1.2.1 Volatile Organic Compounds

Analytical results for VOCs in groundwater at Site 09 are summarized in the following sections (Figure 5-5).

Phase I Remedial Investigation

Groundwater samples were not analyzed for VOCs during the phase I RI.

Phase II Remedial Investigation

Groundwater samples were not analyzed for VOCs during the phase II RI.

Quarterly Groundwater Monitoring

Monitoring well 09-MW01 was sampled for MTBE twice during quarterly sampling events. MTBE was not reported in either event.

Environmental Baseline Study Sampling

Monitoring well 09-MW01 was sampled for MTBE during the EBS. No MTBE was reported.

Additional Remedial Investigation 2002

Groundwater samples from all seven Site 09 monitoring wells were analyzed for VOCs during the additional RI. Only MTBE and M,P-xylenes were reported in water samples. MTBE was reported in samples collected from 09-MW02, 09-MW03, 09-MW04, and 09-MW05 at estimated concentrations of 0.3 microgram per liter (µg/L) in each sample. M,P-xylenes were reported at an estimated concentration of 0.3 µg/L in a sample collected from 09-MW05.

5.1.2.2 Total Petroleum Hydrocarbons

Analytical results for TPH constituents in groundwater at Site 09 are summarized in the following sections (Figure 5-5).

Phase I Remedial Investigation

Groundwater samples were not collected during the phase I RI.

Phase II Remedial Investigation

Groundwater samples collected from hydropunch borings 09-HP001, 09-HP006, 09-HP007, 09-HP008, and monitoring well 09-MW01 were analyzed for TPH during the phase II RI. TPH constituents were reported in samples from hydropunch boring 09-HP001 and monitoring well 09-MW01. The highest concentrations of TPH were found in hydropunch boring 09-HP001, TPH-d concentrations of 0.42 mg/L and TPH-m concentrations of 0.78 mg/L.

Quarterly Groundwater Sampling

TPH-m was reported at a maximum concentration of 0.088 mg/L in monitoring well 09-MW01. TPH-d was not reported in any sample during the quarterly groundwater monitoring.

Environmental Baseline Study Sampling

Monitoring well 09-MW01 was sampled for TPH-p during the EBS. No TPH constituents were reported during the EBS sampling.

Additional Remedial Investigation 2002

All groundwater samples collected from Site 09 monitoring wells were analyzed for TPH during the additional RI completed in 2002. No TPH constituents were reported from any groundwater samples collected. TPH in groundwater is presently at nondetectable levels. TPH contamination identified in soils at Site 09 does not appear to be affecting groundwater.

5.1.2.3 Semivolatile Organic Compounds

Analytical results for SVOCs in groundwater at Site 09 are summarized in the following sections (Figure 5-6).

Phase I Remedial Investigation

No groundwater samples were collected during the phase I RI.

Phase II Remedial Investigation

Groundwater samples collected from hydropunch borings 09-HP001, 09-HP006, 09-HP007, 09-HP008, and monitoring well 09-MW01 were analyzed for SVOCs. SVOCs were not reported in any samples collected during the phase II RI.

A wastewater sample was collected from the paint booth catch basin inside Building 41. Phenol was reported in the sample at an estimated concentration of 14 µg/L, and 4-methylphenol was reported at a concentration of 62 µg/L.

Quarterly Groundwater Monitoring

SVOCs were not reported in any samples collected during quarterly groundwater monitoring events.

Environmental Baseline Study Sampling

SVOCs were not analyzed in soil samples collected during the EBS sampling event.

Additional Remedial Investigation 2002

SVOCs were reported in all samples collected from Site 09 monitoring wells during the 2002 RI. The use of available lower analytical detection levels for groundwater samples collected during the additional RI allowed for SVOCs to be identified at relatively low (generally estimated) levels in all on-site monitoring wells. Relative to other samples, phenol was reported at an elevated concentration of 8.8 µg/L in samples collected from 09-MW02. Phenol was also reported in all monitoring wells except monitoring well 09-MW01. In samples from monitoring well 09-MW05, acenaphthene was reported at a concentration pf 1.1 µg/L, and dibenzofuran was reported at a concentration of 2.5 µg/L. These SVOCs were the only SVOCs reported above estimated levels.

5.1.2.4 Pesticides and Polychlorinated Biphenyls

Groundwater samples were analyzed for pesticides and PCBs only during the additional RI. Samples from all seven wells were analyzed for pesticides and PCBs. Three pesticides were reported in samples analyzed from the 2002 sampling event. Alpha chlordane was reported in a sample from monitoring well 09-MW05 at a concentration of 0.0067 µg/L. Endosulfan II and gamma-Benzenehexachloride (lindane) were reported in a sample from monitoring well 09-MW07 at concentrations of 0.014 and 0.0071 µg/L, respectively.

PCBs were not reported in groundwater samples from Site 09. Pesticide and PCB concentrations for Site 09 groundwater samples are shown in Figure 5-7.

5.1.2.5 Metals

Ambient levels of metals in groundwater have been established for metals at NAVSTA TI (Table 2-6, Appendix G). Groundwater samples collected at Site 09 since the RI began, have contained concentrations of metals that exceeded all ambient levels in one well or another. Concentrations of metals from samples collected using low-flow sampling techniques, however, exhibit lower concentrations compared to sample results collected using bailers.

Groundwater samples were not collected during the phase I RI. Samples collected in 1995 during phase II RI from monitoring well 09-MW01 were collected with a bailer, and many of the ambient levels were exceeded. Using low-flow sampling methods in 2001, none of the ambient levels were exceeded in samples collected from 09-MW01. Metal concentrations decreased during the quarterly monitoring events once low-flow sampling was instituted, providing groundwater data that were more representative of aquifer conditions. It appears that most elevated metal concentrations are associated with sampling methods that disturb the sediment in the bottom of the well and introduce metals attached to colloidal material into the water sample. Samples collected using low-flow methods such as a peristaltic pump or bladder pump reduce the amount of suspended material in the water column, thereby producing a more representative sample of groundwater conditions in the aquifer.

During the phase II RI, groundwater samples collected from all hydropunch borings were analyzed for lead. The highest lead concentration, 9.2 µg/L, was reported in a sample collected from hydropunch boring 09-HP002. Samples collected from groundwater monitoring well 09-MW01 were analyzed for total metals. Reported metal concentrations for Site 09 groundwater samples are shown in Figure 5-8.

A wastewater sample collected from the paint booth catch basin inside Building 41 was analyzed for metals. Lead was reported at a concentration of 405 µg/L, and arsenic was reported at a concentration of 3.5 µg/L.

Low-flow sampling methods were used to collect groundwater samples at Site 09 during the additional RI. Iron concentrations exceeded the ambient level of 200 µg/L in all samples collected from the new wells, and a maximum concentration of 3,930 µg/L was reported in samples collected from monitoring well 09-MW05. Aluminum exceeded the ambient concentration of 27 µg/L in three wells, and a maximum concentration of 2,040 µg/L was reported in samples collected from monitoring well 09-MW05. Chromium exceeded its ambient level of 0.13 µg/L in samples from monitoring well 09-MW05 at a concentration of 9.8 µg/L. Ambient lead levels of 2.0 µg/L were exceeded in one sample from monitoring well 09-MW04 at a concentration of 4.03 µg/L. Ambient nickel levels of 5.8 µg/L were exceeded in one sample from monitoring well 09-MW05 at a concentration of 11.9 µg/L. While reported results exceeded the ambient concentrations in groundwater samples collected from newly installed monitoring wells, the levels were generally low compared to earlier monitoring events of 09-MW01 and within ranges reported at other sites.

5.2 SITE 10

Areas adjacent to Building 335 at Site 10 where disposal of hazardous wastes most likely occurred were identified in the PA/SI. Handling practices reported at similar sites on NAVSTA TI indicated that waste paints, thinners, and solvents may have been released onto the ground near Building 335. Building 335 was also reportedly used for storage, mixing, and handling of pest control solutions (pesticides and chlorinated herbicides). It was also reported that Building 335 housed a self-service steam rack used to clean vehicles, drums, and related equipment. A floor drain in the building possibly drained cleaning fluids to the storm water sewer system.

During the phase I RI, 12 soil samples collected from four soil borings (10-SB01 to 10-SB04) were analyzed for VOCs, SVOCs, metals, pesticides/PCBs, chlorinated herbicides and TPH-e. During the phase II RI, 20 hydropunch soil borings and one groundwater monitoring well were installed. Two to three soil samples were collected from hydropunch borings 07/10-HP001 through 07/10-HP013. Samples were first screened for total TPH and total PAHs using immunoassay field screening methods. Groundwater samples collected from each boring were field screened for total TPH. Based on field screening results, selected soil and groundwater samples were sent for off-site laboratory analyses for VOCs, SVOCs, pesticides, chlorinated herbicides, metals, and TPH-e. Only groundwater samples were collected from hydropunch borings 07/10-014 through 07/10-HP020. Samples collected from 07/10-HP014 and 07/10-HP015 were analyzed for SVOCs and TPH-e. Samples collected from 07/10-HP016 through 07/10-HP020 were field screened for TPH.

Two quarterly groundwater samples were collected from 10-MW01 and analyzed for VOCs, SVOCs, pesticides/PCBs, chlorinated herbicides, metals, TDS, and TPH-e.

In addition, two catch basins were sampled to check for contamination from storm water drainage from the site. Two sediment samples and one water sample collected from the catch basins were analyzed for VOCs, SVOCs, pesticides/PCBs, chlorinated herbicides, lead, TPH-e, and TPH-p.

Three shallow soil borings were drilled on the south side of Building 335 during the EBS to investigate possible subsurface contamination adjacent to catch basins on that side of the building. These soil samples were collected from 7.5 to 9 feet bgs and analyzed for BTEX, MTBE, SVOCs, pesticides, metals, TPH-p, and TPH-e. The three soil borings installed were SS-6-01, SS-6-02, and SS-6-03. No groundwater samples were collected at Site 10 as part of the EBS.

During the additional RI completed in 2002, 25 soil borings and two groundwater monitoring wells were installed at Site 10. Three soil samples were collected from each boring from the surface down to the water table. Nine of the borings were located on the east side of the building to investigate PAH soil contamination reported during the previous investigations. Samples were analyzed for SVOCs only. Twelve soil borings were drilled, and one monitoring well was installed on the north side of Building 335 to investigate previously reported pesticide contamination. Samples were analyzed for pesticides only. Two soil borings and one monitoring well were installed inside Building 335 to investigate the former floor drain area. Samples from inside the building were analyzed for VOCs, SVOCs, pesticides/PCBs, metals, TPH-e, and TPH-p. Two soil borings were also drilled on the south side of the building to investigate a discolored surface area identified in historic aerial photographs. Samples from the discolored area were analyzed for VOCs, SVOCs, pesticides/PCB, metals, TPH-e, and TPH-p.

One additional monitoring well (14-MW03) was installed at Site 10 during the RI at Site 14. Monitoring wells 07/10-MW01 and 14-MW03 were sampled during quarterly basewide groundwater monitoring events, but monitoring well 07/10-MW01 was accidentally destroyed

and subsequently abandoned. Monitoring wells 10-MW02 and 10-MW03 were installed during the 2002 additional RI and therefore only were sampled once.

5.2.1 Soil Sample Results

Analytical results for soil samples collected at Site 10 are included in Tables 5-5 and 5-8 and presented in Figures 5-9 through 5-13. Sediment and drain sample results are provided in Table 5-7. Soil and sediment analytical results are discussed in the following text.

5.2.1.1 Volatile Organic Compounds

Analytical results for VOCs in soil at Site 10 are summarized in the following sections (Figure 5-9).

Phase I Remedial Investigation

No VOCs were reported from soil samples collected from borings 10-SB01 through 10-SB04 during the phase I RI.

Phase II Remedial Investigation

Soil samples from borings 07/10-HP001 through 07/10-HP011 were analyzed for VOCs. No VOCs were reported from phase II RI soil analyses.

Sediment samples collected from catch basin C and catch basin 335R were also analyzed for VOCs. VOCs were not reported in the sample collected from catch basin C. The sample collected from catch basin 335R contained ethylbenzene at a concentration of 25 mg/kg; toluene at a concentration of 42 mg/kg; and xylene at a concentration of 160 mg/kg.

Environmental Baseline Study Sampling

Soil borings SS-6-01, SS-6-02, and SS-6-03 were sampled during the EBS. No VOCs were reported in samples analyzed.

Additional Remedial Investigation 2002

Soil samples from four soil borings (10-SB26 through 10-SB29) were analyzed for VOCs during the additional RI. Toluene was reported in the sample collected at 6.0 to 7.5 feet bgs from boring 10-SB28 at a concentration of 0.002 mg/kg. Toluene was reported in the sample collected at 0.5 to 2.0 feet bgs from 10-SB29 at a concentration of 0.00068 mg/kg.

5.2.1.2 Total Petroleum Hydrocarbons

Analytical results for TPH constituents in soil at Site 10 are summarized in the following sections (Figure 5-9).

Phase I Remedial Investigation

Soil samples from borings 10-SB01 through 10-SB04 were analyzed for TPH-d during the phase I RI. Only one sample, from the 6.0- to 6.5-foot bgs interval in boring 10-SB04, contained reportable TPH-d concentrations at 185 mg/kg.

Phase II Remedial Investigation

Soil samples from borings 07/10-HP002, 004, 006, 007, 008, 010, 011, 012, and 013 were analyzed for TPH. TPH constituents were reported in 4 of 13 samples analyzed for TPH-e during the phase II RI. TPH-m was reported in samples from hydropunch boring 07/10-HP010 at a concentration of 330 mg/kg (1.0 to 1.5 feet bgs); in hydropunch boring 07/10-HP011 at a concentration of 1,400 mg/kg (1.25 to 1.75 feet bgs); in hydropunch boring 07/10-HP012 at a concentration of 83 mg/kg (.25 to .75 feet bgs); and in hydropunch boring 07/10-HP013 at a concentration of 1,200 mg/kg (.75 to 1.25 feet bgs). TPH-d was reported in one near surface sample (.25 to .75 feet bgs) from hydropunch boring 07/10-HP012 at a concentration of 36 mg/kg. Results from TPH-i also reported TPH concentrations between 15 and 100 parts per million (ppm) in samples collected from hydropunch borings 07/10-HP004, 07/10-HP008, and 07/10-HP009. Laboratory analyses for the verification sample from hydropunch boring 07/10-HP008 did not report TPH. Laboratory analyses were not performed on the corresponding samples from 07/10-HP004 and 07/10-HP009. Immunoassay field screening results for Site 10 is listed in Table 5-8.

TPH-m was reported in the sediment samples collected from catch basins C at a concentration of 5,700 mg/kg and from catch basin 335R at a concentration of 19,000 mg/kg. These catch basins have been cleaned out (PRC 1997b).

Environmental Baseline Study Sampling

TPH constituents were identified in one sample collected during the EBS. One soil sample collected from boring SS-6-01 reported a TPH-m concentration of 9.9 mg/kg in the 7.5- to 8.0-foot bgs interval.

Additional Remedial Investigation 2002

Soil samples collected from borings 10-SB26 through 10-SB29 were analyzed for TPH constituents. Samples from boring 10-SB28 had reported TPH-m concentrations ranging from 4.6 mg/kg in the 6.0- to 7.5-foot bgs interval to 390 mg/kg in the 0.5- to 2.0-foot bgs interval. TPH-d was reported in the same boring at 34 mg/kg in the 0.5- to 2.0-foot interval. All reported

concentrations are below the NAVSTA TI residential screening criteria of 1,900 mg/kg for TPH-m and 1,400 mg/kg for TPH-d. Risk associated with TPH constituents are assessed in the HHRA (Section 7.0) and ERA (Section 8.0).

5.2.1.3 Semivolatile Organic Compounds

Analytical results for SVOCs in soil at Site 10 are summarized in the following sections (Figure 5-10).

Phase I Remedial Investigation

Samples from all four phase I borings were analyzed for SVOCs, and SVOCs were reported in one sample. The soil sample from boring 10-SB03 in the 6.0- to 6.5-foot bgs interval reported concentrations of fluoranthene, phenanthrene, and pyrene at 1 mg/kg, chrysene at a concentration of 0.52 mg/kg, benzo(a)anthracene at a concentration of 0.38 mg/kg, and benzo(a)pyrene and benzo(b)fluoranthene at concentrations of 0.3 and 0.27 mg/kg, respectively.

Phase II Remedial Investigation

Soil samples from borings 07/10-HP002, 004, 006, 007, 008, 010, 011, 012, and 013 were analyzed for SVOCs. Phenol was the only SVOC reported in soil samples during the phase II RI. Phenol concentrations ranged from 0.21 to 1.6 mg/kg and were reported in most samples. PAH-i was also performed on select samples. PAH concentrations between 1.0 and 5.0 ppm were reported in samples from hydropunch borings 07/10-HP004 and 07/10-HP010. Although laboratory analyses for samples from 07/10-HP010 did not report PAHs, corresponding samples from 07/10-HP004 were not analyzed at the laboratory.

The sediment samples from catch basins C and 335R were also analyzed for SVOCs. The sample from catch basin C reported bis(2-ethylhexyl) phthalate at a concentration of 3.7 mg/kg, butylbenzylphthalate at a concentration of 37 mg/kg, and di-n-octylphthalate at a concentration of 0.5 mg/kg. The sample from catch basin 335R reported 4-methylphenol at a concentration of 12 mg/kg.

Environmental Baseline Study Sampling

No SVOCs were reported in samples collected during the EBS.

Additional Remedial Investigation 2002

Nine soil borings (10-SB15 through 10-SB018, 10-SB21 through 10-SB25) drilled during the additional RI were centered around the phase I RI boring 10-SB03 to evaluate the horizontal and vertical extent of PAH contamination previously detected in this soil boring.

SVOCs were reported in soil samples from 8 of the 9 borings collected around 10-SB03. The highest SVOC concentrations were reported in soil boring 10-SB17 from the 6.0- to 7.5-foot bgs interval. These concentrations included anthracene at 0.17 mg/kg, benzo(a)anthracene at 0.29 mg/kg, benzo(a)pyrene at 0.3 mg/kg, benzo(b)fluoranthene at 0.16 mg/kg, benzo(g,h,i) perylene at 0.25 mg/kg, and benzo(k)fluoranthene at 0.25 mg/kg. In general, SVOC concentrations in other borings were approximately 1 order of magnitude less than concentrations reported in boring 10-SB17. Soil boring 10-SB24, located adjacent to the former boring 10-SB03, reported low concentrations of benzo(g,h,i)perylene (0.024 mg/kg), chrysene (0.015 mg/kg), and pyrene (0.05 mg/kg) in the 6.0- to 7.5-foot bgs sample interval.

Four additional borings (10-SB26 through 10-SB29) were also sampled for SVOCs to investigate previously undocumented areas around the former floor drain in Building 335 and the discolored area on the south side of the building. SVOCs were reported in soil samples from 3 of the 4 borings collected. In general, low-level SVOCs were reported, with the exception of 12 mg/kg of bis(2-ethylehexyl)phthalate at 3.5 to 5.0 feet bgs from 10-SB27. In general, low-level SVOC soil contamination exists at the site from the surface to the groundwater table.

5.2.1.4 Pesticides and Polychlorinated Biphenyls

Analytical results for pesticides and PCBs in soil at Site 10 are summarized in the following sections (Figure 5-11).

Phase I Remedial Investigation

Soil samples from all phase I borings were analyzed for pesticides/PCBs. No PCBs were reported in soil samples collected during the phase I RI. The pesticides endrin aldehyde and endrin ketone were reported in a sample collected from boring 10-SB02 at 3.0 to 3.5 feet bgs at concentrations of 0.128 mg/kg and 0.014 mg/kg, respectively. The pesticides 4,4-dichlorodiphenyldichloroethane (DDD) and DDT were reported in the sample collected from boring 10-SB03 at 1.0 to 1.5 feet bgs at concentrations of 0.0038 mg/kg and 0.0054 mg/kg respectively.

Phase II Remedial Investigation

Soil samples from borings 07/10-HP001, 002, 004, 006, 012, and 013 were analyzed for pesticides/PCBs. PCBs were not reported in samples collected during the phase II RI. Pesticides were reported in samples from four boreholes (07/10-HP004, 07/10-HP006, 07/10-HP012 and 07/10-HP013). Alpha chlordane and gamma chlordane were reported in all four boring while DDD, 4,4-dichlorodiphenyldichloroethene (DDE), DDT, and heptachlor epoxide were each reported in at least one borehole. The highest concentrations of alpha and gamma chlordane, however, were reported in samples collected from 3.0 to 4.0 feet bgs in hydropunch boring 07/10-HP006 at concentrations of 2.1 and 1.9 mg/kg, respectively.

The sediment sample from catch basin C reported DDD at a concentration of 0.67 mg/kg, DDE at a concentration of 0.079 mg/kg, alpha chlordane at a concentration of 0.038 mg/kg, and gamma chlordane at a concentration of 0.042 mg/kg. The sediment sample from catch basin 335R reported DDE at a concentration of 0.079 mg/kg and beta-Benzenehexachloride at a concentration of 0.043 mg/kg.

Additional Remedial Investigation 2002

No PCBs were reported in any sample collected and analyzed during the 2002 additional RI. Samples from the 12 borings located on the north side of Building 335 and centered on former hydropunch boring location 07/10-HP006 were analyzed for pesticides during the additional RI. Pesticide analysis was also performed on samples from the two soil borings located inside Building 335 and the two soil borings located on the south side of the building in the discolored area. Pesticides were reported in samples collected from 11 of the 12 borings drilled around hydropunch boring 07/10-HP006. No pesticides were reported in soil samples collected from the borings located in Building 335 or in the discolored area south of the building.

Soil boring 10-SB19 was drilled immediately adjacent to the location of former hydropunch boring 07/10-HP006 installed during the phase II RI. Soil samples collected from hydropunch boring 07/10-HP006 reported alpha chlordane at a concentration of 2.1 mg/kg and gamma chlordane at a concentration of 1.9 mg/kg from the 3.0 to 4.0 feet bgs depth interval. Soil samples collected from soil boring 10-SB19 reported alpha chlordane at a concentration of 0.0018 mg/kg and gamma chlordane at a concentration of 0.026 mg/kg from the 3.5 to 5.0 feet bgs depth interval. While pesticides were identified at various depths above the water table, they were more prevalent in the near surface (0.5 to 2.0 foot bgs) interval. The highest concentrations of DDD (1 mg/kg), DDE (0.11 mg/kg), DDT (0.75 mg/kg), endosulfan sulfate (0.39 mg/kg), and endrin aldehyde (0.015 mg/kg) were found in a sample collected from 10-SB12 at 0.5 to 2.0 feet bgs. The highest concentrations of alpha-chlordane (0.3 mg/kg), gamma chlordane (0.36 mg/kg), heptachlor (0.041 mg/kg), and heptachlor-epoxide (0.016 mg/kg) were found in a sample collected from 10-SB07 at 0.5 to 2.0 feet bgs. All other pesticides were undetected.

5.2.1.5 Metals

Analytical results for metals in soil at Site 10 are summarized in the following sections (Figure 5-12). Ambient metals concentrations in dredged fill at NAVSTA TI are listed in Table 2-5 and Appendix F.

Phase I Remedial Investigation

Samples from all four phase I borings were analyzed for metals. Five metals were reported at elevated concentrations above the ambient concentration during the phase I RI. Beryllium was reported at a high concentration of 0.25 mg/kg in a sample from boring 10-SB02, slightly above its ambient concentration of 0.12 mg/kg. Chromium was reported above its ambient concentration of 75 mg/kg at a maximum concentration of 89.5 mg/kg in boring 10-SB02. Manganese was reported at a maximum concentration of 731 mg/kg, above its ambient

concentration of 550 mg/kg in boring 10-SB03. Silver was reported at a maximum concentration of 1.8 mg/kg, above the ambient concentration of 0.45 mg/kg in boring 10-SB02. Vanadium was reported at a maximum concentration of 39.1 mg/kg, above the ambient concentration of 33 mg/kg in boring 10-SB02.

Phase II Remedial Investigation

Soil samples from hydropunch borings 07/10-HP001, 07/10-HP002, 07/10-HP004, and 07/10-HP006 were analyzed for lead only during the phase II RI. The highest reported lead concentration in samples from the borings was 4.6 mg/kg from a sample collected at 1.3 to 2.0 feet bgs in hydropunch boring 07/10-HP004.

Soil samples collected from hydropunch borings 07/10-HP007, 07/10-HP008, 07/10-HP010, and 07/10-HP011 were analyzed for total metals. Antimony, lead, and zinc had reported concentrations above ambient concentrations in two samples. Antimony was reported in hydropunch boring 07/10-HP010 at a concentration of 6.1 mg/kg, slightly above its ambient concentration of 2.9 mg/kg. Lead was reported in hydropunch boring 07/10-HP010 at a concentration of 112 mg/kg and in hydropunch boring 07/10-HP011 at a concentration of 91.9 mg/kg, exceeding the ambient concentration of 21 mg/kg. Zinc was reported in hydropunch boring 07/10-HP010 at a concentration of 331 mg/kg and in hydropunch boring 07/10-HP011 at a concentration of 138 mg/kg, exceeding the ambient concentration of 94 mg/kg.

Sediment samples from catch basins C and 335R were analyzed for lead. Lead was reported in catch basin C at a concentration of 183 mg/kg and in catch basin 335R at a concentration of 97.7 mg/kg.

Environmental Baseline Study Sampling

All three soil samples collected for the EBS (SS-6-01, SS-6-02, and SS-6-03) were analyzed for total metals. Only two metals, molybdenum and thallium, were reported at concentrations above ambient concentrations. Molybdenum was reported at concentrations of 11.6 mg/kg in soil sample SS-6-01, 14.1 mg/kg in soil sample SS-6-02, and 11.6 mg/kg in soil sample SS—6-03, all above the ambient concentration of 2.0 mg/kg. Thallium was reported at a concentration of 1.1 mg/kg in the soil sample collected at location SS-6-03, slightly above the ambient level of 0.71 mg/kg.

Additional Remedial Investigation 2002

Soil samples collected from four boreholes installed during the 2002 RI, 10-SB26 through 10-SB29, were analyzed for metals. Only arsenic and beryllium were reported at concentrations above ambient concentrations. Arsenic was reported at a concentration of 12.7 mg/kg in borehole 10-SB27, slightly above the ambient concentration of 10 mg/kg. Beryllium was reported at a concentration of 0.18 mg/kg, slightly above the ambient concentration of 0.12 mg/kg in borehole 10-SB2.

5.2.1.6 Herbicides

Analytical results for herbicides in soil at Site 10 are summarized in the following sections.

Phase I Remedial Investigation

Soil samples collected from borings 10-SB02, 10-SB03, and 10-SB04 were analyzed for herbicides during the phase I RI (Figure 5-13). 4-(2,4-dichlorophenoxy)butanoic acid (2,4-DB) and dicamba were reported in samples collected from 10-SB03 at concentrations of 0.178 mg/kg and 0.0674 mg/kg, respectively. Dalapon was reported in the sample collected from 10-SB04 at a concentration of 0.105 mg/kg (Figure 5-13).

Phase II Remedial Investigation

During the phase II RI, soil samples from borings 07/10-HP001, 002, 004, and 006 were analyzed for herbicides. Dicamba was reported in one sample from boring 07/10-HP001 at an estimated concentration of 0.012 mg/kg from the sample collected at 7.0 to 7.5 feet bgs (Figure 5-13).

Environmental Baseline Study Sampling

Samples were not analyzed for herbicides during the EBS.

Additional Remedial Investigation 2002

Samples were not analyzed for herbicides during the additional RI.

5.2.2 Groundwater Sample Results

The results of groundwater and wastewater samples collected at Site 10 are discussed in the following sections. Groundwater monitoring wells 07/10-MW01 and 14-MW03 were sampled repeatedly during the pre-2000 phases of the RI. Monitoring wells 10-MW02 and 10-MW03 were installed during the 2002 RI and sampled once. All groundwater analytical results for Site 10 are presented in Table 5-6, Table 5-8, and Figures 5-14 through 5-17. Sediment and drain analytical results for Site 10 are presented in Table 5-7.

5.2.2.1 Volatile Organic Compounds

Analytical results for VOCs in groundwater at Site 10 are summarized in the following sections (Figure 5-14).

Phase I Remedial Investigation

Groundwater samples were not collected during the phase I RI.

Phase II Remedial Investigation

Groundwater samples were collected from borings 07/10-HP001, 002, 004, 006, 009, and 011, and monitoring well 07/10-MW01 during the phase II RI and analyzed for VOCs. Only one VOC was reported in groundwater. Chloroform was reported at a concentration of 2.0 µg/L in hydropunch 07/10-HP006.

A wastewater sample from catch basin C was analyzed for VOCs. Benzene was reported at a concentration of 8 µg/L, chloroform at a concentration of 1 µg/L, ethylbenzene at a concentration of 7 µg/L, toluene at a concentration of 34 µg/L, and total xylenes were reported at a concentration of 37 µg/L.

Quarterly Groundwater Sampling

Monitoring wells 07/10-MW01 and 14-MW03 were sampled during the quarterly monitoring events. Carbon disulfide was detected at estimated concentrations of 0.4 µg/L (07/10-MW01) and 0.03 µg/L (14-MW03). Tetrachloroethene (PCE) was reported at an estimated concentration of 0.09 µg/L (07/10-MW01). These compounds were detected in only one quarterly sample each. MTBE was reported in three samples from monitoring well 14-MW03 with concentrations ranging from 1.0 to 4.0 µg/L.

5.2.2.2 Total Petroleum Hydrocarbons

Analytical results for TPH constituents in groundwater at Site 10 are summarized in the following sections (Figure 5-14).

Phase I Remedial Investigation

No groundwater samples were collected during the phase I RI.

Phase II Remedial Investigation

Eight of eleven groundwater samples collected during the phase II RI were analyzed for TPH-d and TPH-m. Samples from borings 07/10-HP004, 009, 011, 012, 013, 014, and 015, and monitoring well 07/10-MW01 were analyzed for TPH constituents. The highest reported value of TPH-d was reported in hydropunch 07/10-HP012 at a concentration of 0.49 mg/L. The highest reported value of TPH-m was identified in boring 07/10-HP013 at a concentration of 0.21 mg/L. TPH-i in groundwater samples were nondetect.

The wastewater sample from catch basin C was analyzed for TPH. TPH-d was reported at a concentration of 1.3 mg/L, TPH-m was reported at a concentration of 1.1 mg/L, and TPH-p was reported at a concentration of 0.489 mg/L.

Quarterly Groundwater Sampling

Monitoring wells 07/10-MW01 and 14-MW03 were sampled for TPH-d and TPH-m during the quarterly groundwater sampling events. As with previous sampling, only minimal levels of TPH were reported with a maximum concentration of 0.3 mg/L. TPH as gasoline was also analyzed in samples from monitoring well 14-MW03. The maximum concentration reported was 0.03 mg/L.

Additional Remedial Investigation 2002

Samples from only one monitoring well, 10-MW03, were analyzed for TPH during the additional RI completed in 2002. TPH constituents were not reported. TPH contamination has not been a chemical of concern during the RI.

5.2.2.3 Semivolatile Organic Compounds

Analytical results for SVOCs in groundwater at Site 10 are summarized in the following sections (Figure 5-15).

Phase I Remedial Investigation

Groundwater samples were not collected during the phase I RI.

Phase II Remedial Investigation

Samples collected from borings 07/10-HP004, 009, 011, 012, 013, 014, and 015, and monitoring well 07/10-MW01 were analyzed for SVOCs. SVOCs were not reported in any groundwater samples collected during the phase II RI.

The wastewater sample from catch basin C contained 4-methylphenol at 17 µg/L and naphthalene at 6 µg/L.

Quarterly Groundwater Sampling

SVOCs were not reported in any quarterly groundwater sampling events.

Environmental Baseline Study Sampling

Groundwater samples were not collected at Site 10 during the EBS.

Additional Remedial Investigation 2002

Based on the lack of reported SVOCs in previously investigated areas of the site, only monitoring well 10-MW03 was sampled for SVOCs. Monitoring well 10-MW03 is located next to the former floor drain inside Building 335, an area that has not been previously investigated. Three SVOCs were reported in the sample from monitoring well 10-MW03; fluoranthene, phenol, and pyrene were reported at concentrations of 0.031 µg/L, 0.11 µg/L, and 0.034 µg/L, respectively. All reported values were estimated.

5.2.2.4 Pesticides and Polychlorinated Biphenyls

Analytical results for pesticides and PCBs in groundwater at Site 10 are summarized in the following sections (Figure 5-16).

Phase I Remedial Investigation

Groundwater samples were not collected during the phase I RI.

Phase II Remedial Investigation

Samples collected from borings 07/10-HP001, 002, 004, 006, 012, and 013, and monitoring well 07/10-MW01 were analyzed for pesticides/PCBs during the phase II RI. PCBs were not reported in groundwater samples collected during the phase II RI. A groundwater sample collected from hydropunch boring 07/10-HP006 was the only sample to contain reported pesticides during the phase II RI. Alpha chlordane and gamma-chlordane were reported at concentrations of 0.12 µg/L and 0.1 µg/L, respectively.

Quarterly Groundwater Monitoring

PCBs and pesticides were not reported during any of the quarterly monitoring events.

Additional Remedial Investigation 2002

Monitoring well 10-MW02 was installed to evaluate pesticide contamination reported in samples collected from hydropunch boring 07/10-HP006 during the phase II RI. No pesticides were reported in the groundwater sample collected from monitoring well 10-MW02 using laboratory detection limits much lower than the limits used during the phase II RI. The groundwater sample from monitoring well 10-MW02 was not analyzed for PCBs.

Groundwater samples from monitoring well 10-MW03 were analyzed individually for both pesticides and PCBs. Neither contaminant was reported present in groundwater.

5.2.2.5 Metals

Ambient levels for metals in groundwater have been established at NAVSTA TI (Table 2-6, Appendix G). Groundwater samples collected at Site 10 during various sampling events since the RI began contained reportable concentrations of metals in groundwater that exceeded all 12 ambient levels in at least one well. Concentrations of metals from samples collected using low-flow sampling techniques, however, exhibit lower concentrations compared to sample results collected using bailers.

Groundwater samples were not collected during the phase I RI. Samples collected in 1995 from monitoring well 14-MW03 were collected with a bailer, and all 11 ambient levels were exceeded. A filtered groundwater sample collected in 1998 from monitoring well 07/10-MW01 contained concentrations of aluminum (31.1 µg/L) and arsenic (20.6 µg/L) that slightly exceeded ambient levels. Using low-flow sampling methods in 2001, as described in Section 5.2.1.5, none of the ambient levels was exceeded in samples collected from monitoring well 14-MW03. Metal concentrations decreased during the quarterly monitoring events once low-flow sampling was instituted, providing groundwater data that were more representative of aquifer conditions. All reported metals concentrations in groundwater for Site 10 are shown in Figure 5-17.

Additional Remedial Investigation 2002

Low-flow sampling methods were used to collect groundwater samples from monitoring well 10-MW03 at Site 09 during the additional RI. Aluminum, chromium, and lead, were the only metals exceeding ambient levels with concentrations of 349 µg/L, 3.6 µg/L, and 1,030 µg/L respectively. Groundwater samples collected using low-flow methods did not show metals levels to be a contaminant of concern at Site 10.

5.2.2.6 Herbicides

Groundwater samples collected from borings 07/10-HP001, 002, 004, and 006 and monitoring well 07/10-MW01 were analyzed for herbicides during the phase II RI. Groundwater samples from monitoring well 07/10-MW01 were also analyzed for herbicides during three additional quarterly monitoring events. No herbicides were reported in groundwater samples at Site 10.

5.3 QUALITY CONTROL

Quality control (QC) samples collected for this RI included field duplicates for groundwater, equipment rinsate samples, and trip blanks. The use of field duplicates for soils and laboratory QC are also discussed in this section.

5.3.1 Field Duplicates

Field duplicate samples are collected at the same time and from the same source as environmental samples and then submitted as separate samples to the laboratory for analysis. Groundwater samples 30209GW01001 and 30209GW20001 were collected as duplicates. Combined field and laboratory precision is evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a relative percent difference (RPD).

$$RPD = \frac{|A - B|}{(A + B)/2} \; x \; 100$$

where A = first duplicate concentration
B = second duplicate concentration

No RPDs were obtained for field duplicate samples 30209GW01001 and 30209GW20001 because sample results were nondetected.

Although field duplicate solid matrix samples are sometimes collected as samples from adjacent locations, the SAP (Tetra Tech 2002e) specified that duplicate samples would not be collected. There are two reasons. First, since adjacent samples incorporate some spatial variability, these samples cannot be used directly to assess sampling precision; in addition, it is not practical to set QC limits for the RPD of such samples, which precludes the use of these samples for QC purposes. Second, while the spatial variability information that can be obtained from adjacent sediment samples may be useful in assessing or implementing remedial options, no DQOs relating to these data uses were identified in the SAP (Tetra Tech 2002e).

5.3.2 Equipment Rinsate Samples

Equipment rinsate samples demonstrate whether decontamination procedures are effective in removing contaminants from the field sampling equipment. The presence of contamination in equipment rinsate samples indicates that cleaning procedures were not effective, allowing for the possibility of cross-contamination.

All but the following five equipment rinsate samples for this RI exhibited nondetect values for all analytes:

- Sample 30209GW10001, collected on October 23, 2002. This sample contained reportable concentrations of pentachlorophenol and phenol. The RI data were not affected by the blank levels because the sample results were greater than 5 times the maximum blank contamination or were nondetected. In addition,

calcium, iron and zinc were reported. Only results less than 5 times the maximum blank contamination were qualified.

- Sample 30209GW10002, collected on October 24, 2002. This sample contained reportable concentrations of fluoranthene, phenanthene, naphthalene, and pyrene. The RI data were not affected by the equipment rinsate blank contamination because associated sample results were above the action level or were nondetected. In addition, calcium, lead, and molybdenum were reported. For the RI data, results less than 5 times the maximum blank contamination were qualified.
- Sample 30209GW10003, collected on October 25, 2002. This sample contained reportable concentrations of dibenzofuran, fluorine, phenanthrene, anthracene, fluoranthene, pyrene, chrysene, carbazole, calcium, iron, magnesium, molybdenum, and sodium. Results less than 5 times the maximum blank contamination were qualified.
- Sample 30209GW10007, collected on November 1, 2002. This sample contained reportable concentrations of chloroform, bromodichloromethane, dibromochloromethane, and bromoform. The RI data were not affected because the sample results were nondetected.
- Sample 30210GW30001, collected on October 22, 2002. This sample contained reportable concentrations of pentachlorophenol, 4-chloro-3-methylphenol, phenanthrene, fluoranthene, and pyrene. The RI data were not affected because sample results were greater than 5 times the maximum blank contamination or were nondetected.

5.3.3 Trip Blanks

Trip blanks were prepared in the laboratory by pouring carbon-free (or distilled) water into the appropriate sample containers and including all appropriate preservative chemicals. The trip blank then traveled with the cooler and other sample containers from the laboratory to the field and back to the laboratory. The purpose of the trip blank sample is to monitor for introduced contamination of VOCs from the field to the laboratory. All trip blanks for this RI contained nondetected values for all analytes.

5.3.4 Instrument Calibration and Frequency

All field equipment was operated, maintained, calibrated, and standardized in accordance with the EPA and manufacturer's recommended procedures. The equipment was calibrated at the beginning of each day and checked throughout the day as warranted. Calibration data were recorded in the field logbooks.

Laboratory instrument and equipment testing, inspection, and maintenance followed the EPA CLP statement of work for organic analysis, multimedia, multiconcentration (EPA 1999).

5.3.5 Laboratory Data Validation

A data validation review was completed for the October 2002 sampling data. Table 5-9 summarizes the results of the data validation review. All data were considered usable, and data quality was within acceptable limits, except as summarized in Table 5-9. A copy of the laboratory analytical data is provided in Appendix C for Site 09 and in Appendix D for Site 10. Copies of the laboratory data validation reports for the October 2002 sampling event are included as Appendix E. Data validation reports for sampling conducted before October 2002 are presented in previous reports (see Section 2.2).

TABLES

TABLE 5-1: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP003	09-HP003	09-HP004	09-HP004
Sample ID	199HH001	199HH004	199HH006	199HH007	199HH008	199HH009	199HH010
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995
Sample Depth	1.25 - 1.75	6.50 - 7.00	1.00 - 1.50	3.25 - 3.75	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75
Volatile Organic Compounds (mg/kg)							
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	21 Y	38,000 JY	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	85 Y	12,000 JY	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,4-DICHLOROBENZENE	< 0.38 U	< 12 U	NA	NA	NA	NA	NA
2-METHYLNAPHTHALENE	< 0.38 U	< 12 U	NA	NA	NA	NA	NA
ACENAPHTHENE	< 0.38 U	< 12 U	NA	NA	NA	NA	NA
BENZO(A)ANTHRACENE	< 0.38 U	< 12 UJ	NA	NA	NA	NA	NA
BENZO(A)PYRENE	< 0.38 U	12 R *	NA	NA	NA	NA	NA
BENZO(B)FLUORANTHENE	< 0.38 U	12 R *	NA	NA	NA	NA	NA
BENZO(G,H,I)PERYLENE	< 0.38 U	12 R *	NA	NA	NA	NA	NA
BENZO(K)FLUORANTHENE	< 0.38 U	12 R *	NA	NA	NA	NA	NA
CHRYSENE	< 0.38 U	< 12 UJ	NA	NA	NA	NA	NA
DIBENZ(A,H)ANTHRACENE	< 0.38 U	12 R *	NA	NA	NA	NA	NA
DIBENZOFURAN	< 0.38 U	< 12 U	NA	NA	NA	NA	NA
FLUORANTHENE	< 0.38 U	< 12 UJ	NA	NA	NA	NA	NA
FLUORENE	< 0.38 U	< 12 U	NA	NA	NA	NA	NA

TABLE 5-2: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP004	09-HP005	09-HP006	09-HP007
Sample ID	199HH502	199HH501	199HH503	199HH504	199HH505	199HH506	199HH507
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	08/08/1995
Volatile Organic Compounds (µg/L)							
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
None Detected	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	0.42 Y	NA	NA	NA	NA	< 0.1 U	< 0.1 U
MOTOR OIL RANGE ORGANICS	0.78 Y	NA	NA	NA	NA	< 0.1 U	< 0.1 U
Gasoline Range (purgeables)							
None Detected	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)							
2-METHYLNAPHTHALENE	< 10 U	NA	NA	NA	NA	< 10 U	< 10 U
2-NITROPHENOL	< 10 U	NA	NA	NA	NA	< 10 U	< 10 U
ACENAPHTHENE	< 10 U	NA	NA	NA	NA	< 10 U	< 10 U
DIBENZOFURAN	< 10 U	NA	NA	NA	NA	< 10 U	< 10 U
FLUORENE	< 10 U	NA	NA	NA	NA	< 10 U	< 10 U
NAPHTHALENE	< 10 U	NA	NA	NA	NA	< 10 U	< 10 U
PENTACHLOROPHENOL	< 25 U	NA	NA	NA	NA	< 25 U	< 25 U
PHENANTHRENE	< 10 U	NA	NA	NA	NA	< 10 U	< 10 U
PHENOL	< 10 U	NA	NA	NA	NA	< 10 U	< 10 U
PYRENE	< 10 U	NA	NA	NA	NA	< 10 U	< 10 U
PCBs/Pesticides (µg/L)							
PCBs							
None Detected	NA	NA	NA	NA	NA	NA	NA
Pesticides							
ALPHA-CHLORDANE	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN II	NA	NA	NA	NA	NA	NA	NA
GAMMA-BHC (LINDANE)	NA	NA	NA	NA	NA	NA	NA
Metals (µg/L)							
Unfiltered							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA

TABLE 5-3: ANALYTICAL RESULTS FOR SITE 09 OIL AND DRAIN SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	FLOOR DRAIN
Sample ID	199HH510
Sample Date	8/7/1995
Matrix	SWATER
Semivolatile Organic Compounds (µg/L)	
4-METHYLPHENOL	62
PHENOL	14 J
Metals (µg/L)	
ALUMINUM	29,100
ANTIMONY	9.3
ARSENIC	3.5 J
BARIUM	754
BERYLLIUM	0.15 J
CADMIUM	11.5
CALCIUM	96,600
CHROMIUM	45.6
COBALT	9.3 J
COPPER	200
IRON	88,600
LEAD	405
MAGNESIUM	10,000
MANGANESE	1,160
MERCURY	1.1
NICKEL	30.8 J
POTASSIUM	5,340
SELENIUM	4 J
SILVER	1.2 J
SODIUM	59,100
VANADIUM	4.8 J
ZINC	3,280 J

Sample Location ID	TRENCH OIL
Sample ID	199HH511
Sample Date	8/15/1995
Matrix	PRODUCT
PCBs (mg/kg)	
None Detected	ND

Notes: Categories of analyses are shown, but only detected compounds are presented.

ID Identification
J Estimated value
mg/kg Milligram per kilogram
ND None detected
µg/L Microgram per liter

TABLE 5-4: ANALYTICAL RESULTS FOR SITE 09 IMMUNOASSAY ANALYSES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Location	Sample	Depth	Lab	Field	Compare	Lab	Field	Compare	Lab		Field	Compare
			PCB (ppm)	PCB (ppm)	PCB	PAH (ppm)	PAH (ppm)	PAH	Diesel (ppm)	Oil (ppm)	TPH (ppm)	TPH
HP001	199HH001	1.25 - 1.75	< 0.16	< 0.5	M	< 0.76	< 1.0	M	21	85	< 15	FN
HP001	199HH005	5.5 - 6.0		< 0.5			< 1.0				< 15	
HP001	199HH502	Water		--	--		--		0.42	0.78	0.25 - 2.5	M
HP002	199HH002	1.0 - 1.5		< 0.5			< 1.0				< 15	
HP002	199HH003	5.5 - 6.0		< 0.5			< 1.0				< 15	
HP002	199HH004	6.5 - 7.0		--	--	24	--		38,000	12,000	--	
HP002	199HH501	Water		--			--				0.25 - 2.5	
HP003	199HH006	1.0 - 1.5	< 0.038	0.5 - 1.0	FP		< 1.0				< 15	
HP006	199HH506	Water		--			--		< 0.10	< 0.10	< 0.25	M
HP007	199HH507	Water		--			--		< 0.10	< 0.10	< 0.25	M
HP008	199HH508	Water		--			--		< 0.10	< 0.10	< 0.25	M

Notes:

PAH - Soil Data Comparison

Number of soil data comparisons	1
Percentage of matching (M) field screening results	100%
Percentage of false negative (FN) results	0%
Percentage of false positive (FP) results	0%

TPH - Soil Data Comparison

Number of soil data comparisons	1
Percentage of matching (M) field screening results	0%
Percentage of false negative (FN) results	100%
Percentage of false positive (FP) results	0%

PCB - Soil Data Comparison

Number of soil data comparisons	2
Percentage of matching (M) field screening results	50%
Percentage of false negative (FN) results	0%
Percentage of false positive (FP) results	50%

TPH - Water Data Comparison

Number of soil data comparisons	4
Percentage of matching (M) field screening results	100%
Percentage of false negative (FN) results	0%
Percentage of false positive (FP) results	0%

Data Comparison: Field TPH results were compared to laboratory diesel results

- M Field and laboratory results match
- FN False negative (field result less than laboratory result)
- FP False positive (field result greater than laboratory result)

Abbreviations:

- Lab Analysis performed by off-site analytical laboratory
- Field Analysis performed using on-site field screening analysis
- PAH Polycyclic aromatic hydrocarbon
- PCB Polychlorinated biphenyls
- TPH Total petroleum hydrocarbons as diesel
- ppm Parts per million; milligrams per kilogram for soil samples; milligrams per liter for water samples
- < The result is not detected; the value reported is the detection limit
- -- Not analyzed/No comparison applicable

Blank spaces indicate that either analyses was not performed or no comparison was made

TABLE 5-5: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP001	07/10-HP002	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP004
Sample ID	199AA082	199AA083	199AA084	199AA085	199AA089	199AA090	199AA091
Sample Date	06/09/1995	06/09/1995	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50	1.25 - 1.50	7.25 - 7.75	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
Volatile Organic Compounds (mg/kg)							
TOLUENE	< 0.01 U	< 0.011 U	< 0.01 U	< 0.011 U	< 0.01 U	< 0.011 U	< 0.011 U
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	< 11 U	NA	NA	< 11 U
MOTOR OIL RANGE ORGANICS	NA	NA	NA	< 11 U	NA	NA	< 11 U
Gasoline Range (purgeables)							
None Detected	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
4-CHLOROANILINE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
ACENAPHTHYLENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
ANTHRACENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
BENZO(A)ANTHRACENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
BENZO(A)PYRENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
BENZO(B)FLUORANTHENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
BENZO(G,H,I)PERYLENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
BENZO(K)FLUORANTHENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
CHRYSENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
FLUORANTHENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
FLUORENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
PHENANTHRENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
PHENOL	NA	NA	NA	< 0.37 U	NA	NA	0.23 J
PYRENE	NA	NA	NA	< 0.37 U	NA	NA	< 0.36 U
PCBs/Pesticides (mg/kg)							
PCBs							
None Detected	ND	ND	ND	ND	ND	ND	ND
Pesticides							
4,4'-DDD	< 0.0034 U	< 0.0035 U	< 0.0035 U	< 0.0037 U	< 0.0035 U	< 0.0035 U	0.0019 J

TABLE 5-6: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP006	07/10-HP009	07/10-HP011
Sample ID	199AA529	199AA530	199AA533	199AA534	199AA536	199AA539	199AA541
Sample Date	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995
Volatile Organic Compounds (µg/L)							
CARBON DISULFIDE	< 0.5 U	< 0.5 U	< 0.5 U	< 0.5 U	< 0.5 U	< 0.5 U	< 0.5 U
CHLOROFORM	< 0.5 UJ	< 0.5 U	< 0.5 UJ	< 0.5 UJ	2	< 0.5 U	< 0.5 U
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	< 0.5 U	< 0.5 U	< 0.5 U	< 0.5 U	< 0.5 U	< 0.5 U	< 0.5 U
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	< 0.1 U	< 0.1 U	NA	< 0.1 U	< 0.1 U
MOTOR OIL RANGE ORGANICS	NA	NA	< 0.1 U	< 0.1 U	NA	0.086 JY	0.086 JY
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)							
FLUORANTHENE	NA	NA	< 10 U	< 10 U	NA	< 10 U	< 10 U
PHENOL	NA	NA	< 10 U	< 10 U	NA	< 10 U	< 10 U
PYRENE	NA	NA	< 10 U	< 10 U	NA	< 10 U	< 10 U
PCBs/Pesticides (µg/L)							
PCBs							
None Detected	ND	ND	ND	ND	ND	NA	NA
Pesticides							
ALPHA-CHLORDANE	< 0.05 U	< 0.05 U	< 0.05 U	< 0.05 U	0.12	NA	NA
GAMMA-CHLORDANE	< 0.05 U	< 0.05 U	< 0.05 U	< 0.05 U	0.1	NA	NA
Metals (µg/L)							
Unfiltered							
ALUMINUM	NA	NA	NA	NA	NA	142	612 J
ANTIMONY	NA	NA	NA	NA	NA	< 2.1 U	< 2.1 U
ARSENIC	NA	NA	NA	NA	NA	10	< 2.8 U
BARIUM	NA	NA	NA	NA	NA	2.2 J	4.4 J
BERYLLIUM	NA	NA	NA	NA	NA	< 0.1 U	< 0.1 U
CALCIUM	NA	NA	NA	NA	NA	36,600	52,800
CHROMIUM	NA	NA	NA	NA	NA	< 1.8 U	< 1.8 U
COBALT	NA	NA	NA	NA	NA	0.55 J	< 0.75 UJ
COPPER	NA	NA	NA	NA	NA	1.8 J	< 2.4 UJ

TABLE 5-7: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C
Sample ID	199AA565
Sample Date	7/5/1995
Matrix	SWATER
Volatile Organic Compounds (µg/L)	
BENZENE	8
CHLOROFORM	1
ETHYLBENZENE	7
TOLUENE	34 J
XYLENE (TOTAL)	37
Petroleum Hydrocarbons (mg/L)	
Diesel/Motor Oil Range (extractables)	
DIESEL RANGE ORGANICS	1.3 Y
MOTOR OIL RANGE ORGANICS	1.1 Y
Gasoline Range (purgeables)	
GASOLINE RANGE ORGANICS	0.48 Y
Semivolatile Organic Compounds (µg/L)	
4-METHYLPHENOL	17
NAPHTHALENE	6 J
PCBs/Pesticides (µg/L)	
Pesticides	
None Detected	ND
Metals (µg/L)	
None Detected	ND
Chlorinated Herbicides (µg/L)	
None Detected	ND

Sample Location ID	CATCH BASIN #C	CATCH BASIN
Sample ID	199AA566	199AA567
Sample Date	7/5/1995	7/5/1995
Matrix	SEDIMENT	SEDIMENT
Volatile Organic Compounds (mg/kg)		
ETHYLBENZENE	< 0.015 U	25
TOLUENE	< 0.015 U	42
XYLENE (TOTAL)	< 0.015 U	160 J
Petroleum Hydrocarbons (mg/kg)		
Diesel/Motor Oil Range (extractables)		
MOTOR OIL RANGE ORGANICS	5,700 Y	19,000 Y
Gasoline Range (purgeables)		
GASOLINE RANGE ORGANICS	46 Y	850 Y
Semivolatile Organic Compounds (mg/kg)		
4-METHYLPHENOL	< 0.51 UJ	12 J
BIS(2-ETHYLHEXYL)PHTHALATE	3.7 J	< 22 UJ
BUTYLBENZYLPHTHALATE	37 J	< 22 U
DI-N-OCTYLPHTHALATE	0.5 J	< 22 U
PCBs/Pesticides (mg/kg)		
Pesticides		
4,4'-DDD	0.67	< 0.037 U
4,4'-DDE	0.079 J	0.019 J
ALPHA-CHLORDANE	0.038 J	< 0.019 U
BETA-BHC	< 0.051 U	0.043
GAMMA-CHLORDANE	0.042 J	< 0.019 U
Metals (mg/kg)		
LEAD	183 J	97.7 J
Chlorinated Herbicides (mg/kg)		
DICAMBA	< 0.006 U	0.14

Notes:
ID Identification
J Estimated value
mg/L Milligram per liter
mg/kg Milligram per kilogram
ND None detected
U Nondetected
µg/L Microgram per liter
Y Chromatographic pattern resembles hydrocarbon fuel pattern and was quantitated using the standard it resembled most.
Categories of analyses are shown, but only detected compounds are presented.

TABLE 5-8: ANALYTICAL RESULTS FOR SITE 10 IMMUNOASSAY ANALYSES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Location	Sample	Depth	Lab	Field	Compare PAH	Lab		Field	Compare TPH
			PAH (ppm)	PAH (ppm)		Diesel (ppm)	Oil (ppm)	TPH (ppm)	
HP001	199AA082	1.25 - 1.75		< 1.0				< 15	
	199AA083	7.0 - 7.5		< 1.0				< 15	
	199AA529	Water		--				< 0.25	
HP002	199AA084	1.25 - 1.5		< 1.0				< 15	
	199AA085	7.25 - 7.75	< 2.96	--	--	< 11	<11	--	--
	199AA530	Water		--				< 0.25	
HP004	199AA089	1.3 - 2.0		1.0 - 5.0				15 -100	
	199AA090	3.3 - 4.0		< 1.0				< 15	
	199AA091	6.3 - 7.0	< 2.88	< 1.0	M	< 11	< 11	< 15	M
	199AA533	Water	< 0.08	--	--	< 0.1	< 0.1	< 0.25	M
HP006	199AA095	1.0 -2.0		< 1.0				< 15	
	199AA096	3.0 - 4.0		< 1.0				--	
	199AA097	6.0 - 7.0		< 1.0				< 15	
	199AA536	Water		--				< 0.25	
HP007	199AA098	1.3 - 2.0	< 2.72	< 1.0	M	< 10	< 10	< 15	M
	199AA099	3.3 - 4.0		< 1.0				< 15	
	199AA100	6.3 - 7.0		< 1.0				< 15	
	199AA537	Water		--				< 0.25	
HP008	199AA101	1.0 - 1.5		< 1.0				< 15	
	199AA102	4.5 - 5.0		< 1.0				< 15	
	199AA103	7.25 - 7.75	< 2.72	< 1.0	M	< 10	< 10	15 -100	FP
	199AA538	Water		--				< 0.25	
HP009	199AA104	1.0 - 1.5		< 1.0				< 15	
	199AA105	3.75 - 4.0		< 1.0				< 15	
	199AA106	7.0 - 7.5		< 1.0				15 -100	
	199AA539	Water	< 0.08	--	--	< 0.1	0.086	< 0.25	M
HP010	199AA107	1.0 - 1.5	< 2.72	1.0 - 5.0	M	< 100	330	15 -100	M
	199AA108	3.75 - 4.0		< 1.0				< 15	
	199AA109	7.0 - 7.5		< 1.0				< 15	
	199AA540	Water		--				< 0.25	
HP011	199AA110	1.25 - 1.75	< 2.72	< 1.0	M	< 260	1400	< 15	M
	199AA111	3.75 - 4.0	< 2.80	< 1.0	M	< 10	< 10	< 15	M
	199AA112	7.0 - 7.5		< 1.0				15 -100	
	199AA541	Water	< 0.08	--	--	< 0.01	0.086	< 0.25	M
HP016	199AA542C	Water		--	--			< 0.25	
HP017	199AA543C	Water		--	--			> 3.0 (BTEX)	
HP018	199AA544C	Water		--	--			0.25 - 2.5	
HP019	199AA545C	Water		--	--			< 0.25	

Notes:

PAH - Soil Data Comparison

TABLE 5-9: LABORATORY DATA VALIDATION RESULTS

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

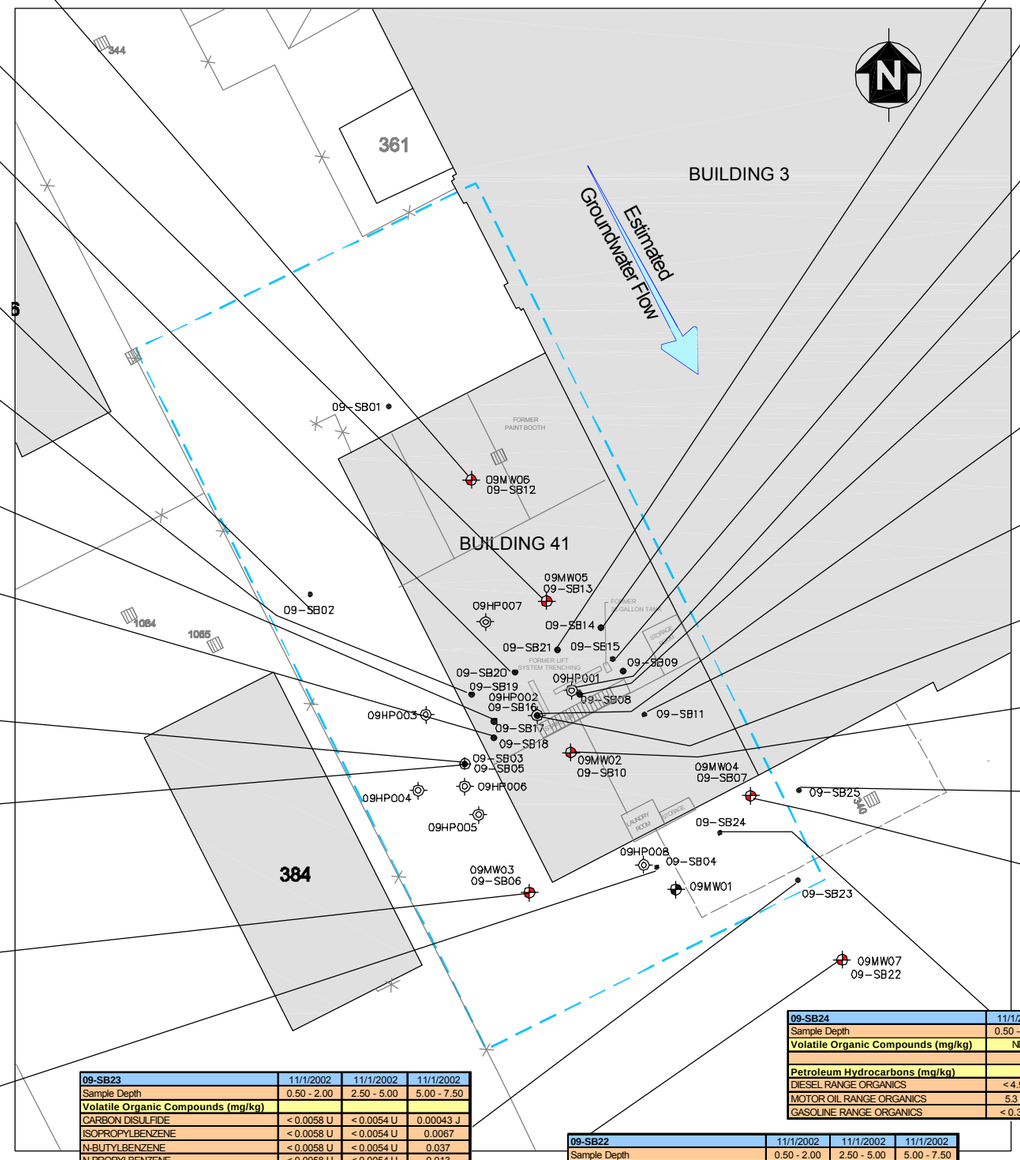
Data Validation SDG No.	Sample IDs Included in SDG	No. of Samples in SDG	Analysis	Validator Comments
161429	30209SB06001 30209SB06002 30209SB06003 30210SB26001* 30210SB26002 30210SB26003 30210SB27001 30210SB27002 30210SB27003 30210SB28001 30210SB28002 30210SB28003 30210SB29001 30210SB29002 30210SB29003 30210TB30001	16	TPH-p VOA	Volatiles were qualified because of blank contamination and results below the CRQL. Because of a surrogate recovery problem in the TPH-p analysis, one sample was qualified as estimated for gasoline. Because of an accuracy problem in the MS/MSD analysis, one sample was qualified as estimated for gasoline. The quality control criteria reviewed, other than those discussed in the data validation report, were met and are considered acceptable. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.
	30209SB07001 30209SB07002* 30209SB07003 30209SB08001 30209SB08002 30209SB08003 30209SB10001 30209SB10002 30209SB10003 30209SB11001 30209SB11002 30209SB11003 30209SB12001 30209SB12002 30209SB12003 30209SB13001* 30209SB13002 30209SB13003 30209SB14001 30209SB14002 30209SB14003 30209SB15001 30209SB15002 30209SB15003 30209SB16001 30209SB16002 30209SB16003* 30209SB17001 30209SB17002 30209SB17003 30209SB18001	44	TPH-p VOA	Volatiles were qualified because of blank contamination and results below the CRQL. Because of surrogate recovery problems in the TPH-p analysis, five samples were qualified as estimated for gasoline. TPH-p samples were also qualified because of blank contamination. The quality control criteria reviewed, other than those discussed in the data validation report, were met and are considered acceptable. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.

FIGURES

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- SITE BOUNDARY

J	Estimated value
mg/kg	Milligrams per kilogram
NA	Not analyzed
ND	Not detected
R	Results rejected during quality assurance review
U	Nondetected for individual compound
Y	Chromatographic pattern resembles hydrocarbon fuel pattern and was quanitifed using the standard it resembles most
D	Chromatographic pattern resembles diesel
L	Chromatographic pattern is the lighter hydrocarbon end of the analyte's range in the standard
H	Chromatographic pattern is in the heavier hydrocarbon end of the analyte's range in the standard
M	Chromatographic pattern resembles motor oil



15 0 15 30

SCALE IN FEET

09-SB12	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	83 Y	< 13 UJ	< 5.4 U
MOTOR OIL RANGE ORGANICS	330 M	< 59 UJ	< 5.4 U
GASOLINE RANGE ORGANICS	< 0.61 U	< 0.46 U	< 0.24 U

09-SB13	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)	ND	ND	ND

09-SB20	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)			
4-METHYL-2-PENTANONE	0.004 J	< 0.012 U	< 0.011 U
TOLUENE	0.0012 J	< 0.0062 U	< 0.0057 U
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	96 Y	< 4.5 U	< 4.7 U
MOTOR OIL RANGE ORGANICS	74 M	< 4.5 U	8.8 M
GASOLINE RANGE ORGANICS	< 0.3 U	< 0.23 U	< 0.22 U

09-SB02	7/16/1992	7/16/1992	7/16/1992
Sample Depth	0.80 - 1.30	2.50 - 3.00	4.50 - 5.00
Volatile Organic Compounds (mg/kg)			
ACETONE	0.3	< 0.014 UJ	< 0.024 UJ
TOLUENE	0.003 J	< 0.01 U	< 0.01 U
Petroleum Hydrocarbons (mg/kg)	NA	NA	NA

09-SB19	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	20 D	< 4.5 U	< 5.2 U
MOTOR OIL RANGE ORGANICS	37 M	< 4.5 U	< 5.2 U
GASOLINE RANGE ORGANICS	< 0.22 U	< 0.26 U	< 0.23 U

09-SB17	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)			
CARBON DISULFIDE	0.0012 J	< 0.0054 U	< 0.0058 U
Petroleum Hydrocarbons (mg/kg)	ND	ND	ND

09-SB18	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.05 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)			
CARBON DISULFIDE	0.0004 J	0.00049 J	0.00049 J
Petroleum Hydrocarbons (mg/kg)	ND	ND	ND

09-SB03	7/16/1992	7/16/1992	7/16/1992
Sample Depth	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)	NA	NA	NA

09-SB05	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)			
CARBON DISULFIDE	0.0007 J	< 0.0057 U	< 0.0063 U
METHYLENE CHLORIDE	< 0.035 U	< 0.023 UJ	0.16
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	19 H	< 4.5 U	< 5 U
MOTOR OIL RANGE ORGANICS	150 M	16 M	< 5 U
GASOLINE RANGE ORGANICS	< 0.41 UJ	< 0.23 U	< 0.26 UJ

09-SB06	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	6.6 H	< 4.5 U	< 5.3 U
MOTOR OIL RANGE ORGANICS	48 M	4.7 M	< 5.3 U
GASOLINE RANGE ORGANICS	< 0.25 UJ	< 0.23 U	< 0.22 U

09-SB04	7/16/1992	7/16/1992	7/16/1992	7/16/1992
Sample Depth	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00	4.00 - 4.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)	NA	NA	NA	NA

09-SB23	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)			
CARBON DISULFIDE	< 0.0058 U	< 0.0054 U	0.00043 J
ISOPROPYLBENZENE	< 0.0058 U	< 0.0054 U	0.0067
N-BUTYLBENZENE	< 0.0058 U	< 0.0054 U	0.037
N-PROPYLBENZENE	< 0.0058 U	< 0.0054 U	0.013
NAPHTHALENE	< 0.0058 U	< 0.0054 U	0.024
SEC-BUTYLBENZENE	< 0.0058 U	< 0.0054 U	0.027
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	< 4.4 U	78 Y	7,600
MOTOR OIL RANGE ORGANICS	< 4.4 U	52 M	400 D
GASOLINE RANGE ORGANICS	< 0.21 U	< 0.22 U	150 H

09-SB22	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	21 H	< 4.4 U	< 4.9 U
MOTOR OIL RANGE ORGANICS	240 M	< 4.4 U	< 4.9 U
GASOLINE RANGE ORGANICS	< 0.21 U	< 0.23 U	< 0.23 U

09-SB24	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	< 4.9 U	< 5 U	< 5 U
MOTOR OIL RANGE ORGANICS	5.3 MJ	< 5 U	< 5 U
GASOLINE RANGE ORGANICS	< 0.31 U	< 0.23 U	< 0.22 U

09-SB21	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	38 H	< 4.6 U	< 5.1 U
MOTOR OIL RANGE ORGANICS	200 M	15 M	< 5.1 U
GASOLINE RANGE ORGANICS	< 0.54 UJ	< 0.22 U	< 0.45 U

09-SB14	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)	ND	ND	ND

09-SB15	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)	ND	ND	ND

09-HP001	8/3/1995
Sample Depth	1.25 - 1.75
Volatile Organic Compounds (mg/kg)	NA
Petroleum Hydrocarbons (mg/kg)	
DIESEL RANGE ORGANICS	21 Y
MOTOR OIL RANGE ORGANICS	85 Y
GASOLINE RANGE ORGANICS	NA

09-SB08	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	8.9 H	< 4.5 U	< 4.9 U
MOTOR OIL RANGE ORGANICS	61 M	11 M	< 4.9 U
GASOLINE RANGE ORGANICS	< 0.21 U	< 0.28 U	< 0.24 U

09-HP002	8/3/1995
Sample Depth	6.50 - 7.00
Volatile Organic Compounds (mg/kg)	NA
Petroleum Hydrocarbons (mg/kg)	
DIESEL RANGE ORGANICS	38,000 JY
MOTOR OIL RANGE ORGANICS	12,000 JY
GASOLINE RANGE ORGANICS	NA

09-SB11	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	5.5 D	< 4.4 U	6.6 D
MOTOR OIL RANGE ORGANICS	58 M	< 4.4 U	7.9 Z
GASOLINE RANGE ORGANICS	< 0.29 UJ	< 0.22 U	< 0.23 U

09-SB16	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)			
CARBON DISULFIDE	< 0.0098 U	0.00049 J	< 0.0054 U
METHYL-TERT-BUTYL ETHER	< 0.0098 U	< 0.0061 U	0.0021 J
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	< 6.8 UJ	1,100 Y	1,300 Y
MOTOR OIL RANGE ORGANICS	< 53 UJ	400 L	430 L
GASOLINE RANGE ORGANICS	< 0.36 UJ	< 0.23 U	< 0.25 U

09-SB10	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	< 6.1 U	< 4.5 U	< 5 U
MOTOR OIL RANGE ORGANICS	11 M	< 4.5 U	< 5 U
GASOLINE RANGE ORGANICS	< 0.23 U	< 0.29 U	< 0.26 U

09-SB25	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	R
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	< 4.4 U	< 4.4 U	< 5 U
MOTOR OIL RANGE ORGANICS	6.3 M	7 M	5.2 M
GASOLINE RANGE ORGANICS	< 0.22 U	< 0.22 U	< 0.2 U

09-SB07	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)			
N-BUTYLBENZENE	< 0.0056 U	< 0.0094 U	0.0027 J
N-PROPYLBENZENE	< 0.0056 U	< 0.0094 U	0.00078 J
SEC-BUTYLBENZENE	< 0.0056 U	< 0.0094 U	0.0015 J
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	470 D	26 H	7,100 D
MOTOR OIL RANGE ORGANICS	410 M	24 M	220 L
GASOLINE RANGE ORGANICS	< 0.23 U	< 0.4 U	91 HJ

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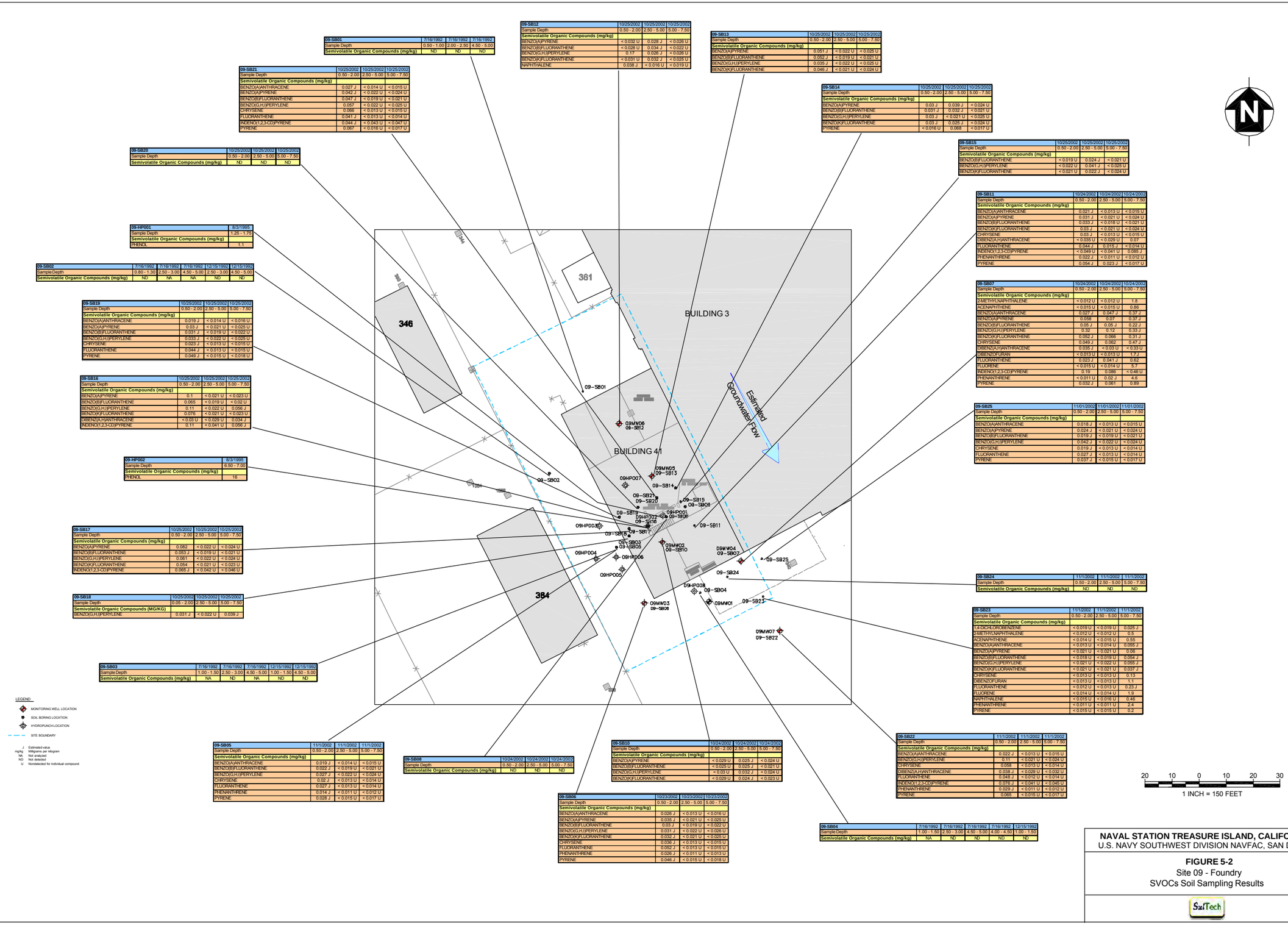
FIGURE 5-1

Site 09 - Foundry
VOCs and TPH Soil Sampling Results

fig 6 ltr-9 prop samp loc.dwg - DWH - 07/02/02 - G0069.302.B.05.01.02



09-SB01	7/16/1992	7/16/1992	7/16/1992
Sample Depth	0.50 - 1.00	2.00 - 2.50	4.50 - 5.00
Semivolatile Organic Compounds (mg/kg)	ND	ND	ND

09-SB12	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)PYRENE	< 0.032 U	0.028 J	< 0.028 U
BENZO(B)FLUORANTHENE	< 0.028 U	0.034 J	< 0.022 U
BENZO(G,H,I)PERYLENE	0.17	0.026 J	< 0.026 U
BENZO(K)FLUORANTHENE	< 0.031 U	0.032 J	< 0.025 U
NAPHTHALENE	0.038 J	< 0.016 U	< 0.019 U

09-SB13	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)PYRENE	0.051 J	< 0.022 U	< 0.025 U
BENZO(B)FLUORANTHENE	0.052 J	< 0.019 U	< 0.021 U
BENZO(G,H,I)PERYLENE	0.035 J	< 0.022 U	< 0.025 U
BENZO(K)FLUORANTHENE	0.046 J	< 0.021 U	< 0.024 U

09-SB14	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)PYRENE	0.03 J	0.039 J	< 0.024 U
BENZO(B)FLUORANTHENE	0.031 J	0.032 J	< 0.021 U
BENZO(G,H,I)PERYLENE	0.03 J	< 0.021 U	< 0.025 U
BENZO(K)FLUORANTHENE	0.03 J	0.025 J	< 0.024 U
PYRENE	< 0.016 U	0.068	< 0.017 U

09-SB21	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	0.027 J	< 0.014 U	< 0.015 U
BENZO(A)PYRENE	0.042 J	< 0.022 U	< 0.024 U
BENZO(B)FLUORANTHENE	0.047 J	< 0.019 U	< 0.021 U
BENZO(G,H,I)PERYLENE	0.057	< 0.022 U	< 0.025 U
CHRYSENE	0.066	< 0.013 U	< 0.015 U
FLUORANTHENE	0.041 J	< 0.013 U	< 0.014 U
INDENO(1,2,3-CD)PYRENE	0.044 J	< 0.043 U	< 0.047 U
PYRENE	0.067	< 0.016 U	< 0.017 U

09-SB20	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)	ND	ND	ND

09-HP001	8/3/1995
Sample Depth	1.25 - 1.75
Semivolatile Organic Compounds (mg/kg)	
PHENOL	1.1

09-SB02	7/16/1992	7/16/1992	7/16/1992	12/15/1992	12/15/1992
Sample Depth	0.80 - 1.30	2.50 - 3.00	4.50 - 5.00	2.50 - 3.00	4.50 - 5.00
Semivolatile Organic Compounds (mg/kg)	ND	NA	NA	ND	ND

09-SB19	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	0.019 J	< 0.014 U	< 0.016 U
BENZO(A)PYRENE	0.03 J	< 0.021 U	< 0.025 U
BENZO(B)FLUORANTHENE	0.031 J	< 0.019 U	< 0.022 U
BENZO(G,H,I)PERYLENE	0.033 J	< 0.022 U	< 0.025 U
CHRYSENE	0.023 J	< 0.013 U	< 0.015 U
FLUORANTHENE	0.044 J	< 0.013 U	< 0.015 U
PYRENE	0.049 J	< 0.015 U	< 0.018 U

09-SB16	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)PYRENE	0.1	< 0.021 U	< 0.023 U
BENZO(B)FLUORANTHENE	0.065	< 0.019 U	< 0.02 U
BENZO(G,H,I)PERYLENE	0.11	< 0.022 U	0.056 J
BENZO(K)FLUORANTHENE	0.076	< 0.021 U	< 0.023 U
DIBENZ(A,H)ANTHRACENE	< 0.03 U	< 0.029 U	0.034 J
INDENO(1,2,3-CD)PYRENE	0.11	< 0.041 U	0.056 J

09-HP002	8/3/1995
Sample Depth	6.50 - 7.00
Semivolatile Organic Compounds (mg/kg)	
PHENOL	16

09-SB17	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)PYRENE	0.082	< 0.022 U	< 0.024 U
BENZO(B)FLUORANTHENE	0.053 J	< 0.019 U	< 0.021 U
BENZO(G,H,I)PERYLENE	0.061	< 0.022 U	< 0.024 U
BENZO(K)FLUORANTHENE	0.054	< 0.021 U	< 0.023 U
INDENO(1,2,3-CD)PYRENE	0.065 J	< 0.042 U	< 0.046 U

09-SB18	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.05 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (MG/KG)			
BENZO(G,H,I)PERYLENE	0.031 J	< 0.022 U	0.039 J

09-SB03	7/16/1992	7/16/1992	7/16/1992	12/15/1992	12/15/1992
Sample Depth	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50	4.50 - 5.00
Semivolatile Organic Compounds (mg/kg)	NA	ND	NA	ND	ND

09-SB15	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(B)FLUORANTHENE	< 0.019 U	0.024 J	< 0.021 U
BENZO(G,H,I)PERYLENE	< 0.022 U	0.041 J	< 0.025 U
BENZO(K)FLUORANTHENE	< 0.021 U	0.022 J	< 0.024 U

09-SB11	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	0.021 J	< 0.013 U	< 0.015 U
BENZO(A)PYRENE	0.031 J	< 0.021 U	< 0.024 U
BENZO(B)FLUORANTHENE	0.033 J	< 0.019 U	< 0.021 U
BENZO(K)FLUORANTHENE	0.03 J	< 0.021 U	< 0.024 U
CHRYSENE	0.03 J	< 0.013 U	< 0.015 U
DIBENZ(A,H)ANTHRACENE	< 0.035 U	< 0.029 U	0.07
FLUORANTHENE	0.044 J	0.015 J	< 0.014 U
INDENO(1,2,3-CD)PYRENE	< 0.049 U	< 0.041 U	0.085 J
PHENANTHRENE	0.022 J	< 0.011 U	< 0.012 U
PYRENE	0.054 J	0.023 J	< 0.017 U

09-SB07	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
2-METHYLNAPHTHALENE	< 0.012 U	< 0.012 U	1.8
ACENAPHTHENE	< 0.015 U	< 0.015 U	0.86
BENZO(A)ANTHRACENE	0.027 J	0.047 J	0.37 J
BENZO(A)PYRENE	0.058	0.07	0.37 J
BENZO(B)FLUORANTHENE	0.05 J	0.05 J	0.22 J
BENZO(G,H,I)PERYLENE	0.32	0.12	0.33 J
BENZO(K)FLUORANTHENE	0.052 J	0.066	0.31 J
CHRYSENE	0.049 J	0.062	0.47 J
DIBENZ(A,H)ANTHRACENE	0.035 J	< 0.03 U	< 0.33 U
DIBENZOFURAN	< 0.013 U	< 0.013 U	1.7 J
FLUORANTHENE	0.023 J	0.041 J	0.62
FLUORENE	< 0.015 U	< 0.014 U	5.7
INDENO(1,2,3-CD)PYRENE	0.19	0.086	< 0.46 U
PHENANTHRENE	< 0.011 U	0.02 J	4.6
PYRENE	0.032 J	0.061	0.89

09-SB25	11/01/2002	11/01/2002	11/01/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	0.018 J	< 0.013 U	< 0.015 U
BENZO(A)PYRENE	0.024 J	< 0.021 U	< 0.024 U
BENZO(B)FLUORANTHENE	0.019 J	< 0.019 U	< 0.021 U
BENZO(G,H,I)PERYLENE	0.042 J	< 0.022 U	< 0.024 U
CHRYSENE	0.019 J	< 0.013 U	< 0.014 U
FLUORANTHENE	0.027 J	< 0.013 U	< 0.014 U
PYRENE	0.037 J	< 0.015 U	< 0.017 U

09-SB24	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)	ND	ND	ND

09-SB23	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
1,4-DICHLOROBENZENE	< 0.019 U	< 0.019 U	0.025 J
2-METHYLNAPHTHALENE	< 0.012 U	< 0.012 U	0.5
ACENAPHTHENE	< 0.014 U	< 0.015 U	0.55
BENZO(A)ANTHRACENE	< 0.013 U	< 0.014 U	0.055 J
BENZO(A)PYRENE	< 0.021 U	< 0.021 U	0.06
BENZO(B)FLUORANTHENE	< 0.018 U	< 0.019 U	0.054 J
BENZO(G,H,I)PERYLENE	< 0.021 U	< 0.022 U	0.055 J
BENZO(K)FLUORANTHENE	< 0.021 U	< 0.021 U	0.037 J
CHRYSENE	< 0.013 U	< 0.013 U	0.13
DIBENZOFURAN	< 0.013 U	< 0.013 U	1.1
FLUORANTHENE	< 0.012 U	< 0.013 U	0.23 J
FLUORENE	< 0.014 U	< 0.014 U	1.9
NAPHTHALENE	< 0.015 U	< 0.016 U	0.46
PHENANTHRENE	< 0.011 U	< 0.011 U	2.4
PYRENE	< 0.015 U	< 0.015 U	0.2

09-SB05	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	0.019 J	< 0.014 U	< 0.015 U
BENZO(B)FLUORANTHENE	0.022 J	< 0.019 U	< 0.021 U
BENZO(G,H,I)PERYLENE	0.027 J	< 0.022 U	< 0.024 U
CHRYSENE	0.02 J	< 0.013 U	< 0.014 U
FLUORANTHENE	0.027 J	< 0.013 U	< 0.014 U
PHENANTHRENE	0.014 J	< 0.011 U	< 0.012 U
PYRENE	0.028 J	< 0.015 U	< 0.017 U

09-SB08	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)	ND	ND	ND

09-SB10	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)PYRENE	< 0.029 U	0.025 J	< 0.024 U
BENZO(B)FLUORANTHENE	< 0.025 U	0.025 J	< 0.021 U
BENZO(G,H,I)PERYLENE	< 0.03 U	0.032 J	< 0.024 U
BENZO(K)FLUORANTHENE	< 0.029 U	0.024 J	< 0.023 U

09-SB06	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	0.026 J	< 0.013 U	< 0.016 U
BENZO(A)PYRENE	0.035 J	< 0.021 U	< 0.025 U
BENZO(B)FLUORANTHENE	0.03 J	< 0.019 U	< 0.022 U
BENZO(G,H,I)PERYLENE	0.031 J	< 0.022 U	< 0.026 U
BENZO(K)FLUORANTHENE	0.032 J	< 0.021 U	< 0.025 U
CHRYSENE	0.036 J	< 0.013 U	< 0.015 U
FLUORANTHENE	0.052 J	< 0.013 U	< 0.015 U
PHENANTHRENE	0.026 J	< 0.011 U	< 0.013 U
PYRENE	0.046 J	< 0.015 U	< 0.018 U

09-SB22	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	0.022 J	< 0.013 U	< 0.015 U
BENZO(G,H,I)PERYLENE	0.11	< 0.021 U	< 0.024 U
CHRYSENE	0.058	< 0.013 U	< 0.014 U
DIBENZ(A,H)ANTHRACENE	0.038 J	< 0.029 U	< 0.032 U
FLUORANTHENE	0.048 J	< 0.012 U	< 0.014 U
INDENO(1,2,3-CD)PYRENE	0.076 J	< 0.041 U	< 0.045 U
PHENANTHRENE	0.029 J	< 0.011 U	< 0.012 U
PYRENE	0.065	< 0.015 U	< 0.017 U

09-SB04	7/16/1992	7/16/1992	7/16/1992	7/16/1992	12/15/1992
Sample Depth	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00	4.00 - 4.50	1.00 - 1.50
Semivolatile Organic Compounds (mg/kg)	NA	ND	ND	ND	ND

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- SITE BOUNDARY

J Estimated value
mg/kg Milligrams per kilogram
NA Not analyzed
ND Not detected
U Nondetected for individual compound

NAVAL STATION TREASURE ISLAND, CALIFORNIA
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FIGURE 5-2
Site 09 - Foundry
SVOCs Soil Sampling Results

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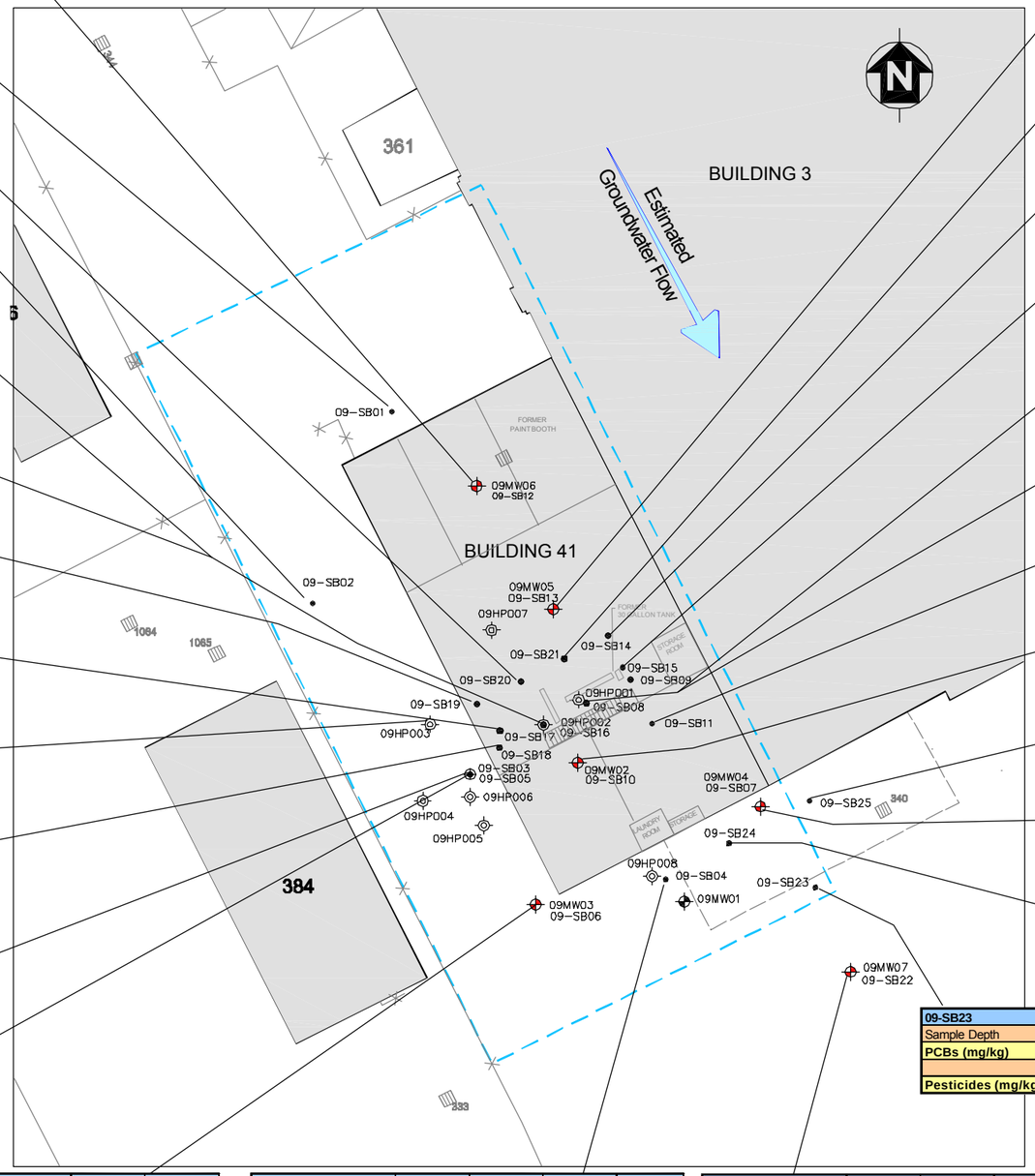
LEGEND

MONITORING WELL LOCATION
SOIL BORING LOCATION
HYDROPUNCH LOCATION
SITE BOUNDARY

PCB Polychlorinated biphenols
J Estimated value
mg/kg Milligrams per kilogram
NA Not analyzed
ND Not detected
R Results rejected during quality asssurance review
U Nondetected for individual compound



09-SB12	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)			
AROCHLOR - 1260	0.058	0.016	< 0.0011 U
Pesticides (mg/kg)			
4,4'-DDD	0.0063 J	0.0014 J	< 0.0002 U
4,4'-DDE	0.0034 J	< 0.0014 U	< 0.00032 U
4,4'-DDT	0.037	0.0092	< 0.00022 U
ALPHA-CHLORDANE	0.0018 J	< 0.00058 U	< 0.00014 U
ENDOSULFAN SULFATE	0.0058 J	< 0.00087 U	< 0.00021 U
METHOXYCHLOR	< 0.0079 U	0.0014 J	< 0.00021 U

09-SB01	7/16/1992	7/16/1992	7/16/1992
Sample Depth	0.50 - 1.00	2.00 - 2.50	4.50 - 5.00
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB20	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB02	7/16/1992	7/16/1992	7/16/1992
Sample Depth	0.80 - 1.30	2.50 - 3.00	4.50 - 5.00
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB16	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)			
4,4'-DDD	< 0.00017 U	0.007 J	0.0027 J
4,4'-DDT	< 0.00019 U	< 0.011 U	0.0071 J
ENDRIN ALDEHYDE	< 0.00039 U	< 0.0038 U	0.0041 J

09-HP002	8/3/1995
Sample Depth	6.50 - 7.00
PCBs (mg/kg)	ND
Pesticides (mg/kg)	ND

09-SB19	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB17	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-HP003	8/3/1995	8/3/1995	8/3/1995
Sample Depth	1.00 - 1.50	3.25 - 3.75	5.50 - 6.00
PCBs (mg/kg)	ND	NA	NA
Pesticides (mg/kg)	ND	NA	NA

09-SB18	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.05 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB03	7/16/1992	7/16/1992	7/16/1992
Sample Depth	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB05	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)			
AROCLOR - 1260	0.032	< 0.00088 U	< 0.00097 U
Pesticides (mg/kg)	ND	ND	ND

09-SB06	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)			
AROCLOR - 1260	0.0015 J	< 0.00087 U	< 0.0011 U
Pesticides (mg/kg)	ND	ND	ND

09-SB04	7/16/1992	7/16/1992	7/16/1992	7/16/1992
Sample Depth	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00	4.00 - 4.50
PCBs (mg/kg)	ND	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND	ND

09-SB22	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB13	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB21	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB14	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB15	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)			
ENDOSULFAN I	< 0.00014 U	< 0.00067 U	0.0013

09-HP001	8/3/1995
Sample Depth	1.25 - 1.75
PCBs (mg/kg)	ND
Pesticides (mg/kg)	ND

09-SB08	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB11	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB10	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB25	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB07	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)			
ENDOSULFAN SULFATE	< 0.0018 U	< 0.00017 U	0.00068 J

09-SB24	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

09-SB23	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

15 0 15 30
SCALE IN FEET

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NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-3
Site 09 - Foundry
Pesticides and PCB Soil Sampling Results

Site 9 hitbox soil pest and pcbs.dwg - JHD - 07/02/03 - G0069.302.B.05.01.02

10-SB02	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.0-1.5	3.0-3.5	6.0-6.5
Metals (mg/kg)			
ALUMINUM	4,570	4,220	9,840
ANTIMONY	9.9U	9.9U	12.1U
ARSENIC	5.9	5.7	7.7
BARIUM	10.7J	10.9J	28J
BERYLLIUM	**0.21J**	**0.21J**	**0.25J**
CALCIUM	5,390J	11,900J	19,300J
CHROMIUM	31.1	**89.5**	46.7
COBALT	8.4J	8.6J	13.6
COPPER	6	8.6	7.3
IRON	15,900	16,700	24,900
LEAD	3.4	3	5.5
MAGNESIUM	5,100	9,360	7,110
MANGANESE	251J	416J	467J
NICKEL	47.1	93.2	59.3
POTASSIUM	714J	574J	1280
SILVER	1U	1U	**1.8J**
SODIUM	108J	166J	363J
VANADIUM	23.7	23	**39.1**
ZINC	25.3	24.5	46.2

09-SB20	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	3,410	3,010	3,810
ARSENIC	2.7	2.1	2.4
BARIUM	12.4	5.3	7.4
BERYLLIUM	0.07J	0.09J	0.1J
CADMIUM	0.06	0.04J	0.05J
CALCIUM	2,280	1,260	4,280
CHROMIUM	21	20.8	21.2
COBALT	5.5	5.6	6
COPPER	4	3.09	4.47
IRON	8,580	7,680	9,140
LEAD	3.9	1.71	2.33
MAGNESIUM	2,200	1,890	2,370
MANGANESE	86.8	61.8	80.7
MERCURY	0.01J	<0.01U	<0.01U
MOLYBDENUM	0.15	<0.07UJ	<0.08UJ
NICKEL	19.8J	18.6J	21.8J
POTASSIUM	504J	463J	574J
SILVER	0.015J	0.012J	0.05
SODIUM	77.8	52	78.5
THALLIUM	0.028	0.028	0.045
VANADIUM	15	13.2	15
ZINC	15.5	13.7	16.9

09-SB21	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	5,210	3,930	3,430
ANTIMONY	0.18J	<0.07UJ	<0.05UJ
ARSENIC	6.3	2.4	2.8
BARIUM	23.5	8.4	6.4
BERYLLIUM	0.12J	0.1J	0.11J
CADMIUM	0.08	0.05J	0.06J
CALCIUM	11,500	1,910	1,790
CHROMIUM	35	25.8	21.3
COBALT	6.7	5.9	6.7
COPPER	10	4.44	3.8
IRON	14,500	9,460	9,260
LEAD	12.6	2.14	2.29
MAGNESIUM	4,890	2,300	2,310
MANGANESE	232	83.9	83.8
MERCURY	0.12	<0.01U	<0.01U
MOLYBDENUM	0.24	<0.08UJ	<0.1UJ
NICKEL	40.5J	21.3J	22.8J
POTASSIUM	601J	567J	582J
SILVER	0.042	0.02J	0.014J
SODIUM	198	67	78.2
THALLIUM	0.036	0.035	0.041
VANADIUM	22.2	16.9	14.4
ZINC	29.6	16.3	16.9

09-SB01	7/16/1992		
Sample Depth	0.5-1.0	2.0-2.5	4.5-5.0
Metals (mg/kg)			
ALUMINUM	5,960J	3,900J	5,000J
ARSENIC	7	2.1J	2.5
BARIUM	48	8.9J	11.7J
BERYLLIUM	**0.22J**	**0.21J**	**0.22J**
CADMIUM	0.89J	<0.64U	<0.65U
CALCIUM	10,000J	1,990J	2,700J
CHROMIUM	57.3	27.8	34.8
COBALT	8.4J	7.4J	8.9J
IRON	15,900	9,410	11,900
LEAD	**42J**	2.9J	3J
MAGNESIUM	4,640	2,010	2,480
MANGANESE	269J	86.9J	105J
NICKEL	43.8	25	28.5
POTASSIUM	682J	708J	917J
SILVER	**2.9J**	<1.1U	<1.1U
VANADIUM	25.6	16.9	22.6
ZINC	**101J**	<28UJ	<25.7UJ

09-SB12	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	**13,800**	4,490	4,310
ANTIMONY	0.39J	0.1J	0.09J
ARSENIC	**16.9**	2.7	2.7
BARIUM	181J	24.2J	8.6J
BERYLLIUM	**0.36J**	0.11J	0.1J
CADMIUM	0.57	0.05J	0.05J
CALCIUM	10,400	2,800	1,900
CHROMIUM	52	32.4	27.4
COBALT	6	5.8	6.5
COPPER	21.8	4.92	4.39
IRON	20,400	10,300	10,100
LEAD	**24.7**	3.31	2.67
MAGNESIUM	3,520	2,370	2,550
MANGANESE	290	85.2	79.2
MERCURY	0.04	0.01J	0.01J
MOLYBDENUM	**4.31J**	<0.3UJ	<0.13UJ
NICKEL	40.9	22.3	25.9
POTASSIUM	1,060J	591J	625J
SELENIUM	0.3J	<0.2U	<0.2U
SILVER	0.158	0.021J	0.018J
SODIUM	468	100	81.1
THALLIUM	0.146	0.051	0.051
VANADIUM	**48.8**	22.3	19.4
ZINC	58.1	20.1	18.7

09-SB13	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	5,830	3,900	4,140
ANTIMONY	0.1J	0.06J	0.07J
ARSENIC	7.1	2.4	2.4
BARIUM	23.1J	7.3J	9.3J
BERYLLIUM	**0.16J**	0.11J	0.1J
CADMIUM	0.06J	0.05J	0.05J
CALCIUM	9,100	3,580	3,100
CHROMIUM	39.1	24.7	25.4
COBALT	8J	6	6.6
COPPER	5.99	4.8	4.53
IRON	18,200	8,890	9,610
LEAD	5.25	2.36	2.23
MAGNESIUM	5,960	2,210	2,520
MANGANESE	289	77.1	87.5
MERCURY	0.03	0.01J	0.03
NICKEL	36.1	20.5	24.5
POTASSIUM	630J	631J	616J
SILVER	0.026	0.018J	0.017J
SODIUM	219J	84.9	99.1
THALLIUM	0.039	0.036	0.04
VANADIUM	27.7	17.3	18.3
ZINC	26.6J	15.7	17.8

09-SB14	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	3,770	4,640	5,710
ANTIMONY	0.07J	0.07J	0.09J
ARSENIC	4.4	4.4	2.9
BARIUM	10.9J	13.2J	10.7J
BERYLLIUM	0.12J	**0.13J**	0.12J
CADMIUM	0.05J	0.05J	0.07
CALCIUM	9,160	4,820	17,700
CHROMIUM	25	36.1	33.9
COBALT	6.3	5.9	7.9
COPPER	4.04	5.29	7.06
IRON	11,100	13,700	11,600
LEAD	5.01	3.59	2.57
MAGNESIUM	3,310	3,730	3,230
MANGANESE	231	173	118
MERCURY	0.03	0.01J	0.01J
NICKEL	29	31.2	28.3
POTASSIUM	560J	610J	842J
SILVER	0.017J	0.021	0.025
SODIUM	186	132	184
THALLIUM	0.038	0.035	0.053
VANADIUM	18.4	22.1	24.8
ZINC	18.1	21.2	21.5

09-SB15	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	4,540	3,890	4,890
ANTIMONY	0.11J	0.18J	0.07J
ARSENIC	2.9	4.3	3.3
BARIUM	12.1J	17.1J	10.3J
BERYLLIUM	0.12J	0.08J	0.12J
CADMIUM	0.07	0.4	0.08
CALCIUM	3,830	6,940	2,120
CHROMIUM	29.6	26.6	28.5
COBALT	6.6	5.1	6.8
COPPER	12.2	**2370**	8.64
IRON	10,800	10,500	10,800
LEAD	6.46	**64.1**	3.51
MAGNESIUM	2,920	2,860	2,730
MANGANESE	111	186	86.8
MERCURY	0.01J	0.01J	0.01J
NICKEL	25.4	23	25.5
POTASSIUM	686J	539J	705J
SILVER	0.04	0.02J	0.021J
SODIUM	167	110	99.8
THALLIUM	0.043	0.034	0.07
VANADIUM	20.2	19.6	19
ZINC	27.2	48	19.5

09-SB11	10/24/2002		
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	6,000	5,010	4,780
ANTIMONY	0.15J	<0.08UJ	<0.08UJ
ARSENIC	8.8	5.5	2.8
BARIUM	35.5J	11.8J	15.4J
BERYLLIUM	**0.15J**	**0.13J**	0.12J
CADMIUM	0.26	0.06	0.06
CALCIUM	3,890J	5,340J	3,590J
CHROMIUM	33.8J	36.3J	29J
COBALT	6.7	6	5.7
COPPER	32.1	4.52	5.11
IRON	13,600	12,100	9,330
LEAD	**26.4J**	3.17J	2.13J
MAGNESIUM	3,480	3,460	2,320
MANGANESE	217J	163J	79.5J
MERCURY	0.06	0.02	0.02
NICKEL	28	28.6	23.7
POTASSIUM	740J	928J	705J
SILVER	0.04	0.019J	0.018J
SODIUM	176J	104J	82.8J
THALLIUM	0.062J	0.03J	0.038J
VANADIUM	26.7	23	18.1
ZINC	26	24.2	17.6

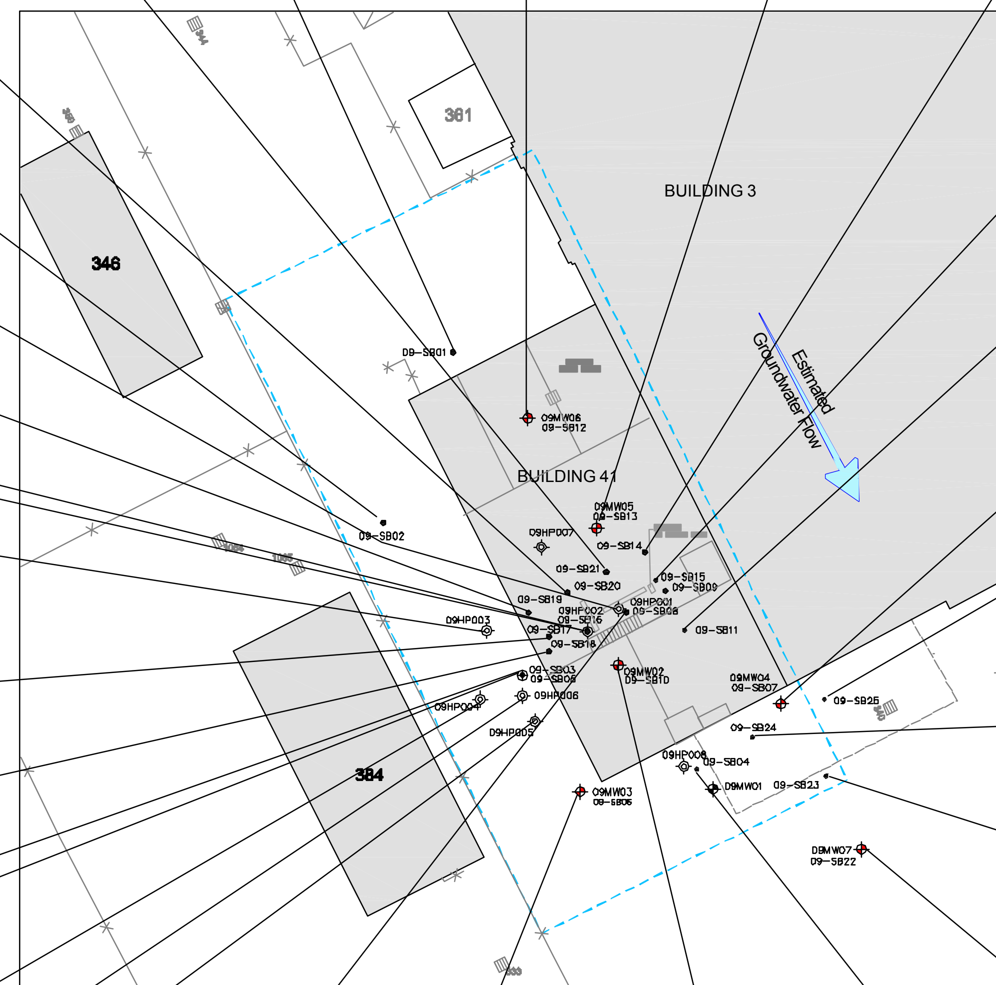
09-SB16	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	7,390	4,640	5,380
ANTIMONY	0.09J	0.05J	0.07J
ARSENIC	6.1	2.5	3.6
BARIUM	18.5J	12.4J	13.4J
BERYLLIUM	**0.19J**	0.12J	**0.13J**
CADMIUM	0.09	0.06	0.04J
CALCIUM	14,900	2,410	2,210
CHROMIUM	33.8	30.9	30
COBALT	8.2	7.2	7.6J
COPPER	8.91	3.54	4.15
IRON	17,300	10,400	11,800
LEAD	6.72	2.09	2.47
MAGNESIUM	6,090	2,460	2,870
MANGANESE	428	89.5	91.7
MERCURY	0.05	<0.01U	0.01J
NICKEL	41.3	23.4	27
POTASSIUM	1,080J	655J	751J
SILVER	0.051	0.018J	0.022J
SODIUM	353	83	90.3J
THALLIUM	0.07	0.039	0.045
VANADIUM	27.6	20.6	22.4
ZINC	34.1	17.4	20.4J

09-SB19	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	3,990	6,380	3,940
ANTIMONY	0.21J	<0.08UJ	<0.08UJ
ARSENIC	7.2	2.7	2.7
BARIUM	13.6	11.7	7.8
BERYLLIUM	**0.13J**	0.12J	0.1J
CADMIUM	0.11	0.06	0.04J
CALCIUM	3,700	1,960	1,660
CHROMIUM	32.6	30.4	24.7
COBALT	7	5.4	7
COPPER	13	6.46	3.67
IRON	12,400	14,000	10,400
LEAD	7.76	2.48	2.26
MAGNESIUM	3,200	3,980	2,430
MANGANESE	167	101	76.6
MERCURY	0.06	<0.01U	<0.01U
MOLYBDENUM	0.81	0.16	0.31
NICKEL	28.2J	26.5J	22.9J
POTASSIUM	542J	918J	584J
SILVER	0.025	0.036	0.017J
SODIUM	135	91	68.2
THALLIUM	0.041	0.044	0.037
VANADIUM	19.9	22.3	15.8
ZINC	23.2	26.7	17.7

09-HP001	8/3/1995
Sample Depth	1.25-1.75
Metals (mg/kg)	
CHROMIUM	38.6
LEAD	17.9

09-SB07	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	4,730	4,200	3,810
ANTIMONY	**4.15J**	2.07J	2.33J
ARSENIC	3.8	3.2	2.7
BARIUM	18.8	8.5	9.6
BERYLLIUM	0.12J	0.1J	0.11J
CADMIUM	0.33	0.05	0.06
CALCIUM	3,230	2,050	1,850
CHROMIUM	31	25	25.1
COBALT	6.6	11.4	7.2
COPPER	6.74	5.46	4.39
IRON	11,700	9,780	9,330
LEAD	7.68	2.97	2.64
MAGNESIUM	2,720	2,460	2,150
MANGANESE	106	100	76.9
MERCURY	0.03	0.01J	0.01J
NICKEL	25.5J	24.8J	22.3J
POTASSIUM	553J	500J	507J
SILVER	0.034	0.02J	0.019J
SODIUM	81.8	57.9	49.9
THALLIUM	0.031	0.044	0.039
VANADIUM	21.7	17.9	16.3
ZINC	**642**	27.3	43.8

09-SB25	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	3,730	3,940	4,650
ANTIMONY	0.038J	0.031J	0.034J
ARSENIC	6.4	2.7	2.9
BARIUM	12.9	7.9	9.7
BERYLLIUM	0.11J	0.12J	**0.14J**
CADMIUM	0.03J	0.05J	0.06J
CALCIUM	6,690J	2,260J	1,940J
CHROMIUM	22.9	28.2	27.7
COBALT	5.4	6.5	6.9
COPPER	4.29	3.7	4.26
IRON	12,700	9,570	11,200
LEAD	3.49	2.1	2.16
MAGNESIUM	3,240	1,870	2,420
MANGANESE	238	80	83.9
MERCURY	0.02J	0.01J	0.01J
MOLYBDENUM	0.11	0.07	0.08
NICKEL	25.6	21.2	26.5
POTASSIUM	484J	544J	769J
SILVER	0.019J	0.019J	0.02J
SODIUM	139J	60.5J	80.5J
THALLIUM	0.028	0.034	0.044
VANADIUM	19.3	16.9	17.9
ZINC	18.8	16.1	19.8



09-SB17	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	5,180	4,670	5,110
ANTIMONY	0.1J	<0.05UJ	<0.05UJ
ARSENIC	9.1	3.6	2.4
BARIUM	33.3J	10.4J	11.3J
BERYLLIUM	0.11J	**0.13J**	0.12J
CADMIUM	0.12	0.08	0.05J
CALCIUM	9,460	1,830	3,000
CHROMIUM	34.7	27.2	33.1
COBALT	5.7	6.8	7
COPPER	6.68	8.1	3.62
IRON	13,000	10,600	10,700
LEAD	7.65	3.14	1.98
MAGNESIUM	3,780	2,910	2,630
MANGANESE	241	95.1	92.7
MERCURY	0.03	0.01U	0.02J
NICKEL	29.8	26.2	25.7
POTASSIUM	519J	676J	661J
SILVER	0.029	0.022	0.021J
SODIUM	196	90	92.1
THALLIUM	0.046	0.048	0.034
VANADIUM	23.4	19.3	20.8
ZINC	19.5	20	18.9

09-HP002	8/3/1995
Sample Depth	6.5-7.0
Metals (mg/kg)	
CHROMIUM	25.1
LEAD	2.6

09-HP003	8/3/1995	8/3/1995	8/3/1995
Sample Depth	1-1.5	3.25-3.75	5.5-6.0
Metals (mg/kg)			
LEAD	2.8	2.7	2.7
CHROMIUM	23.2	NA	NA

09-SB18	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	8,390	4,390	3,640
ANTIMONY	0.19J	<0.05UJ	<0.07UJ
ARSENIC	**17.7**	2.7	2.7
BARIUM	77.7J	8.8J	9.7
BERYLLIUM	**0.19J**	**0.13J**	0.09J
CADMIUM	0.5	0.05J	0.04J
CALCIUM	7,190	2,420	1,390
CHROMIUM	59.2	30	20.6
COBALT	5.7	6.1	6.6
COPPER	13.9	3.63	3.84
IRON	15,300	10,000	9,340
LEAD	**26.1**	2.15	1.9
MAGNESIUM	3,700	2,350	2,320
MANGANESE	232	85.1	71.2
MERCURY	0.03	<0.01U	<0.01U
MOLYBDENUM	**2.01J**	<0.09UJ	0.17
NICKEL	33.5	23.3	21.6J
POTASSIUM	657J	545J	570J
SELENIUM	0.2J	<0.2U	<0.2U
SILVER	0.089	0.017J	0.015J
SODIUM	378	66.9	62.1
THALLIUM	0.059	0.036	0.058
VANADIUM	32.3	19.5	14.8
ZINC	37.5	17	16.9

09-HP004	8/3/1995	8/3/1995	8/3/1995
Sample Depth	0.75-1.25	3.25-3.75	5.5-6.0
Metals (mg/kg)			
LEAD	2.4	2.4	2.4

09-HP006	8/8/1995
Sample Depth	0.5-1.0
Metals (mg/kg)	
LEAD	**40**

09-SB03	7/16/1992	7/16/1992	7/16/1992
Sample Depth	1.0-1.5	2.5-3.0	4.5-5.0
Metals (mg/kg)			
ALUMINUM	9,600J	**23,200J**	**25,200J**
ARSENIC	**14.8**	2J	4.2
BARIUM	128	180	186
BERYLLIUM	**0.24J**	**0.96J**	**0.73J**
CADMIUM	0.97J	<0.72U	<0.73U
CALCIUM	9,400J	2,680J	1,950J
CHROMIUM	63.3	**105**	**115**
COBALT	9J	**27.3**	**17.2**
COPPER	52.6	<16.5UJ	<18.2UJ
IRON	18,800	36,900	38,800
LEAD	**974J**	8.2J	8.5J
MAGNESIUM	3,240	3,160	4,560
MANGANESE	234J	**879J**	396J
MOLYBDENUM	<2.4U	<2.4U	<2.4U
NICKEL	40.9	46.2	49
POTASSIUM	916J	793J	998J
SILVER	**8.8J**	**11.5J**	**11.7J**
SODIUM	336J	<164UJ	<157UJ
VANADIUM	**42.4**	**89.8**	**92**
ZINC	**119J**	45J	49J

09-SB05	10/23/2002	10/23/2002	10/23/2002	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.5-1.0	1.0-2.0	2.0-3.0	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)						
ALUMINUM	NA	NA	NA	3,920	3,960	4,610
ANTIMONY	NA	NA	NA	0.066	<0.027UJ	0.048J
ARSENIC	NA	NA	NA	6.7	2.8	2.9
BARIUM	NA	NA	NA	15.1	7	11.3
BERYLLIUM	NA	NA	NA	0.12J	0.12J	**0.14J**
CADMIUM	NA	NA	NA	0.16	0.07	0.05J
CALCIUM	NA	NA	NA	3,670J	1,940J	1,930J
CHROMIUM	NA	NA	NA	30	25.7	27.3
COBALT	NA	NA	NA	5.7	6	6.6
COPPER	NA	NA	NA	6.84	7.03	4.11
IRON	NA	NA	NA	10,400	9,120	10,400
LEAD	**76.2**	2.41	2.7	7.93	2.74	3.7
MAGNESIUM	NA	NA	NA	2,350	1,950	2,410
MANGANESE	NA	NA	NA	136	77.4	79
MERCURY	NA	NA	NA	0.07	0.01B	0.01J
MOLYBDENUM	NA	NA	NA	1.8	0.08	0.06
NICKEL	NA	NA	NA	23.9	20.6	23
POTASSIUM	NA	NA	NA	493J	471J	729J
SILVER	NA	NA	NA	0.024	0.016J	0.023J
SODIUM	NA	NA	NA	89.7J	56.3J	78.8J
THALLIUM	NA	NA	NA	0.037	0.061	0.038
VANADIUM	NA	NA	NA	18.3	16.5	17.8
ZINC	NA	NA	NA	21.2	16	18.5

09-HP005	8/3/1995	8/3/1995	8/3/1995
Sample Depth	0.75-1.25	3.25-3.75	5.5-6.0
Metals (mg/kg)			
LEAD	4.1	2.9	24

09-SB08	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	4,180	4,360	4,210
ARSENIC	2.5	2.9	2.5
BARIUM	11.7	9	8.3
BERYLLIUM	0.09J	0.11J	0.12J
CADMIUM	0.06	0.05J	0.04J
CALCIUM	2,600	2,470	2,190
CHROMIUM	31.6	28.2	25.7
COBALT	6.1	6.2	5.9
COPPER	3.54	3.86	3.64
IRON	9,810	10,600	9,630
LEAD	2.3	2.4	1.86
MAGNESIUM	2,350	2,590	2,330
MANGANESE	85.5	92.7	79.1
MERCURY	0.14	<0.01U	<0.01U
NICKEL	21.3J	22.8J	22.8J
POTASSIUM	513J	563J	568J
SILVER	0.016J	0.018J	0.018J
SODIUM	98.3	93.9	67
THALLIUM	0.032	0.032	0.033
VANADIUM	20.1	19	17
ZINC	16.3	17.3	17.1

09-SB06	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	6,210	3,920	4,060
ANTIMONY	0.73J	<0.08UJ	<0.1UJ
ARSENIC	7.3	2.7	2.6
BARIUM	61.2J	7.9J	8.2J
BERYLLIUM	**0.2J**	0.11J	0.11J
CADMIUM	0.28	0.05J	0.04J
CALCIUM	4,590	2,240	1,720
CHROMIUM	30.7J	29.3J	23.7J
COBALT	6	5.7	6.2
COPPER	14.9	3.55	3.42
IRON	13,300	9,160	9,340
LEAD	**22.9**	2.04	1.88
MAGNESIUM	2,970	2,090	2,370
MANGANESE	244J	77.2J	75.6J
MERCURY	0.02	0.03	0.02J
MOLYBDENUM	1.16	0.08	0.07
NICKEL	27.8	21.3	22
POTASSIUM	567	578	702
SILVER	0.046	0.016J	0.018J
SODIUM	131	60.4	81.2
THALLIUM	0.038	0.034	0.03
VANADIUM	27.1	18.8	16.1
ZINC	**109**	16	17.3

09-SB10	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	8,420	3,740	4,680
ANTIMONY	1.07J	<0.09UJ	<0.08UJ
ARSENIC	**15.4**	2.7	3
BARIUM	111	8.8	8.5
BERYLLIUM	**0.25J**	0.1J	0.12J
CADMIUM	0.24	0.04J	0.06J
CALCIUM	10,200	1,850	1,750
CHROMIUM	30.7	26	27.7
COBALT	6.1	5.8	7.2
COPPER	13	4.03	4.48
IRON	16,900	9,130	10,900
LEAD	**33.1**	2.81	2.11
MAGNESIUM	4,110	2,160	2,610
MANGANESE	300	78.4	87.4
MERCURY	0.02J	<0.01U	<0.01U
MOLYBDENUM	**3.11**	0.48	<0.06UJ
NICKEL	30.7J	21.2J	24.8J
POTASSIUM	553J	521J	659J
SELENIUM	**0.6J**	<0.2U	<0.2U
SILVER	0.051	0.016J	0.02J
SODIUM	684	81.1	63.7
THALLIUM	0.051	0.031	0.041
VANADIUM	**33.4**	16.2	18.4
ZINC	24.2	15.8	18.5

09-SB04	7/16/1992	7/16/1992	7/16/1992	7/16/1992
Sample Depth	1.0-1.5	2.5-3.0	4.0-4.5.0	4.5-5.0
Metals (mg/kg)				
ALUMINUM	7,630J	**15,600J**	4,210J	4,530J
ARSENIC	7.3	5.3	2.4	2.9
BARIUM	51J	28.2J	8.3J	9.6J
BERYLLIUM	**0.36J**	**0.42J**	**0.22J**	**0.21J**
CALCIUM	4,880J	5,520J	2,000J	2,370J
CHROMIUM	54.2	59.6	27.1	38.1
COBALT	13.9J	14.7	7.9J	9.8J
IRON	21,900	26,300	10,300	11,700
LEAD	9.6J	6.3J	2.7J	3J
MAGNESIUM	4,740	8,130	2,160	2,400
MANGANESE	381J	236J	84.9J	108J
NICKEL	53.1	69.1	24.9	28.9
POTASSIUM	1,080J	2,130	858J	826J
SILVER	**2.9J**	**1.3J**	<1.1U	<1.1U
VANADIUM	**38.1**	**48.4**	17.5	20.5
ZINC	58.8J	57.7J	<35.4UJ	<24.4UJ

09-SB23	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	3,880	3,710	4,530
ANTIMONY	0.053	0.039J	0.045J
ARSENIC	2.5	2.5	2.6
BARIUM	10.1	7.2	9.1
BERYLLIUM	0.11J	0.1J	0.11J
CADMIUM	0.04J	0.05	0.05J
CALCIUM	4,920J	1,660J	2,240J
CHROMIUM	25.4	23.8	29.6
COBALT	5.7	5	7.1
COPPER	4.06	4.14	4.6
IRON	10,800	9,230	10,400
LEAD	2.39	2.2	2.47
MAGNESIUM	3,250	2,150	2,620
MANGANESE	164	63.2	84.9
MERCURY	0.01J	0.02J	0.01J
MOLYBDENUM	0.08	0.07	0.13
NICKEL	26.1	20	26.9
POTASSIUM	584J	631J	727J
SILVER	0.021	0.016J	0.021J
SODIUM	102J	57.9J	76.3J
THALLIUM	0.031	0.043	0.044
VANADIUM	17.7	17	19.7
ZINC	18.9	16.8	19.9

09-SB24	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	6,870	4,330	4,200
ANTIMONY	0.152	0.102	0.036J
ARSENIC	5.6	3.2	2.7
BARIUM	52	14.1	8.3
BERYLLIUM	**0.23J**	**0.13J**	0.12J
CADMIUM	0.22	0.07	0.04J
CALCIUM	3,300J	2,350J	2,120J
CHROMIUM	27.6	28.7	25.9
COBALT	6.6	6.7	6.3
COPPER	11	17.7	4.1
IRON	14,700	10,400	9,930
LEAD	10.2	5.41	2.16
MAGNESIUM	2,920	2,410	2,310
MANGANESE	266	89.7	78.7
MERCURY	0.04	0.03	0.01J
MOLYBDENUM	0.77	0.12	0.1
NICKEL	24.2	22.4	22.9
POTASSIUM	869J	625J	620J
SILVER	0.051	0.03	0.017J
SODIUM	80.5J	69.6J	67.3J
THALLIUM	0.08	0.041	0.04
VANADIUM	25.2	18.7	18.1
ZINC	32.3	24.3	18.5

09-SB22	11/1/2002	11/1/2002	11/1/2002
Sample Depth	0.5-2.0	2.5-5.0	5.0-7.5
Metals (mg/kg)			
ALUMINUM	3,870	3,580	3,850
ANTIMONY	0.051J	0.047J	0.053J
ARSENIC	4.9	2.3	2.5
BARIUM	8.9	6.7	7.5
BERYLLIUM	0.12J	0.1J	0.1J
CADMIUM	0.05J	0.04J	0.04J
CALCIUM	6,450J	1,410J	1,510J
CHROMIUM	22.4	22.2	23
COBALT	6	6.2	5.7
COPPER	4.31	3.48	3.73
IRON	11,900	8,710	8,690
LEAD	4.55	1.89	1.92
MAGNESIUM	3,520	2,130	2,190
MANGANESE	187	70.6	70.9
MERCURY	<0.02UJ	0.02	0.01J
MOLYBDENUM	0.2	0.1	0.06
NICKEL	28.2	19.9	21.9
POTASSIUM	749J	663J	623J
SILVER	0.023	0.018J	0.021J
SODIUM	147J	60.4J	245J
THALLIUM	0.056	0.042	0.042
VANADIUM	18.3	14.9	15.4
ZINC	21.3	16.1	17.1

LEGEND
MONITORING WELL LOCATION
SOIL BORING LOCATION
HYDROPUNCH LOCATION
J Estimated value
mg/kg Milligrams per kilogram
NA Not analyzed
ND Not detected
U Nondetected for individual compound

N

20 10 0 10 20 30
1 INCH = 15 FEET

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-4
Site 09 - Foundry
Metals Soil Sampling Results

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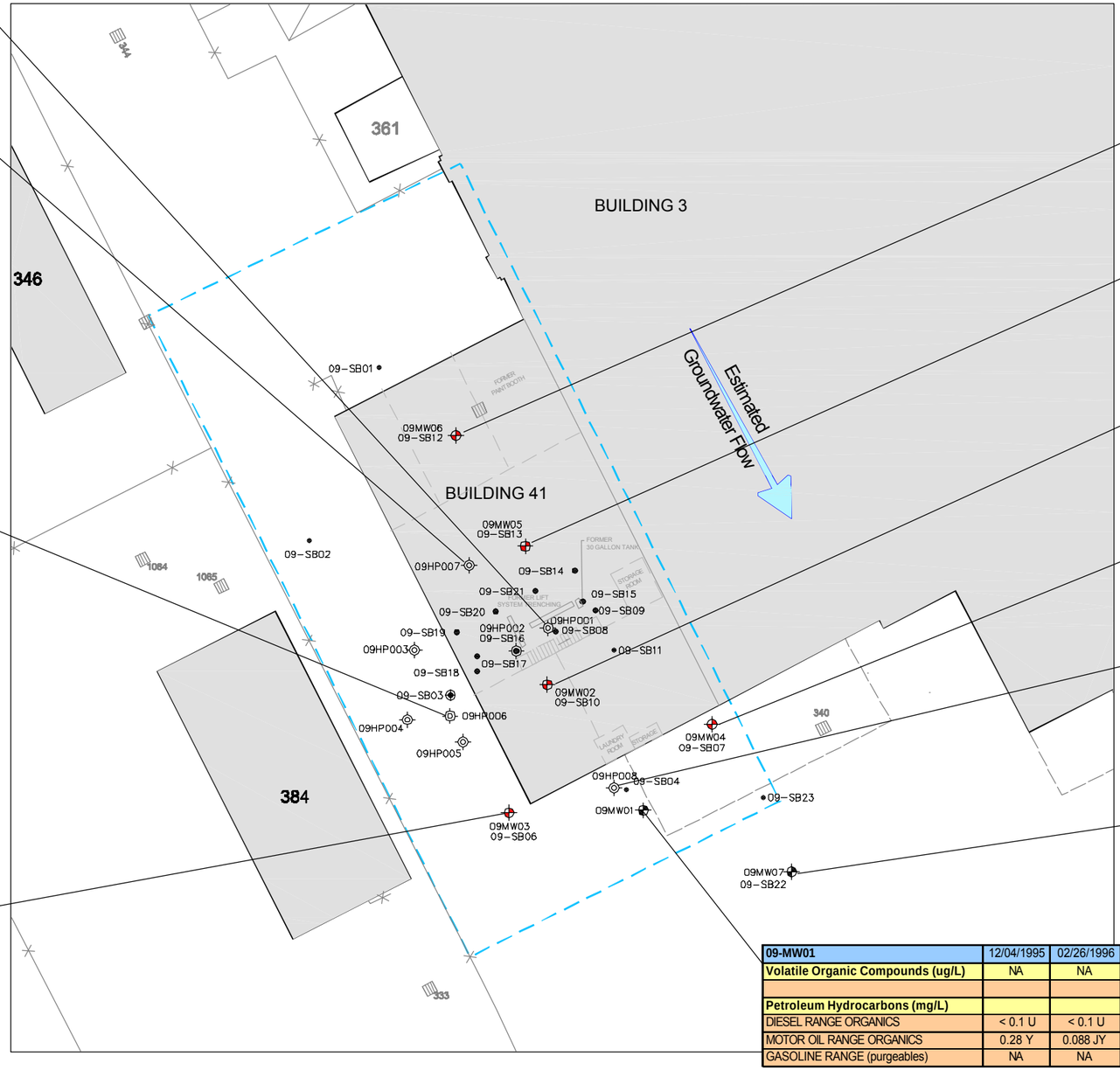
09-HP001	8/3/1995
Volatile Organic Compounds (ug/L)	NA
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	0.42 Y
MOTOR OIL RANGE ORGANICS	0.78 Y
GASOLINE RANGE (purgeables)	NA

09-HP007	8/8/1995
Volatile Organic Compounds (ug/L)	NA
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	< 0.1 U
MOTOR OIL RANGE ORGANICS	< 0.1 U
GASOLINE RANGE (purgeables)	NA

09-HP006	8/8/1995
Volatile Organic Compounds (ug/L)	NA
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	< 0.1 U
MOTOR OIL RANGE ORGANICS	< 0.1 U
GASOLINE RANGE (purgeables)	NA

09-MW03	10/31/2002
Volatile Organic Compounds (ug/L)	
METHYL-TERT-BUTYL ETHER	0.3 J
Petroleum Hydrocarbons (mg/L)	ND



09-MW06	10/31/2002
Volatile Organic Compounds (ug/L)	ND
Petroleum Hydrocarbons (mg/L)	ND

09-MW05	10/31/2002
Volatile Organic Compounds (ug/L)	
M,P-XYLENES	0.3 J
METHYL-TERT-BUTYL ETHER	0.3 J
Petroleum Hydrocarbons (mg/L)	ND

09-MW02	10/31/2002
Volatile Organic Compounds (ug/L)	
METHYL-TERT-BUTYL ETHER	0.3 J
Petroleum Hydrocarbons (mg/L)	ND

09-MW04	10/30/2002
Volatile Organic Compounds (ug/L)	
METHYL-TERT-BUTYL ETHER	0.3 J
Petroleum Hydrocarbons (mg/L)	ND

09-HP008	8/8/1995
Volatile Organic Compounds (ug/L)	NA
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	< 0.1 U
MOTOR OIL RANGE ORGANICS	< 0.1 U
GASOLINE RANGE (purgeables)	NA

09-MW07	11/4/2002
Volatile Organic Compounds (ug/L)	ND
Petroleum Hydrocarbons (mg/L)	ND

09-MW01	12/04/1995	02/26/1996	06/10/1996	06/10/1996	09/05/1996	08/28/1997	11/03/1998	04/03/2000	10/10/2000	10/31/2002	10/31/2002
Volatile Organic Compounds (ug/L)	NA	NA	NA	NA	NA	ND	NA	ND	ND	ND	ND
Petroleum Hydrocarbons (mg/L)											
DIESEL RANGE ORGANICS	< 0.1 U	< 0.1 U	< 0.1 U	< 0.1 U	< 0.1 U	NA	<0.13 U	<0.1 U	<0.1 U	<0.045 U	<0.045 U
MOTOR OIL RANGE ORGANICS	0.28 Y	0.088 JY	< 0.1 U	< 0.1 U	0.065 JY	NA	<0.26 U	<0.1 U	<0.1 U	<0.03 U	<0.03 U
GASOLINE RANGE (purgeables)	NA	NA	NA	NA	NA	<0.05 U	NA	<0.05 U	<0.05 U	<0.05 U	<0.05 U

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- SITE BOUNDARY

J	Estimated value
mg/L	Milligrams per liter
NA	Not analyzed
ND	Not detected
U	Nondetected for individual compound
ug/L	Micrograms per liter
Y	Chromatographic pattern resembles hydrocarbon fuel pattern and was quanitifed using the standard it resembles the most

N

15 0 15 30

SCALE IN FEET

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NAVAL STATION TREASURE ISLAND, CALIFORNIA

U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-5

Site 09 - Foundry
VOCs and TPH Groundwater Sampling Results

Site 9 GW VOC TPH.dwg - JHD - 07/02/03 - G0069.302.B.05.01.02

09-HP001	8/3/1995
Semivolatile Organic Compounds (ug/L)	ND

09-HP007	8/8/1995
Semivolatile Organic Compounds (ug/L)	ND

09-MW06	10/31/2002
Semivolatile Organic Compounds (ug/L)	
2-NITROPHENOL	0.2 J
NAPHTHALENE	0.025 J
PHENOL	4.2

09-MW05	10/31/2002
Semivolatile Organic Compounds (ug/L)	
2-METHYLNAPHTHALENE	0.019 J
ACENAPHTHENE	1.1
DIBENZOFURAN	2.5
NAPHTHALENE	0.038 J
PHENOL	5.6
PYRENE	0.023 J

09-MW02	10/31/2002
Semivolatile Organic Compounds (ug/L)	
2-METHYLNAPHTHALENE	0.025 J
2-NITROPHENOL	0.11 J
NAPHTHALENE	0.033 J
PHENOL	8.8

09-MW04	10/30/2002
Semivolatile Organic Compounds (ug/L)	
ACENAPHTHENE	0.041 J
DIBENZOFURAN	0.043 J
FLUORENE	0.066 J
PHENOL	0.037
PYRENE	0.031 J

09-HP008	8/8/1995
Semivolatile Organic Compounds (ug/L)	ND

09-MW07	11/4/2002
Semivolatile Organic Compounds (ug/L)	
PENTACHLOROPHENOL	0.089 J
PHENANTHRENE	0.03 J
PHENOL	0.48 J
PYRENE	0.027

09-MW03	10/31/2002
Semivolatile Organic Compounds (ug/L)	
2-METHYLNAPHTHALENE	0.023 J
PHENOL	3.3

09-MW01	12/4/1995	2/26/1996	6/10/1996	6/10/1996	9/5/1996	8/28/1997	11/3/1998	4/3/2000	10/10/2000	10/31/2002	10/31/2002
Semivolatile Organic Compounds (ug/L)	ND	ND	ND	ND	ND	NA	NA	NA	NA		ND
NAPHTHALENE										0.028 J	

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- SITE BOUNDARY

ID Identification
J Estimated value
mg/L Milligrams per liter
ND Not detected
ug/L Micrograms per liter

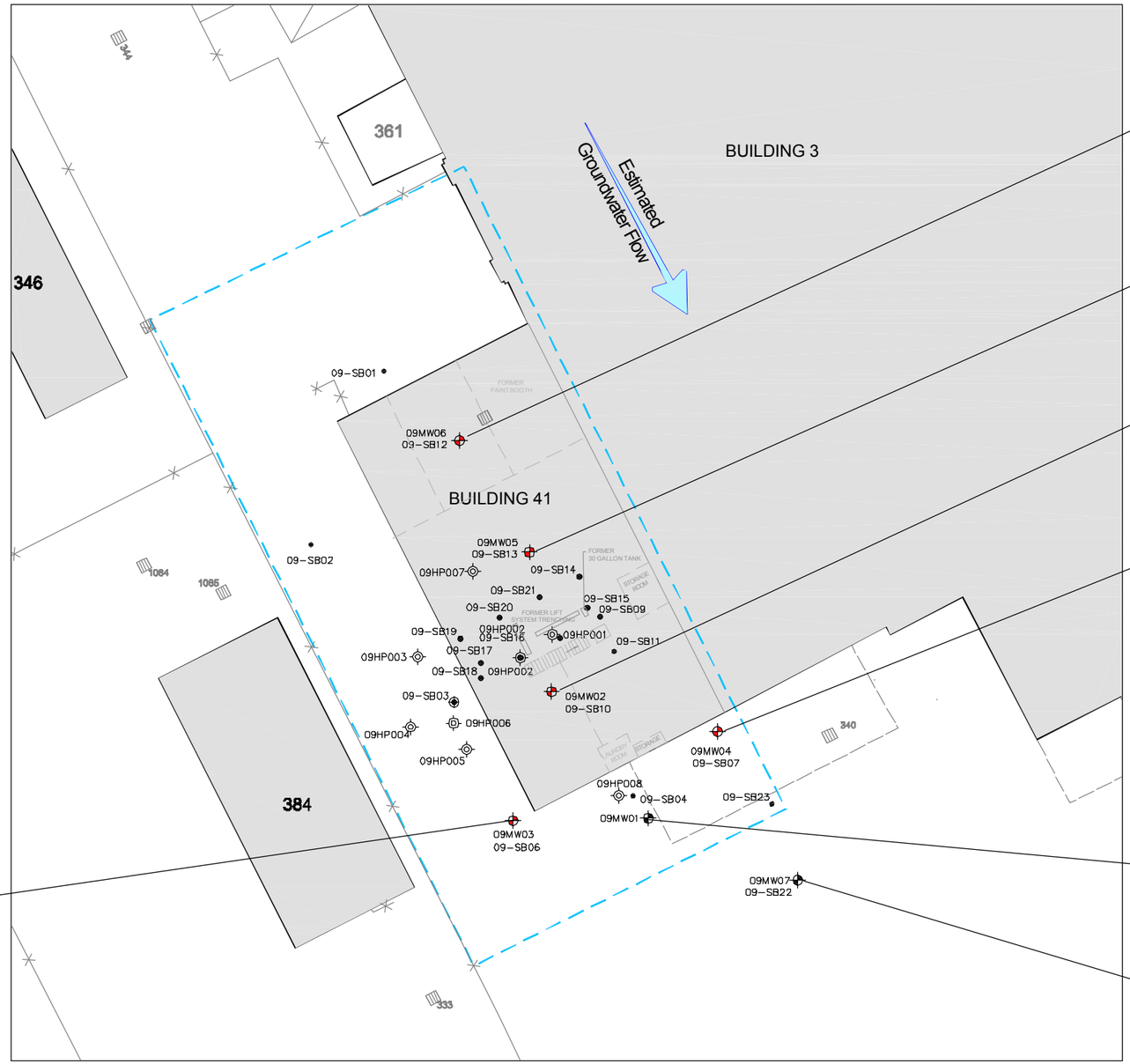
15 0 15 30
SCALE IN FEET

SwTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-6
Site 09 - Foundry
SVOCs Groundwater Sampling Results

sITE 9 HITBOX gw svocS.dwg - jhd - 07/02/03 - G0069.302.B.05.01.02



09-MW06	10/31/2002
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

09-MW05	10/31/2002
PCBs (ug/L)	ND
Pesticides (ug/L)	
ALPHA-CHLORDANE	0.0067 J

09-MW02	10/31/2002
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

09-MW04	10/30/2002
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

09-MW03	10/31/2002
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

09-MW01	10/31/2002
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

09-MW07	11/4/2002
PCBs (ug/L)	ND
Pesticides (ug/L)	
ENDOSULFAN II	0.014
GAMMA-BHC (LINDANE)	0.0071 J

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- SITE BOUNDARY

J	Estimated value
mg/L	Milligrams per liter
ND	Not detected
U	Nondetected for individual compound
ug/L	Micrograms per liter

N

15 0 15 30

SCALE IN FEET

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NAVAL STATION TREASURE ISLAND, CALIFORNIA

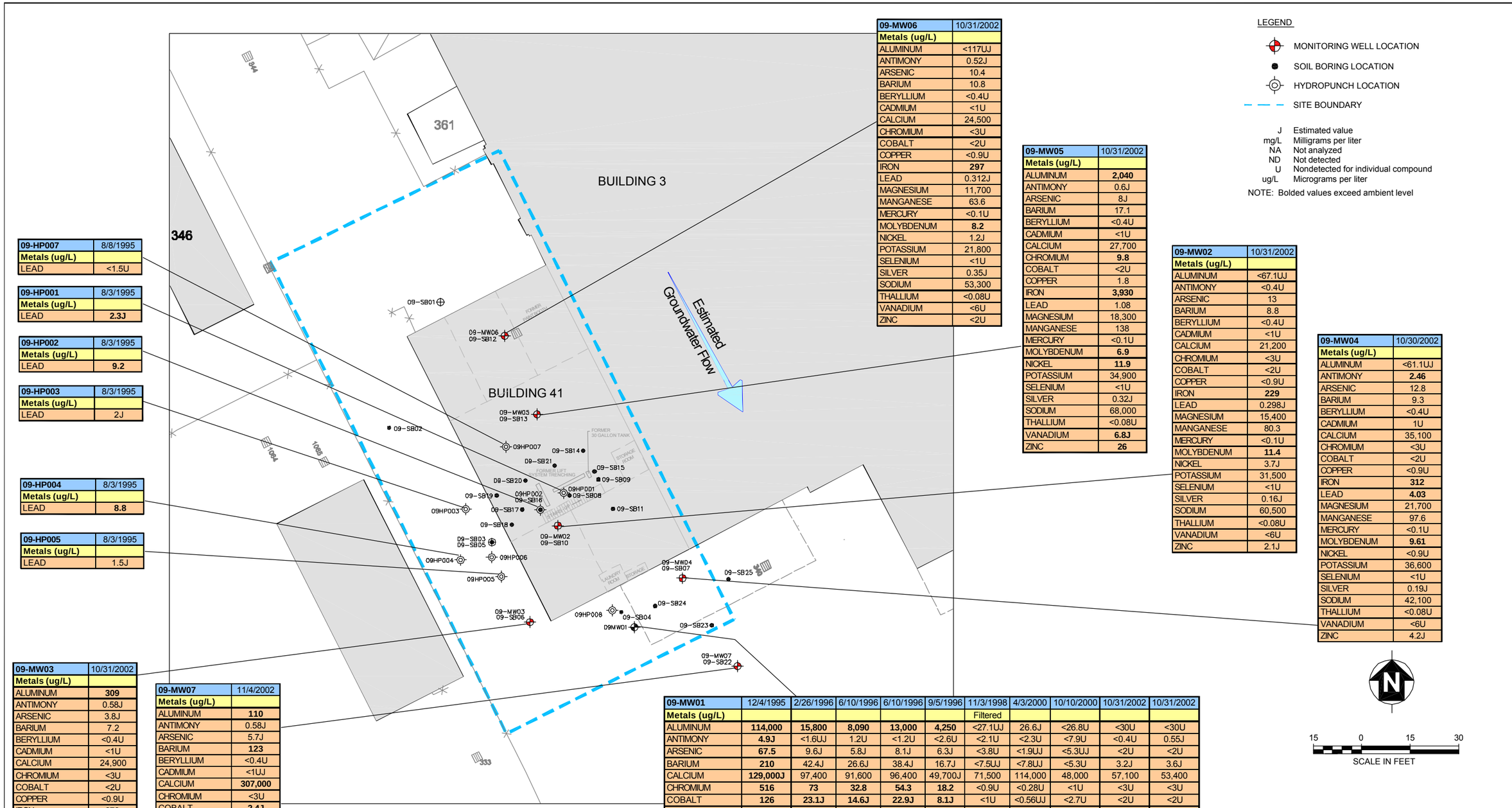
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-7

Site 09 - Foundry

Pesticides and PCB Groundwater Sampling Results

Site 9 Hitbox GW pest_pcb.dwg - jhd - 07/02/03 - G0069.302.B.05.01.02



09-HP007	8/8/1995
Metals (ug/L)	
LEAD	<1.5U

09-HP001	8/3/1995
Metals (ug/L)	
LEAD	**2.3J**

09-HP002	8/3/1995
Metals (ug/L)	
LEAD	**9.2**

09-HP003	8/3/1995
Metals (ug/L)	
LEAD	2J

09-HP004	8/3/1995
Metals (ug/L)	
LEAD	**8.8**

09-HP005	8/3/1995
Metals (ug/L)	
LEAD	1.5J

09-MW06	10/31/2002
Metals (ug/L)	
ALUMINUM	<117UJ
ANTIMONY	0.52J
ARSENIC	10.4
BARIUM	10.8
BERYLLIUM	<0.4U
CADMIUM	<1U
CALCIUM	24,500
CHROMIUM	<3U
COBALT	<2U
COPPER	<0.9U
IRON	**297**
LEAD	0.312J
MAGNESIUM	11,700
MANGANESE	63.6
MERCURY	<0.1U
MOLYBDENUM	**8.2**
NICKEL	1.2J
POTASSIUM	21,800
SELENIUM	<1U
SILVER	0.35J
SODIUM	53,300
THALLIUM	<0.08U
VANADIUM	<6U
ZINC	<2U

09-MW05	10/31/2002
Metals (ug/L)	
ALUMINUM	**2,040**
ANTIMONY	0.6J
ARSENIC	8J
BARIUM	17.1
BERYLLIUM	<0.4U
CADMIUM	<1U
CALCIUM	27,700
CHROMIUM	**9.8**
COBALT	<2U
COPPER	1.8
IRON	**3,930**
LEAD	1.08
MAGNESIUM	18,300
MANGANESE	138
MERCURY	<0.1U
MOLYBDENUM	**6.9**
NICKEL	**11.9**
POTASSIUM	34,900
SELENIUM	<1U
SILVER	0.32J
SODIUM	68,000
THALLIUM	<0.08U
VANADIUM	**6.8J**
ZINC	**26**

09-MW02	10/31/2002
Metals (ug/L)	
ALUMINUM	<67.1UJ
ANTIMONY	<0.4U
ARSENIC	13
BARIUM	8.8
BERYLLIUM	<0.4U
CADMIUM	<1U
CALCIUM	21,200
CHROMIUM	<3U
COBALT	<2U
COPPER	<0.9U
IRON	**229**
LEAD	0.298J
MAGNESIUM	15,400
MANGANESE	80.3
MERCURY	<0.1U
MOLYBDENUM	**11.4**
NICKEL	3.7J
POTASSIUM	31,500
SELENIUM	<1U
SILVER	0.16J
SODIUM	60,500
THALLIUM	<0.08U
VANADIUM	<6U
ZINC	2.1J

09-MW04	10/30/2002
Metals (ug/L)	
ALUMINUM	<61.1UJ
ANTIMONY	**2.46**
ARSENIC	12.8
BARIUM	9.3
BERYLLIUM	<0.4U
CADMIUM	1U
CALCIUM	35,100
CHROMIUM	<3U
COBALT	<2U
COPPER	<0.9U
IRON	**312**
LEAD	**4.03**
MAGNESIUM	21,700
MANGANESE	97.6
MERCURY	<0.1U
MOLYBDENUM	**9.61**
NICKEL	<0.9U
POTASSIUM	36,600
SELENIUM	<1U
SILVER	0.19J
SODIUM	42,100
THALLIUM	<0.08U
VANADIUM	<6U
ZINC	4.2J

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- SITE BOUNDARY

J	Estimated value
mg/L	Milligrams per liter
NA	Not analyzed
ND	Not detected
U	Nondetected for individual compound
ug/L	Micrograms per liter

NOTE: Bolded values exceed ambient level

09-MW03	10/31/2002
Metals (ug/L)	
ALUMINUM	**309**
ANTIMONY	0.58J
ARSENIC	3.8J
BARIUM	7.2
BERYLLIUM	<0.4U
CADMIUM	<1U
CALCIUM	24,900
CHROMIUM	<3U
COBALT	<2U
COPPER	<0.9U
IRON	**679**
LEAD	0.503
MAGNESIUM	11,500
MANGANESE	57.3
MERCURY	<0.1U
MOLYBDENUM	6.5
NICKEL	0.9J
POTASSIUM	22,200
SELENIUM	<1U
SILVER	0.37J
SODIUM	23,900
THALLIUM	<0.08U
VANADIUM	<6U
ZINC	4.1J

09-MW07	11/4/2002
Metals (ug/L)	
ALUMINUM	**110**
ANTIMONY	0.58J
ARSENIC	5.7J
BARIUM	**123**
BERYLLIUM	<0.4U
CADMIUM	<1UJ
CALCIUM	**307,000**
CHROMIUM	<3U
COBALT	**2.4J**
COPPER	<0.9UJ
IRON	**2,190**
LEAD	0.149J
MAGNESIUM	**615,000**
MANGANESE	710
MERCURY	<0.1U
MOLYBDENUM	**11**
NICKEL	1.2J
POTASSIUM	**168,000**
SELENIUM	<5UJ
SILVER	0.18J
SODIUM	**4,480,000**
THALLIUM	<0.08U
VANADIUM	<6U
ZINC	**8.1J**

09-MW01	12/4/1995	2/26/1996	6/10/1996	6/10/1996	9/5/1996	11/3/1998	4/3/2000	10/10/2000	10/31/2002	10/31/2002
Metals (ug/L)						Filtered				
ALUMINUM	**114,000**	**15,800**	**8,090**	**13,000**	**4,250**	<27.1UJ	26.6J	<26.8U	<30U	<30U
ANTIMONY	**4.9J**	<1.6UJ	1.2U	<1.2U	<2.6U	<2.1U	<2.3U	<7.9U	<0.4U	0.55J
ARSENIC	**67.5**	9.6J	5.8J	8.1J	6.3J	<3.8U	<1.9UJ	<5.3UJ	<2U	<2U
BARIUM	**210**	42.4J	26.6J	38.4J	16.7J	<7.5UJ	<7.8UJ	<5.3U	3.2J	3.6J
CALCIUM	**129,000J**	97,400	91,600	96,400	49,700J	71,500	114,000	48,000	57,100	53,400
CHROMIUM	**516**	**73**	**32.8**	**54.3**	**18.2**	<0.9U	<0.28U	<1U	<3U	<3U
COBALT	**126**	**23.1J**	**14.6J**	**22.9J**	**8.1J**	<1U	<0.56UJ	<2.7U	<2U	<2U
COPPER	**150**	**25.4**	**13.7J**	**20.8J**	**9.2J**	<1.5UJ	<1.1UJ	<9.9UJ	<0.9U	<0.9U
IRON	**231,000**	**33,400**	**16,000**	**26,000**	**8,800**	<19.9U	<44.2UJ	<25.4U	11.1J	6.4J
LEAD	**88.3**	**14.3**	**8.4**	**14.3**	**4.8**	<1.9U	0.87R	<1.8U	0.122J	0.184J
MAGNESIUM	**89,300**	31,600	28,000	31,300	21,300	15,500	24,800	11,700	13,200	12,400
MANGANESE	**1800**	318	242	390	138	<1.2UJ	<7.4UJ	3.3J	0.5J	<0.4U
MERCURY	**1.2**	<0.16UJ	<0.1U	<0.1U	<0.1U	**0.12J**	<0.11U	<0.1U	<0.1U	<0.1U
MOLYBDENUM	<1.4UJ	<1.4UJ	1.1J	1J	3.2J	2J	<0.92UJ	<3.1U	2.25	2.48
NICKEL	**445**	**73.6**	**36J**	**55.1**	**19.7J**	1.6J	<4UJ	<3.4U	<0.9U	1.7J
POTASSIUM	**49,700**	21,100	19,600	20,900	31,800	16,500J	16,000J	20,400	16,200	15,900
SELENIUM	**4.8J**	2.3U	<2.2U	<2.2U	<3.9U	<2.1UJ	**2R**	<3.7U	<1U	<1U
SILVER	<0.7U	0.5U	<0.7U	<0.7U	<0.4U	<1.2U	<0.5U	<2.6U	0.16J	0.2J
SODIUM	**26,200**	15,900	14,900	14,900	25,600	21,400	16,800	17,200	19,900	19,200
THALLIUM	**5.5**	1.9U	<1.7U	<1.7U	<1.8UJ	<1.1U	<1.3U	<4.5U	<0.08U	<0.08U
VANADIUM	**411**	**57.7**	**27.8J**	**44.8J**	**17.9J**	<0.7U	<0.52U	<1.9U	<6U	<6U
ZINC	**498J**	**90.1**	<46.9UJ	<70.3UJ	**36**	<2.5UJ	<5.3UJ	<3.5U	2.2J	<2U

15 0 15 30

SCALE IN FEET

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-8

Site 09 - Foundry
Metals Groundwater Sampling Results

fig 6 IR-9 prop samp loc.dwg - DWH - 07/02/02 - G0069.302.B.05.01.02

07/10-HP012	8/10/1995	8/10/1995	8/10/1995
Sample Depth	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75
Volatile Organic Compounds (mg/kg)	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	36 Y	< 10 U	< 11 U
MOTOR OIL RANGE ORGANICS	83 Y	< 10 U	< 11 U
GASOLINE RANGE (PURGEABLES)	NA	NA	NA

07/10-HP013	8/10/1995	8/10/1995	8/10/1995
Sample Depth	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
Volatile Organic Compounds (mg/kg)	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	< 140 U	< 10 U	< 11 U
MOTOR OIL RANGE ORGANICS	1,200 Y	< 10 U	< 11 U
GASOLINE RANGE (PURGEABLES)	NA	NA	NA

07/10-HP006	6/13/1995	6/13/1995	6/13/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)	NA	NA	NA

07/10-HP007	6/13/1995
Sample Depth	1.30 - 2.00
Volatile Organic Compounds (mg/kg)	ND
Petroleum Hydrocarbons (mg/kg)	
DIESEL RANGE ORGANICS	< 10 U
MOTOR OIL RANGE ORGANICS	< 10 U
GASOLINE RANGE (PURGEABLES)	NA

10-SB27	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)	ND	ND	ND

07/10-HP004	6/13/1995	6/13/1995	6/13/1995
Sample Depth	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	NA	NA	< 11 U
MOTOR OIL RANGE ORGANICS	NA	NA	< 11 U
GASOLINE RANGE (PURGEABLES)	NA	NA	NA

07/10-HP002	6/9/1995	6/9/1995
Sample Depth	1.25 - 1.50	7.25 - 7.75
Volatile Organic Compounds (mg/kg)	ND	ND
Petroleum Hydrocarbons (mg/kg)		
DIESEL RANGE ORGANICS	NA	< 11 U
MOTOR OIL RANGE ORGANICS	NA	< 11 U
GASOLINE RANGE (PURGEABLES)	NA	NA

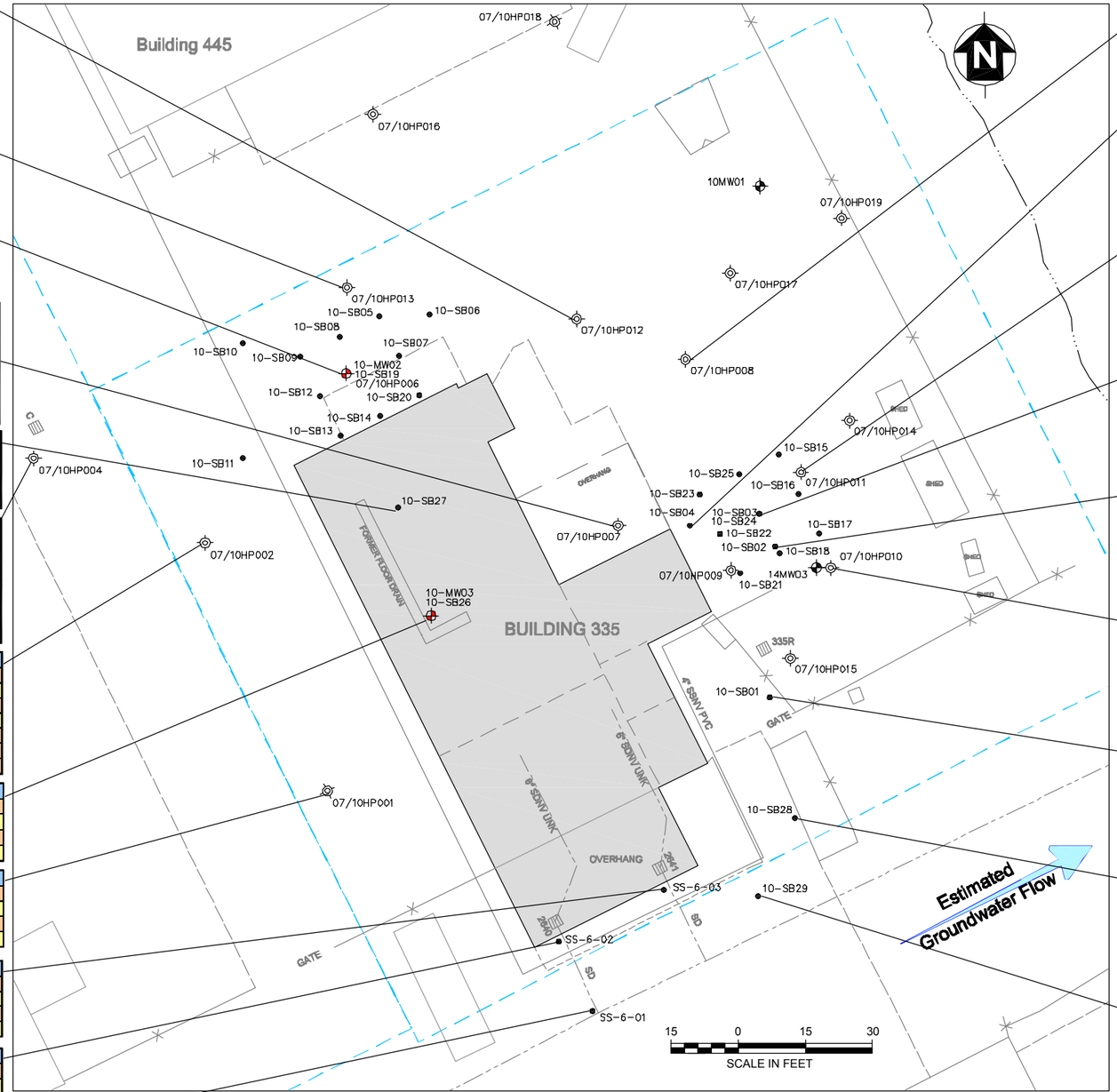
10-SB26	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)	ND	ND	ND

07/10-HP001	6/9/1995	6/9/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50
Volatile Organic Compounds (mg/kg)	ND	ND
Petroleum Hydrocarbons (mg/kg)	NA	NA

SS-6-03	1/29/1997
Sample Depth	8.00 - 9.00
Volatile Organic Compounds (mg/kg)	ND
Petroleum Hydrocarbons (mg/kg)	ND

SS-6-02	1/29/1997
Sample Depth	8.00 - 9.00
Volatile Organic Compounds (mg/kg)	ND
Petroleum Hydrocarbons (mg/kg)	ND

SS-6-01	1/29/1997
Sample Depth	7.50 - 8.00
Volatile Organic Compounds (mg/kg)	ND
Petroleum Hydrocarbons (mg/kg)	
DIESEL RANGE ORGANICS	< 12 U
MOTOR OIL RANGE ORGANICS	9.9 J
GASOLINE RANGE (PURGEABLES)	<0.12 U



07/10-HP008	6/14/1995
Sample Depth	7.25 - 7.75
Volatile Organic Compounds (mg/kg)	ND
Petroleum Hydrocarbons (mg/kg)	
DIESEL RANGE ORGANICS	< 10 U
MOTOR OIL RANGE ORGANICS	< 10 U
GASOLINE RANGE (PURGEABLES)	NA

10-SB04	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	< 13.2 U	< 13.3 U	185 JY
MOTOR OIL RANGE ORGANICS	NA	NA	NA
GASOLINE RANGE (PURGEABLES)	NA	NA	NA

07/10-HP011	6/14/1995	6/14/1995
Sample Depth	1.25 - 1.75	3.75 - 4.00
Volatile Organic Compounds (mg/kg)	ND	ND
Petroleum Hydrocarbons (mg/kg)		
DIESEL RANGE ORGANICS	< 260 U	< 10 U
MOTOR OIL RANGE ORGANICS	1,400 Y	< 10 U
GASOLINE RANGE (PURGEABLES)	NA	NA

10-SB03	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	< 12.7 U	< 13.4 U	< 15 U
MOTOR OIL RANGE ORGANICS	NA	NA	NA
GASOLINE RANGE (PURGEABLES)	NA	NA	NA

10-SB02	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	< 12.7 U	< 12.9 U	< 15.5 U
MOTOR OIL RANGE ORGANICS	NA	NA	NA
GASOLINE RANGE (PURGEABLES)	NA	NA	NA

07/10-HP010	6/14/1995
Sample Depth	1.00 - 1.50
Volatile Organic Compounds (mg/kg)	ND
Petroleum Hydrocarbons (mg/kg)	
DIESEL RANGE ORGANICS	< 100 U
MOTOR OIL RANGE ORGANICS	330 Y
GASOLINE RANGE (PURGEABLES)	NA

10-SB01	7/28/1992	7/28/1992	7/28/1992	7/28/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50
Volatile Organic Compounds (mg/kg)	ND	ND	ND	ND
Petroleum Hydrocarbons (mg/kg)				
DIESEL RANGE ORGANICS	< 12.9 U	< 12.9 U	< 13 U	< 14.6 U
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA
GASOLINE RANGE (PURGEABLES)	NA	NA	NA	NA

10-SB28	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)			
TOLUENE	< 0.0051 U	< 0.005 U	0.002 J
Petroleum Hydrocarbons (mg/kg)			
DIESEL RANGE ORGANICS	34 H	< 4.5 U	< 4.5 U
MOTOR OIL RANGE ORGANICS	390 M	25 M	4.6 M
GASOLINE RANGE (PURGEABLES)	<0.22 U	<0.22 U	<0.24 U

10-SB29	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)			
TOLUENE	0.00068 J	< 0.0052 U	< 0.006 U
Petroleum Hydrocarbons (mg/kg)	ND	ND	ND

LEGEND

MONITORING WELL LOCATION

SOIL BORING LOCATION

HYDROPUNCH LOCATION

IR SITE BOUNDARY

STORM DRAIN

J	Estimated value
mg/kg	Milligrams per kilogram
NA	Not analyzed
ND	Not detected
TPH	Total petroleum hydrocarbons
U	Nondetected for individual compound
Y	Chromatographic pattern resembles hydrocarbon fuel pattern and was quanitifed using the standard it resembles the most
H	Chromatographic pattern is in the heavier hydrocarbon end of the analyte's range in the standard
M	Chromatographic pattern resembles motor oil

NOTE: Soil Samples From Borings SB05 Through SB25 Were Not Analyzed for VOCs or TPH

SuiTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-9

Site 10 - Bus Painting Shop
VOCs and TPH Soil Sampling Results

Site 10 Soil VOC TPH.dwg – JHD – 07/02/03 – G0069.302.B.05.01.03

07/10-HP008	6/14/1995
Sample Depth	7.25 - 7.75
Semivolatile Organic Compounds (mg/kg)	ND

07/10-HP012	8/10/1995	8/10/1995	8/10/1995
Sample Depth	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75
Semivolatile Organic Compounds (mg/kg)			
PHENOL	< 0.34 U	0.33 J	0.55

07/10-HP013	8/10/1995	8/10/1995	8/10/1995
Sample Depth	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
Semivolatile Organic Compounds (mg/kg)			
PHENOL	0.21 J	0.66	1.6

10-SB04	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Semivolatile Organic Compounds (mg/kg)	ND	ND	ND

07/10-HP007	6/13/1995
Sample Depth	1.30 - 2.00
Semivolatile Organic Compounds (mg/kg)	
PHENOL	0.32 J

10-SB27	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
SVOCs (MG/KG)			
BENZO(A)PYRENE	< 0.021 U	0.032 J	< 0.021 U

07/10-HP002	6/9/1995
Sample Depth	7.25 - 7.75
Semivolatile Organic Compounds (mg/kg)	ND

07/10-HP004	6/13/1995
Sample Depth	6.30 - 7.00
Semivolatile Organic Compounds (mg/kg)	
PHENOL	0.23 J

10-SB18	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(G,H,I)PERYLENE	< 0.021 U	< 0.021 U	0.028 J

10-SB26	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	< 0.013 U	< 0.013 U	0.017 J
BENZO(B)FLUORANTHENE	< 0.018 U	< 0.018 U	0.024 J
CHRYSENE	< 0.012 U	< 0.013 U	0.018 J

10-SB01	7/28/1992	7/28/1992	7/28/1992	7/28/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50
Semivolatile Organic Compounds (mg/kg)	ND	ND	ND	ND

10-SB28	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
ANTHRACENE	< 0.015 U	< 0.015 U	0.053 J
BENZO(A)ANTHRACENE	< 0.013 U	0.024 J	0.042 J
BENZO(A)PYRENE	< 0.021 U	0.022 J	0.039 J
BENZO(B)FLUORANTHENE	< 0.018 U	< 0.019 U	0.023 J
BENZO(G,H,I)PERYLENE	0.051 J	< 0.022 U	0.023 J
BENZO(K)FLUORANTHENE	< 0.021 U	0.027 J	0.039 J
CHRYSENE	< 0.013 U	0.022 J	0.073
FLUORANTHENE	0.016 J	0.051 J	0.065
PHENANTHRENE	0.013 J	0.037 J	0.05 J
PYRENE	0.021 J	0.054	0.092

SS-6-03	1/29/1997
Sample Depth	8.00 - 9.00
Semivolatile Organic Compounds (mg/kg)	ND

10-SB29	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
FLUORANTHENE	< 0.013 U	< 0.013 U	0.026 J
PYRENE	< 0.015 U	< 0.015 U	0.029 J

SS-6-02	1/29/1997
Sample Depth	8.00 - 9.00
Semivolatile Organic Compounds (mg/kg)	ND

SS-6-01	1/29/1997
Sample Depth	7.50 - 8.00
Semivolatile Organic Compounds (mg/kg)	ND

10-SB23	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(B)FLUORANTHENE	0.02 J	< 0.018 U	< 0.021 U
BENZO(G,H,I)PERYLENE	0.056	< 0.021 U	< 0.024 U
FLUORANTHENE	< 0.012 U	< 0.012 U	0.022 J
PHENANTHRENE	0.014 J	< 0.011 U	< 0.012 U
PYRENE	< 0.015 U	< 0.015 U	0.028 J

10-SB15	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
4-CHLOROANILINE	0.073 J	< 0.015 U	< 0.016 U
BENZO(A)ANTHRACENE	0.032 J	< 0.013 U	< 0.014 U
BENZO(A)PYRENE	0.055	< 0.021 U	< 0.022 U
BENZO(B)FLUORANTHENE	0.06	< 0.018 U	< 0.019 U
BENZO(G,H,I)PERYLENE	0.072	< 0.021 U	< 0.022 U
BENZO(K)FLUORANTHENE	0.053	< 0.021 U	< 0.021 U
DIBENZ(A,H)ANTHRACENE	0.032 J	< 0.029 U	< 0.03 U
INDENO(1,2,3-CD)PYRENE	0.05 J	< 0.041 U	< 0.043 U

10-SB25	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.05 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)	ND	ND	ND

07/10-HP011	6/14/1995	6/14/1995
Sample Depth	1.25 - 1.75	3.75 - 4.00
Semivolatile Organic Compounds (mg/kg)		
PHENOL	0.75	0.22 J

10-SB16	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	0.016 J	< 0.013 U	< 0.014 U
BENZO(A)PYRENE	0.049 J	< 0.021 U	< 0.022 U
BENZO(B)FLUORANTHENE	0.072	< 0.018 U	< 0.019 U
BENZO(G,H,I)PERYLENE	0.12	< 0.021 U	< 0.022 U
BENZO(K)FLUORANTHENE	0.042 J	< 0.021 U	< 0.022 U
DIBENZ(A,H)ANTHRACENE	0.049 J	< 0.029 U	< 0.03 U
INDENO(1,2,3-CD)PYRENE	0.061 J	< 0.041 U	< 0.043 U

10-SB03	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(A)ANTHRACENE	< 0.68 U	< 0.69 U	0.38 J
BENZO(A)PYRENE	< 0.68 U	< 0.69 U	0.3 J
BENZO(B)FLUORANTHENE	< 0.68 U	< 0.69 U	0.27 J
BENZO(K)FLUORANTHENE	< 0.68 U	< 0.69 U	0.27 J
CHRYSENE	< 0.68 U	< 0.69 U	0.52 J
FLUORANTHENE	< 0.68 U	< 0.69 U	1
PHENANTHRENE	< 0.68 U	< 0.69 U	1
PYRENE	< 0.68 U	< 0.69 U	1

10-SB17	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
ACENAPHTHYLENE	< 0.013 U	< 0.014 U	0.03 J
ANTHRACENE	< 0.015 U	< 0.015 U	0.17
BENZO(A)ANTHRACENE	< 0.013 U	< 0.013 U	0.29
BENZO(A)PYRENE	0.041 J	< 0.021 U	0.3
BENZO(B)FLUORANTHENE	0.041 J	< 0.019 U	0.16
BENZO(G,H,I)PERYLENE	0.12	< 0.022 U	0.25
BENZO(K)FLUORANTHENE	0.031 J	< 0.021 U	0.25
CHRYSENE	< 0.013 U	< 0.015 UJ	0.31
DIBENZ(A,H)ANTHRACENE	0.063	< 0.03 U	< 0.032 U
FLUORANTHENE	< 0.012 U	< 0.019 UJ	0.54
FLUORENE	< 0.014 U	< 0.014 U	0.055 J
INDENO(1,2,3-CD)PYRENE	0.088	< 0.042 U	0.25
PHENANTHRENE	< 0.011 U	< 0.02 UJ	0.61
PYRENE	< 0.015 U	< 0.025 UJ	0.68

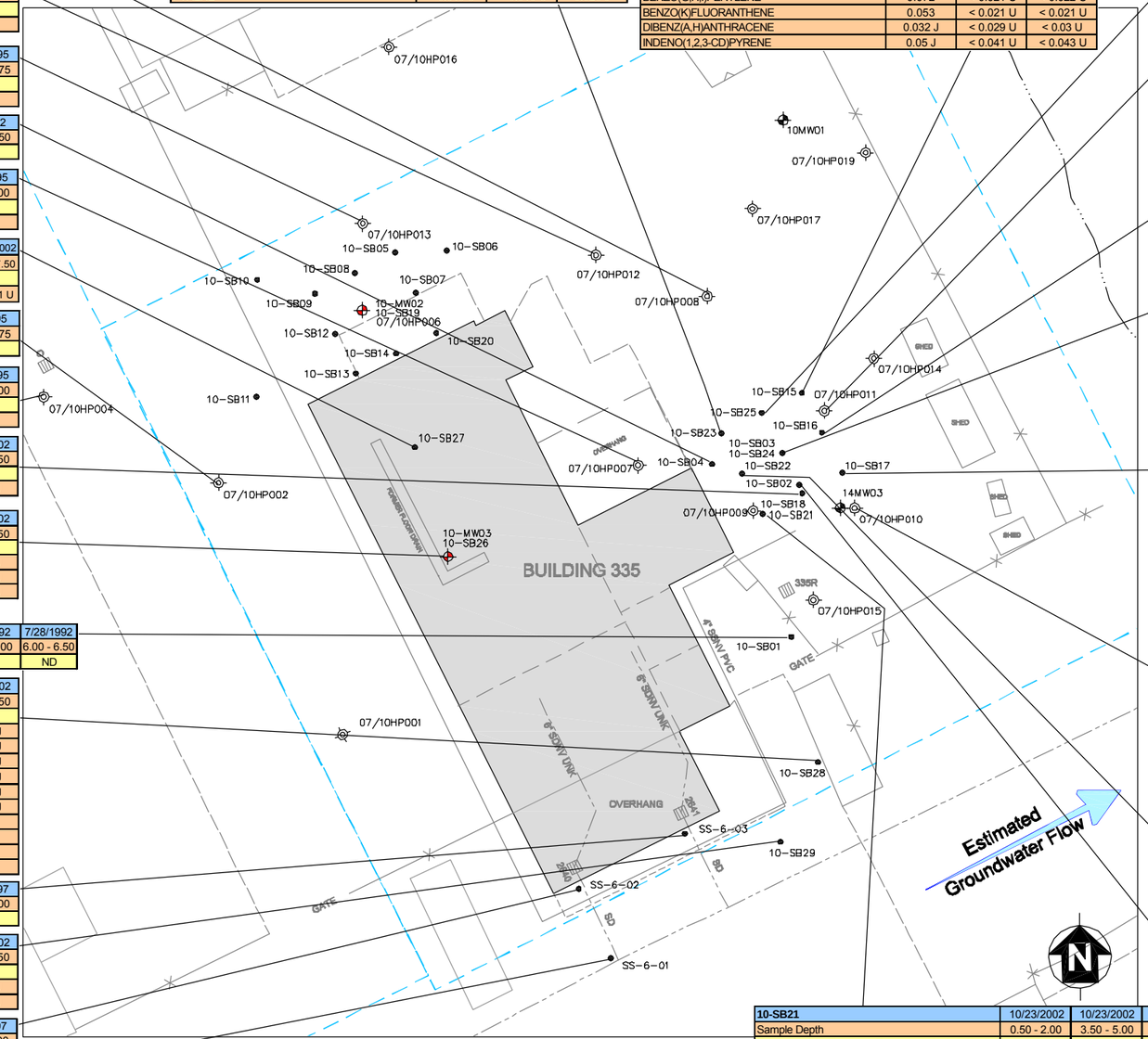
07/10-HP010	6/14/1995
Sample Depth	1.00 - 1.50
Semivolatile Organic Compounds (mg/kg)	
PHENOL	0.44

10-SB24	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(G,H,I)PERYLENE	< 0.021 U	< 0.021 U	0.024 J
CHRYSENE	< 0.012 U	< 0.013 U	0.015 J
PYRENE	0.035 J	< 0.015 U	0.05 J

10-SB22	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
BENZO(B)FLUORANTHENE	< 0.018 U	< 0.018 U	0.02 J
FLUORANTHENE	< 0.012 U	0.022 J	< 0.013 U
PYRENE	< 0.015 U	0.019 J	< 0.016 U

10-SB02	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Semivolatile Organic Compounds (mg/kg)	ND	ND	ND

10-SB21	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)			
ANTHRACENE	< 0.015 U	< 0.017 U	0.041 J
BENZO(A)ANTHRACENE	< 0.013 U	< 0.015 U	0.087
BENZO(A)PYRENE	< 0.021 U	< 0.024 U	0.091
BENZO(B)FLUORANTHENE	0.018 J	< 0.021 U	0.055
BENZO(G,H,I)PERYLENE	< 0.021 U	< 0.025 U	0.07
BENZO(K)FLUORANTHENE	< 0.02 U	< 0.024 U	0.065
CHRYSENE	< 0.013 U	< 0.015 U	0.093
DIBENZ(A,H)ANTHRACENE	< 0.029 U	< 0.033 U	0.031 J
FLUORANTHENE	< 0.012 U	< 0.014 U	0.18
INDENO(1,2,3-CD)PYRENE	< 0.04 U	< 0.047 U	0.068 J
PHENANTHRENE	< 0.011 U	< 0.012 U	0.17
PYRENE	< 0.015 U	< 0.017 U	0.23



15 0 15 30

SCALE IN FEET

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- IR SITE BOUNDARY
- STORM DRAIN

J	Estimated value
mg/kg	Milligrams per kilogram
NA	Not analyzed
ND	Not detected
U	Nondetected for individual compound

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FIGURE 5-10
Site 10 - Bus Painting Shop
SVOC's Soil Sampling Results

fig 7A IR-10 prop samp loc.dwg – DWH – 08/26/02 – G0069.302.B.05.01.03

10-SB08	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	4.00 - 5.50	6.50 - 8.00
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
4,4'-DDD	0.0082	< 0.00016 U	< 0.00017 U
4,4'-DDE	0.0048	< 0.00026 U	< 0.00027 U
4,4'-DDT	0.025	< 0.00033 UJ	< 0.00019 U
ALPHA-CHLORDANE	0.0049	< 0.00012 U	< 0.00012 U
ENDOSULFAN SULFATE	0.0011 J	< 0.00017 U	< 0.00018 U
GAMMA-CHLORDANE	0.0072	< 0.00016 U	< 0.00017 U
HEPTACHLOR	0.00057 J	< 0.00014 U	< 0.00015 U

07/10-HP013	8/10/1995	8/10/1995	8/10/1995
Sample Depth	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)			
4,4'-DDD	0.0037 J	< 0.0033 U	< 0.0035 U
4,4'-DDT	0.0077	< 0.0033 U	< 0.0035 U
ALPHA-CHLORDANE	0.0049	< 0.0017 U	< 0.0018 U
GAMMA-CHLORDANE	0.0048	< 0.0017 U	< 0.0018 U

10-SB05	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	2.50 - 4.00	6.50 - 8.00
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
4,4'-DDD	0.0049 J	< 0.00016 U	< 0.00017 U
4,4'-DDE	0.0021 J	< 0.00026 U	< 0.00028 U
4,4'-DDT	0.014	< 0.00028 U	< 0.00019 U
ALPHA-CHLORDANE	0.0033 J	< 0.00011 U	< 0.00012 U
GAMMA-CHLORDANE	0.0046 J	< 0.00016 U	< 0.00017 U

10-SB06	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.50 - 8.00
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
4,4'-DDT	0.0051 J	0.00028 J	< 0.00019 U
ALPHA-CHLORDANE	0.0031 J	0.00028 J	< 0.00012 U
GAMMA-CHLORDANE	0.0045 J	< 0.00038 UJ	< 0.00017 U

10-SB07	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.50 - 4.50	6.00 - 7.50
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
4,4'-DDD	0.1	< 0.00016 U	< 0.00016 U
4,4'-DDE	0.049	< 0.00026 U	< 0.00026 U
4,4'-DDT	0.32	< 0.00054 UJ	< 0.00018 U
ALPHA-CHLORDANE	0.3	0.00027 J	< 0.00012 U
ENDRIN ALDEHYDE	0.014	< 0.00037 U	< 0.00037 U
GAMMA-CHLORDANE	0.36	< 0.00038 UJ	< 0.00016 U
HEPTACHLOR	0.041	< 0.00014 U	< 0.00015 U
HEPTACHLOR EPOXIDE	0.016	< 0.00015 U	< 0.00015 U

10-SB09	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
4,4'-DDD	0.0066	0.0008 J	< 0.00016 U
4,4'-DDE	0.0034	< 0.00026 U	< 0.00026 U
4,4'-DDT	0.0057	0.0011 J	< 0.00018 U
ALPHA-CHLORDANE	0.0014	< 0.00036 UJ	< 0.00012 U
ENDOSULFAN SULFATE	0.00084 J	< 0.00017 U	< 0.00017 U
GAMMA-CHLORDANE	0.0021	< 0.00053 UJ	< 0.00016 U

07/10-HP012	8/10/1995	8/10/1995	8/10/1995
Sample Depth	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)			
4,4'-DDT	0.0041	< 0.0035 U	< 0.0037 U
ALPHA-CHLORDANE	0.0016 J	< 0.0017 U	< 0.0018 U
GAMMA-CHLORDANE	0.0018	< 0.0017 U	< 0.0018 U

10-SB20	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
HEPTACHLOR EPOXIDE	< 0.00015 U	0.0016	< 0.00045 UJ

10-SB10	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
4,4'-DDD	0.043	< 0.00016 U	< 0.00016 U
4,4'-DDE	0.05	< 0.00026 U	< 0.00026 U
4,4'-DDT	0.13	< 0.00018 U	< 0.00018 U
ALPHA-CHLORDANE	0.023	< 0.0003 UJ	< 0.00012 U
ENDOSULFAN SULFATE	0.0058 J	< 0.00017 U	< 0.00017 U
GAMMA-CHLORDANE	0.034	< 0.00043 UJ	< 0.00016 U
HEPTACHLOR	0.0019 J	< 0.00014 U	< 0.00015 U

10-SB14	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
ALPHA-CHLORDANE	0.0025	< 0.00012 U	< 0.00012 U
GAMMA-CHLORDANE	0.0089	< 0.00016 U	< 0.00017 U
HEPTACHLOR	0.0066	< 0.00038 UJ	< 0.00015 U
HEPTACHLOR EPOXIDE	0.0019	< 0.00015 U	< 0.00016 U

10-SB19	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
4,4'-DDD	< 0.00016 U	0.0018 J	< 0.00016 U
4,4'-DDT	< 0.00018 U	0.002 J	< 0.00018 U
ALPHA-CHLORDANE	< 0.00012 U	0.0018 J	< 0.00012 U
GAMMA-CHLORDANE	< 0.00016 U	0.0026 J	< 0.00016 U

10-SB13	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
4,4'-DDD	0.066	0.0018	< 0.00045 UJ
4,4'-DDE	0.014	< 0.00026 U	< 0.00027 U
4,4'-DDT	0.099	0.0027	< 0.00029 UJ
ALPHA-CHLORDANE	0.16	0.00076 J	< 0.00012 U
ENDOSULFAN SULFATE	0.023	< 0.00048 UJ	< 0.00018 U
GAMMA-CHLORDANE	0.21	< 0.0011 U	< 0.00016 U
HEPTACHLOR	0.034	< 0.00048 UJ	< 0.00015 U
HEPTACHLOR EPOXIDE	0.013	< 0.00015 U	0.00055 J

07/10-HP004	6/13/1995	6/13/1995	6/13/1995
Sample Depth	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)			
4,4'-DDD	< 0.0035 U	< 0.0035 U	0.0019 J
4,4'-DDE	< 0.0035 U	< 0.0035 U	0.013
4,4'-DDT	< 0.0035 U	< 0.0035 U	0.035
ALPHA-CHLORDANE	< 0.0017 U	< 0.0018 U	0.006
GAMMA-CHLORDANE	< 0.0017 U	< 0.0018 U	0.006

10-SB03	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)			
4,4'-DDD	0.0038	< 0.0035 U	< 0.004 U
4,4'-DDT	0.0054 J	< 0.0035 U	< 0.004 U

07/10-HP006	6/13/1995	6/13/1995	6/13/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)			
4,4'-DDE	0.0028 J	< 0.0034 U	< 0.0035 U
ALPHA-CHLORDANE	0.0032	2.1	0.0009 J
GAMMA-CHLORDANE	0.0034	1.9	0.0011 J
HEPTACHLOR EPOXIDE	0.0021	< 0.0017 U	< 0.0017 U

10-SB04	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

10-SB12	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)			
4,4'-DDD	1	0.00055 J	< 0.00017 U
4,4'-DDE	0.11 J	< 0.00026 U	< 0.00027 U
4,4'-DDT	0.75	< 0.00033 UJ	< 0.00019 U
ALPHA-CHLORDANE	0.17	< 0.00012 U	< 0.00012 U
ENDOSULFAN SULFATE	0.39	< 0.00017 U	< 0.00018 U
ENDRIN ALDEHYDE	0.015	< 0.00037 U	< 0.00039 U
GAMMA-CHLORDANE	0.25	< 0.00016 U	< 0.00016 U
HEPTACHLOR	0.0073	< 0.00014 U	< 0.00015 U
HEPTACHLOR EPOXIDE	0.0034 J	< 0.00015 U	< 0.00015 U

10-SB02	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)			
ENDRIN ALDEHYDE	< 0.0034 U	0.0128 J	< 0.0041 U
ENDRIN KETONE	< 0.0034 U	0.014 J	< 0.0041 U

10-SB11	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50
PCBs (mg/kg)	NA	NA	NA
Pesticides (mg/kg)	ND	ND	ND

10-SB01	7/28/1992	7/28/1992	7/28/1992	7/28/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50
PCBs (mg/kg)	ND	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND	ND

07/10-HP002	6/9/1995	6/9/1995
Sample Depth	1.25 - 1.50	7.25 - 7.75
PCBs (mg/kg)	ND	ND
Pesticides (mg/kg)	ND	ND

10-SB28	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

10-SB29	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

10-SB27	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

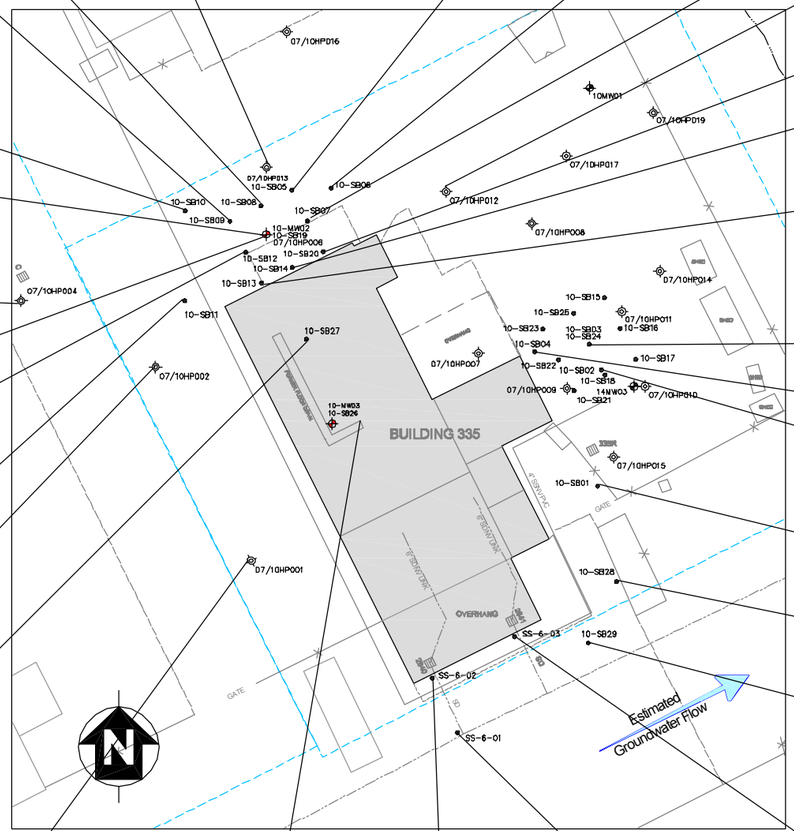
SS-6-03	1/29/1997
Sample Depth	8.00 - 9.00
PCBs (mg/kg)	NA
Pesticides (mg/kg)	ND

07/10-HP001	6/9/1995	6/9/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50
PCBs (mg/kg)	ND	ND
Pesticides (mg/kg)	ND	ND

10-SB26	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs (mg/kg)	ND	ND	ND
Pesticides (mg/kg)	ND	ND	ND

SS-6-02	1/29/1997
Sample Depth	8.00 - 9.00
PCBs (mg/kg)	NA
Pesticides (mg/kg)	ND

SS-6-01	1/29/1997
Sample Depth	7.50 - 8.00
PCBs (mg/kg)	NA
Pesticides (mg/kg)	ND



LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- IR SITE BOUNDARY
- STORM DRAIN

20 10 0 10 20 30

1 INCH = 15 FEET

J Estimated value
mg/kg Milligrams per kilogram
NA Not analyzed
ND Not detected
R Results rejected during quality assurance review
U Nondetected

NAVAL STATION TREASURE ISLAND, CALIFORNIA

U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-11

Site 10 - Bus Painting Shop
Pesticides and PCB Soil Sampling Results

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10-SB04	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.0-1.5	3.0-3.5	6.0-6.5
Metals (mg/kg)			
ALUMINUM	3,530	3,340	6,130
ARSENIC	5.8	5.7	5.7
BARIUM	12.8J	7.1J	18.5J
BERYLLIUM	**0.21J**	**0.21J**	**0.24J**
CALCIUM	14,500J	4,950J	23,100J
CHROMIUM	26.8	65.6	33.4
COBALT	7J	8.4J	9.1J
COPPER	5.4	3.8J	5.5J
IRON	14,000	15,700	18,900
LEAD	3.7	3	4.7
MAGNESIUM	4,020	7,830	4,880
MANGANESE	310J	307J	**661J**
NICKEL	32.8	78.5	38.2
POTASSIUM	421J	468J	947J
SODIUM	166J	104J	300J
VANADIUM	19.4	21.1	30.3
ZINC	25.8	43.6	92.1

07/10-HP008	6/14/1995
Sample Depth	7.25-7.75
Metals (mg/kg)	
ALUMINUM	2,900
ARSENIC	7.1
BARIUM	9.6J
CALCIUM	7,720J
CHROMIUM	24.7
COBALT	6.4J
COPPER	2.9J
IRON	11,700
LEAD	3.3
MAGNESIUM	3,430
MANGANESE	210J
NICKEL	19
POTASSIUM	467J
VANADIUM	18.7
ZINC	18.1

07/10-HP011	6/14/1995	6/14/1995
Sample Depth	1.25-1.75	3.75-4.0
Metals (mg/kg)		
ALUMINUM	6,070	2,600
ANTIMONY	2J	0.44UJ
ARSENIC	4.8	5.5
BARIUM	61.1	6.3J
CADMIUM	0.59J	0.04U
CALCIUM	17,600J	2,470J
CHROMIUM	35	22
COBALT	7.4J	5.5J
COPPER	60	3.2J
IRON	13,600	9,660
LEAD	**91.9**	2.8
MAGNESIUM	4,890	3,350
MANGANESE	289	162
MERCURY	0.08J	0.05U
NICKEL	34.8	25.4
POTASSIUM	998J	521J
SODIUM	433J	953UJ
VANADIUM	26.2	16.2
ZINC	**138J**	15.9J

07/10-HP013	8/10/1995	8/10/1995
Sample Depth	3.25-3.75	7.25 - 7.75
Metals (mg/kg)		
CHROMIUM	36.1	33.8

07/10-HP012	8/10/1995
Sample Depth	7.25-7.75
Metals (mg/kg)	
CHROMIUM	52.4

07/10-HP006	6/13/1995	6/13/1995	6/13/1995
Sample Depth	1.0-2.0	3.0-4.0	6.0-7.0
Metals (mg/kg)			
LEAD	3.1	3.1	3.3

10-SB03	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.0-1.5	3.0-3.5	6.0-6.5
Metals (mg/kg)			
ALUMINUM	5,050	4,000	7,190
ANTIMONY	9.9U	10.1U	11.7U
ARSENIC	6.2	5	6.7
BARIUM	12.6J	10.5J	29J
BERYLLIUM	**0.21J**	**0.21J**	**0.24J**
CALCIUM	5,890J	10,300J	38,000J
CHROMIUM	40.6	32.9	37
COBALT	8.4J	7.1J	13.2
COPPER	6.6	9	16.8
IRON	17,000	14,400	22,500
LEAD	5.5	2.6	5.2
MAGNESIUM	5,830	3,390	6,820
MANGANESE	348J	270J	**731J**
NICKEL	38.5	30.6	55.8
POTASSIUM	606J	538J	1,440
SODIUM	107J	147J	558J
VANADIUM	25.1	22.2	**36.5**
ZINC	28.8	31.8	47.5

10-SB02	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.0-1.5	3.0-3.5	6.0-6.5
Metals (mg/kg)			
ALUMINUM	4,570	4,220	9,840
ANTIMONY	9.9U	9.9U	12.1U
ARSENIC	5.9	5.7	7.7
BARIUM	10.7J	10.9J	28J
BERYLLIUM	**0.21J**	**0.21J**	**0.25J**
CALCIUM	5,390J	11,900J	19,300J
CHROMIUM	31.1	**89.5**	46.7
COBALT	8.4J	8.6J	13.6
COPPER	6	8.6	7.3
IRON	15,900	16,700	24,900
LEAD	3.4	3	5.5
MAGNESIUM	5,100	9,360	7,110
MANGANESE	251J	416J	467J
NICKEL	47.1	93.2	59.3
POTASSIUM	714J	574J	1280
SILVER	1U	1U	**1.8J**
SODIUM	108J	166J	363J
VANADIUM	23.7	23	**39.1**
ZINC	25.3	24.5	46.2

10-SB27	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.5-2.0	3.5-5.0	6.0-7.5
Metals (mg/kg)			
ALUMINUM	7,400	3,000	3,220
ANTIMONY	0.11J	0.11J	0.11J
ARSENIC	5	6.6	**12.7**
BARIUM	14.1J	13.1J	7.6J
BERYLLIUM	**0.18J**	0.1J	0.09J
CADMIUM	0.13	0.05J	0.03J
CALCIUM	6,630	7,980	15,600
CHROMIUM	33.4J	21.4J	37.1J
COBALT	7.3	4.7	5.4
COPPER	14.8	3.24	3.38
IRON	17,000	11,000	12,500
LEAD	4.48	2.78	2.32
MAGNESIUM	5,950	3,420	6,330
MANGANESE	201J	236J	337J
MERCURY	0.03	0.01U	0.01J
MOLYBDENUM	0.19	0.18	0.12
NICKEL	39	26	45
POTASSIUM	1,420	586	572
SILVER	0.046	0.016J	0.15J
SODIUM	730	319	327
THALLIUM	0.057	0.04	0.012J
VANADIUM	28.8	15.5	18.5
ZINC	34.2	16	16.3

07/10-HP010	6/14/1995
Sample Depth	1.0-1.5
Metals (mg/kg)	
ALUMINUM	4,560
ANTIMONY	**6.1J**
ARSENIC	6.2
BARIUM	59.7
CALCIUM	6,660J
CHROMIUM	48.3
COBALT	9.3J
COPPER	22.5
IRON	13,200
LEAD	**112**
MAGNESIUM	6,030
MANGANESE	251J
NICKEL	46.3
POTASSIUM	779J
VANADIUM	22.4
ZINC	**331**

07/10-HP004	6/13/1995	6/13/1995	6/13/1995
Sample Depth	1.3-2.0	3.3-4.0	6.3-7.0
Metals (mg/kg)			
LEAD	4.6	3.6	3.4

07/10-HP002	6/9/1995	6/9/1995
Sample Depth	1.25-1.75	7.0-7.5
Metals (mg/kg)		
LEAD	3.2	3.4

10-SB01	7/28/1992	7/28/1992	7/28/1992	7/28/1992
Sample Depth	1.5-2.0	2.0-2.5	2.5-3.0	6.0-6.5
Metals (mg/kg)				
ALUMINUM	4,000	3,720	3,050	4,620
ANTIMONY	10UJ	10.1UJ	10UJ	11.3UJ
ARSENIC	4.6J	4.5J	5.2J	4.9J
BARIUM	10.4J	9J	8.4J	19J
CALCIUM	4,970J	4,190J	19,600J	9,070J
CHROMIUM	31.6J	22.9J	19.2J	24.9J
COBALT	6.5J	6.7J	5.6J	8.9J
COPPER	6.2J	7.6J	6.7J	13.8J
IRON	13,300	13,800	11,300	16,800
LEAD	3.1J	3.9J	4.5J	6.4J
MAGNESIUM	3,370	3,240	2,970	4,030
MANGANESE	204J	273J	251J	319J
NICKEL	32.5J	31.5J	28.5J	36.1J
POTASSIUM	622J	654J	531J	795J
SILVER	1U	1.1U	1U	**1.6J**
SODIUM	172J	99.3J	295J	177J
VANADIUM	19.4	19.8	15.7	25.8
ZINC	28.7	23.8	22.8	32.8

10-SB26	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.5-2.0	3.5-5.0	6.0-7.5
Metals (mg/kg)			
ALUMINUM	2,600	3,250	2,880
ARSENIC	6.4	7	6
BARIUM	5.7J	5.4J	5J
BERYLLIUM	0.09J	0.1J	0.07J
CADMIUM	0.03J	0.04J	0.03J
CALCIUM	6,970J	4,510J	6,710J
CHROMIUM	40.5J	36.8J	16J
COBALT	4.6	4.7	4.3
COPPER	3.62	3.31	3.26
IRON	10,400	11,200	9,890
LEAD	2.45J	2.35J	2.42J
MAGNESIUM	3,670	3,770	2,660
MANGANESE	178J	191J	182J
MERCURY	0.01J	0.01J	0.01U
MOLYBDENUM	0.13J	0.17J	0.14J
NICKEL	22.6	27.9	17.2
POTASSIUM	490J	570J	448J
SILVER	0.011J	0.012J	0.01J
SODIUM	277J	245J	191J
THALLIUM	0.014J	0.052	0.015J
VANADIUM	14.1	16.9	14.2
ZINC	13.7	15.5	14.4

10-SB28	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.5-2.0	3.5-5.0	6.0-7.5
Metals (mg/kg)			
ALUMINUM	2,980	3,690	3,320
ANTIMONY	0.11J	0.08UJ	0.12J
ARSENIC	5.9	6	6.8
BARIUM	8.5J	7.3J	10.8J
BERYLLIUM	0.11J	0.11J	0.11J
CADMIUM	0.05J	0.03J	0.04J
CALCIUM	5,340	4,960	13,900
CHROMIUM	24.9J	20.9J	47J
COBALT	5.2	5.4	6.2
COPPER	3.87	3.24	5.62
IRON	10,900	11,700	14,800
LEAD	3.22	2.82	2.98
MAGNESIUM	3,920	3,180	7,120
MANGANESE	185J	174J	309J
MERCURY	0.01J	0.01J	0.01J
MOLYBDENUM	0.11	0.19	0.15
NICKEL	32	24	58.9
POTASSIUM	491	576	533
SILVER	0.015J	0.015J	0.015J
SODIUM	117	114	213
THALLIUM	0.028	0.025	0.026
VANADIUM	16.4	17.5	20.9
ZINC	16.1	17.6	18

10-SB29	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.5-2.0	3.5-5.0	6.0-7.5
Metals (mg/kg)			
ALUMINUM	3,100	2,820	2,690
ARSENIC	4.8	5.6	**11.3**
BARIUM	8.7J	8.8J	7.5J
BERYLLIUM	0.09J	0.1J	0.11J
CADMIUM	0.04J	0.04J	0.08J
CALCIUM	15,200	15,100	13,200
CHROMIUM	35.4J	22.2J	18.1J
COBALT	5.8	4.8	4.9
COPPER	3.65	3.13	6.08
IRON	12,000	11,000	10,600
LEAD	2.77	2.42	5.33
MAGNESIUM	5,010	3,700	2,970
MANGANESE	327J	275J	299J
MERCURY	0.01J	0.01J	0.01J
MOLYBDENUM	0.07	0.06	0.2
NICKEL	48	23.6	22.1
POTASSIUM	473	498	483
SILVER	0.013J	0.013J	0.012J
SODIUM	196	207	201
THALLIUM	0.015J	0.019J	0.037J
VANADIUM	16.7	15.5	14.2
ZINC	17.2	14.9	15.6

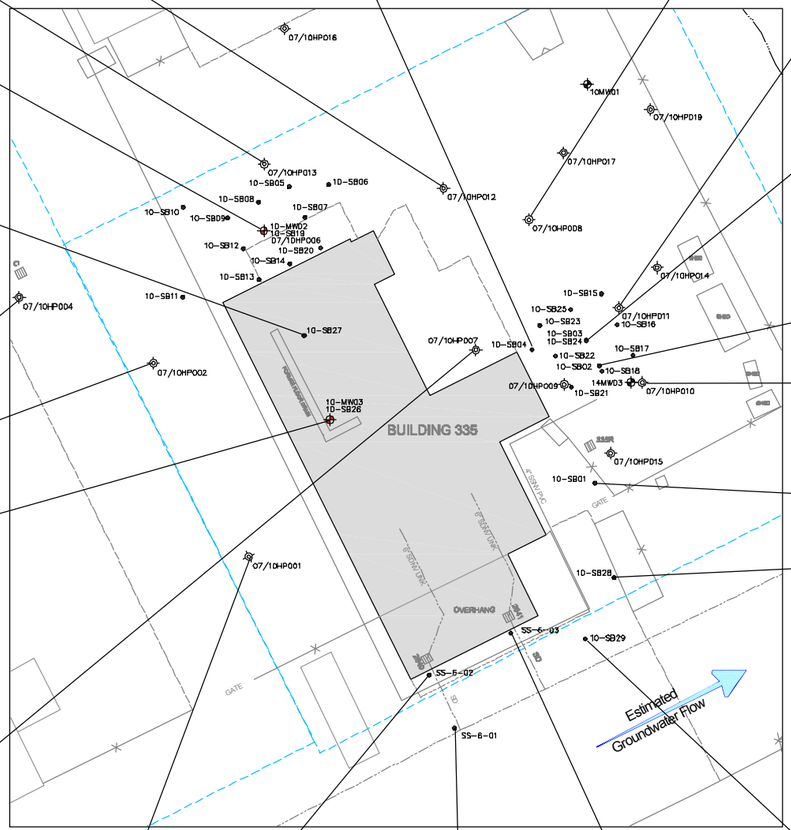
07/10-HP007	6/13/1995
Sample Depth	1.3-2.0
Metals (mg/kg)	
ALUMINUM	2,620
ARSENIC	5
BARIUM	6J
CALCIUM	11,300J
CHROMIUM	21.5
COBALT	5.4J
COPPER	3.2J
IRON	9,400
LEAD	3.3
MAGNESIUM	3,150
MANGANESE	216J
NICKEL	22
POTASSIUM	548J
SODIUM	194J
VANADIUM	14.8
ZINC	16.4

07/10-HP001	6/9/1995	6/9/1995
Sample Depth	1.25-1.75	7.0-7.5
Metals (mg/kg)		
LEAD	3.8	3.5

SS-6-02	1/29/1997
Sample Depth	8.0-9.0
Metals (mg/kg)	
ALUMINUM	6,710
ANTIMONY	0.57J
ARSENIC	6.1
BARIUM	13.3
CADMIUM	0.43
CALCIUM	10,400
CHROMIUM	28.5J
COBALT	7.5
COPPER	10.7J
IRON	15,300
LEAD	3.6J
MAGNESIUM	5,470
MANGANESE	197
MOLYBDENUM	**14.1**
NICKEL	33.2
POTASSIUM	1,110
SODIUM	1,220J
THALLIUM	**0.94**
VANADIUM	26.3
ZINC	26.9

SS-6-01	1/29/1997
Sample Depth	7.5-8.0
Metals (mg/kg)	
ALUMINUM	3,770
ARSENIC	5.3
BARIUM	7.4
CADMIUM	0.28
CALCIUM	6,700
CHROMIUM	22.1J
IRON	12,100
LEAD	2.6J
MAGNESIUM	3,880
MANGANESE	211
MOLYBDENUM	**11.6**
NICKEL	29.2
POTASSIUM	714
SELENIUM	0.44J
SODIUM	666J
THALLIUM	0.39
VANADIUM	18.1
ZINC	19.2

SS-6-03	1/29/1997
Sample Depth	8.0-9.0
Metals (mg/kg)	
ALUMINUM	3,480
ARSENIC	8
BARIUM	8.3
CADMIUM	0.33
CALCIUM	7,710
CHROMIUM	22J
IRON	11,600
LEAD	3.1J
MAGNESIUM	3,800
MANGANESE	212
MOLYBDENUM	**11.6**
NICKEL	30.2
POTASSIUM	656
SODIUM	876J
THALLIUM	**1.1**
VANADIUM	17.1
ZINC	16.6



LEGEND

- MONITORING WELL LOCATION
- GEOPROBE SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- IR SITE BOUNDARY
- STORM DRAIN

J Estimated value
mg/kg Milligrams per kilogram
NA Not analyzed
ND Not detected
U Nondetected for individual compound

NOTE: Bold Values Indicate Analysis Exceeded Screening Criteria

20 10 0 10 20 30

1 INCH = 15 FEET

NAVAL STATION TREASURE ISLAND, CALIFORNIA

U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-12

Site 10 - Bus Painting Shop
Metals Soil Sampling Results

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07/10-HP006	6/13/1995	6/13/1995	6/13/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00
Chlorinated Herbicides (mg/kg)	ND	ND	ND

07/10-HP004	6/13/1995	6/13/1995	6/13/1995
Sample Depth	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
Chlorinated Herbicides (mg/kg)	ND	ND	ND

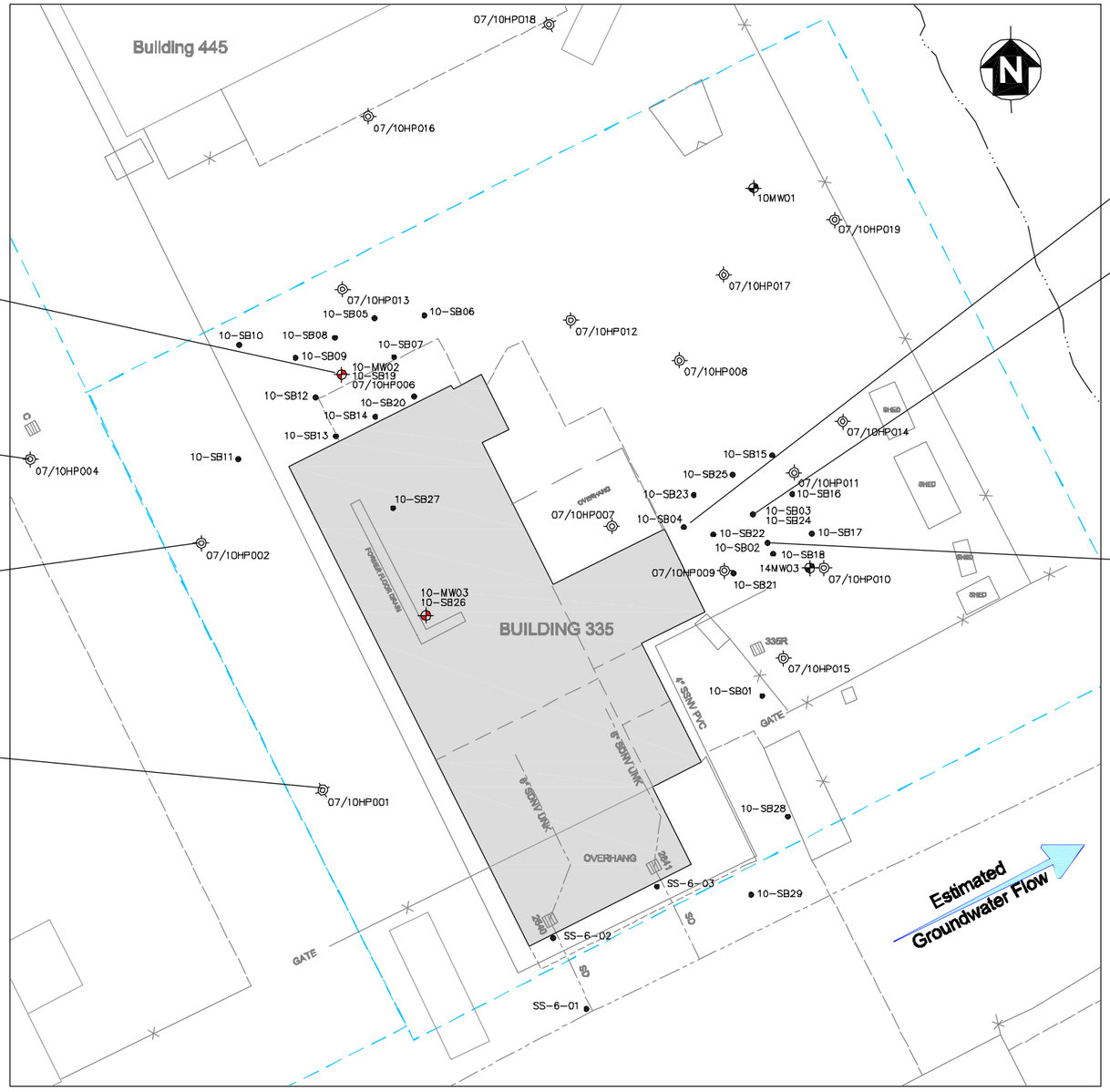
07/10-HP002	6/9/1995	6/9/1995
Sample Depth	1.25 - 1.50	7.25 - 7.75
Chlorinated Herbicides (mg/kg)	ND	ND

07/10-HP001	6/9/1995	6/9/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50
Chlorinated Herbicides (mg/kg)		
DICAMBA	< 0.005 U	0.012 J

10-SB04	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Chlorinated Herbicides (mg/kg)			
DALAPON	0.105	< 0.0522 U	< 0.0583 U

10-SB03	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Chlorinated Herbicides (mg/kg)			
2,4-DB	0.178	< 0.052 U	< 0.0598 U
DICAMBA	< 0.0504 U	0.0674	< 0.0598 U

10-SB02	8/5/1992	8/5/1992	8/5/1992
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Chlorinated Herbicides (mg/kg)	ND	ND	ND



LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- IR SITE BOUNDARY
- STORM DRAIN

J	Estimated value
mg/kg	Milligrams perkKilogram
NA	Not analyzed
ND	Not detected
U	Nondetected for individual compound

15 0 15 30
SCALE IN FEET

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U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-13

Site 10 - Bus Painting Shop
Herbicides Soil Sampling Results

fig 7A IR-10 prop samp loc.dwg — DWH — 08/26/02 — G0069.302.B.05.01.03

07/10-HP012	8/10/1995
Volatile Organic Compounds (ug/L)	NA
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	0.49 Y
MOTOR OIL RANGE ORGANICS	0.15 Y
GASOLINE RANGE ORGANICS	NA

07/10-HP013	8/10/1995
Volatile Organic Compounds (ug/L)	NA
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	0.06 JY
MOTOR OIL RANGE ORGANICS	0.21 Y
GASOLINE RANGE ORGANICS	NA

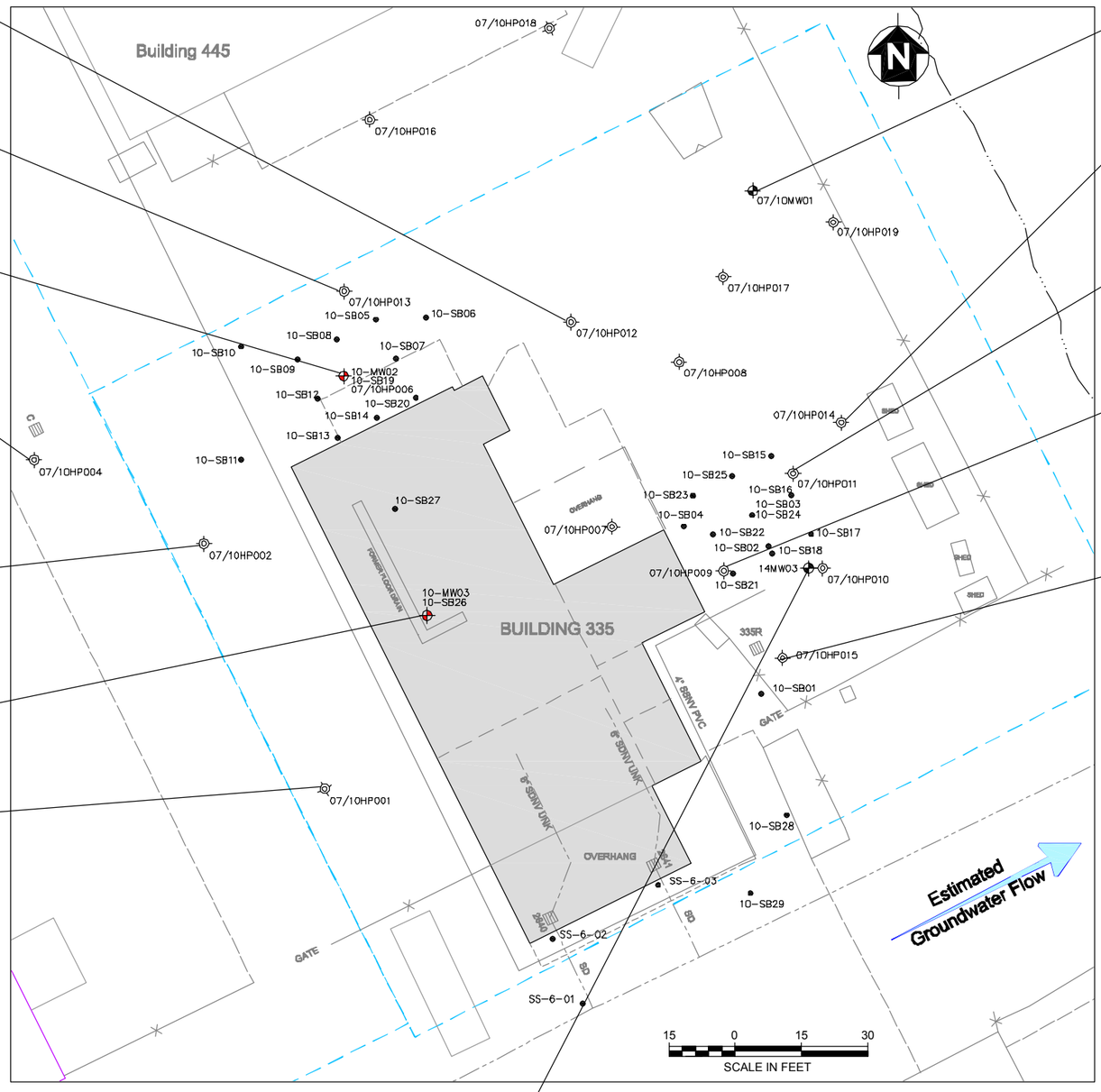
07/10-HP006	6/13/1995
Volatile Organic Compounds (ug/L)	
CHLOROFORM	2
Petroleum Hydrocarbons (mg/L)	NA

07/10-HP004	6/13/1995
Volatile Organic Compounds (ug/L)	ND
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	< 0.1 U
MOTOR OIL RANGE ORGANICS	< 0.1 U
GASOLINE RANGE ORGANICS	NA

07/10-HP002	6/9/1995
Volatile Organic Compounds (ug/L)	ND
Petroleum Hydrocarbons (mg/L)	NA

10-MW03	10/30/2002
Volatile Organic Compounds (ug/L)	ND
Petroleum Hydrocarbons (mg/L)	ND

07/10-HP001	6/9/1995
Volatile Organic Compounds (ug/L)	ND
Petroleum Hydrocarbons (mg/L)	NA



07/10-MW01	12/8/1995	2/26/1996	6/10/1996	9/4/1996	11/2/1998
Volatile Organic Compounds (ug/L)					
CARBON DISULFIDE	< 0.5 U	< 0.5 U	< 0.5 U	0.4 J	< 2 UJ
TETRACHLOROETHENE	< 0.5 U	< 0.5 U	0.09 J	< 0.5 U	< 0.5 U
Petroleum Hydrocarbons (mg/L)					
DIESEL RANGE ORGANICS	< 0.1 U	0.12 Y	< 0.1 U	< 0.1 U	< 0.12 U
MOTOR OIL RANGE ORGANICS	< 0.1 U	0.27 Y	< 0.1 U	0.093 JY	<0.24 U
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA

07/10-HP014	8/10/1995
Volatile Organic Compounds (ug/L)	NA
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	< 0.1 U
MOTOR OIL RANGE ORGANICS	0.087 JY
GASOLINE RANGE ORGANICS	NA

07/10-HP011	6/14/1995
Volatile Organic Compounds (ug/L)	ND
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	< 0.1 U
MOTOR OIL RANGE ORGANICS	0.086 JY
GASOLINE RANGE ORGANICS	NA

07/10-HP009	6/14/1995
Volatile Organic Compounds (ug/L)	ND
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	< 0.1 U
MOTOR OIL RANGE ORGANICS	0.086 JY
GASOLINE RANGE ORGANICS	NA

07/10-HP015	8/10/1995
Volatile Organic Compounds (ug/L)	NA
Petroleum Hydrocarbons (mg/L)	
DIESEL RANGE ORGANICS	< 0.1 U
MOTOR OIL RANGE ORGANICS	< 0.1 U
GASOLINE RANGE ORGANICS	NA

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- IR SITE BOUNDARY
- STORM DRAIN

J	Estimated value
mg/L	Milligrams per liter
NA	Not analyzed
ND	Not detected
U	Nondetected for individual compound
ug/L	Micrograms per liter
Y	Chromatographic pattern resembles hydrocarbons fuel pattern and was quantified using the standard it resembles the most
D	Chromatographic pattern resembles diesel

14-MW03	11/21/1995	2/26/1996	6/10/1996	9/4/1996	9/4/1996	5/21/1998	11/17/1998	5/26/2000	10/30/2001
Volatile Organic Compounds (ug/L)									
CARBON DISULFIDE	< 0.5 U	0.3 J	< 0.5 U	< 0.5 U	< 0.5 U	< 2 U	< 2 UJ	< 1 U	< 2 U
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	2	4 J	< 1 U	1 J
Petroleum Hydrocarbons (mg/L)									
DIESEL RANGE ORGANICS	0.052 JY	0.053 JY	< 0.1 U	< 0.1 U	< 0.1 U	NA	< 0.12 U	< 0.1 U	0.3 DJ
MOTOR OIL RANGE ORGANICS	0.17 Y	0.12 Y	< 0.1 U	0.055 JY	< 0.1 U	NA	<0.24 U	<0.1 U	<0.5
GASOLINE RANGE ORGANICS	0.087 Y	0.026 JY	0.047 JY	0.047 JY	0.049 JY	NA	0.03 JZ	< 0.05 U	< 0.05 U

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U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-14

Site 10 - Bus Painting Shop
VOCs and TPH Groundwater Sampling Results

Site 10 GW VOC TPH.dwg – JHD – 07/02/03 – G0069.302.B.05.01.03

07/10-HP012	8/10/1995
Semivolatile Organic Compounds (ug/L)	ND

07/10-HP013	8/10/1995
Semivolatile Organic Compounds (ug/L)	ND

07/10-HP004	6/13/1995
Semivolatile Organic Compounds (ug/L)	ND

10-MW03	10/30/2002
Semivolatile Organic Compounds (ug/L)	
FLUORANTHENE	0.031 J
PHENOL	0.11 J
PYRENE	0.034 J

07/10-MW01	12/8/1995	2/26/1996	6/10/1996	9/4/1996	11/2/1998
Semivolatile Organic Compounds (UG/L)	ND	ND	ND	ND	NA

07/10-HP014	8/10/1995
Semivolatile Organic Compounds (ug/L)	ND

07/10-HP011	6/14/1995
Semivolatile Organic Compounds (ug/L)	ND

14-MW03	11/21/1995	2/26/1996	6/10/1996	9/4/1996	9/4/1996	5/21/1998	11/17/1998	5/26/2000	10/30/2001
Semivolatile Organic Compounds (ug/L)	ND	ND	ND	ND	ND	NA	NA	ND	ND

07/10-HP009	6/14/1995
Semivolatile Organic Compounds (ug/L)	ND

07/10-HP015	8/10/1995
Semivolatile Organic Compounds (ug/L)	ND

Building 445

BUILDING 335

OVERHANG

FORMER FLOOR DRAIN

4" SSNV PVC

8" SDNV UNK

SHED

GATE

OVERHANG

07/10HP018
07/10HP016
07/10MW01
07/10HP019
07/10HP017
07/10HP013
10-SB05
10-SB06
07/10HP012
10-SB10
10-SB08
10-SB07
10-SB09
10-MW02
10-SB19
07/10HP006
07/10HP008
10-SB12
10-SB20
10-SB14
07/10HP014
10-SB13
10-SB11
07/10HP004
10-SB15
10-SB25
07/10HP011
10-SB16
10-SB23
10-SB03
10-SB24
10-SB27
10-SB04
07/10HP007
10-SB22
10-SB17
07/10HP002
10-SB02
10-SB18
07/10HP009
14MW03
07/10HP010
10-MW03
10-SB26
335R
07/10HP015
10-SB01
07/10HP001
10-SB28
SS-6-03
10-SB29
SS-6-02
SS-6-01
Estimated Groundwater Flow

15 0 15 30
SCALE IN FEET

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- IR SITE BOUNDARY
- STORM DRAIN

ID	Identification
J	Estimated value
mg/L	Milligrams per liter
NA	Not analyzed
ND	Not detected
U	Nondetected for individual compound
ug/L	Micrograms per liter

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NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-15

Site 10 - Bus Painting Shop
SVOCs Groundwater Sampling Results

fig 7A IR-10 prop samp loc.dwg - DWH - 08/26/02 - G0069.302.B.05.01.03

07/10-HP012	8/10/1995
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

07/10-HP013	8/10/1995
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

07/10-HP006	6/13/1995
PCBs (ug/L)	ND
Pesticides (ug/L)	
ALPHA-CHLORDANE	0.12
GAMMA-CHLORDANE	0.1

10-MW02	10/30/2002
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

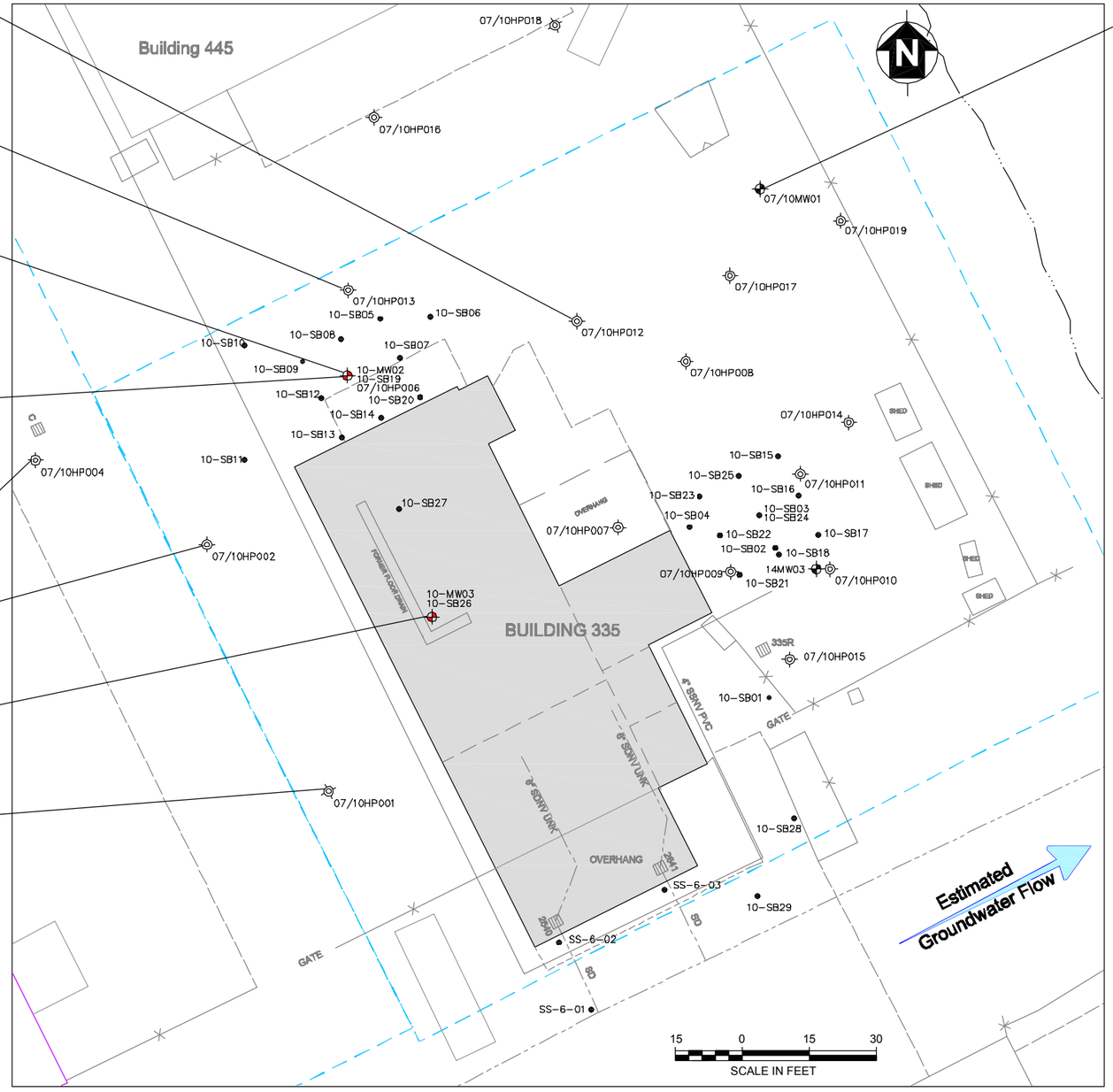
07/10-HP004	6/13/1995
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

07/10-HP002	6/9/1995
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

10-MW03	10/30/2002
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

07/10-HP001	6/9/1995
PCBs (ug/L)	ND
Pesticides (ug/L)	ND

07/10-MW01	12/8/1995	2/26/1996	6/10/1996	9/4/1996
PCBs (ug/L)	ND	ND	ND	ND
Pesticides (ug/L)	ND	ND	ND	ND



LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- IR SITE BOUNDARY
- STORM DRAIN

ID	Identification
NA	Not analyzed
ND	Not detected
U	Nondetected for individual compound
ug/L	Micrograms per liter

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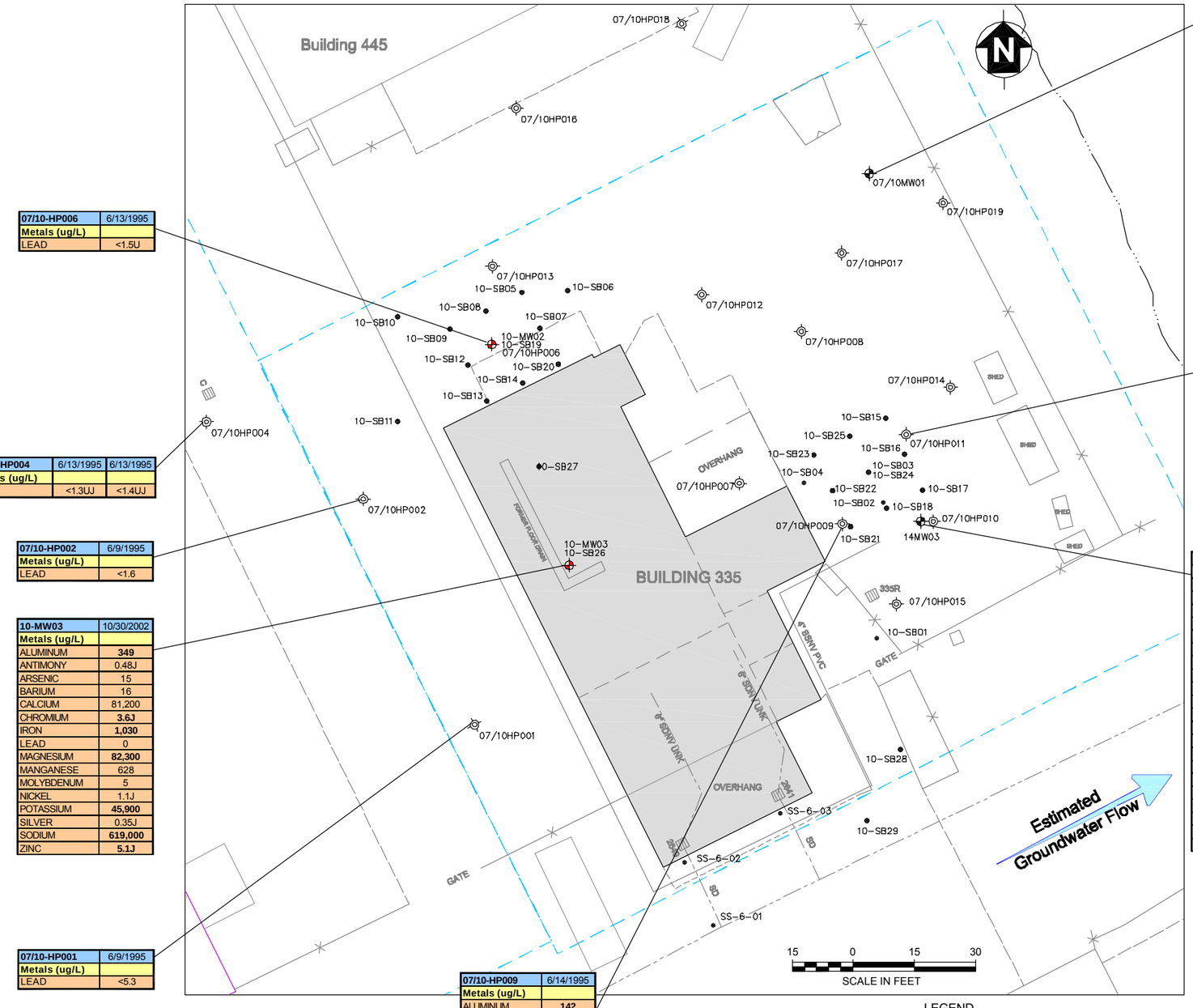
NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 5-16

Site 10 - Bus Painting Shop
Pesticides and PCBs Groundwater
Sampling Results

Site 10 Hitbox GW Pest and PCBs.dwg — JHD — 07/02/03 — 00069.302.B.05.01.03



07/10-HP006	6/13/1995
Metals (ug/L)	
LEAD	<1.5U

07/10-HP004	6/13/1995	6/13/1995
Metals (ug/L)		
LEAD	<1.3UJ	<1.4UJ

07/10-HP002	6/9/1995
Metals (ug/L)	
LEAD	<1.6

10-MW03	10/30/2002
Metals (ug/L)	
ALUMINUM	**349**
ANTIMONY	0.48J
ARSENIC	15
BARIUM	16
CALCIUM	81,200
CHROMIUM	**3.6J**
IRON	**1,030**
LEAD	0
MAGNESIUM	**82,300**
MANGANESE	628
MOLYBDENUM	5
NICKEL	1.1J
POTASSIUM	**45,900**
SILVER	0.35J
SODIUM	**619,000**
ZINC	**5.1J**

07/10-HP001	6/9/1995
Metals (ug/L)	
LEAD	<5.3

07/10-HP009	6/14/1995
Metals (ug/L)	
ALUMINUM	**142**
ARSENIC	10
BARIUM	2.2J
CALCIUM	36,600
COBALT	0.55J
COPPER	1.8J
IRON	**295**
MAGNESIUM	17,500
MANGANESE	334
POTASSIUM	26,400
SODIUM	23,600
VANADIUM	**5J**
ZINC	**10.9J**

07/10-MW01	12/8/1995	2/26/1996	6/10/1996	9/4/1996	11/2/1998
Metals (ug/L)					
ALUMINUM	**6,570**	**39,900**	**9,610**	**3280J**	**31.1J**
ARSENIC	**23**	**36**	**30**	**28**	**21**
BARIUM	26.7J	116J	38.1J	13.7J	<3.4UJ
CALCIUM	59,800	**185,000**	71,200	44,000	37,500
CHROMIUM	**22**	**119**	**27**	**9.7J**	<0.9U
COBALT	**5.5J**	**33.1J**	**11J**	**3J**	1J
COPPER	<10UJ	**60**	**20.6J**	**9.3J**	<1.5UJ
IRON	**12,300**	**55,300**	**14,400**	**4,460**	<19.9U
LEAD	**9**	**37**	**14**	**3**	<1.9U
MAGNESIUM	38,100	**92,200**	37,900	28,500	30,800
MANGANESE	374	**3,350**	**1,330**	359	5.7J
MERCURY	<0.1U	**1**	**0.11J**	<0.1U	<0.1U
MOLYBDENUM	<5.3UJ	3.9J	2.7J	4.4J	4.5J
NICKEL	**23.6J**	**115**	**30J**	**12J**	1.4J
POTASSIUM	34,000	**43,800**	31,800	31,500	33,300J
SODIUM	**269,000**	**776,000**	210,000	192,000	224,000
THALLIUM	<1.9UJ	**3.8J**	<1.8UJ	<1.8U	<1.1U
VANADIUM	**25.7J**	**118**	**31.2J**	**12.2J**	<3.8UJ
ZINC	**49**	**298**	<66.5UJ	**52**	<7.8UJ

07/10-HP011	6/14/1995
Metals (ug/L)	
ALUMINUM	**612J**
BARIUM	4.4J
CALCIUM	52,800
IRON	**905J**
MAGNESIUM	11,400
MANGANESE	26
NICKEL	4.6J
POTASSIUM	10,100J
SODIUM	13,800
VANADIUM	3.6J

14-MW03	11/21/1995	2/26/1996	6/10/1996	9/4/1996	9/4/1996	11/17/1998	5/26/2000	10/30/2001
Metals (ug/L)								
ALUMINUM	**84,200**	**10,700**	**22,700**	**4,850J**	**5,520J**	<73.4UJ	<16.3U	<52.9UJ
ANTIMONY	**4.3J**	<2UJ	<1.2U	<2.6UJ	<2.6UJ	<2.1U	<4.6U	<6.1UJ
ARSENIC	**80**	**15**	**36**	**22**	**24**	13	9J	12
BARIUM	**204**	37.3J	77J	18.7J	20.4J	2.1J	<10.7U	4.9J
BERYLLIUM	**0.36J**	<0.1U	<0.25UJ	<0.1U	<0.1U	<0.47UJ	<0.3U	<0.15U
CALCIUM	**164,000**	46,500	78,600	40,700	40,000	34,900	55,300	56,700
CHROMIUM	**338**	**42**	**78**	**18**	**20**	<0.9U	<2.2U	<0.57UJ
COBALT	**83**	**11.3J**	**30.4J**	**5.3J**	**5.6J**	<1U	<3U	<0.41U
COPPER	**167**	**20.2J**	**47**	**12.8J**	**11.6J**	<1.1U	<2.1U	<1.6U
IRON	**176,000**	**18,200**	**39,700**	**8,600**	**9,350**	<19.9U	<24.9U	42
LEAD	**138**	**17**	**60**	**9**	**8**	<2.6UJ	<2.3U	<0.78U
MAGNESIUM	**78,500**	17,900	28,400	20,800	21,000	11,500	16,100	20,900
MANGANESE	**2,740**	840	**1,520**	402	404	<4.1UJ	2.4J	<9.2UJ
MERCURY	**1.3J**	<0.1U	**0**	<0.1U	<0.1U	<0.32U	**0.14J**	<0.17UJ
MOLYBDENUM	<5.5UJ	<2.4UJ	1J	2.3J	3.4J	<1.1UJ	<1.5U	<2.7UJ
NICKEL	**298**	**35.9J**	**74**	**18.6J**	**20.1J**	1.5J	<2.9U	<2.1UJ
POTASSIUM	**44,300**	15,400	20,700	23,100	23,700	15,600	16,100	17,300
SELENIUM	<3.9U	<2.3U	<2.2U	<3.9U	<3.9U	<2.1U	<4U	**2.2J**
SODIUM	46,900	13,900	17,100	28,000	27,200	13,000	13,100	21,300
VANADIUM	**291**	**36.4J**	**77**	**19.7J**	**21.8J**	<5.1UJ	**4.7J**	**5**
ZINC	**479**	**73**	**145**	**76**	**49**	<4.3UJ	2.2J	<59.8UJ

LEGEND

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- IR SITE BOUNDARY
- STORM DRAIN

J Estimated value
mg/L Milligrams per liter
NA Not analyzed
ND Not detected
U Nondetected
ug/L Micrograms per liter

NOTE: Bold Values Indicate Analysis Exceeded Screening Criteria

NOTE: Categories of anaylses are shown, but only detected components are presented:

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FIGURE 5-17

Site 10 - Bus Painting Shop
Site 10 Metals Groundwater Sampling Results

Site 10 Hitbox GW Metals.dwg – JHD – 07/02/03 – G0069.302.B.05.01.03

6.0 PRINCIPLES OF ENVIRONMENTAL FATE AND TRANSPORT

Previous sections of this report describe field investigations and the nature and extent of contaminants at Sites 09 and 10. This section provides information to support an evaluation of the fate and transport of organic and inorganic contaminants present at Sites 09 and 10. The contaminants discussed in this section were identified as chemicals of potential concern (COPC) at Sites 09 and 10. This section assesses contaminant fate and transport in general terms and in relation to conditions at the individual sites.

Few identified contaminants pose a risk to human health or the environment at Sites 09 and 10 (see Sections 7.0 and 8.0). Groups of contaminants are presented, and their fate and transport are evaluated. The COPCs are evaluated individually in Sections 6.2.1 and 6.2.2. Data suggest that little risk to human health or the environment is associated with releases at Sites 09 and 10.

Section 6.1 discusses physical, chemical, and biological processes influencing contaminant fate and transport of organic and inorganic contaminants. Section 6.2 presents the individual contaminant characteristics important to fate and transport. Supporting tables are presented in Appendix K.

6.1 ENVIRONMENTAL FATE AND TRANSPORT PROCESSES

The fate and transport of organic and inorganic COPCs in soil and groundwater are influenced by physical, chemical, and biological processes. The following subsections summarize each process and how it influences the fate and transport of contaminants. In addition, many chemical and physical properties that relate to contaminant fate and transport processes are discussed.

6.1.1 Physical Processes

The physical processes that influence contaminant fate and transport include volatilization, sorption, advection, diffusion, and precipitation.

6.1.1.1 Volatilization

Volatilization is the process by which a chemical changes from a solid or liquid state to the vapor phase. In general, volatilization from a neat (chemically pure) liquid or solid is a function of the temperature and partial pressure of the chemical surrounding the liquid or solid when equilibrium is achieved. The equilibrium partial pressure is compound specific and independent of other gases present; however, it does contribute to the total pressure of the system. Vapor pressure, usually in units of millimeters of mercury (mm Hg), is the common measure of equilibrium partial vapor pressures. As examples, the vapor pressure of water at 20 °C is 17.5 mm Hg, and the vapor pressure of carbon dioxide is 4.3×10^4 mm Hg.

Based on Henry's Law, volatilization of chemicals from aqueous solutions is directly proportional to the partial pressure of the chemical in the vapor phase above the solution (surface water). Henry's Law constants indicate the tendency of compounds under equilibrium conditions to partition into the aqueous or vapor phase but do not suggest a rate of volatilization from aqueous solution when not in equilibrium. Moreover, the rate of chemical mass transfers from surface waters is difficult to estimate because the rate is a function of chemical properties such as molecular weight and solubility as well as environmental conditions, which include temperature, wind velocity, and biological activity.

Volatilization of chemicals from soil is also a complex process dependent upon climatic factors, soil composition, and chemical properties of the contaminant. Studies conducted on the volatilization of pesticides from soils indicate soil moisture content and air temperature affect pesticide volatilization rates (Nash 1983). Additional investigations have shown soil organic matter contents strongly influence the volatilization of pesticides and VOCs from soils (Spencer 1970). Volatilization from soils will vary considerably depending on the contaminant and its environment.

Chemicals often thought of as volatile in the pure state are much less volatile in an aqueous solution or when present in soil. Volatilization is an important fate and transport mechanism for aliphatic chlorinated compounds and the petroleum constituents BTEX.

6.1.1.2 Sorption

Sorption is defined as the removal of an element or compound from the fluid phase to the solid phase (Dragun 1988). Two basic kinds of sorptive mechanisms can be distinguished, adsorption and absorption. Both phenomena are the result of electrical attraction between ions or compounds in the solution and solid mineral and organic matter surfaces or mineral lattices. Adsorption refers to the replacement of positive charged ions on mineral surfaces by metal cations or organic compounds in solution. This process may also be termed ion exchange. Absorption refers to the incorporation of ions or compounds into the crystal lattice of the absorbing material. The term sorption is used to define both of these processes in a general sense.

The sorption of organic contaminants is strongly influenced by the chemical composition of the compound. Important chemical parameters include compound size and shape and the presence of charged functional groups. The organic carbon partition coefficient, K_{oc}, is often used to estimate the potential for sorption of organic contaminants in the environment.

The sorption of inorganic ions is largely determined by the complex chemical equilibria involving the charge and size of the element or complex ion, the nature of the sorbing material, and the pH of the aqueous solution. The properties of the surface of the sorbing material that influence inorganic sorption include net surface charge, the presence and configuration of binding sites, and the pH dependence of those sites. The structure of the solid, whether crystalline or amorphous, may also affect adsorption and absorption reactions.

Sorption is an important fate and transport mechanism for many of the more hydrophobic chemicals including PAH.

6.1.1.3 Advection

Advection refers to the bulk movement of fluid, usually groundwater. This transport mechanism is the main factor in the distribution of soluble contaminants in aquifers. Dissolved, nonreactive (or conservative) constituents such as chlorine or fluorine move at a rate similar to the groundwater, although the variation of flow paths can contribute to spreading or dispersion of the solutes. If a preferential pathway exists, this can also contribute to spreading of the solutes. Because at both sites the utility lines appear to be continuously above the water table (Tetra Tech. 2003b), the preferential pathways for groundwater contaminants to reach the ecological point of exposure were not considered. One cause of dispersion is the exclusion of molecules from some portion of the water flow paths (called negative adsorption). This results in a faster movement through a porous medium. Conversely, some fraction of the solute may move along more tortuous and longer flow paths, resulting in slower movement through the porous medium. Dissolved species capable of interacting with aquifer materials, for example trichloroethene or 1,2-dichloroethene, move at a rate less than flowing groundwater (retardation); therefore, contaminants in groundwater disperse as they move with the bulk flow. This spreading phenomenon is called hydrodynamic dispersion and is roughly proportional to the advection rate. In addition, diffusion caused by concentration differences also causes spreading of solutes, as discussed in Section 6.1.1.4. Advection is an important transport mechanism for all the VOCs and soluble metals.

6.1.1.4 Diffusion

Diffusion is the process by which atoms, molecules, or ions move from one position to another within a solvent phase under the influence of a chemical potential concentration gradient. Diffusion occurs even in the absence of any bulk hydraulic movement of the solution. Diffusion ceases only when concentration gradients become nonexistent (Freeze and Cherry 1979). The rate of diffusion is temperature dependent. In warmer solutions, where atoms and molecules have more kinetic energy, diffusion will occur more rapidly than in cold solutions. Diffusion is a relatively slow process whose effects are usually masked by the effects of advection associated with bulk water movement. Diffusion is therefore not a primary transport mechanism for chemicals in groundwater.

6.1.1.5 Precipitation

The maximum concentration of inorganic contaminants in groundwater can be estimated based on principles of equilibrium chemistry. The maximum concentrations of dissolved inorganic ions in groundwater can be calculated using the thermodynamic solubility constants of solid phases that contain the dissolved ion. If the solubility limits of a mineral phase are exceeded, the dissolved species should begin to precipitate to form the solid phase. Precipitation is a possible fate and transport mechanism for inorganic compounds but is highly dependent on soil and groundwater conditions.

Natural systems are usually more complex than the well defined systems from which chemical equilibrium measurements are made. For instance, even when groundwater is oversaturated with respect to a certain mineral phase (or phases), the most stable mineral may not precipitate because the kinetics of precipitation for that mineral are too slow or unfavorable.

Additionally, the kinetics of dissolution of a mineral may be slower than the rate of groundwater flow, and groundwater may never reach saturation with respect to that mineral. Further, a change in oxidation reduction (redox) conditions or pH of groundwater can affect the solubility of minerals.

6.1.2 Chemical Processes

This section discusses chemical processes that influence contaminant fate and transport, including photolysis, oxidation, and hydrolysis. Although these chemical processes are important fate and transport mechanisms for many organic and inorganic contaminants, they are difficult to predict because of the dependence on proper conditions in the soil and groundwater.

6.1.2.1 Photolysis

Photolysis refers to the transformation or degradation of a substance after absorption of light energy. This reaction may occur in surface soil, water, or the atmosphere. Two types of photolysis are generally recognized: direct photolysis and sensitized photolysis. Direct photolysis refers to photodegradation or transformation of a substance by direct absorption of light energy. Sensitized photolysis refers to photodegradation or transformation of a substance in which energy is indirectly transferred to the target substance from some other species in the aqueous medium. The rates of direct photolysis and sensitized photolysis depend on the properties of both the substance and the medium.

6.1.2.2 Oxidation

Oxidation refers to the degradation or transformation of a substance because of the loss of electrons. This may be a result of the action of single oxygen atoms, free radicals, or other reactive species present in the medium. Complete oxidation of organic compounds results in the production of carbon dioxide and water, which is called mineralization. In general, abiotic oxidation of organic compounds in the subsurface is extremely slow (Olsen and Davis 1990). Biologically mediated oxidation of organic compounds, however, may proceed rapidly in soils and groundwater.

6.1.2.3 Hydrolysis

Hydrolysis refers to a chemical transformation process in which a molecule (MX) reacts with water forming a new compound with the replacement of a leaving group (X) by a hydroxyl (OH) group. The chemical reaction may be represented as follows:

$$MX + H_2O > MOH + HX$$

The rate of hydrolysis depends on the hydronium ion (H^+) concentration, the chemical stability of MX and MOH, and the energy required to form MOH.

6.1.3 Biological Processes

This section summarizes biological processes that affect fate and transport including biotransformation, biodegradation, and bioaccumulation.

6.1.3.1 Biotransformation and Biodegradation

Biotransformation and biodegradation refer to the transformation and degradation, respectively, of chemical compounds by natural biological processes. Biodegradation and biotransformation result from the metabolism of contaminant chemicals, primarily by microorganisms in soil and water. Specific reactions that occur during metabolism of the contaminant chemicals included oxidation, reduction, and dehydrohalogenation. The resulting products range from less complex organic substances to inorganic compounds. Complete biodegradation of organic compounds results in the production of water and carbon dioxide (mineralization). The rates of biodegradation and biotransformation range widely, depending on the chemical compounds and the type and abundance of microorganisms present. This fate process is important in aqueous systems and soils and plays a significant role in breakdown of organic components (Olsen and Davis 1990). Aliphatic hydrocarbons have a higher propensity to biodegrade.

6.1.3.2 Bioaccumulation

Bioaccumulation refers to the increase in concentration of a substance in living species over the concentration in a given medium. It is an unusual transport mechanism since the chemicals are spread throughout the food chain once a living species is exposed to a source. Bioaccumulation is generally reported in terms of a bioconcentration factor (BCF), the ratio of the concentration of the substance in a living organism to the equilibrium concentration in the medium in which the organism lives. Concentrations in the two phases are usually expressed in the same units. Bioaccumulation is especially important for hydrophobic chemicals, such as many chlorinated pesticides and PAHs, which can be partitioned into fat and lipid tissues. Partitioning of inorganic chemicals into bone marrow represents an additional form of bioaccumulation. BCFs reported in the literature generally range from 1 to 1 million.

6.2 CHEMICAL CHARACTERISTICS OF CONTAMINANTS

The chemical and physical properties of organic contaminants will, to a great extent, determine their behavior in soil and groundwater environments. Similarly, the general geochemistry of inorganic contaminants, in this case metals and inorganic ions, provides important information that will aid in predicting their fate and transport in soil, groundwater, and sediments. Sections 6.2.1 and 6.2.2 discuss the physical and geochemical characteristics of organic and inorganic COPCs, respectively.

6.2.1 Chemical Characteristics of Organic Chemicals of Potential Concern

The following subsections discuss the chemical characteristics of organic COPCs at Sites 09 and 10. Appendix K contains Tables K-1 and K-2 that summarize the chemical and physical characteristics of the COPCs. Table K-3 summarizes the primary fate and transport mechanisms for these COPCs. The following paragraphs provide a brief description of each characteristic and highlight its relevance to the fate and transport of the contaminants. The text also discusses the fate and transport of organic compounds detected in soil and groundwater at Sites 09 and 10.

The molecular weight is an indication of a compound's size. This property affects the adsorption of a compound to soil or its dissolution in groundwater. Generally, as the molecular weight of a compound increases, the tendency for a compound to be sorbed onto soil increases, and its stability in water decreases.

The water solubility of a compound is an important factor in estimating a chemical's fate and transport in the aquatic environment. Compounds with high water solubility's commonly enter the water table more readily than their less soluble counterparts and are less likely to volatilize once in solution. Because dissolved compounds are more available to microorganisms in the groundwater and saturated soils, they are more susceptible to biodegradation than adsorbed compounds.

Vapor pressure measurements reflect the tendency of a chemical to volatilize from a solid or liquid to a vapor or gaseous state. Henry's Law constants indicate the tendency of a compound to volatilize from an aqueous solution.

The soil/water partition coefficient, K_{oc}, (normalized for organic carbon content of the soil) provides a measure of the extent that a compound will sorb to soil. K_{oc} values may be used for ranking and comparing a chemical's potential for leaching. Generally, as K_{oc} increases, adsorption to soil increases. Based on the classification of soil mobility potential developed by McCall and others (1980), compounds with a K_{oc} value below 150 may be considered highly mobile.

The octanol-water partition coefficient, K_{ow}, provides a measure of the hydrophobicity of a compound, which is used to estimate chemical portioning between water and contaminants. These values are used to predict whether an organic contaminant will have a tendency to

solubilize in a hydrocarbon layer, the groundwater, or adsorb to soil. In general, the higher the K_{ow} value, the more likely the chemical is to partition into a hydrophobic hydrocarbon than to remain in water. K_{ow} is also used to predict accumulation of hydrophobic contaminants in fat tissue in aquatic organisms. A log K_{ow} value greater than 1 suggests a compound may bioaccumulate.

6.2.1.1 Pesticides

The following subsections discuss the chemical characteristics of pesticides at Site 09. The only pesticides identified as COPCs were alpha-chlordane and Endosulfan II. Both were detected in groundwater samples at Site 09 at concentrations exceeding groundwater screening values.

Alpha Chlordane

Alpha chlordane is a cyclodiene insecticide. In general, cyclodiene insecticides are strong insecticides that persist in the environment. Their persistence, toxicity, and tendency to bioaccumulate led to the eventual banning of these insecticides for agricultural use.

The chlorinated cyclodienes are structurally similar compounds composed of two cyclic (ring) groups. The base ring consists of a six-carbon cyclodiene and a bridging carbon. Four chlorines are bound to the cyclodiene, and two are bound to the bridging carbon.

The chlorinated cyclodienes, like alpha chlordane, are characterized by low vapor pressures and Henry's Law constants. Table K-1 in Appendix K provides chemical characteristics of the chlorinated cyclodienes. Vapor pressure value for chlordane is 1×10^{-5}. Henry's Law constant for chlordane is 4.86×10^{-5} atmosphere meter cubed per mole (atm m^3/mol). These equilibrium vapor pressure values suggest these pesticides will not volatilize rapidly.

Aqueous solubility's of the chlorinated cyclodienes, indicative of hydrophobic compounds, are low. Measured solubility for chlordane is 0.056 mg/L. The solubility of these insecticides is probably enhanced by dissolved organic matter or mixtures of contaminants (cosolvent effect). Conversely, high concentrations of dissolved inorganics may reduce the aqueous solubility of these insecticides.

The sorption of hydrophobic compounds, such as the chlorinated cyclodienes, is reasonably approximated by organic carbon partitioning coefficients. The logarithm of K_{oc} values for chlordane is 4.58 mg/L. The K_{oc} data suggest the chlorinated cyclodienes will strongly sorb to soil organic matter.

Biodegradation of the chlorinated cyclodienes is limited. Dieldrin, for example, has been shown to be microbially degraded to (E)-Aldrin-diol and other products (Tu and others 1968; Matsumura and Boush 1967). Less than 10 percent of the dieldrin, however, was observed to biodegrade during the Matsumura and Boush study. Heptachlor epoxide is a metabolite of heptachlor. Bacteria, fungi, and molds capable of oxidizing heptachlor to the epoxide include

Rhizopus, Fusarium, Penicillium, Trichoderma, Neoardia, Streptomyces, Bacillus, and Micromonospura (Miles and others 1969). Finally, microbial dechlorination of heptachlor produces chlordane that can undergo epoxidation to chlordane epoxide.

Several chlorinated cyclodienes worked into soil environments were found to persist for long time periods. Heptachlor was observed to have the longest half-life, ranging from 7 to 12 years (Menzi 1972). Soil half-lives for chlordane and dieldrin ranged from 2 to 4 and 1 to 7 years, respectively. Additional studies by Edwards (1966) reported the disappearance times for chlorinated cyclodienes from soil environments. The time required for 95 percent of the chlordane and heptachlor to disappear ranged from 3 to 5 years. Dieldrin was observed to have a longer 95 percent disappearance time, ranging from 5 to 25 years. The apparent contradiction of results from these studies underscores the variability of soil environments.

Endosulfan Sulfate

Endosulfan II is one of two endosulfan isomers. Little information is available to evaluate the fate of endosulfan II in the environment. Based on its low solubility and high log K_{oc} and log K_{ow} values (Table K-1), sorption to soil and bioaccumulation are probably the major processes affecting the distribution of endosulfan sulfate in the environment.

6.2.1.2 Semivolatile Organic Compounds

SVOCs detected in soil at Sites 09 and 10 include PAHs, benzo(a)pyrene, and dibenz(a,h)anthracene. The physical and chemical properties of these compounds are listed in Appendix K, Table K-2.

Polycyclic Aromatic Hydrocarbons: Benzo(a)pyrene and Dibenz(a,h)anthracene

PAHs are defined as compounds containing two or more aromatic rings. For the purpose of describing environmental fate, these PAHs can be grouped into low, medium, and high molecular weight classes. PAHs are released to the environment from natural and manmade sources. Manmade sources now provide a much greater release volume than natural sources. PAHs are common constituents of petroleum hydrocarbon mixtures such as diesel, motor oil, and asphalt. They are also found in creosote, dyes, paints, plastics, insulating materials, building materials, and rubber. Transport and partitioning of PAHs in the environment are largely determined by the physical and chemical properties described in Appendix K, Table K-2.

In general, PAHs have low water solubility's and are found sorbed to soil or particles within groundwater. Sorption to soil particles is the primary process responsible for their removal from aqueous systems. The PAHs have Henry's Law constants ranging from 10^{-5} to 10^{-8} atm m^3/mol. Compounds with values less than 10^{-5} atm m^3/mol volatilize from water only to a limited extent (Lyman and others 1982). The K_{oc} indicates the chemical's potential to bind to organic carbon in soil and sediment. The high molecular weight PAHs have K_{oc} values in the range of 10^{-5} to 10^{-6},

which indicate a strong tendency to adsorb to organic carbon (Agency for Toxic Substances and Disease Registry [ATSDR] 1990).

Sorption of PAHs to soil and sediment increases with increasing organic carbon content and is also directly dependent on particle size. Smaller particles with higher surface-area-to-volume ratios are more efficient at sorbing PAHs. Sorption has been correlated with bioconcentration in aqueous organisms. Information on the organic metabolism of PAHs in the subsurface environment is often conflicting; however, it appears that the three simplest PAHs, naphthalene, anthracene, and phenanthrene, are the only compounds of this class that support the growth of microorganisms. None of the more complex PAHs has been shown to support growth when present as the sole carbon sources (Ribbons and Eaton 1982). In addition, hydrolysis is not considered to be an important degradation process for PAHs (ATSDR 1990); therefore, PAHs are very persistent in the environment.

6.2.2 Chemical Characteristics of Inorganic Chemicals of Potential Concern

Estimation techniques for predicting fate and transport of inorganic contaminants are strictly qualitative. The movement of metals in soil can be qualitatively assessed based on several soil characteristics as well as the physical and chemical properties of the leaching solution. Leaching solution properties include viscosity, surface tension, redox potential (Eh), pH, total soluble iron content, and the amount and strength of organic and inorganic complex formers. The soil characteristics include particle size, surface area, cation exchange capacity, pH, organic matter content, microbial activity, and others. The Eh and pH of the media control the metal speciation. In addition, knowledge of the particular metal species at a site is extremely important in evaluating a metal's fate and transport. The following sections discuss the general geochemistry of the metal COPCs at Site 09, and Appendix K, Table K-3 summarizes the primary fate and transport mechanisms.

Nickel

Sewage sludge is the major manmade source of nickel. Nickel occurs in the zero (0) and divalent (+2) oxidation states in the natural environment. Nickel forms compounds of low solubility with common anions such as hydroxide, carbonate, and sulfate in the aqueous environment. At conditions above pH 8, precipitation of nickel hydroxide probably controls nickel mobility.

Naturally occurring organic acids complex nickel and influence its solubility and precipitation behavior. Rashid and Leonard (1973) exposed a saturated nickel carbonate solution to humic acid and found that an additional 200 mg of nickel was released to solution for each gram of humic acid added. In similar experiments, however, the addition of humic acid did not increase the solubility of nickel sulfide. These data suggest that organic matter can play an important role in remobilizing previously mineralized nickel. Humic acids are common in nature and can be expected to substantially increase nickel solubility.

Sorption of nickel by organic material and iron or manganese oxides exerts a major control on the mobility of nickel. In unpolluted natural water systems, sorption onto iron or manganese oxides is moderately successful in reducing the mobility of nickel. This suggests that metal oxides attract nickel more strongly that organic matter; however, the biomass that forms a large portion of the sludge waste in landfills may sorb more nickel than the metal oxides.

In a laboratory study, organic acids were found to increase the solubility of nickel in the presence of clay (Jackson and others 1978). Korte and others (1976) developed a qualitative procedure for determining heavy metal-soil interaction using seven metals with seven different soil types. In general, the higher the clay content, the lower the mobility of nickel. This study demonstrates that soil composition plays an extremely important role in nickel transport potential.

Nickel is not bioaccumulated in significant amounts. It is bioaccumulated in some aquatic organisms, but most BCFs are less than 1,000. In addition, nickel is not known to be biotransformed.

7.0 HUMAN HEALTH RISK ASSESSMENT

The guiding principles in EPA's "Risk Assessment Guidance for Superfund" (RAGS) were applied at Sites 09 and 10, along with companion Navy and State of California guidance, as outlined in Section 7.1. Results of the risk assessments are presented in Section 7.2, and conclusions and recommendations related to human health are summarized in Section 7.3.

7.1 METHODS AND ASSUMPTIONS

This section summarizes the methodology used to conduct the HHRA for Sites 09 and 10. The HHRA methodology is consistent with EPA (1989, 1991, 1997a, 2001a, 2001b, 2002a, 2002b, 2002c, 2003), DTSC (1992, 1993, 1997), and the risk assessment guidelines from the Navy (2001, 2002).

7.1.1 Data Evaluation

The first step of the HHRA process consisted of reviewing and evaluating available data and identifying COPCs in the environmental media (such as groundwater and soil) at Sites 09 and 10. An extensive data review was conducted during the process to determine whether the data collected adequately reflected site conditions.

See Appendix I, Section 5 for details of the data reduction. With the exception of the data quality issues noted in that section, all data without qualifiers and all data qualified as estimated (J) were used in the HHRA with the exception of the data quality issues noted in Appendix I, Section 5. Data qualified as not detected (U) were incorporated into the HHRA by using a proxy concentration of one-half of the sample quantitation limit (EPA 1989). Consistent with EPA guidance, only data qualified as rejected (R) were considered unusable for risk assessment purposes (EPA 1989, 1992). None of the rejected data (summarized in Appendix I, Section 5) presented a data gap for the HHRA.

7.1.1.1 Soil Data

Soil data were evaluated in two separate depth intervals: 0 to 2.0 and 0 to 8.0 feet bgs. Current site conditions were evaluated using the 0- to 2.0-foot bgs data set and assuming minimal disturbance of the surface soils, which is most consistent with the proposed future use of Sites 09 and 10. The deeper soil depth was used to predict future exposures because earthmoving or soil excavation activities could bring subsurface soils to the surface in some parts of Sites 09 and 10. Chemicals in soils down to 8 feet bgs were combined to evaluate this potential future developed site condition. Attachment I-1 of Appendix I lists all samples used in the HHRA database.

7.1.1.2 Groundwater Data

Two separate groundwater data sets were evaluated (one each for Site 09 and Site 10) based on the locations of monitoring wells and the direction of groundwater flow. The more recent fall 2002 data formed the basis for the HHRA at Sites 09 and 10, as detailed further in Section 5.3 of Appendix I. These data were collected with micropurge (low-flow) techniques intended to represent aquifer conditions and avoid (1) lowered VOC concentrations during sampling because of volatilization as well as (2) entrained aquifer sediment in the groundwater sample.

Groundwater data for Site 09 are presented in Figures 5-5, 5-6, 5-7, and 5-8 for VOCs and TPH; SVOCs; pesticides and PCBs; and metals, respectively. Groundwater data for Site 10 are presented in Figures 5-14, 5-15, 5-16, and 5-17 for VOCs and TPH; SVOCs; pesticides and PCBs; and metals, respectively. Available data were grouped by site for evaluation, as follows:

All seven wells (09MW01 through 09MW07) on the 0.25-acre Site 09 remain functional and were sampled in 2002, so the Site 09 data set is robust for fall 2002. Details of the appropriateness of the data set are presented in Section 5.3.1 of Appendix I.

By October 2002, only MW02 and MW03 remained on Site 10. The upgradient, control well for Site 14 that was placed on Site 10 (well 14MW03) was destroyed some time between 1998 and 2002. Similarly, although MW01 previously existed on Site 10, it was also destroyed or buried some time between 1998 and 2002. As detailed in Section 5.3.2 of Appendix I, the 2002 data from the two newer wells (MW02 and MW03) are considered sufficient to characterize likely conditions in the aquifer underlying Site 10 for three reasons. First, Site 10 is small (0.73 acre); second, the sampling locations of the existing wells are biased (nearest to a suspected release); and third, the groundwater underlying Site 10 is not a drinking water source.

As detailed in Section 5.3 of Appendix I, historic data were summarized in standard RAGS Part D format (see Tables I-2.1 through I-2.8 of Appendix I) to provide the data range for groundwater at Sites 09 and 10. While all historic data are presented, the most recent fall 2002 data formed the "snapshot" for evaluating the HHRA groundwater risks, as detailed in Section 5.3 of Appendix I. This information was used to identify COPCs as discussed in the following section.

7.1.2 Identifying Chemicals of Potential Concern

COPCs represent those site-related chemicals assumed to account for the majority of any estimated health impacts at a site and are considered contributors to "incremental site risk." Consistent with EPA and Navy guidance (EPA 1989, 2001b; Navy 2001), the criteria enumerated in the following text were used to identify site-related COPCs for both sites.

7.1.2.1 Soil Chemicals of Potential Concern

Consistent with EPA and Navy guidance (EPA 1989, 2001b; Navy 2001), COPCs were selected for chemicals detected in soil as follows:

- If the maximum detected chemical concentration in soil exceeded the EPA (2002a) residential PRG for soil, it was retained as a COPC. Residential soil PRGs account for chemical exposures associated with incidental ingestion, dermal contact, and inhalation of soil particulates and vapors by persons living in an area of contamination.
- If an inorganic chemical is considered an essential nutrient (such as calcium, magnesium, potassium, or sodium), it was excluded as a COPC if the maximum reported concentration fell below levels associated with adverse health effects.
- Consistent with Navy (2004) and DTSC (1997) guidance, inorganic analytes statistically shown to be below ambient concentrations in ambient fill material (see Attachment I3) were eliminated as COPCs.

In addition, in response to DTSC requests to evaluate the contribution of all detected analytes to total risk without applying the EPA and Navy guidance for COPC selection, a sensitivity analysis was presented in Section 10.3 of Appendix I. In this process, all detected contaminants in soils were evaluated, and the maximum detected concentration was presented as a ratio relative to its residential PRG. This ratio approach is effectively a shortcut (suggested in the Navy tiered guidance [Navy 2001] and an integral part of the RAGS Part D COPC selection process [EPA 2001b]) that present enough total risk information to ensure that human health risks are not being underpredicted during a COPC selection process using residential PRGs. As noted in Section 10.3 of Appendix I, the total risk findings from the residential scenario did not affect the overall conclusions of the HHRA, including use of the COPC selection process, which followed EPA (1989, 2001b) and Navy (2001) guidance.

7.1.2.2 Groundwater Chemicals of Potential Concern

Because groundwater at Sites 09 and 10 is not a source of drinking water (Section 4.3.1.4), potential exposure to chemicals in groundwater would occur only through the inhalation of volatiles migrating upward into in the air (breathing zone). All data (including non-VOC data) were screened, however, as requested by EPA, DTSC, and the Navy during the May 19, 2003, teleconference call (Tetra Tech 2003b) to evaluate whether formal institutional controls would be necessary to ensure no future wells would be installed.

The potentially complete pathway (volatile migration upward into future indoor air) was screened as follows. VOCs detected in groundwater were identified as COPCs if the maximum detected concentration exceeded the risk-based screening levels for vapor intrusion to indoor air detailed by EPA (2002b). The groundwater values selected for screening were adopted from EPA's Table 2c (EPA 2002b), which are based on a target cancer risk of 1×10^{-6} and a hazard quotient of 1 for each chemical.

These vapor screening criteria account for the inhalation of chemical vapors inside a building, which is the only complete and significant exposure pathway expected for chemicals detected in groundwater. For this reason, these vapor screening criteria were used as COPC selection criteria when evaluating VOCs detected in groundwater at Sites 09 and 10. In addition, while it is possible that subpart per million VOC maxima detected in soils would contribute to indoor air inhalation risks, a review of the maxima presented in Tables I-2.1 through I-2.8 of the HHRA (Appendix I) indicates that because all VOCs were (1) present at extremely low levels below residential PRGs and (2) present with extremely low frequency, the soil-to-indoor air pathway is insignificant, as indicated on the HHRA conceptual site model (Figure 7-1).

Table's I-2.1 through I-2.8 of the HHRA (Appendix I) present all chemicals detected in at least one sample for each site and medium evaluated in the HHRA. The following table summarizes the chemicals detected in soil and groundwater at a concentration exceeding their EPA Region IX residential PRG (EPA 2002a) or draft EPA (2002b) vapor screening values, respectively. These chemicals were retained as COPCs and quantitatively assessed in the HHRA.

Chemical of Potential Concern[a]	IR Site 09		IR Site 10	
	Current/Future Reuse Scenarios (0 to 2.0 ft bgs)	Future Reuse Scenarios (0 to 8.0 ft bgs)[b]	Current/Future Reuse Scenarios (0 to 2.0 ft bgs)	Future Reuse Scenarios (0 to 8.0 ft bgs)
Metals				
Iron	--	X	--	X
Volatile Organic Chemicals: None				
Semivolatile Organic Chemicals				
Benzo(a)pyrene	X	X	--	X
Dibenz(a,h)anthracene	--	X	X	X
Polychlorinated Biphenyls/Pesticides: None				

Notes:

a Soil COPCs only. No groundwater COPCs were identified. See Section 6.3 of the human health risk assessment (Appendix I).

b Soil was evaluated to a depth of 8 feet, which was the maximum depth sampled because of the presence of a shallow water table at this depth.

-- Chemical was not considered a COPC in this scenario.

ft bgs Feet below ground surface

COPC Chemical of potential concern

X Chemical was evaluated as a COPC in soil for the depth indicated.

7.1.3 Exposure Assessment

Considerations relevant to predicting current and future exposures were based spatially across Sites 09 and 10 as well as based on probable reuse patterns, as summarized in the following text. While probable reuse played a role in selection of the receptor populations, a future residential scenario was evaluated to account for the unlikely possibility that a home(s) would be placed on these sites in the future.

Site 09 (Figure I-1) is a relatively small site of approximately 11,000 square feet (or approximately 0.25 acre). Its small size allowed for reasonable evaluation of exposures across the IR site without further subdividing the IR site into smaller exposure areas. The most likely future land use for Site 09 is commercial/industrial, as detailed in Section 7.1 of Appendix I.

Site 10 (Figure I-2) is a relatively small site of approximately 32,000 square feet, or 0.73 acre. Its small size allowed for reasonable evaluation of exposures across the IR site without further subdividing the IR site into smaller exposure areas. The most likely future land use for Site 10 is commercial/industrial, as detailed in Section 7.1 of Appendix I.

Under the exposure assessment, potential human populations and related exposure pathways are identified based on current and expected future uses of the land. This step also involves compiling or developing receptor-specific intake assumptions, estimating exposure point concentrations (EPC), and estimating daily chemical intakes for each receptor. Together with chemical intakes, EPCs are used to estimate pathway-specific intakes (doses) for use in subsequent risk calculations. For both Site 09 and Site 10, a hypothetical future resident, an industrial worker, and a construction worker receptor were all evaluated. A recreational user was not evaluated at either of these NAVSTA TI sites because future reuse indicated other receptors were more appropriate.

A complete summary of exposure pathways evaluated for each receptor is provided in Section 7.1 of Appendix I. For all receptors evaluated at Sites 09 and 10, both a reasonable maximum exposure (RME) and a central tendency exposure (CTE) were evaluated. An RME scenario represents a plausible upper-end exposure situation while a CTE scenario represents an average or more typical exposure. Evaluating an RME scenario will address potential health impacts to most of the exposed population, absent those extremely sensitive individuals within a particular receptor population.

The standard EPA methods (EPA 2002e) were used to estimate EPCs for direct-contact exposures (for example, ingestion of soil), and the EPC was based directly on the measured COPC levels in soil. For the RME scenario, the EPC was the lesser of the maximum detected concentration and the 95th percentile upper confidence limit on the arithmetic mean (UCL_{95}). For the CTE scenario, the arithmetic mean was used to represent the EPC. COPC EPCs adsorbed to suspended soil particles were estimated using the EPA's particulate emission factor of 1.3×10^9 cubic meters per kg.

The standard EPA RAGS equations were applied (based on the site-specific exposure parameters established for each of the two sites) to determine daily doses (EPA 1989). Daily doses represent an estimated amount of a COPC to which a hypothetical human receptor might be exposed and were estimated for each receptor and each complete and significant exposure pathway.

7.1.4 Toxicity Assessment

The toxicity assessment for the HHRA included identification of toxicity values used to characterize noncancer health effects and cancer risk, respectively. Toxicity factors recommended by EPA Region IX were compiled from EPA-approved sources following the recommended hierarchy:

Integrated Risk Information System (IRIS)

National Center for Environmental Assessment (NCEA)

Health Effects Assessment Summary Tables (HEAST)

As summarized by EPA (1989), reference doses (RfD) have been developed to evaluate noncancer effects, and cancer slope factors (SF) have been developed to evaluate chemicals classified as known or potential human carcinogens. In the event a chemical is considered to cause both cancer and noncancer adverse health effects, both SFs and RfDs may be listed for a chemical.

Table's I-5.1 through I-6.2 of Appendix I present toxicity values used for each site. To avoid data gaps, if EPA sources did not provide toxicity values for some chemicals, surrogate compounds were selected to represent those chemicals (see Section 8.4 of Appendix I). Where route-specific toxicity values were not available, route-to-route extrapolations were used to derive toxicity values for organic compounds, but not for metals, consistent with EPA Region IX conventions for route-to-route extrapolations (EPA 2002a).

Consistent with Navy HHRA guidelines (Navy 2002), two sets of toxicity values were considered: one set consisting solely of EPA-developed toxicity values (from the IRIS, NCEA, and HEAST) and another set of combined Cal/EPA and EPA toxicity values. As detailed in Section 8.0 of Appendix I, a dual tracking approach to the toxicity assessment was not needed for Sites 09 and 10, as the COPCs identified do not have noncancer California-specific toxicity values, and the cancer toxicity values were not significantly different. No California-specific cancer or noncancer toxicity values were available for iron (Cal/EPA Office of Environmental Health Hazard Assessment [OEHHA] 1994, 1997). No California-specific noncancer toxicity values were available for the two PAH COPCs, benzo(a)pyrene or dibenz(a,h)anthracene (OEHHA 1997).

Using these criteria, toxicity values were compiled for each COPC identified for each of the two sites, and cancer risks and noncancer adverse health effects were estimated as discussed in the following text. In addition, a separate "total risk" sensitivity analysis was incorporated as detailed in Section 9.3 of Appendix I and summarized in Section 7.2.3.

7.1.5 Risk Characterization

The risk characterization step combines the results of all the previously described steps to estimate cancer risks and noncancer effects (as hazard indices [HI]). Because carcinogens and noncarcinogens manifest their effects through uniquely different mechanisms, adverse health effects are estimated separately for chemical carcinogens and noncarcinogens. For each receptor, cancer risks and HIs were estimated separately for each COPC and each complete exposure pathway. Cancer risk estimates and HIs were then summed across media and exposure pathways for a combined effect estimate. In the risk characterization discussion, the Site 09 and Site 10 risks were compared to the acceptable risk levels where a HI should be below unity (1) for noncancer effects, and the incremental site risk should be below one in a million (1×10^{-6}) for cancer effects. Where noncancer HIs exceeded unity for a receptor, effects were segregated by target organ to determine whether systemic effects would be unacceptable for a specific target organ or system. In addition, cancer risks between 10^{-6} (1 in 1,000,000) and 10^{-4} (1 in 10,000) are described as being within the risk management range.

Two chemical classes (lead and nondiscrete TPH) were not included in the cumulative risk characterization. Specifically, because of its unique recognized toxicological properties, EPCs for lead were compared against the corresponding EPA Region IX soil PRGs (EPA 2002a) appropriate for each receptor. Although a single reported sample contained lead in excess of the residential PRG for lead (400 mg/kg) at Site 09, lead was reportedly below ambient fill concentrations. In addition, when the site-wide EPC was calculated for lead (as described in Section 7.3 of Appendix I) at two depths, no Site 09 EPCs were greater than either the EPA Region IX residential PRG (400 mg/kg) or the California-modified (Cal-modified) residential PRG of 150 mg/kg. No maximum detected concentrations of lead exceeded the EPA Region IX residential PRG of 400 mg/kg or the Cal-modified PRG of 150 mg/kg, so lead was not a COPC for Site 10, and no EPCs were calculated (see Section 11.4 of Appendix I).

For TPH, nondiscrete TPH was evaluated based on its indicator compound components, consistent with state guidance (DTSC 1993). This approach is summarized in Section 10.4 of Appendix I.

7.1.6 Uncertainty Analysis

The HHRA incorporates a number of uncertainties inherent in the risk assessment process. Depending on the type of uncertainty, impacts to the results of the HHRA can include an over- or underestimation of cancer risks or HIs. The following summary presents information related to the main uncertainties in the Site 09 and 10 HHRA; detail is provided in Section 11 of Appendix I.

Uncertainty is introduced during the data evaluation and selection of COPCs. Each of the strengths and weaknesses associated with the data is carried through to the risk assessment. Fortunately, the very small sizes of Sites 09 and 10 (0.25-acre and 0.73-acre, respectively) and the relatively large number of samples collected from site media indicate that sufficient data are available to detect human health risks, and no underestimate is presented. To ensure that risks

were not underestimated by use of the COPC selection process, a quantitative assessment of the impact of a "no screen" HHRA is presented as a "total risk" assessment for soil (see Section 10.3 in Appendix I). This discussion concluded that no risk drivers were excluded from the HHRA and that the conclusions of the HHRA would not change had the COPC screen not been followed in accordance with Navy (2001) guidance.

Uncertainties were identified in association with four areas of the exposure assessment process: (1) the selection of exposure scenarios, (2) the selection of exposure pathways, (3) the estimation of EPCs, and (4) the selection of exposure variables used to estimate chemical intake. All parameters are expected to err on the conservative side, rather than underpredicting unforeseen human health risks.

Ingestion of homegrown produce was considered an incomplete pathway. The likelihood that potential risks are underestimated by not including this pathway are negligible because (1) the only surface soil COPCs were large molecular weight PAHs that are fairly insoluble in water, which inhibits uptake and thus makes these COPCs unlikely to accumulate in hypothetical produce; (2) the 1996 planned reuse indicates receptors are unlikely to spend significant time at the site; and (3) all inorganics (except silver) are below ambient fill concentrations..

The primary uncertainties associated with the toxicity assessment are related to derivation of toxicity values for COPCs. Standard RfDs and SFs developed by EPA were used to estimate potential cancer and noncancer health effects from exposure to COPCs at the site. These values are derived by applying conservative (health-protective) assumptions and are intended to protect the most sensitive potentially exposed individuals. Although the State of California has its own toxicity values to describe the cancer potency of the two organic risk drivers (benzo(a)pyrene and dibenzo(a,h)anthracene, one California value is higher, and one is lower, resulting in an insignificant change to the risk characterization if one toxicity assessment were chosen over the other. Application of dual toxicity assessments (per Navy [2002] guidance) was not needed in this site-specific case because uncertainty was not significant to the risk characterization findings.

Standard EPA methodologies were used for the risk characterization step (EPA 1989). Using these methods, the risks from exposure to multiple carcinogens were added to estimate the total cancer risk associated with exposures at the site. The underlying assumption with this approach is that the risks from carcinogens with different target organs are additive. This assumption contributes to the uncertainty in the risk assessment and may result in underestimated or overestimated risks, depending on whether there are synergistic or antagonistic interactions between the site COPCs. Because information on such interactions, however, is generally not available, most possible interactions were not evaluated in this HHRA. The target organ-specific analyses may be conducted if additive effects contributed to HIs greater than unity; however, for Sites 09 and 10, no unacceptable HIs were found, so no target organ breakdown was necessary.

In summary, the HHRA was developed based upon a series of assumptions, all conservative, that are expected to yield an overestimate of risks.

7.2 RESULTS

Each of the site-specific HHRA results is discussed in the following text for each receptor representing a different land use.

7.2.1 Human Health Risk Assessment Summary for Site 09

This section summarizes the results of the HHRA conducted for NAVSTA TI Site 09. The HHRA is detailed in Appendix I. The HHRA risk assessment methodology and approach, including receptors and exposure pathways, are discussed in Section 7.1 (see also Appendix I). Table 7-1 summarizes the cancer risks and noncancer hazards for each receptor for Site 09. The RME results are discussed in the following text.

Risks and health hazards discussed in the text and main tables of the RI report and the HHRA appendix are limited to one significant figure, as recommended by RAGS Part A (EPA 1989). To facilitate checks for mathematical accuracy to additional decimals, however, the tables of Appendix I include results beyond the single significant figure.

Arsenic was not considered significantly greater than background at Site 09. Three samples (15.4, 16.9, and 17.7 mg/kg) at Site 09 were considered potential outliers, but were within the range of naturally occurring arsenic in the United States and are likely a manifestation of two different soil types from different geologic deposits (i.e., native soils and fill/dredged material). A full discussion of arsenic at Site 09 is provided in Attachment I3 of Appendix I.

7.2.1.1 Future Site Conditions Assuming Minimal Disturbance (0 to 2 Feet Below Ground Surface)

No current cancer or noncancer risks were projected for Site 09 because no current use of the property exists. Risks were calculated for a hypothetical future resident and on-site commercial/industrial worker, however, based on the assumption that future site configurations and redevelopment would disturb soils only to a depth of 2 feet bgs, such as with only simple removal of all existing asphalt and other ground cover. The other receptor (a construction worker) was evaluated in Section 7.2.1.2 because the future Site 09 reuse resulting in exposure to this receptor is more likely to involve more intrusive redevelopment, including soils at 2 to 8 feet bgs.

Benzo(a)pyrene was the only constituent evaluated quantitatively as a COPC because all other constituents fell below EPA Region IX PRGs. The estimated cancer risk for the future commercial/industrial worker is 5×10^{-7}, which is less than the agency risk range of 10^{-4} to 10^{-6} for cancer effects. The cancer risk probability for an on-site adult/child resident would be 2×10^{-6}, which is slightly greater than the agency target cancer risk level "brightline" of 10^{-6}. Consistent with the method EPA Region IX uses to develop soil PRGs for benzo(a)pyrene, no noncancer hazards were estimated because no noncancer toxicity values are available for this chemical (EPA 2003).

7.2.1.2 Future Site Conditions (0 to 8 Feet Below Ground Surface)

If Site 09 is developed in the future, subsurface soil (0 to 8 feet bgs, where the water table is encountered) could become available to receptors through direct contact. The estimated cancer risk for the combined future on-site child and adult resident is 4×10^{-6}, which is within the agency risk range of 10^{-4} to 10^{-6} for cancer effects. The HI for this receptor is 0.5, which is below the agency threshold of 1 for noncancer effects. The future residential user scenario assumes significant redevelopment and exposure to soil that may presently be 0 to 8 feet bgs.

In this scenario, a cancer risk of 1×10^{-6} was estimated for the commercial/industrial worker, which is within the agency risk range of 10^{-4} to 10^{-6} for cancer effects. An HI of 0.04 was predicted for a future commercial/industrial worker, which is below the agency threshold of 1 for noncancer effects (see Table 7-1).

A future construction worker in contact with soil (0 to 8 feet bgs) was calculated to have no unacceptable noncancer risk (HI of 0.1), and this receptor's cancer risk (1×10^{-7}) was also below the acceptable risk point of departure of 10^{-6} (Table 7-1).

7.2.2 Human Health Risk Assessment Summary for Site 10

This section summarizes the results of the HHRA conducted for NAVSTA TI Site 10. The HHRA is detailed in Appendix I. The HHRA risk assessment methodology and approach, including receptors and exposure pathways, are discussed in Section 7.1. Table 7-2 summarizes the cancer risks and noncancer hazards for each receptor evaluated for Site 10.

7.2.2.1 Current and Future Site Conditions Assuming Minimal Disturbance (0 to 2 Feet Below Ground Surface)

Dibenz(a,h)anthracene was the only COPC identified in this depth interval. The estimated cancer risk for the current commercial/industrial worker is 3×10^{-7}, which is below the acceptable agency target risk level of 10^{-6}. The estimated cancer risk for the future on-site adult/child resident is 2×10^{-6}, which is slightly greater than the EPA target risk level of 10^{-6}. Consistent with the method EPA Region IX uses to develop soil PRGs for dibenz(a,h)anthracene, noncancer hazards were not estimated because noncancer toxicity values are not available for this chemical (EPA 2003).

7.2.2.2 Future Site Conditions (0 to 8 Feet Below Ground Surface)

If Site 10 is developed in the future, subsurface soil (0 to 8 feet bgs, where the water table is encountered) could become available to receptors through direct contact. The estimated cancer risk for the combined future on-site child and adult resident is 5×10^{-6}, which is within the agency risk range of 10^{-4} to 10^{-6} for cancer effects. The HI for this receptor is 0.6, which is below the agency threshold of 1 for noncancer effects. The future residential scenario assumes significant redevelopment and exposure to soil that may presently be at 0 to 8 feet bgs.

In this scenario, a cancer risk of 1 x 10^{-6} was estimated for the commercial/industrial worker, which is within the agency risk range of 10^{-4} to 10^{-6} for cancer effects. An HI of 0.05 was predicted for a future commercial/industrial worker, which is below the agency threshold of 1 for noncancer effects (see Table 7-2).

A future construction worker in contact with soil (0 to 8 feet bgs) was calculated to have no unacceptable noncancer risk (HI of 0.2), and cancer risk (1×10^{-7}) was also below the acceptable agency target risk level of 10^{-6} (Table 7-2).

7.2.3 Total Risk Sensitivity Analysis

As detailed in Section 10.3 of Appendix I, DTSC has voiced an interest that "total risk" (with no risk-based screen, such that all detected analytes above ambient concentrations were included in the risk assessment) be communicated in addition to the incremental risk. To effectively communicate these differences and continue to follow Navy (2001) guidance that implements a risk-based screening step, the following total risk screening was conducted. Because no COPCs were identified in groundwater (see Section 7.1.2), the analysis focused on soil.

During this process, all detected contaminants in soils were evaluated, and the EPC was screened relative to its residential and industrial PRGs. Effectively, this screening is a "shortcut" (suggested in the Navy tiered guidance [Navy 2001]) that still presents enough information to ensure that human health risks are not being underpredicted by use of a risk-based PRG screen to identify COPCs. Findings of this approach are presented as follows. Tables 7-1 and 7-2 summarize the cancer risks and noncancer hazards for each receptor for Sites 09 and 10 respectively.

7.2.3.1 "Total Risk" Based on Site 09 Soil

The "Total Risk" evaluation assumed that a resident lived on Site 09 and was exposed to the EPC of every chemical detected in Site 09 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 3×10^{-5} and noncancer hazard of 2 would result. Note that the ambient fill contribution (cancer risk of 2×10^{-5} and noncancer hazard of 0.9) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that a resident lived on Site 09 and was exposed to the EPC of every chemical detected in all Site 09 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 2×10^{-5} and noncancer hazard of 1 would result. Note that the ambient fill contribution (cancer risk of 1×10^{-5} and noncancer hazard of 0.6) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

The "Total Risk" evaluation assumed that a commercial/industrial worker at Site 09 was exposed to the EPC of every chemical detected in Site 09 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 7×10^{-6}

and noncancer hazard of 0.1 would result. Note that the ambient fill contribution (cancer risk of 6×10^{-6} and noncancer hazard of 0.08) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that a commercial/industrial worker at Site 09 was exposed to all Site 09 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 5×10^{-6} and noncancer hazard of 0.1 would result. Note that the ambient fill contribution (cancer risk of 3×10^{-6} and noncancer hazard of 0.05) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

Arsenic was not considered significantly greater than background at Site 09. Three samples (15.4, 16.9, and 17.7 mg/kg) at Site 09 were considered potential outliers, but were within the range of naturally occurring arsenic in the United States and are likely a manifestation of two different soil types from different geologic deposits (i.e., native soils and fill/dredged material). A full discussion of arsenic at Site 09 is provided in Attachment I3 of Appendix I.

The results associated with the "Total Risk" evaluation would not change the conclusions of the HHRA presented in Section 7.2.

7.2.3.2 "Total Risk" Based on Site 10 Soil

The "Total Risk" evaluation assumed that a resident lived on Site 10 and was exposed to the EPC of every chemical detected in Site 10 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 2×10^{-5} and noncancer hazard of 2 would result. Note that the ambient fill contribution (cancer risk of 2×10^{-5} and noncancer hazard of 0.8) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that same resident lived on Site 10 and was exposed to the EPC of every chemical detected in all Site 10 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 2×10^{-5} and noncancer hazard of 2 would result. Note that the ambient fill contribution (cancer risk of 2×10^{-5} and noncancer hazard of 0.9) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

The "Total Risk" evaluation assumed that a commercial/industrial worker at Site 10 was exposed to the EPC of every chemical detected in Site 10 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 5×10^{-6} and noncancer hazard of 0.1 would result. Note that the ambient fill contribution (cancer risk of 4×10^{-6} and noncancer hazard of 0.07) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that same commercial/industrial worker at Site 10 was exposed to all Site 10 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 6×10^{-6} and noncancer hazard of 0.1 would result. Note that the ambient fill contribution (cancer risk of 4×10^{-6} and noncancer hazard of 0.08) is a

significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

The results associated with the "Total Risk" evaluation would not change the conclusions of the HHRA presented in Section 7.2.

7.3 CONCLUSIONS AND RECOMMENDATIONS

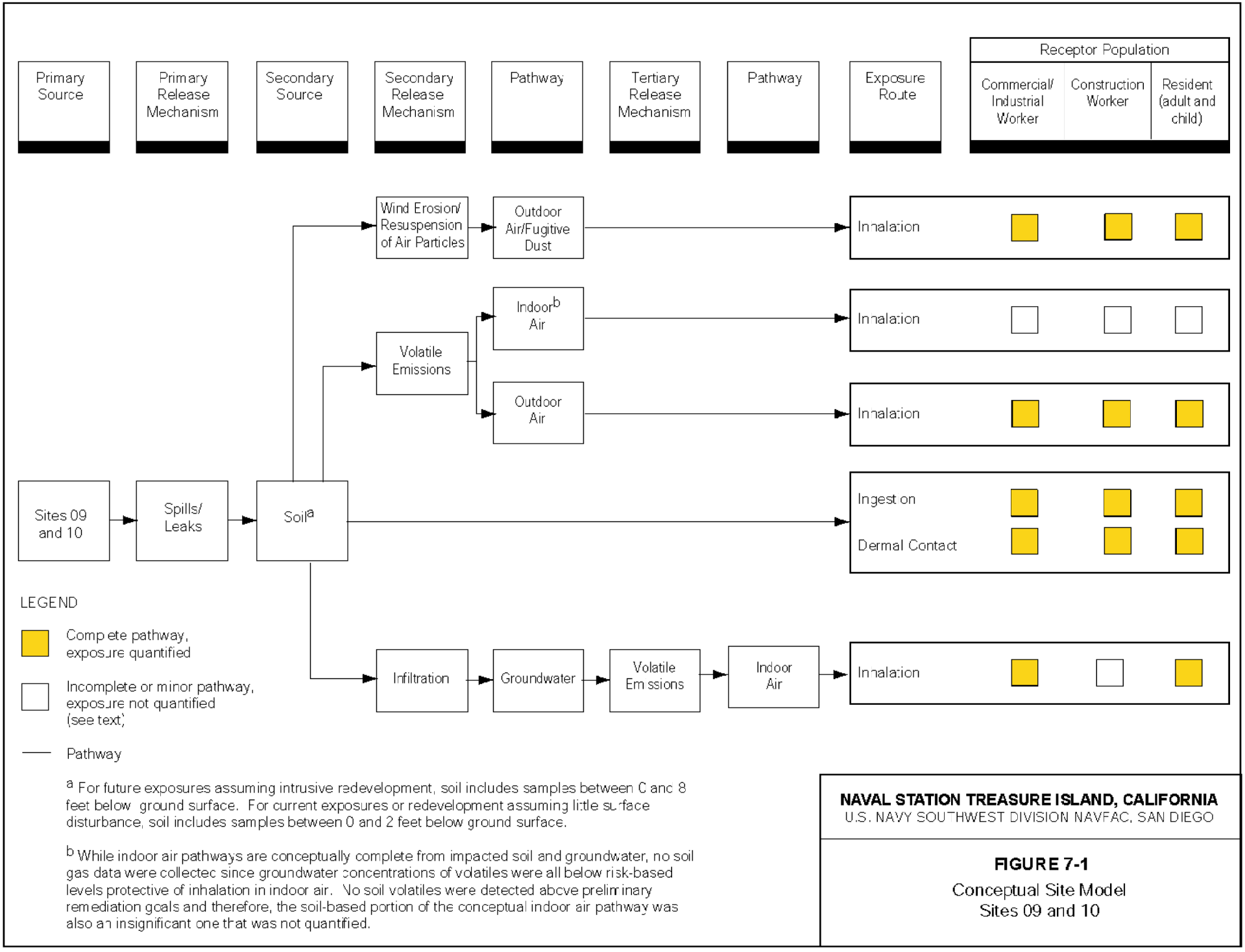
Among the objectives of the RI were to address the following:

Do the collected data indicate that contaminant concentrations exceed risk management criteria considered protective of human health?

Do the potential risks to human health warrant an evaluation of remedial alternatives in an FS?

These questions were addressed through investigation and assessment of each of the two sites discussed in this RI. Since all risks were acceptable or well within the risk management range, no risk-based remedial action to protect human health is required at Sites 09 and 10.

FIGURES



[a] For future exposures assuming intrusive redevelopment, soil includes samples between 0 and 8 feet below ground surface. For current exposures or redevelopment assuming little surface disturbance, soil includes samples between 0 and 2 feet below ground surface.

[b] While indoor air pathways are conceptually complete from impacted soil and groundwater, no soil gas data were collected since groundwater concentrations of volatiles were all below risk-based levels protective of inhalation in indoor air. No soil volatiles were detected above preliminary remediation goals and therefore, the soil-based portion of the conceptual indoor air pathway was also an insignificant one that was not quantified.

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE 7-1
Conceptual Site Model
Sites 09 and 10

TABLES

TABLE 7-1: CANCER RISK AND NONCANCER HAZARD INDEX SUMMARY FOR SITE 09: REASONABLE MAXIMUM EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Incremental Risk

Reasonable Maximum Exposure	CANCER RISK					NONCANCER HAZARD				
Exposure Pathway	Current Industrial Worker	Future Industrial Worker	Future Construction Worker	Future Resident (Adult + Child)	Future Intrusive Resident (Adult + Child)	Current Industrial Worker	Future Industrial Worker	Future Construction Worker	Future Resident (Child)	Future Intrusive Resident (Child)
Soil Exposure Pathways										
Soil Ingestion	3.00E-07	7.00E-07	9.00E-08	1.00E-06	3.00E-06	--	4.00E-02	1.00E-01	--	5.00E-01
Dermal Contact with Soil	2.00E-07	7.00E-07	4.00E-08	5.00E-07	1.00E-06	--	--	--	--	--
Inhalation of Particulates Released from Soil to Outdoor Air	4.00E-11	1.00E-10	4.00E-12	8.00E-11	2.00E-10	--	--	--	--	--
Multipathway Total	**5.00E-07**	**1.00E-06**	**1.00E-07**	**2.00E-06**	**4.00E-06**	**0.00E+00**	**4.00E-02**	**1.00E-01**	**0.00E+00**	**5.00E-01**

Total Risk

Reasonable Maximum Exposure	CANCER RISK					NONCANCER HAZARD				
Exposure Pathway	Current Industrial Worker	Future Industrial Worker	Future Resident	Future Intrusive Resident		Current Industrial Worker	Future Industrial Worker	Future Resident	Future Intrusive Resident	
Soil Exposure Pathways										
Detected Analytes without Ambient Inorganics	9.00E-07	2.00E-06	3.00E-06	6.00E-06		5.00E-02	5.00E-02	7.00E-01	5.00E-01	
Ambient Inorganics	6.00E-06	3.00E-06	2.00E-05	1.00E-05		8.00E-02	5.00E-02	9.00E-01	6.00E-01	
Multipathway Total	**7.00E-06**	**5.00E-06**	**3.00E-05**	**2.00E-05**		**1.00E-01**	**1.00E-01**	**2.00E+00**	**1.00E+00**	

Note:

Because cancer risks are calculated over a lifetime, both adult and childhood exposures are combined in this table to present a lifetime cancer risk. For noncancer hazards, exposures are predicted to result in a health effect only during the time when exposure is occurring. For this reason, child hazard indices are greater than adult hazard indices, and thus, only the children's noncancer hazard is shown here.

TABLE 7-2: CANCER RISK AND NONCANCER HAZARD INDEX SUMMARY FOR SITE 10: REASONABLE MAXIMUM EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Incremental Risk

Reasonable Maximum Exposure	CANCER RISK					NONCANCER HAZARD				
Exposure Pathway	Current Industrial Worker	Future Industrial Worker	Future Construction Worker	Future Resident (Adult + Child)	Future Intrusive Resident (Adult + Child)	Current Industrial Worker	Future Industrial Worker	Future Construction Worker	Future Resident (Child)	Future Intrusive Resident (Child)
Soil Exposure Pathways										
Soil Ingestion	2.00E-07	8.00E-07	1.00E-07	7.00E-07	3.00E-06	--	5.00E-02	2.00E-01	--	6.00E-01
Dermal Contact with Soil	2.00E-07	7.00E-07	4.00E-08	3.00E-07	2.00E-06	--	--	--	--	--
Inhalation of Particulates Released from Soil to Outdoor Air	2.00E-11	1.00E-10	5.00E-12	5.00E-11	2.00E-10	--	--	--	--	--
Multipathway Total	**3.00E-07**	**1.00E-06**	**1.00E-07**	**1.00E-06**	**5.00E-06**	**0.00E+00**	**5.00E-02**	**2.00E-01**	**0.00E+00**	**6.00E-01**

Total Risk

Reasonable Maximum Exposure	CANCER RISK					NONCANCER HAZARD				
Exposure Pathway	Current Industrial Worker	Future Industrial Worker	Future Resident	Future Intrusive Resident		Current Industrial Worker	Future Industrial Worker	Future Resident	Future Intrusive Resident	
Soil Exposure Pathways										
Detected Analytes without Ambient Inorganics	9.00E-07	2.00E-06	3.00E-06	7.00E-06		5.00E-02	5.00E-02	6.00E-01	6.00E-01	
Ambient Inorganics	4.00E-06	4.00E-06	2.00E-05	2.00E-05		7.00E-02	8.00E-02	8.00E-01	9.00E-01	
Multipathway Total	**5.00E-06**	**6.00E-06**	**2.00E-05**	**2.00E-05**		**1.00E-01**	**1.00E-01**	**2.00E+00**	**2.00E+00**	

Note:

Because cancer risks are calculated over a lifetime, both adult and childhood exposures are combined in this table to present a lifetime cancer risk. For noncancer hazards, exposures are predicted to result in a health effect only during the time when exposure is occurring. For this reason, child hazard indices are greater than adult hazard indices, and thus, only the children's noncancer hazard is shown here.

8.0 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

A SLERA for Sites 09 and 10 following Navy policy (Navy 1999) and EPA guidance for conducting SLERAs (EPA 1997b). Results and conclusions of the screening level risk assessments are presented in Section 8.2.

8.1 METHODS AND ASSUMPTIONS

The following sections describe the methodology and assumptions used in this SLERA, in accordance with Steps 1 and 2 of EPA guidance for ERAs at Superfund sites (EPA 1997b).

8.1.1 Environmental Setting and Ecological Characterization

Generally, the terrestrial habitat of NAVSTA TI is of poor quality for wildlife species because NAVSTA TI is predominantly covered with urbanized areas. To increase the understanding of the habitat and conditions at NAVSTA TI and YBI, a group of Navy and federal, state, and regional agency representatives drove and walked through the IR sites on both NAVSTA TI and YBI. During the site tour, conducted on June 3, 1994, the group characterized the habitat on NAVSTA TI as poor quality, with large areas of pavement, gravel, or buildings restricting use of the sites by receptors of concern. Additionally, the vegetated parts of NAVSTA TI are made up of lawns and landscaped areas; lawns, in general, provide poor habitat, and the landscaped areas are planted with largely nonnative species. Disturbance from vehicular traffic and widespread human presence also reduce the quality of the habitat for wildlife species onshore at NAVSTA TI. With higher quality habitat nearby at YBI, the group concluded that receptor species' use of NAVSTA TI was infrequent and that terrestrial receptor risk was minimal (PRC 1997b). All of these factors were considered in the determination that NAVSTA TI did not contain significant habitat and should not be considered for a detailed ERA for terrestrial receptors.

Specifically, the onshore Sites 09 and 10 SLERA addresses detected chemicals in groundwater at Sites 09 and 10 and the potential risk to aquatic receptors associated with chemical groundwater migration to the offshore surface waters of the Bay. The Sites 09 and 10 conceptual site model, which diagrams potential exposure pathways and routes, fate and transport of chemicals, and receptors, is located in Appendix J.

8.1.2 Groundwater Data

Two separate groundwater data sets were evaluated (one each for Site 09 and Site 10) based on the locations of monitoring wells and the direction of groundwater flow. The more recent fall 2002 data were collected with micropurge (low-flow) techniques intended to represent aquifer conditions. These data formed the basis for the SLERA at Sites 09 and 10, as detailed further in Section 2.2.1 of Appendix J.

In summary, all seven wells (09MW01 through 09MW07) on Site 09 remain functional and were sampled in 2002. By October 2002, only MW02 and MW03 remained on Site 10. The upgradient, control well for Site 14 that was placed on Site 10 (well 14MW03) was destroyed some time

between 1998 and 2002. Similarly, MW01 previously existed on Site 10, but it was also destroyed or buried some time between 1998 and 2002. No results reflecting current conditions are available for these wells at Site 10. The 2002 data from the two newer wells (MW02 and MW03), however, provide a conservative snapshot of representative conditions in the aquifer underlying Site 10. Unfortunately, MW02 was only sampled for the pesticide and PCB analytical suite in 2002; both MW02 and MW03 have only been sampled once, in 2002. Still, because of the small size of Site 10 and the biased sample location (nearest to suspected release), the data are sufficient to characterize the migration and eventual discharge of groundwater into the Bay and the effects this may potentially have on offshore aquatic biota.

8.1.3 Identification of Chemicals of Potential Ecological Concern

Chemicals of potential ecological concern (COPEC) at Sites 09 and 10 are considered the major potential stressors in the offshore environment at NAVSTA TI for aquatic receptors. Furthermore, COPECs represent those site-related chemicals that are assumed to account for the majority of any estimated ecological health impacts at a site. COPECs were identified by a comparison of groundwater site concentrations to ambient water quality criteria (AWQC), as summarized in the following text.

Determination

The toxicity criteria presented in Appendix J (Table J-1) were compiled through comprehensive reviews of published regulatory standards, goals, and guidance, including the following:

- "Water Quality Control Plan, San Francisco Bay Basin Region" (RWQCB 1995)
- "A Compilation of Water Quality Goals" (RWQCB 2000)
- "Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California." (EPA 2000)
- "National Recommended Water Quality Criteria: 2002." and "Revision of National Recommended Water Quality Criteria." (EPA 2002c, 2002d)
- Other sources, as appropriate (RWQCB 1998; Tetra Tech 1999b).

A step-wise approach for evaluating chemicals in groundwater was used to identify COPECs for the offshore point of exposure areas at NAVSTA TI. Individual screening criteria were selected using the methodology described in Section 2.2.2 of Appendix J. If inorganic or organic chemical data exceeded specific screening criteria, then the chemical was deemed a COPEC.

Identification

COPECs for Sites 09 included nickel, alpha-chlordane, and endosulfan II. No COPECs were identified for Site 10. All COPECs, maximum concentration results, and respective screening criteria for both Sites 09 and 10 appear in Appendix J (Table J-3).

8.1.4 Fate and Transport Modeling and Identification of Chemicals of Ecological Concern

Groundwater is not of ecological concern at NAVSTA TI until it meets or becomes surface water or when it can transport dissolved chemicals into the offshore environment. The Sites 09 and 10 SLERA focuses on groundwater chemicals, which have migrated to the offshore environment and are bioavailable or potentially bioavailable to aquatic receptors.

Chemicals of ecological concern (COEC) were identified by simulating the fate and transport of COPECs (nickel, alpha-chlordane, and endosulfan II) in groundwater to the ecological point of exposure in an analytical model (BIOSCREEN). The approach to groundwater modeling and the eventual identification of COECs included the selection of model input parameters that would result in the most conservative modeling results possible. For this assessment, "conservative model results" are defined as results that would yield reasonable maximum exposure concentrations of COPECs at the ecological point of exposure. A detailed summary of the modeling concept and specific parameters used is located in Appendix H.

In summary, identified COPECs at Site 09 were not determined to be COECs. Additionally, at Site 10, COPECs did not exist, and therefore, COECs were not identified. Complete results of the fate and transport modeling and COPEC concentrations post fate and transport modeling appear in Appendix J (Table J-5).

8.1.5 Uncertainty Analysis

The SLERA incorporates a number of uncertainties inherent in the risk assessment process. Depending on the type of uncertainty, impacts to the results of the SLERA can include an overestimation or underestimation of potential risk to receptors. The potential impacts of uncertainties on the results of the SLERA are discussed in Section 4.0 of Appendix J.

8.2 Risk Assessment Results and Conclusions

For aquatic receptors offshore of Site 09, three chemicals were originally identified as COPECs (nickel, alpha-chlordane, and endosulfan II). After simulating the fate and transport of these chemicals to the ecological point of exposure at Site 09, however, the specific groundwater chemical concentrations decreased to levels within the limits of the respective screening criteria. COECs were not identified at either Sites 09 or 10.

In conclusion, groundwater at Sites 09 and 10 does not pose an unacceptable risk to aquatic biota offshore of NAVSTA TI.

9.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This RI report was prepared as part of CTO 024 under the SulTech contract. Under CTO 024, Tetra Tech was tasked to complete an RI of Sites 09 and 10 under the Navy's IRP for NAVSTA TI. Work completed as part of the additional investigation in 2002 filled data gaps identified during the phase I and phase II RIs completed in the mid 1990s and led to a comprehensive understanding of environmental conditions at Sites 09 and 10. NAVSTA TI is a closed base under the Base Closure and Realignment Act of 1990 and is scheduled to be transferred to the City of San Francisco in early 2004. In carrying out BRAC and preparing RI activities, the Navy implemented an accelerated approach for the IRP at NAVSTA TI. This accelerated approach was employed to quickly meet regulatory requirements, streamline decision making, encourage public involvement, foster a partnership with all stakeholders, and integrate the City of San Francisco's reuse plan for NAVSTA TI into the environmental decision-making process.

The RI for Sites 09 and 10 completed at NAVSTA TI involved characterizing the nature and extent of risks to human health and the environment posed by uncontrolled release of hazardous substances. This included the following steps:

- Establishing the nature and extent of contamination
- Characterizing the geology, hydrogeology, and physical features
- Identifying potential contaminant migration pathways and receptors
- Evaluating the fate and transport potential of contaminants
- Conducting a baseline HHRA and ERA

The following sections provide overall project conclusions (Section 9.1) and recommendations (Section 9.2) for the RI. The conclusions are based on the results of the information contained in Sections 1.0 through 8.0 of this report.

9.1 CONCLUSIONS

The following sections are divided into topics presented in previous sections and subsections of this report. The topics include physical characteristics, land use, nature and extent of contamination, HHRA, and ERA.

9.1.1 Physical Characteristics

As part of the RI, a comprehensive evaluation of the physical conditions was completed. Data gaps filled during the RI included a more thorough evaluation of the hydrogeologic setting. Results of past efforts to characterize the physical setting, including the phase I and phase II RI, were integrated with data collected during this investigation to establish a comprehensive database needed to complete final characterization of the physical conditions at NAVSTA TI.

TI was constructed on the Yerba Buena Shoals, a sand spit extending north and northwest of YBI. TI is relatively flat and ranges in elevation from 9 to 12 feet above mean sea level based on national geodetic vertical datum of 1929. As discussed in Section 4.0, subsurface materials at TI can be divided into the following five units, listed from youngest to oldest:

- Fill (Dredged Sand Fill)
- Shoal Sands (Yerba Buena Shoal Sands)
- Younger Bay Mud
- Older Bay Mud
- Franciscan Assemblage

The dredged sand fill and the underlying shoal sands range in combined thickness of approximately 30 to 50 feet. The boundary between the two units is sometimes difficult to identify in soil borings.

Site 09

Site 09 is paved with asphalt, with the exception of the area covered by Building 41. This building has concrete foundations and flooring. The asphalt is underlain by sandy dredge fill. The sandy fill consists of tan to grayish-brown, fine- to coarse-grained, angular sand with some pea-size gravel. Minor silt and clay lenses are scattered throughout the sand, and locally, shell fragments can range from minor to abundant. Native formations such as the Bay Mud were not encountered in the shallow borings.

Groundwater at Site 09 was encountered at approximately 7 feet bgs during the 2002 sampling event. During the 2002 sampling event, groundwater levels varied only 0.15 foot across the site, and no consistent groundwater flow direction could be derived from the data. Based on general TI hydrogeology and basewide groundwater monitoring data, groundwater at Site 09 flows to the south and southeast, toward the shoreline.

Site 10

The geology of Site 10 is similar to Site 09 except that the surface material varies throughout the site. The western and southern sides of Building 335 is mostly covered by asphalt while the northern and eastern sides of the building has surface material consisting of a combination of soil, gravel, and wood chips because of the landscaping activities presently taking place at the site. Building 335 has a cement foundation and concrete floors. The thickness of the asphalt at Site 10 ranges from approximately 3 to 6 inches with a thin layer of aggregate base gravel. The asphalt is underlain by sandy dredge fill. The sandy fill consists of tan to grayish-brown, fine- to coarse-grained, angular sand with some pea-size gravel. Minor silt and clay lenses are scattered throughout the sand, and shell fragments found locally range from minor to abundant. Native formations such as the Bay Mud were not encountered in the shallow borings.

Groundwater at Site 10 was encountered at approximately 7 feet bgs during the 2002 sampling event. Near-surface groundwater is encountered in the unconfined, homogeneous dredged sand that makes up TI. Water levels were measured in two monitoring wells, 10-MW02 and 10-MW03, during the 2002 sampling event. Based on general TI hydrogeology and basewide groundwater monitoring and flow data, groundwater at Site 10 likely flows to the northeast, toward the shoreline.

9.1.2 Land Use

The City of San Francisco leased NAVSTA TI to the Navy in 1941 for the duration of World War II, and it became a major naval facility. After the war, the City of San Francisco agreed to trade the deed for NAVSTA TI to the Navy in exchange for government-owned land south of San Francisco, where the San Francisco International Airport was eventually built. In 1993, NAVSTA TI was designated for closure under the Base Closure and Realignment Act of 1990. The base was closed on September 30, 1997, and is in the process of being transferred to the City of San Francisco. NAVSTA TI is scheduled to be transferred to the City of San Francisco in early 2004.

According to the draft 1996 reuse plan, the reuse for the area that includes Site 09 is designated as a "Film Production/Conference Center." This includes land that could be used for "publicly-oriented recreation/cultural/ entertainment" and specifically as a film/events district. The reuse for the area that includes Site 10 is designated as "Residential/Open Space/Publicly Oriented Uses." This includes land designated for institutional use, specifically as a public facilities district. Both Sites 09 and 10 have the potential to have residential housing associated with the proposed reuse.

9.1.3 Nature and Extent of Contamination - Soil and Groundwater

Chemical data sets from past efforts (including the phase I and phase II RIs, EBS sampling, and basewide groundwater monitoring) and the recent additional RI were used to characterize the nature and extent of contamination at Sites 09 and 10. Only validated data were used to quantify the nature and extent of contamination. In addition, only recent groundwater samples collected using low-flow sampling methods were assessed in the risk assessment because these samples are more representative of actual groundwater conditions. The following is a summary of the nature and extent of contamination in Sites 09 and 10.

No major sources of organic or inorganic contamination were identified in soil at either Site 09 or 10. Small and isolated amounts of contamination in soil were identified at various locations. Only soil contamination that remains at the IR sites was evaluated during the HHRA and ERA.

Two areas of soil contamination were identified at Site 09. The former hydraulic lift system at Site 09 was considered a potential source of TPH contamination. TPH-d and TPH-m contamination was reported in soil from a sample collected during the phase II RI immediately adjacent to the lift system. TPH-d was reported at a concentration of 38,000 mg/kg, and TPH-m

was reported at a concentration of 12,000 mg/kg. Results from additional samples during the additional RI reported the highest concentration of TPH-d at 1,300 mg/kg and TPH-m at 430 mg/kg from the same area. Both TPH-d and TPH-m concentrations are below TPH screening criteria.

During the additional RI associated with sampling downgradient of the hydraulic lift system, elevated concentrations of TPH-d at 7,600 mg/kg and 7,100 mg/kg were found near the southeast corner of the IR Site 09 boundary. Additional sampling was completed in the area. The contamination appears localized and does not impact groundwater.

Similar to soil, no major sources of groundwater contamination were identified at either Site 09 or 10. Pesticide contamination reported north of Building 335 at Site 10 during the phase II RI appears to have been associated with sediment entrained in the groundwater sample. Follow-up sampling during the additional RI did not report pesticide concentrations in groundwater at this area. The basewide groundwater monitoring program continues to collect groundwater data at Sites 09 and 10, and no anomalous results have been reported

9.1.4 Human Health Risk

A quantitative baseline HHRA was completed as part of this RI (Section 7.0) and is based on phase I and phase II RI, site-specific groundwater monitoring data from the base wide groundwater monitoring program, and additional RI data collected from IR sites from 1994 through 2002. Because groundwater at Sites 09 and 10 is not a source of drinking water (Section 4.3.1.4), potential exposure to chemicals in groundwater would occur only through the inhalation of volatiles migrating upward into in the air (breathing zone). For this reason, only VOCs were evaluated as potential COPCs in groundwater.

No groundwater COPCs were identified for either Sites 09 or 10. COPCs identified in soil at IR Site 09 and 10 included iron, benzo(a)pyrene, and dibenz(a,h)anthracene.

Incremental Risk

The following risks were calculated for Site 09: the current industrial worker RME multipathway cancer risk total was 5×10^{-7}; the future industrial worker RME multipathway cancer risk total was 1×10^{-6}; the future construction worker RME multipathway cancer risk total was 1×10^{-7}; the future resident (adult + child) multipathway cancer risk total was 2×10^{-6}; the future intrusive resident (adult + child) multipathway cancer risk total was 4×10^{-6}. The noncancer HI for the same risk scenarios was less than 1.

The following risks were calculated for Site 10: the current industrial worker RME multipathway cancer risk total was 3×10^{-7}; the future industrial worker RME multipathway cancer risk total was 1×10^{-6}; the future construction worker RME multipathway cancer risk total was 1×10^{-7}; the future resident (adult + child) multipathway cancer risk total was 1×10^{-6};

the future intrusive resident (adult + child) multipathway cancer risk total was 5×10^{-6}. The noncancer HI for the same risk scenarios was less than 1.

The most significant exposure pathway at Sites 09 and 10 is dermal contact and soil ingestion for the future resident scenario. Multipathway risk results fall within the target risk range for this scenario and for the industrial worker scenario as well.

Total Risk

The "Total Risk" evaluation assumed that a resident lived on Site 09 and was exposed to the EPC of every chemical detected in Site 09 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 3×10^{-5} and noncancer hazard of 2 would result. Note that the ambient fill contribution (cancer risk of 2×10^{-5} and noncancer hazard of 0.9) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that a resident lived on Site 09 and was exposed to the EPC of every chemical detected in all Site 09 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 2×10^{-5} and noncancer hazard of 1 would result. Note that the ambient fill contribution (cancer risk of 1×10^{-5} and noncancer hazard of 0.6) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

The "Total Risk" evaluation assumed that a commercial/industrial worker at Site 09 was exposed to the EPC of every chemical detected in Site 09 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 7×10^{-6} and noncancer hazard of 0.1 would result. Note that the ambient fill contribution (cancer risk of 6×10^{-6} and noncancer hazard of 0.08) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that a commercial/industrial worker at Site 09 was exposed to all Site 09 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 5×10^{-6} and noncancer hazard of 0.1 would result. Note that the ambient fill contribution (cancer risk of 3×10^{-6} and noncancer hazard of 0.05) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

The "Total Risk" evaluation assumed that a resident lived on Site 10 and was exposed to the EPC of every chemical detected in Site 10 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 2×10^{-5} and noncancer hazard of 2 would result. Note that the ambient fill contribution (cancer risk of 2×10^{-5} and noncancer hazard of 0.8) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that same resident lived on Site 10 and was exposed to the EPC of every chemical detected in all Site 10 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 2×10^{-5} and noncancer hazard of 2 would result.

Note that the ambient fill contribution (cancer risk of 2×10^{-5} and noncancer hazard of 0.9) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

The "Total Risk" evaluation assumed that a commercial/industrial worker at Site 10 was exposed to the EPC of every chemical detected in Site 10 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 5×10^{-6} and noncancer hazard of 0.1 would result. Note that the ambient fill contribution (cancer risk of 4×10^{-6} and noncancer hazard of 0.07) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that same commercial/industrial worker at Site 10 was exposed to all Site 10 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 6×10^{-6} and noncancer hazard of 0.1 would result. Note that the ambient fill contribution (cancer risk of 4×10^{-6} and noncancer hazard of 0.08) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

9.1.5 Ecological Risk

A SLERA for Sites 09 and 10 at NAVSTA TI was conducted following Navy policy and EPA guidance for conducting SLERAs (Navy 1999; EPA 1997b). The terrestrial habitat of TI is of poor quality for wildlife species because the island is predominantly covered with urbanized areas. The Navy and federal and state regulators have agreed that TI did not contain significant habitat and should not be considered for a detailed ERA for terrestrial receptors. Groundwater discharge to the Bay is a potential concern because marine ecological receptors could be affected. The Sites 09 and 10 SLERA addressed chemicals identified in groundwater at each site and the potential risk to aquatic receptors associated with chemical groundwater migration to the offshore surface waters of the Bay.

Contaminants reported in groundwater were screened against TI screening criteria. COPECs identified for Site 09 included nickel, alpha-chlordane, and endosulfan II. No COPECs were identified for Site 10. Groundwater is not of ecological concern at NAVSTA TI until it meets or becomes surface water, or when it can transport dissolved chemicals into the offshore environment. The Sites 09 and 10 SLERA focused on groundwater chemicals, which have migrated to the offshore environment and are bioavailable or potentially bioavailable to aquatic receptors.

COECs were evaluated by simulating the fate and transport of COPECs (nickel, alpha-chlordane, and endosulfan II) in groundwater to the ecological point of exposure in an analytical model. For this assessment, "conservative model results" are defined as those results that would yield reasonable maximum exposure concentrations of COPECs at the ecological point of exposure. COPECs identified at Site 09 were not determined to be COECs. Additionally, at Site 10, COPECs did not exist, and therefore, COECs were not identified. In summary, groundwater at Sites 09 and 10 does not pose an unacceptable risk to aquatic biota offshore of NAVSTA TI.

9.2 RECOMMENDATIONS

The following recommendations are provided for Sites 09 and 10 at NAVSTA TI:

- No additional soil or groundwater data are needed at Sites 09 and 10. The current level of site characterization is adequate to complete the human health and ecological risk assessments.
- Based on the results of the human health risk assessment, remedial action is not required for soil or groundwater at Sites 09 and 10.
- Based on the results of the ecological risk assessment, remedial action is not required for soil or groundwater at Sites 09 and 10.
- The IRP effort for soil and groundwater at Sites 09 and 10 should be to pursue site closure through a No Action Record of Decision.

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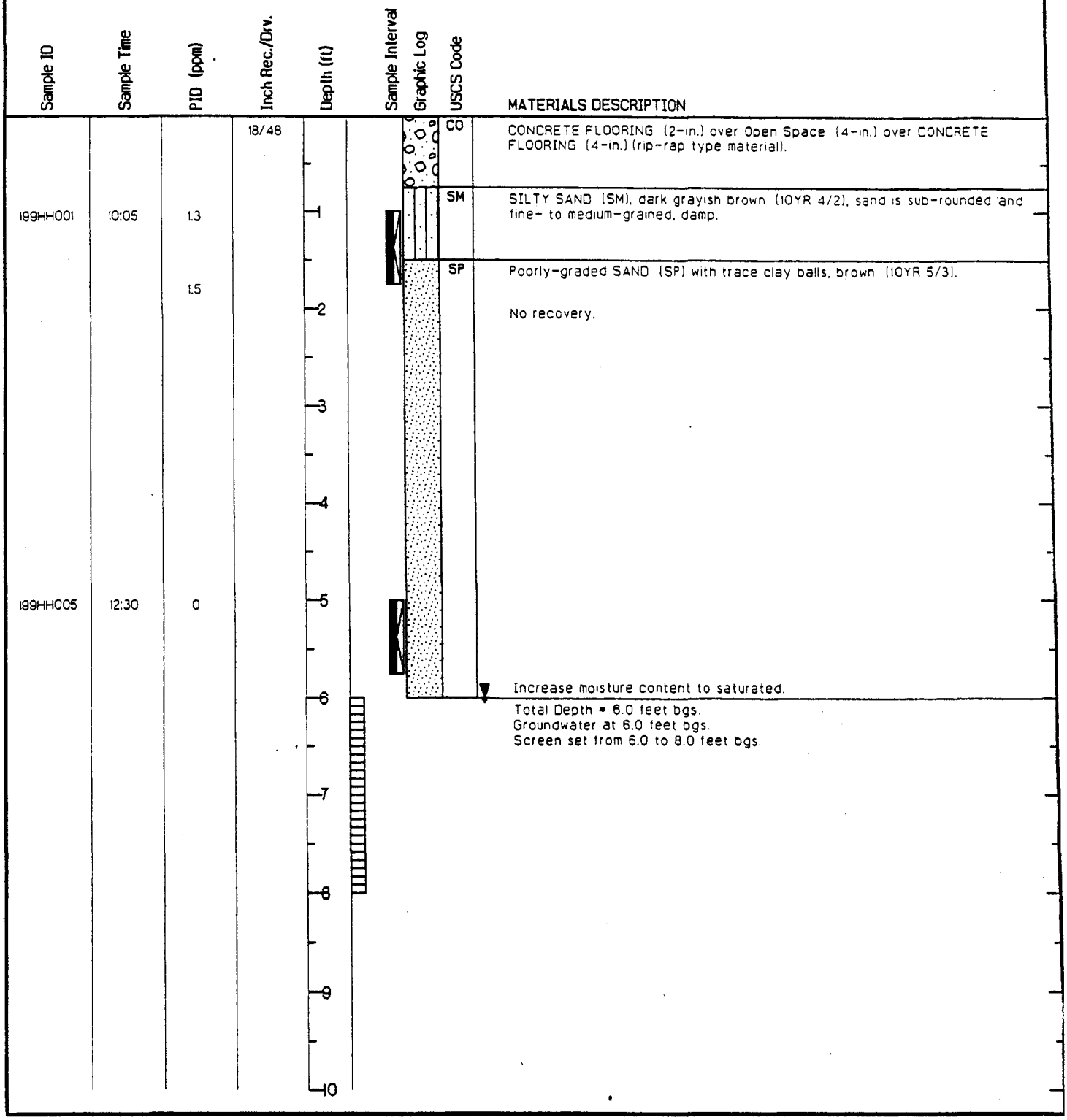
APPENDIX A
BOREHOLE LOGS AND WELL CONSTRUCTION DETAILS

SITE 09
FOUNDRY

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 09-HP001



Water Table
Split Spoon
Soil Sample
Screen Interval

PROJECT Naval Station Treasure Island	SAMPLING METHOD Macro-Core
LOCATION IR Site 09	GROUND ELEVATION NA
JOB NUMBER 044-0199R12BGI	TOC ELEVATION NA
LOGGED BY Paul Hibser	BORING DIAMETER 1.5 Inches
DATE DRILLED 08/03/95	TOTAL DEPTH OF HOLE 6 Feet bgs
DRILLER PRC	WATER LEVEL 6 Feet bgs
DRILL METHOD Geoprobe	WELL INSTALLED? (Y/N) N

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 09-HP002

Sample ID	Sample Time	PID (ppm)	Inch Rec./Drv.	Depth (ft)	Sample Interval	Graphic Log	USCS Code	MATERIALS DESCRIPTION
			31/48				CO	CONCRETE (CO) (4-in.) over BASEROCK (4-in.).
199HH002	10:30	0		1			SP	Poorly-graded SAND (SP) with trace very fine-grained pebbles, brown (10YR 5/3), sand is sub-rounded and fine-grained, damp.
		0		2				Trace clay balls, color change to yellowish brown (10YR 5/4), iron-oxide staining.
				3				Color change to brown (10YR 5/3).
			24/48	4				
				5				Increase moisture content to moist.
199HH003	10:45	0		6				Increase moisture content to saturated.
		0						
199HH004	11:00	0		7				Color change to dark gray (10YR 4/1), staining, petroleum odor*.
		0		8				Total Depth = 8.0 feet bgs. Groundwater at 6.0 feet bgs. Screen set from 6.0 to 8.0 feet bgs. *Petroleum Hydrocarbon odor.
				9				
				10				

Water Table
Split Spoon
Soil Sample
Screen Interval

PROJECT Naval Station Treasure Island
LOCATION IR Site 09
JOB NUMBER 044-0199R12BGI
LOGGED BY Paul Hibser
DATE DRILLED 08/03/95
DRILLER PRC
DRILL METHOD Geoprobe

SAMPLING METHOD Macro-Core
GROUND ELEVATION NA
TOC ELEVATION NA
BORING DIAMETER 1.5 Inches
TOTAL DEPTH OF HOLE 8 Feet bgs
WATER LEVEL 6 Feet bgs
WELL INSTALLED? (Y/N) N

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 09-HP003

Sample ID	Sample Time	PID (ppm)	Inch Rec./Drv.	Depth (ft)	Sample Interval	Graphic Log	USCS Code	MATERIALS DESCRIPTION
			45/48	0			AS	ASPHALT (AS) (3-in.) over BASEROCK (4-in.).
199HH006	15:05	0.70		1			ML	Low-plasticity SILT (ML), black (10YR 2/1), silt is sub-rounded, damp.
		1.8		2			SP	Poorly-graded SAND (SP), brown (10YR 5/3), sand is sub-rounded and fine- to very fine-grained, damp.
199HH007	15:20			3				Increase shell fragment and clay ball contents to trace. Clay balls are low-plasticity.
		1.0	28/48	4				
199HH008	15:30	1.3		5				
				6				Increase moisture content to saturated.
				7				
				8				Total Depth = 8.0 feet bgs. Groundwater at 6.0 feet bgs. Screen set from 6.0 to 8.0 feet bgs.
				9				
				10				

Water Table

Split Spoon

Soil Sample

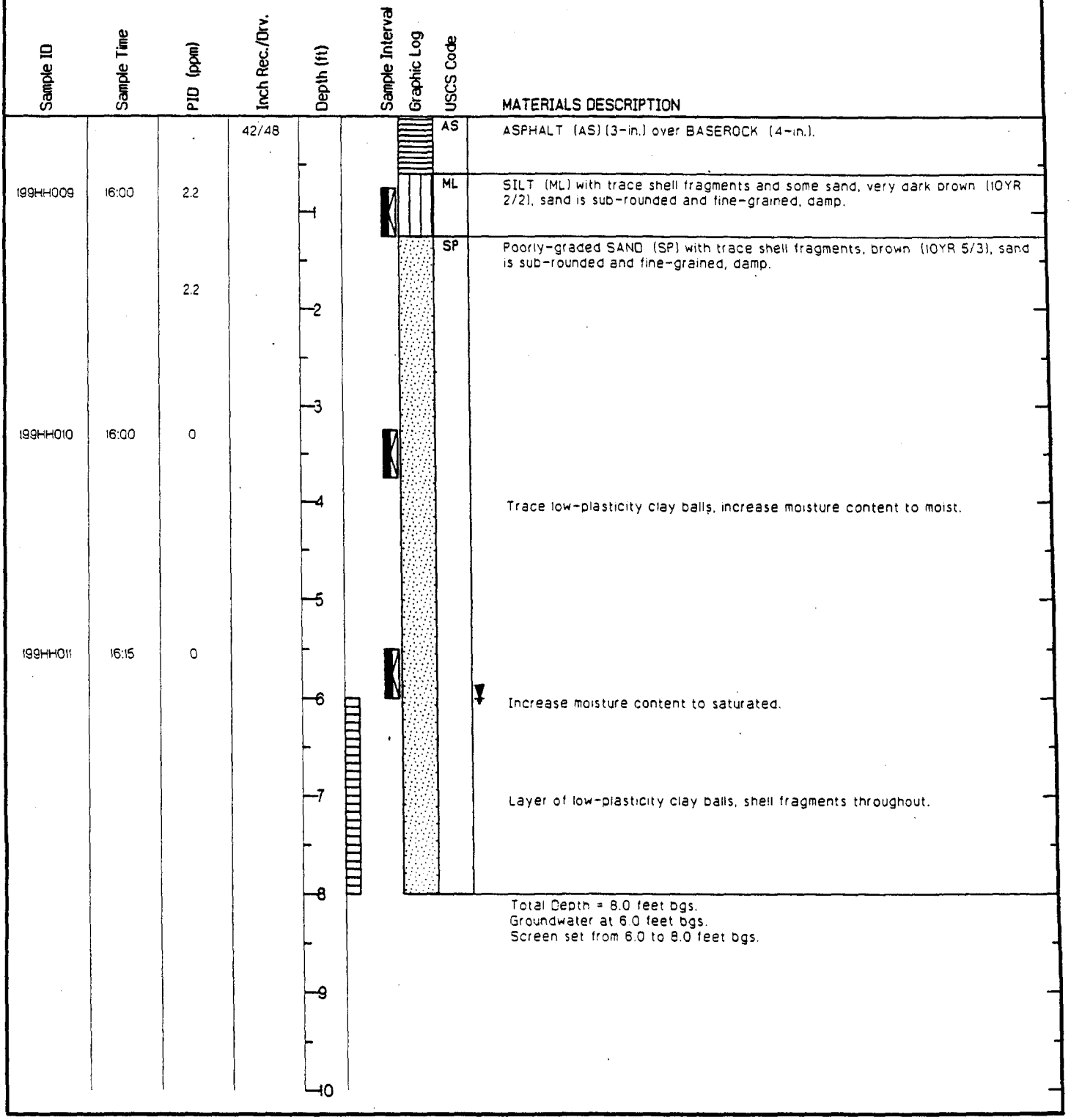
Screen Interval

PROJECT Naval Station Treasure Island
LOCATION IR Site 09
JOB NUMBER 044-0199R12BGI
LOGGED BY Paul Hibser
DATE DRILLED 08/03/95
DRILLER PRC
DRILL METHOD Geoprobe

SAMPLING METHOD Macro-Core
GROUND ELEVATION NA
TOC ELEVATION NA
BORING DIAMETER 1.5 Inches
TOTAL DEPTH OF HOLE 8 Feet bgs
WATER LEVEL 6 Feet bgs
WELL INSTALLED? (Y/N) N

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 09-HP004



Water Table

Split Spoon

Soil Sample

Screen Interval

PROJECT Naval Station Treasure Island
LOCATION IR Site 09
JOB NUMBER 044-0199R12BGI
LOGGED BY Paul Hibser
DATE DRILLED 08/03/95
DRILLER PRC
DRILL METHOD Geoprobe

SAMPLING METHOD Macro-Core
GROUND ELEVATION NA
TOC ELEVATION NA
BORING DIAMETER 1.5 Inches
TOTAL DEPTH OF HOLE 8 Feet bgs
WATER LEVEL 6 Feet bgs
WELL INSTALLED? (Y/N) N

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 09-HP005

Sample ID	Sample Time	PID (ppm)	Inch Rec./Drv.	Depth (ft)	Sample Interval	Graphic Log	USCS Code	MATERIALS DESCRIPTION
			45/48				AS	ASPHALT (AS) (3-in.) over BASEROCK (4-in.).
199HH012	16:40			1			ML	Low-plasticity SILT (ML) with trace pebbles, black (10YR 2/1), silt is sub-rounded, damp.
		0.90					SP	Poorly-graded SAND (SP), brown (10YR 5/3), sand is sub-rounded and fine-grained, damp.
				2				
								Trace high-plasticity clay balls, color change to brown (10YR 4/2).
199HH013	16:45	0.70		3				
				4				Increase moisture content to moist.
				5				Trace clay balls.
199HH014	16:50							
		0.20		6				Increase moisture content to saturated.
				7				Trace shell fragments.
				8				Total Depth = 8.0 feet bgs. Groundwater at 6.0 feet bgs. Screen set from 6.0 to 8.0 feet bgs.
				9				
				10				

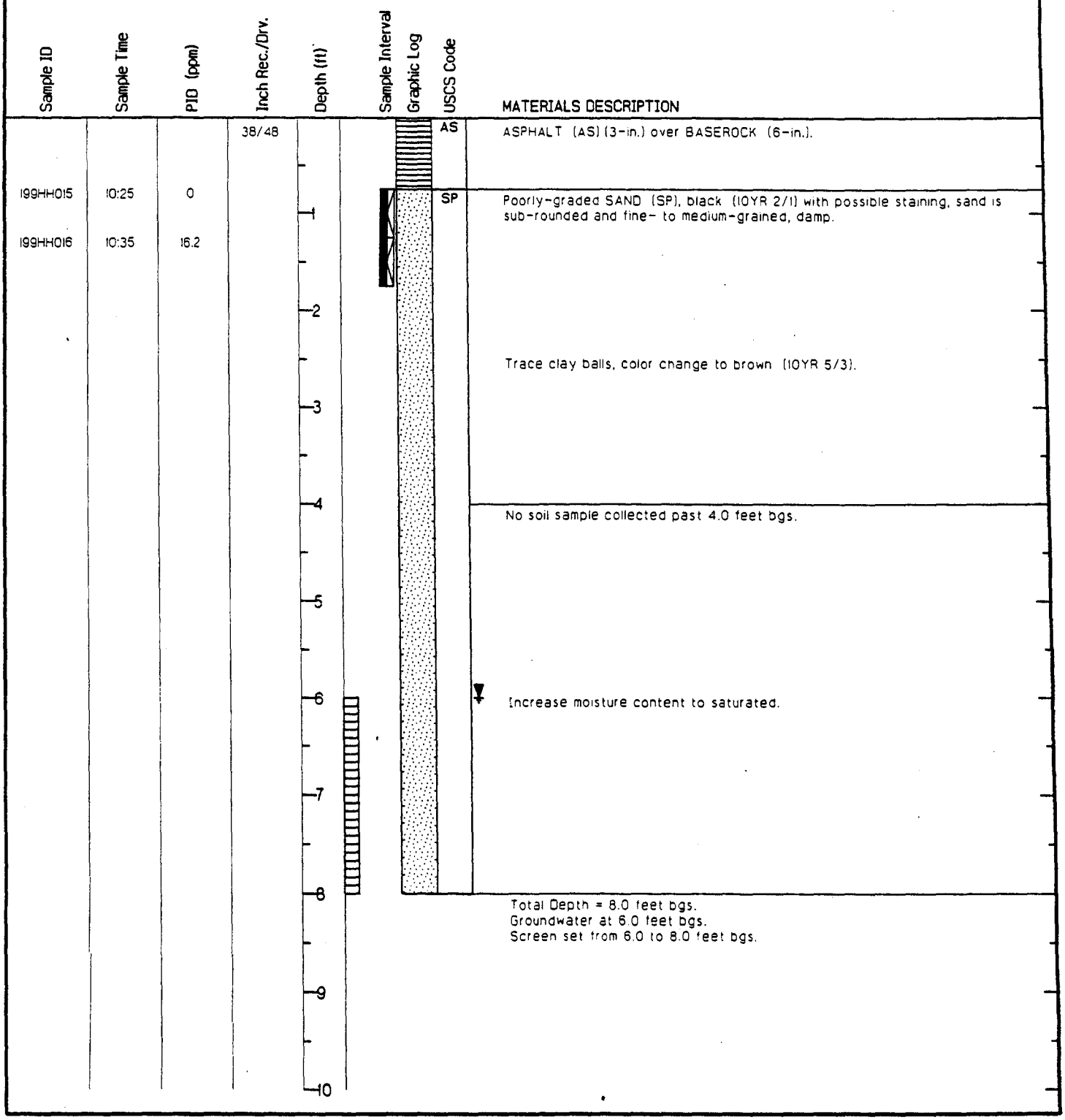
Water Table
Split Spoon
Soil Sample
Screen Interval

PROJECT Naval Station Treasure Island
LOCATION IR Site 09
JOB NUMBER 044-0199RI2BGI
LOGGED BY Paul Hibser
DATE DRILLED 08/03/95
DRILLER PRC
DRILL METHOD Geoprobe

SAMPLING METHOD Macro-Core
GROUND ELEVATION NA
TOC ELEVATION NA
BORING DIAMETER 1.5 inches
TOTAL DEPTH OF HOLE 8 Feet bgs
WATER LEVEL 6 Feet bgs
WELL INSTALLED? (Y/N) N

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 09-HP006



Water Table
Split Spoon
Soil Sample
Screen Interval

PROJECT Naval Station Treasure Island
LOCATION IR Site 09
JOB NUMBER 044-0199R12BGI
LOGGED BY Paul Hibser
DATE DRILLED 08/08/95
DRILLER PRC
DRILL METHOD Geoprobe

SAMPLING METHOD Macro-Core
GROUND ELEVATION NA
TOC ELEVATION NA
BORING DIAMETER 1.5 Inches
TOTAL DEPTH OF HOLE 8 Feet bgs
WATER LEVEL 6 Feet bgs
WELL INSTALLED? (Y/N) N

FIELD BORELOG

PRC ENVIRONMENTAL MANAGEMENT, INC.

SHEET 1 OF 1

LOCATION OF BORING	JOB NO.: 044-01991RRISB	BOREHOLE DESIGNATION: SB-01
	CLIENT: NAVY	SURFACE ELEVATION: N/A
	SITE: TREASURE ISLAND	DEPTH TO WATER: N/A
	SUBSITE: 9	LOGGED BY: Mark Reisig
	DRILLING CO.: Spectrum Drilling	DRILLING DATE(S): July 16, 1992
	DRILLING PERSONNEL/METHOD: Mark Reisig, Michael Tucker, Doug Shaver, John Sump. CME 55 eight-inch hollow stem auger.	

SAMPLE TYPE	SAMPLE DEPTH (feet) TOP	SAMPLE DEPTH (feet) BOT	BLOWS/6 IN. SAMPLE	RECOVERED (inches)	DRIVEN (inches)	SAMPLE NUMBER	PID Rdg (ppm)	ANLYS PHYS	ANLYS CHEM	TIME	DEPTH (feet)	USCS SOIL TYPE GRAPHIC LOG	SOIL DESCRIPTION
SS	0.0	0.5		0			0			10:09			0" - 6" ASPHALT.
	0.5	1.0	4	6	12	SB01-a	5.5		X		1		SAND (SP), 7.5YR 3/0, medium grained, angular, moist, loose, non-plastic. Some small gravel from roadbase.
SS	2.0	2.5	6	6		SB01-b	0		X	10:15	2		SAND (SW), 10YR 6/4, fine to medium grained, clean, angular, moist, loose, non-plastic.
	2.5	3.0	9	6	12						3		
											4		
SS	4.0	4.5	6	6			8.1			10:17			
	4.5	5.0	8	6	12	SB01-c			X		5		Boring terminated at 5.0 feet and backfilled with grout.
											6		
											7		
											8		
											9		
											0		
											1		
											2		
											3		
											4		
											5		
											6		
											7		
											8		
											9		
											0		

FIELD BORELOG

PRC ENVIRONMENTAL MANAGEMENT, INC.

SHEET 1 OF 1

LOCATION OF BORING	JOB NO.: 044-0199IRRISB	BOREHOLE DESIGNATION: SB-02
	CLIENT: NAVY	SURFACE ELEVATION: N/A
	SITE: TREASURE ISLAND	DEPTH TO WATER: N/A
	SUBSITE: 9	LOGGED BY: Mark Reisig
	DRILLING CO.: Spectrum Drilling	DRILLING DATE(S): July 16, 1992
	DRILLING PERSONNEL/METHOD: Mark Reisig, Michael Tucker, Doug Shaver, John Sump. CME 55 eight-inch hollow stem auger.	

SAMPLE TYPE	SAMPLE DEPTH (feet) TOP	BOT	BLOWS/6 IN. SAMPLE	RECOVERED (inches)	DRIVEN (inches)	SAMPLE NUMBER	PID Rdg (ppm).	ANLYS PHYS	ANLYS CHEM	TIME	DEPTH (feet).	USCS SOIL TYPE GRAPHIC LOG	SOIL DESCRIPTION
SS	0.3	0.8	5	0			0			10:42			0" - 4" ASPHALT.
	0.8	1.3	4	6	12	SB02-a			X		1		4" - 12" Aggregate base GRAVEL (GP).
													SAND (SP), 10YR 5/6, medium grained, angular, moist, loose, non-plastic. Small shells present in sample.
											2		
SS	2.0	2.5	4	6			3.3			10:51			
	2.5	3.0	10	6	12	SB02-b			X		3		
											4		
SS	4.0	4.5	5	4			12.5			10:55			
	4.5	5.0	6	6	12	SB02-c			X		5		11.0 ppm PID reading downhole
													Boring terminated at 5.0 feet and backfilled with grout.
											6		
											7		
											8		
											9		
											0		
											1		
											2		
											3		
											4		
											5		
											6		
											7		
											8		
											9		
											0		

FIELD BORELOG

PRC ENVIRONMENTAL MANAGEMENT, INC.

SHEET 1 OF 1

LOCATION OF BORING	JOB NO.: 044-0199IRRISB	BOREHOLE DESIGNATION: SB-03
	CLIENT: NAVY	SURFACE ELEVATION: N/A
	SITE: TREASURE ISLAND	DEPTH TO WATER: N/A
	SUBSITE: 9	LOGGED BY: Mark Reisig
	DRILLING CO.: Spectrum Drilling	DRILLING DATE(S): July 16, 1992
	DRILLING PERSONNEL/METHOD: Mark Reisig, Michael Tucker, Doug Shuver, John Sump. CME 55 eight-inch hollow stem auger.	

SAMPLER TYPE	SAMPLE DEPTH (feet) TOP	BOT	BLOWS/6 IN. SAMPLE	RECOVERED (inches)	UNDRIVEN (inches)	SAMPLE NUMBER	PID Rdg (ppm).	ANLYS PHYS	ANLYS CHEM	TIME	DEPTH (feet).	USCS SOIL TYPE GRAPHIC LOG	SOIL DESCRIPTION
SS	0.5	1.0	5	0						11:05	1		0" - 6" ASPHALT. 6" - 10" Aggregate base GRAVEL.
	1.0	1.5	6	6	12	SB03-a			X				CLAY (CH), 10YR 3/4, moist, very soft, plastic.
SS	2.0	2.5	1	0			0			11:07	2		
	2.5	3.0	1	6	12	SB03-b			X		3		
SS	4.0	4.5	2	6			0			11:16	4		SAND (SP), 10YR 4/3, medium grained, angular, very loose, non-plastic, moist.
	4.5	5.0	2	6	12	SB03-c			X		5		Boring terminated at 5.0 feet and backfilled with grout.
											6		
											7		
											8		
											9		
											0		
											1		
											2		
											3		
											4		
											5		
											6		
											7		
											8		
											9		
											0		

FIELD BORELOG

PRC ENVIRONMENTAL MANAGEMENT, INC.

SHEET 1 OF 1

LOCATION OF BORING	JOB NO.: 044-01991RRISB	BOREHOLE DESIGNATION: SB-04
	CLIENT: NAVY	SURFACE ELEVATION: N/A
	SITE: TREASURE ISLAND	DEPTH TO WATER: N/A
	SUBSITE: 9	LOGGED BY: Mark Reisig
	DRILLING CO.: Spectrum Drilling	DRILLING DATE(S): July 16, 1992
	DRILLING PERSONNEL/METHOD: Mark Reisig, Michael Tucker, Doug Shaver, John Sump. CME 55 eight-inch hollow stem auger.	

SAMPLER TYPE	SAMPLE DEPTH (feet) TOP	BOT	BLOWS/6 IN SAMPLE	RECOVERED (inches)	DRIVEN (inches)	SAMPLE NUMBER	PID Rdg (ppm).	ANLYS PHYS	ANLYS CHEM	TIME	DEPTH (feet).	USCS SOIL TYPE GRAPHIC LOG	SOIL DESCRIPTION
SS	0.5	1.0	2	0			0			11:35	1		0" - 6" ASPHALT. 1" - 1' 13" Black Clayey asphalt.
	1.0	1.5	10	6	12	SB04-a			X				SAND (SP), 10YR 3/4, fine to medium grained, angular, moist, loose, non-plastic.
SS	2.0	2.5	4	6			0			11:37	2		
	2.5	3.0	7	6	12	SB04-b			X		3		
											4		
SS	4.0	4.5	3	6			0			11:39			
	4.5	5.0	6	6	12	SB03-c			X		5		Boring terminated at 5.0 feet and backfilled with grout.
											6		
											7		
											8		
											9		
											0		
											1		
											2		
											3		
											4		
											5		
											6		
											7		
											8		
											9		
											0		

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF MONITORING WELL 09-MW01

Sample ID	Sample Time	Blow Counts/6-in.	Inch Rec./Drv.	Depth (ft)	USCS Code	MATERIALS DESCRIPTION
				0	AS	ASPHALT (AS)
				1	SM	SILTY SAND (SM), very dark brown (10YR 2/2), sand is fine-grained, dry.
199HH017	13:55	3		2	SW	Well-graded SAND (SW), yellowish brown (10YR 5/4), sand is medium- to fine-grained, dry.
		6				
		8		3		
				4		
				5		Color change to yellowish brown (10YR 5/4), increase moisture content to damp.
				6		
199HH018	14:00	3		7		Increase moisture content to saturated.
		3				
		5		8		
				9		
				10		
				11		
				12		
				13		
				14		
				15		Total Depth = 14.5 feet bgs. Groundwater at 7.0 feet bgs. Screen set from 3.5 to 13.5 feet bgs.

WELL DIAGRAM

Sample Interval

Graphic Log

2" Solid Casing

Sch. 40 PVC 0.020" slotted screen

Wet Pond/Silt Trap

Grout

Bentonite Seal

Lonestar #2/12 sand filter pack

Water Table

Soil Sample

Screen Interval

PROJECT	Naval Station Treasure Island	SAMPLING METHOD	Split Spoon
LOCATION	IR Site 09	GROUND ELEVATION	NA
JOB NUMBER	044-0199R12BMW	TOC ELEVATION	NA
LOGGED BY	Darlene McCray	BORING DIAMETER	8 Inches
DATE DRILLED	11/09/95	TOTAL DEPTH OF HOLE	14.5 Feet bgs
DRILLER	SES Drilling	WATER LEVEL	7 Feet bgs
DRILL METHOD	HSA Drill Rig	WELL INSTALLED? (Y/N)	Y

IR SITE 9
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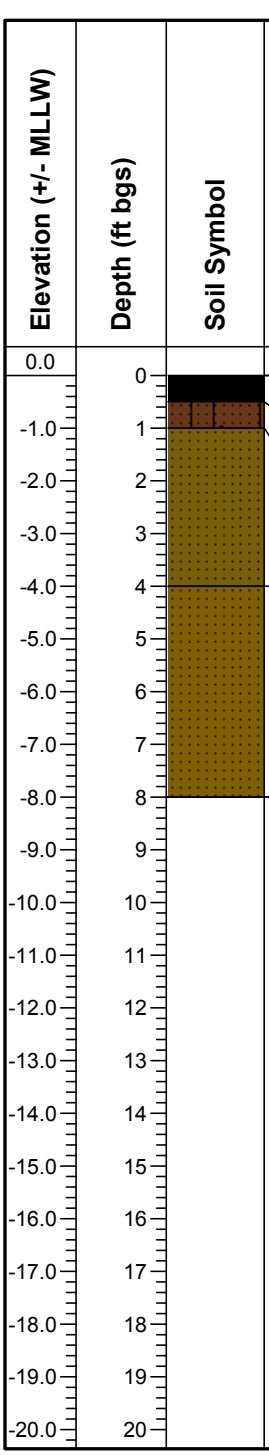
California

LOG OF BOREHOLE

Borehole: 09-SB05



DRILLING DATE: 11/1/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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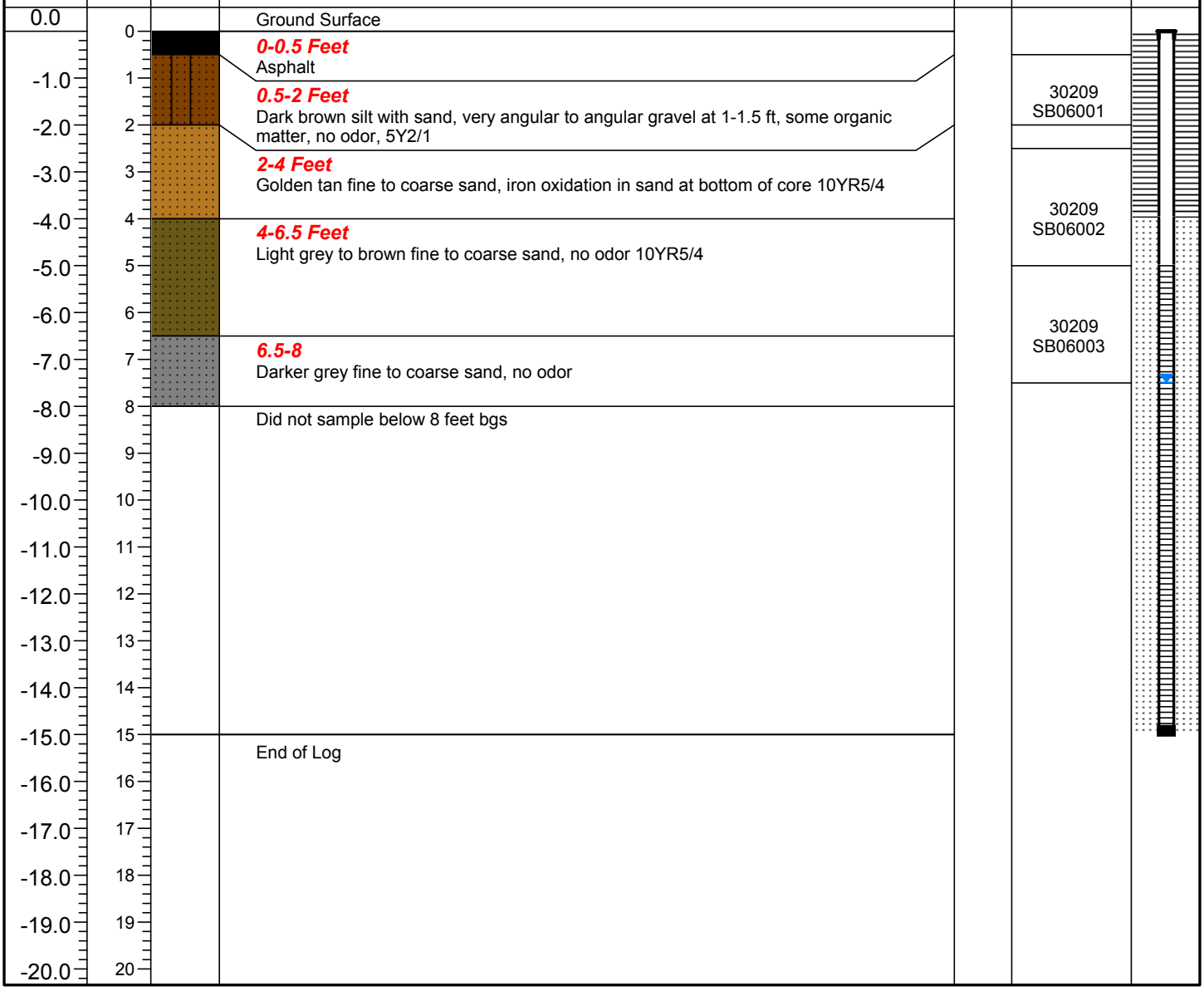
IR SITE 9
TREASURE ISLAND
SAN FRANCISCO COUNTY
CALIFORNIA

LOG OF BOREHOLE

Borehole/Well ID: SB06/MW03



DRILLING DATE: 10/23/02
DRILLING METHOD: Direct Push
BOREHOLE DEPTH (ft bgs): 15'
TOTAL WELL DEPTH (ft btoc): 15'
LOGGED BY: Greg LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0203

BOREHOLE DIAMETER (in.): 2"
WELL CASING DIAMETER (in.): 1"
TOC ELEVATION (ft AMSL):
GROUND ELEVATION (ft AMSL):
DRILLING CO.: Resonant Sonic Intl
WATER LEVEL (ft btoc): 7.5
GROUNDWATER ELEV (ft AMSL).:

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LOG OF BOREHOLE

Borehole/Well ID: SB07/MW04

Elevation (+/- AMSL)	Depth (ft bgs)	Lithologic Symbol/ Recovery	Lithologic Description	Headspace PID Reading	Soil Sample ID/ Sample Interval	Monitoring Well Completion
0.0	0		Ground Surface			
			0 - 0.5 Feet Asphalt			
-1.0	1		***0.5-1 Feet*** Black organic material, silt with sand in some clods, no odor 10YR2/2	1.8	30209 SB07001	
-2.0	2					
-3.0	3		***1-4 Feet*** Golden brown fine to coarse sand, no odor 10YR5/4			
-4.0	4			27	30209 SB07002	
-5.0	5		***4-7 Feet*** Golden brown fine to coarse sand 10YR5/4			
-6.0	6				30209 SB07003	
-7.0	7			1.8		
-8.0	8		***7-8 Feet*** Dark grey fine to coarse sand, strong petroleum odor, N2			
-9.0	9		***8-12 Feet*** Dark grey fine to medium coarse sand, petroleum odor, wet, N2			
-10.0	10					
-11.0	11					
-12.0	12		Did not sample below 12 feet bgs			
-13.0	13					
-14.0	14					
-15.0	15		End of Log			
-16.0	16					
-17.0	17					
-18.0	18					
-19.0	19					
-20.0	20					

DRILLING DATE: 10/24/02
DRILLING METHOD: Direct Push
BOREHOLE DEPTH (ft bgs): 15'
TOTAL WELL DEPTH (ft btoc): 15'
LOGGED BY: Greg LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0203

BOREHOLE DIAMETER (in.): 2"
WELL CASING DIAMETER (in.): 1"
TOC ELEVATION (ft AMSL):
GROUND ELEVATION (ft AMSL):
DRILLING CO.: Resonant Sonic Intl
WATER LEVEL (ft btoc): 6.5
GROUNDWATER ELEV (ft AMSL).:

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LOG OF BOREHOLE

Borehole: 09-SB08

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0-0.5 Feet Concrete	
-1.0	1		***0.5-1.5 Feet*** Dark brown organic silt with fine sand, some clods 5YR2/1	30209SB08001
-2.0	2		***1.5-4 Feet*** Golden brown fine to moderately coarse sand, no odor 10YR 5/4	
-3.0	3			30209SB08002
-4.0	4			
-5.0	5		***4-6 Feet*** Golden brown fine to moderately coarse sand, small faint petroleum odor 10YR5/4	
-6.0	6		***6-8 Feet*** Golden brown fine to moderately coarse sand 10YR5/4	30209SB08003
-7.0	7			
-8.0	8			
-9.0	9		***8-12 Feet*** Greyish fine to moderate coarse sand, a pocket of silt at 10.5 ft N4	
-10.0	10			
-11.0	11			
-12.0	12		End of Log	
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10/24/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 12'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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LOG OF BOREHOLE

Borehole/Well ID: SB10/MW02

Elevation (+/- AMSL)	Depth (ft bgs)	Lithologic Symbol/ Recovery	Lithologic Description	Headspace PID Reading	Soil Sample ID/ Sample Interval	Monitoring Well Completion
0.0	0		Ground Surface			
-1.0	1		***0.0-1.5 Feet*** Black organic silt with fine sand, no odor 5YR 2/1.			
-2.0	2		***1.5-4.0 Feet*** Golden brown fine to moderate sand, odor 10YR 5/4		30209 SB10001	
-3.0	3					
-4.0	4		***4.0-8.0 Feet*** Golden brown fine to moderate coarse sand, no odor 10YR 5/4	3	30209 SB10002	
-5.0	5					
-6.0	6				30209 SB10003	
-7.0	7					
-8.0	8		Did not sample below 8 feet bgs			
-9.0	9					
-10.0	10					
-11.0	11					
-12.0	12					
-13.0	13					
-14.0	14					
-15.0	15					
-16.0	16					
-17.0	17					
-18.0	18					
-19.0	19					
-20.0	20					

DRILLING DATE: 10/24/02
DRILLING METHOD: Direct Push
BOREHOLE DEPTH (ft bgs): 15'
TOTAL WELL DEPTH (ft btoc): 15'
LOGGED BY: Greg LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0203

BOREHOLE DIAMETER (in.): 2"
WELL CASING DIAMETER (in.): 1"
TOC ELEVATION (ft AMSL):
GROUND ELEVATION (ft AMSL):
DRILLING CO.: Resonant Sonic Intl
WATER LEVEL (ft btoc): 6.5
GROUNDWATER ELEV (ft AMSL).:

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California

LOG OF BOREHOLE

Borehole: 09-SB11

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0-0.5 Concrete	
-1.0	1		***0.5-1.5 Feet*** Dark brown to black organic fine sandy silt with clods and pockets of a white unknown substance (silica sandy pure white material with no odor) 5YR2/1	30209SB11001
-2.0	2			
-3.0	3		***1.5-3.75 Feet*** Golden brown fine to moderate coarse sand, 10YR5/4	30209SB11002
-4.0	4		***3.75-4 Feet*** Fine sandy clay, no odor	
-5.0	5		***4-6 Feet*** Golden brown fine to moderately coarse sand	
-6.0	6			30209SB11003
-7.0	7		***6-8 Feet*** Brown fine to moderately coarse sand, wet at 6 ft, shell fragments, no odor	
-8.0	8		End of Log	
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10/24/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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LOG OF BOREHOLE

Borehole/Well ID: SB12/MW06

Elevation (+/- AMSL)	Depth (ft bgs)	Lithologic Symbol/ Recovery	Lithologic Description	Headspace PID Reading	Soil Sample ID/ Sample Interval	Monitoring Well Completion
0.0	0		Ground Surface			
			0-2 Feet Black to dark brown organic fine sandy silt, clods, no odors, 5YR2/1		30209 SB12001	
-2.0	2		***2-4 Feet*** Golden brown fine to moderate coarse sand with round gravel 10YR5/4		30209 SB12002	
-4.0	4		***4-6.5 Feet*** Same as above			
-6.0	6				30209SB12003	
-7.0	7		***6.5-8*** Wet greyish fine to moderately coarse sand, with round gravel, faint unknown odor, some shell fragments			
-8.0	8		***No Returns***			
-15.0	15		End of Log			
-20.0	20					

DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
BOREHOLE DEPTH (ft bgs): 15'
TOTAL WELL DEPTH (ft btoc): 15'
LOGGED BY: Greg LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0203

BOREHOLE DIAMETER (in.): 2"
WELL CASING DIAMETER (in.): 1"
TOC ELEVATION (ft AMSL):
GROUND ELEVATION (ft AMSL):
DRILLING CO.: Resonant Sonic Intl
WATER LEVEL (ft btoc): 6.5
GROUNDWATER ELEV (ft AMSL).:

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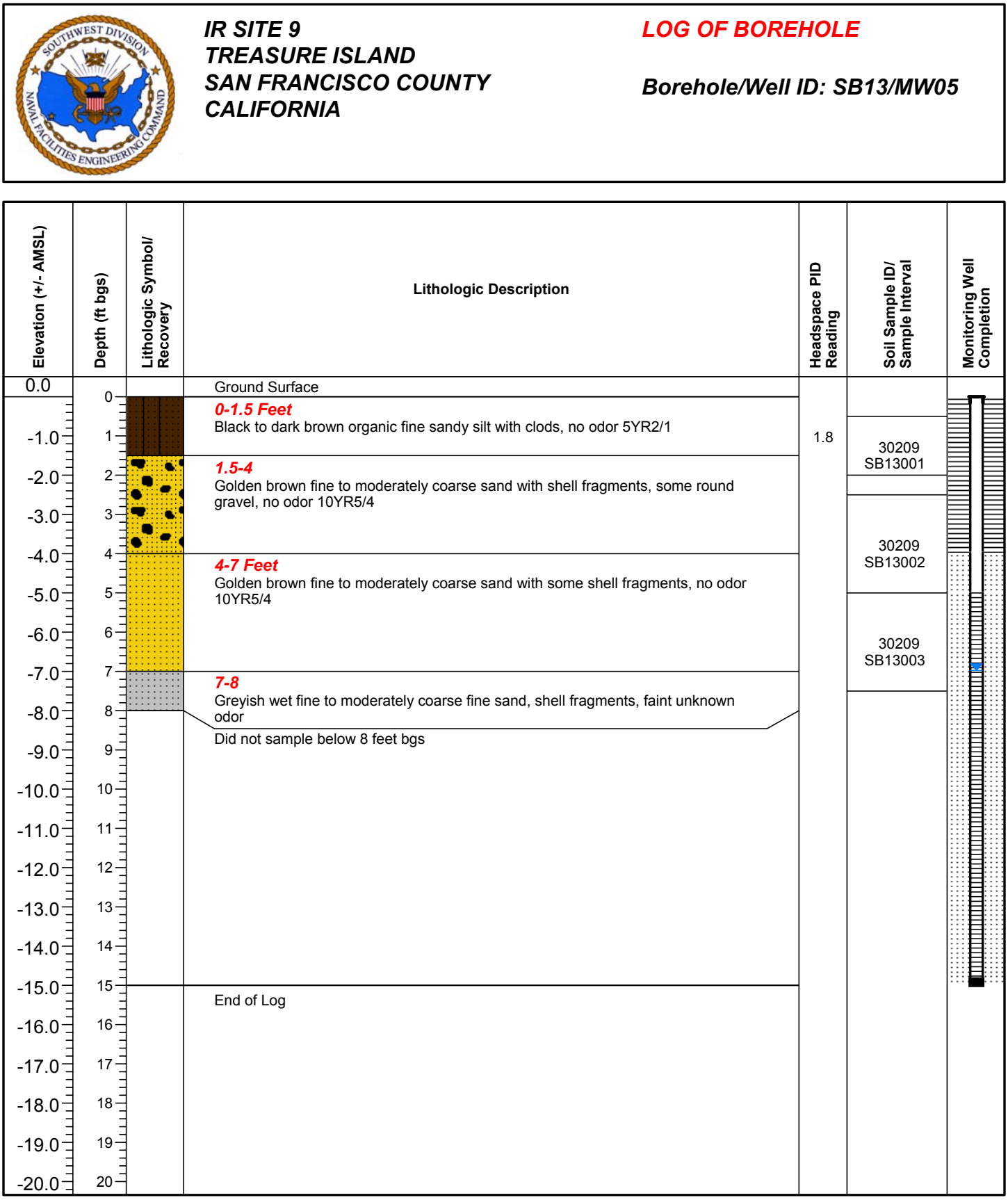
LOG OF BOREHOLE

Borehole/Well ID: SB13/MW05



DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
BOREHOLE DEPTH (ft bgs): 15'
TOTAL WELL DEPTH (ft btoc): 15'
LOGGED BY: Greg LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0203

BOREHOLE DIAMETER (in.): 2"
WELL CASING DIAMETER (in.): 1"
TOC ELEVATION (ft AMSL):
GROUND ELEVATION (ft AMSL):
DRILLING CO.: Resonant Sonic Intl
WATER LEVEL (ft btoc): 7
GROUNDWATER ELEV (ft AMSL).:

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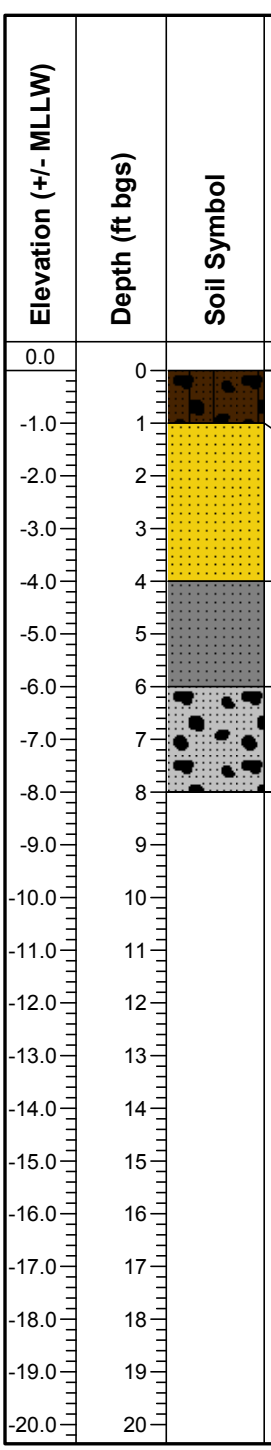
LOG OF BOREHOLE

Borehole: SB14



Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0-1 Feet Black tp brown organic fine sany silt with clods, shell fragments, small angular to subangular gravel, no odor 10YR5/4	30209SB14001
-1.0	1		***1-4 Feet*** Golden brown fine to coarse sand some shell fragments	
-2.0	2			
-3.0	3			30209SB14002
-4.0	4			
-5.0	5		***4-6 Feet*** Greyish golden fine to moderately coarse sand, shell fragments, no odor 10YR5/4	
-6.0	6			30209SB14003
-7.0	7		***6-8 Feet*** Darker grey fine to moderately coarse sand, shell fragments, some subrounded to rounded gravel, no odor, wet at 7.5 10YR4/2	
-8.0	8		End of Log	
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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IR SITE 9
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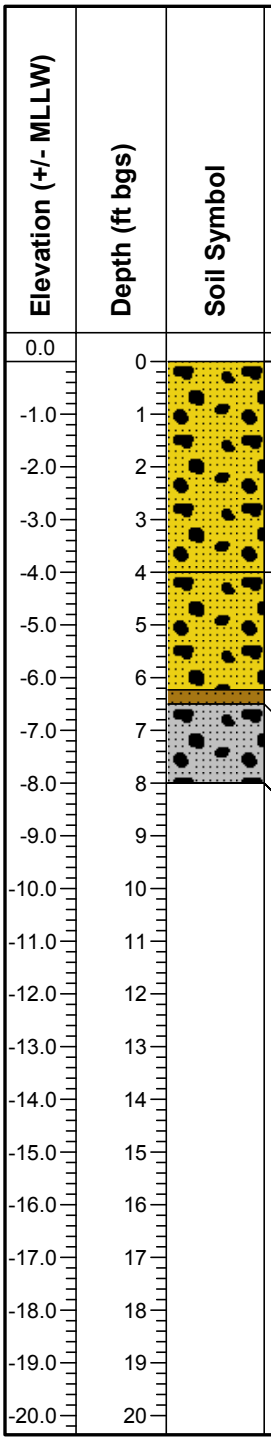
LOG OF BOREHOLE

Borehole: SB15



Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0-4 Feet Golden brownish fine with moderately coarse sand, shell fragments, rounded gravel, no odor 10YR4/2	30209SB15001
-4.0	4		***4-6 Feet*** Golden brownish fine to moderately coarse sand, some shell fragments, bits of rounded gravel, no odor 10YR4/2	30209SB15002
-6.0	6		***6-6.5*** Pocket of clayey silt with some fine sand	30209SB15003
-8.0	8		***6.5-8 Feet*** Greyish fine to moderately coarse sand, shell fragments, bits of rounded gravel, no odor	
			End of Log	

DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 9
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: SB16

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
-1.0	1		***0-1.5 Feet*** Black to brown fine sandy silt in some clods with little shell fragments, no odor 5YR 2/1	30209SB16001
-2.0	2		***1.5-4 Feet*** Golden brown fine to coarse sand with shell fragments, very little rounded gravel, no odor 10YR4/2	
-3.0	3			30209SB16002
-4.0	4		***4-8 Feet*** Golden brown fine to coarse sand with shell fragments and some rounded gravel, no odor 10YR4/2	
-5.0	5			
-6.0	6			30209SB16003
-7.0	7			
-8.0	8		End of Log	
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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San Francisco, California 94105
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TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: SB17

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
-1.0	1		***0-1.5 Feet*** Black to brown fine sandy silt in with shell fragments, no odor	30209SB17001
-2.0	2		***1.5-4 Feet*** Golden brown fine to coarse sand, shell fragments, very minor rounded gravel, pockets of clayey silt at 3 ft, no odor 10YR4/2	
-3.0	3			30209SB17002
-4.0	4			
-5.0	5		***4-6 Feet*** Golden brown fine to coarse sand with shell fragments, bits of rounded gravel, no odor 10YR4/2	
-6.0	6			30209SB17003
-7.0	7		***6-8 Feet*** Grey to golden brown, fine to coarse sand, wet, shell fragments, pockets of clayey silt with some sand at 8 ft, no odor 10YR4/2	
-8.0	8		End of Log	
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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San Francisco, California 94105
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IR SITE 9
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: SB18

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
-1.0	1		***0-1 Feet*** Brown organic fine sandy silt in with bits of subangular to rounded gravel, some shell fragments, no odor	30209SB18001
-2.0	2		***1-4 Feet*** Golden brown fine to coarse sand with shell fragments, minor subangular to rounded gravel, no odor 10YR4/2	
-3.0	3			30209SB18002
-4.0	4		***4-8 Feet*** Golden brown fine to coarse sand, shell fragments, bits of rounded gravel, no odor, 10YR4/2	
-5.0	5			30209SB18003
-6.0	6			
-7.0	7			
-8.0	8		End of Log	
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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135 Main Street, Suite 1800
San Francisco, California 94105
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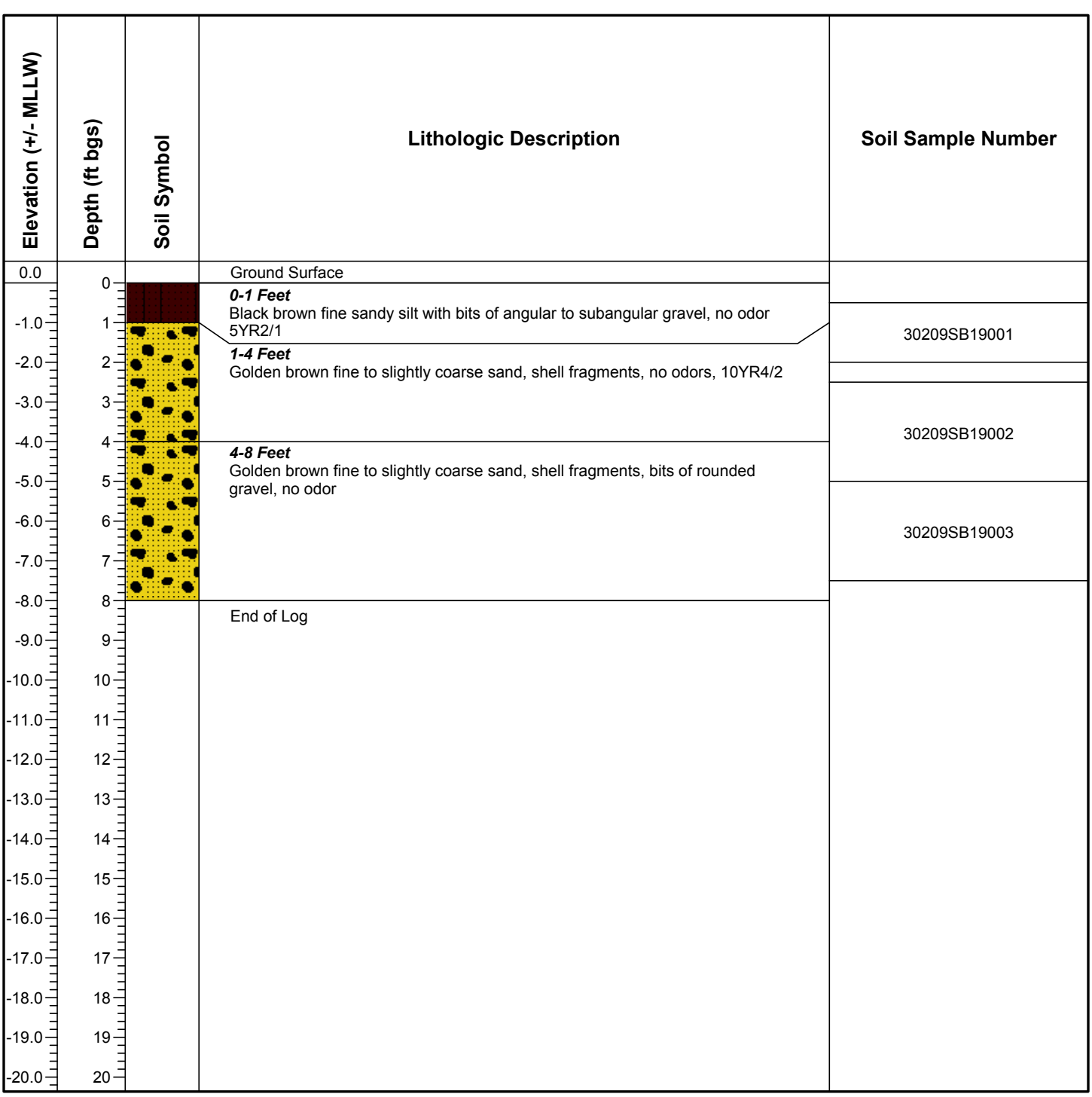
IR SITE 9
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: SB19



DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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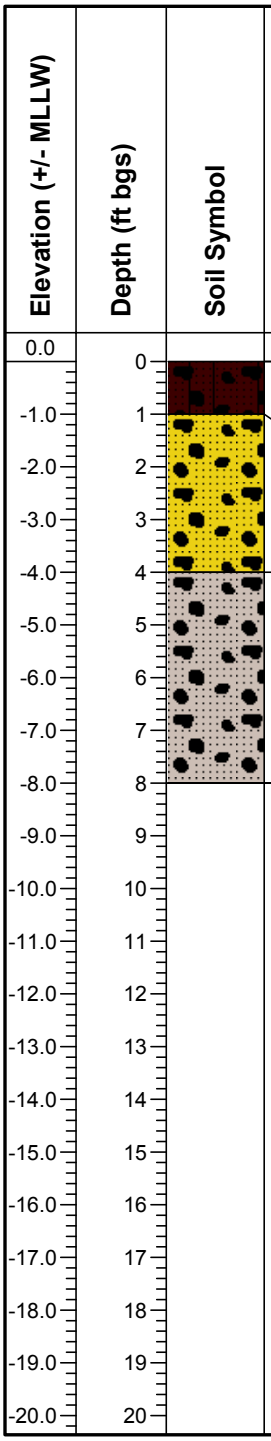
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 9
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: SB20



DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 9
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: SB21

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
-1.0	1		***0-1.5 Feet*** Brown organic fine sandy silt with small bits of subangular gravel, shell fragments, no odors	30209SB21001
-2.0	2		***1.5-4 Feet*** Golden brown fine to coarse sand with shell fragments, some fine rounded gravel, no odor	
-3.0	3			30209SB21002
-4.0	4			
-5.0	5		***4-6 Feet*** Same as above	
-6.0	6			30209SB21003
-7.0	7		***6-8 Feet*** Greyish golden fine to coarse sand, shell fragments, pocket of silt with clay and minor sand at 7 ft, bits of rounded gravel, no odor	
-8.0	8		End of Log	
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10/25/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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IR SITE 9
TREASURE ISLAND
SAN FRANCISCO COUNTY
CALIFORNIA

LOG OF BOREHOLE

Borehole/Well ID: SB22/MW07

Elevation (+/- AMSL)	Depth (ft bgs)	Lithologic Symbol/ Recovery	Lithologic Description	Headspace PID Reading	Soil Sample ID/ Sample Interval	Monitoring Well Completion
0.0	0		Ground Surface			
-1.0	1		***0-4 Feet*** Light brown medium to coarse sand with trace of fine gravel and minor shell fragmens, grades to fine to medium sand with no gravel, no staining and no odor 10YR5/4	1.1	30209 SB22001	
-2.0	2			1.4		
-3.0	3			1.1	30209 SB22002	
-4.0	4					
-5.0	5		***4-8 Feet*** Light brown fine to medium sand with minor coarse sand with minor shell fragments, small amount of clay at 8 ft, wet at 7.5 ft, no staining and no odor 10YR5/4			
-6.0	6			1.2	30209 SB22003	
-7.0	7					
-8.0	8		***8-12 Feet*** Greyish medium sand, wet, minor clay at 8.5, no staining and no odor, N5			
-9.0	9					
-10.0	10					
-11.0	11					
-12.0	12		Did not sample below 12 feet bgs			
-13.0	13					
-14.0	14					
-15.0	15		End of Log			
-16.0	16					
-17.0	17					
-18.0	18					
-19.0	19					
-20.0	20					

DRILLING DATE: 11/1/02
DRILLING METHOD: Direct Push
BOREHOLE DEPTH (ft bgs): 15'
TOTAL WELL DEPTH (ft btoc): 15'
LOGGED BY: Randy Laskowski
CLIENT: SW Division
PROJECT NO.: G0069302B0203

BOREHOLE DIAMETER (in.): 2"
WELL CASING DIAMETER (in.): 1"
TOC ELEVATION (ft AMSL):
GROUND ELEVATION (ft AMSL):
DRILLING CO.: Resonant Sonic Intl
WATER LEVEL (ft btoc): 7
GROUNDWATER ELEV (ft AMSL).:

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IR SITE 9
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: SB23

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0-0.5 Feet Concrete	
-1.0	1		***0.5-4 Feet*** Light brown fine to medium sand with trace of fine gravel, no staining and no odor 10YR5/4	30209SB23001
-2.0	2			
-3.0	3			30209SB23002
-4.0	4		***4-7 Feet*** Same as above	
-5.0	5			
-6.0	6			30209SB23003
-7.0	7		***7-9 Feet*** Grey fine to medium sand with strong petroleum odor, light staining, wet at 7 ft, N5	
-8.0	8			
-9.0	9		***9-12 Feet*** Grey fine to medium sand with some coarse sand and shell fragments, minor to no petroleum odor, N5	
-10.0	10			
-11.0	11			
-12.0	12		End of Log	
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 11/1/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 12'
GROUND ELEVATION:
GROUNDWATER ELEV.:

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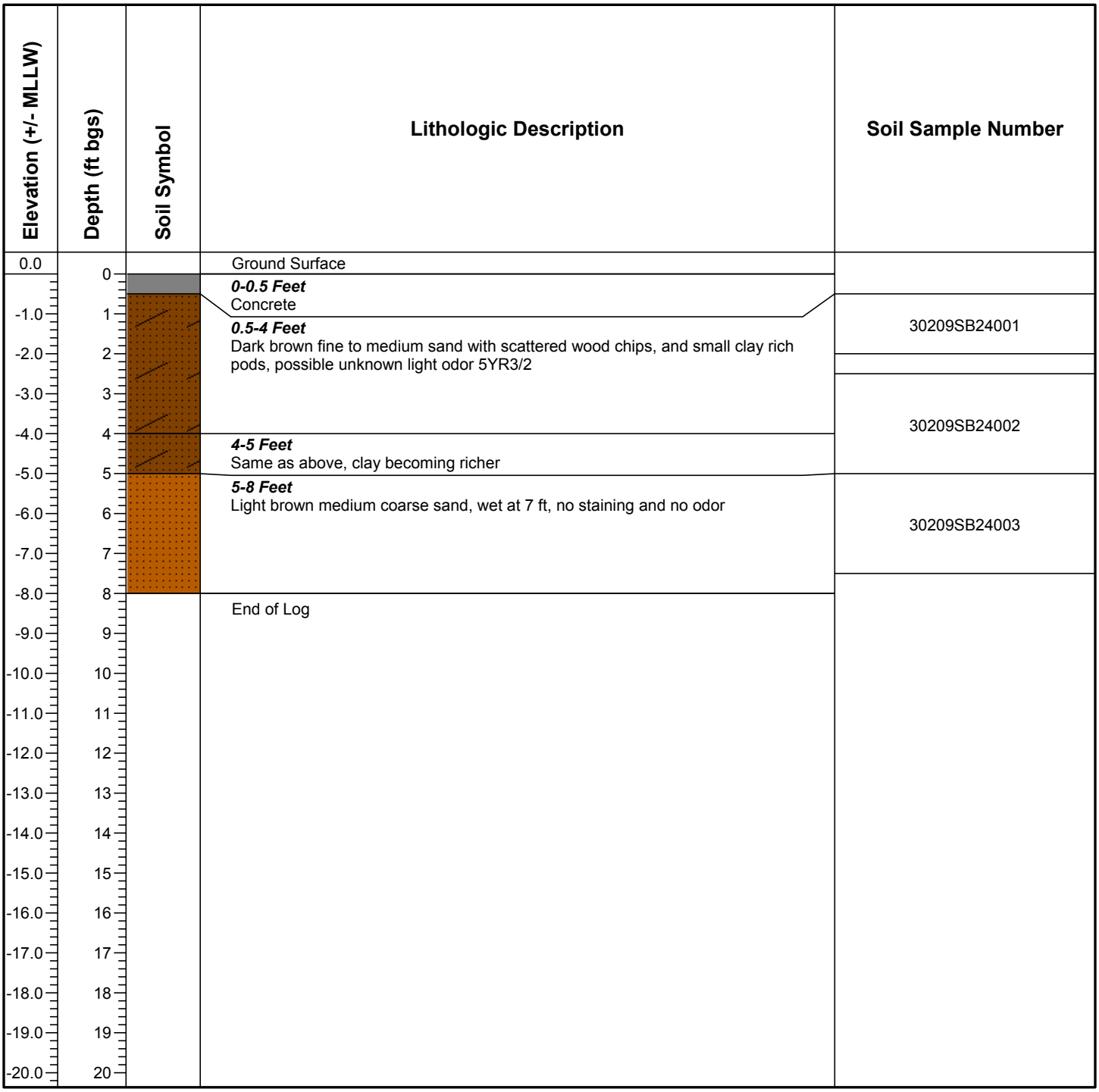
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 9
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: SB24



DRILLING DATE: 11/1/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8
GROUND ELEVATION:
GROUNDWATER ELEV.:

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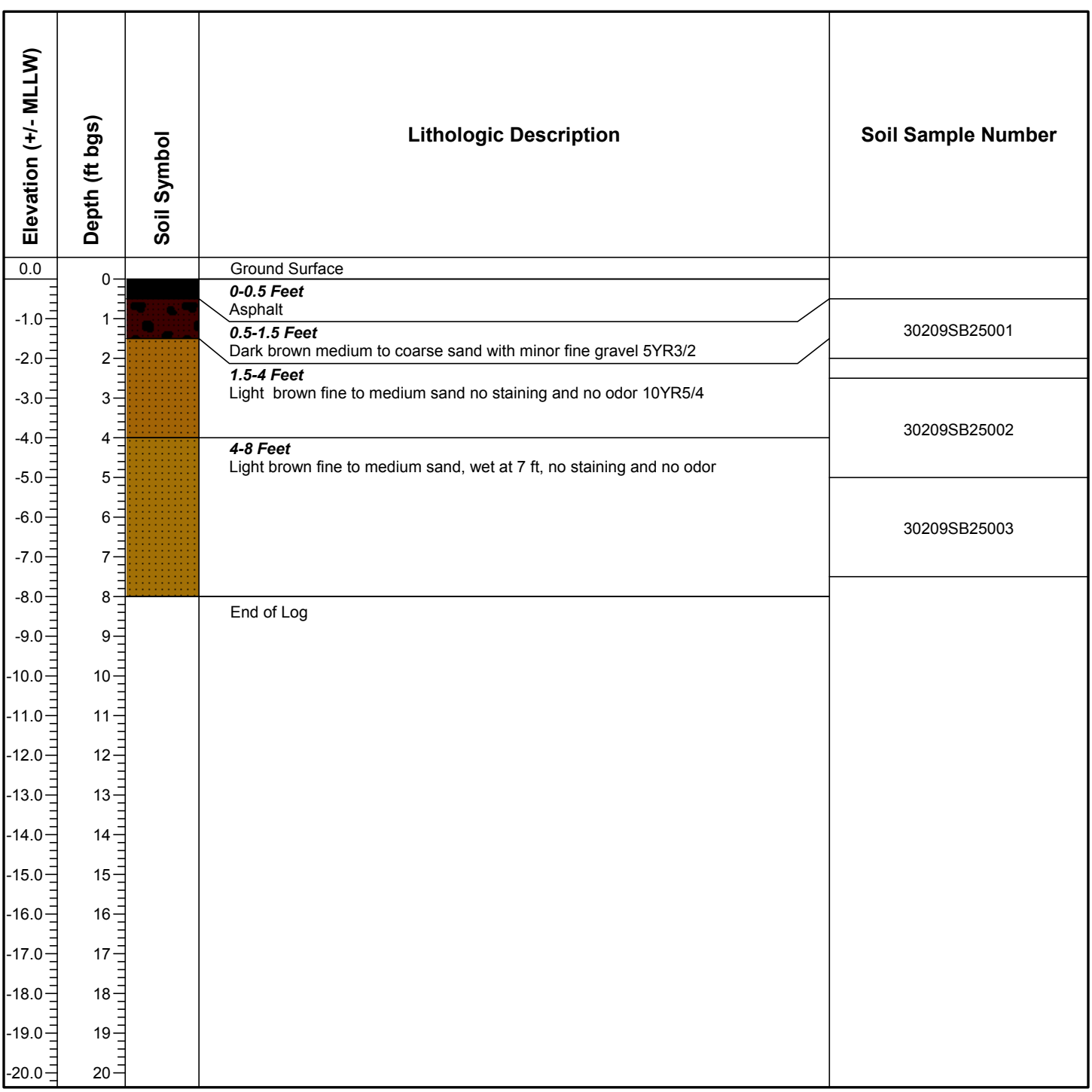
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 9
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: SB25



DRILLING DATE: 11/1/02
DRILLING METHOD: Direct Push
DRILLING CO.: Resonant Sonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

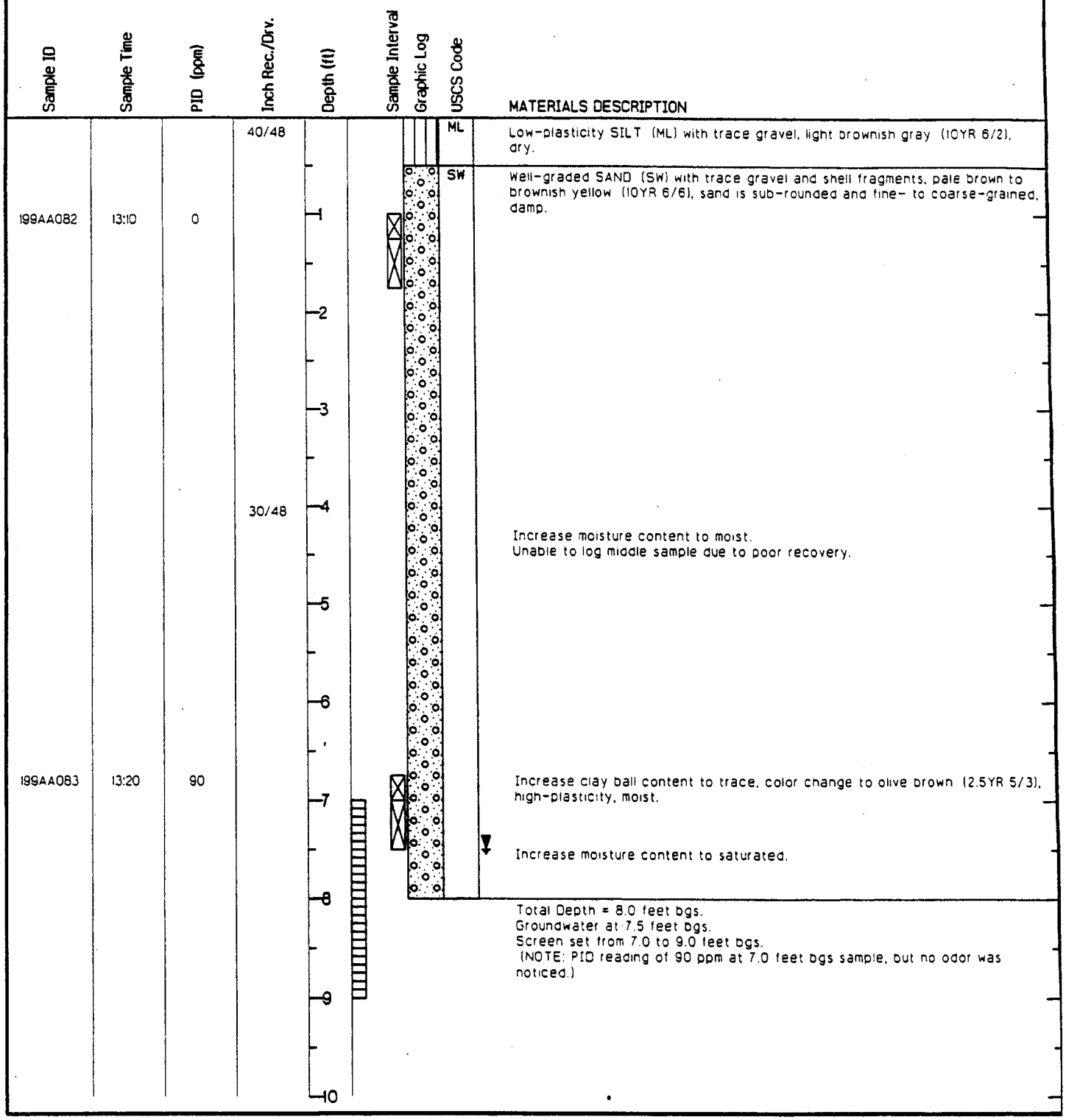
BOREHOLE DIAMETER: 2"
TOTAL BOREHOLE DEPTH: 8'
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

SITE 10
BUS PAINTING SHOP

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 7/10-HP001



Water Table

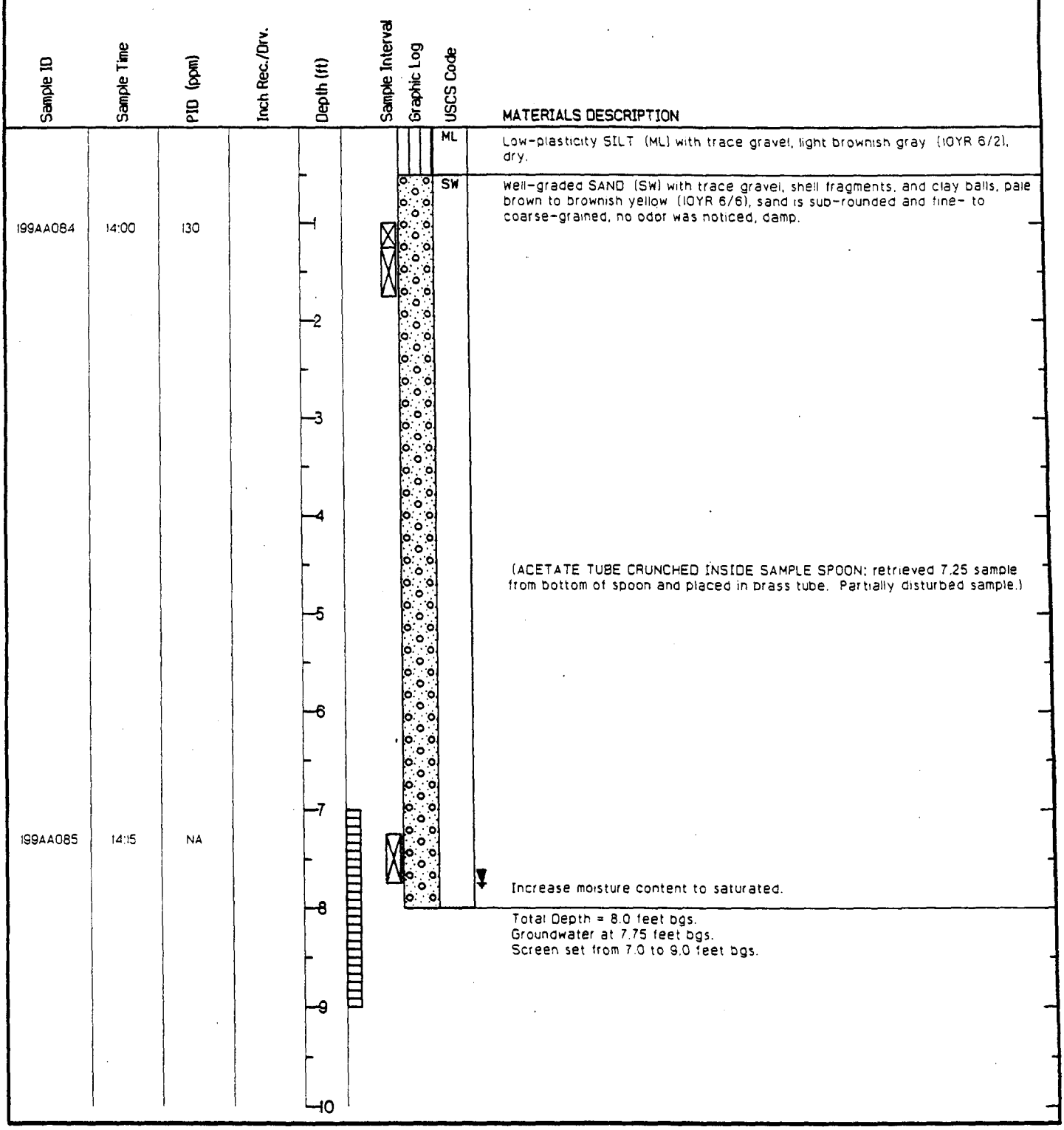
Soil Sample

Screen Interval

PROJECT Naval Station Treasure Island	SAMPLING METHOD Macro-Core
LOCATION IR Site 07/10	GROUND ELEVATION NA
JOB NUMBER 044-0199R12BGI	TOC ELEVATION NA
LOGGED BY Paul Bigelow	BORING DIAMETER 1.5 Inches
DATE DRILLED 06/09/95	TOTAL DEPTH OF HOLE 8 Feet bgs
DRILLER PRC	WATER LEVEL 7.5 Feet bgs
DRILL METHOD Geoprobe	WELL INSTALLED? (Y/N) N

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 7/10-HP002



Water Table

Soil Sample

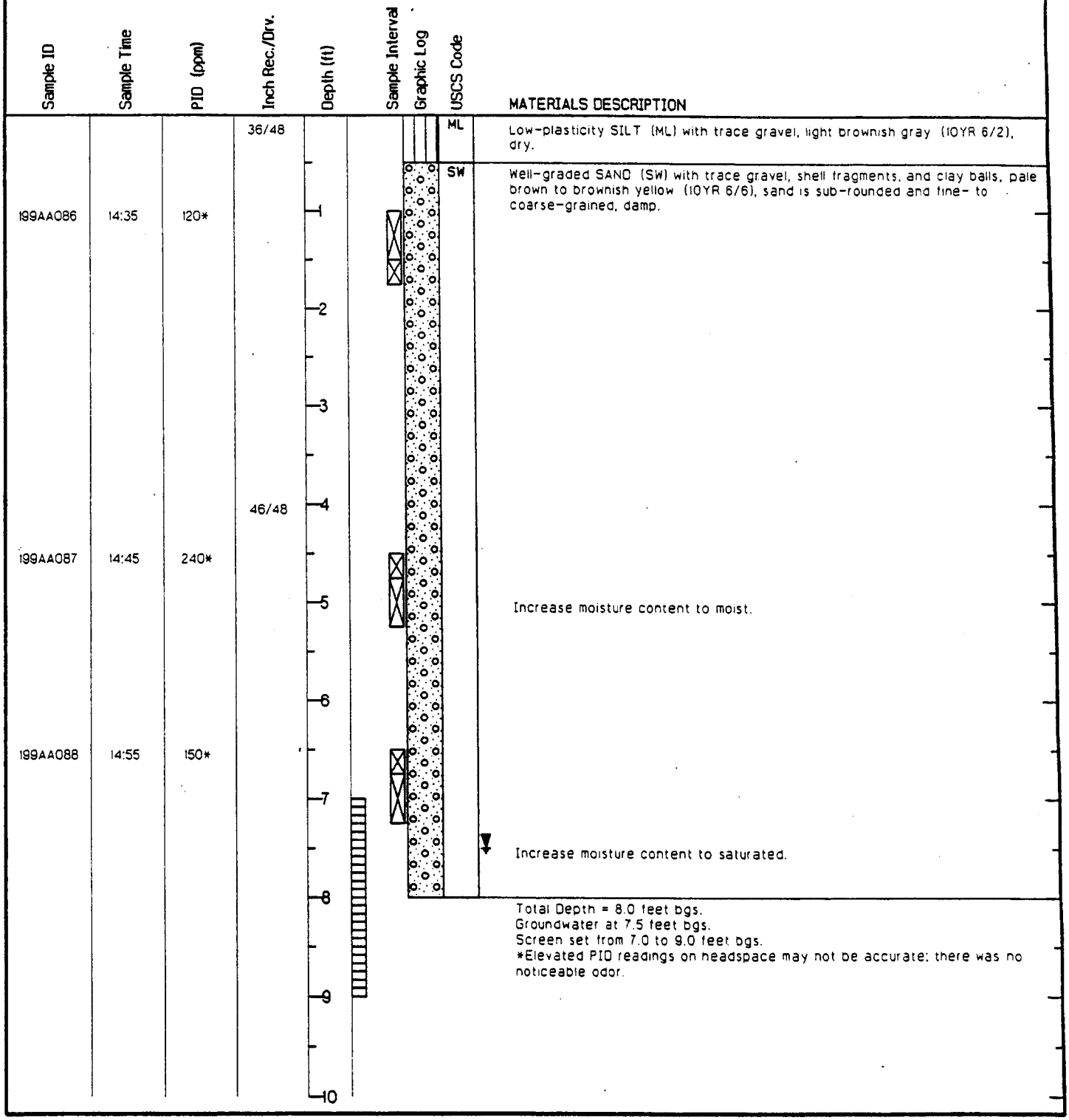
Screen Interval

PROJECT Naval Station Treasure Island
LOCATION IR Site 07/10
JOB NUMBER 044-0199R12BGI
LOGGED BY Paul Bigelow
DATE DRILLED 06/09/95
DRILLER PRC
DRILL METHOD Geoprobe

SAMPLING METHOD Macro-Core
GROUND ELEVATION NA
TOC ELEVATION NA
BORING DIAMETER 1.5 Inches
TOTAL DEPTH OF HOLE 8 Feet bgs
WATER LEVEL 7.75 Feet bgs
WELL INSTALLED? (Y/N) N

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 7/10-HP003



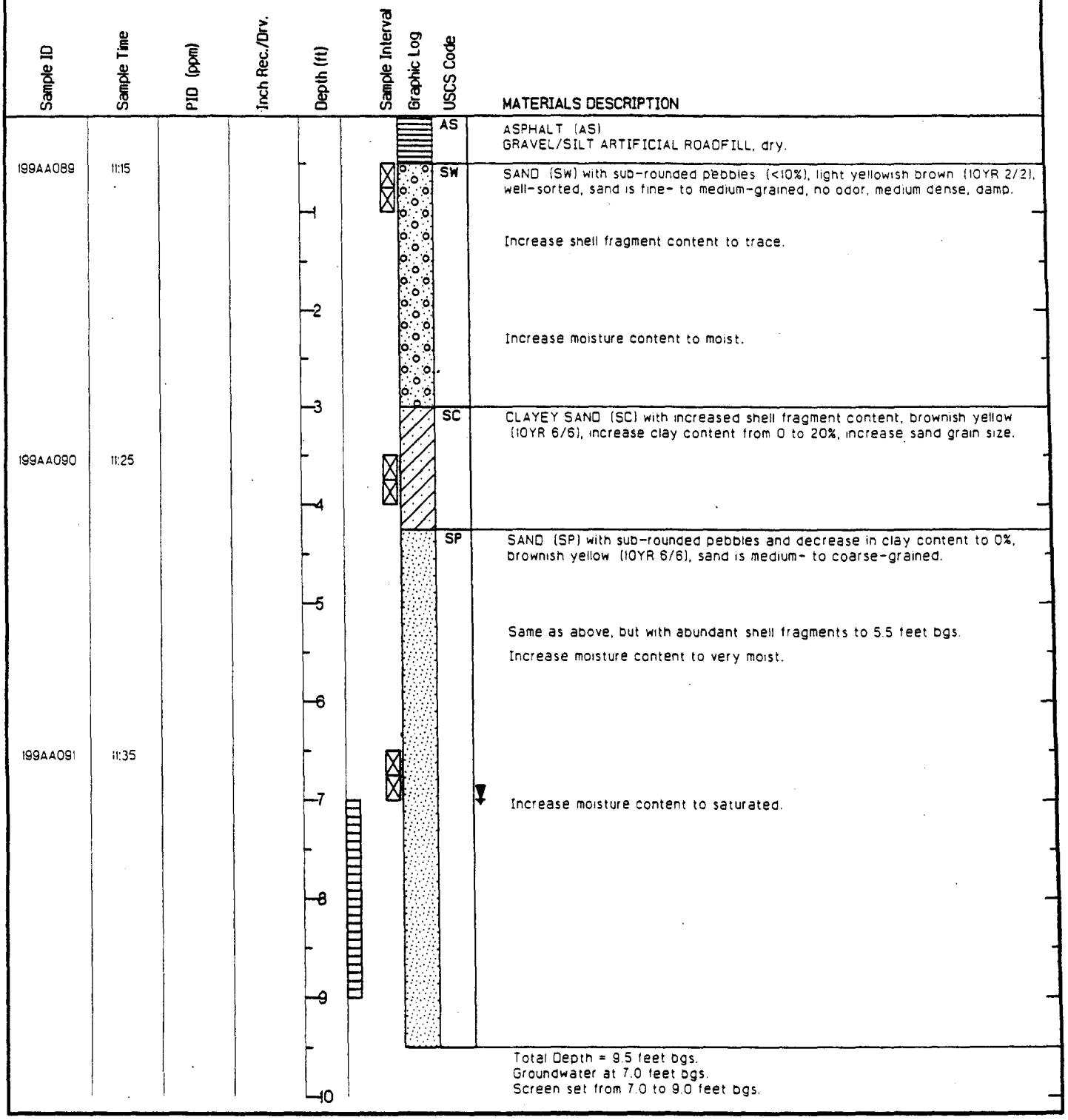
Total Depth = 8.0 feet bgs.
Groundwater at 7.5 feet bgs.
Screen set from 7.0 to 9.0 feet bgs.
*Elevated PID readings on headspace may not be accurate; there was no noticeable odor.

Water Table
Soil Sample
Screen Interval

PROJECT Naval Station Treasure Island	SAMPLING METHOD Macro-Core
LOCATION IR Site 07/10	GROUND ELEVATION NA
JOB NUMBER 044-0199RI2BGI	TOC ELEVATION NA
LOGGED BY Paul Bigelow	BORING DIAMETER 1.5 Inches
DATE DRILLED 06/09/95	TOTAL DEPTH OF HOLE 8 Feet bgs
DRILLER PRC	WATER LEVEL 7.5 Feet bgs
DRILL METHOD Geoprobe	WELL INSTALLED? (Y/N) N

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 7/10-HP004



Water Table

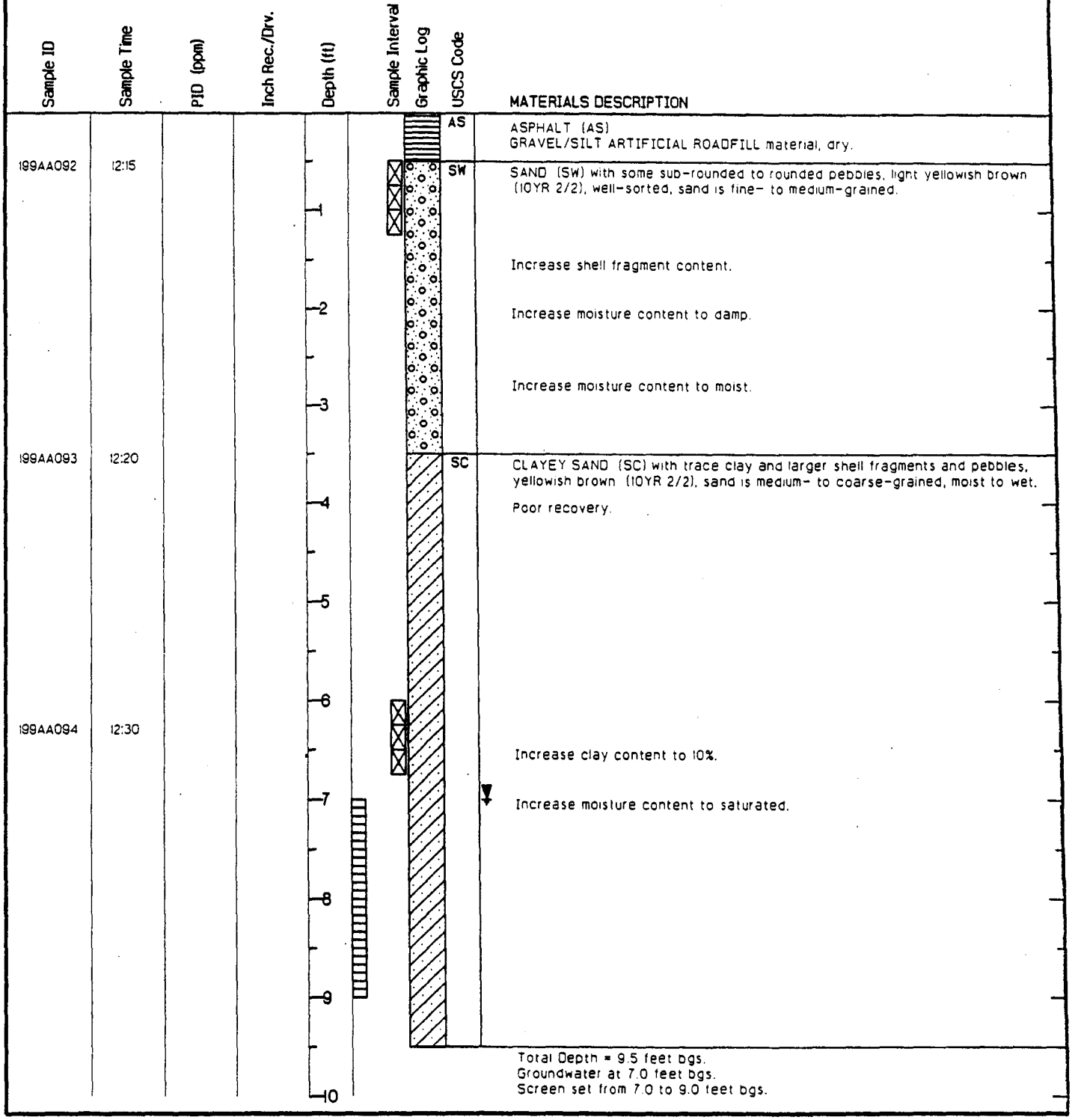
Soil Sample

Screen Interval

PROJECT	Naval Station Treasure Island	SAMPLING METHOD	Macro-Core
LOCATION	IR Site 07/10	GROUND ELEVATION	NA
JOB NUMBER	044-0199RI2BGI	TOC ELEVATION	NA
LOGGED BY	Jon Gould	BORING DIAMETER	1.5 Inches
DATE DRILLED	06/13/95	TOTAL DEPTH OF HOLE	9.5 Feet bgs
DRILLER	PRC	WATER LEVEL	7 Feet bgs
DRILL METHOD	Geoprobe	WELL INSTALLED? (Y/N)	N

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF BORING 7/10-HP005



Water Table

Soil Sample

Screen Interval

PROJECT	Naval Station Treasure Island	SAMPLING METHOD	Macro-Core
LOCATION	IR Site 07/10	GROUND ELEVATION	NA
JOB NUMBER	044-0199R12BGI	TOC ELEVATION	NA
LOGGED BY	JCE	BORING DIAMETER	1.5 Inches
DATE DRILLED	06/13/95	TOTAL DEPTH OF HOLE	9.5 Feet bgs
DRILLER	PRC	WATER LEVEL	7 Feet bgs
DRILL METHOD	Geoprobe	WELL INSTALLED? (Y/N)	N

FIELD BORELOG

PRC ENVIRONMENTAL MANAGEMENT, INC.

SHEET 1 OF 1

LOCATION OF BORING	JOB NO.: 044-0199IRRISB	BOREHOLE DESIGNATION: SB-01
	CLIENT: NAVY	SURFACE ELEVATION: N/A
	SITE: TREASURE ISLAND	DEPTH TO WATER: N/A
	SUBSITE: 10	LOGGED BY: Mike Stephens
	DRILLING CO.: Spectrum Drilling	DRILLING DATE(S): July 28, 1992
	DRILLING PERSONNEL/METHOD: CME 55, six-inch hollow stem auger	

SAMPLER TYPE	SAMPLE DEPTH (feet) TOP	SAMPLE DEPTH (feet) BOT	BLOWS/6 IN SAMPLE	RECOVERED (inches)	DRIVEN (inches)	SAMPLE NUMBER	PID Rdg (ppm)	ANLYS PHYS	ANLYS CHEM	TIME	DEPTH (feet)	USCS SOIL TYPE GRAPHIC LOG	SOIL DESCRIPTION
											1		SAND (SP), medium to coarse grained, slighty moist, brownish gray, slight surface stains.
SS	1.5	2.0		6	6	SB01-a	0		X	10:43	2		
SS	2.5	3.0		6	6	SB01-b	0		X	10:45	3		SAND (SW), grades to fine to medium grain.
											4		
											5		
											6		
SS	6.0	6.5		6	6	SB01-c	0		X	10:51	7		Water encountered at 6.5 feet.
											8		
											9		
											10		SAND (SP), gray, 2.5YR 4/0.
SS	10	11.5					0			10:55	1		
											2		
											3		
											4		
SS	15	16.5								11:00	5		Shell content increasing, slight petroleum odor at 15 feet.
											6		
											7		
											8		
											9		
											20		Boring terminated at 20 feet and backfilled with grout.

FIELD BORELOG

PRC ENVIRONMENTAL MANAGEMENT, INC.

SHEET 1 OF 1

LOCATION OF BORING	JOB NO.: 044-0199IRRISB	BOREHOLE DESIGNATION: SB-02
	CLIENT: NAVY	SURFACE ELEVATION: N/A
	SITE: TREASURE ISLAND	DEPTH TO WATER: N/A
	SUBSITE: 10	LOGGED BY: Kirk Olds
	DRILLING CO.:	DRILLING DATE(S): August 5,1992
	DRILLING PERSONNEL/METHOD: Kirk Olds. Hand auger	

SAMPLER TYPE	SAMPLE DEPTH (feet) TOP	BOT	BLOWS/6 IN SAMPLE	RECOVERED (inches)	DRIVEN (inches)	SAMPLE NUMBER	PID Rdg (ppm).	ANLYS PHYS	ANLYS CHEM	TIME	DEPTH (feet).	USCS SOIL TYPE GRAPHIC LOG	SOIL DESCRIPTION
	1.0	1.5		6	6	SB02-a	0		X	12:20	1		SAND (SP), coarse to medium grained, dry, loose, light olive.
	3.0	3.5		6	6	SB02-b	0		X	13:15	3		Damp, olive gray.
	6.0	6.5		6	6	SB02-c	0		X	13:43	6		Water encountered at 6.3 feet. Boring terminated at 6.5 feet and backfilled with grout.

FIELD BORELOG

PRC ENVIRONMENTAL MANAGEMENT, INC.

SHEET 1 OF 1

LOCATION OF BORING	JOB NO.: 044-01991RRISB	BOREHOLE DESIGNATION: SB-03
	CLIENT: NAVY	SURFACE ELEVATION: N/A
	SITE: TREASURE ISLAND	DEPTH TO WATER: N/A
	SUBSITE: 10	LOGGED BY: Kirk Olds
	DRILLING CO.:	DRILLING DATE(S): August 5,1992
	DRILLING PERSONNEL/METHOD: Kirk Olds. Hand auger	

SAMPLER TYPE	SAMPLE DEPTH (feet) TOP	SAMPLE DEPTH (feet) BOT	BLOWS/6 IN SAMPLE	RECOVERED (inches)	DRIVEN (inches)	SAMPLE NUMBER	PID Rdg (ppm).	ANLYS SAMP	ANLYS CHEM	TIME	DEPTH (feet).	USCS SOIL TYPE GRAPHIC LOG	SOIL DESCRIPTION
	1.0	1.5		6	6	SB03-a	0		X	15:10	1		SAND (SP), coarse to medium grained, dry, loose, light olive.
											2		
	3.0	3.5		6	6	SB03-b	0		X	15:36	3		Damp, olive gray.
											4		Shells encountered.
											5		
	6.0	6.5		6	6	SB03-c	0		X	15:49	6		Water encountered at 6.3 feet.
											7		Boring terminated at 6.5 feet and backfilled with grout.
											8		
											9		
											0		
											1		
											2		
											3		
											4		
											5		
											6		
											7		
											8		
											9		
											0		

FIELD BORELOG

PRC ENVIRONMENTAL MANAGEMENT, INC.

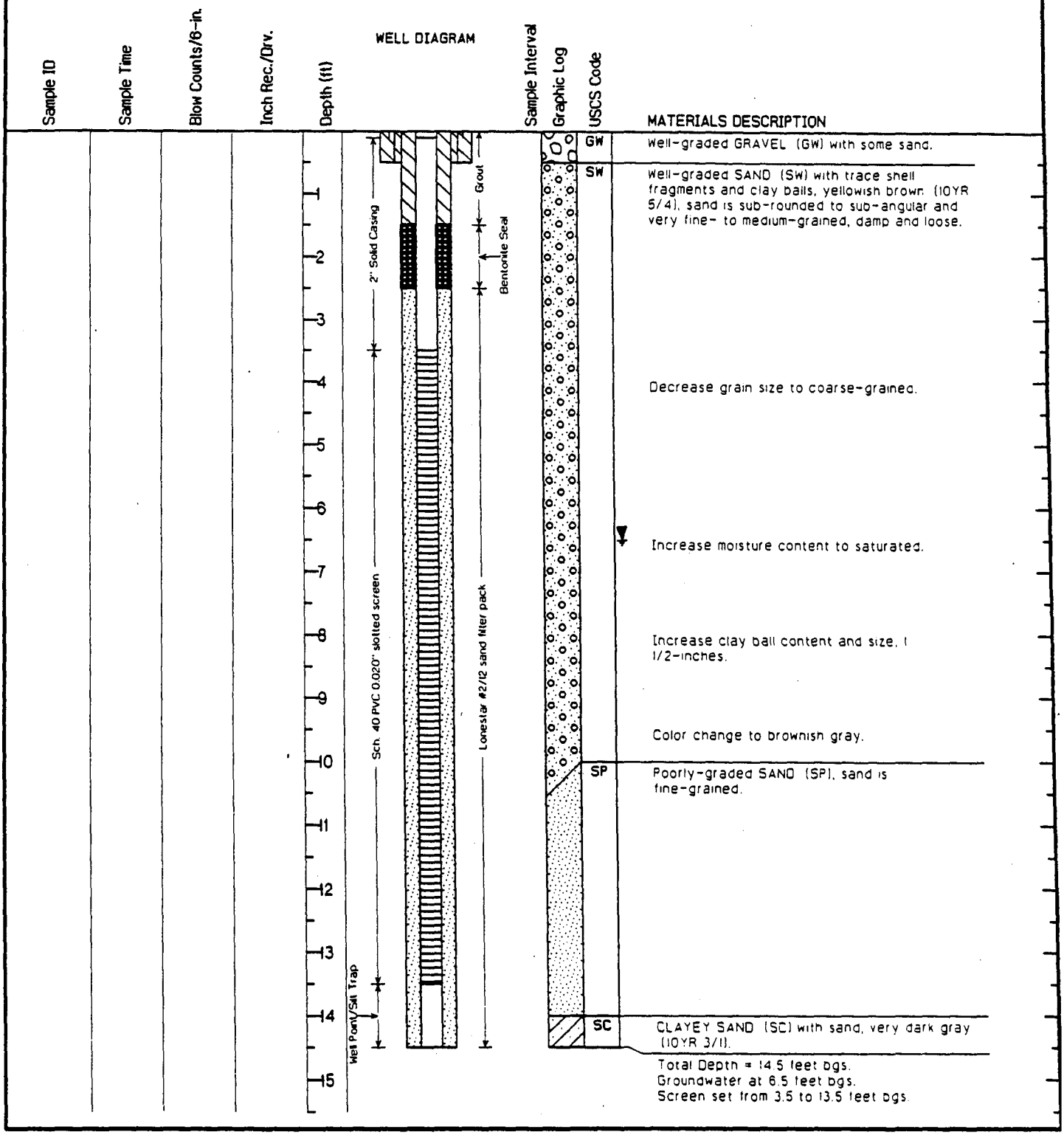
SHEET 1 OF 1

LOCATION OF BORING	JOB NO.: 044-0199IRRISB	BOREHOLE DESIGNATION: SB-04
	CLIENT: NAVY	SURFACE ELEVATION: N/A
	SITE: TREASURE ISLAND	DEPTH TO WATER: N/A
	SUBSITE: 10	LOGGED BY: Kirk Olds
	DRILLING CO.:	DRILLING DATE(S): August 5,1992
	DRILLING PERSONNEL/METHOD: Kirk Olds. Hand auger	

SAMPLER TYPE	SAMPLE DEPTH (feet) TOP	SAMPLE DEPTH (feet) BOT	BLOWS/6 IN SAMPL	RECOVERED (inches)	DRIVEN (inches)	SAMPLE NUMBER	PID Rdg (ppm).	ANLYS HNVS	ANLYS GTEM	TIME	DEPTH (feet).	USCS SOIL TYPE GRAPHIC LOG	SOIL DESCRIPTION
	1.0	1.5		6	6	SB04-a	0		X	16:09	1		SAND (SP), coarse to medium grained, dry, loose, light olive.
											2		
	3.0	3.5		6	6	SB04-b	0		X	16:21	3		Damp, olive gray.
											4		Shells encountered.
											5		Small amount of .25 inch gravel encountered.
	6.0	6.5		6	6	SB04-c	0		X	16:40	6		Water encountered at 6.3 feet.
											7		Boring terminated at 6.5 feet and backfilled with grout.
											8		
											9		
											0		
											1		
											2		
											3		
											4		
											5		
											6		
											7		
											8		
											9		
											0		

PRC ENVIRONMENTAL MANAGEMENT, INC.

LOG OF MONITORING WELL 10-MW01



Water Table

Soil Sample

Screen Interval

PROJECT	Naval Station Treasure Island	SAMPLING METHOD	Split Spoon
LOCATION	IR Site 10	GROUND ELEVATION	NA
JOB NUMBER	044-0199R12BMW	TOC ELEVATION	NA
LOGGED BY	Steve Broering	BORING DIAMETER	8 Inches
DATE DRILLED	11/15/95	TOTAL DEPTH OF HOLE	14.5 Feet bgs
DRILLER	SES Drilling	WATER LEVEL	6.5 Feet bgs
DRILL METHOD	HSA Drill Rig	WELL INSTALLED? (Y/N)	Y

CLIENT: Navy - NSTI	JOB NO:	BOREHOLE NUMBER: SS-6-01	
PROJECT: CleanII - CTO 041		LOCATION: Target Corridor 6	
DRILLING CO: Gregg		HOLE DIAMETER: 1	ELEVATION:
DRILLING METHOD: geoprobe		DATE: 1/29/97	
SAMPLING METHOD: 2" drive		RECORDED BY: (JCB)	
		REGISTERED GEOLOGIST:	

DEPTH (Feet)	BLOWS/ 6 INCH	CORE RECOV.	MOISTURE CONTENT	LITHOLOGIC DESCRIPTIONS / REMARKS	SAMPLE I.D. #	SAMPLE TIME
1				Asphalt		
2						
3						
4						
5						
6						
7						
8		X	M-Wet	Sand - fine sand, 15-25% medium	041TL14	10:55a
9		NR		loose, no fines	7.5-8'	
10		NR		V. Soft		
11		NR				
12						
13						
14						
15						
16						
17						
18						
19						
20						

CLIENT: Navy	JOB NO:	BOREHOLE NUMBER: 35-6-02	
PROJECT: Grant CTO #41		LOCATION: Target Corridor	
DRILLING CO: Gregg		HOLE DIAMETER: 1"	ELEVATION:
DRILLING METHOD:		DATE: 1/29/93	
SAMPLING METHOD:		RECORDED BY: VEB	
		REGISTERED GEOLOGIST:	

DEPTH (Feet)	BLOWS/ 6 INCH	CORE RECOV.	MOISTURE CONTENT	LITHOLOGIC DESCRIPTIONS / REMARKS	SAMPLE I.D. #	SAMPLE TIME
1				Asphalt		
2						
3						
4						
5						
6						
7						
8						
9			Wet	grey silt - soft	41TC13 8-9'	10:45
10		NR NR		Sand - fine to med sand, <10% shell fragments, loose		
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

CLIENT: Navy	JOB NO:	BOREHOLE NUMBER: SS-6-03	
PROJECT: CleanII CTO 041		LOCATION: Target Corridor 6	
DRILLING CO: Gregg Drilling		HOLE DIAMETER: 1"	ELEVATION:
DRILLING METHOD: geoprobe		DATE: 1/29/97	
SAMPLING METHOD: 2' drive		RECORDED BY: JDB	
		REGISTERED GEOLOGIST:	

DEPTH (Feet)	BLOWS/ 6 INCH	CORE RECOV.	MOISTURE CONTENT	LITHOLOGIC DESCRIPTIONS / REMARKS	SAMPLE I.D. #	SAMPLE TIME
1				Asphalt		
2						
3						
4						
5						
6						
7						
8						
9		X	wet	Sandy - medium sand, <10% fine sand, loose,	041TC12 BV 9.0	10:35
10		X NR NR				
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

IR SITE 10
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB05

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0 - 4.0 feet	
-1.0	1		Light brown fine sand with silt and variable minor medium sand and fine to medium gravel.	30210SB05001
-2.0	2			
-3.0	3			30210SB05002
-4.0	4			
			4.0 - 8.0	
-5.0	5		Light brown fine to coarse sand with minor fine gravel and scattered minor clay.	
-6.0	6			
-7.0	7			30210SB05003
-8.0	8			
			8.0 - 9.0 feet	
-9.0	9		Dark grey wet fine sand with shell fragments. Water at 8 feet. N4	
			9.0 - 12.0	
-10.0	10		Dark grey silty clay with some fine sand. N4	
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 12 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 10
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB06

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
-1.0	1		***0.0 - 4.0 feet***	
-2.0	2		Light brown fine sand with small angular gravel to brown fine to coarse sand with rounded gravel.	30210SB06001
-3.0	3		10YR5/4	
-4.0	4		10YR8/2	
-5.0	5		***4.0 - 8.0 feet***	30210SB06002
-6.0	6		Dark tan fine to coarse gravel to fine to coarse gravel with medium pockets of silt clay.	
-7.0	7		Water at 8.0 feet.	30210SB06003
-8.0	8		10YR4/2	
-9.0	9		***8.0 - 10.0 feet***	
-10.0	10		No recovery	
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 10 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 10
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB07

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
-1.0	1		***0.0 - 4.0 feet*** Grey angular gravel to fine to coarse brown sand with shell fragments. 10YR4/2	30210SB07001
-2.0	2			
-3.0	3			
-4.0	4			30210SB07002
-5.0	5		***4.0 - 8.0 feet*** Brown fine to coarse sand with shell fragments to small angular and subangular gravel with pockets of silt with clay. water at 7.0 feet. 10YR4/2	
-6.0	6			
-7.0	7			30210SB07003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 10
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San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB08

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 4.0 feet	
-1.0	1		Light tan angular gravel with fine sand to dark brown angular gravel with small fragments of hard clay.	30210SB08001
-2.0	2		10YR4/2	
-3.0	3			
-4.0	4		***4.0 - 8.0 feet***	
-5.0	5		Brown fine to coarse sand with angular to subangular gravel.	30210SB08002
-6.0	6		10YR4/2	
-7.0	7			30210SB08003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

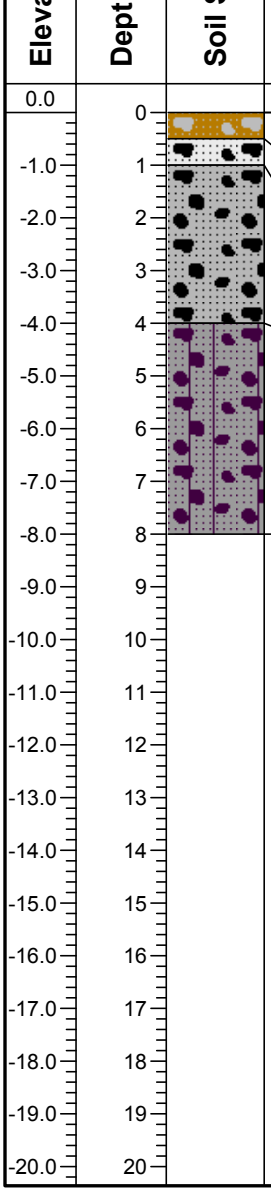
BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 10
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB09



Elevation (+/- MLLW)	Depth (ft bgs)	Lithologic Description	Soil Sample Number
0.0	0	Ground Surface	
		0.0 - 0.5 feet Mulch with subangular gravel and light tan fine sand	
-1.0	1	***0.5-1.0 feet*** Large angular to subangular gravel with fine sand, grey to chalk white	30210SB09001
-2.0	2		
-3.0	3	***1.0 - 4.0 feet*** Grey fine to coarse sand with small subangular to round gravel, some shell fragments 10YR4/2	
-4.0	4		30210SB09002
-5.0	5	***4.0 - 8.0 feet*** Fine to coarse sand with small subangular round grey gravel with pockets of silt with clay. 10YR4/2	
-6.0	6		
-7.0	7		30210SB09003
-8.0	8		
-9.0	9		
-10.0	10		
-11.0	11		
-12.0	12		
-13.0	13		
-14.0	14		
-15.0	15		
-16.0	16		
-17.0	17		
-18.0	18		
-19.0	19		
-20.0	20		

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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San Francisco, California 94105
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San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB10

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
-1.0	1		***0.0 - 4.0 feet***	
-2.0	2		Mulch with light tan and chalk white fine sand with angular and subangular gravel to light brown sand with some coarse angular and subangular gravel with shell fragments.	30210SB10001
-3.0	3		5Y7/2	
-4.0	4		5Y5/2	
-5.0	5		***4.0 - 8.0 feet***	30210SB10002
-6.0	6		Grey fine to coarse sand with subangular round gravel and shell fragments.	
-7.0	7		10YR4/2	30210SB10003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 10
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB11

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 0.5 feet Light tan fine sand with angular and subangular gravel	
-1.0	1			30210SB11001
-2.0	2		***0.5 - 4.0 feet*** Grey fine to coarse sand with anugular to subangular gravel, some shell fragments	
-3.0	3			
-4.0	4			30210SB11002
-5.0	5		***4.0 - 8.0 feet*** Grey fine to coarse sand with angular and subangular gravel with shell fragments. 10YR4/2	
-6.0	6			
-7.0	7			30210SB11003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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San Francisco, California 94105
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IR SITE 10
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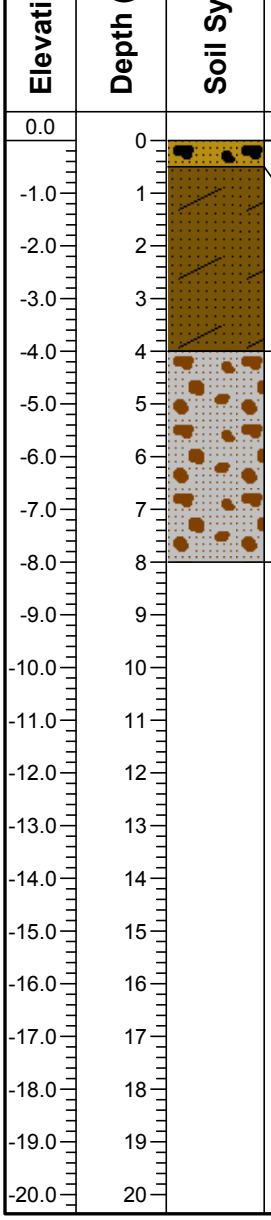
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB12



Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 0.5 feet Fine sand with light tan angular and subangular gravel 5Y7/2	30210SB12001
-1.0	1			
-2.0	2		***0.5 - 4.0 feet*** Brown silt with sand to fine sand with angular to subangular gravel 10YR2/2 10YR4/2	
-3.0	3			30210SB12002
-4.0	4			
-5.0	5		***4.0 - 8.0 feet*** Grey/brown fine to coarse sand with angular and subangular gravel with some pockets of clay. 10YR4/2	
-6.0	6			30210SB12003
-7.0	7			
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 10
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB13

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 0.5 feet Asphalt	
-1.0	1			30210SB13001
-2.0	2		***0.5 - 4.0 feet*** Tan fine sand with angular to subangular gravel	
-3.0	3			
-4.0	4		***4.0 - 8.0 feet*** Grey fine to coarse sand w angular to subangular gravel with shell fragments. 10YR4/2	30210SB13002
-5.0	5			
-6.0	6			
-7.0	7			30210SB13003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 10
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB14

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 1.0 feet Concrete	
-1.0	1			30210SB14001
			1.0 - 1.5 feet Light tan chalky fine sand with small angular gravel	
-2.0	2			
-3.0	3		***1.5 - 4.0 feet*** Grey fine to coarse sand with subangular gravel	
-4.0	4			30210SB14002
-5.0	5		***4.0 - 8.0 feet*** Grey fine to coarse sand with angular and subangular gravel. 10YR4/2	
-6.0	6			
-7.0	7			30210SB14003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 10
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB15

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 1.0 feet Light tan fine sand with chalky white material and angular and subangular gravel	30210SB15001
-4.0	4		***1.0 - 4.0 feet*** Grey fine to coarse sand with angular to subangular gravel	30210SB15002
-8.0	8		***4.0 - 8.0 feet*** Grey fine to coarse sand with angular and subangular gravel with shell fragments. 10YR4/2	30210SB15003

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105
(415)543-4880

IR SITE 10
TREASURE ISLAND
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB16

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
-1.0	1		***0.0 - 2.0 feet*** Light tan fine sand with angular and subangular gravel	30210SB16001
-2.0	2			
-3.0	3		***2.0 - 4.0 feet*** Grey fine to coarse sand with iron deposits and angular to subangular gravel, some shell fragments	
-4.0	4			30210SB16002
-5.0	5		***4.0 - 8.0 feet*** Grey fine to coarse sand with angular and subangular gravel with shell fragments. 10YR4/2	
-6.0	6			
-7.0	7			30210SB16003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

Tetra Tech EM Inc.
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San Francisco, California 94105
(415)543-4880

IR SITE 10
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San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB17

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
-1.0	1		***0.0 - 1.5 feet*** Light tan fine sand with angular and subangular gravel with shell fragments	30210SB17001
-2.0	2		***1.5 - 4.0 feet*** Greyish brown fine to coarse sand with angular to subangular gravel, some shell fragments	
-3.0	3			
-4.0	4		***4.0 - 8.0 feet*** Grey fine to coarse sand with angular and subangular gravel with packets of silt and clay with shell fragments. 10YR4/2	30210SB17002
-5.0	5			
-6.0	6			
-7.0	7			30210SB17003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10--22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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LOG OF BOREHOLE

Borehole: 10-SB18

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 1.0 feet	
-1.0	1		Mulch to brown / grey fine sand with angular and subangular gravel.	30210SB18001
			1.0 - 4.0 feet	
-2.0	2		Light grey fine to coarse sand with angular and subangular gravel with shell fragments.	
-3.0	3		10YR4/2	
-4.0	4		***4.0 - 8.0 feet***	30210SB18002
-5.0	5		Grey fine to coarse sand with angular and subangular gravel with shell fragments.	
-6.0	6		10YR4/2	
-7.0	7			30210SB18003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-22-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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SAN FRANCISCO COUNTY
CALIFORNIA

LOG OF BOREHOLE

Borehole/Well ID: SB19/MW02

Elevation (+/- AMSL)	Depth (ft bgs)	Lithologic Symbol/ Recovery	Lithologic Description	Headspace PID Reading	Soil Sample ID/ Sample Interval	Monitoring Well Completion
0.0	0		Ground Surface			
			0.0 - 1.0 feet Light tan fine sand with angular and subangular gravel. At 0.5 there is a 2" layer of dark black organic material.			
-1.0	1		***1.0 - 4.0 feet*** Brown fine to coarse sand with iron deposits and angular and subangular gravel with shell fragments. 10YR4/2			
-2.0	2					
-3.0	3					
-4.0	4		***4.0 - 8.0 feet*** Grey fine to coarse sand with subangular round gravel with shell fragments and pockets of silt with clay. 10YR4/2			
-5.0	5					
-6.0	6					
-7.0	7					
-8.0	8		No samples collected below 8 feet bgs.			
-9.0	9					
-10.0	10					
-11.0	11					
-12.0	12					
-13.0	13					
-14.0	14					
-15.0	15					
-16.0	16					
-17.0	17					
-18.0	18					
-19.0	19					
-20.0	20					

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
BOREHOLE DEPTH (ft bgs): 15'
TOTAL WELL DEPTH (ft btoc): 15'
LOGGED BY: R. Laskowski
CLIENT: Navy
PROJECT NO.: G0069302B0203

BOREHOLE DIAMETER (in.): 2 "
WELL CASING DIAMETER (in.): 1 "
TOC ELEVATION (ft AMSL):
GROUND ELEVATION (ft AMSL):
DRILLING CO.: Resonant Sonic Intl.
WATER LEVEL (ft btoc):
GROUNDWATER ELEV (ft AMSL).:

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California

LOG OF BOREHOLE

Borehole: 10-SB20

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 0.5 feet Chalky concrete material with angular and subangular gravel.	
-1.0	1		***0.5 - 1.0*** Brown fine sand with silt with iron deposits and shell fragments.	30210SB20001
-2.0	2			
-3.0	3		***1.0 - 4.0*** Brown fine to coarse sand with angular and subangular gravel with shell fragments. 10YR4/2	
-4.0	4			30210SB20002
-5.0	5		***4.0 - 8.0 feet*** Grey fine to coarse sand with lenses of silt with clay and iron deposits with gravel.	
-6.0	6			
-7.0	7			30210SB20003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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LOG OF BOREHOLE

Borehole: 10-SB21

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 0.5 feet Mulch and Organic Material	
-1.0	1			30210SB21001
-2.0	2		***0.5 - 4.0 feet*** Brown fine to coarse sand with subangular to rounded gravel and shell fragments. 10YR4/2	
-3.0	3			
-4.0	4			30210SB21002
-5.0	5		***4.0 - 8.0 feet*** Grey fine to coarse sand with subangular to rounded gravel wtih shell fragments and minor silt and clay. 10YR4/2	
-6.0	6			
-7.0	7			30210SB21003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB22

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 0.5 feet Mulch to brown fine to coarse sand with subangular gravel.	
-1.0	1			30210SB22001
-2.0	2		***0.5 - 4.0 feet*** Brown fine to coarse sand with subangular to rounded gravel with shell fragments.	
-3.0	3			
-4.0	4			30210SB22002
-5.0	5		***4.0 - 8.0 feet*** Grey fine to coarse sand with subangular gravel and shell fragments 10YR4/2	
-6.0	6			
-7.0	7			30210SB22003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB23

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 1.0 feet	
-1.0	1		Mulch to fine sand with angular and subangular gravel.	30210SB23001
			1.0 - 4.0 feet	
-2.0	2		Greyish fine to coarse sand with subangular to rounded gravel and shell fragments.	
-3.0	3		10YR4/2	
-4.0	4			30210SB23002
			4.0 - 8.0 feet	
-5.0	5		Grey fine to coarse sand with subangular gravel and shell fragments.	
-6.0	6		10YR4/2	
-7.0	7			30210SB23003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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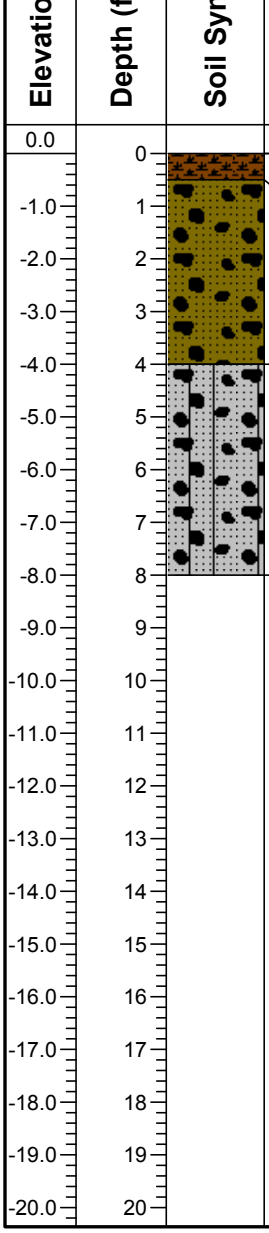
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB24



Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 0.5 feet Mulch	
-1.0	1			30210SB24001
-2.0	2		***0.5 - 4.0 feet*** Tan fine to coarse sand with subangular to rounded gravel with shell fragments. 10YR4/2	
-3.0	3			
-4.0	4			30210SB24002
-5.0	5		***4.0 - 8.0 feet*** Grey fine to coarse sand with subangular to rounded gravel with shell fragments and pockets of silt and clay.	
-6.0	6			
-7.0	7			30210SB24003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB25

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 0.5 feet Mulch	
-1.0	1			30210SB25001
-2.0	2		***0.5 - 4.0 feet*** Brown fine to coarse sand with angular and subangular gravel with shell fragments. 10YR4/2	
-3.0	3			
-4.0	4			30210SB25002
-5.0	5		***4.0 - 8.0 feet*** Greyish fine to coarse sand with angular and subangular gravel with shell fragments. 10YR4/2	
-6.0	6			
-7.0	7			30210SB25003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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IR SITE 10
TREASURE ISLAND
SAN FRANCISCO COUNTY
CALIFORNIA

LOG OF BOREHOLE

Borehole/Well ID: SB26/MW03

Elevation (+/- AMSL)	Depth (ft bgs)	Lithologic Symbol/ Recovery	Lithologic Description	Headspace PID Reading	Soil Sample ID/ Sample Interval	Monitoring Well Completion
0.0	0		Ground Surface			
			0.0 - 0.5 feet Dark brown fine sand with angular gravel with some cream and tan color to it.			
-1.0	1		***0.5 - 1.0 feet*** Light brown fine sand with subangular to angular gravel.		30210SB26001	
-2.0	2					
-3.0	3		***1.0 - 4.0*** Brown fine to coarse sand with subangular gravel, shell fragments.			
-4.0	4			5.5	30210SB26002	
-5.0	5		***4.0 - 8.0 feet*** Grey fine to coarse sand with pockets of silt and clay and some subangular gravel and shell fragments. 10YR4/2			
-6.0	6					
-7.0	7				30210SB26003	
-8.0	8		No samples collected below 8 feet bgs.			
-9.0	9					
-10.0	10					
-11.0	11					
-12.0	12					
-13.0	13					
-14.0	14					
-15.0	15					
-16.0	16					
-17.0	17					
-18.0	18					
-19.0	19					
-20.0	20					

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
BOREHOLE DEPTH (ft bgs): 15'
TOTAL WELL DEPTH (ft btoc): 15'
LOGGED BY: R. Laskowski
CLIENT: Navy
PROJECT NO.: G0069302B0203

BOREHOLE DIAMETER (in.): 2 "
WELL CASING DIAMETER (in.): 1 "
TOC ELEVATION (ft AMSL):
GROUND ELEVATION (ft AMSL):
DRILLING CO.: Resonant Sonic Intl.
WATER LEVEL (ft btoc):
GROUNDWATER ELEV (ft AMSL).:

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LOG OF BOREHOLE

Borehole: 10-SB27

Elevation (+/- MLLW)	Depth (ft bgs)	Soil Symbol	Lithologic Description	Soil Sample Number
0.0	0		Ground Surface	
			0.0 - 1.5 feet Cream color fine to coarse sand with subangular to rounded gravel.	
-1.0	1			30210SB27001
-2.0	2		***1.5 - 4.0 feet*** Grey fine to coarse sand with subangular gravel and shell fragments. Minor pockets of clay. 10YR4/2	
-3.0	3			
-4.0	4		***4.0 - 8.0 feet*** Grey fine to coarse sand with pockets of silt and clay and subangular and rounded gravel with shell fragments. 10YR4/2	30210SB27002
-5.0	5			
-6.0	6			
-7.0	7			30210SB27003
-8.0	8			
-9.0	9			
-10.0	10			
-11.0	11			
-12.0	12			
-13.0	13			
-14.0	14			
-15.0	15			
-16.0	16			
-17.0	17			
-18.0	18			
-19.0	19			
-20.0	20			

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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IR SITE 10
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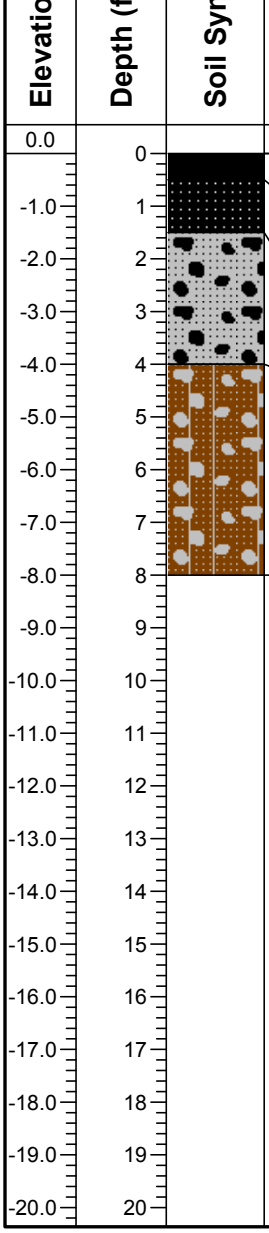
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB28



Elevation (+/- MLLW)	Depth (ft bgs)	Lithologic Description	Soil Sample Number
0.0	0	Ground Surface	
		0.0 - 0.5 feet Asphalt	
-1.0	1		30210SB28001
		0.5 - 1.5 feet Black organic fine sand with angular to subangular gravel. 5YR2/1	
-2.0	2		
-3.0	3	***1.5 - 4.0 feet*** Greyish fine coarse sand with angular to subangular gravel with a pocket of silt and clay, shell fragments.	
-4.0	4		30210SB28002
-5.0	5	***4.0 - 8.0 feet*** Brown fine to coarse sand with angular and subangular gravel with shell fragments and pockets of silt and clay. 10YR4/2	
-6.0	6		
-7.0	7		30210SB28003
-8.0	8		
-9.0	9		
-10.0	10		
-11.0	11		
-12.0	12		
-13.0	13		
-14.0	14		
-15.0	15		
-16.0	16		
-17.0	17		
-18.0	18		
-19.0	19		
-20.0	20		

DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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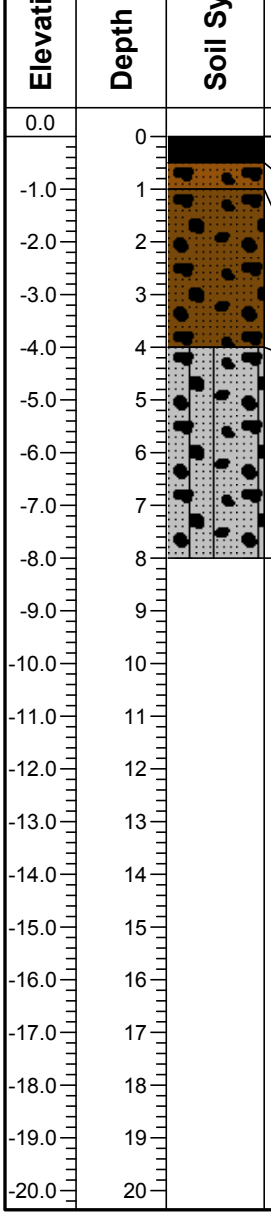
San Francisco County
California

LOG OF BOREHOLE

Borehole: 10-SB29



DRILLING DATE: 10-23-02
DRILLING METHOD: Direct Push
DRILLING CO.: ResonantSonic Intl.
LOGGED BY: G. LaHue
CLIENT: SW Division
PROJECT NO.: G0069302B0201

BOREHOLE DIAMETER: 2 inch
TOTAL BOREHOLE DEPTH: 8 feet
GROUND ELEVATION:
GROUNDWATER ELEV.:

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San Francisco, California 94105
(415)543-4880

APPENDIX B
WELL DEVELOPMENT DATA

WELL DEVELOPMENT DATA SHEET

Boring No. ____ Well No. 09-MW01

Project Treasure Island
Project No. 044-0199
Date(s) of Installation 11/9/95
Date(s) of Development 12/1/95
Personnel/Company PRC - R. Sugerman
Soils Exploration Service - Rick
Type of Rig Used ____

Casing Diameter/Type 2" PVC
Borehole Diameter 8"
Screened Interval(s) 13.5 - 3.5
Total Length of Well Casing 14.5
Measured Total Depth (TOC) Initial 12.73
Final 13.31
Initial Depth to Water (TOC) 6.75 Date 12/1/95 Time 0930
Stabilized Depth to Water (TOC) 6.70 Date 12/1/95 Time 1025

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

___ Jetting (Airlift) ____
___ Surge Block ____
___ Bailing ____
X Pumping REDIFLOW
___ Other ____

FLUIDS ADDED

Lost Drilling Fluid: ____ Gallons
Lost Purge Water: ____ Gallons
Water During Installation: ____ Gallons
Total Fluids Added: ____ Gallons
Source of Added Water: ____
Ground Water Quality Parameters of Added Water Measured: Y N
Sample Collected of Added Water: Y N
Sample Designation of Added Water: ____

PURGE VOLUME CALCULATION

Casing Volume: 6.08 Feet of Water
X .163 Gallons/Foot
= .99 Gallons per Single Casing Volume
Sand Pack Volume: 12 Ft. of Saturated Sand Pack
X 2.6 Gallons/Ft. (Borehole Dia.)
= 31.2 Gallons (in Borehole)
RPS - ~~30.21~~ .99 Gallons of Casing Volume
RPS = ~~30.21 x 0.30~~ x 0.3 (Assuming porosity = 30%)
= 9.06 Gallons within Sand Pack
Single Purge Volume: ~~9.06~~ 10.05 Gallons (Casing Vol. + (RPS) Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: ~~27.19~~ RPS Gallons 30.16
Actual Purge Volume: 40 Gallons
Volume Measured by: 55 GALLON DRUM
Rate of Development ____ Gallons/Minute (Hour,Day)
Pumping Rate/Depth ____ @ ____ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness ____

INSTRUMENT CALIBRATION

pH Meter: HORIBA U-10
pH 4.0 = ____ @ ____ °C
pH 7.0 = ____ @ ____ °C
pH 10.0 = ____ @ ____ °C
Dissolved Oxygen Meter: HORIBA U-10

Spec. Conductance Meter: HORIBA U-10
Standard ____ µmhos/cm@ 25°C
Reading ____ µmhos/cm @ ____ °C
Turbidity Meter: ____
Other: ____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity or D.O.	Clarity, Odor & PID Readings, Other:	
10 GAL	2 gal/min	932	19.9	7.35	.656	>999	7.38	Slight Odor
20 GAL	1 gal/min	946	20.3	7.46	.639	>999	0.84	0.02
30 GAL	1 gal/min	1004	20.6	7.52	.659	7	2.13	0.02
33 GAL	1 gal/min	1012	20.8	7.52	.637	8.5	1.11	0.02
40 GAL	1 gal/min	1020	20.5	7.56	.643	5	1.43	0.02

Development Completed at ~~1022~~ 40 Gallons Discharged. Date: 12/1/95 Time: 1020
Criteria: ____ Personnel: R Sugerman

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

WELL DEVELOPMENT DATA SHEET

WELL DEVELOPMENT DATA SHEET

Sheet ___ of ___

S.Tr 9 BORING NO. _____ WELL NO. ~~MW~~ 01

Project Treasure Island
Project No. G00693002B00401
Date(s) of Installation _____
Date(s) of Development 10/28
Personnel/Company _____
Type of Rig Used _____

Casing Diameter/Type 6
Borehole Diameter 1
Screened Interval(s) 10'
Total Length of Well Casing _____
Measured Total Depth (TOC) Initial 14.61
Final _____
Initial Depth to Water (TOC) 6.7 Date 10.28 Time 1110
Stabilized Depth to Water (TOC) _____ Date _____ Time _____

DEVELOPMENT TECHNIQUE(S) / EQUIPMENT TYPE/CAPACITY

___ Surging _____
___ Overpumping Peristaltic Pump
___ Air Lift Pumping _____
___ Backwashing _____
___ Bailing _____
___ Well Jetting _____

FLUIDS ADDED

Lost Drilling Fluid: _____ Gallons
Lost Purge Water: _____ Gallons
Water During Installation: _____ Gallons
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Sample Collected of Added Water: Y N
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: 7.91 Ft. of water
x .08 Gallons/Foot
= .63 Gallons per Single Casing Volume
Sand Pack Volume: .16 Ft. of Saturated Sand Pack
x 7.91 Gallons/Foot (borehole diameter)
= 1.26 Gallons (in borehole)
- .63 Gallons of Casing Volume
= .63 x 0.3 (Assuming porosity = 30%)
= .18 Gallons Within Sand Pack
Single Purge Volume: .24 Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: .72 Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development .5 Gallons/(Minute)/Hour, Day)
Pumping Rate/Depth .5 @ 14.6 Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness _____

Development Criteria: _____

Total Volume Discharged	Rate of Discharge	Time	Temp C°	pH	Specific Conductance	Turbidity (NTU)	D.O., ~~Clarity, Odor, PID Readings, Other:~~ ≥1%
0	.5	1204	19.5	5.95	.611	999	.58 .04
1 L	.5	1207	19.3	6.81	.816	999	1.43 .03
2 L	.5	1209	19.3	6.91	.791	999	.05 .03
3 L	.5	1211	19.1	6.94	.771	999	.07 .03
4 L	.5	1213	19.2	6.88	.767	367	.26 .03
5 L	.5	1215	18.8	7.01	.757	191	.31 .01
6 L	.5	1217	18.7	7.05	.756	164	.09 .01
7 L	.5	1219	18.6	6.91	.754	54	.17 .03
8 L	.5	1221	18.6	7.03	.748	29	.12 .03
9 L	.5	1223	19.2	6.91	.746	24	.13 .03

Development Completed at _____ Gallons Discharged. Date: _____ Time: _____

Personnel: _____

Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

WELL DEVELOPMENT DATA SHEET

Sheet ___ of ___

WELL DEVELOPMENT DATA SHEET

Site 9 BORING NO. _____ WELL NO. south room MW-02

Project Treasure Island
Project No. 600693.2B.04.01
Date(s) of Installation _____
Date(s) of Development 10/29
Personnel/Company _____
_____
Type of Rig Used _____

Casing Diameter/Type 6
Borehole Diameter 1
Screened Interval(s) 10'
Total Length of Well Casing _____
Measured Total Depth (TOC) Initial 14.66
Final _____
Initial Depth to Water (TOC) 6.72 Date 10/29 Time 1022
Stabilized Depth to Water (TOC) _____ Date _____ Time _____

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

___ Surging _____
___ Overpumping peristaltic
___ Air Lift Pumping _____
___ Backwashing _____
___ Bailing _____
___ Well Jetting _____

FLUIDS ADDED

Lost Drilling Fluid: _____ Gallons
Lost Purge Water: _____ Gallons
Water During Installation: _____ Gallons
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Sample Collected of Added Water: Y N
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: 7.94 Ft. of water
x .08 Gallons/Foot
= .63 Gallons per Single Casing Volume
Sand Pack Volume: 10 Ft. of Saturated Sand Pack
x .326 Gallons/Foot (borehole diameter)
= 3.26 Gallons (in borehole)
- .63 Gallons of Casing Volume
= 2.63 x 0.3 (Assuming porosity = 30%)
= .78 Gallons Within Sand Pack
Single Purge Volume: 1.41 Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: 4.23 Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development _____ Gallons/Minute (Hour, Day)
Pumping Rate/Depth _____ @ _____ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness _____

Development Criteria: _____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., ~~Clarity, Odor, PID~~ Readings, Other: sal %
0	.5 L/m	1050	17.4	7.12	.777	999	-.36 .03
2		1053	17.2	7.20	.759	411	1.71 .03
4		1058	17.4	7.24	.760	0	.52 .03
6		1103	17.5	7.20	.760	0	.77 .03
8		1107	17.1	7.27	.784	0	.53 .03
10		1113	17.1	7.28	.784	0	.72 .02
12		1117	17.3	7.24	.781	0	.41 .03
14							

Development Completed at 4 Gallons Discharged. Date: 10/29 Time: 1120

Personnel: _____
_____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

WELL DEVELOPMENT DATA SHEET

WELL DEVELOPMENT DATA SHEET

Sheet ___ of ___

Site 9 BORING NO. _____ WELL NO. 03

Project Treasure Island
Project No. 60060432004401
Date(s) of Installation _____
Date(s) of Development 10/28
Personnel/Company _____
Type of Rig Used _____

Casing Diameter/Type 6
Borehole Diameter 1
Screened Interval(s) 10
Total Length of Well Casing _____
Measured Total Depth (TOC) Initial 14.16
Final _____
Initial Depth to Water (TOC) 7.61 Date 10/28 Time 1300
Stabilized Depth to Water (TOC) _____ Date _____ Time _____

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

___ Surging _____
___ Overpumping peristaltic pump
___ Air Lift Pumping _____
___ Backwashing _____
___ Bailing _____
___ Well Jetting _____

FLUIDS ADDED

Lost Drilling Fluid: _____ Gallons
Lost Purge Water: _____ Gallons
Water During Installation: _____ Gallons
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Sample Collected of Added Water: Y N
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: 6.99 Ft. of water
x .08 Gallons/Foot
= .55 Gallons per Single Casing Volume
Sand Pack Volume: .7 Ft. of Saturated Sand Pack
x .326 Gallons/Foot (borehole diameter)
= 2.28 Gallons (in borehole)
- .55 Gallons of Casing Volume
= 1.73 x 0.3 (Assuming porosity = 30%)
= .51 Gallons Within Sand Pack
Single Purge Volume: 2.83 Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: 8.49 Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development _____ Gallons/Minute (Hour, Day)
Pumping Rate/Depth _____ @ _____ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness _____

Development Criteria: _____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., Clarity, Odor, PID Readings, Other: Sal %
0	.5	1309	20.3	7.08	.728	799	-1.04 .03
2L	.5	1312	20.1	7.04	.625	813	.01 .02
4L	.5	1316	20.3	7.03	.565	131	-.44 .02
6L	.5	1320	20.4	7.04	.522	40	-.23 .02
8L	.5	1325	20.2	7.08	.497	49	-.33 .02
10L	.5	1329	20.2	7.08	.478	18	.17 .01
12L	.5	1337	20.0	7.16	.463	11	.11 .01
14L	.5	1346	20.0	7.18	.453	5	.27 .01
16L	.5	1350	20.0	7.22	.448	3	.34 .01
18L	.5	1354	20.0	7.21	~~.45~~.440	5	.37 .01

Development Completed at _____ Gallons Discharged. Date: _____ Time: _____

Personnel: _____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

WELL DEVELOPMENT DATA SHEET

WELL DEVELOPMENT DATA SHEET

Site 9 BORING NO. _____ WELL NO. 04

Project Treasure Island
Project No. 6006938284001
Date(s) of Installation 10/28
Date(s) of Development _____
Personnel/Company _____
_____
Type of Rig Used _____

Casing Diameter/Type 6
Borehole Diameter 11
Screened Interval(s) 10
Total Length of Well Casing _____
Measured Total Depth (TOC) Initial _____
Final _____
Initial Depth to Water (TOC) _____ Date _____ Time _____
Stabilized Depth to Water (TOC) _____ Date _____ Time _____

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

___ Surging _____
___ Overpumping peristaltic
___ Air Lift Pumping _____
___ Backwashing _____
___ Bailing _____
___ Well Jetting _____

FLUIDS ADDED

Lost Drilling Fluid: _____ Gallons
Lost Purge Water: _____ Gallons
Water During Installation: _____ Gallons
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Sample Collected of Added Water: Y N
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: _____ Ft. of water
x _____ Gallons/Foot
= _____ Gallons per Single Casing Volume
Sand Pack Volume: _____ Ft. of Saturated Sand Pack
x _____ Gallons/Foot (borehole diameter)
= _____ Gallons (in borehole)
- _____ Gallons of Casing Volume
= _____ x 0.3 (Assuming porosity = 30%)
= _____ Gallons Within Sand Pack
Single Purge Volume: _____ Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: _____ Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development _____ Gallons/Minute (Hour, Day)
Pumping Rate/Depth _____ @ _____ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness _____

Development Criteria: _____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., Clarity, Odor, PID Readings, Other: S/%
10L	.5		19.1	6.93	.751	13	.19 .01
11L	.5		19.0	6.87	.745	10	.20 .03
12L	.5		19.1	6.91	.736	154	.58 .03
13L	.5		19.2	6.85	.746	43	1.30 .03
14L	.5		19.0	6.88	.745	152	.64 .03
15L	.5		19.0	6.91	.745	13	.23 .03
16L	.5		19.1	6.94	.742	6	.59 .01
17L	.5		19.0	6.92	.741	7	.85 .02
18L	.5		19.0	6.95	.736	8	.20 .01

Development Completed at _____ Gallons Discharged. Date: _____ Time: _____

Personnel: _____
_____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

WELL DEVELOPMENT DATA SHEET

Sheet ___ of ___

WELL DEVELOPMENT DATA SHEET

Site 9 BORING NO. _____ WELL NO. main room well MW-05

Project Treasure Island
Project No. GP0693B2B0401
Date(s) of Installation [illegible]
Date(s) of Development 10/29
Personnel/Company _____
Type of Rig Used _____

Casing Diameter/Type 6
Borehole Diameter 10
Screened Interval(s) 10
Total Length of Well Casing _____
Measured Total Depth (TOC) Initial 14.65
Final _____
Initial Depth to Water (TOC) 6.46 Date 10/29 Time 940
Stabilized Depth to Water (TOC) _____ Date _____ Time _____

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

___ Surging _____
___ Overpumping peristaltic
___ Air Lift Pumping _____
___ Backwashing _____
___ Bailing _____
___ Well Jetting _____

FLUIDS ADDED

Lost Drilling Fluid: _____ Gallons
Lost Purge Water: _____ Gallons
Water During Installation: _____ Gallons
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Sample Collected of Added Water: Y N
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: 8.19 Ft. of water
x .08 Gallons/Foot
= .65 Gallons per Single Casing Volume
Sand Pack Volume: 10 Ft. of Saturated Sand Pack
x .326 Gallons/Foot (borehole diameter)
= 3.26 Gallons (in borehole)
- .65 Gallons of Casing Volume
= 2.61 x 0.3 (Assuming porosity = 30%)
= .783 Gallons Within Sand Pack
Single Purge Volume: 1.43 Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: 4.29 Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development _____ Gallons/Minute (Hour, Day)
Pumping Rate/Depth _____ @ _____ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness _____

Development Criteria: _____

Total Volume Discharged	Rate of Discharge	Time	Temp C	pH	Specific* Conductance	Turbidity (NTU)	D.O., Clarity, Odor, PID Readings, Other: sat/%
0	.5 L/m	1004	17.2	6.73	.864	999	.77 .03
2		1008	17.2	7.04	.876	999	.27 .03
4			16.7	7.13	.856	916	1.36 .03
6		1020	17.4	7.05	.837	459	.15 .03
8		1024	17.3	7.06	.829	152	-.33 .03
10		1028	17.3	7.09	.825	3	.25 .03
12		1033	17.3	7.09	.827	2	-.05 .03
14		1038	17.4	7.05	.819	0	.42 .03

Development Completed at 4 gal Gallons Discharged. Date: 10/29 Time: 1040

Personnel: _____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

WELL DEVELOPMENT DATA SHEET

Sheet ___ of ___

WELL DEVELOPMENT DATA SHEET

Site 9 BORING NO. _____ WELL NO. N. Room MW-06

Project Treasure Island
Project No. 60606930213040 1
Date(s) of Installation 10/28
Date(s) of Development 10/29
Personnel/Company _____

Type of Rig Used _____

Casing Diameter/Type 6
Borehole Diameter 8 1
Screened Interval(s) 10-15
Total Length of Well Casing _____
Measured Total Depth (TOC) Initial 14.65
Final _____
Initial Depth to Water (TOC) 6.61 Date 10/29 Time 900
Stabilized Depth to Water (TOC) _____ Date _____ Time _____

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

___ Surging _____
___ Overpumping Peristaltic
___ Air Lift Pumping _____
___ Backwashing _____
___ Bailing _____
___ Well Jetting _____

FLUIDS ADDED

Lost Drilling Fluid: _____ Gallons
Lost Purge Water: _____ Gallons
Water During Installation: _____ Gallons
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Sample Collected of Added Water: Y N
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: 8.04 Ft. of water
x .08 Gallons/Foot
= .64 Gallons per Single Casing Volume
Sand Pack Volume: 10 Ft. of Saturated Sand Pack
x 1.326 Gallons/Foot (borehole diameter)
= 3.26 Gallons (in borehole)
- .64 Gallons of Casing Volume
= 2.62 x 0.3 (Assuming porosity = 30%)
= .78 Gallons Within Sand Pack
Single Purge Volume: 1.42 Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: 4.26 Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development 1 ~~Gallons~~/Minute (Hour, Day)
Pumping Rate/Depth 1 L/m @ 14.5 Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness _____

Development Criteria: _____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., ~~Clarity, Odor, PID~~ Readings, Other: Sal ‰
0	.5L/m	906	17.1	6.31	1.07	999	-.42 .04
2 L	"	909	17.2	6.77	.833	999	.09 .23
4	"	913	16.4	7.02	.541	75	2.46 .03
6	"	916	16.6	7.23	.702	25	.51 .01
8	"	919	16.5	7.14	.742	29	.75 .01
10	"	925	16.7	7.16	.745	0	1.39 .02
12	1	930	16.7	7.23	.713	0	.98 .01
14	✓	934	16.8	7.24	.694	0	.95 .03
16							
18							

Development Completed at 4 gal Gallons Discharged. Date: 10/29 Time: 940

Personnel: _____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

WELL DEVELOPMENT DATA SHEET

Boring No. —

Well No. ID-MW01

Project Treasure Island

Project No. 044-0199RI2BMW

Date(s) of Installation 11/15/95

Date(s) of Development 12-7-95

Personnel/Company SES - Rick

Type of Rig Used —

Casing Diameter/Type 2" PVC

Borehole Diameter 8"

Screened Interval(s) 13.5 - 3.5

Total Length of Well Casing 14.5 - 0

Measured Total Depth (TOC) Initial 13.75 Final 13.65

Initial Depth to Water (TOC) 6.35 Date 12-7-95 Time 1240

Stabilized Depth to Water (TOC) 6.42 Date 12-7-95 Time 1326

DEVELOPMENT

TECHNIQUE(S)	EQUIPMENT TYPE/CAPACITY
___ Jetting (Airlift)	
___ Surge Block	
___ Bailing	
X Pumping	Sedi-Flow
___ Other	

FLUIDS ADDED

Lost Drilling Fluid: ______ Gallons

Lost Purge Water: ______ Gallons

Water During Installation: ______ Gallons

Total Fluids Added: ______ Gallons

Source of Added Water: ______

Ground Water Quality Parameters of Added Water Measured: Y N

Sample Collected of Added Water: Y N

Sample Designation of Added Water: ______

PURGE VOLUME CALCULATION

Casing Volume: 7.4 Feet of Water

X .163 Gallons/Foot

= 1.20 Gallons per Single Casing Volume

Sand Pack Volume: 7.4 Ft. of Saturated Sand Pack

X 2.6 Gallons/Ft. (Borehole Dia.)

= 19.24 Gallons (in Borehole)

\- 1.20 Gallons of Casing Volume

= 18.04 x 0.3 (Assuming porosity = 30%)

= 5.4 Gallons within Sand Pack

Single Purge Volume: 6.6 Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)

Minimum Purge Volume: 19.8 Gallons

Actual Purge Volume: 30 Gallons

Volume Measured by: 5 gal. drum

Rate of Development ______ Gallons/Minute (Hour,Day)

Pumping Rate/Depth ______ @ ______ Ft. (Below Grd.)

Immiscible Phases Present: Y (N) Thickness —

INSTRUMENT CALIBRATION

pH Meter: Horiba

pH 4.0 = 4.07 @ 16.6 °C

pH 7.0 = ______ @ ______ °C

pH 10.0 = ______ @ ______ °C

Dissolved Oxygen Meter: Horiba U-10

Spec. Conductance Meter: Horiba U-10

Standard 4.40 µmhos/cm @ 25°C

Reading 4.40 µmhos/cm @ 16.6 °C

Turbidity Meter: HF DRT 15C

Other: —

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	(Turbidity) or D.O.	Clarity, Odor PID Readings, Other: D.O.	Salinity
Initial	1 gpm	1250	18.9	7.92	1.52	7999	0.92	0.08
15	1 gpm	1300	18.9	7.69	1.66	7999	0.86	0.07
20	.5 gpm	1305	19.2	7.66	1.74	382	1.01	0.08
25	.5 gpm	1310	19.3	7.63	1.75	22	1.13	0.08
30	.5 gpm	1315	19.3	7.64	1.81	3	0.98	0.08

Development Completed at 30 Gallons Discharged. Date: 12-7-95 Time: 1315

Criteria: Parameters Stable, Turbidity ≤ 5 NTU Personnel: SES/Rick

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

WELL DEVELOPMENT DATA SHEET

WELL DEVELOPMENT DATA SHEET

Sheet ___ of ___

BORING NO. _____ WELL NO. 09MW02 10

Project Treasure Island
Project No. 60693023B401
Date(s) of Installation _____
Date(s) of Development 10/29
Personnel/Company _____
Type of Rig Used _____

Casing Diameter/Type 6
Borehole Diameter 1
Screened Interval(s) 10
Total Length of Well Casing _____
Measured Total Depth (TOC) Initial 14.52
Final _____
Initial Depth to Water (TOC) 6.91 Date 10/29 Time 1220
Stabilized Depth to Water (TOC) _____ Date _____ Time _____

DEVELOPMENT TECHNIQUE(S) EQUIPMENT TYPE/CAPACITY

___ Surging _____
___ Overpumping peristaltic
___ Air Lift Pumping _____
___ Backwashing _____
___ Bailing _____
___ Well Jetting _____

FLUIDS ADDED

Lost Drilling Fluid: _____ Gallons
Lost Purge Water: _____ Gallons
Water During Installation: _____ Gallons
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Sample Collected of Added Water: Y N
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: 7.61 Ft. of water
x .08 Gallons/Foot
= .60 Gallons per Single Casing Volume
Sand Pack Volume: 10 Ft. of Saturated Sand Pack
x .326 Gallons/Foot (borehole diameter)
= 3.26 Gallons (in borehole)
- .60 Gallons of Casing Volume
= 1.38 x 0.3 (Assuming porosity = 30%)
= .41 Gallons Within Sand Pack
Single Purge Volume: 1.0' Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: 3.03 Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development _____ Gallons/Minute (Hour, Day)
Pumping Rate/Depth _____ @ _____ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness _____

Development Criteria: _____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., Clarity, Odor, PID Readings, Other: Sal %
0	1 L/m	1227	17.6	6.76	27.5	999	.65 1.69
2		1231	17.7	6.75	28.5	14	.68 1.78
4		1237	17.6	6.78	29.1	0	.57 1.81
6		1243	17.5	6.79	29.1	0	.39 1.81
8		1249	17.7	6.8	29.1	0	1.23 1.8
10		1256	17.3	6.79	29.2	0	.45 1.82
12	↓	1301	17.3	6.80	29.1	0	.41 1.82
14							

Development Completed at 4 Gallons Discharged. Date: 10/29 Time: 1305

Personnel: _____

* Specific Conductance readings temperature compensated to 25° C, if not, report temperatures at which reading obtained.

WELL DEVELOPMENT DATA SHEET

Sheet ___ of ___

WELL DEVELOPMENT DATA SHEET

BORING NO. _____ WELL NO. 6MW03 (10)

Project Treasure Island
Project No. 60693023B401
Date(s) of Installation _____
Date(s) of Development 10/29
Personnel/Company _____
Type of Rig Used _____

Casing Diameter/Type 6
Borehole Diameter 1
Screened Interval(s) 10
Total Length of Well Casing _____
Measured Total Depth (TOC) Initial 14.60
Final _____
Initial Depth to Water (TOC) 7.0 Date 10/29 Time 1241
Stabilized Depth to Water (TOC) _____ Date _____ Time _____

DEVELOPMENT TECHNIQUE(S) / EQUIPMENT TYPE/CAPACITY

___ Surging _____
___ Overpumping peristaltic
___ Air Lift Pumping _____
___ Backwashing _____
___ Bailing _____
___ Well Jetting _____

FLUIDS ADDED

Lost Drilling Fluid: _____ Gallons
Lost Purge Water: _____ Gallons
Water During Installation: _____ Gallons
Total Fluids Added: _____ Gallons
Source of Added Water: _____
Sample Collected of Added Water: Y N
Sample Designation of Added Water: _____

PURGE VOLUME CALCULATION

Casing Volume: 7.6 Ft. of water
x .08 Gallons/Foot
= .60 Gallons per Single Casing Volume
Sand Pack Volume: 10 Ft. of Saturated Sand Pack
x .325 Gallons/Foot (borehole diameter)
= 3.25 Gallons (in borehole)
- .60 Gallons of Casing Volume
= 2.65 x 0.3 (Assuming porosity = 30%)
= .79 Gallons Within Sand Pack
Single Purge Volume: 1.39 Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)
Minimum Purge Volume: 4.1 Gallons
Actual Purge Volume: _____ Gallons
Volume Measured by: _____
Rate of Development _____ Gallons/Minute (Hour, Day)
Pumping Rate/Depth _____ @ _____ Ft. (Below Grd.)
Immiscible Phases Present: Y N Thickness _____

Development Criteria: _____

Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific* Conductance	Turbidity (NTU)	D.O., ~~Clarity, Odor, PID~~ Readings, Other: Salinity
0	1 L/m	1312	17.2	7.2	6.41	967	.42 .35
2		1315	17.2	7.16	4.64	118	1.59 .24
4		1319	17.2	7.11	4.29	0	.40 .22
6		1323	17.2	7.1	4.17	6	.28 .21
8		1327	17.2	7.1	4.14	3	.35 .21
10		1333	17.3	7.09	4.14	9	.4 .21
12							
14							

Development Completed at _____ Gallons Discharged. Date: 10/29 Time: _____

Personnel: _____

* Specific Conductance readings temperature compensated to 25°C, if not, report temperatures at which reading obtained.

TETRA TECH EM INC.
MONITORING WELL SAMPLING SHEET

Date: 10/31/02

Monitoring Well No.: 09-MW01 Chain of Custody No.:

Personnel: Doug Sterling

Organic Vapor Concentration TOC: ppm Breathing Zone: ppm

Depth to Well Bottom: 12.0 ft.

Depth to Water: 6.8 ft.

Water Column: 5.2 ft.

Well Volume: 2-inch well = water column x 0.163 gal/ft
3-inch well = water column x 0.367 gal/ft
4-inch well = water column x 0.652 gal/ft

Well Volume Calculation: .84 gal

Time	Vol. Purged ( )	Flow Rate (L/m)	Water Level ( )	pH	Conductivity ( )	Temperature (°C/°F)	Turbidity (NTU)	D. O. (mg/L)	O. R. P. ( )
0830	0	.5	6.8	7.19	397	21.1	3.8	62.9	61.3
0834	1	.5	/	6.94	398	20.3	1.0	21.1	37.9
0837	2	.5	/	6.94	396	20.3	.6	20.2	33.7
0840	3	.5	/	6.93	397	20.4	.2	19.3	29.6
0843	4	.5	/	6.93	395	20.4	.2	18.6	26.6
0845	5	.5	/	6.93	396	20.4	0	19.0	23.5
0847	6	.5	/	6.94	393	20.3	0	17.3	22.7
0850	7	.5	/	6.93	392	20.3	0	16.9	21.7
0853	8	.5	/	6.93	391	20.3	.1	16.2	20.7
0857	9	.5	/	6.94	390	20.3	.1	15.9	19.5
0901	10	.5	/	6.95	387	20.3	0	15.9	19.0

Begin Purge: 0830 Method of Purging Peri Pump Purged Dry? NO

End Purge: 901 Total Volume Purged: 2.5 How Measured? Grad Bucket

QA/QC Sample Collected Here? ☒ Duplicate ☐ Matrix Spike ☐ Equip. Blank ☐ No QA/QC Sample

Date and Time of Sample Collection: 10/31/02 905 Sample Number (s):

Comments:

TETRA TECH EM INC.
MONITORING WELL SAMPLING SHEET

Date: 10/31/02

Monitoring Well No.: 09-MW02 Chain of Custody No.:

Personnel: Doug Sterling

Organic Vapor Concentration TOC: ppm Breathing Zone: ppm

Depth to Well Bottom: 14.6 ft.

Depth to Water: 6.81 ft.

Water Column: 7.79 ft.

Well Volume: 2-inch well = water column x 0.163 gal/ft
3-inch well = water column x 0.367 gal/ft
4-inch well = water column x 0.652 gal/ft

Well Volume Calculation: 1.62 gal

Time	Vol. Purged (L)	Flow Rate (L/m)	Water Level (ft)	pH	Conductivity ( )	Temperature (°C °F)	Turbidity (NTU)	D. O. (mg/L)	O. R. P. ( )
941	0	.5	6.81	7.47	316	17.9	373.4	42.4	30.4
943	1	.5	/	7.53	327	17.4	17.1	11.2	-43.2
947	2	.5	/	7.6	343	17.4	8.0	7.7	-79.2
949	3	.5	/	7.64	357	17.4	4.3	6.6	-100.5
951	4	.5	/	7.67	367	17.4	3.1	5.9	-111.0
953	5	.5	/	7.69	377	17.3	2.3	5.5	-120.5
955	6	.5	/	7.7	385	17.4	1.9	5.0	-128.1
957	7	.5	/	7.7	390	17.3	1.3	4.7	-131.9
959	8	.5	/	7.7	394	17.3	.7	4.5	-134.0
	9								
	10								

Begin Purge: 941 Method of Purging Purged Dry?

End Purge: 959 Total Volume Purged: How Measured?

QA/QC Sample Collected Here? ☐ Duplicate ☐ Matrix Spike ☐ Equip. Blank ☐ No QA/QC Sample

Date and Time of Sample Collection: 10/31/02 1000 Sample Number (s):

Comments:

14

TETRA TECH EM INC.
MONITORING WELL SAMPLING SHEET

Date: 10-31-02

Monitoring Well No.: 09-MW03 Chain of Custody No.: _____

Personnel: D. Sterling

Organic Vapor Concentration TOC: _____ ppm Breathing Zone: _____ ppm

Depth to Well Bottom: ~~4~~ 14.6 ft.

Depth to Water: 6.5' ft.

Water Column: 8.1 ft.

Well Volume: 2-inch well = water column x 0.163 gal/ft
3-inch well = water column x 0.367 gal/ft
4-inch well = water column x 0.652 gal/ft

Well Volume Calculation: .64 gal

Time	Vol. Purged (L/m)	Flow Rate (L/m)	Water Level ( )	pH	Conductivity ( )	Temperature (°C/°F)	Turbidity (NTU)	D. O. (mg/L)	O. R. P. ( )
0740	0	.25	6.5	7.25	331	19.3	56.4	5.06	39.5
0743	2	.5	/	7.54	331	19.5	22.6	1.0	-57.9
0745	3	.5	/	7.61	313	19.5	9.3	9.5	-96.6
0747	4	.5	/	7.65	300	19.6	6.7	8.7	-111.1
0750	5	.5	/	7.67	290	19.6	3.7	9.1	-127.7
0753	6	.5	/	7.68	283	19.6	2.3	7.6	-136.1
0756	7	.5	/	7.69	278	19.6	2.2	7.4	-141.6
0758	8	.5	/	7.7	276	19.7	2.2	7.1	-145.4
0800	9	.5	/	7.7	274	19.6	1.6	6.8	-145.8
0801	10	.5	/	7.7	272	19.7	1.4	6.7	-148.0

Begin Purge: 0740 Method of Purging Peri Pump Purged Dry? NO

End Purge: 0801 Total Volume Purged: 2.5 g How Measured? Grad. Bucket

QA/QC Sample Collected Here? ☐ Duplicate ☒ Matrix Spike ☐ Equip. Blank ☐ No QA/QC Sample

Date and Time of Sample Collection: 10/31/02 805 Sample Number (s): 30209GW03001

Comments: S

TETRA TECH EM INC.
MONITORING WELL SAMPLING SHEET

Date: 10/29/02

Monitoring Well No.: 9 MW 04 Chain of Custody No.: _____

Personnel: _____

Organic Vapor Concentration TOC: _____ ppm Breathing Zone: _____ ppm

Depth to Well Bottom: 16.61 ft.

Depth to Water: 6.65 ft.

Water Column: 9.96 ft.

Well Volume: 2-inch well = water column x 0.163 gal/ft
3-inch well = water column x 0.367 gal/ft
4-inch well = water column x 0.652 gal/ft

Well Volume Calculation: 1.79 gal

Time	Vol. Purged ( )	Flow Rate (L/m)	Water Level ( )	pH	Conductivity ( )	Temperature (°C/°F)	Turbidity (NTU)	D. O. (mg/L)	~~O. R. P.~~ Sal % ( )
1225	0	.5	6.65	7.19	.840	20.0	24	1.12	.03
1231	2	.5	/	6.84	.783	19.5	55	1.09	.02
1235	4	.5	/	7.10	.761	19.5	24	-.19	.03
1238	6	.5	/	7.12	.763	19.5	15	.49	.03
1241	8	.5	/	7.10	.761	19.4	14	1.0	.03
1244	10	.5	/	7.10	.759	19.2	9	1.03	.03
1246	12	.5	/	7.06	.758	19.3	7	.19	.03
1250	14	.5	/	7.03	.756	19.4	4	.52	.03

Begin Purge: 1225 Method of Purging Peristaltic Pump Purged Dry? NO

End Purge: _____ Total Volume Purged: _____ How Measured? _____

QA/QC Sample Collected Here? ☐ Duplicate ☐ Matrix Spike ☐ Equip. Blank ☐ No QA/QC Sample

Date and Time of Sample Collection: _____ Sample Number (s): _____

Comments: _____

TETRA TECH EM INC.
MONITORING WELL SAMPLING SHEET

Date: 10/31/02

Monitoring Well No.: 09-MW05 Chain of Custody No.: _____

Personnel: Doug Sterling

Organic Vapor Concentration TOC: _____ ppm Breathing Zone: _____ ppm

Depth to Well Bottom: 14.6 ft.

Depth to Water: 6.52 ft.

Water Column: 8.08 ft.

Well Volume: 2-inch well = water column x 0.163 gal/ft
3-inch well = water column x 0.367 gal/ft
4-inch well = water column x 0.652 gal/ft

Well Volume Calculation: 1.64 gal

Time	Vol. Purged (L)	Flow Rate (L/m)	Water Level (ft)	pH	Conductivity ( )	Temperature (°C/°F)	Turbidity (NTU)	D.O. (mg/L)	O.R.P. ( )
1020	0	.5	6.52	7.26	518	17.25	131.0	58.6	161.2
1023	1	.5	"	7.50	483	17.37	40.1	11.1	-136.2
1025	2	.5	"	7.57	470	17.38	19.1	6.6	-182.6
1027	3	.5	"	7.60	461	17.39	23.0	5.7	-199.6
1030	4	.5	"	7.62	455	17.39	23.6	5.1	-213.4
1032	5	.5	"	7.63	453	17.39	86.0	4.7	-222.5
1034	6	.5	"	7.63	453	17.39	43.5	4.6	-224.0
1036	7	.5	"	7.63	451	17.39	18.1	4.3	-228.7
1038	8	.5	"	7.64	450	17.39	10.2	4.2	-231.7
1040	9	.5	"	7.64	449	17.39	6.1	4.1	-233.1
1042	10	.5	"	7.64	449	17.40	4.0	4.0	-235.9

Begin Purge: 1020 Method of Purging _____ Purged Dry? NO

End Purge: 1043 Total Volume Purged: 2.5 How Measured? _____

QA/QC Sample Collected Here? ☐ Duplicate ☐ Matrix Spike ☐ Equip. Blank ☐ No QA/QC Sample

Date and Time of Sample Collection: 10/31/02 1045 Sample Number (s): _____

Comments: _____

TETRA TECH EM INC.
MONITORING WELL SAMPLING SHEET

Date: 10/31/02

Monitoring Well No.: 09-MW06 Chain of Custody No.: _____

Personnel: Doug Sterling

Organic Vapor Concentration TOC: _____ ppm Breathing Zone: _____ ppm

Depth to Well Bottom: 14.6 ft.

Depth to Water: 6.63 ft.

Water Column: 7.97 ft.

Well Volume: 2-inch well = water column x 0.163 gal/ft
3-inch well = water column x 0.367 gal/ft
4-inch well = water column x 0.652 gal/ft

Well Volume Calculation: 1.63 gal

Time	Vol. Purged (L)	Flow Rate (L/m)	Water Level (ft)	pH	Conductivity ( )	Temperature (°C/°F)	Turbidity (NTU)	D. O. (mg/L)	O. R. P. ( )
1110	0	.5	6.63	7.25	598	17.31	422.6	54.9	-23.6
1114	1	.5	✓	7.38	557	17.43	57.6	9.7	-99.2
1116	2	.5	✓	7.47	519	17.45	27.2	6.4	-120.8
1118	3	.5	✓	7.56	459	17.45	16.2	5.3	-131.9
1120	4	.5	✓	7.60	425	17.45	9.4	4.8	-140.4
1122	5	.5	✓	7.62	404	17.45	7.0	4.4	-143.6
1124	6	.5	✓	7.69	376	17.45	6.3	4.1	-150.7
1126	7	.5	✓	7.68	374	17.45	4.0	3.9	-151.3
1128	8	.5	✓	7.70	368	17.45	3.5	3.8	-154.8
1130	9	.5	✓	7.73	362	17.45	4.4	3.7	-159.5
	10								

Begin Purge: 1110 Method of Purging _____ Purged Dry? _____

End Purge: 1133 Total Volume Purged: _____ How Measured? _____

QA/QC Sample Collected Here? ☐ Duplicate ☐ Matrix Spike ☐ Equip. Blank ☐ No QA/QC Sample

Date and Time of Sample Collection: 10/31/02 1135 Sample Number (s): _____

Comments: _____

Tetra Tech EM Inc.
Monitor Well Sampling Form

Date: 11-4-02 **Project:** Treasure Island

Well Name: 09-mw07 **Well Location:** Site 9

Well Stick Up: Flush **Measuring Point:** TOC

Well Depth: 15' **Purge Method:** Peristaltic

Static Water Level: 6.84' **Well Diameter:** 3/4"

Water in Well (feet): 8.16' **Volume in Well (gallons):**

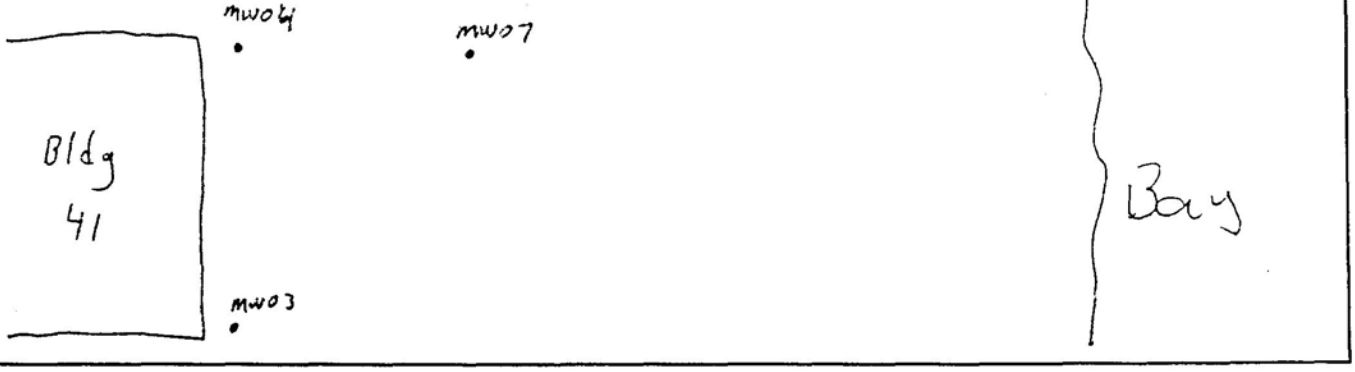
			Parameters							
Date	**Time Sampled**	**Volume Purged (gallons)**	Temp	uS/cm Cond.	DO mg/l	pH	ORP	Turb NTU		
11-4-02		2	19.30	24054	1.95	7.04	-63	58.1		
		2.2	19.31	23816	1.82	7.07	-76	46.4		
		2.4	19.37	22614	1.33	7.17	-121	11.3		
		2.5	19.36	22582	1.34	7.17	-121	10.5		
		2.6	19.35	22501	1.29	7.17	-124	9.9		
	0900	2.7	19.35	22496	1.29	7.17	-125	9.7		

Comments:

Purge + surge 2 gallons until water is clear
Sample well for VOC's, SVOC's, Metals, Pest/PCB, + TPH(E+P)
Sample time 0900

Volumes: 2" - .16xh, 4" - .67xh, 6" - 1.5xh, 8" - 2.68xh

Location Diagram



TETRA TECH EM INC.
MONITORING WELL SAMPLING SHEET

Date: 10/30/02

Monitoring Well No.: 19-MW02 Chain of Custody No.: _____

Personnel: _____

Organic Vapor Concentration TOC: _____ ppm Breathing Zone: _____ ppm

Depth to Well Bottom: 14.6 ft.

Depth to Water: 7.0 ft.

Water Column: 7.6 ft.

Well Volume: 2-inch well = water column x 0.163 gal/ft
3-inch well = water column x 0.367 gal/ft
4-inch well = water column x 0.652 gal/ft

Well Volume Calculation: .52 gal

Time	Vol. Purged ( )	Flow Rate (l/m)	Water Level ( )	pH	Conductivity ( )	Temperature (°C/°F)	Turbidity (NTU)	D. O. (mg/L)	Sal % ~~O. R. P.~~ ( )
1112	0	.5	7.0	7.01	4.24	17.1	0	.15	.21
1116	2	.5	/	7.02	4.59	17.3	0	.18	.23
1118	4	.5	/	7.04	4.56	17.3	0	.10	.23
1121	6	.5	/	7.03	4.53	17.3	0	0	.23

Begin Purge: 1112 Method of Purging Peristaltic Pump Purged Dry? NO

End Purge: 1122 Total Volume Purged: 1 gal How Measured? _____

QA/QC Sample Collected Here? ☐ Duplicate ☐ Matrix Spike ☐ Equip. Blank ☐ No QA/QC Sample

Date and Time of Sample Collection: 10/30/02 Sample Number (s): _____

Comments: _____

TETRA TECH EM INC.
MONITORING WELL SAMPLING SHEET

Date: 10/30/02

Monitoring Well No.: ~~03~~ 10 MW03 Chain of Custody No.:

Personnel:

Organic Vapor Concentration TOC: ppm Breathing Zone: ppm

Depth to Well Bottom: 14.52 ft. Well Volume: 2-inch well = water column x 0.163 gal/ft
3-inch well = water column x 0.367 gal/ft
4-inch well = water column x 0.652 gal/ft

Depth to Water: 7.9 ft.

Water Column: 6.62 ft. Well Volume Calculation: .32 gal

Time	Vol. Purged ( )	Flow Rate (L/m)	Water Level ( )	pH	Conduc-tivity ( )	Temp-erature (°C/°F)	Turbidity (NTU)	D. O. (mg/L)	Sal% ~~O.R.P.~~ ( )
1020	0	.5	7.9	6.79	27.1	17.5	0	.32	1.66
1025	2			6.78	27.2	17.5	0	.32	1.67
1028	4			6.77	27.3	17.8	0	.32	1.68

Begin Purge: 1020 Method of Purging Peristaltic Pump Purged Dry? NO

End Purge: 1030 Total Volume Purged: 1 gal How Measured? Graduated Bucket

QA/QC Sample Collected Here? ☐ Duplicate ☐ Matrix Spike ☐ Equip. Blank ☐ No QA/QC Sample

Date and Time of Sample Collection: 10/30/02 1040 Sample Number (s):

Comments:

APPENDIX C
SITE 09 ANALYTICAL DATA

SITE 09
SOIL ANALYTICAL RESULTS

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP003	09-HP003	09-HP004	09-HP004
Sample ID	199HH001	199HH004	199HH006	199HH007	199HH008	199HH009	199HH010
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995
Sample Depth	1.25 - 1.75	6.50 - 7.00	1.00 - 1.50	3.25 - 3.75	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP003	09-HP003	09-HP004	09-HP004
Sample ID	199HH001	199HH004	199HH006	199HH007	199HH008	199HH009	199HH010
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995
Sample Depth	1.25 - 1.75	6.50 - 7.00	1.00 - 1.50	3.25 - 3.75	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP003	09-HP003	09-HP004	09-HP004
Sample ID	199HH001	199HH004	199HH006	199HH007	199HH008	199HH009	199HH010
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995
Sample Depth	1.25 - 1.75	6.50 - 7.00	1.00 - 1.50	3.25 - 3.75	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	21 Y	38,000 JY a	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	85 Y	12,000 JY a	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.38 U	12 U	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	0.38 U	12 U	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	0.38 U	12 U	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	0.38 U	12 U	NA	NA	NA	NA	NA
2,2'-OXYBIS(1-CHLOROPROPANE)	0.38 U	12 U	NA	NA	NA	NA	NA
2,4,5-TRICHLOROPHENOL	0.95 U	30 U	NA	NA	NA	NA	NA
2,4,6-TRICHLOROPHENOL	0.38 U	12 U	NA	NA	NA	NA	NA
2,4-DICHLOROPHENOL	0.38 U	12 U	NA	NA	NA	NA	NA
2,4-DIMETHYLPHENOL	0.38 U	12 U	NA	NA	NA	NA	NA
2,4-DINITROPHENOL	0.95 U	30 U	NA	NA	NA	NA	NA
2,4-DINITROTOLUENE	0.38 U	12 U	NA	NA	NA	NA	NA
2,6-DINITROTOLUENE	0.38 U	12 U	NA	NA	NA	NA	NA
2-CHLORONAPHTHALENE	0.38 U	12 U	NA	NA	NA	NA	NA
2-CHLOROPHENOL	0.38 U	12 U	NA	NA	NA	NA	NA
2-METHYLNAPHTHALENE	0.38 U	12 U	NA	NA	NA	NA	NA
2-METHYLPHENOL	0.38 U	12 U	NA	NA	NA	NA	NA
2-NITROANILINE	0.95 U	30 U	NA	NA	NA	NA	NA
2-NITROPHENOL	0.38 U	12 U	NA	NA	NA	NA	NA
3,3'-DICHLOROBENZIDINE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
3-NITROANILINE	0.95 U	30 U	NA	NA	NA	NA	NA
4,6-DINITRO-2-METHYLPHENOL	0.95 U	30 UJ i	NA	NA	NA	NA	NA
4-BROMOPHENYL-PHENYLETHER	0.38 U	12 UJ i	NA	NA	NA	NA	NA
4-CHLORO-3-METHYLPHENOL	0.38 U	12 U	NA	NA	NA	NA	NA
4-CHLOROANILINE	0.38 U	12 U	NA	NA	NA	NA	NA
4-CHLOROPHENYL-PHENYLETHER	0.38 U	12 U	NA	NA	NA	NA	NA
4-METHYLPHENOL	0.38 U	12 U	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP003	09-HP003	09-HP004	09-HP004
Sample ID	199HH001	199HH004	199HH006	199HH007	199HH008	199HH009	199HH010
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995
Sample Depth	1.25 - 1.75	6.50 - 7.00	1.00 - 1.50	3.25 - 3.75	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.95 U	30 U	NA	NA	NA	NA	NA
4-NITROPHENOL	0.95 U	30 U	NA	NA	NA	NA	NA
ACENAPHTHENE	0.38 U	12 U	NA	NA	NA	NA	NA
ACENAPHTHYLENE	0.38 U	12 U	NA	NA	NA	NA	NA
ANTHRACENE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
BENZO(A)ANTHRACENE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
BENZO(A)PYRENE	0.38 U	12 R i	NA	NA	NA	NA	NA
BENZO(B)FLUORANTHENE	0.38 U	12 R i	NA	NA	NA	NA	NA
BENZO(G,H,I)PERYLENE	0.38 U	12 R i	NA	NA	NA	NA	NA
BENZO(K)FLUORANTHENE	0.38 U	12 R i	NA	NA	NA	NA	NA
BIS(2-CHLOROETHOXY)METHANE	0.38 U	12 U	NA	NA	NA	NA	NA
BIS(2-CHLOROETHYL)ETHER	0.38 U	12 U	NA	NA	NA	NA	NA
BIS(2-ETHYLHEXYL)PHTHALATE	0.38 U	7.6 UJ i	NA	NA	NA	NA	NA
BUTYLBENZYLPHTHALATE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
CARBAZOLE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
CHRYSENE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
DI-N-BUTYLPHTHALATE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
DI-N-OCTYLPHTHALATE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
DIBENZ(A,H)ANTHRACENE	0.38 U	12 R i	NA	NA	NA	NA	NA
DIBENZOFURAN	0.38 U	12 U	NA	NA	NA	NA	NA
DIETHYLPHTHALATE	0.38 U	12 U	NA	NA	NA	NA	NA
DIMETHYLPHTHALATE	0.38 U	12 U	NA	NA	NA	NA	NA
FLUORANTHENE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
FLUORENE	0.38 U	12 U	NA	NA	NA	NA	NA
HEXACHLOROBENZENE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	0.38 U	12 U	NA	NA	NA	NA	NA
HEXACHLOROCYCLOPENTADIENE	0.38 U	12 U	NA	NA	NA	NA	NA
HEXACHLOROETHANE	0.38 U	12 U	NA	NA	NA	NA	NA
INDENO(1,2,3-CD)PYRENE	0.38 U	12 R i	NA	NA	NA	NA	NA
ISOPHORONE	0.38 U	12 U	NA	NA	NA	NA	NA
N-NITROSO-DI-N-PROPYLAMINE	0.38 U	12 U	NA	NA	NA	NA	NA
N-NITROSODIPHENYLAMINE (1)	0.38 U	12 UJ i	NA	NA	NA	NA	NA
NAPHTHALENE	0.38 U	12 U	NA	NA	NA	NA	NA
NITROBENZENE	0.38 U	12 U	NA	NA	NA	NA	NA
PENTACHLOROPHENOL	0.95 U	30 UJ i	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP003	09-HP003	09-HP004	09-HP004
Sample ID	199HH001	199HH004	199HH006	199HH007	199HH008	199HH009	199HH010
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995
Sample Depth	1.25 - 1.75	6.50 - 7.00	1.00 - 1.50	3.25 - 3.75	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
PHENOL	1.1	16	NA	NA	NA	NA	NA
PYRENE	0.38 U	12 UJ i	NA	NA	NA	NA	NA
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.0076 U	0.079 U	0.0037 UJ h	NA	NA	NA	NA
4,4'-DDE	0.0076 U	0.079 U	0.0037 UJ h	NA	NA	NA	NA
4,4'-DDT	0.0076 U	0.079 U	0.0037 UJ h	NA	NA	NA	NA
ALDRIN	0.0038 U	0.04 U	0.0019 UJ h	NA	NA	NA	NA
ALPHA-BHC	0.0038 U	0.04 U	0.0019 UJ h	NA	NA	NA	NA
ALPHA-CHLORDANE	0.0038 U	0.04 U	0.0019 UJ h	NA	NA	NA	NA
AROCLOR-1016	0.076 U	0.79 U	0.019 UJ h	NA	NA	NA	NA
AROCLOR-1221	0.15 U	1.6 U	0.019 UJ h	NA	NA	NA	NA
AROCLOR-1232	0.076 U	0.79 U	0.019 UJ h	NA	NA	NA	NA
AROCLOR-1242	0.076 U	0.79 U	0.019 UJ h	NA	NA	NA	NA
AROCLOR-1248	0.076 U	0.79 U	0.019 UJ h	NA	NA	NA	NA
AROCLOR-1254	0.076 U	0.79 U	0.019 UJ h	NA	NA	NA	NA
AROCLOR-1260	0.076 U	0.79 U	0.019 UJ h	NA	NA	NA	NA
BETA-BHC	0.0038 U	0.04 U	0.0019 UJ h	NA	NA	NA	NA
DELTA-BHC	0.0038 U	0.04 U	0.0019 UJ h	NA	NA	NA	NA
DIELDRIN	0.0076 U	0.079 U	0.0037 UJ h	NA	NA	NA	NA
ENDOSULFAN I	0.0038 U	0.04 U	0.0019 UJ h	NA	NA	NA	NA
ENDOSULFAN II	0.0076 U	0.079 U	0.0037 UJ h	NA	NA	NA	NA
ENDOSULFAN SULFATE	0.0076 U	0.079 U	0.0037 UJ h	NA	NA	NA	NA
ENDRIN	0.0076 U	0.079 U	0.0037 UJ h	NA	NA	NA	NA
ENDRIN ALDEHYDE	0.0076 U	0.079 U	0.0037 UJ h	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP003	09-HP003	09-HP004	09-HP004
Sample ID	199HH001	199HH004	199HH006	199HH007	199HH008	199HH009	199HH010
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995
Sample Depth	1.25 - 1.75	6.50 - 7.00	1.00 - 1.50	3.25 - 3.75	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0076 U	0.079 U	0.0037 UJ h	NA	NA	NA	NA
GAMMA-BHC (LINDANE)	0.0038 U	0.04 U	0.0019 UJ h	NA	NA	NA	NA
GAMMA-CHLORDANE	0.0038 U	0.04 U	0.0019 UJ h	NA	NA	NA	NA
HEPTACHLOR	0.0038 U	0.04 U	0.0019 UJ h	NA	NA	NA	NA
HEPTACHLOR EPOXIDE	0.0038 U	0.04 U	0.0004 UJ h	NA	NA	NA	NA
METHOXYCHLOR	0.038 U	0.4 U	0.019 UJ h	NA	NA	NA	NA
TOXAPHENE	0.38 U	4 U	0.11 UJ h	NA	NA	NA	NA
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	38.6	25.1	NA	NA	23.2	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	17.9	2.6	2.8	2.7	2.7	2.4	2.4
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	0.05 UJ e	0.05 UJ e	NA	NA	0.05 UJ e	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP004	09-HP005	09-HP005	09-HP005	09-HP006	09-SB01	09-SB01
Sample ID	199HH011	199HH012	199HH013	199HH014	199HH015	09SB01A	09SB01B
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	07/16/1992	07/16/1992
Sample Depth	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75	5.50 - 6.00	0.50 - 1.00	0.50 - 1.00	2.00 - 2.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	0.011 U	0.011 U
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	0.011 U	0.011 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	0.011 U	0.011 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	0.011 U	0.011 U
ACETONE	NA	NA	NA	NA	NA	0.011 U	0.011 U
BENZENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
BROMOFORM	NA	NA	NA	NA	NA	0.011 U	0.011 U
BROMOMETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
CARBON DISULFIDE	NA	NA	NA	NA	NA	0.011 U	0.011 U
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	0.011 U	0.011 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP004	09-HP005	09-HP005	09-HP005	09-HP006	09-SB01	09-SB01
Sample ID	199HH011	199HH012	199HH013	199HH014	199HH015	09SB01A	09SB01B
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	07/16/1992	07/16/1992
Sample Depth	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75	5.50 - 6.00	0.50 - 1.00	0.50 - 1.00	2.00 - 2.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
CHLOROETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
CHLOROFORM	NA	NA	NA	NA	NA	0.011 U	0.011 U
CHLOROMETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	0.011 U	0.011 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	0.014 UJ b	0.036 UJ b
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
TOLUENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
TRICHLOROETHENE	NA	NA	NA	NA	NA	0.011 U	0.011 U
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	0.011 U	0.011 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	0.011 U	0.011 U
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP004	09-HP005	09-HP005	09-HP005	09-HP006	09-SB01	09-SB01
Sample ID	199HH011	199HH012	199HH013	199HH014	199HH015	09SB01A	09SB01B
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	07/16/1992	07/16/1992
Sample Depth	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75	5.50 - 6.00	0.50 - 1.00	0.50 - 1.00	2.00 - 2.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	NA	NA	NA	0.73 U	0.7 U
2,4,5-TRICHLOROPHENOL	NA	NA	NA	NA	NA	1.8 U	1.7 U
2,4,6-TRICHLOROPHENOL	NA	NA	NA	NA	NA	0.73 U	0.7 U
2,4-DICHLOROPHENOL	NA	NA	NA	NA	NA	0.73 U	0.7 U
2,4-DIMETHYLPHENOL	NA	NA	NA	NA	NA	0.73 U	0.7 U
2,4-DINITROPHENOL	NA	NA	NA	NA	NA	1.8 U	1.7 U
2,4-DINITROTOLUENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
2,6-DINITROTOLUENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
2-CHLORONAPHTHALENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
2-CHLOROPHENOL	NA	NA	NA	NA	NA	0.73 U	0.7 U
2-METHYLNAPHTHALENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
2-METHYLPHENOL	NA	NA	NA	NA	NA	0.73 U	0.7 U
2-NITROANILINE	NA	NA	NA	NA	NA	1.8 U	1.7 U
2-NITROPHENOL	NA	NA	NA	NA	NA	0.73 U	0.7 U
3,3'-DICHLOROBENZIDINE	NA	NA	NA	NA	NA	0.73 U	0.7 U
3-NITROANILINE	NA	NA	NA	NA	NA	1.8 U	1.7 U
4,6-DINITRO-2-METHYLPHENOL	NA	NA	NA	NA	NA	1.8 U	1.7 U
4-BROMOPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	0.73 U	0.7 U
4-CHLORO-3-METHYLPHENOL	NA	NA	NA	NA	NA	0.73 U	0.7 U
4-CHLOROANILINE	NA	NA	NA	NA	NA	0.73 U	0.7 U
4-CHLOROPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	0.73 U	0.7 U
4-METHYLPHENOL	NA	NA	NA	NA	NA	0.73 U	0.7 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP004	09-HP005	09-HP005	09-HP005	09-HP006	09-SB01	09-SB01
Sample ID	199HH011	199HH012	199HH013	199HH014	199HH015	09SB01A	09SB01B
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	07/16/1992	07/16/1992
Sample Depth	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75	5.50 - 6.00	0.50 - 1.00	0.50 - 1.00	2.00 - 2.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	NA	NA	NA	NA	NA	1.8 U	1.7 U
4-NITROPHENOL	NA	NA	NA	NA	NA	1.8 U	1.7 U
ACENAPHTHENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
ACENAPHTHYLENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
ANTHRACENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
BENZO(A)ANTHRACENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
BENZO(A)PYRENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
BENZO(G,H,I)PERYLENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
BENZO(K)FLUORANTHENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
BIS(2-CHLOROETHOXY)METHANE	NA	NA	NA	NA	NA	0.73 U	0.7 U
BIS(2-CHLOROETHYL)ETHER	NA	NA	NA	NA	NA	0.73 U	0.7 U
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	NA	NA	0.73 U	0.7 UJ b
BUTYLBENZYLPHTHALATE	NA	NA	NA	NA	NA	0.73 U	0.7 UJ b
CARBAZOLE	NA	NA	NA	NA	NA	0.73 U	0.7 U
CHRYSENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
DI-N-BUTYLPHTHALATE	NA	NA	NA	NA	NA	0.73 U	0.7 U
DI-N-OCTYLPHTHALATE	NA	NA	NA	NA	NA	0.73 U	0.7 U
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
DIBENZOFURAN	NA	NA	NA	NA	NA	0.73 U	0.7 U
DIETHYLPHTHALATE	NA	NA	NA	NA	NA	0.73 U	0.7 U
DIMETHYLPHTHALATE	NA	NA	NA	NA	NA	0.73 U	0.7 U
FLUORANTHENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
FLUORENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
HEXACHLOROBENZENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
HEXACHLOROCYCLOPENTADIENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
HEXACHLOROETHANE	NA	NA	NA	NA	NA	0.73 U	0.7 U
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
ISOPHORONE	NA	NA	NA	NA	NA	0.73 U	0.7 U
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	NA	NA	NA	0.73 U	0.7 U
N-NITROSODIPHENYLAMINE (1)	NA	NA	NA	NA	NA	0.73 U	0.7 U
NAPHTHALENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
NITROBENZENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
PENTACHLOROPHENOL	NA	NA	NA	NA	NA	1.8 U	1.7 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP004	09-HP005	09-HP005	09-HP005	09-HP006	09-SB01	09-SB01
Sample ID	199HH011	199HH012	199HH013	199HH014	199HH015	09SB01A	09SB01B
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	07/16/1992	07/16/1992
Sample Depth	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75	5.50 - 6.00	0.50 - 1.00	0.50 - 1.00	2.00 - 2.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
PHENOL	NA	NA	NA	NA	NA	0.73 U	0.7 U
PYRENE	NA	NA	NA	NA	NA	0.73 U	0.7 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	NA	NA	NA	NA	NA	0.0036 U	0.0035 U
4,4'-DDE	NA	NA	NA	NA	NA	0.0036 U	0.0035 U
4,4'-DDT	NA	NA	NA	NA	NA	0.0036 U	0.0035 U
ALDRIN	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
ALPHA-BHC	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
ALPHA-CHLORDANE	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
AROCLOR-1016	NA	NA	NA	NA	NA	0.0364 U	0.0347 U
AROCLOR-1221	NA	NA	NA	NA	NA	0.074 U	0.0704 U
AROCLOR-1232	NA	NA	NA	NA	NA	0.0364 U	0.0347 U
AROCLOR-1242	NA	NA	NA	NA	NA	0.0364 U	0.0347 U
AROCLOR-1248	NA	NA	NA	NA	NA	0.0364 U	0.0347 U
AROCLOR-1254	NA	NA	NA	NA	NA	0.0364 U	0.0347 U
AROCLOR-1260	NA	NA	NA	NA	NA	0.0364 U	0.0347 U
BETA-BHC	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
DELTA-BHC	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
DIELDRIN	NA	NA	NA	NA	NA	0.0036 U	0.0035 U
ENDOSULFAN I	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
ENDOSULFAN II	NA	NA	NA	NA	NA	0.0036 U	0.0035 U
ENDOSULFAN SULFATE	NA	NA	NA	NA	NA	0.0036 U	0.0035 U
ENDRIN	NA	NA	NA	NA	NA	0.0036 U	0.0035 U
ENDRIN ALDEHYDE	NA	NA	NA	NA	NA	0.0036 U	0.0035 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP004	09-HP005	09-HP005	09-HP005	09-HP006	09-SB01	09-SB01
Sample ID	199HH011	199HH012	199HH013	199HH014	199HH015	09SB01A	09SB01B
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	07/16/1992	07/16/1992
Sample Depth	5.50 - 6.00	0.75 - 1.25	3.25 - 3.75	5.50 - 6.00	0.50 - 1.00	0.50 - 1.00	2.00 - 2.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	NA	NA	NA	NA	NA	0.0036 U	0.0035 U
GAMMA-BHC (LINDANE)	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
GAMMA-CHLORDANE	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
HEPTACHLOR	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
HEPTACHLOR EPOXIDE	NA	NA	NA	NA	NA	0.0019 U	0.0018 U
METHOXYCHLOR	NA	NA	NA	NA	NA	0.0188 U	0.0179 U
TOXAPHENE	NA	NA	NA	NA	NA	0.188 U	0.179 U
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	5,960 J e	3,900 J e
ANTIMONY	NA	NA	NA	NA	NA	10.7 UJ e	10.2 UJ e
ARSENIC	NA	NA	NA	NA	NA	7	2.1 J g
BARIUM	NA	NA	NA	NA	NA	48	8.9 J g
BERYLLIUM	NA	NA	NA	NA	NA	0.22 J g	0.21 J g
CADMIUM	NA	NA	NA	NA	NA	0.89 J g	0.64 U
CALCIUM	NA	NA	NA	NA	NA	10,000 J d	1,990 J d
CHROMIUM	NA	NA	NA	NA	NA	57.3	27.8
COBALT	NA	NA	NA	NA	NA	8.4 J g	7.4 J g
COPPER	NA	NA	NA	NA	NA	33.6 UJ b	16.1 UJ b
IRON	NA	NA	NA	NA	NA	15,900	9,410
LEAD	2.4	4.1	2.9	2.4	40	42 J de	2.9 J de
MAGNESIUM	NA	NA	NA	NA	NA	4,640	2,010
MANGANESE	NA	NA	NA	NA	NA	269 J e	86.9 J e
MERCURY	NA	NA	NA	NA	NA	0.11 UJ dh	0.11 UJ dh
MOLYBDENUM	NA	NA	NA	NA	NA	2.2 U	2.1 U
NICKEL	NA	NA	NA	NA	NA	43.8	25
POTASSIUM	NA	NA	NA	NA	NA	682 J g	708 J g
SELENIUM	NA	NA	NA	NA	NA	0.67 U	0.64 U
SILVER	NA	NA	NA	NA	NA	2.9 J e	1.1 U
SODIUM	NA	NA	NA	NA	NA	192 UJ b	45.6 U
THALLIUM	NA	NA	NA	NA	NA	0.67 U	0.64 UJ e
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	25.6	16.9
ZINC	NA	NA	NA	NA	NA	101 J d	28 UJ bd
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB01	09-SB02	09-SB02	09-SB02	09-SB02	09-SB02	09-SB03
Sample ID	09SB01C	09SB02A	09SB02B	09SB02C	09SB02BA	09SB02CA	09SB03A
Sample Date	07/16/1992	07/16/1992	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992
Sample Depth	4.50 - 5.00	0.80 - 1.30	2.50 - 3.00	4.50 - 5.00	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
1,1,2,2-TETRACHLOROETHANE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
1,1,2-TRICHLOROETHANE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
1,1-DICHLOROETHANE	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
1,1-DICHLOROETHENE	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
1,2-DICHLOROETHENE (TOTAL)	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
1,2-DICHLOROPROPANE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
ACETONE	0.019 UJ b	0.3	0.014 UJ b	0.024 UJ b	NA	NA	0.012 U
BENZENE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
BROMOFORM	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
BROMOMETHANE	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
CARBON DISULFIDE	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
CARBON TETRACHLORIDE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB01	09-SB02	09-SB02	09-SB02	09-SB02	09-SB02	09-SB03
Sample ID	09SB01C	09SB02A	09SB02B	09SB02C	09SB02BA	09SB02CA	09SB03A
Sample Date	07/16/1992	07/16/1992	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992
Sample Depth	4.50 - 5.00	0.80 - 1.30	2.50 - 3.00	4.50 - 5.00	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
CHLOROETHANE	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
CHLOROFORM	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
CHLOROMETHANE	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
DIBROMOCHLOROMETHANE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	0.011 UJ b	0.022 UJ b	0.01 UJ b	0.01 UJ b	NA	NA	0.012 UJ b
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
TOLUENE	0.011 U	0.003 J gj	0.01 U	0.01 U	NA	NA	0.012 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
TRICHLOROETHENE	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	0.011 U	0.01 U	0.01 U	0.01 U	NA	NA	0.012 U
XYLENE (TOTAL)	0.011 U	0.01 UJ i	0.01 U	0.01 U	NA	NA	0.012 U
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB01	09-SB02	09-SB02	09-SB02	09-SB02	09-SB02	09-SB03
Sample ID	09SB01C	09SB02A	09SB02B	09SB02C	09SB02BA	09SB02CA	09SB03A
Sample Date	07/16/1992	07/16/1992	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992
Sample Depth	4.50 - 5.00	0.80 - 1.30	2.50 - 3.00	4.50 - 5.00	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
1,2-DICHLOROBENZENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
1,3-DICHLOROBENZENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
1,4-DICHLOROBENZENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2,2'-OXYBIS(1-CHLOROPROPANE)	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2,4,5-TRICHLOROPHENOL	1.7 U	1.7 U	NA	NA	1.6 U	1.7 U	NA
2,4,6-TRICHLOROPHENOL	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2,4-DICHLOROPHENOL	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2,4-DIMETHYLPHENOL	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2,4-DINITROPHENOL	1.7 U	1.7 U	NA	NA	1.6 U	1.7 U	NA
2,4-DINITROTOLUENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2,6-DINITROTOLUENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2-CHLORONAPHTHALENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2-CHLOROPHENOL	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2-METHYLNAPHTHALENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2-METHYLPHENOL	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
2-NITROANILINE	1.7 U	1.7 U	NA	NA	1.6 U	1.7 U	NA
2-NITROPHENOL	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
3,3'-DICHLOROBENZIDINE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
3-NITROANILINE	1.7 U	1.7 U	NA	NA	1.6 U	1.7 U	NA
4,6-DINITRO-2-METHYLPHENOL	1.7 U	1.7 U	NA	NA	1.6 U	1.7 U	NA
4-BROMOPHENYL-PHENYLETHER	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
4-CHLORO-3-METHYLPHENOL	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
4-CHLOROANILINE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
4-CHLOROPHENYL-PHENYLETHER	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
4-METHYLPHENOL	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB01	09-SB02	09-SB02	09-SB02	09-SB02	09-SB02	09-SB03
Sample ID	09SB01C	09SB02A	09SB02B	09SB02C	09SB02BA	09SB02CA	09SB03A
Sample Date	07/16/1992	07/16/1992	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992
Sample Depth	4.50 - 5.00	0.80 - 1.30	2.50 - 3.00	4.50 - 5.00	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	1.7 U	1.7 U	NA	NA	1.6 U	1.7 U	NA
4-NITROPHENOL	1.7 U	1.7 U	NA	NA	1.6 U	1.7 U	NA
ACENAPHTHENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
ACENAPHTHYLENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
ANTHRACENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
BENZO(A)ANTHRACENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
BENZO(A)PYRENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
BENZO(B)FLUORANTHENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
BENZO(G,H,I)PERYLENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
BENZO(K)FLUORANTHENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
BIS(2-CHLOROETHOXY)METHANE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
BIS(2-CHLOROETHYL)ETHER	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
BIS(2-ETHYLHEXYL)PHTHALATE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
BUTYLBENZYLPHTHALATE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
CARBAZOLE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
CHRYSENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
DI-N-BUTYLPHTHALATE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
DI-N-OCTYLPHTHALATE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
DIBENZ(A,H)ANTHRACENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
DIBENZOFURAN	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
DIETHYLPHTHALATE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
DIMETHYLPHTHALATE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
FLUORANTHENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
FLUORENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
HEXACHLOROBENZENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
HEXACHLOROBUTADIENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
HEXACHLOROCYCLOPENTADIENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
HEXACHLOROETHANE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
INDENO(1,2,3-CD)PYRENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
ISOPHORONE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
N-NITROSO-DI-N-PROPYLAMINE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
N-NITROSODIPHENYLAMINE (1)	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
NAPHTHALENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
NITROBENZENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
PENTACHLOROPHENOL	1.7 U	1.7 U	NA	NA	1.6 U	1.7 U	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB01	09-SB02	09-SB02	09-SB02	09-SB02	09-SB02	09-SB03
Sample ID	09SB01C	09SB02A	09SB02B	09SB02C	09SB02BA	09SB02CA	09SB03A
Sample Date	07/16/1992	07/16/1992	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992
Sample Depth	4.50 - 5.00	0.80 - 1.30	2.50 - 3.00	4.50 - 5.00	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
PHENOL	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
PYRENE	0.72 U	0.69 U	NA	NA	0.68 U	0.71 U	NA
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.0036 U	0.0034 U	0.0034 U	0.0034 U	NA	NA	0.004 U
4,4'-DDE	0.0036 U	0.0034 U	0.0034 U	0.0034 U	NA	NA	0.004 U
4,4'-DDT	0.0036 U	0.0034 U	0.0034 U	0.0034 U	NA	NA	0.004 U
ALDRIN	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
ALPHA-BHC	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
ALPHA-CHLORDANE	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
AROCLOR-1016	0.0359 U	0.0342 U	0.0342 U	0.0342 U	NA	NA	0.04 U
AROCLOR-1221	0.0729 U	0.0694 U	0.0695 U	0.0695 U	NA	NA	0.0813 U
AROCLOR-1232	0.0359 U	0.0342 U	0.0342 U	0.0342 U	NA	NA	0.04 U
AROCLOR-1242	0.0359 U	0.0342 U	0.0342 U	0.0342 U	NA	NA	0.04 U
AROCLOR-1248	0.0359 U	0.0342 U	0.0342 U	0.0342 U	NA	NA	0.04 U
AROCLOR-1254	0.0359 U	0.0342 U	0.0342 U	0.0342 U	NA	NA	0.04 U
AROCLOR-1260	0.0359 U	0.0342 U	0.0342 U	0.0342 U	NA	NA	0.04 U
BETA-BHC	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
DELTA-BHC	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
DIELDRIN	0.0036 U	0.0034 U	0.0034 U	0.0034 U	NA	NA	0.004 U
ENDOSULFAN I	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
ENDOSULFAN II	0.0036 U	0.0034 U	0.0034 U	0.0034 U	NA	NA	0.004 U
ENDOSULFAN SULFATE	0.0036 U	0.0034 U	0.0034 U	0.0034 U	NA	NA	0.004 U
ENDRIN	0.0036 U	0.0034 U	0.0034 U	0.0034 U	NA	NA	0.004 U
ENDRIN ALDEHYDE	0.0036 U	0.0034 U	0.0034 U	0.0034 U	NA	NA	0.004 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB01	09-SB02	09-SB02	09-SB02	09-SB02	09-SB02	09-SB03
Sample ID	09SB01C	09SB02A	09SB02B	09SB02C	09SB02BA	09SB02CA	09SB03A
Sample Date	07/16/1992	07/16/1992	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992
Sample Depth	4.50 - 5.00	0.80 - 1.30	2.50 - 3.00	4.50 - 5.00	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0036 U	0.0034 U	0.0034 U	0.0034 U	NA	NA	0.004 U
GAMMA-BHC (LINDANE)	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
GAMMA-CHLORDANE	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
HEPTACHLOR	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
HEPTACHLOR EPOXIDE	0.0019 U	0.0018 U	0.0018 U	0.0018 U	NA	NA	0.0021 U
METHOXYCHLOR	0.0185 U	0.0176 U	0.0176 U	0.0176 U	NA	NA	0.0206 U
TOXAPHENE	0.185 U	0.176 U	0.176 U	0.176 U	NA	NA	0.206 U
Metals (mg/kg)							
ALUMINUM	5,000 J e	5,130 J e	3,320 J e	3,960 J e	NA	NA	9,600 J e
ANTIMONY	10.4 UJ e	10 UJ e	10 UJ e	10.1 UJ e	NA	NA	20 UJ be
ARSENIC	2.5	3.6	2.6	2.9	NA	NA	14.8
BARIUM	11.7 J g	24.1 J g	7.9 J g	8.8 J g	NA	NA	128
BERYLLIUM	0.22 J g	0.21 J g	0.21 J g	0.21 J g	NA	NA	0.24 J g
CADMIUM	0.65 U	0.62 U	0.63 U	0.63 U	NA	NA	0.97 J g
CALCIUM	2,700 J d	9,080 J d	1,710 J d	2,080 J d	NA	NA	9,400 J d
CHROMIUM	34.8	34.5	26.3	30.4	NA	NA	63.3
COBALT	8.9 J g	7.9 J g	6.5 J g	7.7 J g	NA	NA	9 J g
COPPER	10 UJ b	16.8 UJ b	6.5 UJ b	8.4 UJ b	NA	NA	52.6
IRON	11,900	12,600	8,790	9,860	NA	NA	18,800
LEAD	3 J de	4.4 J de	2.6 J de	4.3 J de	NA	NA	974 J de
MAGNESIUM	2,480	2,910	1,830	2,060	NA	NA	3,240
MANGANESE	105 J e	199 J e	74.1 J e	93 J e	NA	NA	234 J e
MERCURY	0.11 UJ dh	0.1 UJ dh	0.1 UJ dh	0.1 UJ dh	NA	NA	0.12 UJ dh
MOLYBDENUM	2.2 U	2.1 U	2.1 U	2.1 U	NA	NA	2.4 U
NICKEL	28.5	32.2	22.1	24.3	NA	NA	40.9
POTASSIUM	917 J g	779 J g	645 J g	729 J g	NA	NA	916 J g
SELENIUM	0.65 U	0.62 U	0.63 U	0.63 U	NA	NA	0.73 U
SILVER	1.1 U	1.2 J eg	1 U	1 U	NA	NA	8.8 J e
SODIUM	61.1 UJ b	164 UJ b	56.8 UJ b	82.1 UJ b	NA	NA	336 J g
THALLIUM	0.65 UJ e	0.62 UJ e	0.63 UJ e	0.63 UJ e	NA	NA	0.73 UJ e
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	22.6	22.4	15.4	18	NA	NA	42.4
ZINC	25.7 UJ bd	34.7 UJ bd	18.4 UJ bd	24.3 UJ bd	NA	NA	119 J d
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB03	09-SB03	09-SB03	09-SB03	09-SB04	09-SB04	09-SB04
Sample ID	09SB03B	09SB03C	09SB03AA	09SB03CA	09SB04A	09SB04B	09SB04C
Sample Date	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992	07/16/1992	07/16/1992
Sample Depth	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50	4.50 - 5.00	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
1,1,2,2-TETRACHLOROETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
1,1,2-TRICHLOROETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
1,1-DICHLOROETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
1,1-DICHLOROETHENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
1,2-DICHLOROETHENE (TOTAL)	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
1,2-DICHLOROPROPANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
ACETONE	0.023 UJ b	0.012 UJ b	NA	NA	0.018 U	0.011 UJ b	0.011 U
BENZENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
BROMOFORM	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
BROMOMETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
CARBON DISULFIDE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
CARBON TETRACHLORIDE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB03	09-SB03	09-SB03	09-SB03	09-SB04	09-SB04	09-SB04
Sample ID	09SB03B	09SB03C	09SB03AA	09SB03CA	09SB04A	09SB04B	09SB04C
Sample Date	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992	07/16/1992	07/16/1992
Sample Depth	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50	4.50 - 5.00	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
CHLOROETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
CHLOROFORM	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
CHLOROMETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
DIBROMOCHLOROMETHANE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	0.012 UJ b	0.012 UJ b	NA	NA	0.018 UJ b	0.01 UJ b	0.011 UJ b
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
TOLUENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
TRICHLOROETHENE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
XYLENE (TOTAL)	0.012 U	0.012 U	NA	NA	0.018 U	0.01 U	0.011 U
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB03	09-SB03	09-SB03	09-SB03	09-SB04	09-SB04	09-SB04
Sample ID	09SB03B	09SB03C	09SB03AA	09SB03CA	09SB04A	09SB04B	09SB04C
Sample Date	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992	07/16/1992	07/16/1992
Sample Depth	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50	4.50 - 5.00	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
1,2-DICHLOROBENZENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
1,3-DICHLOROBENZENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
1,4-DICHLOROBENZENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2,4,5-TRICHLOROPHENOL	1.9 U	NA	1.8 U	1.8 U	NA	1.7 U	1.7 U
2,4,6-TRICHLOROPHENOL	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2,4-DICHLOROPHENOL	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2,4-DIMETHYLPHENOL	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2,4-DINITROPHENOL	1.9 U	NA	1.8 U	1.8 U	NA	1.7 U	1.7 U
2,4-DINITROTOLUENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2,6-DINITROTOLUENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2-CHLORONAPHTHALENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2-CHLOROPHENOL	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2-METHYLNAPHTHALENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2-METHYLPHENOL	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
2-NITROANILINE	1.9 U	NA	1.8 U	1.8 U	NA	1.7 U	1.7 U
2-NITROPHENOL	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
3,3'-DICHLOROBENZIDINE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
3-NITROANILINE	1.9 U	NA	1.8 U	1.8 U	NA	1.7 U	1.7 U
4,6-DINITRO-2-METHYLPHENOL	1.9 U	NA	1.8 U	1.8 U	NA	1.7 U	1.7 U
4-BROMOPHENYL-PHENYLETHER	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
4-CHLORO-3-METHYLPHENOL	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
4-CHLOROANILINE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
4-CHLOROPHENYL-PHENYLETHER	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
4-METHYLPHENOL	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB03	09-SB03	09-SB03	09-SB03	09-SB04	09-SB04	09-SB04
Sample ID	09SB03B	09SB03C	09SB03AA	09SB03CA	09SB04A	09SB04B	09SB04C
Sample Date	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992	07/16/1992	07/16/1992
Sample Depth	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50	4.50 - 5.00	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	1.9 U	NA	1.8 U	1.8 U	NA	1.7 U	1.7 U
4-NITROPHENOL	1.9 U	NA	1.8 U	1.8 U	NA	1.7 U	1.7 U
ACENAPHTHENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
ACENAPHTHYLENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
ANTHRACENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
BENZO(A)ANTHRACENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
BENZO(A)PYRENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
BENZO(B)FLUORANTHENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
BENZO(G,H,I)PERYLENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
BENZO(K)FLUORANTHENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
BIS(2-CHLOROETHOXY)METHANE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
BIS(2-CHLOROETHYL)ETHER	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 UJ b	0.71 U
BUTYLBENZYLPHTHALATE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
CARBAZOLE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
CHRYSENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
DI-N-BUTYLPHTHALATE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
DI-N-OCTYLPHTHALATE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
DIBENZ(A,H)ANTHRACENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
DIBENZOFURAN	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
DIETHYLPHTHALATE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
DIMETHYLPHTHALATE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
FLUORANTHENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
FLUORENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
HEXACHLOROBENZENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
HEXACHLOROBUTADIENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
HEXACHLOROCYCLOPENTADIENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
HEXACHLOROETHANE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
INDENO(1,2,3-CD)PYRENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
ISOPHORONE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
N-NITROSO-DI-N-PROPYLAMINE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
N-NITROSODIPHENYLAMINE (1)	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
NAPHTHALENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
NITROBENZENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
PENTACHLOROPHENOL	1.9 U	NA	1.8 U	1.8 U	NA	1.7 U	1.7 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB03	09-SB03	09-SB03	09-SB03	09-SB04	09-SB04	09-SB04
Sample ID	09SB03B	09SB03C	09SB03AA	09SB03CA	09SB04A	09SB04B	09SB04C
Sample Date	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992	07/16/1992	07/16/1992
Sample Depth	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50	4.50 - 5.00	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
PHENOL	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
PYRENE	0.79 U	NA	0.74 U	0.73 U	NA	0.69 U	0.71 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.0039 U	0.004 U	NA	NA	0.0059 U	0.0034 U	0.0035 U
4,4'-DDE	0.0039 U	0.004 U	NA	NA	0.0059 U	0.0034 U	0.0035 U
4,4'-DDT	0.0039 U	0.004 U	NA	NA	0.0059 U	0.0034 U	0.0035 U
ALDRIN	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
ALPHA-BHC	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
ALPHA-CHLORDANE	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
AROCLOR-1016	0.0394 U	0.04 U	NA	NA	0.0589 U	0.0344 U	0.0353 U
AROCLOR-1221	0.0801 U	0.0811 U	NA	NA	0.12 U	0.0699 U	0.0718 U
AROCLOR-1232	0.0394 U	0.04 U	NA	NA	0.0589 U	0.0344 U	0.0353 U
AROCLOR-1242	0.0394 U	0.04 U	NA	NA	0.0589 U	0.0344 U	0.0353 U
AROCLOR-1248	0.0394 U	0.04 U	NA	NA	0.0589 U	0.0344 U	0.0353 U
AROCLOR-1254	0.0394 U	0.04 U	NA	NA	0.0589 U	0.0344 U	0.0353 U
AROCLOR-1260	0.0394 U	0.04 U	NA	NA	0.0589 U	0.0344 U	0.0353 U
BETA-BHC	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
DELTA-BHC	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
DIELDRIN	0.0039 U	0.004 U	NA	NA	0.0059 U	0.0034 U	0.0035 U
ENDOSULFAN I	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
ENDOSULFAN II	0.0039 U	0.004 U	NA	NA	0.0059 U	0.0034 U	0.0035 U
ENDOSULFAN SULFATE	0.0039 U	0.004 U	NA	NA	0.0059 U	0.0034 U	0.0035 U
ENDRIN	0.0039 U	0.004 U	NA	NA	0.0059 U	0.0034 U	0.0035 U
ENDRIN ALDEHYDE	0.0039 U	0.004 U	NA	NA	0.0059 U	0.0034 U	0.0035 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB03	09-SB03	09-SB03	09-SB03	09-SB04	09-SB04	09-SB04
Sample ID	09SB03B	09SB03C	09SB03AA	09SB03CA	09SB04A	09SB04B	09SB04C
Sample Date	07/16/1992	07/16/1992	12/15/1992	12/15/1992	07/16/1992	07/16/1992	07/16/1992
Sample Depth	2.50 - 3.00	4.50 - 5.00	1.00 - 1.50	4.50 - 5.00	1.00 - 1.50	2.50 - 3.00	4.50 - 5.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0039 U	0.004 U	NA	NA	0.0059 U	0.0034 U	0.0035 U
GAMMA-BHC (LINDANE)	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
GAMMA-CHLORDANE	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
HEPTACHLOR	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
HEPTACHLOR EPOXIDE	0.002 U	0.0021 U	NA	NA	0.003 U	0.0018 U	0.0018 U
METHOXYCHLOR	0.0203 U	0.0206 U	NA	NA	0.0304 U	0.0177 U	0.0182 U
TOXAPHENE	0.203 U	0.206 U	NA	NA	0.304 U	0.177 U	0.182 U
Metals (mg/kg)							
ALUMINUM	23,200 J e	25,200 J e	NA	NA	7,630 J e	15,600 J e	4,530 J e
ANTIMONY	11.5 UJ e	11.7 UJ e	NA	NA	17.1 UJ e	10.1 UJ e	10.3 UJ e
ARSENIC	2 J g	4.2	NA	NA	7.3	5.3	2.9
BARIUM	180	186	NA	NA	51 J g	28.2 J g	9.6 J g
BERYLLIUM	0.96 J g	0.73 J g	NA	NA	0.36 J g	0.42 J g	0.21 J g
CADMIUM	0.72 U	0.73 U	NA	NA	1.1 U	0.63 U	0.64 U
CALCIUM	2,680 J d	1,950 J d	NA	NA	4,880 J d	5,520 J d	2,370 J d
CHROMIUM	105	115	NA	NA	54.2	59.6	38.1
COBALT	27.3	17.2	NA	NA	13.9 J g	14.7	9.8 J g
COPPER	16.5 UJ b	18.2 UJ b	NA	NA	23.5 UJ b	25.9 UJ b	4.7 UJ b
IRON	36,900	38,800	NA	NA	21,900	26,300	11,700
LEAD	8.2 J de	8.5 J de	NA	NA	9.6 J de	6.3 J de	3 J de
MAGNESIUM	3,160	4,560	NA	NA	4,740	8,130	2,400
MANGANESE	879 J e	396 J e	NA	NA	381 J e	236 J e	108 J e
MERCURY	0.12 UJ dh	0.12 UJ dh	NA	NA	0.18 UJ dh	0.11 UJ dh	0.11 UJ dh
MOLYBDENUM	2.4 U	2.4 U	NA	NA	3.6 U	2.1 U	2.1 U
NICKEL	46.2	49	NA	NA	53.1	69.1	28.9
POTASSIUM	793 J g	998 J g	NA	NA	1,080 J g	2,130	826 J g
SELENIUM	0.72 U	0.73 U	NA	NA	1.1 U	0.63 U	0.64 U
SILVER	11.5 J e	11.7 J e	NA	NA	2.9 J eg	1.3 J eg	1.1 U
SODIUM	164 UJ b	157 UJ b	NA	NA	129 UJ b	217 UJ b	69.3 UJ b
THALLIUM	0.72 UJ e	0.73 UJ e	NA	NA	1.1 UJ e	0.63 UJ e	0.64 UJ e
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	89.8	92	NA	NA	38.1	48.4	20.5
ZINC	45 J d	49 J d	NA	NA	58.8 J d	57.7 J d	24.4 UJ bd
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB04	09-SB04	09-SB05	09-SB05	09-SB05	09-SB05	09-SB05
Sample ID	09SB14C	09SB04AA	30209SB05001	30209SB05002	30209SB05003	30209SB05004	30209SB05005
Sample Date	07/16/1992	12/15/1992	10/23/2002	10/23/2002	10/23/2002	11/01/2002	11/01/2002
Sample Depth	4.00 - 4.50	1.00 - 1.50	0.50 - 1.00	1.00 - 2.00	2.00 - 3.00	0.50 - 2.00	2.50 - 5.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
1,1,1-TRICHLOROETHANE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
1,1,2,2-TETRACHLOROETHANE	0.011 U	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
1,1,2-TRICHLOROETHANE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
1,1-DICHLOROETHANE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
1,1-DICHLOROETHENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
1,2-DICHLOROETHANE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
1,2-DICHLOROETHENE (TOTAL)	0.011 U	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	0.0087 U	0.0057 UJ c
2-BUTANONE	0.011 U	NA	NA	NA	NA	0.035 UJ b	0.011 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
2-HEXANONE	0.011 U	NA	NA	NA	NA	0.017 U	0.011 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
4-METHYL-2-PENTANONE	0.011 U	NA	NA	NA	NA	0.017 U	0.011 U
ACETONE	0.052 UJ bc	NA	NA	NA	NA	0.12 UJ b	0.023 UJ b
BENZENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
BROMOBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
BROMODICHLOROMETHANE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
BROMOFORM	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
BROMOMETHANE	0.011 U	NA	NA	NA	NA	0.017 U	0.011 U
CARBON DISULFIDE	0.011 U	NA	NA	NA	NA	0.0007 J g	0.0057 U
CARBON TETRACHLORIDE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB04	09-SB04	09-SB05	09-SB05	09-SB05	09-SB05	09-SB05
Sample ID	09SB14C	09SB04AA	30209SB05001	30209SB05002	30209SB05003	30209SB05004	30209SB05005
Sample Date	07/16/1992	12/15/1992	10/23/2002	10/23/2002	10/23/2002	11/01/2002	11/01/2002
Sample Depth	4.00 - 4.50	1.00 - 1.50	0.50 - 1.00	1.00 - 2.00	2.00 - 3.00	0.50 - 2.00	2.50 - 5.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
CHLOROETHANE	0.011 U	NA	NA	NA	NA	0.017 U	0.011 U
CHLOROFORM	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
CHLOROMETHANE	0.011 U	NA	NA	NA	NA	0.017 U	0.011 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
CIS-1,3-DICHLOROPROPENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
DIBROMOCHLOROMETHANE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
ETHYLBENZENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
FREON 11	NA	NA	NA	NA	NA	0.0087 U	0.0057 UJ c
FREON 113	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
FREON 12	NA	NA	NA	NA	NA	0.017 U	0.011 UJ c
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
M,P-XYLENES	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
METHYLENE CHLORIDE	0.011 UJ b	NA	NA	NA	NA	0.035 U	0.023 UJ b
N-BUTYLBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
N-PROPYLBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
NAPHTHALENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
O-XYLENE	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
STYRENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	0.0087 UJ i	0.0057 U
TETRACHLOROETHENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
TOLUENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	0.0087 U	0.0057 U
TRANS-1,3-DICHLOROPROPENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
TRICHLOROETHENE	0.011 U	NA	NA	NA	NA	0.0087 U	0.0057 U
VINYL ACETATE	NA	NA	NA	NA	NA	0.087 U	0.057 U
VINYL CHLORIDE	0.011 U	NA	NA	NA	NA	0.017 U	0.011 U
XYLENE (TOTAL)	0.011 U	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	19 H	4.5 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB04	09-SB04	09-SB05	09-SB05	09-SB05	09-SB05	09-SB05
Sample ID	09SB14C	09SB04AA	30209SB05001	30209SB05002	30209SB05003	30209SB05004	30209SB05005
Sample Date	07/16/1992	12/15/1992	10/23/2002	10/23/2002	10/23/2002	11/01/2002	11/01/2002
Sample Depth	4.00 - 4.50	1.00 - 1.50	0.50 - 1.00	1.00 - 2.00	2.00 - 3.00	0.50 - 2.00	2.50 - 5.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	150 M	16 M
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	0.41 UJ a	0.23 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.72 U	1.2 U	NA	NA	NA	0.012 U	0.012 U
1,2-DICHLOROBENZENE	0.72 U	1.2 U	NA	NA	NA	0.019 U	0.02 U
1,3-DICHLOROBENZENE	0.72 U	1.2 U	NA	NA	NA	0.02 U	0.02 U
1,4-DICHLOROBENZENE	0.72 U	1.2 U	NA	NA	NA	0.019 U	0.019 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.72 U	1.2 U	NA	NA	NA	0.015 U	0.015 U
2,4,5-TRICHLOROPHENOL	1.7 U	2.9 U	NA	NA	NA	0.018 U	0.019 U
2,4,6-TRICHLOROPHENOL	0.72 U	1.2 U	NA	NA	NA	0.016 U	0.016 U
2,4-DICHLOROPHENOL	0.72 U	1.2 U	NA	NA	NA	0.018 U	0.018 U
2,4-DIMETHYLPHENOL	0.72 U	1.2 U	NA	NA	NA	0.016 U	0.017 U
2,4-DINITROPHENOL	1.7 U	2.9 U	NA	NA	NA	0.12 U	0.12 U
2,4-DINITROTOLUENE	0.72 U	1.2 U	NA	NA	NA	0.016 U	0.016 U
2,6-DINITROTOLUENE	0.72 U	1.2 U	NA	NA	NA	0.017 U	0.017 U
2-CHLORONAPHTHALENE	0.72 U	1.2 U	NA	NA	NA	0.011 U	0.011 U
2-CHLOROPHENOL	0.72 U	1.2 U	NA	NA	NA	0.011 U	0.011 U
2-METHYLNAPHTHALENE	0.72 U	1.2 U	NA	NA	NA	0.012 U	0.012 U
2-METHYLPHENOL	0.72 U	1.2 U	NA	NA	NA	0.018 U	0.018 U
2-NITROANILINE	1.7 U	2.9 U	NA	NA	NA	0.018 U	0.018 U
2-NITROPHENOL	0.72 U	1.2 U	NA	NA	NA	0.015 U	0.015 U
3,3'-DICHLOROBENZIDINE	0.72 U	1.2 U	NA	NA	NA	0.029 U	0.029 U
3-NITROANILINE	1.7 U	2.9 U	NA	NA	NA	0.19 U	0.19 U
4,6-DINITRO-2-METHYLPHENOL	1.7 U	2.9 U	NA	NA	NA	0.16 U	0.16 U
4-BROMOPHENYL-PHENYLETHER	0.72 U	1.2 U	NA	NA	NA	0.013 U	0.013 U
4-CHLORO-3-METHYLPHENOL	0.72 U	1.2 U	NA	NA	NA	0.018 U	0.018 U
4-CHLOROANILINE	0.72 U	1.2 U	NA	NA	NA	0.016 U	0.016 U
4-CHLOROPHENYL-PHENYLETHER	0.72 U	1.2 U	NA	NA	NA	0.017 U	0.018 U
4-METHYLPHENOL	0.72 U	1.2 U	NA	NA	NA	0.018 U	0.018 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB04	09-SB04	09-SB05	09-SB05	09-SB05	09-SB05	09-SB05
Sample ID	09SB14C	09SB04AA	30209SB05001	30209SB05002	30209SB05003	30209SB05004	30209SB05005
Sample Date	07/16/1992	12/15/1992	10/23/2002	10/23/2002	10/23/2002	11/01/2002	11/01/2002
Sample Depth	4.00 - 4.50	1.00 - 1.50	0.50 - 1.00	1.00 - 2.00	2.00 - 3.00	0.50 - 2.00	2.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	1.7 U	2.9 U	NA	NA	NA	0.19 U	0.2 U
4-NITROPHENOL	1.7 U	2.9 U	NA	NA	NA	0.16 U	0.16 U
ACENAPHTHENE	0.72 U	1.2 U	NA	NA	NA	0.015 U	0.015 U
ACENAPHTHYLENE	0.72 U	1.2 U	NA	NA	NA	0.014 U	0.014 U
ANTHRACENE	0.72 U	1.2 U	NA	NA	NA	0.015 U	0.015 U
BENZO(A)ANTHRACENE	0.72 U	1.2 U	NA	NA	NA	0.019 J g	0.014 U
BENZO(A)PYRENE	0.72 U	1.2 U	NA	NA	NA	0.021 U	0.022 U
BENZO(B)FLUORANTHENE	0.72 U	1.2 U	NA	NA	NA	0.022 J g	0.019 U
BENZO(G,H,I)PERYLENE	0.72 U	1.2 U	NA	NA	NA	0.027 J g	0.022 U
BENZO(K)FLUORANTHENE	0.72 U	1.2 U	NA	NA	NA	0.021 U	0.021 U
BIS(2-CHLOROETHOXY)METHANE	0.72 U	1.2 U	NA	NA	NA	0.012 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	0.72 U	1.2 U	NA	NA	NA	0.013 U	0.013 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.72 UJ b	1.2 U	NA	NA	NA	0.02 U	0.32 UJ b
BUTYLBENZYLPHTHALATE	0.72 U	1.2 U	NA	NA	NA	0.018 U	0.018 U
CARBAZOLE	0.72 U	1.2 U	NA	NA	NA	0.012 U	0.012 U
CHRYSENE	0.72 U	1.2 U	NA	NA	NA	0.02 J g	0.013 U
DI-N-BUTYLPHTHALATE	0.72 U	1.2 U	NA	NA	NA	0.013 U	0.013 U
DI-N-OCTYLPHTHALATE	0.72 U	1.2 U	NA	NA	NA	0.026 U	0.026 U
DIBENZ(A,H)ANTHRACENE	0.72 U	1.2 U	NA	NA	NA	0.029 U	0.03 U
DIBENZOFURAN	0.72 U	1.2 U	NA	NA	NA	0.013 U	0.013 U
DIETHYLPHTHALATE	0.72 U	1.2 U	NA	NA	NA	0.015 U	0.015 U
DIMETHYLPHTHALATE	0.72 U	1.2 U	NA	NA	NA	0.018 U	0.018 U
FLUORANTHENE	0.72 U	1.2 U	NA	NA	NA	0.027 J g	0.013 U
FLUORENE	0.72 U	1.2 U	NA	NA	NA	0.014 U	0.014 U
HEXACHLOROBENZENE	0.72 U	1.2 U	NA	NA	NA	0.016 U	0.016 U
HEXACHLOROBUTADIENE	0.72 U	1.2 U	NA	NA	NA	0.015 U	0.015 U
HEXACHLOROCYCLOPENTADIENE	0.72 U	1.2 U	NA	NA	NA	0.014 U	0.014 U
HEXACHLOROETHANE	0.72 U	1.2 U	NA	NA	NA	0.023 U	0.023 U
INDENO(1,2,3-CD)PYRENE	0.72 U	1.2 U	NA	NA	NA	0.041 U	0.042 U
ISOPHORONE	0.72 U	1.2 U	NA	NA	NA	0.015 U	0.015 U
N-NITROSO-DI-N-PROPYLAMINE	0.72 U	1.2 U	NA	NA	NA	0.021 U	0.021 U
N-NITROSODIPHENYLAMINE (1)	0.72 U	1.2 U	NA	NA	NA	0.019 U	0.02 U
NAPHTHALENE	0.72 U	1.2 U	NA	NA	NA	0.016 U	0.016 U
NITROBENZENE	0.72 U	1.2 U	NA	NA	NA	0.028 U	0.028 U
PENTACHLOROPHENOL	1.7 U	2.9 U	NA	NA	NA	0.14 U	0.14 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB04	09-SB04	09-SB05	09-SB05	09-SB05	09-SB05	09-SB05
Sample ID	09SB14C	09SB04AA	30209SB05001	30209SB05002	30209SB05003	30209SB05004	30209SB05005
Sample Date	07/16/1992	12/15/1992	10/23/2002	10/23/2002	10/23/2002	11/01/2002	11/01/2002
Sample Depth	4.00 - 4.50	1.00 - 1.50	0.50 - 1.00	1.00 - 2.00	2.00 - 3.00	0.50 - 2.00	2.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.72 U	1.2 U	NA	NA	NA	0.014 J g	0.011 U
PHENOL	0.72 U	1.2 U	NA	NA	NA	0.021 U	0.021 U
PYRENE	0.72 U	1.2 U	NA	NA	NA	0.028 J g	0.015 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	0.00087 U	0.00088 U
AROCLOR-1221	NA	NA	NA	NA	NA	0.00087 U	0.00088 U
AROCLOR-1232	NA	NA	NA	NA	NA	0.00087 U	0.00088 U
AROCLOR-1242	NA	NA	NA	NA	NA	0.00087 U	0.00088 U
AROCLOR-1248	NA	NA	NA	NA	NA	0.00087 U	0.00088 U
AROCLOR-1254	NA	NA	NA	NA	NA	0.00087 U	0.00088 U
AROCLOR-1260	NA	NA	NA	NA	NA	0.032	0.00088 U
Pesticides							
4,4'-DDD	0.0036 U	NA	NA	NA	NA	0.0008 U	0.00017 U
4,4'-DDE	0.0036 U	NA	NA	NA	NA	0.0013 U	0.00027 U
4,4'-DDT	0.0036 U	NA	NA	NA	NA	0.0053 UJ j	0.00018 U
ALDRIN	0.0018 U	NA	NA	NA	NA	0.0013 U	0.00025 U
ALPHA-BHC	0.0018 U	NA	NA	NA	NA	0.00054 U	0.00011 U
ALPHA-CHLORDANE	0.0018 U	NA	NA	NA	NA	0.00057 U	0.00012 U
AROCLOR-1016	0.0358 U	NA	NA	NA	NA	NA	NA
AROCLOR-1221	0.0726 U	NA	NA	NA	NA	NA	NA
AROCLOR-1232	0.0358 U	NA	NA	NA	NA	NA	NA
AROCLOR-1242	0.0358 U	NA	NA	NA	NA	NA	NA
AROCLOR-1248	0.0358 U	NA	NA	NA	NA	NA	NA
AROCLOR-1254	0.0358 U	NA	NA	NA	NA	NA	NA
AROCLOR-1260	0.0358 U	NA	NA	NA	NA	NA	NA
BETA-BHC	0.0018 U	NA	NA	NA	NA	0.00078 U	0.00016 U
DELTA-BHC	0.0018 U	NA	NA	NA	NA	0.002 U	0.0004 U
DIELDRIN	0.0036 U	NA	NA	NA	NA	0.0017 U	0.00033 U
ENDOSULFAN I	0.0018 U	NA	NA	NA	NA	0.00065 U	0.00014 U
ENDOSULFAN II	0.0036 U	NA	NA	NA	NA	0.0012 U	0.00024 U
ENDOSULFAN SULFATE	0.0036 U	NA	NA	NA	NA	0.00084 U	0.00018 U
ENDRIN	0.0036 U	NA	NA	NA	NA	0.0007 U	0.00015 U
ENDRIN ALDEHYDE	0.0036 U	NA	NA	NA	NA	0.0019 U	0.00038 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB04	09-SB04	09-SB05	09-SB05	09-SB05	09-SB05	09-SB05
Sample ID	09SB14C	09SB04AA	30209SB05001	30209SB05002	30209SB05003	30209SB05004	30209SB05005
Sample Date	07/16/1992	12/15/1992	10/23/2002	10/23/2002	10/23/2002	11/01/2002	11/01/2002
Sample Depth	4.00 - 4.50	1.00 - 1.50	0.50 - 1.00	1.00 - 2.00	2.00 - 3.00	0.50 - 2.00	2.50 - 5.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0036 U	NA	NA	NA	NA	0.0013 U	0.00017 U
GAMMA-BHC (LINDANE)	0.0018 U	NA	NA	NA	NA	0.0013 U	0.00026 U
GAMMA-CHLORDANE	0.0018 U	NA	NA	NA	NA	0.00078 U	0.00016 U
HEPTACHLOR	0.0018 U	NA	NA	NA	NA	0.00071 U	0.00015 U
HEPTACHLOR EPOXIDE	0.0018 U	NA	NA	NA	NA	0.00072 U	0.00015 U
METHOXYCHLOR	0.0184 U	NA	NA	NA	NA	0.00085 U	0.00018 U
TOXAPHENE	0.184 U	NA	NA	NA	NA	0.14 U	0.0098 U
Metals (mg/kg)							
ALUMINUM	4,210 J e	NA	NA	NA	NA	3,920	3,960
ANTIMONY	10.5 UJ e	NA	NA	NA	NA	0.066	0.027 UJ b
ARSENIC	2.4	NA	NA	NA	NA	6.7	2.8
BARIUM	8.3 J g	NA	NA	NA	NA	15.1	7
BERYLLIUM	0.22 J g	NA	NA	NA	NA	0.12 J g	0.12 J g
CADMIUM	0.66 U	NA	NA	NA	NA	0.16	0.07
CALCIUM	2,000 J d	NA	NA	NA	NA	3,670 J d	1,940 J d
CHROMIUM	27.1	NA	NA	NA	NA	30	25.7
COBALT	7.9 J g	NA	NA	NA	NA	5.7	6
COPPER	26.6 UJ b	NA	NA	NA	NA	6.84	7.03
IRON	10,300	NA	NA	NA	NA	10,400	9,120
LEAD	2.7 J de	NA	76.2	2.41	2.7	7.93	2.74
MAGNESIUM	2,160	NA	NA	NA	NA	2,350	1,950
MANGANESE	84.9 J e	NA	NA	NA	NA	136	77.4
MERCURY	0.11 UJ dh	NA	NA	NA	NA	0.07	0.01
MOLYBDENUM	2.2 U	NA	NA	NA	NA	1.8	0.08
NICKEL	24.9	NA	NA	NA	NA	23.9	20.6
POTASSIUM	858 J g	NA	NA	NA	NA	493 J j	471 J j
SELENIUM	0.66 U	NA	NA	NA	NA	0.2 U	0.2 U
SILVER	1.1 U	NA	NA	NA	NA	0.024	0.016 J g
SODIUM	56.6 UJ b	NA	NA	NA	NA	89.7 J d	56.3 J d
THALLIUM	0.66 UJ e	NA	NA	NA	NA	0.037	0.061
TIN	NA	NA	NA	NA	NA	2.1 U	2.3 UJ b
VANADIUM	17.5	NA	NA	NA	NA	18.3	16.5
ZINC	35.4 UJ bd	NA	NA	NA	NA	21.2	16
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB05	09-SB06	09-SB06	09-SB06	09-SB07	09-SB07	09-SB07
Sample ID	30209SB05006	30209SB06001	30209SB06002	30209SB06003	30209SB07001	30209SB07002	30209SB07003
Sample Date	11/01/2002	10/23/2002	10/23/2002	10/23/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,1,1-TRICHLOROETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,1,2,2-TETRACHLOROETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,1,2-TRICHLOROETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,1-DICHLOROETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,1-DICHLOROETHENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,1-DICHLOROPROPENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,2,3-TRICHLOROBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,2,3-TRICHLOROPROPANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,2,4-TRICHLOROBENZENE	0.0063 U	0.0061 UJ c	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,2,4-TRIMETHYLBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,2-DIBROMO-3-CHLOROPROPANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,2-DIBROMOETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,2-DICHLOROBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,2-DICHLOROETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,3,5-TRIMETHYLBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,3-DICHLOROBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,3-DICHLOROPROPANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
1,4-DICHLOROBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
2,2-DICHLOROPROPANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
2-BUTANONE	0.013 U	0.012 U	0.012 U	0.011 U	0.011 U	0.019 U	0.011 U
2-CHLOROTOLUENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
2-HEXANONE	0.013 U	0.012 U	0.012 U	0.011 U	0.011 U	0.019 U	0.011 U
4-CHLOROTOLUENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
4-METHYL-2-PENTANONE	0.013 U	0.012 U	0.012 U	0.011 U	0.011 U	0.019 U	0.011 U
ACETONE	0.025 UJ b	0.024 U	0.024 UJ b	0.021 UJ b	0.022 U	0.038 U	0.023 U
BENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
BROMOBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
BROMOCHLOROMETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
BROMODICHLOROMETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
BROMOFORM	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
BROMOMETHANE	0.013 U	0.012 U	0.012 U	0.011 U	0.011 U	0.019 U	0.011 U
CARBON DISULFIDE	0.0063 U	0.0061 U	0.006 U	0.00063 J g	0.0056 U	0.0094 U	0.0057 U
CARBON TETRACHLORIDE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB05	09-SB06	09-SB06	09-SB06	09-SB07	09-SB07	09-SB07
Sample ID	30209SB05006	30209SB06001	30209SB06002	30209SB06003	30209SB07001	30209SB07002	30209SB07003
Sample Date	11/01/2002	10/23/2002	10/23/2002	10/23/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
CHLOROETHANE	0.013 U	0.012 U	0.012 U	0.011 U	0.011 U	0.019 U	0.011 U
CHLOROFORM	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
CHLOROMETHANE	0.013 U	0.012 U	0.012 U	0.011 U	0.011 U	0.019 U	0.011 U
CIS-1,2-DICHLOROETHENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
CIS-1,3-DICHLOROPROPENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
DIBROMOCHLOROMETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
DIBROMOMETHANE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
ETHYLBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
FREON 11	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
FREON 113	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
FREON 12	0.013 U	0.012 U	0.012 U	0.011 U	0.011 U	0.019 U	0.011 U
HEXACHLOROBUTADIENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
ISOPROPYLBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
M,P-XYLENES	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
METHYL-TERT-BUTYL ETHER	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
METHYLENE CHLORIDE	0.16	0.024 U	0.024 U	0.021 U	0.022 U	0.038 UJ b	0.023 UJ b
N-BUTYLBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0027 J g
N-PROPYLBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.00078 J g
NAPHTHALENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
O-XYLENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
PARA-ISOPROPYL TOLUENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
SEC-BUTYLBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0015 J g
STYRENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
TERT-BUTYLBENZENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
TETRACHLOROETHENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
TOLUENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
TRANS-1,2-DICHLOROETHENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
TRANS-1,3-DICHLOROPROPENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
TRICHLOROETHENE	0.0063 U	0.0061 U	0.006 U	0.0053 U	0.0056 U	0.0094 U	0.0057 U
VINYL ACETATE	0.063 U	0.061 U	0.06 U	0.053 U	0.056 UJ c	0.094 UJ c	0.057 UJ c
VINYL CHLORIDE	0.013 U	0.012 U	0.012 U	0.011 U	0.011 U	0.019 U	0.011 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	5 U	6.6 H	4.5 U	5.3 U	470 D	26 H	7,100 D

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB05	09-SB06	09-SB06	09-SB06	09-SB07	09-SB07	09-SB07
Sample ID	30209SB05006	30209SB06001	30209SB06002	30209SB06003	30209SB07001	30209SB07002	30209SB07003
Sample Date	11/01/2002	10/23/2002	10/23/2002	10/23/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	5 U	48 M	4.7 M	5.3 U	410 M	24 M	220 L
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.26 UJ a	0.25 UJ a	0.23 U	0.22 U	0.23 U	0.4 U	91 HJ a
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.013 U	0.013 U	0.012 U	0.014 U	0.012 U	0.012 U	0.13 U
1,2-DICHLOROBENZENE	0.022 U	0.022 U	0.019 U	0.023 U	0.02 U	0.019 U	0.21 U
1,3-DICHLOROBENZENE	0.022 U	0.022 U	0.02 U	0.023 U	0.02 U	0.02 U	0.22 U
1,4-DICHLOROBENZENE	0.021 U	0.021 U	0.019 U	0.022 U	0.019 U	0.019 U	0.21 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.017 U	0.017 U	0.015 U	0.018 U	0.016 U	0.015 U	0.17 U
2,4,5-TRICHLOROPHENOL	0.021 U	0.021 U	0.018 U	0.022 U	0.019 U	0.019 U	0.21 U
2,4,6-TRICHLOROPHENOL	0.017 U	0.017 U	0.016 U	0.018 U	0.016 U	0.016 U	0.17 U
2,4-DICHLOROPHENOL	0.02 U	0.02 U	0.018 U	0.021 U	0.018 U	0.018 U	0.2 U
2,4-DIMETHYLPHENOL	0.018 U	0.018 U	0.016 U	0.019 U	0.017 U	0.016 U	0.18 U
2,4-DINITROPHENOL	0.14 U	0.14 U	0.12 U	0.14 U	0.13 U	0.12 U	1.4 U
2,4-DINITROTOLUENE	0.018 U	0.018 U	0.016 U	0.019 U	0.017 U	0.016 U	0.18 U
2,6-DINITROTOLUENE	0.019 U	0.019 U	0.017 U	0.02 U	0.017 U	0.017 U	0.19 U
2-CHLORONAPHTHALENE	0.012 U	0.012 U	0.011 U	0.013 U	0.011 U	0.011 U	0.12 U
2-CHLOROPHENOL	0.012 U	0.012 U	0.011 U	0.013 U	0.011 U	0.011 U	0.12 U
2-METHYLNAPHTHALENE	0.013 U	0.013 U	0.012 U	0.014 U	0.012 U	0.012 U	1.8
2-METHYLPHENOL	0.02 U	0.02 U	0.018 U	0.021 U	0.019 U	0.018 U	0.2 U
2-NITROANILINE	0.02 U	0.02 U	0.018 U	0.022 U	0.019 U	0.018 U	0.2 U
2-NITROPHENOL	0.017 U	0.017 U	0.015 U	0.018 U	0.016 U	0.015 U	0.17 U
3,3'-DICHLOROBENZIDINE	0.032 U	0.032 U	0.029 U	0.034 U	0.03 U	0.029 U	0.32 U
3-NITROANILINE	0.21 U	0.21 U	0.19 U	0.22 U	0.19 U	0.19 U	2.1 U
4,6-DINITRO-2-METHYLPHENOL	0.17 U	0.17 U	0.16 U	0.18 U	0.16 U	0.16 U	1.7 U
4-BROMOPHENYL-PHENYLETHER	0.015 U	0.015 U	0.013 U	0.016 U	0.014 U	0.013 U	0.15 U
4-CHLORO-3-METHYLPHENOL	0.02 U	0.02 U	0.018 U	0.021 U	0.018 U	0.018 U	0.2 U
4-CHLOROANILINE	0.017 U	0.017 U	0.016 U	0.018 U	0.016 U	0.016 U	0.17 U
4-CHLOROPHENYL-PHENYLETHER	0.019 U	0.019 U	0.017 U	0.02 U	0.018 U	0.017 U	0.19 U
4-METHYLPHENOL	0.02 U	0.02 U	0.018 U	0.021 U	0.019 U	0.018 U	0.2 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB05	09-SB06	09-SB06	09-SB06	09-SB07	09-SB07	09-SB07
Sample ID	30209SB05006	30209SB06001	30209SB06002	30209SB06003	30209SB07001	30209SB07002	30209SB07003
Sample Date	11/01/2002	10/23/2002	10/23/2002	10/23/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.22 U	0.22 U	0.19 U	0.23 U	0.2 U	0.19 U	2.1 U
4-NITROPHENOL	0.18 U	0.18 U	0.16 U	0.19 U	0.16 U	0.16 U	1.8 U
ACENAPHTHENE	0.016 U	0.016 U	0.015 U	0.017 U	0.015 U	0.015 U	0.86
ACENAPHTHYLENE	0.015 U	0.015 U	0.014 U	0.016 U	0.014 U	0.014 U	0.15 U
ANTHRACENE	0.017 U	0.017 U	0.015 U	0.018 U	0.016 U	0.015 U	0.17 U
BENZO(A)ANTHRACENE	0.015 U	0.026 J g	0.013 U	0.016 U	0.027 J g	0.047 J g	0.37 J g
BENZO(A)PYRENE	0.024 U	0.035 J g	0.021 U	0.025 U	0.058	0.07	0.37 J g
BENZO(B)FLUORANTHENE	0.021 U	0.03 J g	0.019 U	0.022 U	0.05 J g	0.05 J g	0.22 J g
BENZO(G,H,I)PERYLENE	0.024 U	0.031 J g	0.022 U	0.026 U	0.32	0.12	0.33 J g
BENZO(K)FLUORANTHENE	0.023 U	0.032 J g	0.021 U	0.025 U	0.052 J g	0.066	0.31 J g
BIS(2-CHLOROETHOXY)METHANE	0.013 U	0.013 U	0.012 U	0.014 U	0.012 U	0.012 U	0.13 U
BIS(2-CHLOROETHYL)ETHER	0.014 U	0.014 U	0.013 U	0.015 U	0.013 U	0.013 U	0.14 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.022 U	0.022 U	0.02 U	0.024 U	0.021 U	0.02 U	0.22 U
BUTYLBENZYLPHTHALATE	0.02 U	0.02 U	0.018 U	0.021 U	0.018 U	0.018 U	0.2 U
CARBAZOLE	0.014 U	0.014 U	0.012 U	0.014 U	0.013 U	0.012 U	0.14 U
CHRYSENE	0.014 U	0.036 J g	0.013 U	0.015 U	0.049 J g	0.062	0.47 J g
DI-N-BUTYLPHTHALATE	0.015 U	0.015 U	0.013 U	0.016 U	0.014 U	0.013 U	0.15 U
DI-N-OCTYLPHTHALATE	0.029 U	0.029 U	0.026 U	0.03 U	0.026 U	0.026 U	0.29 U
DIBENZ(A,H)ANTHRACENE	0.033 U	0.033 U	0.029 U	0.035 U	0.035 J g	0.03 U	0.33 U
DIBENZOFURAN	0.014 U	0.014 U	0.013 U	0.015 U	0.013 U	0.013 U	1.7 J g
DIETHYLPHTHALATE	0.017 U	0.017 U	0.015 U	0.018 U	0.016 U	0.015 U	0.17 U
DIMETHYLPHTHALATE	0.02 U	0.02 U	0.018 U	0.021 U	0.018 U	0.018 U	0.2 U
FLUORANTHENE	0.014 U	0.052 J g	0.013 U	0.015 U	0.023 J g	0.041 J g	0.62
FLUORENE	0.016 U	0.016 U	0.014 U	0.017 U	0.015 U	0.014 U	5.7
HEXACHLOROBENZENE	0.018 U	0.018 U	0.016 U	0.019 U	0.016 U	0.016 U	0.18 U
HEXACHLOROBUTADIENE	0.017 U	0.017 U	0.015 U	0.018 U	0.016 U	0.015 U	0.17 U
HEXACHLOROCYCLOPENTADIENE	0.015 U	0.015 U	0.014 U	0.016 U	0.014 U	0.014 U	0.15 U
HEXACHLOROETHANE	0.026 U	0.026 U	0.023 U	0.027 U	0.024 U	0.023 U	0.26 U
INDENO(1,2,3-CD)PYRENE	0.046 U	0.046 U	0.041 U	0.049 U	0.19	0.086	0.46 U
ISOPHORONE	0.017 U	0.017 U	0.015 U	0.018 U	0.016 U	0.015 U	0.17 U
N-NITROSO-DI-N-PROPYLAMINE	0.023 U	0.023 U	0.021 U	0.024 U	0.021 U	0.021 U	0.23 U
N-NITROSODIPHENYLAMINE (1)	0.022 U	0.022 U	0.019 U	0.023 U	0.02 U	0.02 U	0.22 U
NAPHTHALENE	0.017 U	0.017 U	0.016 U	0.018 U	0.016 U	0.016 U	0.17 U
NITROBENZENE	0.031 U	0.031 U	0.028 U	0.033 U	0.029 U	0.028 U	0.31 U
PENTACHLOROPHENOL	0.15 U	0.15 U	0.14 U	0.16 U	0.14 U	0.14 U	1.5 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB05	09-SB06	09-SB06	09-SB06	09-SB07	09-SB07	09-SB07
Sample ID	30209SB05006	30209SB06001	30209SB06002	30209SB06003	30209SB07001	30209SB07002	30209SB07003
Sample Date	11/01/2002	10/23/2002	10/23/2002	10/23/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.012 U	0.026 J g	0.011 U	0.013 U	0.011 U	0.02 J g	4.6
PHENOL	0.023 U	0.023 U	0.021 U	0.025 U	0.022 U	0.021 U	0.23 U
PYRENE	0.017 U	0.046 J g	0.015 U	0.018 U	0.032 J g	0.061	0.89
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.00097 U	0.00097 U	0.00087 U	0.0011 U	0.00089 U	0.00087 U	0.00097 U
AROCLOR-1221	0.00097 U	0.00097 U	0.00087 U	0.0011 U	0.00089 U	0.00087 U	0.00097 U
AROCLOR-1232	0.00097 U	0.00097 U	0.00087 U	0.0011 U	0.00089 U	0.00087 U	0.00097 U
AROCLOR-1242	0.00097 U	0.00097 U	0.00087 U	0.0011 U	0.00089 U	0.00087 U	0.00097 U
AROCLOR-1248	0.00097 U	0.00097 U	0.00087 U	0.0011 U	0.00089 U	0.00087 U	0.00097 U
AROCLOR-1254	0.00097 U	0.00097 U	0.00087 U	0.0011 U	0.00089 U	0.00087 U	0.00097 U
AROCLOR-1260	0.00097 U	0.0015 J g	0.00087 U	0.0011 U	0.0033 UJ g	0.0019 UJ g	0.00097 U
Pesticides							
4,4'-DDD	0.00018 U	0.00018 U	0.00016 U	0.00019 U	0.0017 U	0.00016 U	0.00018 U
4,4'-DDE	0.00029 U	0.00029 U	0.00026 U	0.00031 U	0.0027 U	0.00026 U	0.00029 U
4,4'-DDT	0.0002 U	0.0002 UJ c	0.00018 UJ c	0.00022 UJ c	0.0019 U	0.00063 UJ j	0.0012 U
ALDRIN	0.00028 U	0.00028 U	0.00025 U	0.00029 U	0.0026 U	0.00025 U	0.0012 U
ALPHA-BHC	0.00013 U	0.00012 U	0.00011 U	0.00013 U	0.0012 U	0.00011 U	0.00053 U
ALPHA-CHLORDANE	0.00013 U	0.00013 U	0.00012 U	0.00014 U	0.0012 U	0.00012 U	0.00013 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.0012 U	0.00018 U	0.00016 U	0.00019 U	0.0016 U	0.00016 U	0.0012 U
DELTA-BHC	0.00044 U	0.00044 U	0.00039 U	0.00046 U	0.004 U	0.0004 U	0.00044 U
DIELDRIN	0.00037 U	0.00036 U	0.00033 U	0.00039 U	0.0034 U	0.00033 U	0.00036 U
ENDOSULFAN I	0.00015 U	0.00015 U	0.00013 U	0.00016 U	0.0014 U	0.00014 U	0.00016 U
ENDOSULFAN II	0.00026 U	0.00026 U	0.00023 U	0.00028 U	0.0024 U	0.00024 U	0.00032 U
ENDOSULFAN SULFATE	0.00019 U	0.0015 U	0.00017 U	0.0002 U	0.0018 U	0.00017 U	0.00068 J g
ENDRIN	0.00016 U	0.00016 U	0.00014 U	0.00017 U	0.0015 U	0.00014 U	0.00016 U
ENDRIN ALDEHYDE	0.00042 U	0.00042 U	0.00038 U	0.00044 U	0.0039 U	0.00038 U	0.00042 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB05	09-SB06	09-SB06	09-SB06	09-SB07	09-SB07	09-SB07
Sample ID	30209SB05006	30209SB06001	30209SB06002	30209SB06003	30209SB07001	30209SB07002	30209SB07003
Sample Date	11/01/2002	10/23/2002	10/23/2002	10/23/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00019 U	0.00019 U	0.00017 U	0.0002 U	0.0018 U	0.00017 U	0.00019 U
GAMMA-BHC (LINDANE)	0.00029 U	0.00029 U	0.00026 U	0.00031 U	0.0027 U	0.00026 U	0.0012 U
GAMMA-CHLORDANE	0.00018 U	0.00018 U	0.00016 U	0.00019 U	0.0016 U	0.00016 U	0.0012 U
HEPTACHLOR	0.00016 U	0.00016 U	0.00015 U	0.00017 U	0.0015 U	0.00015 U	0.00016 U
HEPTACHLOR EPOXIDE	0.00017 U	0.00019 U	0.00015 U	0.00017 U	0.0015 U	0.00015 U	0.00026 U
METHOXYCHLOR	0.00019 U	0.00019 UJ c	0.00017 UJ c	0.00021 UJ c	0.0018 U	0.00024 U	0.00028 U
TOXAPHENE	0.011 U	0.052 U	0.0097 U	0.012 U	0.1 U	0.012 U	0.022 U
Metals (mg/kg)							
ALUMINUM	4,610	6,210	3,920	4,060	4,730	4,200	3,810
ANTIMONY	0.048 J g	0.73 J e	0.08 UJ be	0.1 UJ be	4.15 J e	2.07 J e	2.33 J e
ARSENIC	2.9	7.3	2.7	2.6	3.8	3.2	2.7
BARIUM	11.3	61.2 J d	7.9 J d	8.2 J d	18.8	8.5	9.6
BERYLLIUM	0.14 J g	0.2 J g	0.11 J g	0.11 J g	0.12 J g	0.1 J g	0.11 J g
CADMIUM	0.05 J g	0.28	0.05 J g	0.04 J g	0.33	0.05	0.06
CALCIUM	1,930 J d	4,590	2,240	1,720	3,230	2,050	1,850
CHROMIUM	27.3	30.7 J d	29.3 J d	23.7 J d	31	25	25.1
COBALT	6.6	6	5.7	6.2	6.6	11.4	7.2
COPPER	4.11	14.9	3.55	3.42	6.74	5.46	4.39
IRON	10,400	13,300	9,160	9,340	11,700	9,780	9,330
LEAD	3.7	22.9	2.04	1.88	7.68	2.97	2.64
MAGNESIUM	2,410	2,970	2,090	2,370	2,720	2,460	2,150
MANGANESE	79	244 J e	77.2 J e	75.6 J e	106	100	76.9
MERCURY	0.01 J g	0.02	0.03	0.02 J g	0.03	0.01 J g	0.01 J g
MOLYBDENUM	0.06	1.16	0.08	0.07	0.12 UJ f	0.09 UJ f	0.09 UJ f
NICKEL	23	27.8	21.3	22	25.5 J j	24.8 J j	22.3 J j
POTASSIUM	729 J j	567	578	702	553 J j	500 J j	507 J j
SELENIUM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
SILVER	0.023 J g	0.046	0.016 J g	0.018 J g	0.034	0.02 J g	0.019 J g
SODIUM	78.8 J d	131	60.4	81.2	81.8	57.9	49.9
THALLIUM	0.038	0.038	0.034	0.03	0.031	0.044	0.039
TIN	2.4 U	2.4 U	2.3 UJ b	2.5 U	2.2 U	2.8 UJ b	2.7 UJ b
VANADIUM	17.8	27.1	18.8	16.1	21.7	17.9	16.3
ZINC	18.5	109	16	17.3	642	27.3	43.8
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB08	09-SB08	09-SB08	09-SB10	09-SB10	09-SB10	09-SB11
Sample ID	30209SB08001	30209SB08002	30209SB08003	30209SB10001	30209SB10002	30209SB10003	30209SB11001
Sample Date	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,1,1-TRICHLOROETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,1,2,2-TETRACHLOROETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,1,2-TRICHLOROETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,1-DICHLOROETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,1-DICHLOROETHENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,1-DICHLOROPROPENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,2,3-TRICHLOROBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,2,3-TRICHLOROPROPANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,2,4-TRICHLOROBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,2,4-TRIMETHYLBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,2-DIBROMO-3-CHLOROPROPANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,2-DIBROMOETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,2-DICHLOROBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,2-DICHLOROETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,3,5-TRIMETHYLBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,3-DICHLOROBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,3-DICHLOROPROPANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
1,4-DICHLOROBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
2,2-DICHLOROPROPANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
2-BUTANONE	0.011 U	0.011 U	0.01 U	0.012 U	0.013 U	0.013 U	0.013 U
2-CHLOROTOLUENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
2-HEXANONE	0.011 U	0.011 U	0.01 U	0.012 U	0.013 U	0.013 U	0.013 U
4-CHLOROTOLUENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
4-METHYL-2-PENTANONE	0.011 U	0.011 U	0.01 U	0.012 U	0.013 U	0.013 U	0.013 U
ACETONE	0.021 U	0.022 U	0.021 U	0.024 U	0.027 UJ b	0.027 U	0.027 U
BENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
BROMOBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
BROMOCHLOROMETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
BROMODICHLOROMETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
BROMOFORM	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
BROMOMETHANE	0.011 U	0.011 U	0.01 U	0.012 U	0.013 U	0.013 U	0.013 U
CARBON DISULFIDE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
CARBON TETRACHLORIDE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB08	09-SB08	09-SB08	09-SB10	09-SB10	09-SB10	09-SB11
Sample ID	30209SB08001	30209SB08002	30209SB08003	30209SB10001	30209SB10002	30209SB10003	30209SB11001
Sample Date	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
CHLOROETHANE	0.011 U	0.011 U	0.01 U	0.012 U	0.013 U	0.013 U	0.013 U
CHLOROFORM	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
CHLOROMETHANE	0.011 U	0.011 U	0.01 U	0.012 U	0.013 U	0.013 U	0.013 U
CIS-1,2-DICHLOROETHENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
CIS-1,3-DICHLOROPROPENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
DIBROMOCHLOROMETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
DIBROMOMETHANE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
ETHYLBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
FREON 11	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
FREON 113	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
FREON 12	0.011 U	0.011 U	0.01 U	0.012 U	0.013 U	0.013 U	0.013 U
HEXACHLOROBUTADIENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
ISOPROPYLBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
M,P-XYLENES	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
METHYL-TERT-BUTYL ETHER	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
METHYLENE CHLORIDE	0.021 UJ b	0.022 UJ b	0.021 UJ b	0.024 UJ b	0.027 UJ b	0.027 UJ b	0.027 UJ b
N-BUTYLBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
N-PROPYLBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
NAPHTHALENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
O-XYLENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
PARA-ISOPROPYL TOLUENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
SEC-BUTYLBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
STYRENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
TERT-BUTYLBENZENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
TETRACHLOROETHENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
TOLUENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
TRANS-1,2-DICHLOROETHENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
TRANS-1,3-DICHLOROPROPENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
TRICHLOROETHENE	0.0054 U	0.0055 U	0.0052 U	0.0061 U	0.0067 U	0.0067 U	0.0066 U
VINYL ACETATE	0.054 UJ c	0.055 UJ c	0.052 UJ c	0.061 UJ c	0.067 UJ c	0.067 UJ c	0.066 UJ c
VINYL CHLORIDE	0.011 U	0.011 U	0.01 U	0.012 U	0.013 U	0.013 U	0.013 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	8.9 H	4.5 U	4.9 U	6.1 U	4.5 U	5 U	5.5 D

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB08	09-SB08	09-SB08	09-SB10	09-SB10	09-SB10	09-SB11
Sample ID	30209SB08001	30209SB08002	30209SB08003	30209SB10001	30209SB10002	30209SB10003	30209SB11001
Sample Date	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	61 M	11 M	4.9 U	11 M	4.5 U	5 U	58 M
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.21 U	0.28 U	0.24 U	0.23 U	0.29 U	0.26 U	0.29 UJ a
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.012 U	0.013 U	0.016 U	0.012 U	0.013 U	0.014 U
1,2-DICHLOROBENZENE	0.019 U	0.02 U	0.021 U	0.026 U	0.019 U	0.022 U	0.023 U
1,3-DICHLOROBENZENE	0.019 U	0.02 U	0.022 U	0.027 U	0.02 U	0.022 U	0.024 U
1,4-DICHLOROBENZENE	0.019 U	0.019 U	0.021 U	0.026 U	0.019 U	0.021 U	0.023 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.015 U	0.016 U	0.017 U	0.021 U	0.015 U	0.017 U	0.018 U
2,4,5-TRICHLOROPHENOL	0.018 U	0.019 U	0.02 U	0.025 U	0.019 U	0.021 U	0.022 U
2,4,6-TRICHLOROPHENOL	0.015 U	0.016 U	0.017 U	0.021 U	0.016 U	0.017 U	0.019 U
2,4-DICHLOROPHENOL	0.017 U	0.018 U	0.02 U	0.024 U	0.018 U	0.02 U	0.021 U
2,4-DIMETHYLPHENOL	0.016 U	0.017 U	0.018 U	0.022 U	0.016 U	0.018 U	0.02 U
2,4-DINITROPHENOL	0.12 U	0.13 U	0.13 U	0.17 U	0.12 U	0.14 U	0.15 U
2,4-DINITROTOLUENE	0.016 U	0.016 U	0.018 U	0.022 U	0.016 U	0.018 U	0.019 U
2,6-DINITROTOLUENE	0.017 U	0.017 U	0.019 U	0.023 U	0.017 U	0.019 U	0.02 U
2-CHLORONAPHTHALENE	0.011 U	0.011 U	0.012 U	0.015 U	0.011 U	0.012 U	0.013 U
2-CHLOROPHENOL	0.011 U	0.011 U	0.012 U	0.015 U	0.011 U	0.012 U	0.013 U
2-METHYLNAPHTHALENE	0.012 U	0.012 U	0.013 U	0.016 U	0.012 U	0.013 U	0.014 U
2-METHYLPHENOL	0.018 U	0.018 U	0.02 U	0.025 U	0.018 U	0.02 U	0.022 U
2-NITROANILINE	0.018 U	0.019 U	0.02 U	0.025 U	0.018 U	0.02 U	0.022 U
2-NITROPHENOL	0.015 U	0.015 U	0.017 U	0.021 U	0.015 U	0.017 U	0.018 U
3,3'-DICHLOROBENZIDINE	0.028 U	0.029 U	0.032 U	0.04 U	0.029 U	0.032 U	0.035 U
3-NITROANILINE	0.19 U	0.19 U	0.21 U	0.26 U	0.19 U	0.21 U	0.23 U
4,6-DINITRO-2-METHYLPHENOL	0.15 U	0.16 U	0.17 U	0.21 U	0.16 U	0.17 U	0.19 U
4-BROMOPHENYL-PHENYLETHER	0.013 U	0.014 U	0.015 U	0.018 U	0.013 U	0.015 U	0.016 U
4-CHLORO-3-METHYLPHENOL	0.018 U	0.018 U	0.02 U	0.024 U	0.018 U	0.02 U	0.021 U
4-CHLOROANILINE	0.015 U	0.016 U	0.017 U	0.021 U	0.016 U	0.017 U	0.019 U
4-CHLOROPHENYL-PHENYLETHER	0.017 U	0.018 U	0.019 U	0.024 U	0.017 U	0.019 U	0.021 U
4-METHYLPHENOL	0.018 U	0.019 U	0.02 U	0.025 U	0.018 U	0.02 U	0.022 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB08	09-SB08	09-SB08	09-SB10	09-SB10	09-SB10	09-SB11
Sample ID	30209SB08001	30209SB08002	30209SB08003	30209SB10001	30209SB10002	30209SB10003	30209SB11001
Sample Date	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.19 U	0.2 U	0.21 U	0.26 U	0.19 U	0.22 U	0.23 U
4-NITROPHENOL	0.16 U	0.16 U	0.17 U	0.22 U	0.16 U	0.18 U	0.19 U
ACENAPHTHENE	0.014 U	0.015 U	0.016 U	0.02 U	0.015 U	0.016 U	0.017 U
ACENAPHTHYLENE	0.014 U	0.014 U	0.015 U	0.019 U	0.014 U	0.015 U	0.016 U
ANTHRACENE	0.015 U	0.015 U	0.017 U	0.021 U	0.015 U	0.017 U	0.018 U
BENZO(A)ANTHRACENE	0.013 U	0.014 U	0.015 U	0.018 U	0.014 U	0.015 U	0.021 J g
BENZO(A)PYRENE	0.021 U	0.022 U	0.023 U	0.029 U	0.025 J g	0.024 U	0.031 J g
BENZO(B)FLUORANTHENE	0.018 U	0.019 U	0.02 U	0.025 U	0.025 J g	0.021 U	0.033 J g
BENZO(G,H,I)PERYLENE	0.021 U	0.022 U	0.024 U	0.03 U	0.032 J g	0.024 U	0.06 UJ b
BENZO(K)FLUORANTHENE	0.021 U	0.021 U	0.023 U	0.029 U	0.024 J g	0.023 U	0.03 J g
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.012 U	0.013 U	0.016 U	0.012 U	0.013 U	0.014 U
BIS(2-CHLOROETHYL)ETHER	0.013 U	0.013 U	0.014 U	0.017 U	0.013 U	0.014 U	0.015 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.02 U	0.02 U	0.022 U	0.027 U	0.027 UJ b	0.022 U	0.024 U
BUTYLBENZYLPHTHALATE	0.017 U	0.018 U	0.019 U	0.024 U	0.018 U	0.02 U	0.021 U
CARBAZOLE	0.012 U	0.013 U	0.013 U	0.017 U	0.012 U	0.014 U	0.015 U
CHRYSENE	0.013 U	0.013 U	0.014 U	0.018 U	0.013 U	0.014 U	0.03 J g
DI-N-BUTYLPHTHALATE	0.013 U	0.018 UJ b	0.015 U	0.018 U	0.013 U	0.015 U	0.016 U
DI-N-OCTYLPHTHALATE	0.025 U	0.026 U	0.028 U	0.035 U	0.026 U	0.029 U	0.031 U
DIBENZ(A,H)ANTHRACENE	0.029 U	0.03 U	0.032 U	0.04 U	0.03 U	0.033 U	0.035 U
DIBENZOFURAN	0.013 U	0.013 U	0.014 U	0.018 U	0.013 U	0.014 U	0.015 U
DIETHYLPHTHALATE	0.015 U	0.016 U	0.017 U	0.021 U	0.015 U	0.017 U	0.018 U
DIMETHYLPHTHALATE	0.017 U	0.018 U	0.02 U	0.024 U	0.018 U	0.02 U	0.021 U
FLUORANTHENE	0.012 U	0.013 U	0.014 U	0.017 U	0.013 U	0.014 U	0.044 J g
FLUORENE	0.014 U	0.014 U	0.016 U	0.019 U	0.014 U	0.016 U	0.017 U
HEXACHLOROBENZENE	0.016 U	0.016 U	0.018 U	0.022 U	0.016 U	0.018 U	0.019 U
HEXACHLOROBUTADIENE	0.015 U	0.016 U	0.017 U	0.021 U	0.015 U	0.017 U	0.018 U
HEXACHLOROCYCLOPENTADIENE	0.013 U	0.014 U	0.015 U	0.019 U	0.014 U	0.015 U	0.016 U
HEXACHLOROETHANE	0.023 U	0.024 U	0.026 U	0.032 U	0.023 U	0.026 U	0.028 U
INDENO(1,2,3-CD)PYRENE	0.041 U	0.042 U	0.046 U	0.057 U	0.042 U	0.046 U	0.049 U
ISOPHORONE	0.015 U	0.016 U	0.017 U	0.021 U	0.015 U	0.017 U	0.018 U
N-NITROSO-DI-N-PROPYLAMINE	0.02 U	0.021 U	0.023 U	0.028 U	0.021 U	0.023 U	0.025 U
N-NITROSODIPHENYLAMINE (1)	0.019 U	0.02 U	0.021 U	0.027 U	0.02 U	0.022 U	0.023 U
NAPHTHALENE	0.015 U	0.016 U	0.017 U	0.021 U	0.016 U	0.017 U	0.019 U
NITROBENZENE	0.027 U	0.028 U	0.031 U	0.038 U	0.028 U	0.031 U	0.033 U
PENTACHLOROPHENOL	0.13 U	0.14 U	0.15 U	0.19 U	0.14 U	0.15 U	0.16 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB08	09-SB08	09-SB08	09-SB10	09-SB10	09-SB10	09-SB11
Sample ID	30209SB08001	30209SB08002	30209SB08003	30209SB10001	30209SB10002	30209SB10003	30209SB11001
Sample Date	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.011 U	0.011 U	0.012 U	0.015 U	0.011 U	0.012 U	0.022 J g
PHENOL	0.021 U	0.021 U	0.023 U	0.029 U	0.021 U	0.023 U	0.025 U
PYRENE	0.015 U	0.016 U	0.017 U	0.021 U	0.015 U	0.017 U	0.054 J g
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.00085 U	0.00088 U	0.00096 U	0.0012 U	0.00087 U	0.00097 U	0.0011 U
AROCLOR-1221	0.00085 U	0.00088 U	0.00096 U	0.0012 U	0.00087 U	0.00097 U	0.0011 U
AROCLOR-1232	0.00085 U	0.00088 U	0.00096 U	0.0012 U	0.00087 U	0.00097 U	0.0011 U
AROCLOR-1242	0.00085 U	0.00088 U	0.00096 U	0.0012 U	0.00087 U	0.00097 U	0.0011 U
AROCLOR-1248	0.00085 U	0.00088 U	0.00096 U	0.0012 U	0.00087 U	0.00097 U	0.0011 U
AROCLOR-1254	0.00085 U	0.00088 U	0.00096 U	0.0012 U	0.00087 U	0.00097 U	0.0011 U
AROCLOR-1260	0.00085 U	0.00088 U	0.00096 U	0.0012 U	0.00087 U	0.00097 U	0.0011 U
Pesticides							
4,4'-DDD	0.00016 U	0.00017 U	0.00018 U	0.00039 U	0.00016 U	0.00018 U	0.0002 U
4,4'-DDE	0.00026 U	0.00027 U	0.00029 U	0.00036 U	0.00026 U	0.00029 U	0.00031 U
4,4'-DDT	0.00018 U	0.00019 U	0.0002 U	0.00072 UJ j	0.00018 U	0.0002 U	0.00022 U
ALDRIN	0.00025 U	0.00025 U	0.00027 U	0.00034 U	0.00025 U	0.00028 U	0.0003 U
ALPHA-BHC	0.00011 U	0.00011 U	0.00012 U	0.00015 U	0.00011 U	0.00013 U	0.00013 U
ALPHA-CHLORDANE	0.00012 U	0.00012 U	0.00013 U	0.00016 U	0.00012 U	0.00013 U	0.00014 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.0012 U	0.00016 U	0.00032 U	0.00022 U	0.00016 U	0.00018 U	0.00019 U
DELTA-BHC	0.00039 U	0.0004 U	0.00043 U	0.00054 U	0.0004 U	0.00044 U	0.00047 U
DIELDRIN	0.00032 U	0.00033 U	0.00036 U	0.00045 U	0.00033 U	0.00037 U	0.00039 U
ENDOSULFAN I	0.00013 U	0.00014 U	0.00022 U	0.00018 U	0.00053 U	0.00015 U	0.00016 U
ENDOSULFAN II	0.00023 U	0.00024 U	0.00026 U	0.00032 U	0.00024 U	0.00026 U	0.00028 U
ENDOSULFAN SULFATE	0.00017 U	0.00018 U	0.00019 U	0.00024 U	0.00017 U	0.00019 U	0.00021 U
ENDRIN	0.00014 U	0.00015 U	0.00016 U	0.0002 U	0.00014 U	0.00016 U	0.00017 U
ENDRIN ALDEHYDE	0.00037 U	0.00038 U	0.00041 U	0.00052 U	0.00038 U	0.00042 U	0.00045 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB08	09-SB08	09-SB08	09-SB10	09-SB10	09-SB10	09-SB11
Sample ID	30209SB08001	30209SB08002	30209SB08003	30209SB10001	30209SB10002	30209SB10003	30209SB11001
Sample Date	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002	10/24/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00017 U	0.00018 U	0.00019 U	0.00023 U	0.00017 U	0.00019 U	0.00063 UJ j
GAMMA-BHC (LINDANE)	0.0011 U	0.00027 U	0.00029 U	0.00036 U	0.00026 U	0.00029 U	0.00031 U
GAMMA-CHLORDANE	0.00016 U	0.00016 U	0.00018 U	0.00022 U	0.00016 U	0.00018 U	0.00019 U
HEPTACHLOR	0.00014 U	0.00015 U	0.00016 U	0.0002 U	0.00015 U	0.00016 U	0.00018 U
HEPTACHLOR EPOXIDE	0.00015 U	0.00015 U	0.00016 U	0.0002 U	0.00015 U	0.00017 U	0.00018 U
METHOXYCHLOR	0.00017 U	0.00018 U	0.00019 U	0.00067 U	0.00018 U	0.00019 U	0.00021 UJ c
TOXAPHENE	0.0096 U	0.0099 U	0.011 U	0.017 U	0.0098 U	0.011 U	0.028 U
Metals (mg/kg)							
ALUMINUM	4,180	4,360	4,210	8,420	3,740	4,680	6,000
ANTIMONY	0.05 UJ be	0.05 UJ be	0.06 UJ be	1.07 J e	0.09 UJ be	0.08 UJ be	0.15 J e
ARSENIC	2.5	2.9	2.5	15.4	2.7	3	8.8
BARIUM	11.7	9	8.3	111	8.8	8.5	35.5 J d
BERYLLIUM	0.09 J g	0.11 J g	0.12 J g	0.25 J g	0.1 J g	0.12 J g	0.15 J g
CADMIUM	0.06	0.05 J g	0.04 J g	0.24	0.04 J g	0.06 J g	0.26
CALCIUM	2,600	2,470	2,190	10,200	1,850	1,750	3,890 J d
CHROMIUM	31.6	28.2	25.7	30.7	26	27.7	33.8 J ed
COBALT	6.1	6.2	5.9	6.1	5.8	7.2	6.7
COPPER	3.54	3.86	3.64	13	4.03	4.48	32.1
IRON	9,810	10,600	9,630	16,900	9,130	10,900	13,600
LEAD	2.3	2.4	1.86	33.1	2.81	2.11	26.4 J d
MAGNESIUM	2,350	2,590	2,330	4,110	2,160	2,610	3,480
MANGANESE	85.5	92.7	79.1	300	78.4	87.4	217 J e
MERCURY	0.14	0.01 U	0.01 U	0.02 J g	0.01 U	0.01 U	0.06
MOLYBDENUM	0.08 UJ f	0.07 UJ f	0.1 UJ f	3.11	0.48	0.06 UJ f	0.86 UJ bd
NICKEL	21.3 J j	22.8 J j	22.8 J j	30.7 J j	21.2 J j	24.8 J j	28
POTASSIUM	513 J j	563 J j	568 J j	553 J jg	521 J j	659 J j	740 J j
SELENIUM	0.2 U	0.2 U	0.2 U	0.6 J g	0.2 U	0.2 U	0.3 U
SILVER	0.016 J g	0.018 J g	0.018 J g	0.051	0.016 J g	0.02 J g	0.04
SODIUM	98.3	93.9	67	684	81.1	63.7	176 J j
THALLIUM	0.032	0.032	0.033	0.051	0.031	0.041	0.062 J d
TIN	3 UJ b	2.1 U	2.8 UJ b	2.9 U	3.1 UJ b	3.8 UJ b	2.5 U
VANADIUM	20.1	19	17	33.4	16.2	18.4	26.7
ZINC	16.3	17.3	17.1	24.2	15.8	18.5	26
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB11	09-SB11	09-SB12	09-SB12	09-SB12	09-SB13	09-SB13
Sample ID	30209SB11002	30209SB11003	30209SB12001	30209SB12002	30209SB12003	30209SB13001	30209SB13002
Sample Date	10/24/2002	10/24/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,1,1-TRICHLOROETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,1,2,2-TETRACHLOROETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,1,2-TRICHLOROETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,1-DICHLOROETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,1-DICHLOROETHENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,1-DICHLOROPROPENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,2,3-TRICHLOROBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,2,3-TRICHLOROPROPANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,2,4-TRICHLOROBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,2,4-TRIMETHYLBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,2-DIBROMO-3-CHLOROPROPANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,2-DIBROMOETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,2-DICHLOROBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,2-DICHLOROETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,3,5-TRIMETHYLBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,3-DICHLOROBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,3-DICHLOROPROPANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
1,4-DICHLOROBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
2,2-DICHLOROPROPANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
2-BUTANONE	0.011 U	0.011 U	0.027 U	0.012 U	0.011 U	0.031 U	0.012 U
2-CHLOROTOLUENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
2-HEXANONE	0.011 U	0.011 U	0.027 U	0.012 U	0.011 U	0.031 U	0.012 U
4-CHLOROTOLUENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
4-METHYL-2-PENTANONE	0.011 U	0.011 U	0.027 U	0.012 U	0.011 U	0.031 U	0.012 U
ACETONE	0.021 U	0.022 U	0.054 U	0.023 U	0.023 U	0.062 U	0.023 U
BENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
BROMOBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
BROMOCHLOROMETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
BROMODICHLOROMETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
BROMOFORM	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
BROMOMETHANE	0.011 U	0.011 U	0.027 U	0.012 U	0.011 U	0.031 U	0.012 U
CARBON DISULFIDE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 UJ c
CARBON TETRACHLORIDE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB11	09-SB11	09-SB12	09-SB12	09-SB12	09-SB13	09-SB13
Sample ID	30209SB11002	30209SB11003	30209SB12001	30209SB12002	30209SB12003	30209SB13001	30209SB13002
Sample Date	10/24/2002	10/24/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
CHLOROETHANE	0.011 U	0.011 U	0.027 U	0.012 U	0.011 U	0.031 U	0.012 U
CHLOROFORM	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
CHLOROMETHANE	0.011 U	0.011 U	0.027 U	0.012 U	0.011 U	0.031 U	0.012 U
CIS-1,2-DICHLOROETHENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
CIS-1,3-DICHLOROPROPENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
DIBROMOCHLOROMETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
DIBROMOMETHANE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
ETHYLBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
FREON 11	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
FREON 113	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
FREON 12	0.011 U	0.011 U	0.027 U	0.012 U	0.011 U	0.031 U	0.012 U
HEXACHLOROBUTADIENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
ISOPROPYLBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
M,P-XYLENES	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
METHYL-TERT-BUTYL ETHER	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
METHYLENE CHLORIDE	0.021 UJ b	0.022 UJ b	0.054 U	0.023 U	0.023 UJ b	0.062 UJ b	0.023 UJ b
N-BUTYLBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
N-PROPYLBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
NAPHTHALENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
O-XYLENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
PARA-ISOPROPYL TOLUENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
SEC-BUTYLBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
STYRENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
TERT-BUTYLBENZENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
TETRACHLOROETHENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
TOLUENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
TRANS-1,2-DICHLOROETHENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
TRANS-1,3-DICHLOROPROPENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
TRICHLOROETHENE	0.0054 U	0.0055 U	0.013 U	0.0058 U	0.0057 U	0.015 U	0.0059 U
VINYL ACETATE	0.054 UJ c	0.055 UJ c	0.13 UJ c	0.058 UJ c	0.057 UJ c	0.15 UJ c	0.059 UJ c
VINYL CHLORIDE	0.011 U	0.011 U	0.027 U	0.012 U	0.011 U	0.031 U	0.012 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	4.4 U	6.6 D	83 Y	13 UJ b	5.4 U	8.4 UJ b	4.5 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB11	09-SB11	09-SB12	09-SB12	09-SB12	09-SB13	09-SB13
Sample ID	30209SB11002	30209SB11003	30209SB12001	30209SB12002	30209SB12003	30209SB13001	30209SB13002
Sample Date	10/24/2002	10/24/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	4.4 U	7.9 Z	330 M	59 UJ b	5.4 U	44 UJ b	4.5 U
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.22 U	0.23 U	0.61 U	0.46 U	0.24 U	0.36 U	0.22 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.014 U	0.018 U	0.012 U	0.014 U	0.016 U	0.012 U
1,2-DICHLOROBENZENE	0.019 U	0.022 U	0.029 U	0.02 U	0.023 U	0.026 U	0.02 U
1,3-DICHLOROBENZENE	0.02 U	0.022 U	0.029 U	0.02 U	0.024 U	0.026 U	0.02 U
1,4-DICHLOROBENZENE	0.019 U	0.021 U	0.028 U	0.019 U	0.023 U	0.025 U	0.019 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.015 U	0.017 U	0.023 U	0.016 U	0.018 U	0.02 U	0.015 U
2,4,5-TRICHLOROPHENOL	0.018 U	0.021 U	0.028 U	0.019 U	0.022 U	0.025 U	0.019 U
2,4,6-TRICHLOROPHENOL	0.015 U	0.018 U	0.023 U	0.016 U	0.019 U	0.021 U	0.016 U
2,4-DICHLOROPHENOL	0.018 U	0.02 U	0.026 U	0.018 U	0.021 U	0.024 U	0.018 U
2,4-DIMETHYLPHENOL	0.016 U	0.019 U	0.024 U	0.017 U	0.02 U	0.022 U	0.017 U
2,4-DINITROPHENOL	0.12 U	0.14 U	0.18 U	0.13 U	0.15 U	0.16 U	0.12 U
2,4-DINITROTOLUENE	0.016 U	0.018 U	0.024 U	0.017 U	0.019 U	0.022 U	0.016 U
2,6-DINITROTOLUENE	0.017 U	0.019 U	0.025 U	0.017 U	0.02 U	0.023 U	0.017 U
2-CHLORONAPHTHALENE	0.011 U	0.012 U	0.016 U	0.011 U	0.013 U	0.015 U	0.011 U
2-CHLOROPHENOL	0.011 U	0.012 U	0.016 U	0.011 U	0.013 U	0.015 U	0.011 U
2-METHYLNAPHTHALENE	0.012 U	0.014 U	0.018 U	0.012 U	0.014 U	0.016 U	0.012 U
2-METHYLPHENOL	0.018 U	0.02 U	0.027 U	0.019 U	0.022 U	0.024 U	0.018 U
2-NITROANILINE	0.018 U	0.021 U	0.027 U	0.019 U	0.022 U	0.024 U	0.018 U
2-NITROPHENOL	0.015 U	0.017 U	0.022 U	0.016 U	0.018 U	0.02 U	0.015 U
3,3'-DICHLOROBENZIDINE	0.029 U	0.033 U	0.043 U	0.03 U	0.035 U	0.039 U	0.029 U
3-NITROANILINE	0.19 U	0.21 U	0.28 U	0.19 U	0.23 U	0.25 U	0.19 U
4,6-DINITRO-2-METHYLPHENOL	0.15 U	0.18 U	0.23 U	0.16 U	0.19 U	0.21 U	0.16 U
4-BROMOPHENYL-PHENYLETHER	0.013 U	0.015 U	0.02 U	0.014 U	0.016 U	0.018 U	0.013 U
4-CHLORO-3-METHYLPHENOL	0.018 U	0.02 U	0.027 U	0.018 U	0.022 U	0.024 U	0.018 U
4-CHLOROANILINE	0.016 U	0.018 U	0.023 U	0.016 U	0.019 U	0.021 U	0.016 U
4-CHLOROPHENYL-PHENYLETHER	0.017 U	0.02 U	0.026 U	0.018 U	0.021 U	0.023 U	0.018 U
4-METHYLPHENOL	0.018 U	0.021 U	0.027 U	0.019 U	0.022 U	0.024 U	0.018 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB11	09-SB11	09-SB12	09-SB12	09-SB12	09-SB13	09-SB13
Sample ID	30209SB11002	30209SB11003	30209SB12001	30209SB12002	30209SB12003	30209SB13001	30209SB13002
Sample Date	10/24/2002	10/24/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.19 U	0.22 U	0.29 U	0.2 U	0.23 U	0.26 U	0.2 U
4-NITROPHENOL	0.16 U	0.18 U	0.24 U	0.16 U	0.19 U	0.21 U	0.16 U
ACENAPHTHENE	0.014 U	0.017 U	0.022 U	0.015 U	0.018 U	0.019 U	0.015 U
ACENAPHTHYLENE	0.014 U	0.016 U	0.021 U	0.014 U	0.017 U	0.018 U	0.014 U
ANTHRACENE	0.015 U	0.017 U	0.022 U	0.016 U	0.018 U	0.02 U	0.015 U
BENZO(A)ANTHRACENE	0.013 U	0.015 U	0.02 U	0.017 UJ f	0.016 U	0.018 U	0.014 U
BENZO(A)PYRENE	0.021 U	0.024 U	0.032 U	0.028 J g	0.026 U	0.051 J g	0.022 U
BENZO(B)FLUORANTHENE	0.018 U	0.021 U	0.028 U	0.034 J g	0.022 U	0.052 J g	0.019 U
BENZO(G,H,I)PERYLENE	0.028 UJ b	0.083 UJ b	0.17	0.026 J g	0.026 U	0.035 J g	0.022 U
BENZO(K)FLUORANTHENE	0.021 U	0.024 U	0.031 U	0.032 J g	0.025 U	0.046 J g	0.021 U
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.014 U	0.018 U	0.012 U	0.014 U	0.016 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	0.013 U	0.015 U	0.019 U	0.013 U	0.015 U	0.017 U	0.013 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.02 U	0.023 U	0.53 UJ b	0.36 UJ b	0.024 U	0.027 U	0.02 U
BUTYLBENZYLPHTHALATE	0.017 U	0.02 U	0.026 U	0.018 U	0.021 U	0.024 U	0.018 U
CARBAZOLE	0.012 U	0.014 U	0.018 U	0.013 U	0.015 U	0.016 U	0.012 U
CHRYSENE	0.013 U	0.015 U	0.026 UJ f	0.014 UJ f	0.015 U	0.021 UJ f	0.013 U
DI-N-BUTYLPHTHALATE	0.013 U	0.015 U	0.02 U	0.014 U	0.016 U	0.018 U	0.013 U
DI-N-OCTYLPHTHALATE	0.026 U	0.029 U	0.038 U	0.026 U	0.031 U	0.034 U	0.026 U
DIBENZ(A,H)ANTHRACENE	0.029 U	0.07	0.044 U	0.03 U	0.035 U	0.039 U	0.03 U
DIBENZOFURAN	0.013 U	0.015 U	0.019 U	0.013 U	0.015 U	0.017 U	0.013 U
DIETHYLPHTHALATE	0.015 U	0.017 U	0.023 U	0.016 U	0.018 U	0.02 U	0.015 U
DIMETHYLPHTHALATE	0.018 U	0.02 U	0.026 U	0.018 U	0.021 U	0.024 U	0.018 U
FLUORANTHENE	0.015 J g	0.014 U	0.019 U	0.013 U	0.015 U	0.025 UJ f	0.013 U
FLUORENE	0.014 U	0.016 U	0.021 U	0.015 U	0.017 U	0.019 U	0.014 U
HEXACHLOROBENZENE	0.016 U	0.018 U	0.024 U	0.016 U	0.019 U	0.021 U	0.016 U
HEXACHLOROBUTADIENE	0.015 U	0.017 U	0.023 U	0.016 U	0.018 U	0.02 U	0.015 U
HEXACHLOROCYCLOPENTADIENE	0.014 U	0.015 U	0.02 U	0.014 U	0.016 U	0.018 U	0.014 U
HEXACHLOROETHANE	0.023 U	0.026 U	0.035 U	0.024 U	0.028 U	0.031 U	0.023 U
INDENO(1,2,3-CD)PYRENE	0.041 U	0.085 J g	0.062 U	0.043 U	0.05 U	0.056 U	0.042 U
ISOPHORONE	0.015 U	0.017 U	0.023 U	0.016 U	0.018 U	0.02 U	0.015 U
N-NITROSO-DI-N-PROPYLAMINE	0.02 U	0.023 U	0.031 U	0.021 U	0.025 U	0.028 U	0.021 U
N-NITROSODIPHENYLAMINE (1)	0.019 U	0.022 U	0.029 U	0.02 U	0.023 U	0.026 U	0.02 U
NAPHTHALENE	0.016 U	0.018 U	0.038 J g	0.016 U	0.019 U	0.021 U	0.016 U
NITROBENZENE	0.028 U	0.032 U	0.042 U	0.029 U	0.034 U	0.037 U	0.028 U
PENTACHLOROPHENOL	0.14 U	0.15 U	0.2 U	0.14 U	0.16 U	0.18 U	0.14 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB11	09-SB11	09-SB12	09-SB12	09-SB12	09-SB13	09-SB13
Sample ID	30209SB11002	30209SB11003	30209SB12001	30209SB12002	30209SB12003	30209SB13001	30209SB13002
Sample Date	10/24/2002	10/24/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.011 U	0.012 U	0.027 UJ f	0.011 U	0.013 U	0.015 U	0.011 U
PHENOL	0.021 U	0.024 U	0.031 U	0.022 U	0.025 U	0.028 U	0.021 U
PYRENE	0.023 J g	0.017 U	0.023 U	0.016 U	0.018 U	0.042 UJ f	0.015 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.00086 U	0.00099 U	0.0013 U	0.00089 U	0.0011 U	0.0012 U	0.00088 U
AROCLOR-1221	0.00086 U	0.00099 U	0.0013 U	0.00089 U	0.0011 U	0.0012 U	0.00088 U
AROCLOR-1232	0.00086 U	0.00099 U	0.0013 U	0.00089 U	0.0011 U	0.0012 U	0.00088 U
AROCLOR-1242	0.00086 U	0.00099 U	0.0013 U	0.00089 U	0.0011 U	0.0012 U	0.00088 U
AROCLOR-1248	0.00086 U	0.00099 U	0.0013 U	0.00089 U	0.0011 U	0.0012 U	0.00088 U
AROCLOR-1254	0.00086 U	0.00099 U	0.0013 U	0.00089 U	0.0011 U	0.0012 U	0.00088 U
AROCLOR-1260	0.00086 U	0.00099 U	0.058	0.016	0.0011 U	0.0012 U	0.00088 U
Pesticides							
4,4'-DDD	0.00016 U	0.00019 U	0.0063 J g	0.0014 J g	0.0002 U	0.00022 U	0.00017 U
4,4'-DDE	0.00026 U	0.0003 U	0.0034 J g	0.0014 U	0.00032 U	0.00035 U	0.00027 U
4,4'-DDT	0.00018 U	0.00021 U	0.037	0.0092	0.00022 U	0.00024 U	0.00018 U
ALDRIN	0.00025 U	0.00028 U	0.0019 U	0.0013 U	0.0003 U	0.00033 U	0.00025 U
ALPHA-BHC	0.00011 U	0.00013 U	0.00081 U	0.00056 U	0.00013 U	0.00015 U	0.00011 U
ALPHA-CHLORDANE	0.00012 U	0.00013 U	0.0018 J g	0.00058 U	0.00014 U	0.00016 U	0.00012 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00016 U	0.00018 U	0.0012 U	0.0008 U	0.00019 U	0.00021 U	0.00017 U
DELTA-BHC	0.00039 U	0.00045 U	0.003 U	0.002 U	0.00047 U	0.00053 U	0.0004 U
DIELDRIN	0.00032 U	0.00037 U	0.0025 U	0.0017 U	0.00039 U	0.00044 U	0.00033 U
ENDOSULFAN I	0.00013 U	0.00015 U	0.00098 U	0.00067 U	0.00016 U	0.00018 U	0.00014 U
ENDOSULFAN II	0.00023 U	0.00027 U	0.0023 U	0.0012 U	0.00028 U	0.00031 U	0.00024 U
ENDOSULFAN SULFATE	0.00017 U	0.0002 U	0.0058 J g	0.00087 U	0.00021 U	0.00023 U	0.00018 U
ENDRIN	0.00014 U	0.00016 U	0.0011 U	0.00072 U	0.00017 U	0.00019 U	0.00015 U
ENDRIN ALDEHYDE	0.00037 U	0.00043 U	0.0028 U	0.002 U	0.00045 U	0.0005 U	0.00038 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB11	09-SB11	09-SB12	09-SB12	09-SB12	09-SB13	09-SB13
Sample ID	30209SB11002	30209SB11003	30209SB12001	30209SB12002	30209SB12003	30209SB13001	30209SB13002
Sample Date	10/24/2002	10/24/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00021 U	0.0002 U	0.0025 U	0.00093 U	0.00021 U	0.00024 U	0.00017 U
GAMMA-BHC (LINDANE)	0.00026 U	0.0003 U	0.002 U	0.0014 U	0.00031 U	0.00035 U	0.00026 U
GAMMA-CHLORDANE	0.00016 U	0.00018 U	0.0056 UJ j	0.0008 U	0.00019 U	0.00021 U	0.00016 U
HEPTACHLOR	0.00015 U	0.00017 U	0.0011 U	0.00074 U	0.00018 U	0.0002 U	0.00015 U
HEPTACHLOR EPOXIDE	0.00015 U	0.00017 U	0.0011 U	0.00074 U	0.00018 U	0.0002 U	0.00015 U
METHOXYCHLOR	0.00017 UJ c	0.0002 UJ c	0.0079 U	0.0014 J g	0.00021 U	0.00029 U	0.00018 U
TOXAPHENE	0.0096 U	0.012 U	0.25 U	0.06 U	0.012 U	0.014 U	0.0098 U
Metals (mg/kg)							
ALUMINUM	5,010	4,780	13,800	4,490	4,310	5,830	3,900
ANTIMONY	0.08 UJ be	0.08 UJ be	0.39 J ed	0.1 J ed	0.09 J ed	0.1 J ed	0.06 J ed
ARSENIC	5.5	2.8	16.9	2.7	2.7	7.1	2.4
BARIUM	11.8 J d	15.4 J d	181 J d	24.2 J d	8.6 J d	23.1 J dj	7.3 J d
BERYLLIUM	0.13 J g	0.12 J g	0.36 J g	0.11 J g	0.1 J g	0.16 J g	0.11 J g
CADMIUM	0.06	0.06	0.57	0.05 J g	0.05 J g	0.06 J g	0.05 J g
CALCIUM	5,340 J d	3,590 J d	10,400	2,800	1,900	9,100	3,580
CHROMIUM	36.3 J ed	29 J ed	52	32.4	27.4	39.1	24.7
COBALT	6	5.7	6	5.8	6.5	8 J j	6
COPPER	4.52	5.11	21.8	4.92	4.39	5.99	4.8
IRON	12,100	9,330	20,400	10,300	10,100	18,200	8,890
LEAD	3.17 J d	2.13 J d	24.7	3.31	2.67	5.25	2.36
MAGNESIUM	3,460	2,320	3,520	2,370	2,550	5,960	2,210
MANGANESE	163 J e	79.5 J e	290	85.2	79.2	289	77.1
MERCURY	0.02	0.02	0.04	0.01 J g	0.01 J g	0.03	0.01 J g
MOLYBDENUM	0.14 UJ bd	0.08 UJ bd	4.31 J d	0.3 UJ fd	0.13 UJ fd	0.4 UJ fd	0.07 UJ bd
NICKEL	28.6	23.7	40.9	22.3	25.9	36.1	20.5
POTASSIUM	928 J j	705 J j	1,060 J j	591 J j	625 J j	630 J j	631 J j
SELENIUM	0.2 U	0.2 U	0.3 J g	0.2 U	0.2 U	0.2 U	0.2 U
SILVER	0.019 J g	0.018 J g	0.158	0.021 J g	0.018 J g	0.026	0.018 J g
SODIUM	104 J j	82.8 J j	468	100	81.1	219 J j	84.9
THALLIUM	0.03 J d	0.038 J d	0.146	0.051	0.051	0.039	0.036
TIN	2.1 U	2.4 U	2.3 U	2.2 U	2.1 U	2.4 UJ j	2.1 U
VANADIUM	23	18.1	48.8	22.3	19.4	27.7	17.3
ZINC	24.2	17.6	58.1	20.1	18.7	26.6 J j	15.7
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB13	09-SB14	09-SB14	09-SB14	09-SB15	09-SB15	09-SB15
Sample ID	30209SB13003	30209SB14001	30209SB14002	30209SB14003	30209SB15001	30209SB15002	30209SB15003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,1,1-TRICHLOROETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,1,2,2-TETRACHLOROETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,1,2-TRICHLOROETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,1-DICHLOROETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,1-DICHLOROETHENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,1-DICHLOROPROPENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,2,3-TRICHLOROBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,2,3-TRICHLOROPROPANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,2,4-TRICHLOROBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,2,4-TRIMETHYLBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,2-DIBROMO-3-CHLOROPROPANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,2-DIBROMOETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,2-DICHLOROBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,2-DICHLOROETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,3,5-TRIMETHYLBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,3-DICHLOROBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,3-DICHLOROPROPANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
1,4-DICHLOROBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
2,2-DICHLOROPROPANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
2-BUTANONE	0.012 U	0.011 U	0.011 U	0.011 U	0.012 U	0.012 U	0.011 U
2-CHLOROTOLUENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
2-HEXANONE	0.012 U	0.011 U	0.011 U	0.011 U	0.012 U	0.012 U	0.011 U
4-CHLOROTOLUENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
4-METHYL-2-PENTANONE	0.012 U	0.011 U	0.011 U	0.011 U	0.012 U	0.012 U	0.011 U
ACETONE	0.023 U	0.021 U	0.021 UJ b	0.023 UJ b	0.024 UJ b	0.023 UJ b	0.023 UJ b
BENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
BROMOBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
BROMOCHLOROMETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
BROMODICHLOROMETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
BROMOFORM	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
BROMOMETHANE	0.012 U	0.011 U	0.011 U	0.011 UJ b	0.012 UJ b	0.012 U	0.011 UJ b
CARBON DISULFIDE	0.0058 UJ c	0.0053 UJ c	0.0054 UJ c	0.0057 U	0.006 UJ b	0.0058 U	0.0057 UJ b
CARBON TETRACHLORIDE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB13	09-SB14	09-SB14	09-SB14	09-SB15	09-SB15	09-SB15
Sample ID	30209SB13003	30209SB14001	30209SB14002	30209SB14003	30209SB15001	30209SB15002	30209SB15003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
CHLOROETHANE	0.012 U	0.011 U	0.011 U	0.011 U	0.012 U	0.012 U	0.011 U
CHLOROFORM	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
CHLOROMETHANE	0.012 U	0.011 U	0.011 U	0.011 U	0.012 U	0.012 U	0.011 U
CIS-1,2-DICHLOROETHENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
CIS-1,3-DICHLOROPROPENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
DIBROMOCHLOROMETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
DIBROMOMETHANE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
ETHYLBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
FREON 11	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
FREON 113	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
FREON 12	0.012 U	0.011 U	0.011 U	0.011 UJ c	0.012 UJ c	0.012 UJ c	0.011 UJ c
HEXACHLOROBUTADIENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
ISOPROPYLBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
M,P-XYLENES	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
METHYL-TERT-BUTYL ETHER	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
METHYLENE CHLORIDE	0.023 UJ b	0.021 UJ b	0.021 UJ b	0.023 U	0.024 U	0.023 U	0.023 U
N-BUTYLBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
N-PROPYLBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
NAPHTHALENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
O-XYLENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
PARA-ISOPROPYL TOLUENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
SEC-BUTYLBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
STYRENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
TERT-BUTYLBENZENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
TETRACHLOROETHENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
TOLUENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
TRANS-1,2-DICHLOROETHENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
TRANS-1,3-DICHLOROPROPENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
TRICHLOROETHENE	0.0058 U	0.0053 U	0.0054 U	0.0057 U	0.006 U	0.0058 U	0.0057 U
VINYL ACETATE	0.058 UJ c	0.053 UJ c	0.054 UJ c	0.057 U	0.06 U	0.058 U	0.057 U
VINYL CHLORIDE	0.012 U	0.011 U	0.011 U	0.011 U	0.012 U	0.012 U	0.011 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	5.1 U	6.8 UJ b	5.3 UJ b	5.1 U	7.6 UJ b	13 UJ b	5.1 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB13	09-SB14	09-SB14	09-SB14	09-SB15	09-SB15	09-SB15
Sample ID	30209SB13003	30209SB14001	30209SB14002	30209SB14003	30209SB15001	30209SB15002	30209SB15003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	5.2 U	48 UJ b	18 UJ b	5.1 U	26 UJ b	68 UJ b	5.1 U
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.22 U	0.32 UJ a	0.21 U	0.27 U	0.27 U	0.23 U	0.25 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.014 U	0.012 U	0.012 U	0.014 U	0.012 U	0.012 U	0.014 U
1,2-DICHLOROBENZENE	0.022 U	0.02 U	0.019 U	0.022 U	0.02 U	0.02 U	0.022 U
1,3-DICHLOROBENZENE	0.023 U	0.02 U	0.02 U	0.022 U	0.02 U	0.02 U	0.022 U
1,4-DICHLOROBENZENE	0.022 U	0.019 U	0.019 U	0.021 U	0.019 U	0.02 U	0.021 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.018 U	0.016 U	0.015 U	0.017 U	0.016 U	0.016 U	0.017 U
2,4,5-TRICHLOROPHENOL	0.021 U	0.019 U	0.018 U	0.021 U	0.019 U	0.019 U	0.021 U
2,4,6-TRICHLOROPHENOL	0.018 U	0.016 U	0.015 U	0.018 U	0.016 U	0.016 U	0.018 U
2,4-DICHLOROPHENOL	0.02 U	0.018 U	0.018 U	0.02 U	0.018 U	0.018 U	0.02 U
2,4-DIMETHYLPHENOL	0.019 U	0.017 U	0.016 U	0.018 U	0.017 U	0.017 U	0.019 U
2,4-DINITROPHENOL	0.14 U	0.13 U	0.12 U	0.14 U	0.12 U	0.13 U	0.14 U
2,4-DINITROTOLUENE	0.019 U	0.017 U	0.016 U	0.018 U	0.016 U	0.017 U	0.018 U
2,6-DINITROTOLUENE	0.019 U	0.017 U	0.017 U	0.019 U	0.017 U	0.017 U	0.019 U
2-CHLORONAPHTHALENE	0.013 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.012 U
2-CHLOROPHENOL	0.013 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.012 U
2-METHYLNAPHTHALENE	0.014 U	0.012 U	0.012 U	0.014 U	0.012 U	0.012 U	0.014 U
2-METHYLPHENOL	0.021 U	0.019 U	0.018 U	0.02 U	0.018 U	0.019 U	0.02 U
2-NITROANILINE	0.021 U	0.019 U	0.018 U	0.021 U	0.019 U	0.019 U	0.021 U
2-NITROPHENOL	0.017 U	0.016 U	0.015 U	0.017 U	0.015 U	0.016 U	0.017 U
3,3'-DICHLOROBENZIDINE	0.033 U	0.03 U	0.029 U	0.033 U	0.029 U	0.03 U	0.033 U
3-NITROANILINE	0.22 U	0.19 U	0.19 U	0.21 U	0.19 U	0.2 U	0.21 U
4,6-DINITRO-2-METHYLPHENOL	0.18 U	0.16 U	0.15 U	0.18 U	0.16 U	0.16 U	0.18 U
4-BROMOPHENYL-PHENYLETHER	0.015 U	0.014 U	0.013 U	0.015 U	0.014 U	0.014 U	0.015 U
4-CHLORO-3-METHYLPHENOL	0.021 U	0.019 U	0.018 U	0.02 U	0.018 U	0.019 U	0.02 U
4-CHLOROANILINE	0.018 U	0.016 U	0.015 U	0.018 U	0.016 U	0.016 U	0.018 U
4-CHLOROPHENYL-PHENYLETHER	0.02 U	0.018 U	0.017 U	0.02 U	0.018 U	0.018 U	0.02 U
4-METHYLPHENOL	0.021 U	0.019 U	0.018 U	0.021 U	0.018 U	0.019 U	0.021 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB13	09-SB14	09-SB14	09-SB14	09-SB15	09-SB15	09-SB15
Sample ID	30209SB13003	30209SB14001	30209SB14002	30209SB14003	30209SB15001	30209SB15002	30209SB15003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.22 U	0.2 U	0.19 U	0.22 U	0.2 U	0.2 U	0.22 U
4-NITROPHENOL	0.18 U	0.16 U	0.16 U	0.18 U	0.16 U	0.16 U	0.18 U
ACENAPHTHENE	0.017 U	0.015 U	0.014 U	0.016 U	0.015 U	0.015 U	0.017 U
ACENAPHTHYLENE	0.016 U	0.014 U	0.014 U	0.016 U	0.014 U	0.014 U	0.016 U
ANTHRACENE	0.017 U	0.016 U	0.015 U	0.017 U	0.015 U	0.016 U	0.017 U
BENZO(A)ANTHRACENE	0.015 U	0.014 U	0.023 UJ f	0.015 U	0.017 UJ f	0.014 U	0.015 U
BENZO(A)PYRENE	0.025 U	0.03 J g	0.039 J g	0.024 U	0.022 U	0.022 UJ f	0.024 U
BENZO(B)FLUORANTHENE	0.021 U	0.031 J g	0.032 J g	0.021 U	0.019 U	0.024 J g	0.021 U
BENZO(G,H,I)PERYLENE	0.025 U	0.03 J g	0.021 U	0.025 U	0.022 U	0.041 J g	0.025 U
BENZO(K)FLUORANTHENE	0.024 U	0.03 J g	0.025 J g	0.024 U	0.021 U	0.022 J g	0.024 U
BIS(2-CHLOROETHOXY)METHANE	0.014 U	0.012 U	0.012 U	0.014 U	0.012 U	0.012 U	0.014 U
BIS(2-CHLOROETHYL)ETHER	0.015 U	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.023 U	0.021 U	0.35 UJ b	0.023 U	0.02 U	0.058 UJ b	0.032 UJ b
BUTYLBENZYLPHTHALATE	0.02 U	0.018 U	0.017 U	0.02 U	0.018 U	0.018 U	0.02 U
CARBAZOLE	0.014 U	0.013 U	0.012 U	0.014 U	0.012 U	0.013 U	0.014 U
CHRYSENE	0.015 U	0.013 U	0.031 UJ f	0.015 U	0.021 UJ f	0.013 U	0.015 U
DI-N-BUTYLPHTHALATE	0.015 U	0.014 U	0.013 U	0.015 U	0.013 U	0.014 U	0.015 U
DI-N-OCTYLPHTHALATE	0.03 U	0.027 U	0.025 U	0.029 U	0.026 U	0.027 U	0.029 U
DIBENZ(A,H)ANTHRACENE	0.034 U	0.03 U	0.029 U	0.033 U	0.03 U	0.03 U	0.033 U
DIBENZOFURAN	0.015 U	0.013 U	0.013 U	0.015 U	0.013 U	0.013 U	0.015 U
DIETHYLPHTHALATE	0.018 U	0.016 U	0.015 U	0.017 U	0.016 U	0.016 U	0.017 U
DIMETHYLPHTHALATE	0.02 U	0.018 U	0.018 U	0.02 U	0.018 U	0.018 U	0.02 U
FLUORANTHENE	0.014 U	0.013 U	0.043 UJ f	0.014 U	0.018 UJ f	0.013 U	0.014 U
FLUORENE	0.016 U	0.015 U	0.014 U	0.016 U	0.014 U	0.015 U	0.016 U
HEXACHLOROBENZENE	0.018 U	0.016 U	0.016 U	0.018 U	0.016 U	0.016 U	0.018 U
HEXACHLOROBUTADIENE	0.018 U	0.016 U	0.015 U	0.017 U	0.016 U	0.016 U	0.017 U
HEXACHLOROCYCLOPENTADIENE	0.016 U	0.014 U	0.013 U	0.015 U	0.014 U	0.014 U	0.015 U
HEXACHLOROETHANE	0.027 U	0.024 U	0.023 U	0.026 U	0.024 U	0.024 U	0.026 U
INDENO(1,2,3-CD)PYRENE	0.048 U	0.043 U	0.041 U	0.047 U	0.042 U	0.043 U	0.047 U
ISOPHORONE	0.018 U	0.016 U	0.015 U	0.017 U	0.015 U	0.016 U	0.017 U
N-NITROSO-DI-N-PROPYLAMINE	0.024 U	0.021 U	0.02 U	0.023 U	0.021 U	0.021 U	0.023 U
N-NITROSODIPHENYLAMINE (1)	0.022 U	0.02 U	0.019 U	0.022 U	0.02 U	0.02 U	0.022 U
NAPHTHALENE	0.018 U	0.016 U	0.015 U	0.018 U	0.016 U	0.016 U	0.018 U
NITROBENZENE	0.032 U	0.029 U	0.028 U	0.032 U	0.028 U	0.029 U	0.032 U
PENTACHLOROPHENOL	0.16 U	0.14 U	0.13 U	0.15 U	0.14 U	0.14 U	0.15 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB13	09-SB14	09-SB14	09-SB14	09-SB15	09-SB15	09-SB15
Sample ID	30209SB13003	30209SB14001	30209SB14002	30209SB14003	30209SB15001	30209SB15002	30209SB15003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.013 U	0.011 U	0.016 UJ f	0.012 U	0.011 U	0.011 U	0.012 U
PHENOL	0.024 U	0.022 U	0.021 U	0.024 U	0.021 U	0.022 U	0.024 U
PYRENE	0.018 U	0.016 U	0.068	0.017 U	0.024 UJ f	0.016 U	0.017 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.001 U	0.00089 U	0.00086 U	0.00098 U	0.00088 U	0.0009 U	0.00099 U
AROCLOR-1221	0.001 U	0.00089 U	0.00086 U	0.00098 U	0.00088 U	0.0009 U	0.00099 U
AROCLOR-1232	0.001 U	0.00089 U	0.00086 U	0.00098 U	0.00088 U	0.0009 U	0.00099 U
AROCLOR-1242	0.001 U	0.00089 U	0.00086 U	0.00098 U	0.00088 U	0.0009 U	0.00099 U
AROCLOR-1248	0.001 U	0.00089 U	0.00086 U	0.00098 U	0.00088 U	0.0009 U	0.00099 U
AROCLOR-1254	0.001 U	0.00089 U	0.00086 U	0.00098 U	0.00088 U	0.0009 U	0.00099 U
AROCLOR-1260	0.001 U	0.00089 U	0.00086 U	0.00098 U	0.00088 U	0.0009 U	0.00099 U
Pesticides							
4,4'-DDD	0.00019 U	0.00082 U	0.00016 U	0.00018 U	0.00017 U	0.00083 U	0.00019 U
4,4'-DDE	0.0003 U	0.0014 U	0.00026 U	0.0003 U	0.00027 U	0.0014 U	0.0003 U
4,4'-DDT	0.00021 U	0.00092 U	0.00018 U	0.00021 U	0.00019 U	0.00092 U	0.00021 U
ALDRIN	0.00029 U	0.0013 U	0.00025 U	0.00028 U	0.00025 U	0.0013 U	0.00028 U
ALPHA-BHC	0.00013 U	0.00056 U	0.00011 U	0.00013 U	0.00011 U	0.00056 U	0.00013 U
ALPHA-CHLORDANE	0.00014 U	0.00059 U	0.00012 U	0.00013 U	0.00012 U	0.00059 U	0.00013 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00037 U	0.0008 U	0.00016 U	0.00018 U	0.00016 U	0.0008 U	0.00018 U
DELTA-BHC	0.00045 U	0.0021 U	0.00039 U	0.00044 U	0.0004 U	0.0021 U	0.00045 U
DIELDRIN	0.00038 U	0.0017 U	0.00032 U	0.00037 U	0.00033 U	0.0017 U	0.00037 U
ENDOSULFAN I	0.00015 U	0.00067 U	0.00022 UJ g	0.00055 UJ g	0.00014 U	0.00067 U	0.0013
ENDOSULFAN II	0.00027 U	0.0012 U	0.00023 U	0.00026 U	0.00024 U	0.0012 U	0.00027 U
ENDOSULFAN SULFATE	0.0002 U	0.00087 U	0.00017 U	0.0002 U	0.00018 U	0.00088 U	0.0002 U
ENDRIN	0.00017 U	0.00072 U	0.00014 U	0.00016 U	0.00015 U	0.00072 U	0.00016 U
ENDRIN ALDEHYDE	0.00043 U	0.002 U	0.00037 U	0.00043 U	0.00038 U	0.002 U	0.00043 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB13	09-SB14	09-SB14	09-SB14	09-SB15	09-SB15	09-SB15
Sample ID	30209SB13003	30209SB14001	30209SB14002	30209SB14003	30209SB15001	30209SB15002	30209SB15003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0002 U	0.00087 U	0.00017 U	0.00019 U	0.00017 U	0.00087 U	0.0002 U
GAMMA-BHC (LINDANE)	0.0003 U	0.0014 U	0.00026 U	0.00029 U	0.00026 U	0.0014 U	0.0003 U
GAMMA-CHLORDANE	0.00018 U	0.0008 U	0.00016 U	0.00018 U	0.00016 U	0.0008 U	0.00018 U
HEPTACHLOR	0.00017 U	0.00074 U	0.00015 U	0.00017 U	0.00015 U	0.00074 U	0.00017 U
HEPTACHLOR EPOXIDE	0.00017 U	0.00074 U	0.00015 U	0.00017 U	0.00015 U	0.00074 U	0.00017 U
METHOXYCHLOR	0.0002 U	0.00088 U	0.00017 U	0.0002 U	0.00051 UJ j	0.00088 U	0.0002 U
TOXAPHENE	0.012 U	0.05 U	0.0096 U	0.011 U	0.0099 U	0.051 U	0.012 U
Metals (mg/kg)							
ALUMINUM	4,140	3,770	4,640	5,710	4,540	3,890	4,890
ANTIMONY	0.07 J ed	0.07 J ed	0.07 J ed	0.09 J ed	0.11 J ed	0.18 J ed	0.07 J ed
ARSENIC	2.4	4.4	4.4	2.9	2.9	4.3	3.3
BARIUM	9.3 J d	10.9 J d	13.2 J d	10.7 J d	12.1 J d	17.1 J d	10.3 J d
BERYLLIUM	0.1 J g	0.12 J g	0.13 J g	0.12 J g	0.12 J g	0.08 J g	0.12 J g
CADMIUM	0.05 J g	0.05 J g	0.05 J g	0.07	0.07	0.4	0.08
CALCIUM	3,100	9,160	4,820	17,700	3,830	6,940	2,120
CHROMIUM	25.4	25	36.1	33.9	29.6	26.6	28.5
COBALT	6.6	6.3	5.9	7.9	6.6	5.1	6.8
COPPER	4.53	4.04	5.29	7.06	12.2	2,370	8.64
IRON	9,610	11,100	13,700	11,600	10,800	10,500	10,800
LEAD	2.23	5.01	3.59	2.57	6.46	64.1	3.51
MAGNESIUM	2,520	3,310	3,730	3,230	2,920	2,860	2,730
MANGANESE	87.5	231	173	118	111	186	86.8
MERCURY	0.03	0.03	0.01 J g	0.01 J g	0.01 J g	0.01 J g	0.01 J g
MOLYBDENUM	0.09 UJ bd	0.15 UJ fd	0.15 UJ fd	0.12 UJ fd	0.2 UJ fd	0.27 UJ fd	0.17 UJ fd
NICKEL	24.5	29	31.2	28.3	25.4	23	25.5
POTASSIUM	616 J j	560 J j	610 J j	842 J j	686 J j	539 J j	705 J j
SELENIUM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
SILVER	0.017 J g	0.017 J g	0.021	0.025	0.04	0.02 J g	0.021 J g
SODIUM	99.1	186	132	184	167	110	99.8
THALLIUM	0.04	0.038	0.035	0.053	0.043	0.034	0.07
TIN	2.4 U	2.2 U	2.1 U	2.7 UJ b	2.1 U	2.2 U	2.4 U
VANADIUM	18.3	18.4	22.1	24.8	20.2	19.6	19
ZINC	17.8	18.1	21.2	21.5	27.2	48	19.5
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB16	09-SB16	09-SB16	09-SB17	09-SB17	09-SB17	09-SB18
Sample ID	30209SB16001	30209SB16002	30209SB16003	30209SB17001	30209SB17002	30209SB17003	30209SB18001
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.05 - 2.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,1,1-TRICHLOROETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,1,2,2-TETRACHLOROETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,1,2-TRICHLOROETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,1-DICHLOROETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,1-DICHLOROETHENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,1-DICHLOROPROPENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,2,3-TRICHLOROBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,2,3-TRICHLOROPROPANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,2,4-TRICHLOROBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,2,4-TRIMETHYLBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,2-DIBROMO-3-CHLOROPROPANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,2-DIBROMOETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,2-DICHLOROBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,2-DICHLOROETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,3,5-TRIMETHYLBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,3-DICHLOROBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,3-DICHLOROPROPANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
1,4-DICHLOROBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
2,2-DICHLOROPROPANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
2-BUTANONE	0.02 U	0.012 U	0.011 U	0.032 U	0.011 U	0.012 U	0.01 U
2-CHLOROTOLUENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
2-HEXANONE	0.02 U	0.012 U	0.011 U	0.032 U	0.011 U	0.012 U	0.01 U
4-CHLOROTOLUENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
4-METHYL-2-PENTANONE	0.02 U	0.012 U	0.011 U	0.032 U	0.011 U	0.012 U	0.01 U
ACETONE	0.039 UJ b	0.024 UJ b	0.022 UJ b	0.063 UJ b	0.021 UJ b	0.023 UJ b	0.02 UJ b
BENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
BROMOBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
BROMOCHLOROMETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
BROMODICHLOROMETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
BROMOFORM	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
BROMOMETHANE	0.02 U	0.012 UJ b	0.011 UJ b	0.032 UJ b	0.011 UJ b	0.012 U	0.01 U
CARBON DISULFIDE	0.0098 U	0.00049 J g	0.0054 U	0.0012 J g	0.0054 U	0.0058 U	0.0004 J g
CARBON TETRACHLORIDE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB16	09-SB16	09-SB16	09-SB17	09-SB17	09-SB17	09-SB18
Sample ID	30209SB16001	30209SB16002	30209SB16003	30209SB17001	30209SB17002	30209SB17003	30209SB18001
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.05 - 2.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
CHLOROETHANE	0.02 U	0.012 U	0.011 U	0.032 U	0.011 U	0.012 U	0.01 U
CHLOROFORM	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
CHLOROMETHANE	0.02 U	0.012 U	0.011 U	0.032 U	0.011 U	0.012 U	0.01 U
CIS-1,2-DICHLOROETHENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
CIS-1,3-DICHLOROPROPENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
DIBROMOCHLOROMETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
DIBROMOMETHANE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
ETHYLBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
FREON 11	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
FREON 113	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
FREON 12	0.02 UJ c	0.012 UJ c	0.011 UJ c	0.032 UJ c	0.011 UJ c	0.012 UJ c	0.01 UJ c
HEXACHLOROBUTADIENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
ISOPROPYLBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
M,P-XYLENES	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
METHYL-TERT-BUTYL ETHER	0.0098 U	0.0061 U	0.0021 J g	0.016 U	0.0054 U	0.0058 U	0.0051 U
METHYLENE CHLORIDE	0.039 U	0.024 UJ b	0.022 U	0.063 U	0.021 U	0.023 U	0.02 U
N-BUTYLBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
N-PROPYLBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
NAPHTHALENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
O-XYLENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
PARA-ISOPROPYL TOLUENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
SEC-BUTYLBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
STYRENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
TERT-BUTYLBENZENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
TETRACHLOROETHENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
TOLUENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
TRANS-1,2-DICHLOROETHENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
TRANS-1,3-DICHLOROPROPENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
TRICHLOROETHENE	0.0098 U	0.0061 U	0.0054 U	0.016 U	0.0054 U	0.0058 U	0.0051 U
VINYL ACETATE	0.098 U	0.061 U	0.054 U	0.16 U	0.054 U	0.058 U	0.051 U
VINYL CHLORIDE	0.02 U	0.012 U	0.011 U	0.032 U	0.011 U	0.012 U	0.01 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	6.8 UJ b	1,100 Y	1,300 Y	27 UJ b	5.2 UJ b	5 U	4.4 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB16	09-SB16	09-SB16	09-SB17	09-SB17	09-SB17	09-SB18
Sample ID	30209SB16001	30209SB16002	30209SB16003	30209SB17001	30209SB17002	30209SB17003	30209SB18001
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.05 - 2.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	53 UJ b	400 L	430 L	24 UJ b	4.6 U	5 U	33 UJ b
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.36 UJ a	0.23 U	0.25 U	0.45 U	0.21 U	0.24 U	0.25 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U	0.012 U
1,2-DICHLOROBENZENE	0.02 U	0.019 U	0.021 U	0.02 U	0.02 U	0.021 U	0.019 U
1,3-DICHLOROBENZENE	0.02 U	0.02 U	0.021 U	0.02 U	0.02 U	0.022 U	0.02 U
1,4-DICHLOROBENZENE	0.019 U	0.019 U	0.02 U	0.019 U	0.019 U	0.021 U	0.019 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.016 U	0.015 U	0.017 U	0.016 U	0.016 U	0.017 U	0.015 U
2,4,5-TRICHLOROPHENOL	0.019 U	0.018 U	0.02 U	0.019 U	0.019 U	0.021 U	0.018 U
2,4,6-TRICHLOROPHENOL	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.017 U	0.015 U
2,4-DICHLOROPHENOL	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.02 U	0.018 U
2,4-DIMETHYLPHENOL	0.017 U	0.016 U	0.018 U	0.017 U	0.017 U	0.018 U	0.016 U
2,4-DINITROPHENOL	0.13 U	0.12 U	0.13 U	0.13 U	0.12 U	0.14 U	0.12 U
2,4-DINITROTOLUENE	0.017 U	0.016 U	0.017 U	0.017 U	0.016 U	0.018 U	0.016 U
2,6-DINITROTOLUENE	0.017 U	0.017 U	0.018 U	0.017 U	0.017 U	0.019 U	0.017 U
2-CHLORONAPHTHALENE	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.012 U	0.011 U
2-CHLOROPHENOL	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.012 U	0.011 U
2-METHYLNAPHTHALENE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U	0.012 U
2-METHYLPHENOL	0.019 U	0.018 U	0.019 U	0.018 U	0.018 U	0.02 U	0.018 U
2-NITROANILINE	0.019 U	0.018 U	0.02 U	0.019 U	0.019 U	0.02 U	0.018 U
2-NITROPHENOL	0.016 U	0.015 U	0.016 U	0.015 U	0.015 U	0.017 U	0.015 U
3,3'-DICHLOROBENZIDINE	0.03 U	0.029 U	0.031 U	0.03 U	0.029 U	0.032 U	0.029 U
3-NITROANILINE	0.19 U	0.19 U	0.2 U	0.19 U	0.19 U	0.21 U	0.19 U
4,6-DINITRO-2-METHYLPHENOL	0.16 U	0.16 U	0.17 U	0.16 U	0.16 U	0.17 U	0.16 U
4-BROMOPHENYL-PHENYLETHER	0.014 U	0.013 U	0.014 U	0.014 U	0.014 U	0.015 U	0.013 U
4-CHLORO-3-METHYLPHENOL	0.019 U	0.018 U	0.019 U	0.018 U	0.018 U	0.02 U	0.018 U
4-CHLOROANILINE	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.017 U	0.016 U
4-CHLOROPHENYL-PHENYLETHER	0.018 U	0.017 U	0.019 U	0.018 U	0.018 U	0.019 U	0.017 U
4-METHYLPHENOL	0.019 U	0.018 U	0.02 U	0.019 U	0.018 U	0.02 U	0.018 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB16	09-SB16	09-SB16	09-SB17	09-SB17	09-SB17	09-SB18
Sample ID	30209SB16001	30209SB16002	30209SB16003	30209SB17001	30209SB17002	30209SB17003	30209SB18001
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.05 - 2.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.2 U	0.19 U	0.21 U	0.2 U	0.2 U	0.21 U	0.19 U
4-NITROPHENOL	0.16 U	0.16 U	0.17 U	0.16 U	0.16 U	0.18 U	0.16 U
ACENAPHTHENE	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U	0.015 U
ACENAPHTHYLENE	0.014 U	0.014 U	0.015 U	0.014 U	0.014 U	0.015 U	0.014 U
ANTHRACENE	0.016 U	0.015 U	0.016 U	0.026 UJ f	0.015 U	0.017 U	0.015 U
BENZO(A)ANTHRACENE	0.059 UJ f	0.013 U	0.014 U	0.077 UJ f	0.014 U	0.015 U	0.013 U
BENZO(A)PYRENE	0.1	0.021 U	0.023 U	0.082	0.022 U	0.024 U	0.021 UJ f
BENZO(B)FLUORANTHENE	0.065	0.019 U	0.02 U	0.053 J g	0.019 U	0.021 U	0.019 U
BENZO(G,H,I)PERYLENE	0.11	0.022 U	0.056 J g	0.061	0.022 U	0.024 U	0.031 J g
BENZO(K)FLUORANTHENE	0.076	0.021 U	0.023 U	0.054	0.021 U	0.023 U	0.021 U
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U	0.013 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.021 U	0.02 U	0.022 U	0.02 U	0.02 U	0.022 U	0.02 U
BUTYLBENZYLPHTHALATE	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.02 U	0.018 U
CARBAZOLE	0.013 U	0.012 U	0.013 U	0.013 U	0.012 U	0.014 U	0.012 U
CHRYSENE	0.071 UJ f	0.026 UJ f	0.014 U	0.093 UJ f	0.013 U	0.014 U	0.014 UJ f
DI-N-BUTYLPHTHALATE	0.014 U	0.013 U	0.014 U	0.013 U	0.013 U	0.015 U	0.013 U
DI-N-OCTYLPHTHALATE	0.027 U	0.026 U	0.028 U	0.026 U	0.026 U	0.029 U	0.026 U
DIBENZ(A,H)ANTHRACENE	0.03 U	0.029 U	0.034 J g	0.03 U	0.03 U	0.033 U	0.029 U
DIBENZOFURAN	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U	0.013 U
DIETHYLPHTHALATE	0.016 U	0.015 U	0.017 U	0.016 U	0.016 U	0.017 U	0.015 U
DIMETHYLPHTHALATE	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.02 U	0.018 U
FLUORANTHENE	0.14 UJ f	0.013 U	0.014 U	0.13 UJ f	0.013 U	0.014 U	0.019 UJ f
FLUORENE	0.015 U	0.014 U	0.015 U	0.014 U	0.014 U	0.016 U	0.014 U
HEXACHLOROBENZENE	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.018 U	0.016 U
HEXACHLOROBUTADIENE	0.016 U	0.015 U	0.017 U	0.016 U	0.016 U	0.017 U	0.015 U
HEXACHLOROCYCLOPENTADIENE	0.014 U	0.014 U	0.015 U	0.014 U	0.014 U	0.015 U	0.014 U
HEXACHLOROETHANE	0.024 U	0.023 U	0.025 U	0.024 U	0.024 U	0.026 U	0.023 U
INDENO(1,2,3-CD)PYRENE	0.11	0.041 U	0.056 J g	0.065 J g	0.042 U	0.046 U	0.041 U
ISOPHORONE	0.016 U	0.015 U	0.016 U	0.016 U	0.015 U	0.017 U	0.015 U
N-NITROSO-DI-N-PROPYLAMINE	0.021 U	0.021 U	0.022 U	0.021 U	0.021 U	0.023 U	0.021 U
N-NITROSODIPHENYLAMINE (1)	0.02 U	0.019 U	0.021 U	0.02 U	0.02 U	0.022 U	0.019 U
NAPHTHALENE	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.017 U	0.016 U
NITROBENZENE	0.029 U	0.028 U	0.03 U	0.029 U	0.028 U	0.031 U	0.028 U
PENTACHLOROPHENOL	0.14 U	0.14 U	0.15 U	0.14 U	0.14 U	0.15 U	0.14 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB16	09-SB16	09-SB16	09-SB17	09-SB17	09-SB17	09-SB18
Sample ID	30209SB16001	30209SB16002	30209SB16003	30209SB17001	30209SB17002	30209SB17003	30209SB18001
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.05 - 2.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.09 UJ f	0.011 U	0.012 U	0.16 UJ f	0.011 U	0.012 U	0.011 U
PHENOL	0.022 U	0.021 U	0.023 U	0.021 U	0.021 U	0.023 U	0.021 U
PYRENE	0.2 UJ f	0.015 U	0.016 U	0.21 UJ f	0.015 U	0.017 U	0.024 UJ f
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.00089 U	0.00087 U	0.00094 U	0.00089 U	0.00088 U	0.00097 U	0.00086 U
AROCLOR-1221	0.00089 U	0.00087 U	0.00094 U	0.00089 U	0.00088 U	0.00097 U	0.00086 U
AROCLOR-1232	0.00089 U	0.00087 U	0.00094 U	0.00089 U	0.00088 U	0.00097 U	0.00086 U
AROCLOR-1242	0.00089 U	0.00087 U	0.00094 U	0.00089 U	0.00088 U	0.00097 U	0.00086 U
AROCLOR-1248	0.00089 U	0.00087 U	0.00094 U	0.00089 U	0.00088 U	0.00097 U	0.00086 U
AROCLOR-1254	0.00089 U	0.00087 U	0.00094 U	0.00089 U	0.00088 U	0.00097 U	0.00086 U
AROCLOR-1260	0.00089 U	0.00087 U	0.00094 U	0.00089 U	0.00088 U	0.00097 U	0.0018 UJ g
Pesticides							
4,4'-DDD	0.00017 U	0.007 J g	0.0027 J g	0.00024 U	0.00017 U	0.00018 U	0.00045 U
4,4'-DDE	0.00027 U	0.0026 U	0.0028 U	0.00027 U	0.00027 U	0.00029 U	0.00026 U
4,4'-DDT	0.00019 U	0.011 U	0.0071 J g	0.0002 U	0.00019 U	0.0002 U	0.00018 U
ALDRIN	0.00026 U	0.0025 U	0.0027 U	0.00026 U	0.00025 U	0.00028 U	0.00025 U
ALPHA-BHC	0.00012 U	0.0011 U	0.0012 U	0.00011 U	0.00011 U	0.00012 U	0.00011 U
ALPHA-CHLORDANE	0.00012 U	0.0012 U	0.0013 U	0.00012 U	0.00012 U	0.00013 U	0.00012 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00016 U	0.0016 U	0.0017 U	0.00016 U	0.00016 U	0.00018 U	0.00016 U
DELTA-BHC	0.00041 U	0.0039 U	0.0042 U	0.0004 U	0.0004 U	0.00044 U	0.00039 U
DIELDRIN	0.00034 U	0.0033 U	0.0035 U	0.00033 U	0.00033 U	0.00036 U	0.00033 U
ENDOSULFAN I	0.00014 U	0.0016 U	0.0017 U	0.00014 U	0.00014 U	0.00015 U	0.00013 U
ENDOSULFAN II	0.00024 U	0.0023 U	0.0037 U	0.00024 U	0.00024 U	0.00026 U	0.00023 U
ENDOSULFAN SULFATE	0.0003 U	0.0017 U	0.0029 U	0.00018 U	0.00018 U	0.00019 U	0.00017 U
ENDRIN	0.00015 U	0.0014 U	0.0033 U	0.00015 U	0.00015 U	0.00016 U	0.00014 U
ENDRIN ALDEHYDE	0.00039 U	0.0038 U	0.0041 J g	0.00038 U	0.00038 U	0.00042 U	0.00038 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB16	09-SB16	09-SB16	09-SB17	09-SB17	09-SB17	09-SB18
Sample ID	30209SB16001	30209SB16002	30209SB16003	30209SB17001	30209SB17002	30209SB17003	30209SB18001
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.05 - 2.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00018 U	0.0026 U	0.0032 U	0.00035 U	0.00021 U	0.00019 U	0.00017 U
GAMMA-BHC (LINDANE)	0.00027 U	0.0026 U	0.0028 U	0.00027 U	0.00026 U	0.00029 U	0.00026 U
GAMMA-CHLORDANE	0.00016 U	0.002 U	0.0017 U	0.00016 U	0.00016 U	0.00018 U	0.00016 U
HEPTACHLOR	0.00015 U	0.0015 U	0.0016 U	0.00015 U	0.00015 U	0.00016 U	0.00015 U
HEPTACHLOR EPOXIDE	0.00015 U	0.0015 U	0.0016 U	0.00015 U	0.00015 U	0.00016 U	0.00015 U
METHOXYCHLOR	0.0002 U	0.0054 U	0.012 U	0.00019 U	0.00046 UJ g	0.00019 U	0.00095 U
TOXAPHENE	0.019 U	0.41 U	0.49 U	0.02 U	0.018 U	0.011 U	0.013 U
Metals (mg/kg)							
ALUMINUM	7,390	4,640	5,380	5,180	4,670	5,110	8,390
ANTIMONY	0.09 J ed	0.05 J ed	0.07 J ed	0.1 J ed	0.05 UJ bed	0.05 UJ bed	0.19 J ed
ARSENIC	6.1	2.5	3.6	9.1	3.6	2.4	17.7
BARIUM	18.5 J d	12.4 J d	13.4 J dj	33.3 J d	10.4 J d	11.3 J d	77.7 J d
BERYLLIUM	0.19 J g	0.12 J g	0.13 J g	0.11 J g	0.13 J g	0.12 J g	0.19 J g
CADMIUM	0.09	0.06	0.04 J g	0.12	0.08	0.05 J g	0.5
CALCIUM	14,900	2,410	2,210	9,460	1,830	3,000	7,190
CHROMIUM	33.8	30.9	30	34.7	27.2	33.1	59.2
COBALT	8.2	7.2	7.6 J j	5.7	6.8	7	5.7
COPPER	8.91	3.54	4.15	6.68	8.1	3.62	13.9
IRON	17,300	10,400	11,800	13,000	10,600	10,700	15,300
LEAD	6.72	2.09	2.47	7.65	3.14	1.98	26.1
MAGNESIUM	6,090	2,460	2,870	3,780	2,910	2,630	3,700
MANGANESE	428	89.5	91.7	241	95.1	92.7	232
MERCURY	0.05	0.01 U	0.01 J g	0.03	0.01 U	0.02 J g	0.03
MOLYBDENUM	0.16 UJ fd	0.07 UJ bd	0.08 UJ bd	1.07 UJ fd	0.2 UJ fd	0.12 UJ fd	2.01 J d
NICKEL	41.3	23.4	27	29.8	26.2	25.7	33.5
POTASSIUM	1,080 J j	655 J j	751 J j	519 J j	676 J j	661 J j	657 J j
SELENIUM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 J g
SILVER	0.051	0.018 J g	0.022 J g	0.029	0.022	0.021 J g	0.089
SODIUM	353	83	90.3 J j	196	90	92.1	378
THALLIUM	0.07	0.039	0.045	0.046	0.048	0.034	0.059
TIN	2.2 U	2.4 UJ b	2.3 UJ j	2.2 U	2.1 U	2.9 UJ b	2.1 UJ b
VANADIUM	27.6	20.6	22.4	23.4	19.3	20.8	32.3
ZINC	34.1	17.4	20.4 J j	19.5	20	18.9	37.5
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB18	09-SB18	09-SB19	09-SB19	09-SB19	09-SB20	09-SB20
Sample ID	30209SB18002	30209SB18003	30209SB19001	30209SB19002	30209SB19003	30209SB20001	30209SB20002
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,1,1-TRICHLOROETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,1,2,2-TETRACHLOROETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,1,2-TRICHLOROETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,1-DICHLOROETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,1-DICHLOROETHENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,1-DICHLOROPROPENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,2,3-TRICHLOROBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,2,3-TRICHLOROPROPANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,2,4-TRICHLOROBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,2,4-TRIMETHYLBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,2-DIBROMO-3-CHLOROPROPANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,2-DIBROMOETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,2-DICHLOROBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,2-DICHLOROETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,3,5-TRIMETHYLBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,3-DICHLOROBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,3-DICHLOROPROPANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
1,4-DICHLOROBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
2,2-DICHLOROPROPANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
2-BUTANONE	0.011 U	0.011 U	0.016 U	0.012 U	0.012 U	0.016 U	0.012 U
2-CHLOROTOLUENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
2-HEXANONE	0.011 U	0.011 U	0.016 U	0.012 U	0.012 U	0.016 U	0.012 U
4-CHLOROTOLUENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
4-METHYL-2-PENTANONE	0.011 U	0.011 U	0.016 U	0.012 U	0.012 U	0.004 J g	0.012 U
ACETONE	0.023 UJ b	0.023 UJ b	0.033 UJ b	0.025 UJ b	0.023 UJ b	0.032 UJ b	0.025 UJ b
BENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
BROMOBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
BROMOCHLOROMETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
BROMODICHLOROMETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
BROMOFORM	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
BROMOMETHANE	0.011 U	0.011 U	0.016 U	0.012 U	0.012 U	0.016 U	0.012 U
CARBON DISULFIDE	0.00049 J g	0.00049 J g	0.0081 U	0.0062 UJ c	0.0059 UJ c	0.0081 UJ c	0.0062 UJ c
CARBON TETRACHLORIDE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB18	09-SB18	09-SB19	09-SB19	09-SB19	09-SB20	09-SB20
Sample ID	30209SB18002	30209SB18003	30209SB19001	30209SB19002	30209SB19003	30209SB20001	30209SB20002
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
CHLOROETHANE	0.011 U	0.011 U	0.016 U	0.012 U	0.012 U	0.016 U	0.012 U
CHLOROFORM	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
CHLOROMETHANE	0.011 U	0.011 U	0.016 U	0.012 U	0.012 U	0.016 U	0.012 U
CIS-1,2-DICHLOROETHENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
CIS-1,3-DICHLOROPROPENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
DIBROMOCHLOROMETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
DIBROMOMETHANE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
ETHYLBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
FREON 11	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
FREON 113	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
FREON 12	0.011 UJ c	0.011 UJ c	0.016 UJ c	0.012 U	0.012 U	0.016 U	0.012 U
HEXACHLOROBUTADIENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
ISOPROPYLBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
M,P-XYLENES	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
METHYL-TERT-BUTYL ETHER	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
METHYLENE CHLORIDE	0.023 U	0.023 U	0.033 U	0.025 UJ b	0.023 UJ b	0.032 UJ b	0.025 UJ b
N-BUTYLBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
N-PROPYLBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
NAPHTHALENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
O-XYLENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
PARA-ISOPROPYL TOLUENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
SEC-BUTYLBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
STYRENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
TERT-BUTYLBENZENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
TETRACHLOROETHENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
TOLUENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0012 J g	0.0062 U
TRANS-1,2-DICHLOROETHENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
TRANS-1,3-DICHLOROPROPENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
TRICHLOROETHENE	0.0057 U	0.0057 U	0.0081 U	0.0062 U	0.0059 U	0.0081 U	0.0062 U
VINYL ACETATE	0.057 U	0.057 U	0.081 U	0.062 UJ c	0.059 UJ c	0.081 UJ c	0.062 UJ c
VINYL CHLORIDE	0.011 U	0.011 U	0.016 U	0.012 U	0.012 U	0.016 U	0.012 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	4.6 U	5.3 U	20 D	4.5 U	5.2 U	96 Y	4.5 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB18	09-SB18	09-SB19	09-SB19	09-SB19	09-SB20	09-SB20
Sample ID	30209SB18002	30209SB18003	30209SB19001	30209SB19002	30209SB19003	30209SB20001	30209SB20002
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	4.6 U	5.3 U	37 M	4.5 U	5.2 U	74 M	4.5 U
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.23 U	0.26 U	0.22 U	0.26 U	0.23 U	0.3 U	0.23 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.014 U	0.013 U	0.012 U	0.014 U	0.012 U	0.012 U
1,2-DICHLOROBENZENE	0.02 U	0.023 U	0.021 U	0.019 U	0.023 U	0.019 U	0.019 U
1,3-DICHLOROBENZENE	0.02 U	0.023 U	0.022 U	0.02 U	0.023 U	0.02 U	0.02 U
1,4-DICHLOROBENZENE	0.019 U	0.022 U	0.021 U	0.019 U	0.022 U	0.019 U	0.019 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.016 U	0.018 U	0.017 U	0.015 U	0.018 U	0.015 U	0.015 U
2,4,5-TRICHLOROPHENOL	0.019 U	0.022 U	0.02 U	0.019 U	0.022 U	0.018 U	0.018 U
2,4,6-TRICHLOROPHENOL	0.016 U	0.018 U	0.017 U	0.016 U	0.018 U	0.015 U	0.016 U
2,4-DICHLOROPHENOL	0.018 U	0.021 U	0.019 U	0.018 U	0.021 U	0.018 U	0.018 U
2,4-DIMETHYLPHENOL	0.017 U	0.019 U	0.018 U	0.016 U	0.019 U	0.016 U	0.016 U
2,4-DINITROPHENOL	0.13 U	0.14 U	0.13 U	0.12 U	0.14 U	0.12 U	0.12 U
2,4-DINITROTOLUENE	0.017 U	0.019 U	0.018 U	0.016 U	0.019 U	0.016 U	0.016 U
2,6-DINITROTOLUENE	0.017 U	0.02 U	0.018 U	0.017 U	0.02 U	0.017 U	0.017 U
2-CHLORONAPHTHALENE	0.011 U	0.013 U	0.012 U	0.011 U	0.013 U	0.011 U	0.011 U
2-CHLOROPHENOL	0.011 U	0.013 U	0.012 U	0.011 U	0.013 U	0.011 U	0.011 U
2-METHYLNAPHTHALENE	0.012 U	0.014 U	0.013 U	0.012 U	0.014 U	0.012 U	0.012 U
2-METHYLPHENOL	0.018 U	0.021 U	0.02 U	0.018 U	0.021 U	0.018 U	0.018 U
2-NITROANILINE	0.019 U	0.021 U	0.02 U	0.018 U	0.021 U	0.018 U	0.018 U
2-NITROPHENOL	0.015 U	0.018 U	0.016 U	0.015 U	0.018 U	0.015 U	0.015 U
3,3'-DICHLOROBENZIDINE	0.03 U	0.034 U	0.032 U	0.029 U	0.034 U	0.029 U	0.029 U
3-NITROANILINE	0.19 U	0.22 U	0.21 U	0.19 U	0.22 U	0.19 U	0.19 U
4,6-DINITRO-2-METHYLPHENOL	0.16 U	0.18 U	0.17 U	0.16 U	0.18 U	0.15 U	0.16 U
4-BROMOPHENYL-PHENYLETHER	0.014 U	0.016 U	0.015 U	0.013 U	0.016 U	0.013 U	0.013 U
4-CHLORO-3-METHYLPHENOL	0.018 U	0.021 U	0.02 U	0.018 U	0.021 U	0.018 U	0.018 U
4-CHLOROANILINE	0.016 U	0.018 U	0.017 U	0.016 U	0.018 U	0.015 U	0.016 U
4-CHLOROPHENYL-PHENYLETHER	0.018 U	0.02 U	0.019 U	0.017 U	0.02 U	0.017 U	0.017 U
4-METHYLPHENOL	0.019 U	0.021 U	0.02 U	0.018 U	0.021 U	0.018 U	0.018 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB18	09-SB18	09-SB19	09-SB19	09-SB19	09-SB20	09-SB20
Sample ID	30209SB18002	30209SB18003	30209SB19001	30209SB19002	30209SB19003	30209SB20001	30209SB20002
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.2 U	0.23 U	0.21 U	0.19 U	0.23 U	0.19 U	0.19 U
4-NITROPHENOL	0.16 U	0.19 U	0.17 U	0.16 U	0.18 U	0.16 U	0.16 U
ACENAPHTHENE	0.015 U	0.017 U	0.016 U	0.015 U	0.017 U	0.014 U	0.015 U
ACENAPHTHYLENE	0.014 U	0.016 U	0.015 U	0.014 U	0.016 U	0.014 U	0.014 U
ANTHRACENE	0.015 U	0.018 U	0.016 U	0.015 U	0.018 U	0.015 U	0.015 U
BENZO(A)ANTHRACENE	0.014 U	0.016 U	0.019 J g	0.014 U	0.016 U	0.013 U	0.013 U
BENZO(A)PYRENE	0.022 U	0.025 U	0.03 J g	0.021 U	0.025 U	0.021 U	0.021 U
BENZO(B)FLUORANTHENE	0.019 U	0.022 U	0.031 J g	0.019 U	0.022 U	0.018 U	0.019 U
BENZO(G,H,I)PERYLENE	0.022 U	0.039 J g	0.033 J g	0.022 U	0.025 U	0.021 U	0.022 U
BENZO(K)FLUORANTHENE	0.021 U	0.025 U	0.023 U	0.021 U	0.024 U	0.021 U	0.021 U
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.014 U	0.013 U	0.012 U	0.014 U	0.012 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	0.013 U	0.015 U	0.014 U	0.013 U	0.015 U	0.013 U	0.013 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.02 U	0.036 UJ b	0.022 U	0.02 U	0.023 U	0.02 U	0.02 U
BUTYLBENZYLPHTHALATE	0.018 U	0.021 U	0.019 U	0.018 U	0.021 U	0.017 U	0.018 U
CARBAZOLE	0.013 U	0.014 U	0.013 U	0.012 U	0.014 U	0.012 U	0.012 U
CHRYSENE	0.013 U	0.015 U	0.023 J g	0.013 U	0.015 U	0.013 U	0.013 U
DI-N-BUTYLPHTHALATE	0.013 U	0.016 U	0.014 U	0.013 U	0.015 U	0.013 U	0.013 U
DI-N-OCTYLPHTHALATE	0.026 U	0.03 U	0.028 U	0.026 U	0.03 U	0.025 U	0.026 U
DIBENZ(A,H)ANTHRACENE	0.03 U	0.035 U	0.032 U	0.03 U	0.034 U	0.029 U	0.029 U
DIBENZOFURAN	0.013 U	0.015 U	0.014 U	0.013 U	0.015 U	0.013 U	0.013 U
DIETHYLPHTHALATE	0.016 U	0.018 U	0.017 U	0.015 U	0.018 U	0.015 U	0.015 U
DIMETHYLPHTHALATE	0.018 U	0.021 U	0.019 U	0.018 U	0.021 U	0.018 U	0.018 U
FLUORANTHENE	0.013 U	0.015 U	0.044 J g	0.013 U	0.015 U	0.012 U	0.013 U
FLUORENE	0.014 U	0.017 U	0.015 U	0.014 U	0.017 U	0.014 U	0.014 U
HEXACHLOROBENZENE	0.016 U	0.019 U	0.017 U	0.016 U	0.019 U	0.016 U	0.016 U
HEXACHLOROBUTADIENE	0.016 U	0.018 U	0.017 U	0.015 U	0.018 U	0.015 U	0.015 U
HEXACHLOROCYCLOPENTADIENE	0.014 U	0.016 U	0.015 U	0.014 U	0.016 U	0.013 U	0.014 U
HEXACHLOROETHANE	0.024 U	0.027 U	0.025 U	0.023 U	0.027 U	0.023 U	0.023 U
INDENO(1,2,3-CD)PYRENE	0.042 U	0.049 U	0.045 U	0.042 U	0.048 U	0.041 U	0.041 U
ISOPHORONE	0.016 U	0.018 U	0.017 U	0.015 U	0.018 U	0.015 U	0.015 U
N-NITROSO-DI-N-PROPYLAMINE	0.021 U	0.024 U	0.022 U	0.021 U	0.024 U	0.02 U	0.021 U
N-NITROSODIPHENYLAMINE (1)	0.02 U	0.023 U	0.021 U	0.02 U	0.023 U	0.019 U	0.019 U
NAPHTHALENE	0.016 U	0.018 U	0.017 U	0.016 U	0.018 U	0.015 U	0.016 U
NITROBENZENE	0.029 U	0.033 U	0.03 U	0.028 U	0.033 U	0.028 U	0.028 U
PENTACHLOROPHENOL	0.14 U	0.16 U	0.15 U	0.14 U	0.16 U	0.13 U	0.14 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB18	09-SB18	09-SB19	09-SB19	09-SB19	09-SB20	09-SB20
Sample ID	30209SB18002	30209SB18003	30209SB19001	30209SB19002	30209SB19003	30209SB20001	30209SB20002
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.011 UJ f	0.013 U	0.023 UJ f	0.011 U	0.013 U	0.011 U	0.011 U
PHENOL	0.021 U	0.025 U	0.023 U	0.021 U	0.025 U	0.021 U	0.021 U
PYRENE	0.016 U	0.018 U	0.049 J g	0.015 U	0.018 U	0.015 U	0.015 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.00089 U	0.0011 U	0.00095 U	0.00087 U	0.0011 U	0.00086 U	0.00087 U
AROCLOR-1221	0.00089 U	0.0011 U	0.00095 U	0.00087 U	0.0011 U	0.00086 U	0.00087 U
AROCLOR-1232	0.00089 U	0.0011 U	0.00095 U	0.00087 U	0.0011 U	0.00086 U	0.00087 U
AROCLOR-1242	0.00089 U	0.0011 U	0.00095 U	0.00087 U	0.0011 U	0.00086 U	0.00087 U
AROCLOR-1248	0.00089 U	0.0011 U	0.00095 U	0.00087 U	0.0011 U	0.00086 U	0.00087 U
AROCLOR-1254	0.00089 U	0.0011 U	0.00095 U	0.00087 U	0.0011 U	0.00086 U	0.00087 U
AROCLOR-1260	0.00089 U	0.0011 U	0.0016 UJ g	0.00087 U	0.0011 U	0.0018 UJ g	0.00087 U
Pesticides							
4,4'-DDD	0.00017 U	0.00019 U	0.00018 U	0.00016 U	0.00019 U	0.0002 U	0.00016 U
4,4'-DDE	0.00027 U	0.00031 U	0.00029 U	0.00026 U	0.00031 U	0.00026 U	0.00026 U
4,4'-DDT	0.00019 U	0.00021 U	0.0002 U	0.00018 U	0.00021 U	0.00035 U	0.00018 U
ALDRIN	0.00026 U	0.00029 U	0.00027 U	0.00025 U	0.00029 U	0.00025 U	0.00025 U
ALPHA-BHC	0.00011 U	0.00013 U	0.00012 U	0.00011 U	0.00013 U	0.00011 U	0.00011 U
ALPHA-CHLORDANE	0.00012 U	0.00014 U	0.00013 U	0.00012 U	0.00014 U	0.00012 U	0.00012 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.0008 U	0.00038 U	0.00017 U	0.00016 U	0.00019 U	0.00016 U	0.00023 U
DELTA-BHC	0.0004 U	0.00046 U	0.00043 U	0.0004 U	0.00046 U	0.00039 U	0.00039 U
DIELDRIN	0.00033 U	0.00039 U	0.00036 U	0.00033 U	0.00038 U	0.00032 U	0.00033 U
ENDOSULFAN I	0.00014 U	0.00016 U	0.00015 U	0.00014 U	0.00016 U	0.00013 U	0.00013 U
ENDOSULFAN II	0.00024 U	0.00028 U	0.00026 U	0.00024 U	0.00027 U	0.00023 U	0.00023 U
ENDOSULFAN SULFATE	0.00018 U	0.0002 U	0.00019 U	0.00017 U	0.0002 U	0.00017 U	0.00017 U
ENDRIN	0.00015 U	0.00017 U	0.00016 U	0.00014 U	0.00017 U	0.00014 U	0.00014 U
ENDRIN ALDEHYDE	0.00038 U	0.00044 U	0.00041 U	0.00038 U	0.00044 U	0.00037 U	0.00038 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB18	09-SB18	09-SB19	09-SB19	09-SB19	09-SB20	09-SB20
Sample ID	30209SB18002	30209SB18003	30209SB19001	30209SB19002	30209SB19003	30209SB20001	30209SB20002
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002	10/25/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00018 U	0.0002 U	0.00034 U	0.00017 U	0.0002 U	0.0004 U	0.00017 U
GAMMA-BHC (LINDANE)	0.00027 U	0.00031 U	0.00028 U	0.00026 U	0.0003 U	0.00026 U	0.00026 U
GAMMA-CHLORDANE	0.00016 U	0.00019 U	0.00017 U	0.00016 U	0.00019 U	0.00016 U	0.00016 U
HEPTACHLOR	0.00015 U	0.00017 U	0.00016 U	0.00015 U	0.00017 U	0.00015 U	0.00015 U
HEPTACHLOR EPOXIDE	0.00015 U	0.00017 U	0.00016 U	0.00015 U	0.00017 U	0.00015 U	0.00015 U
METHOXYCHLOR	0.00018 U	0.0002 U	0.00019 U	0.00018 U	0.0002 U	0.00047 U	0.00017 U
TOXAPHENE	0.0099 U	0.012 U	0.017 U	0.0098 U	0.012 U	0.021 U	0.0097 U
Metals (mg/kg)							
ALUMINUM	4,390	3,640	3,990	6,380	3,940	3,410	3,010
ANTIMONY	0.05 UJ bed	0.07 UJ be	0.21 J e	0.08 UJ be	0.08 UJ be	0.07 UJ be	0.07 UJ be
ARSENIC	2.7	2.7	7.2	2.7	2.7	2.7	2.1
BARIUM	8.8 J d	9.7	13.6	11.7	7.8	12.4	5.3
BERYLLIUM	0.13 J g	0.09 J g	0.13 J g	0.12 J g	0.1 J g	0.07 J g	0.09 J g
CADMIUM	0.05 J g	0.04 J g	0.11	0.06	0.04 J g	0.06	0.04 J g
CALCIUM	2,420	1,390	3,700	1,960	1,660	2,280	1,260
CHROMIUM	30	20.6	32.6	30.4	24.7	21	20.8
COBALT	6.1	6.6	7	5.4	7	5.5	5.6
COPPER	3.63	3.84	13	6.46	3.67	4	3.09
IRON	10,000	9,340	12,400	14,000	10,400	8,580	7,680
LEAD	2.15	1.9	7.76	2.48	2.26	3.9	1.71
MAGNESIUM	2,350	2,320	3,200	3,980	2,430	2,200	1,890
MANGANESE	85.1	71.2	167	101	76.6	86.8	61.8
MERCURY	0.01 U	0.01 U	0.06	0.01 U	0.01 U	0.01 J g	0.01 U
MOLYBDENUM	0.09 UJ bd	0.17	0.81	0.16	0.31	0.15	0.07 UJ f
NICKEL	23.3	21.6 J j	28.2 J j	26.5 J j	22.9 J j	19.8 J j	18.6 J j
POTASSIUM	545 J j	570 J j	542 J j	918 J j	584 J j	504 J j	463 J j
SELENIUM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
SILVER	0.017 J g	0.015 J g	0.025	0.036	0.017 J g	0.015 J g	0.012 J g
SODIUM	66.9	62.1	135	91	68.2	77.8	52
THALLIUM	0.036	0.058	0.041	0.044	0.037	0.028	0.028
TIN	2.2 U	3.2 UJ b	2.9 UJ b	2.1 U	3.3 UJ b	2.1 U	2.4 UJ b
VANADIUM	19.5	14.8	19.9	22.3	15.8	15	13.2
ZINC	17	16.9	23.2	26.7	17.7	15.5	13.7
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB20	09-SB21	09-SB21	09-SB21	09-SB22	09-SB22	09-SB22
Sample ID	30209SB20003	30209SB21001	30209SB21002	30209SB21003	30209SB22001	30209SB22002	30209SB22003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,1,1-TRICHLOROETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,1,2,2-TETRACHLOROETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,1,2-TRICHLOROETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,1-DICHLOROETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,1-DICHLOROETHENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,1-DICHLOROPROPENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,2,3-TRICHLOROBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,2,3-TRICHLOROPROPANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,2,4-TRICHLOROBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,2,4-TRIMETHYLBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,2-DIBROMO-3-CHLOROPROPANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,2-DIBROMOETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,2-DICHLOROBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,2-DICHLOROETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,3,5-TRIMETHYLBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,3-DICHLOROBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,3-DICHLOROPROPANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
1,4-DICHLOROBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
2,2-DICHLOROPROPANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
2-BUTANONE	0.011 U	0.026 U	0.011 U	0.02 U	0.01 U	0.011 U	0.012 U
2-CHLOROTOLUENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
2-HEXANONE	0.011 U	0.026 U	0.011 U	0.02 U	0.01 U	0.011 U	0.012 U
4-CHLOROTOLUENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
4-METHYL-2-PENTANONE	0.011 U	0.026 U	0.011 U	0.02 U	0.01 U	0.011 U	0.012 U
ACETONE	0.023 UJ b	0.053 U	0.023 U	0.04 U	0.02 UJ b	0.023 UJ b	0.023 UJ b
BENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
BROMOBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
BROMOCHLOROMETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
BROMODICHLOROMETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
BROMOFORM	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
BROMOMETHANE	0.011 U	0.026 U	0.011 U	0.02 U	0.01 U	0.011 U	0.012 U
CARBON DISULFIDE	0.0057 UJ c	0.013 UJ c	0.0057 UJ c	0.0099 UJ c	0.0051 U	0.0057 U	0.0058 U
CARBON TETRACHLORIDE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB20	09-SB21	09-SB21	09-SB21	09-SB22	09-SB22	09-SB22
Sample ID	30209SB20003	30209SB21001	30209SB21002	30209SB21003	30209SB22001	30209SB22002	30209SB22003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
CHLOROETHANE	0.011 U	0.026 U	0.011 U	0.02 U	0.01 U	0.011 U	0.012 U
CHLOROFORM	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
CHLOROMETHANE	0.011 U	0.026 U	0.011 U	0.02 U	0.01 U	0.011 U	0.012 U
CIS-1,2-DICHLOROETHENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
CIS-1,3-DICHLOROPROPENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
DIBROMOCHLOROMETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
DIBROMOMETHANE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
ETHYLBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
FREON 11	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
FREON 113	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
FREON 12	0.011 U	0.026 U	0.011 U	0.02 U	0.01 U	0.011 U	0.012 U
HEXACHLOROBUTADIENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
ISOPROPYLBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
M,P-XYLENES	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
METHYL-TERT-BUTYL ETHER	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
METHYLENE CHLORIDE	0.023 UJ b	0.053 UJ b	0.023 UJ b	0.04 UJ b	0.03 UJ b	0.023 U	0.031 UJ b
N-BUTYLBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
N-PROPYLBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
NAPHTHALENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
O-XYLENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
PARA-ISOPROPYL TOLUENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
SEC-BUTYLBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
STYRENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
TERT-BUTYLBENZENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
TETRACHLOROETHENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
TOLUENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
TRANS-1,2-DICHLOROETHENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
TRANS-1,3-DICHLOROPROPENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
TRICHLOROETHENE	0.0057 U	0.013 U	0.0057 U	0.0099 U	0.0051 U	0.0057 U	0.0058 U
VINYL ACETATE	0.057 UJ c	0.13 UJ c	0.057 UJ c	0.099 UJ c	0.051 U	0.057 U	0.058 U
VINYL CHLORIDE	0.011 U	0.026 U	0.011 U	0.02 U	0.01 U	0.011 U	0.012 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	4.7 U	38 H	4.6 U	5.1 U	21 H	4.4 U	4.9 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB20	09-SB21	09-SB21	09-SB21	09-SB22	09-SB22	09-SB22
Sample ID	30209SB20003	30209SB21001	30209SB21002	30209SB21003	30209SB22001	30209SB22002	30209SB22003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	8.8 M	200 M	15 M	5.1 U	240 M	4.4 U	4.9 U
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.22 U	0.54 UJ a	0.22 U	0.45 U	0.21 U	0.23 U	0.23 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.013 U	0.012 U	0.012 U	0.014 U	0.012 U	0.012 U	0.013 U
1,2-DICHLOROBENZENE	0.02 U	0.02 U	0.02 U	0.022 U	0.019 U	0.019 U	0.021 U
1,3-DICHLOROBENZENE	0.021 U	0.02 U	0.02 U	0.023 U	0.02 U	0.02 U	0.022 U
1,4-DICHLOROBENZENE	0.02 U	0.019 U	0.019 U	0.022 U	0.019 U	0.019 U	0.021 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.016 U	0.015 U	0.016 U	0.017 U	0.015 U	0.015 U	0.017 U
2,4,5-TRICHLOROPHENOL	0.019 U	0.019 U	0.019 U	0.021 U	0.018 U	0.018 U	0.02 U
2,4,6-TRICHLOROPHENOL	0.016 U	0.016 U	0.016 U	0.018 U	0.015 U	0.015 U	0.017 U
2,4-DICHLOROPHENOL	0.019 U	0.018 U	0.018 U	0.02 U	0.018 U	0.018 U	0.019 U
2,4-DIMETHYLPHENOL	0.017 U	0.017 U	0.017 U	0.019 U	0.016 U	0.016 U	0.018 U
2,4-DINITROPHENOL	0.13 U	0.12 U	0.13 U	0.14 U	0.12 U	0.12 U	0.13 U
2,4-DINITROTOLUENE	0.017 U	0.016 U	0.017 U	0.018 U	0.016 U	0.016 U	0.018 U
2,6-DINITROTOLUENE	0.018 U	0.017 U	0.017 U	0.019 U	0.017 U	0.017 U	0.018 U
2-CHLORONAPHTHALENE	0.012 U	0.011 U	0.011 U	0.013 U	0.011 U	0.011 U	0.012 U
2-CHLOROPHENOL	0.011 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.012 U
2-METHYLNAPHTHALENE	0.013 U	0.012 U	0.012 U	0.014 U	0.012 U	0.012 U	0.013 U
2-METHYLPHENOL	0.019 U	0.018 U	0.019 U	0.021 U	0.018 U	0.018 U	0.02 U
2-NITROANILINE	0.019 U	0.018 U	0.019 U	0.021 U	0.018 U	0.018 U	0.02 U
2-NITROPHENOL	0.016 U	0.015 U	0.016 U	0.017 U	0.015 U	0.015 U	0.016 U
3,3'-DICHLOROBENZIDINE	0.03 U	0.029 U	0.03 U	0.033 U	0.029 U	0.029 U	0.031 U
3-NITROANILINE	0.2 U	0.19 U	0.19 U	0.22 U	0.19 U	0.19 U	0.21 U
4,6-DINITRO-2-METHYLPHENOL	0.16 U	0.16 U	0.16 U	0.18 U	0.15 U	0.15 U	0.17 U
4-BROMOPHENYL-PHENYLETHER	0.014 U	0.013 U	0.014 U	0.015 U	0.013 U	0.013 U	0.015 U
4-CHLORO-3-METHYLPHENOL	0.019 U	0.018 U	0.018 U	0.02 U	0.018 U	0.018 U	0.02 U
4-CHLOROANILINE	0.016 U	0.016 U	0.016 U	0.018 U	0.016 U	0.015 U	0.017 U
4-CHLOROPHENYL-PHENYLETHER	0.018 U	0.018 U	0.018 U	0.02 U	0.017 U	0.017 U	0.019 U
4-METHYLPHENOL	0.019 U	0.018 U	0.019 U	0.021 U	0.018 U	0.018 U	0.02 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB20	09-SB21	09-SB21	09-SB21	09-SB22	09-SB22	09-SB22
Sample ID	30209SB20003	30209SB21001	30209SB21002	30209SB21003	30209SB22001	30209SB22002	30209SB22003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.2 U	0.2 U	0.2 U	0.22 U	0.19 U	0.19 U	0.21 U
4-NITROPHENOL	0.17 U	0.16 U	0.16 U	0.18 U	0.16 U	0.16 U	0.17 U
ACENAPHTHENE	0.015 U	0.015 U	0.015 U	0.017 U	0.015 U	0.014 U	0.016 U
ACENAPHTHYLENE	0.015 U	0.014 U	0.014 U	0.016 U	0.014 U	0.014 U	0.015 U
ANTHRACENE	0.016 U	0.015 U	0.016 U	0.017 U	0.015 U	0.015 U	0.016 U
BENZO(A)ANTHRACENE	0.014 U	0.027 J g	0.014 U	0.015 U	0.022 J g	0.013 U	0.015 U
BENZO(A)PYRENE	0.022 U	0.042 J g	0.022 U	0.024 U	0.021 U	0.021 U	0.023 U
BENZO(B)FLUORANTHENE	0.02 U	0.047 J g	0.019 U	0.021 U	0.018 U	0.018 U	0.02 U
BENZO(G,H,I)PERYLENE	0.023 U	0.057	0.022 U	0.025 U	0.11	0.021 U	0.024 U
BENZO(K)FLUORANTHENE	0.022 U	0.021 U	0.022 U	0.024 U	0.021 U	0.021 U	0.023 U
BIS(2-CHLOROETHOXY)METHANE	0.013 U	0.012 U	0.012 U	0.014 U	0.012 U	0.012 U	0.013 U
BIS(2-CHLOROETHYL)ETHER	0.013 U	0.013 U	0.013 U	0.015 U	0.013 U	0.013 U	0.014 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.021 U	0.02 U	0.021 U	0.023 U	0.02 U	0.02 U	0.022 U
BUTYLBENZYLPHTHALATE	0.019 U	0.018 U	0.018 U	0.02 U	0.018 U	0.017 U	0.019 U
CARBAZOLE	0.013 U	0.012 U	0.013 U	0.014 U	0.012 U	0.012 U	0.013 U
CHRYSENE	0.014 U	0.066	0.013 U	0.015 U	0.058	0.013 U	0.014 U
DI-N-BUTYLPHTHALATE	0.014 U	0.013 U	0.014 U	0.015 U	0.013 U	0.013 U	0.014 U
DI-N-OCTYLPHTHALATE	0.027 U	0.026 U	0.027 U	0.029 U	0.026 U	0.025 U	0.028 U
DIBENZ(A,H)ANTHRACENE	0.031 U	0.03 U	0.03 U	0.034 U	0.038 J g	0.029 U	0.032 U
DIBENZOFURAN	0.014 U	0.013 U	0.013 U	0.015 U	0.013 U	0.013 U	0.014 U
DIETHYLPHTHALATE	0.016 U	0.015 U	0.016 U	0.017 U	0.015 U	0.015 U	0.017 U
DIMETHYLPHTHALATE	0.019 U	0.018 U	0.018 U	0.02 U	0.018 U	0.018 U	0.019 U
FLUORANTHENE	0.013 U	0.041 J g	0.013 U	0.014 U	0.048 J g	0.012 U	0.014 U
FLUORENE	0.015 U	0.014 U	0.015 U	0.016 U	0.014 U	0.014 U	0.015 U
HEXACHLOROBENZENE	0.017 U	0.016 U	0.016 U	0.018 U	0.016 U	0.016 U	0.017 U
HEXACHLOROBUTADIENE	0.016 U	0.015 U	0.016 U	0.017 U	0.015 U	0.015 U	0.017 U
HEXACHLOROCYCLOPENTADIENE	0.014 U	0.014 U	0.014 U	0.016 U	0.014 U	0.013 U	0.015 U
HEXACHLOROETHANE	0.024 U	0.023 U	0.024 U	0.026 U	0.023 U	0.023 U	0.025 U
INDENO(1,2,3-CD)PYRENE	0.044 U	0.044 J g	0.043 U	0.047 U	0.076 J g	0.041 U	0.045 U
ISOPHORONE	0.016 U	0.015 U	0.016 U	0.017 U	0.015 U	0.015 U	0.017 U
N-NITROSO-DI-N-PROPYLAMINE	0.022 U	0.021 U	0.021 U	0.023 U	0.02 U	0.02 U	0.022 U
N-NITROSODIPHENYLAMINE (1)	0.02 U	0.02 U	0.02 U	0.022 U	0.019 U	0.019 U	0.021 U
NAPHTHALENE	0.016 U	0.016 U	0.016 U	0.018 U	0.016 U	0.015 U	0.017 U
NITROBENZENE	0.029 U	0.028 U	0.029 U	0.032 U	0.028 U	0.028 U	0.03 U
PENTACHLOROPHENOL	0.14 U	0.14 U	0.14 U	0.16 U	0.14 U	0.13 U	0.15 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB20	09-SB21	09-SB21	09-SB21	09-SB22	09-SB22	09-SB22
Sample ID	30209SB20003	30209SB21001	30209SB21002	30209SB21003	30209SB22001	30209SB22002	30209SB22003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.012 U	0.021 UJ f	0.011 U	0.013 U	0.029 J g	0.011 U	0.012 U
PHENOL	0.022 U	0.021 U	0.022 U	0.024 U	0.021 U	0.021 U	0.023 U
PYRENE	0.016 U	0.067	0.016 U	0.017 U	0.065	0.015 U	0.017 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.00092 U	0.00088 U	0.00089 U	0.00099 U	0.00086 U	0.00086 U	0.00095 U
AROCLOR-1221	0.00092 U	0.00088 U	0.00089 U	0.00099 U	0.00086 U	0.00086 U	0.00095 U
AROCLOR-1232	0.00092 U	0.00088 U	0.00089 U	0.00099 U	0.00086 U	0.00086 U	0.00095 U
AROCLOR-1242	0.00092 U	0.00088 U	0.00089 U	0.00099 U	0.00086 U	0.00086 U	0.00095 U
AROCLOR-1248	0.00092 U	0.00088 U	0.00089 U	0.00099 U	0.00086 U	0.00086 U	0.00095 U
AROCLOR-1254	0.00092 U	0.00088 U	0.00089 U	0.00099 U	0.00086 U	0.00086 U	0.00095 U
AROCLOR-1260	0.00092 U	0.00088 U	0.00089 U	0.00099 U	0.00086 U	0.00086 U	0.00095 U
Pesticides							
4,4'-DDD	0.00017 U	0.0017 U	0.00017 U	0.00019 U	0.00032 U	0.00016 U	0.00018 U
4,4'-DDE	0.00028 U	0.0027 U	0.00027 U	0.0003 U	0.00052 U	0.00026 U	0.00029 U
4,4'-DDT	0.00019 U	0.0018 U	0.00019 U	0.00021 U	0.00036 U	0.00018 U	0.0002 U
ALDRIN	0.00026 U	0.0025 U	0.00026 U	0.00029 U	0.00049 U	0.00025 U	0.00027 U
ALPHA-BHC	0.00012 U	0.0011 U	0.00012 U	0.00013 U	0.00022 U	0.00011 U	0.00012 U
ALPHA-CHLORDANE	0.00012 U	0.0012 U	0.00012 U	0.00013 U	0.00023 U	0.00012 U	0.00013 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00017 U	0.0016 U	0.00016 U	0.00034 U	0.00031 U	0.00016 U	0.00017 U
DELTA-BHC	0.00041 U	0.004 U	0.0004 U	0.00045 U	0.00078 U	0.00039 U	0.00043 U
DIELDRIN	0.00034 U	0.0033 U	0.00034 U	0.00037 U	0.00064 U	0.00032 U	0.00036 U
ENDOSULFAN I	0.00014 U	0.0014 U	0.00028 UJ g	0.00015 U	0.00026 U	0.00013 U	0.00015 U
ENDOSULFAN II	0.00025 U	0.0024 U	0.00024 U	0.00027 U	0.00046 U	0.00023 U	0.00026 U
ENDOSULFAN SULFATE	0.00018 U	0.0018 U	0.00018 U	0.0002 U	0.00034 U	0.00017 U	0.00019 U
ENDRIN	0.00015 U	0.0015 U	0.00015 U	0.00016 U	0.00028 U	0.00014 U	0.00016 U
ENDRIN ALDEHYDE	0.0004 U	0.0038 U	0.00039 U	0.00043 U	0.00074 U	0.00037 U	0.00041 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB20	09-SB21	09-SB21	09-SB21	09-SB22	09-SB22	09-SB22
Sample ID	30209SB20003	30209SB21001	30209SB21002	30209SB21003	30209SB22001	30209SB22002	30209SB22003
Sample Date	10/25/2002	10/25/2002	10/25/2002	10/25/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00018 U	0.0017 U	0.0011 U	0.0002 U	0.00034 U	0.00017 U	0.00019 U
GAMMA-BHC (LINDANE)	0.00027 U	0.0026 U	0.00027 U	0.0003 U	0.00051 U	0.00026 U	0.00028 U
GAMMA-CHLORDANE	0.00017 U	0.0016 U	0.00016 U	0.00018 U	0.00031 U	0.00016 U	0.00017 U
HEPTACHLOR	0.00015 U	0.0015 U	0.00015 U	0.00017 U	0.00029 U	0.00015 U	0.00016 U
HEPTACHLOR EPOXIDE	0.00016 U	0.0015 U	0.00015 U	0.00017 U	0.00029 U	0.00015 U	0.00016 U
METHOXYCHLOR	0.00018 U	0.0018 U	0.0011 U	0.0002 U	0.00034 U	0.00017 U	0.00019 U
TOXAPHENE	0.011 U	0.098 U	0.019 U	0.012 U	0.02 U	0.0096 U	0.011 U
Metals (mg/kg)							
ALUMINUM	3,810	5,210	3,930	3,430	3,870	3,580	3,850
ANTIMONY	0.05 UJ be	0.18 J e	0.07 UJ be	0.05 UJ be	0.051 J g	0.047 J g	0.053 J g
ARSENIC	2.4	6.3	2.4	2.8	4.9	2.3	2.5
BARIUM	7.4	23.5	8.4	6.4	8.9	6.7	7.5
BERYLLIUM	0.1 J g	0.12 J g	0.1 J g	0.11 J g	0.12 J g	0.1 J g	0.1 J g
CADMIUM	0.05 J g	0.08	0.05 J g	0.06 J g	0.05 J g	0.04 J g	0.04 J g
CALCIUM	4,280	11,500	1,910	1,790	6,450 J d	1,410 J d	1,510 J d
CHROMIUM	21.2	35	25.8	21.3	22.4	22.2	23
COBALT	6	6.7	5.9	6.7	6	6.2	5.7
COPPER	4.47	10	4.44	3.8	4.31	3.48	3.73
IRON	9,140	14,500	9,460	9,260	11,900	8,710	8,690
LEAD	2.33	12.6	2.14	2.29	4.55	1.89	1.92
MAGNESIUM	2,370	4,890	2,300	2,310	3,520	2,130	2,190
MANGANESE	80.7	232	83.9	83.8	187	70.6	70.9
MERCURY	0.01 U	0.12	0.01 U	0.01 U	0.02 UJ b	0.02	0.01 J g
MOLYBDENUM	0.08 UJ f	0.24	0.08 UJ f	0.1 UJ f	0.2	0.1	0.06
NICKEL	21.8 J j	40.5 J j	21.3 J j	22.8 J j	28.2	19.9	21.9
POTASSIUM	574 J j	601 J j	567 J j	582 J j	749 J j	663 J j	623 J j
SELENIUM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
SILVER	0.05	0.042	0.02 J g	0.014 J g	0.023	0.018 J g	0.021 J g
SODIUM	78.5	198	67	78.2	147 J d	60.4 J d	245 J d
THALLIUM	0.045	0.036	0.035	0.041	0.056	0.042	0.042
TIN	3.3 UJ b	2.5 UJ b	2.5 UJ b	2.4 U	2.1 U	2.1 U	2.3 U
VANADIUM	15	22.2	16.9	14.4	18.3	14.9	15.4
ZINC	16.9	29.6	16.3	16.9	21.3	16.1	17.1
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB23	09-SB23	09-SB23	09-SB24	09-SB24	09-SB24	09-SB25
Sample ID	30209SB23001	30209SB23002	30209SB23003	30209SB24001	30209SB24002	30209SB24003	30209SB25001
Sample Date	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,1,1-TRICHLOROETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,1,2,2-TETRACHLOROETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,1,2-TRICHLOROETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,1-DICHLOROETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,1-DICHLOROETHENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,1-DICHLOROPROPENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,2,3-TRICHLOROBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,2,3-TRICHLOROPROPANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,2,4-TRICHLOROBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,2,4-TRIMETHYLBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,2-DIBROMO-3-CHLOROPROPANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,2-DIBROMOETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,2-DICHLOROBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,2-DICHLOROETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,3,5-TRIMETHYLBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,3-DICHLOROBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,3-DICHLOROPROPANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
1,4-DICHLOROBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
2,2-DICHLOROPROPANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
2-BUTANONE	0.012 U	0.011 U	0.011 UJ b	0.014 U	0.012 U	0.011 U	0.011 U
2-CHLOROTOLUENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
2-HEXANONE	0.012 U	0.011 U	0.011 U	0.014 U	0.012 U	0.011 U	0.011 U
4-CHLOROTOLUENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
4-METHYL-2-PENTANONE	0.012 U	0.011 U	0.011 U	0.014 U	0.012 U	0.011 U	0.011 U
ACETONE	0.023 UJ b	0.022 UJ b	0.022 UJ b	0.029 UJ b	0.024 UJ b	0.022 UJ b	0.021 UJ b
BENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
BROMOBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
BROMOCHLOROMETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
BROMODICHLOROMETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
BROMOFORM	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
BROMOMETHANE	0.012 U	0.011 U	0.011 U	0.014 U	0.012 U	0.011 U	0.011 U
CARBON DISULFIDE	0.0058 U	0.0054 U	0.00043 J g	0.0071 U	0.006 U	0.0056 U	0.0053 U
CARBON TETRACHLORIDE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB23	09-SB23	09-SB23	09-SB24	09-SB24	09-SB24	09-SB25
Sample ID	30209SB23001	30209SB23002	30209SB23003	30209SB24001	30209SB24002	30209SB24003	30209SB25001
Sample Date	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
CHLOROETHANE	0.012 U	0.011 U	0.011 U	0.014 U	0.012 U	0.011 U	0.011 U
CHLOROFORM	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
CHLOROMETHANE	0.012 U	0.011 U	0.011 U	0.014 U	0.012 U	0.011 U	0.011 U
CIS-1,2-DICHLOROETHENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
CIS-1,3-DICHLOROPROPENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
DIBROMOCHLOROMETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
DIBROMOMETHANE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
ETHYLBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
FREON 11	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
FREON 113	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
FREON 12	0.012 U	0.011 U	0.011 U	0.014 U	0.012 U	0.011 U	0.011 U
HEXACHLOROBUTADIENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
ISOPROPYLBENZENE	0.0058 U	0.0054 U	0.0067	0.0071 U	0.006 U	0.0056 U	0.0053 U
M,P-XYLENES	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
METHYL-TERT-BUTYL ETHER	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
METHYLENE CHLORIDE	0.023 U	0.022 U	0.022 U	0.029 UJ b	0.049 UJ b	0.093 UJ b	0.021 UJ b
N-BUTYLBENZENE	0.0058 U	0.0054 U	0.037	0.0071 U	0.006 U	0.0056 U	0.0053 U
N-PROPYLBENZENE	0.0058 U	0.0054 U	0.013	0.0071 U	0.006 U	0.0056 U	0.0053 U
NAPHTHALENE	0.0058 U	0.0054 U	0.024	0.0071 U	0.006 U	0.0056 U	0.0053 U
O-XYLENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
PARA-ISOPROPYL TOLUENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
SEC-BUTYLBENZENE	0.0058 U	0.0054 U	0.027	0.0071 U	0.006 U	0.0056 U	0.0053 U
STYRENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
TERT-BUTYLBENZENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
TETRACHLOROETHENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
TOLUENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
TRANS-1,2-DICHLOROETHENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
TRANS-1,3-DICHLOROPROPENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
TRICHLOROETHENE	0.0058 U	0.0054 U	0.0054 U	0.0071 U	0.006 U	0.0056 U	0.0053 U
VINYL ACETATE	0.058 U	0.054 U	0.054 U	0.071 U	0.06 U	0.056 U	0.053 U
VINYL CHLORIDE	0.012 U	0.011 U	0.011 U	0.014 U	0.012 U	0.011 U	0.011 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	4.4 U	78 Y	7,600	4.9 U	5 U	5 U	4.4 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB23	09-SB23	09-SB23	09-SB24	09-SB24	09-SB24	09-SB25
Sample ID	30209SB23001	30209SB23002	30209SB23003	30209SB24001	30209SB24002	30209SB24003	30209SB25001
Sample Date	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	4.4 U	52 M	400 D	5.3 MJ e	5 U	5 U	6.3 M
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.21 U	0.22 U	150 H	0.31 U	0.23 U	0.22 U	0.22 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.012 U	0.013 U	0.013 U	0.013 U	0.013 U	0.012 U
1,2-DICHLOROBENZENE	0.019 U	0.019 U	0.021 U	0.021 U	0.022 U	0.022 U	0.019 U
1,3-DICHLOROBENZENE	0.019 U	0.02 U	0.022 U	0.022 U	0.022 U	0.022 U	0.019 U
1,4-DICHLOROBENZENE	0.019 U	0.019 U	0.025 J g	0.021 U	0.021 U	0.021 U	0.019 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.015 U	0.015 U	0.017 U	0.017 U	0.017 U	0.017 U	0.015 U
2,4,5-TRICHLOROPHENOL	0.018 U	0.019 U	0.021 U	0.02 U	0.021 U	0.021 U	0.018 U
2,4,6-TRICHLOROPHENOL	0.015 U	0.016 U	0.017 U	0.017 U	0.017 U	0.017 U	0.015 U
2,4-DICHLOROPHENOL	0.017 U	0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.017 U
2,4-DIMETHYLPHENOL	0.016 U	0.016 U	0.018 U	0.018 U	0.018 U	0.018 U	0.016 U
2,4-DINITROPHENOL	0.12 U	0.12 U	0.14 U	0.14 U	0.14 U	0.14 U	0.12 U
2,4-DINITROTOLUENE	0.016 U	0.016 U	0.018 U	0.018 U	0.018 U	0.018 U	0.016 U
2,6-DINITROTOLUENE	0.017 U	0.017 U	0.019 U	0.019 U	0.019 U	0.019 U	0.017 U
2-CHLORONAPHTHALENE	0.011 U	0.011 U	0.012 U	0.012 U	0.012 U	0.012 U	0.011 U
2-CHLOROPHENOL	0.011 U	0.011 U	0.012 U	0.012 U	0.012 U	0.012 U	0.011 U
2-METHYLNAPHTHALENE	0.012 U	0.012 U	0.5	0.013 U	0.013 U	0.013 U	0.012 U
2-METHYLPHENOL	0.018 U	0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.018 U
2-NITROANILINE	0.018 U	0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.018 U
2-NITROPHENOL	0.015 U	0.015 U	0.017 U	0.017 U	0.017 U	0.017 U	0.015 U
3,3'-DICHLOROBENZIDINE	0.028 U	0.029 U	0.032 U	0.032 U	0.032 U	0.032 U	0.028 U
3-NITROANILINE	0.19 U	0.19 U	0.21 U	0.21 U	0.21 U	0.21 U	0.19 U
4,6-DINITRO-2-METHYLPHENOL	0.15 U	0.16 U	1.7 U	0.17 U	0.17 U	0.17 U	0.15 U
4-BROMOPHENYL-PHENYLETHER	0.013 U	0.013 U	0.15 U	0.015 U	0.015 U	0.015 U	0.013 U
4-CHLORO-3-METHYLPHENOL	0.018 U	0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.018 U
4-CHLOROANILINE	0.015 U	0.016 U	0.017 U	0.017 U	0.017 U	0.017 U	0.015 U
4-CHLOROPHENYL-PHENYLETHER	0.017 U	0.017 U	0.019 U	0.019 U	0.019 U	0.019 U	0.017 U
4-METHYLPHENOL	0.018 U	0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.018 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB23	09-SB23	09-SB23	09-SB24	09-SB24	09-SB24	09-SB25
Sample ID	30209SB23001	30209SB23002	30209SB23003	30209SB24001	30209SB24002	30209SB24003	30209SB25001
Sample Date	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.19 U	0.19 U	0.21 U	0.21 U	0.22 U	0.22 U	0.19 U
4-NITROPHENOL	0.16 U	0.16 U	0.18 U	0.17 U	0.18 U	0.18 U	0.16 U
ACENAPHTHENE	0.014 U	0.015 U	0.55	0.016 U	0.016 U	0.016 U	0.014 U
ACENAPHTHYLENE	0.014 U	0.014 U	0.015 U	0.015 U	0.015 U	0.015 U	0.014 U
ANTHRACENE	0.015 U	0.015 U	0.17 U	0.017 U	0.017 U	0.017 U	0.015 U
BENZO(A)ANTHRACENE	0.013 U	0.014 U	0.055 J g	0.015 U	0.015 U	0.015 U	0.018 J g
BENZO(A)PYRENE	0.021 U	0.021 U	0.06	0.023 U	0.024 U	0.024 U	0.024 J g
BENZO(B)FLUORANTHENE	0.018 U	0.019 U	0.054 J g	0.02 U	0.021 U	0.021 U	0.019 J g
BENZO(G,H,I)PERYLENE	0.021 U	0.022 U	0.055 J g	0.024 U	0.024 U	0.024 U	0.042 J g
BENZO(K)FLUORANTHENE	0.021 U	0.021 U	0.037 J g	0.023 U	0.023 U	0.023 U	0.021 U
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.012 U	0.013 U	0.013 U	0.013 U	0.013 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	0.013 U	0.013 U	0.014 U	0.014 U	0.014 U	0.014 U	0.013 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.02 U	0.02 U	0.022 U	0.022 U	0.022 U	0.022 U	0.02 U
BUTYLBENZYLPHTHALATE	0.017 U	0.018 U	0.02 U	0.019 U	0.02 U	0.02 U	0.017 U
CARBAZOLE	0.012 U	0.012 U	0.014 U	0.014 U	0.014 U	0.014 U	0.012 U
CHRYSENE	0.013 U	0.013 U	0.13	0.014 U	0.014 U	0.014 U	0.019 J g
DI-N-BUTYLPHTHALATE	0.013 U	0.013 U	0.15 U	0.015 U	0.015 U	0.015 U	0.013 U
DI-N-OCTYLPHTHALATE	0.025 U	0.026 U	0.029 U	0.028 U	0.029 U	0.029 U	0.025 U
DIBENZ(A,H)ANTHRACENE	0.029 U	0.03 U	0.033 U	0.032 U	0.033 U	0.033 U	0.029 U
DIBENZOFURAN	0.013 U	0.013 U	1.1	0.014 U	0.014 U	0.014 U	0.013 U
DIETHYLPHTHALATE	0.015 U	0.015 U	0.017 U	0.017 U	0.017 U	0.017 U	0.015 U
DIMETHYLPHTHALATE	0.017 U	0.018 U	0.02 U	0.02 U	0.02 U	0.02 U	0.017 U
FLUORANTHENE	0.012 U	0.013 U	0.23 J g	0.014 U	0.014 U	0.014 U	0.027 J g
FLUORENE	0.014 U	0.014 U	1.9	0.016 U	0.016 U	0.016 U	0.014 U
HEXACHLOROBENZENE	0.016 U	0.016 U	0.18 U	0.018 U	0.018 U	0.018 U	0.016 U
HEXACHLOROBUTADIENE	0.015 U	0.015 U	0.017 U	0.017 U	0.017 U	0.017 U	0.015 U
HEXACHLOROCYCLOPENTADIENE	0.013 U	0.014 U	0.015 U	0.015 U	0.015 U	0.015 U	0.013 U
HEXACHLOROETHANE	0.023 U	0.023 U	0.026 U	0.026 U	0.026 U	0.026 U	0.023 U
INDENO(1,2,3-CD)PYRENE	0.041 U	0.042 U	0.046 U	0.046 U	0.046 U	0.046 U	0.041 U
ISOPHORONE	0.015 U	0.015 U	0.017 U	0.017 U	0.017 U	0.017 U	0.015 U
N-NITROSO-DI-N-PROPYLAMINE	0.02 U	0.021 U	0.023 U	0.023 U	0.023 U	0.023 U	0.02 U
N-NITROSODIPHENYLAMINE (1)	0.019 U	0.02 U	0.22 U	0.021 U	0.022 U	0.022 U	0.019 U
NAPHTHALENE	0.015 U	0.016 U	0.46	0.017 U	0.017 U	0.017 U	0.015 U
NITROBENZENE	0.027 U	0.028 U	0.031 U	0.031 U	0.031 U	0.031 U	0.027 U
PENTACHLOROPHENOL	0.13 U	0.14 U	1.5 U	0.15 U	0.15 U	0.15 U	0.13 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB23	09-SB23	09-SB23	09-SB24	09-SB24	09-SB24	09-SB25
Sample ID	30209SB23001	30209SB23002	30209SB23003	30209SB24001	30209SB24002	30209SB24003	30209SB25001
Sample Date	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.011 U	0.011 U	2.4	0.012 U	0.012 U	0.012 U	0.011 U
PHENOL	0.021 U	0.021 U	0.023 U	0.023 U	0.023 U	0.023 U	0.021 U
PYRENE	0.015 U	0.015 U	0.2	0.017 U	0.017 U	0.017 U	0.037 J g
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.00085 U	0.00087 U	0.00097 U	0.00096 U	0.00097 U	0.00097 U	0.00085 U
AROCLOR-1221	0.00085 U	0.00087 U	0.00097 U	0.00096 U	0.00097 U	0.00097 U	0.00085 U
AROCLOR-1232	0.00085 U	0.00087 U	0.00097 U	0.00096 U	0.00097 U	0.00097 U	0.00085 U
AROCLOR-1242	0.00085 U	0.00087 U	0.00097 U	0.00096 U	0.00097 U	0.00097 U	0.00085 U
AROCLOR-1248	0.00085 U	0.00087 U	0.00097 U	0.00096 U	0.00097 U	0.00097 U	0.00085 U
AROCLOR-1254	0.00085 U	0.00087 U	0.00097 U	0.00096 U	0.00097 U	0.00097 U	0.00085 U
AROCLOR-1260	0.00085 U	0.00087 U	0.00097 U	0.00096 U	0.00097 U	0.00097 U	0.00085 U
Pesticides							
4,4'-DDD	0.00016 U	0.00016 U	0.00018 U	0.00018 U	0.0012 U	0.00018 U	0.00079 U
4,4'-DDE	0.00026 U	0.00026 U	0.00029 U	0.00029 U	0.00029 U	0.00029 U	0.0013 U
4,4'-DDT	0.00018 U	0.00024 U	0.0002 U	0.00021 U	0.0002 U	0.0002 U	0.00088 U
ALDRIN	0.00025 U	0.00025 U	0.00028 U	0.00028 U	0.00028 U	0.00028 U	0.0013 U
ALPHA-BHC	0.00011 U	0.00011 U	0.00012 U	0.00012 U	0.00013 U	0.00012 U	0.00053 U
ALPHA-CHLORDANE	0.00012 U	0.00012 U	0.00013 U	0.00013 U	0.00013 U	0.00013 U	0.00056 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00016 U	0.00016 U	0.00035 U	0.00018 U	0.00018 U	0.00018 U	0.00077 U
DELTA-BHC	0.00039 U	0.0004 U	0.00044 U	0.00043 U	0.00044 U	0.00044 U	0.002 U
DIELDRIN	0.00032 U	0.00033 U	0.00036 U	0.00036 U	0.00037 U	0.00036 U	0.0016 U
ENDOSULFAN I	0.00013 U	0.00014 U	0.00015 U	0.00015 U	0.00015 U	0.00015 U	0.00064 U
ENDOSULFAN II	0.00023 U	0.00024 U	0.00026 U	0.00026 U	0.00026 U	0.00026 U	0.0012 U
ENDOSULFAN SULFATE	0.00017 U	0.00017 U	0.00019 U	0.00019 U	0.00019 U	0.00019 U	0.00083 U
ENDRIN	0.00014 U	0.00014 U	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.00069 U
ENDRIN ALDEHYDE	0.00037 U	0.00038 U	0.00042 UJ c	0.00041 U	0.00042 U	0.00042 U	0.0019 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB23	09-SB23	09-SB23	09-SB24	09-SB24	09-SB24	09-SB25
Sample ID	30209SB23001	30209SB23002	30209SB23003	30209SB24001	30209SB24002	30209SB24003	30209SB25001
Sample Date	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002	11/01/2002
Sample Depth	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00	2.50 - 5.00	5.00 - 7.50	0.50 - 2.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00017 U	0.00017 U	0.00019 U	0.00019 U	0.00019 U	0.00019 U	0.00083 U
GAMMA-BHC (LINDANE)	0.00026 U	0.00026 U	0.00029 U	0.00029 U	0.00029 U	0.00029 U	0.0013 U
GAMMA-CHLORDANE	0.00016 U	0.00016 U	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00077 U
HEPTACHLOR	0.00014 U	0.00015 U	0.00024 U	0.00016 U	0.00016 U	0.00016 U	0.0007 U
HEPTACHLOR EPOXIDE	0.00015 U	0.00015 U	0.00016 U	0.00016 U	0.00017 U	0.00016 U	0.00071 U
METHOXYCHLOR	0.00017 U	0.00018 U	0.00019 U	0.00019 U	0.00019 U	0.00019 U	0.00084 U
TOXAPHENE	0.0096 U	0.011 U	0.011 U	0.016 U	0.011 U	0.011 U	0.048 U
Metals (mg/kg)							
ALUMINUM	3,880	3,710	4,530	6,870	4,330	4,200	3,730
ANTIMONY	0.053	0.039 J g	0.045 J g	0.152	0.102	0.036 J g	0.038 J g
ARSENIC	2.5	2.5	2.6	5.6	3.2	2.7	6.4
BARIUM	10.1	7.2	9.1	52	14.1	8.3	12.9
BERYLLIUM	0.11 J g	0.1 J g	0.11 J g	0.23 J g	0.13 J g	0.12 J g	0.11 J g
CADMIUM	0.04 J g	0.05	0.05 J g	0.22	0.07	0.04 J g	0.03 J g
CALCIUM	4,920 J d	1,660 J d	2,240 J d	3,300 J d	2,350 J d	2,120 J d	6,690 J d
CHROMIUM	25.4	23.8	29.6	27.6	28.7	25.9	22.9
COBALT	5.7	5	7.1	6.6	6.7	6.3	5.4
COPPER	4.06	4.14	4.6	11	17.7	4.1	4.29
IRON	10,800	9,230	10,400	14,700	10,400	9,930	12,700
LEAD	2.39	2.2	2.47	10.2	5.41	2.16	3.49
MAGNESIUM	3,250	2,150	2,620	2,920	2,410	2,310	3,240
MANGANESE	164	63.2	84.9	266	89.7	78.7	238
MERCURY	0.01 J g	0.02 J g	0.01 J g	0.04	0.03	0.01 J g	0.02 J g
MOLYBDENUM	0.08	0.07	0.13	0.77	0.12	0.1	0.11
NICKEL	26.1	20	26.9	24.2	22.4	22.9	25.6
POTASSIUM	584 J j	631 J j	727 J j	869 J j	625 J j	620 J j	484 J j
SELENIUM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
SILVER	0.021	0.016 J g	0.021 J g	0.051	0.03	0.017 J g	0.019 J g
SODIUM	102 J d	57.9 J d	76.3 J d	80.5 J d	69.6 J d	67.3 J d	139 J d
THALLIUM	0.031	0.043	0.044	0.08	0.041	0.04	0.028
TIN	2.1 U	2.1 U	2.7 UJ b	2.3 U	2.4 UJ b	2.4 U	2.1 U
VANADIUM	17.7	17	19.7	25.2	18.7	18.1	19.3
ZINC	18.9	16.8	19.9	32.3	24.3	18.5	18.8
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB25	09-SB25
Sample ID	30209SB25002	30209SB25003
Sample Date	11/01/2002	11/01/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)		
1,1,1,2-TETRACHLOROETHANE	0.0055 U	0.0051 R i
1,1,1-TRICHLOROETHANE	0.0055 U	0.0051 R i
1,1,2,2-TETRACHLOROETHANE	0.0055 U	0.0051 R i
1,1,2-TRICHLOROETHANE	0.0055 U	0.0051 R i
1,1-DICHLOROETHANE	0.0055 U	0.0051 R i
1,1-DICHLOROETHENE	0.0055 U	0.0051 R i
1,1-DICHLOROPROPENE	0.0055 U	0.0051 R i
1,2,3-TRICHLOROBENZENE	0.0055 U	0.0051 R i
1,2,3-TRICHLOROPROPANE	0.0055 U	0.0051 R i
1,2,4-TRICHLOROBENZENE	0.0055 U	0.0051 R i
1,2,4-TRIMETHYLBENZENE	0.0055 U	0.0051 R i
1,2-DIBROMO-3-CHLOROPROPANE	0.0055 U	0.0051 R i
1,2-DIBROMOETHANE	0.0055 U	0.0051 R i
1,2-DICHLOROBENZENE	0.0055 U	0.0051 R i
1,2-DICHLOROETHANE	0.0055 U	0.0051 R i
1,2-DICHLOROETHENE (TOTAL)	NA	NA
1,2-DICHLOROPROPANE	0.0055 U	0.0051 R i
1,3,5-TRIMETHYLBENZENE	0.0055 U	0.0051 R i
1,3-DICHLOROBENZENE	0.0055 U	0.0051 R i
1,3-DICHLOROPROPANE	0.0055 U	0.0051 R i
1,4-DICHLOROBENZENE	0.0055 U	0.0051 R i
2,2-DICHLOROPROPANE	0.0055 U	0.0051 R i
2-BUTANONE	0.011 U	0.01 R i
2-CHLOROTOLUENE	0.0055 U	0.0051 R i
2-HEXANONE	0.011 U	0.01 R i
4-CHLOROTOLUENE	0.0055 U	0.0051 R i
4-METHYL-2-PENTANONE	0.011 U	0.01 R i
ACETONE	0.022 UJ b	0.004 UJ bi
BENZENE	0.0055 U	0.0051 R i
BROMOBENZENE	0.0055 U	0.0051 R i
BROMOCHLOROMETHANE	0.0055 U	0.0051 R i
BROMODICHLOROMETHANE	0.0055 U	0.0051 R i
BROMOFORM	0.0055 U	0.0051 R i
BROMOMETHANE	0.011 U	0.01 R i
CARBON DISULFIDE	0.0055 U	0.0051 R i
CARBON TETRACHLORIDE	0.0055 U	0.0051 R i

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB25	09-SB25
Sample ID	30209SB25002	30209SB25003
Sample Date	11/01/2002	11/01/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50
Volatile Organic Compounds (mg/kg)		
CHLOROBENZENE	0.0055 U	0.0051 R i
CHLOROETHANE	0.011 U	0.01 R i
CHLOROFORM	0.0055 U	0.0051 R i
CHLOROMETHANE	0.011 U	0.01 R i
CIS-1,2-DICHLOROETHENE	0.0055 U	0.0051 R i
CIS-1,3-DICHLOROPROPENE	0.0055 U	0.0051 R i
DIBROMOCHLOROMETHANE	0.0055 U	0.0051 R i
DIBROMOMETHANE	0.0055 U	0.0051 R i
ETHYLBENZENE	0.0055 U	0.0051 R i
FREON 11	0.0055 U	0.0051 R i
FREON 113	0.0055 U	0.0051 R i
FREON 12	0.011 U	0.01 R i
HEXACHLOROBUTADIENE	0.0055 U	0.0051 R i
ISOPROPYLBENZENE	0.0055 U	0.0051 R i
M,P-XYLENES	0.0055 U	0.0051 R i
METHYL-TERT-BUTYL ETHER	0.0055 U	0.0051 R i
METHYLENE CHLORIDE	0.022 UJ b	0.053 UJ bi
N-BUTYLBENZENE	0.0055 U	0.0051 R i
N-PROPYLBENZENE	0.0055 U	0.0051 R i
NAPHTHALENE	0.0055 U	0.0051 R i
O-XYLENE	0.0055 U	0.0051 R i
PARA-ISOPROPYL TOLUENE	0.0055 U	0.0051 R i
SEC-BUTYLBENZENE	0.0055 U	0.0051 R i
STYRENE	0.0055 U	0.0051 R i
TERT-BUTYLBENZENE	0.0055 U	0.0051 R i
TETRACHLOROETHENE	0.0055 U	0.0051 R i
TOLUENE	0.0055 U	0.0051 R i
TRANS-1,2-DICHLOROETHENE	0.0055 U	0.0051 R i
TRANS-1,3-DICHLOROPROPENE	0.0055 U	0.0051 R i
TRICHLOROETHENE	0.0055 U	0.0051 R i
VINYL ACETATE	0.055 U	0.051 R i
VINYL CHLORIDE	0.011 U	0.01 R i
XYLENE (TOTAL)	NA	NA
Petroleum Hydrocarbons (mg/kg)		
Diesel/Motor Oil Range (extractables) - SG		
DIESEL RANGE ORGANICS	4.4 U	5 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB25	09-SB25
Sample ID	30209SB25002	30209SB25003
Sample Date	11/01/2002	11/01/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50
Petroleum Hydrocarbons (mg/kg)		
Diesel/Motor Oil Range (extractables) - SG		
MOTOR OIL RANGE ORGANICS	7 M	5.2 M
Diesel/Motor Oil Range (extractables)		
DIESEL RANGE ORGANICS	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA
Gasoline Range (purgeables)		
GASOLINE RANGE ORGANICS	0.22 U	0.2 U
Semivolatile Organic Compounds (mg/kg)		
1,2,4-TRICHLOROBENZENE	0.012 U	0.014 U
1,2-DICHLOROBENZENE	0.019 U	0.022 U
1,3-DICHLOROBENZENE	0.02 U	0.022 U
1,4-DICHLOROBENZENE	0.019 U	0.021 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.015 U	0.017 U
2,4,5-TRICHLOROPHENOL	0.018 U	0.021 U
2,4,6-TRICHLOROPHENOL	0.015 U	0.017 U
2,4-DICHLOROPHENOL	0.018 U	0.02 U
2,4-DIMETHYLPHENOL	0.016 U	0.018 U
2,4-DINITROPHENOL	0.12 U	0.14 U
2,4-DINITROTOLUENE	0.016 U	0.018 U
2,6-DINITROTOLUENE	0.017 U	0.019 U
2-CHLORONAPHTHALENE	0.011 U	0.012 U
2-CHLOROPHENOL	0.011 U	0.012 U
2-METHYLNAPHTHALENE	0.012 U	0.014 U
2-METHYLPHENOL	0.018 U	0.02 U
2-NITROANILINE	0.018 U	0.02 U
2-NITROPHENOL	0.015 U	0.017 U
3,3'-DICHLOROBENZIDINE	0.029 U	0.032 U
3-NITROANILINE	0.19 U	0.21 U
4,6-DINITRO-2-METHYLPHENOL	0.16 U	0.17 U
4-BROMOPHENYL-PHENYLETHER	0.013 U	0.015 U
4-CHLORO-3-METHYLPHENOL	0.018 U	0.02 U
4-CHLOROANILINE	0.016 U	0.018 U
4-CHLOROPHENYL-PHENYLETHER	0.017 U	0.019 U
4-METHYLPHENOL	0.018 U	0.02 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB25	09-SB25
Sample ID	30209SB25002	30209SB25003
Sample Date	11/01/2002	11/01/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)		
4-NITROANILINE	0.19 U	0.22 U
4-NITROPHENOL	0.16 U	0.18 U
ACENAPHTHENE	0.015 U	0.016 U
ACENAPHTHYLENE	0.014 U	0.016 U
ANTHRACENE	0.015 U	0.017 U
BENZO(A)ANTHRACENE	0.013 U	0.015 U
BENZO(A)PYRENE	0.021 U	0.024 U
BENZO(B)FLUORANTHENE	0.019 U	0.021 U
BENZO(G,H,I)PERYLENE	0.022 U	0.024 U
BENZO(K)FLUORANTHENE	0.021 U	0.023 U
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.014 U
BIS(2-CHLOROETHYL)ETHER	0.013 U	0.014 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.026 UJ b	0.023 U
BUTYLBENZYLPHTHALATE	0.018 U	0.02 U
CARBAZOLE	0.012 U	0.014 U
CHRYSENE	0.013 U	0.014 U
DI-N-BUTYLPHTHALATE	0.013 U	0.015 U
DI-N-OCTYLPHTHALATE	0.026 U	0.029 U
DIBENZ(A,H)ANTHRACENE	0.029 U	0.033 U
DIBENZOFURAN	0.013 U	0.014 U
DIETHYLPHTHALATE	0.015 U	0.017 U
DIMETHYLPHTHALATE	0.018 U	0.02 U
FLUORANTHENE	0.013 U	0.014 U
FLUORENE	0.014 U	0.016 U
HEXACHLOROBENZENE	0.016 U	0.018 U
HEXACHLOROBUTADIENE	0.015 U	0.017 U
HEXACHLOROCYCLOPENTADIENE	0.014 U	0.015 U
HEXACHLOROETHANE	0.023 U	0.026 U
INDENO(1,2,3-CD)PYRENE	0.041 U	0.047 U
ISOPHORONE	0.015 U	0.017 U
N-NITROSO-DI-N-PROPYLAMINE	0.021 U	0.023 U
N-NITROSODIPHENYLAMINE (1)	0.019 U	0.022 U
NAPHTHALENE	0.016 U	0.018 U
NITROBENZENE	0.028 U	0.031 U
PENTACHLOROPHENOL	0.14 U	0.15 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB25	09-SB25
Sample ID	30209SB25002	30209SB25003
Sample Date	11/01/2002	11/01/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50
Semivolatile Organic Compounds (mg/kg)		
PHENANTHRENE	0.011 U	0.012 U
PHENOL	0.021 U	0.024 U
PYRENE	0.015 U	0.017 U
PCBs/Pesticides (mg/kg)		
PCBs		
AROCLOR-1016	0.00086 U	0.00098 U
AROCLOR-1221	0.00086 U	0.00098 U
AROCLOR-1232	0.00086 U	0.00098 U
AROCLOR-1242	0.00086 U	0.00098 U
AROCLOR-1248	0.00086 U	0.00098 U
AROCLOR-1254	0.00086 U	0.00098 U
AROCLOR-1260	0.00086 U	0.00098 U
Pesticides		
4,4'-DDD	0.00016 U	0.00018 U
4,4'-DDE	0.00026 U	0.00029 U
4,4'-DDT	0.00018 U	0.0002 U
ALDRIN	0.00025 U	0.00028 U
ALPHA-BHC	0.00011 U	0.00013 U
ALPHA-CHLORDANE	0.00012 U	0.00013 U
AROCLOR-1016	NA	NA
AROCLOR-1221	NA	NA
AROCLOR-1232	NA	NA
AROCLOR-1242	NA	NA
AROCLOR-1248	NA	NA
AROCLOR-1254	NA	NA
AROCLOR-1260	NA	NA
BETA-BHC	0.00016 U	0.00018 U
DELTA-BHC	0.00039 U	0.00044 U
DIELDRIN	0.00033 U	0.00037 U
ENDOSULFAN I	0.00013 U	0.00015 U
ENDOSULFAN II	0.00023 U	0.00026 U
ENDOSULFAN SULFATE	0.00017 U	0.00019 U
ENDRIN	0.00014 U	0.00016 U
ENDRIN ALDEHYDE	0.00038 U	0.00042 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-SB25	09-SB25
Sample ID	30209SB25002	30209SB25003
Sample Date	11/01/2002	11/01/2002
Sample Depth	2.50 - 5.00	5.00 - 7.50
PCBs/Pesticides (mg/kg)		
Pesticides		
ENDRIN KETONE	0.00017 U	0.00019 U
GAMMA-BHC (LINDANE)	0.00026 U	0.00029 U
GAMMA-CHLORDANE	0.00016 U	0.00018 U
HEPTACHLOR	0.00015 U	0.00016 U
HEPTACHLOR EPOXIDE	0.00015 U	0.00017 U
METHOXYCHLOR	0.00017 U	0.0002 U
TOXAPHENE	0.0097 U	0.011 U
Metals (mg/kg)		
ALUMINUM	3,940	4,650
ANTIMONY	0.031 J g	0.034 J g
ARSENIC	2.7	2.9
BARIUM	7.9	9.7
BERYLLIUM	0.12 J g	0.14 J g
CADMIUM	0.05 J g	0.06 J g
CALCIUM	2,260 J d	1,940 J d
CHROMIUM	28.2	27.7
COBALT	6.5	6.9
COPPER	3.7	4.26
IRON	9,570	11,200
LEAD	2.1	2.16
MAGNESIUM	1,870	2,420
MANGANESE	80	83.9
MERCURY	0.01 J g	0.01 J g
MOLYBDENUM	0.07	0.08
NICKEL	21.2	26.5
POTASSIUM	544 J j	769 J j
SELENIUM	0.2 U	0.2 U
SILVER	0.019 J g	0.02 J g
SODIUM	60.5 J d	80.5 J d
THALLIUM	0.034	0.044
TIN	2.4 UJ b	2.4 U
VANADIUM	16.9	17.9
ZINC	16.1	19.8
Hexavalent Chromium (mg/kg)		
HEXAVALENT CHROMIUM	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Notes:

a	Surrogate recovery problem.
b	Laboratory blank and common contamination problem.
c	Calibration criteria exceedance.
D	Chromatographic pattern resembles diesel.
d	Duplicate precision problem.
e	Matrix spike/LCS recovery problem.
f	Field blank contamination.
g	Quantification below reporting limit.
H	Chromatographic pattern is in the heavier hydrocarbon end of the analyte's range in the standard.
h	Holding time exceedance.
i	Internal standard exceedance.
ID	Identification.
J	Estimated value.
j	Other qualification reasons.
L	Chromatographic pattern is in the lighter hydrocarbon end of the analyte's range in the standard.
LCS	Laboratory control sample.
M	Chromatographic pattern resembles motor oil.
mg/kg	Milligram per kilogram.
NA	Not analyzed.
NAVSTA	Naval Station.
R	Result rejected during quality assurance review.
SG	Silica Gel.
TPH	Total petroleum hydrocarbons.
U	Nondetected.
Y	Chromatographic pattern resembles hydrocarbon fuel pattern and was quantitated using the standard it resembled most.
Z	Chromatographic pattern does not resemble TPH fuel pattern (individual peaks).

SITE 09
GROUNDWATER ANALYTICAL RESULTS

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP004	09-HP005	09-HP006	09-HP007
Sample ID	199HH502	199HH501	199HH503	199HH504	199HH505	199HH506	199HH507
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	08/08/1995
Volatile Organic Compounds (µg/L)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP004	09-HP005	09-HP006	09-HP007
Sample ID	199HH502	199HH501	199HH503	199HH504	199HH505	199HH506	199HH507
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	08/08/1995
Volatile Organic Compounds (µg/L)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP004	09-HP005	09-HP006	09-HP007
Sample ID	199HH502	199HH501	199HH503	199HH504	199HH505	199HH506	199HH507
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	08/08/1995
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	0.42 Y	NA	NA	NA	NA	0.1 U	0.1 U
MOTOR OIL RANGE ORGANICS	0.78 Y	NA	NA	NA	NA	0.1 U	0.1 U
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)							
1,2,4-TRICHLOROBENZENE	10 U	NA	NA	NA	NA	10 U	10 U
1,2-DICHLOROBENZENE	5 U	NA	NA	NA	NA	5 U	5 U
1,3-DICHLOROBENZENE	5 U	NA	NA	NA	NA	5 U	5 U
1,4-DICHLOROBENZENE	5 U	NA	NA	NA	NA	5 U	5 U
2,2'-OXYBIS(1-CHLOROPROPANE)	10 U	NA	NA	NA	NA	10 U	10 U
2,4,5-TRICHLOROPHENOL	25 U	NA	NA	NA	NA	25 U	25 U
2,4,6-TRICHLOROPHENOL	10 U	NA	NA	NA	NA	10 U	10 U
2,4-DICHLOROPHENOL	10 U	NA	NA	NA	NA	10 U	10 U
2,4-DIMETHYLPHENOL	10 U	NA	NA	NA	NA	10 U	10 U
2,4-DINITROPHENOL	25 U	NA	NA	NA	NA	25 U	25 U
2,4-DINITROTOLUENE	10 U	NA	NA	NA	NA	10 U	10 U
2,6-DINITROTOLUENE	10 U	NA	NA	NA	NA	10 U	10 U
2-CHLORONAPHTHALENE	10 U	NA	NA	NA	NA	10 U	10 U
2-CHLOROPHENOL	10 U	NA	NA	NA	NA	10 U	10 U
2-METHYLNAPHTHALENE	10 U	NA	NA	NA	NA	10 U	10 U
2-METHYLPHENOL	10 U	NA	NA	NA	NA	10 U	10 U
2-NITROANILINE	25 U	NA	NA	NA	NA	25 U	25 U
2-NITROPHENOL	10 U	NA	NA	NA	NA	10 U	10 U
3,3'-DICHLOROBENZIDINE	10 U	NA	NA	NA	NA	10 U	10 U
3-NITROANILINE	25 U	NA	NA	NA	NA	25 U	25 U
4,6-DINITRO-2-METHYLPHENOL	25 U	NA	NA	NA	NA	25 U	25 U
4-BROMOPHENYL-PHENYLETHER	10 U	NA	NA	NA	NA	10 U	10 U
4-CHLORO-3-METHYLPHENOL	10 U	NA	NA	NA	NA	10 U	10 U
4-CHLOROANILINE	10 U	NA	NA	NA	NA	10 U	10 U
4-CHLOROPHENYL-PHENYLETHER	10 U	NA	NA	NA	NA	10 U	10 U
4-METHYLPHENOL	10 U	NA	NA	NA	NA	10 U	10 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP004	09-HP005	09-HP006	09-HP007
Sample ID	199HH502	199HH501	199HH503	199HH504	199HH505	199HH506	199HH507
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	08/08/1995
Semivolatile Organic Compounds (µg/L)							
4-NITROANILINE	25 U	NA	NA	NA	NA	25 U	25 U
4-NITROPHENOL	25 U	NA	NA	NA	NA	25 U	25 U
ACENAPHTHENE	10 U	NA	NA	NA	NA	10 U	10 U
ACENAPHTHYLENE	10 U	NA	NA	NA	NA	10 U	10 U
ANTHRACENE	10 U	NA	NA	NA	NA	10 U	10 U
BENZO(A)ANTHRACENE	10 U	NA	NA	NA	NA	10 U	10 U
BENZO(A)PYRENE	10 U	NA	NA	NA	NA	10 U	10 U
BENZO(B)FLUORANTHENE	10 U	NA	NA	NA	NA	10 U	10 U
BENZO(G,H,I)PERYLENE	10 U	NA	NA	NA	NA	10 U	10 U
BENZO(K)FLUORANTHENE	10 U	NA	NA	NA	NA	10 U	10 U
BIS(2-CHLOROETHOXY)METHANE	10 U	NA	NA	NA	NA	10 U	10 U
BIS(2-CHLOROETHYL)ETHER	10 U	NA	NA	NA	NA	10 U	10 U
BIS(2-ETHYLHEXYL)PHTHALATE	4 U	NA	NA	NA	NA	4 U	4 U
BUTYLBENZYLPHTHALATE	10 U	NA	NA	NA	NA	10 U	10 U
CARBAZOLE	10 U	NA	NA	NA	NA	10 U	10 U
CHRYSENE	10 U	NA	NA	NA	NA	10 U	10 U
DI-N-BUTYLPHTHALATE	10 U	NA	NA	NA	NA	10 U	10 U
DI-N-OCTYLPHTHALATE	10 U	NA	NA	NA	NA	10 U	10 U
DIBENZ(A,H)ANTHRACENE	10 U	NA	NA	NA	NA	10 U	10 U
DIBENZOFURAN	10 U	NA	NA	NA	NA	10 U	10 U
DIETHYLPHTHALATE	10 U	NA	NA	NA	NA	10 U	10 U
DIMETHYLPHTHALATE	10 U	NA	NA	NA	NA	10 U	10 U
FLUORANTHENE	10 U	NA	NA	NA	NA	10 U	10 U
FLUORENE	10 U	NA	NA	NA	NA	10 U	10 U
HEXACHLOROBENZENE	10 U	NA	NA	NA	NA	10 U	10 U
HEXACHLOROBUTADIENE	10 U	NA	NA	NA	NA	10 U	10 U
HEXACHLOROCYCLOPENTADIENE	10 U	NA	NA	NA	NA	10 U	10 U
HEXACHLOROETHANE	10 U	NA	NA	NA	NA	10 U	10 U
INDENO(1,2,3-CD)PYRENE	10 U	NA	NA	NA	NA	10 U	10 U
ISOPHORONE	10 U	NA	NA	NA	NA	10 U	10 U
N-NITROSO-DI-N-PROPYLAMINE	10 U	NA	NA	NA	NA	10 U	10 U
N-NITROSODIPHENYLAMINE (1)	10 U	NA	NA	NA	NA	10 U	10 U
NAPHTHALENE	10 U	NA	NA	NA	NA	10 U	10 U
NITROBENZENE	10 U	NA	NA	NA	NA	10 U	10 U
PENTACHLOROPHENOL	25 U	NA	NA	NA	NA	25 U	25 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP004	09-HP005	09-HP006	09-HP007
Sample ID	199HH502	199HH501	199HH503	199HH504	199HH505	199HH506	199HH507
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	08/08/1995
Semivolatile Organic Compounds (µg/L)							
PHENANTHRENE	10 U	NA	NA	NA	NA	10 U	10 U
PHENOL	10 U	NA	NA	NA	NA	10 U	10 U
PYRENE	10 U	NA	NA	NA	NA	10 U	10 U
PCBs/Pesticides (µg/L)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA
ALDRIN	NA	NA	NA	NA	NA	NA	NA
ALPHA-BHC	NA	NA	NA	NA	NA	NA	NA
ALPHA-CHLORDANE	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	NA	NA	NA	NA	NA	NA	NA
DELTA-BHC	NA	NA	NA	NA	NA	NA	NA
DIELDRIN	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN I	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN II	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN SULFATE	NA	NA	NA	NA	NA	NA	NA
ENDRIN	NA	NA	NA	NA	NA	NA	NA
ENDRIN ALDEHYDE	NA	NA	NA	NA	NA	NA	NA
ENDRIN KETONE	NA	NA	NA	NA	NA	NA	NA
GAMMA-BHC (LINDANE)	NA	NA	NA	NA	NA	NA	NA
GAMMA-CHLORDANE	NA	NA	NA	NA	NA	NA	NA
HEPTACHLOR	NA	NA	NA	NA	NA	NA	NA
HEPTACHLOR EPOXIDE	NA	NA	NA	NA	NA	NA	NA
METHOXYCHLOR	NA	NA	NA	NA	NA	NA	NA
TOXAPHENE	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP004	09-HP005	09-HP006	09-HP007
Sample ID	199HH502	199HH501	199HH503	199HH504	199HH505	199HH506	199HH507
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	08/08/1995
Metals (µg/L)							
Unfiltered							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	2.3 J g	9.2	2 J g	8.8	1.5 J g	NA	1.5 U
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Filtered							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP001	09-HP002	09-HP003	09-HP004	09-HP005	09-HP006	09-HP007
Sample ID	199HH502	199HH501	199HH503	199HH504	199HH505	199HH506	199HH507
Sample Date	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/03/1995	08/08/1995	08/08/1995
Metals (µg/L)							
Filtered							
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP008	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01
Sample ID	199HH508	199Q4024	199Q5009	199Q6009	199Q6052	199Q7009	04109MW01
Sample Date	08/08/1995	12/04/1995	02/26/1996	06/10/1996	06/10/1996	09/05/1996	08/28/1997
Volatile Organic Compounds (µg/L)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	1 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP008	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01
Sample ID	199HH508	199Q4024	199Q5009	199Q6009	199Q6052	199Q7009	04109MW01
Sample Date	08/08/1995	12/04/1995	02/26/1996	06/10/1996	06/10/1996	09/05/1996	08/28/1997
Volatile Organic Compounds (µg/L)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	1 U
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	1 U
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	1 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	1 U
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP008	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01
Sample ID	199HH508	199Q4024	199Q5009	199Q6009	199Q6052	199Q7009	04109MW01
Sample Date	08/08/1995	12/04/1995	02/26/1996	06/10/1996	06/10/1996	09/05/1996	08/28/1997
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA
MOTOR OIL RANGE ORGANICS	0.1 U	0.28 Y	0.088 JY g	0.1 U	0.1 U	0.065 JY g	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	0.05 UJ a
Semivolatile Organic Compounds (µg/L)							
1,2,4-TRICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
1,2-DICHLOROBENZENE	5 U	5 U	5 U	5 U	5 U	5 U	NA
1,3-DICHLOROBENZENE	5 U	5 U	5 U	5 U	5 U	5 U	NA
1,4-DICHLOROBENZENE	5 U	5 U	5 U	5 U	5 U	5 U	NA
2,2'-OXYBIS(1-CHLOROPROPANE)	10 U	10 U	10 U	10 U	10 U	10 U	NA
2,4,5-TRICHLOROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	NA
2,4,6-TRICHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	NA
2,4-DICHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	NA
2,4-DIMETHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	NA
2,4-DINITROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	NA
2,4-DINITROTOLUENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
2,6-DINITROTOLUENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
2-CHLORONAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
2-CHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	NA
2-METHYLNAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
2-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	NA
2-NITROANILINE	25 U	25 U	25 U	25 U	25 U	25 U	NA
2-NITROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	NA
3,3'-DICHLOROBENZIDINE	10 U	10 UJ c	10 UJ c	10 U	10 U	10 U	NA
3-NITROANILINE	25 U	25 U	25 U	25 U	25 U	25 U	NA
4,6-DINITRO-2-METHYLPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	NA
4-BROMOPHENYL-PHENYLETHER	10 U	10 U	10 U	10 U	10 U	10 U	NA
4-CHLORO-3-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	NA
4-CHLOROANILINE	10 U	10 U	10 U	10 U	10 U	10 U	NA
4-CHLOROPHENYL-PHENYLETHER	10 U	10 U	10 U	10 U	10 U	10 U	NA
4-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP008	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01
Sample ID	199HH508	199Q4024	199Q5009	199Q6009	199Q6052	199Q7009	04109MW01
Sample Date	08/08/1995	12/04/1995	02/26/1996	06/10/1996	06/10/1996	09/05/1996	08/28/1997
Semivolatile Organic Compounds (µg/L)							
4-NITROANILINE	25 U	25 U	25 U	25 U	25 U	25 U	NA
4-NITROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	NA
ACENAPHTHENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
ACENAPHTHYLENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
BENZO(A)ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
BENZO(A)PYRENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
BENZO(B)FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
BENZO(G,H,I)PERYLENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
BENZO(K)FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
BIS(2-CHLOROETHOXY)METHANE	10 U	10 U	10 U	10 U	10 U	10 U	NA
BIS(2-CHLOROETHYL)ETHER	10 U	10 U	10 U	10 U	10 U	10 U	NA
BIS(2-ETHYLHEXYL)PHTHALATE	4 U	4 U	4 U	4 U	4 U	4 U	NA
BUTYLBENZYLPHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	NA
CARBAZOLE	10 U	10 U	10 U	10 U	10 U	10 U	NA
CHRYSENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
DI-N-BUTYLPHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	NA
DI-N-OCTYLPHTHALATE	10 U	10 U	10 UJ c	10 U	10 U	10 U	NA
DIBENZ(A,H)ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
DIBENZOFURAN	10 U	10 U	10 U	10 U	10 U	10 U	NA
DIETHYLPHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	NA
DIMETHYLPHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	NA
FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
FLUORENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
HEXACHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
HEXACHLOROBUTADIENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
HEXACHLOROCYCLOPENTADIENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
HEXACHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U	NA
INDENO(1,2,3-CD)PYRENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
ISOPHORONE	10 U	10 U	10 U	10 U	10 U	10 U	NA
N-NITROSO-DI-N-PROPYLAMINE	10 U	10 U	10 U	10 U	10 U	10 U	NA
N-NITROSODIPHENYLAMINE (1)	10 U	10 U	10 U	10 U	10 U	10 U	NA
NAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
NITROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
PENTACHLOROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP008	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01
Sample ID	199HH508	199Q4024	199Q5009	199Q6009	199Q6052	199Q7009	04109MW01
Sample Date	08/08/1995	12/04/1995	02/26/1996	06/10/1996	06/10/1996	09/05/1996	08/28/1997
Semivolatile Organic Compounds (µg/L)							
PHENANTHRENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
PHENOL	10 U	10 U	10 U	10 U	10 U	10 U	NA
PYRENE	10 U	10 U	10 U	10 U	10 U	10 U	NA
PCBs/Pesticides (µg/L)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA
ALDRIN	NA	NA	NA	NA	NA	NA	NA
ALPHA-BHC	NA	NA	NA	NA	NA	NA	NA
ALPHA-CHLORDANE	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	NA	NA	NA	NA	NA	NA	NA
DELTA-BHC	NA	NA	NA	NA	NA	NA	NA
DIELDRIN	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN I	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN II	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN SULFATE	NA	NA	NA	NA	NA	NA	NA
ENDRIN	NA	NA	NA	NA	NA	NA	NA
ENDRIN ALDEHYDE	NA	NA	NA	NA	NA	NA	NA
ENDRIN KETONE	NA	NA	NA	NA	NA	NA	NA
GAMMA-BHC (LINDANE)	NA	NA	NA	NA	NA	NA	NA
GAMMA-CHLORDANE	NA	NA	NA	NA	NA	NA	NA
HEPTACHLOR	NA	NA	NA	NA	NA	NA	NA
HEPTACHLOR EPOXIDE	NA	NA	NA	NA	NA	NA	NA
METHOXYCHLOR	NA	NA	NA	NA	NA	NA	NA
TOXAPHENE	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP008	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01
Sample ID	199HH508	199Q4024	199Q5009	199Q6009	199Q6052	199Q7009	04109MW01
Sample Date	08/08/1995	12/04/1995	02/26/1996	06/10/1996	06/10/1996	09/05/1996	08/28/1997
Metals (µg/L)							
Unfiltered							
ALUMINUM	NA	114,000	15,800	8,090	13,000	4,250	NA
ANTIMONY	NA	4.9 J g	1.6 UJ b	1.2 U	1.2 U	2.6 U	NA
ARSENIC	NA	67.5	9.6 J g	5.8 J g	8.1 J g	6.3 J g	NA
BARIUM	NA	210	42.4 J g	26.6 J g	38.4 J g	16.7 J g	NA
BERYLLIUM	NA	0.18 UJ b	0.1 U	0.1 U	0.1 U	0.1 U	NA
CADMIUM	NA	0.2 U	0.2 U	0.3 U	0.3 U	0.3 U	NA
CALCIUM	NA	129,000 J j	97,400	91,600	96,400	49,700 J j	NA
CHROMIUM	NA	516	73	32.8	54.3	18.2	NA
COBALT	NA	126	23.1 J g	14.6 J g	22.9 J g	8.1 J g	NA
COPPER	NA	150	25.4	13.7 J g	20.8 J g	9.2 J g	NA
IRON	NA	231,000	33,400	16,000	26,000	8,800	NA
LEAD	NA	88.3	14.3	8.4	14.3	4.8	NA
MAGNESIUM	NA	89,300	31,600	28,000	31,300	21,300	NA
MANGANESE	NA	1,800	318	242	390	138	NA
MERCURY	NA	1.2	0.16 UJ b	0.1 U	0.1 U	0.1 U	NA
MOLYBDENUM	NA	1.4 UJ b	1.4 UJ b	1.1 J g	1 J g	3.2 J g	NA
NICKEL	NA	445	73.6	36 J g	55.1	19.7 J g	NA
POTASSIUM	NA	49,700	21,100	19,600	20,900	31,800	NA
SELENIUM	NA	4.8 J g	2.3 U	2.2 U	2.2 U	3.9 U	NA
SILVER	NA	0.7 U	0.5 U	0.7 U	0.7 U	0.4 U	NA
SODIUM	NA	26,200	15,900	14,900	14,900	25,600	NA
THALLIUM	NA	5.5	1.9 U	1.7 U	1.7 U	1.8 UJ b	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	411	57.7	27.8 J g	44.8 J g	17.9 J g	NA
ZINC	NA	498 J d	90.1	46.9 UJ b	70.3 UJ b	36	NA
Filtered							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-HP008	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01
Sample ID	199HH508	199Q4024	199Q5009	199Q6009	199Q6052	199Q7009	04109MW01
Sample Date	08/08/1995	12/04/1995	02/26/1996	06/10/1996	06/10/1996	09/05/1996	08/28/1997
Metals (µg/L)							
Filtered							
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW02	09-MW03
Sample ID	196Q4010	284Q1010	284Q5079	30209GW01001	30209GW20001	30209GW02001	30209GW03001
Sample Date	11/03/1998	04/03/2000	10/10/2000	10/31/2002	10/31/2002	10/31/2002	10/31/2002
Volatile Organic Compounds (µg/L)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	1 U	1 U	1 U	1 U
1,1,1-TRICHLOROETHANE	NA	2 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-TETRACHLOROETHANE	NA	2 U	1 U	1 U	1 U	1 U	1 U
1,1,2-TRICHLOROETHANE	NA	2 U	1 U	1 U	1 U	1 U	1 U
1,1-DICHLOROETHANE	NA	2 U	1 U	1 U	1 U	1 U	1 U
1,1-DICHLOROETHENE	NA	2 U	1 U	1 U	1 U	1 U	1 U
1,1-DICHLOROPROPENE	NA	NA	NA	1 U	1 U	1 U	1 U
1,2,3-TRICHLOROBENZENE	NA	NA	NA	1 U	1 U	1 U	1 U
1,2,3-TRICHLOROPROPANE	NA	NA	NA	1 U	1 U	1 U	1 U
1,2,4-TRICHLOROBENZENE	NA	NA	1 U	1 U	1 U	1 U	1 U
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	1 U	1 U	1 U	1 U
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	1 U	1 U	1 U	1 U	1 U
1,2-DIBROMOETHANE	NA	NA	1 U	1 U	1 U	1 U	1 U
1,2-DICHLOROBENZENE	NA	NA	1 U	1 U	1 U	1 U	1 U
1,2-DICHLOROETHANE	NA	0.5 U	0.5 U	1 U	1 U	1 U	1 U
1,2-DICHLOROETHENE (TOTAL)	NA	2 U	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	2 U	1 U	1 U	1 U	1 U	1 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	1 U	1 U	1 U	1 U
1,3-DICHLOROBENZENE	NA	NA	1 U	1 U	1 U	1 U	1 U
1,3-DICHLOROPROPANE	NA	NA	NA	1 U	1 U	1 U	1 U
1,4-DICHLOROBENZENE	NA	NA	1 U	1 U	1 U	1 U	1 U
2,2-DICHLOROPROPANE	NA	NA	NA	1 U	1 UJ c	1 U	1 UJ c
2-BUTANONE	NA	2 UJ bc	5 U	10 U	10 U	10 U	10 U
2-CHLOROTOLUENE	NA	NA	NA	1 U	1 U	1 U	1 U
2-HEXANONE	NA	2 U	5 U	10 U	10 U	10 U	10 U
4-CHLOROTOLUENE	NA	NA	NA	1 U	1 U	1 U	1 U
4-METHYL-2-PENTANONE	NA	2 U	5 U	10 U	10 U	10 U	10 U
ACETONE	NA	3 UJ bc	5 U	10 U	10 U	10 UJ b	10 UJ b
BENZENE	NA	0.5 U	0.5 U	1 U	1 U	1 U	1 U
BROMOBENZENE	NA	NA	NA	1 U	1 U	1 U	1 U
BROMOCHLOROMETHANE	NA	NA	1 U	1 U	1 U	1 U	1 U
BROMODICHLOROMETHANE	NA	2 U	1 U	1 U	1 U	1 U	1 U
BROMOFORM	NA	2 U	1 U	1 U	1 U	1 U	1 U
BROMOMETHANE	NA	1 UJ c	1 U	1 U	1 U	1 U	1 U
CARBON DISULFIDE	NA	2 U	1 U	1 U	1 U	1 U	1 U
CARBON TETRACHLORIDE	NA	0.5 U	0.5 U	1 U	1 U	1 U	1 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW02	09-MW03
Sample ID	196Q4010	284Q1010	284Q5079	30209GW01001	30209GW20001	30209GW02001	30209GW03001
Sample Date	11/03/1998	04/03/2000	10/10/2000	10/31/2002	10/31/2002	10/31/2002	10/31/2002
Volatile Organic Compounds (µg/L)							
CHLOROBENZENE	NA	2 U	1 U	1 U	1 U	1 U	1 U
CHLOROETHANE	NA	2 U	1 U	1 U	1 U	1 U	1 U
CHLOROFORM	NA	2 U	1 U	1 U	1 U	1 U	1 U
CHLOROMETHANE	NA	2 U	1 U	1 U	1 U	1 U	1 U
CIS-1,2-DICHLOROETHENE	NA	NA	1 U	1 U	1 U	1 U	1 U
CIS-1,3-DICHLOROPROPENE	NA	0.5 U	1 U	1 U	1 U	1 U	1 U
DIBROMOCHLOROMETHANE	NA	2 U	1 U	1 U	1 U	1 U	1 U
DIBROMOMETHANE	NA	NA	NA	1 U	1 U	1 U	1 U
ETHYLBENZENE	NA	2 U	1 U	1 U	1 U	1 U	1 U
FREON 11	NA	NA	NA	1 U	1 U	1 U	1 U
FREON 113	NA	NA	NA	5 U	5 U	5 U	5 U
FREON 12	NA	NA	NA	1 U	1 U	1 U	1 U
HEXACHLOROBUTADIENE	NA	NA	NA	1 U	1 U	1 U	1 U
ISOPROPYLBENZENE	NA	NA	NA	1 U	1 U	1 U	1 U
M,P-XYLENES	NA	NA	NA	1 U	1 U	1 U	1 U
METHYL-TERT-BUTYL ETHER	NA	5 U	1 U	1 U	1 U	0.3 J g	0.3 J g
METHYLENE CHLORIDE	NA	2 U	2 U	10 UJ b	10 UJ b	10 UJ b	10 UJ b
N-BUTYLBENZENE	NA	NA	NA	1 U	1 U	1 U	1 U
N-PROPYLBENZENE	NA	NA	NA	1 U	1 U	1 U	1 U
NAPHTHALENE	NA	NA	NA	1 U	1 U	1 U	1 U
O-XYLENE	NA	NA	NA	1 U	1 U	1 U	1 U
PARA-ISOPROPYL TOLUENE	NA	NA	NA	1 U	1 U	1 U	1 U
SEC-BUTYLBENZENE	NA	NA	NA	1 U	1 U	1 U	1 U
STYRENE	NA	2 U	1 U	1 U	1 U	1 U	1 U
TERT-BUTYLBENZENE	NA	NA	NA	1 U	1 U	1 U	1 U
TETRACHLOROETHENE	NA	2 U	1 U	1 U	1 U	1 U	1 U
TOLUENE	NA	2 U	1 UJ f	1 U	1 U	1 U	1 U
TRANS-1,2-DICHLOROETHENE	NA	NA	1 U	1 U	1 U	1 U	1 U
TRANS-1,3-DICHLOROPROPENE	NA	0.5 U	0.5 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	NA	2 U	1 U	1 U	1 U	1 U	1 U
VINYL ACETATE	NA	NA	NA	10 U	10 U	10 U	10 U
VINYL CHLORIDE	NA	0.5 UJ c	0.5 U	1 U	1 U	1 U	1 U
XYLENE (TOTAL)	NA	2 U	1 U	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	0.13 U	0.1 U	0.1 U	0.045 U	0.045 U	0.045 U	0.045 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW02	09-MW03
Sample ID	196Q4010	284Q1010	284Q5079	30209GW01001	30209GW20001	30209GW02001	30209GW03001
Sample Date	11/03/1998	04/03/2000	10/10/2000	10/31/2002	10/31/2002	10/31/2002	10/31/2002
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	0.26 U	0.1 U	0.1 U	0.03 U	0.03 U	0.03 U	0.03 U
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	0.05 U	0.05 U	0.05 UJ a	0.05 U	0.05 U	0.05 UJ a
Semivolatile Organic Compounds (µg/L)							
1,2,4-TRICHLOROBENZENE	NA	NA	NA	0.016 U	0.016 U	0.016 U	0.016 UJ e
1,2-DICHLOROBENZENE	NA	NA	NA	0.015 U	0.015 U	0.015 U	0.015 U
1,3-DICHLOROBENZENE	NA	NA	NA	0.011 U	0.011 U	0.011 U	0.011 U
1,4-DICHLOROBENZENE	NA	NA	NA	0.014 U	0.014 U	0.014 U	0.014 UJ e
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	NA	0.017 U	0.017 U	0.017 U	0.017 U
2,4,5-TRICHLOROPHENOL	NA	NA	NA	0.026 U	0.026 U	0.026 U	0.026 U
2,4,6-TRICHLOROPHENOL	NA	NA	NA	0.037 U	0.037 U	0.037 U	0.037 U
2,4-DICHLOROPHENOL	NA	NA	NA	0.024 U	0.024 U	0.024 U	0.024 U
2,4-DIMETHYLPHENOL	NA	NA	NA	0.32 U	0.32 U	0.32 U	0.32 U
2,4-DINITROPHENOL	NA	NA	NA	0.53 U	0.53 U	0.53 U	0.53 U
2,4-DINITROTOLUENE	NA	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U
2,6-DINITROTOLUENE	NA	NA	NA	0.0088 U	0.0088 U	0.0088 U	0.0088 U
2-CHLORONAPHTHALENE	NA	NA	NA	0.016 U	0.016 U	0.016 U	0.016 U
2-CHLOROPHENOL	NA	NA	NA	0.015 U	0.015 U	0.015 U	0.015 U
2-METHYLNAPHTHALENE	NA	NA	NA	0.012 U	0.012 U	0.025 J g	0.023 J g
2-METHYLPHENOL	NA	NA	NA	0.06 U	0.06 U	0.06 U	0.06 U
2-NITROANILINE	NA	NA	NA	0.015 U	0.015 U	0.015 U	0.015 U
2-NITROPHENOL	NA	NA	NA	0.014 U	0.014 U	0.11 J g	0.014 U
3,3'-DICHLOROBENZIDINE	NA	NA	NA	0.43 U	0.43 U	0.43 U	0.43 U
3-NITROANILINE	NA	NA	NA	0.23 U	0.23 U	0.23 U	0.23 U
4,6-DINITRO-2-METHYLPHENOL	NA	NA	NA	0.013 U	0.013 U	0.013 U	0.013 U
4-BROMOPHENYL-PHENYLETHER	NA	NA	NA	0.018 U	0.018 U	0.018 U	0.018 U
4-CHLORO-3-METHYLPHENOL	NA	NA	NA	0.029 U	0.029 U	0.029 U	0.029 U
4-CHLOROANILINE	NA	NA	NA	0.018 U	0.018 U	0.018 U	0.018 U
4-CHLOROPHENYL-PHENYLETHER	NA	NA	NA	0.0085 U	0.0085 U	0.0085 U	0.0085 U
4-METHYLPHENOL	NA	NA	NA	0.051 U	0.051 U	0.051 U	0.051 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW02	09-MW03
Sample ID	196Q4010	284Q1010	284Q5079	30209GW01001	30209GW20001	30209GW02001	30209GW03001
Sample Date	11/03/1998	04/03/2000	10/10/2000	10/31/2002	10/31/2002	10/31/2002	10/31/2002
Semivolatile Organic Compounds (µg/L)							
4-NITROANILINE	NA	NA	NA	0.17 U	0.17 U	0.17 U	0.17 U
4-NITROPHENOL	NA	NA	NA	0.54 U	0.54 U	0.54 U	0.54 U
ACENAPHTHENE	NA	NA	NA	0.0088 U	0.0088 U	0.0088 U	0.0088 U
ACENAPHTHYLENE	NA	NA	NA	0.011 U	0.011 U	0.011 U	0.011 U
ANTHRACENE	NA	NA	NA	0.015 U	0.015 U	0.015 U	0.015 U
BENZO(A)ANTHRACENE	NA	NA	NA	0.012 U	0.012 U	0.012 U	0.012 U
BENZO(A)PYRENE	NA	NA	NA	0.016 U	0.016 U	0.016 U	0.016 U
BENZO(B)FLUORANTHENE	NA	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U
BENZO(G,H,I)PERYLENE	NA	NA	NA	0.017 U	0.017 U	0.017 U	0.017 U
BENZO(K)FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
BIS(2-CHLOROETHOXY)METHANE	NA	NA	NA	0.012 U	0.012 U	0.012 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	NA	NA	NA	0.015 U	0.015 U	0.015 U	0.015 U
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	0.27 U	0.31 UJ b	0.46 UJ b	0.27 U
BUTYLBENZYLPHTHALATE	NA	NA	NA	0.026 U	0.026 U	0.091 UJ b	0.026 U
CARBAZOLE	NA	NA	NA	0.013 U	0.013 U	0.013 U	0.013 U
CHRYSENE	NA	NA	NA	0.014 U	0.014 U	0.014 U	0.014 U
DI-N-BUTYLPHTHALATE	NA	NA	NA	0.033 UJ b	0.027 U	0.1 UJ b	0.12 UJ b
DI-N-OCTYLPHTHALATE	NA	NA	NA	0.032 U	0.032 U	0.032 U	0.032 U
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	0.031 U	0.031 U	0.031 U	0.031 U
DIBENZOFURAN	NA	NA	NA	0.014 U	0.014 U	0.014 U	0.014 U
DIETHYLPHTHALATE	NA	NA	NA	0.032 UJ b	0.038 UJ b	0.06 UJ b	0.073 UJ b
DIMETHYLPHTHALATE	NA	NA	NA	0.013 U	0.013 U	0.013 U	0.013 U
FLUORANTHENE	NA	NA	NA	0.013 U	0.013 U	0.013 U	0.013 U
FLUORENE	NA	NA	NA	0.012 U	0.012 U	0.012 U	0.012 U
HEXACHLOROBENZENE	NA	NA	NA	0.015 U	0.015 U	0.015 U	0.015 U
HEXACHLOROBUTADIENE	NA	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U
HEXACHLOROCYCLOPENTADIENE	NA	NA	NA	0.041 U	0.041 U	0.041 U	0.041 U
HEXACHLOROETHANE	NA	NA	NA	0.019 U	0.019 U	0.019 U	0.019 U
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	0.024 U	0.024 U	0.024 U	0.024 U
ISOPHORONE	NA	NA	NA	0.0085 U	0.0085 U	0.0085 U	0.0085 U
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	NA	0.033 U	0.033 U	0.033 U	0.033 UJ e
N-NITROSODIPHENYLAMINE (1)	NA	NA	NA	0.028 U	0.028 U	0.028 U	0.028 U
NAPHTHALENE	NA	NA	NA	0.028 J g	0.012 U	0.033 J g	0.012 U
NITROBENZENE	NA	NA	NA	0.0074 U	0.0074 U	0.0074 U	0.0074 U
PENTACHLOROPHENOL	NA	NA	NA	0.029 U	0.029 U	0.029 U	0.029 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW02	09-MW03
Sample ID	196Q4010	284Q1010	284Q5079	30209GW01001	30209GW20001	30209GW02001	30209GW03001
Sample Date	11/03/1998	04/03/2000	10/10/2000	10/31/2002	10/31/2002	10/31/2002	10/31/2002
Semivolatile Organic Compounds (µg/L)							
PHENANTHRENE	NA	NA	NA	0.011 U	0.011 U	0.021 UJ b	0.019 UJ b
PHENOL	NA	NA	NA	0.02 U	0.02 U	8.8	3.3
PYRENE	NA	NA	NA	0.015 U	0.015 U	0.015 U	0.015 U
PCBs/Pesticides (µg/L)							
PCBs							
AROCLOR-1016	NA	NA	NA	0.022 U	0.022 U	0.022 U	0.022 U
AROCLOR-1221	NA	NA	NA	0.041 U	0.041 U	0.041 U	0.041 U
AROCLOR-1232	NA	NA	NA	0.06 U	0.06 U	0.06 U	0.06 U
AROCLOR-1242	NA	NA	NA	0.036 U	0.036 U	0.036 U	0.036 U
AROCLOR-1248	NA	NA	NA	0.018 U	0.018 U	0.018 U	0.018 U
AROCLOR-1254	NA	NA	NA	0.018 U	0.018 U	0.018 U	0.018 U
AROCLOR-1260	NA	NA	NA	0.027 U	0.027 U	0.027 U	0.027 U
Pesticides							
4,4'-DDD	NA	NA	NA	0.0052 U	0.0052 U	0.0052 U	0.0052 U
4,4'-DDE	NA	NA	NA	0.0083 U	0.0083 U	0.0083 U	0.0083 U
4,4'-DDT	NA	NA	NA	0.0051 U	0.0051 U	0.0051 U	0.0051 U
ALDRIN	NA	NA	NA	0.0034 U	0.0034 U	0.0034 U	0.0034 U
ALPHA-BHC	NA	NA	NA	0.0055 U	0.0055 U	0.0055 U	0.0055 U
ALPHA-CHLORDANE	NA	NA	NA	0.0061 U	0.0061 U	0.0061 U	0.0061 U
BETA-BHC	NA	NA	NA	0.0042 U	0.0042 U	0.0042 U	0.0042 U
DELTA-BHC	NA	NA	NA	0.005 U	0.005 U	0.005 U	0.005 U
DIELDRIN	NA	NA	NA	0.0068 U	0.0068 U	0.0068 U	0.0068 U
ENDOSULFAN I	NA	NA	NA	0.0055 U	0.0055 U	0.0055 U	0.0055 U
ENDOSULFAN II	NA	NA	NA	0.0059 U	0.0059 U	0.0059 U	0.0059 U
ENDOSULFAN SULFATE	NA	NA	NA	0.0067 U	0.0067 U	0.0067 U	0.0067 U
ENDRIN	NA	NA	NA	0.0047 U	0.0047 U	0.0047 U	0.0047 U
ENDRIN ALDEHYDE	NA	NA	NA	0.0047 U	0.0047 U	0.0047 U	0.0047 U
ENDRIN KETONE	NA	NA	NA	0.0061 U	0.0061 U	0.0061 U	0.0061 U
GAMMA-BHC (LINDANE)	NA	NA	NA	0.0042 U	0.0042 U	0.0042 U	0.0042 U
GAMMA-CHLORDANE	NA	NA	NA	0.0075 U	0.0075 U	0.0075 U	0.0075 U
HEPTACHLOR	NA	NA	NA	0.0049 U	0.0049 U	0.0049 U	0.0049 U
HEPTACHLOR EPOXIDE	NA	NA	NA	0.0084 U	0.0084 U	0.0084 U	0.0084 U
METHOXYCHLOR	NA	NA	NA	0.0069 U	0.0069 U	0.0069 U	0.0069 U
TOXAPHENE	NA	NA	NA	0.05 U	0.05 U	0.05 U	0.05 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW02	09-MW03
Sample ID	196Q4010	284Q1010	284Q5079	30209GW01001	30209GW20001	30209GW02001	30209GW03001
Sample Date	11/03/1998	04/03/2000	10/10/2000	10/31/2002	10/31/2002	10/31/2002	10/31/2002
Metals (µg/L)							
Unfiltered							
ALUMINUM	NA	26.6 J g	26.8 U	30 U	30 U	67.1 UJ b	309
ANTIMONY	NA	2.3 U	7.9 U	0.4 U	0.55 J g	0.4 U	0.58 J g
ARSENIC	NA	1.9 UJ b	5.3 UJ b	2 U	2 U	13	3.8 J g
BARIUM	NA	7.8 UJ b	5.3 U	3.2 J g	3.6 J g	8.8	7.2
BERYLLIUM	NA	0.13 U	0.2 U	0.4 U	0.4 U	0.4 U	0.4 U
CADMIUM	NA	0.22 U	1.1 U	1 U	1 U	1 U	1 U
CALCIUM	NA	114,000	48,000	57,100	53,400	21,200	24,900
CHROMIUM	NA	0.28 U	1 U	3 U	3 U	3 U	3 U
COBALT	NA	0.56 UJ b	2.7 U	2 U	2 U	2 U	2 U
COPPER	NA	1.1 UJ b	9.9 UJ b	0.9 U	0.9 U	0.9 U	0.9 U
IRON	NA	44.2 UJ bj	25.4 U	11.1 J g	6.4 J g	229	679
LEAD	NA	0.87 R e	1.8 U	0.122 J g	0.184 J g	0.298 J g	0.503
MAGNESIUM	NA	24,800	11,700	13,200	12,400	15,400	11,500
MANGANESE	NA	7.4 UJ b	3.3 J g	0.5 J g	0.4 U	80.3	57.3
MERCURY	NA	0.11 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
MOLYBDENUM	NA	0.92 UJ b	3.1 U	2.25	2.48	11.4	6.5
NICKEL	NA	4 UJ b	3.4 U	0.9 U	1.7 J g	3.7 J g	0.9 J g
POTASSIUM	NA	16,000 J j	20,400	16,200	15,900	31,500	22,200
SELENIUM	NA	2 R e	3.7 U	1 U	1 U	1 U	1 U
SILVER	NA	0.5 U	2.6 U	0.16 J g	0.2 J g	0.16 J g	0.37 J g
SODIUM	NA	16,800	17,200	19,900	19,200	60,500	23,900
THALLIUM	NA	1.3 U	4.5 U	0.08 U	0.08 U	0.08 U	0.08 U
TIN	NA	8.9 UJ e	NA	NA	NA	NA	NA
VANADIUM	NA	0.52 U	1.9 U	6 U	6 U	6 U	6 U
ZINC	NA	5.3 UJ b	3.5 U	2.2 J g	2 U	2.1 J g	4.1 J g
Filtered							
ALUMINUM	27.1 UJ b	NA	NA	NA	NA	NA	NA
ANTIMONY	2.1 U	NA	NA	NA	NA	NA	NA
ARSENIC	3.8 U	NA	NA	NA	NA	NA	NA
BARIUM	7.5 UJ f	NA	NA	NA	NA	NA	NA
BERYLLIUM	0.3 U	NA	NA	NA	NA	NA	NA
CADMIUM	0.4 U	NA	NA	NA	NA	NA	NA
CALCIUM	71,500	NA	NA	NA	NA	NA	NA
CHROMIUM	0.9 U	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW01	09-MW01	09-MW01	09-MW01	09-MW01	09-MW02	09-MW03
Sample ID	196Q4010	284Q1010	284Q5079	30209GW01001	30209GW20001	30209GW02001	30209GW03001
Sample Date	11/03/1998	04/03/2000	10/10/2000	10/31/2002	10/31/2002	10/31/2002	10/31/2002
Metals (µg/L)							
Filtered							
COBALT	1 U	NA	NA	NA	NA	NA	NA
COPPER	1.5 UJ f	NA	NA	NA	NA	NA	NA
IRON	19.9 U	NA	NA	NA	NA	NA	NA
LEAD	1.9 U	NA	NA	NA	NA	NA	NA
MAGNESIUM	15,500	NA	NA	NA	NA	NA	NA
MANGANESE	1.2 UJ b	NA	NA	NA	NA	NA	NA
MERCURY	0.12 J g	NA	NA	NA	NA	NA	NA
MOLYBDENUM	2 J g	NA	NA	NA	NA	NA	NA
NICKEL	1.6 J g	NA	NA	NA	NA	NA	NA
POTASSIUM	16,500 J j	NA	NA	NA	NA	NA	NA
SELENIUM	2.1 UJ e	NA	NA	NA	NA	NA	NA
SILVER	1.2 U	NA	NA	NA	NA	NA	NA
SODIUM	21,400	NA	NA	NA	NA	NA	NA
THALLIUM	1.1 U	NA	NA	NA	NA	NA	NA
VANADIUM	0.7 U	NA	NA	NA	NA	NA	NA
ZINC	2.5 UJ b	NA	NA	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW04	09-MW05	09-MW06	09-MW07
Sample ID	30209GW04001	30209GW05001	30209GW06001	30209GW07001
Sample Date	10/30/2002	10/31/2002	10/31/2002	11/04/2002
Volatile Organic Compounds (µg/L)				
1,1,1,2-TETRACHLOROETHANE	1 U	1 U	1 U	1 U
1,1,1-TRICHLOROETHANE	1 U	1 U	1 U	1 U
1,1,2,2-TETRACHLOROETHANE	1 U	1 U	1 U	1 U
1,1,2-TRICHLOROETHANE	1 U	1 U	1 U	1 U
1,1-DICHLOROETHANE	1 U	1 U	1 U	1 U
1,1-DICHLOROETHENE	1 U	1 U	1 U	1 U
1,1-DICHLOROPROPENE	1 U	1 U	1 U	1 U
1,2,3-TRICHLOROBENZENE	1 U	1 U	1 U	1 U
1,2,3-TRICHLOROPROPANE	1 U	1 U	1 U	1 U
1,2,4-TRICHLOROBENZENE	1 U	1 U	1 U	1 U
1,2,4-TRIMETHYLBENZENE	1 U	1 U	1 U	1 U
1,2-DIBROMO-3-CHLOROPROPANE	1 U	1 U	1 U	1 U
1,2-DIBROMOETHANE	1 U	1 U	1 U	1 U
1,2-DICHLOROBENZENE	1 U	1 U	1 U	1 U
1,2-DICHLOROETHANE	1 U	1 U	1 U	1 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA
1,2-DICHLOROPROPANE	1 U	1 U	1 U	1 U
1,3,5-TRIMETHYLBENZENE	1 U	1 U	1 U	1 U
1,3-DICHLOROBENZENE	1 U	1 U	1 U	1 U
1,3-DICHLOROPROPANE	1 U	1 U	1 U	1 U
1,4-DICHLOROBENZENE	1 U	1 U	1 U	1 U
2,2-DICHLOROPROPANE	1 U	1 U	1 U	1 U
2-BUTANONE	10 U	10 U	10 U	10 U
2-CHLOROTOLUENE	1 U	1 U	1 U	1 U
2-HEXANONE	10 U	10 U	10 U	10 U
4-CHLOROTOLUENE	1 U	1 U	1 U	1 U
4-METHYL-2-PENTANONE	10 U	10 U	10 U	10 U
ACETONE	10 UJ b	10 U	10 UJ b	10 U
BENZENE	1 U	1 U	1 U	1 U
BROMOBENZENE	1 U	1 U	1 U	1 U
BROMOCHLOROMETHANE	1 U	1 U	1 U	1 U
BROMODICHLOROMETHANE	1 U	1 U	1 U	1 U
BROMOFORM	1 U	1 U	1 U	1 U
BROMOMETHANE	1 U	1 U	1 U	1 U
CARBON DISULFIDE	1 U	1 U	1 U	1 U
CARBON TETRACHLORIDE	1 U	1 U	1 U	1 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW04	09-MW05	09-MW06	09-MW07
Sample ID	30209GW04001	30209GW05001	30209GW06001	30209GW07001
Sample Date	10/30/2002	10/31/2002	10/31/2002	11/04/2002
Volatile Organic Compounds (µg/L)				
CHLOROBENZENE	1 U	1 U	1 U	1 U
CHLOROETHANE	1 U	1 U	1 U	1 U
CHLOROFORM	1 U	1 U	1 U	1 U
CHLOROMETHANE	1 U	1 U	1 U	1 U
CIS-1,2-DICHLOROETHENE	1 U	1 U	1 U	1 U
CIS-1,3-DICHLOROPROPENE	1 U	1 U	1 U	1 U
DIBROMOCHLOROMETHANE	1 U	1 U	1 U	1 U
DIBROMOMETHANE	1 U	1 U	1 U	1 U
ETHYLBENZENE	1 U	1 U	1 U	1 U
FREON 11	1 U	1 U	1 U	1 U
FREON 113	5 U	5 U	5 U	5 U
FREON 12	1 U	1 U	1 U	1 UJ c
HEXACHLOROBUTADIENE	1 U	1 U	1 U	1 U
ISOPROPYLBENZENE	1 U	1 U	1 U	1 U
M,P-XYLENES	1 U	0.3 J g	1 U	1 U
METHYL-TERT-BUTYL ETHER	0.3 J g	0.3 J g	1 U	1 U
METHYLENE CHLORIDE	10 UJ b	10 UJ b	10 UJ b	10 U
N-BUTYLBENZENE	1 U	1 U	1 U	1 U
N-PROPYLBENZENE	1 U	1 U	1 U	1 U
NAPHTHALENE	1 U	1 U	1 U	1 U
O-XYLENE	1 U	1 U	1 U	1 U
PARA-ISOPROPYL TOLUENE	1 U	1 U	1 U	1 U
SEC-BUTYLBENZENE	1 U	1 U	1 U	1 U
STYRENE	1 U	1 U	1 U	1 U
TERT-BUTYLBENZENE	1 U	1 U	1 U	1 U
TETRACHLOROETHENE	1 U	1 U	1 U	1 U
TOLUENE	1 U	1 U	1 U	1 U
TRANS-1,2-DICHLOROETHENE	1 U	1 U	1 U	1 U
TRANS-1,3-DICHLOROPROPENE	1 U	1 U	1 U	1 U
TRICHLOROETHENE	1 U	1 U	1 U	1 U
VINYL ACETATE	10 U	10 U	10 U	10 U
VINYL CHLORIDE	1 U	1 U	1 U	1 U
XYLENE (TOTAL)	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/L)				
Diesel/Motor Oil Range (extractables) - SG				
DIESEL RANGE ORGANICS	0.045 U	0.048 U	0.045 U	0.048 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW04	09-MW05	09-MW06	09-MW07
Sample ID	30209GW04001	30209GW05001	30209GW06001	30209GW07001
Sample Date	10/30/2002	10/31/2002	10/31/2002	11/04/2002
Petroleum Hydrocarbons (mg/L)				
Diesel/Motor Oil Range (extractables) - SG				
MOTOR OIL RANGE ORGANICS	0.03 U	0.032 U	0.03 U	0.032 U
Diesel/Motor Oil Range (extractables)				
DIESEL RANGE ORGANICS	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA
Gasoline Range (purgeables)				
GASOLINE RANGE ORGANICS	0.05 UJ a	0.05 U	0.05 U	0.05 U
Semivolatile Organic Compounds (µg/L)				
1,2,4-TRICHLOROBENZENE	0.016 U	0.016 U	0.016 U	0.017 U
1,2-DICHLOROBENZENE	0.015 U	0.015 U	0.015 U	0.015 U
1,3-DICHLOROBENZENE	0.011 U	0.011 U	0.011 U	0.012 U
1,4-DICHLOROBENZENE	0.014 U	0.014 U	0.014 U	0.014 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.017 U	0.017 U	0.017 U	0.018 U
2,4,5-TRICHLOROPHENOL	0.026 U	0.026 U	0.026 U	0.027 U
2,4,6-TRICHLOROPHENOL	0.037 U	0.037 U	0.037 U	0.039 U
2,4-DICHLOROPHENOL	0.024 U	0.024 U	0.024 U	0.025 U
2,4-DIMETHYLPHENOL	0.32 U	0.32 U	0.32 U	0.34 U
2,4-DINITROPHENOL	0.53 U	0.53 U	0.53 U	0.56 U
2,4-DINITROTOLUENE	0.02 U	0.02 U	0.02 U	0.021 U
2,6-DINITROTOLUENE	0.0088 U	0.0088 U	0.0088 U	0.0093 U
2-CHLORONAPHTHALENE	0.016 U	0.016 U	0.016 U	0.016 U
2-CHLOROPHENOL	0.015 U	0.015 U	0.015 U	0.016 U
2-METHYLNAPHTHALENE	0.012 U	0.019 J g	0.012 U	0.012 U
2-METHYLPHENOL	0.06 U	0.06 U	0.06 U	0.063 U
2-NITROANILINE	0.015 U	0.015 U	0.015 U	0.016 U
2-NITROPHENOL	0.014 U	0.014 U	0.2 J g	0.015 U
3,3'-DICHLOROBENZIDINE	0.43 U	0.43 U	0.43 U	0.46 U
3-NITROANILINE	0.23 U	0.23 U	0.23 U	0.24 U
4,6-DINITRO-2-METHYLPHENOL	0.013 U	0.013 U	0.013 U	0.014 U
4-BROMOPHENYL-PHENYLETHER	0.018 U	0.018 U	0.018 U	0.019 U
4-CHLORO-3-METHYLPHENOL	0.029 U	0.029 U	0.029 U	0.031 U
4-CHLOROANILINE	0.018 U	0.018 U	0.018 U	0.019 U
4-CHLOROPHENYL-PHENYLETHER	0.0085 U	0.0085 U	0.0085 U	0.0089 U
4-METHYLPHENOL	0.051 U	0.051 U	0.051 U	0.054 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW04	09-MW05	09-MW06	09-MW07
Sample ID	30209GW04001	30209GW05001	30209GW06001	30209GW07001
Sample Date	10/30/2002	10/31/2002	10/31/2002	11/04/2002
Semivolatile Organic Compounds (µg/L)				
4-NITROANILINE	0.17 U	0.17 U	0.17 U	0.18 U
4-NITROPHENOL	0.54 U	0.54 U	0.54 U	0.57 U
ACENAPHTHENE	0.041 J g	1.1	0.0088 U	0.0092 U
ACENAPHTHYLENE	0.011 U	0.011 U	0.011 U	0.011 U
ANTHRACENE	0.015 U	0.015 U	0.015 U	0.016 U
BENZO(A)ANTHRACENE	0.012 U	0.012 U	0.012 U	0.013 U
BENZO(A)PYRENE	0.016 U	0.016 U	0.016 U	0.017 U
BENZO(B)FLUORANTHENE	0.02 U	0.02 U	0.02 U	0.021 U
BENZO(G,H,I)PERYLENE	0.017 U	0.017 U	0.017 U	0.018 U
BENZO(K)FLUORANTHENE	NA	NA	NA	NA
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.012 U	0.012 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	0.015 U	0.015 U	0.015 U	0.015 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.27 U	0.27 U	0.27 U	0.29 U
BUTYLBENZYLPHTHALATE	0.026 U	0.026 U	0.026 U	0.086 UJ b
CARBAZOLE	0.013 U	0.013 U	0.013 U	0.014 U
CHRYSENE	0.014 U	0.014 U	0.014 U	0.015 U
DI-N-BUTYLPHTHALATE	0.092 UJ b	0.068 UJ b	0.067 UJ b	0.15 UJ b
DI-N-OCTYLPHTHALATE	0.032 U	0.032 U	0.032 U	0.034 U
DIBENZ(A,H)ANTHRACENE	0.031 U	0.031 U	0.031 U	0.032 U
DIBENZOFURAN	0.043 J g	2.5	0.014 U	0.014 U
DIETHYLPHTHALATE	0.055 UJ b	0.051 UJ b	0.062 UJ b	0.044 UJ b
DIMETHYLPHTHALATE	0.013 U	0.013 U	0.013 U	0.014 U
FLUORANTHENE	0.013 U	0.013 U	0.013 U	0.013 U
FLUORENE	0.066 J g	0.012 U	0.012 U	0.013 U
HEXACHLOROBENZENE	0.015 U	0.015 U	0.015 U	0.015 U
HEXACHLOROBUTADIENE	0.02 U	0.02 U	0.02 U	0.021 U
HEXACHLOROCYCLOPENTADIENE	0.041 U	0.041 U	0.041 U	0.043 U
HEXACHLOROETHANE	0.019 U	0.019 U	0.019 U	0.02 U
INDENO(1,2,3-CD)PYRENE	0.024 U	0.024 U	0.024 U	0.026 U
ISOPHORONE	0.0085 U	0.0085 U	0.0085 U	0.0089 U
N-NITROSO-DI-N-PROPYLAMINE	0.033 U	0.033 U	0.033 U	0.034 U
N-NITROSODIPHENYLAMINE (1)	0.028 U	0.028 U	0.028 U	0.03 U
NAPHTHALENE	0.012 U	0.038 J g	0.025 J g	0.013 U
NITROBENZENE	0.0074 U	0.0074 U	0.0074 U	0.0078 U
PENTACHLOROPHENOL	0.029 U	0.029 U	0.029 U	0.089 J g

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW04	09-MW05	09-MW06	09-MW07
Sample ID	30209GW04001	30209GW05001	30209GW06001	30209GW07001
Sample Date	10/30/2002	10/31/2002	10/31/2002	11/04/2002
Semivolatile Organic Compounds (µg/L)				
PHENANTHRENE	0.011 U	0.027 UJ b	0.013 UJ b	0.03 J g
PHENOL	0.037	5.6	4.2	0.48 J g
PYRENE	0.031 J g	0.023 J g	0.015 U	0.027
PCBs/Pesticides (µg/L)				
PCBs				
AROCLOR-1016	0.022 U	0.022 U	0.022 U	0.022 U
AROCLOR-1221	0.041 U	0.041 U	0.041 U	0.041 U
AROCLOR-1232	0.06 U	0.06 U	0.06 U	0.06 U
AROCLOR-1242	0.036 U	0.036 U	0.036 U	0.036 U
AROCLOR-1248	0.018 U	0.018 U	0.018 U	0.018 U
AROCLOR-1254	0.018 U	0.018 U	0.018 U	0.018 U
AROCLOR-1260	0.027 U	0.027 U	0.027 UJ a	0.027 U
Pesticides				
4,4'-DDD	0.0052 U	0.0052 U	0.0052 U	0.0052 U
4,4'-DDE	0.0083 U	0.0083 U	0.0083 U	0.0083 U
4,4'-DDT	0.0051 U	0.0051 U	0.0051 U	0.0051 U
ALDRIN	0.0034 U	0.0034 U	0.0034 U	0.0034 U
ALPHA-BHC	0.0055 U	0.0055 U	0.0055 U	0.0055 U
ALPHA-CHLORDANE	0.0061 U	0.0067 J g	0.0061 U	0.0061 U
BETA-BHC	0.0042 U	0.0042 U	0.0042 U	0.0042 U
DELTA-BHC	0.005 U	0.005 U	0.005 U	0.005 U
DIELDRIN	0.0068 U	0.0068 U	0.0068 U	0.0068 U
ENDOSULFAN I	0.0055 U	0.0055 U	0.0055 U	0.0055 UJ c
ENDOSULFAN II	0.0059 U	0.0059 U	0.0059 U	0.014
ENDOSULFAN SULFATE	0.0067 U	0.0067 U	0.0067 U	0.0067 U
ENDRIN	0.0047 U	0.0047 U	0.0047 U	0.0047 U
ENDRIN ALDEHYDE	0.0047 U	0.0047 U	0.0047 U	0.0047 U
ENDRIN KETONE	0.0061 U	0.0061 U	0.0061 U	0.0061 U
GAMMA-BHC (LINDANE)	0.0042 U	0.0042 U	0.0042 U	0.0071 J cg
GAMMA-CHLORDANE	0.0075 U	0.0075 U	0.0075 U	0.0075 U
HEPTACHLOR	0.0049 U	0.0049 U	0.0049 U	0.0049 U
HEPTACHLOR EPOXIDE	0.0084 U	0.0084 U	0.0084 U	0.0084 U
METHOXYCHLOR	0.0069 U	0.0069 U	0.0069 U	0.0069 U
TOXAPHENE	0.05 U	0.05 U	0.05 U	0.05 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW04	09-MW05	09-MW06	09-MW07
Sample ID	30209GW04001	30209GW05001	30209GW06001	30209GW07001
Sample Date	10/30/2002	10/31/2002	10/31/2002	11/04/2002
Metals (µg/L)				
Unfiltered				
ALUMINUM	61.1 UJ b	2,040	117 UJ b	110
ANTIMONY	2.46	0.6 J g	0.52 J g	0.58 J g
ARSENIC	12.8	8 J g	10.4	5.7 J g
BARIUM	9.3	17.1	10.8	123
BERYLLIUM	0.4 U	0.4 U	0.4 U	0.4 U
CADMIUM	1 U	1 U	1 U	1 UJ d
CALCIUM	35,100	27,700	24,500	307,000
CHROMIUM	3 U	9.8	3 U	3 U
COBALT	2 U	2 U	2 U	2.4 J g
COPPER	0.9 U	1.8	0.9 U	0.9 UJ e
IRON	312	3,930	297	2,190
LEAD	4.03	1.08	0.312 J g	0.149 J g
MAGNESIUM	21,700	18,300	11,700	615,000
MANGANESE	97.6	138	63.6	710
MERCURY	0.1 U	0.1 U	0.1 U	0.1 U
MOLYBDENUM	9.61	6.9	8.2	11
NICKEL	0.9 U	11.9	1.2 J g	1.2 J jg
POTASSIUM	36,600	34,900	21,800	168,000
SELENIUM	1 U	1 U	1 U	5 UJ e
SILVER	0.19 J g	0.32 J g	0.35 J g	0.18 J eg
SODIUM	42,100	68,000	53,300	4,480,000
THALLIUM	0.08 U	0.08 U	0.08 U	0.08 U
TIN	NA	NA	NA	NA
VANADIUM	6 U	6.8 J g	6 U	6 U
ZINC	4.2 J g	26	2 U	8.1 J jg
Filtered				
ALUMINUM	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	09-MW04	09-MW05	09-MW06	09-MW07
Sample ID	30209GW04001	30209GW05001	30209GW06001	30209GW07001
Sample Date	10/30/2002	10/31/2002	10/31/2002	11/04/2002
Metals (µg/L)				
Filtered				
COBALT	NA	NA	NA	NA
COPPER	NA	NA	NA	NA
IRON	NA	NA	NA	NA
LEAD	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA
SILVER	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA
ZINC	NA	NA	NA	NA

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Notes:

a	Surrogate recovery problem.
b	Laboratory blank and common contamination problem.
c	Calibration criteria exceedance.
d	Duplicate precision problem.
e	Matrix spike/LCS recovery problem.
f	Field blank contamination.
g	Quantification below reporting limit.
ID	Identification.
J	Estimated value.
j	Other qualification reasons.
LCS	Laboratory control sample.
mg/L	Milligram per liter.
NA	Not analyzed.
NAVSTA	Naval Station.
R	Result rejected during quality assurance review.
SG	Silica Gel.
U	Nondetected.
Y	Chromatographic pattern resembles hydrocarbon fuel pattern and was quantitated using the standard it resembled most.
µg/L	Microgram per liter.

SITE 09
OIL AND FLOOR DRAIN ANALYTICAL RESULTS

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 OIL AND DRAIN SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	TRENCH OIL
Sample ID	199HH511
Sample Date	08/15/1995
Matrix	PRODUCT
PCBs/Pesticides (mg/kg)	
PCBs	
AROCLOR-1016	10 UJ h
AROCLOR-1221	20 UJ h
AROCLOR-1232	10 UJ h
AROCLOR-1242	10 UJ h
AROCLOR-1248	10 UJ h
AROCLOR-1254	10 UJ h
AROCLOR-1260	10 UJ h

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 OIL AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	FLOOR DRAIN
Sample ID	199HH510
Sample Date	08/07/1995
Matrix	SWATER
Semivolatile Organic Compounds (µg/L)	
1,2,4-TRICHLOROBENZENE	50 U
1,2-DICHLOROBENZENE	25 U
1,3-DICHLOROBENZENE	25 U
1,4-DICHLOROBENZENE	25 U
2,2'-OXYBIS(1-CHLOROPROPANE)	50 U
2,4,5-TRICHLOROPHENOL	130 U
2,4,6-TRICHLOROPHENOL	50 U
2,4-DICHLOROPHENOL	50 U
2,4-DIMETHYLPHENOL	50 U
2,4-DINITROPHENOL	130 U
2,4-DINITROTOLUENE	50 U
2,6-DINITROTOLUENE	50 U
2-CHLORONAPHTHALENE	50 U
2-CHLOROPHENOL	50 U
2-METHYLNAPHTHALENE	50 U
2-METHYLPHENOL	50 U
2-NITROANILINE	130 U
2-NITROPHENOL	50 U
3,3'-DICHLOROBENZIDINE	50 U
3-NITROANILINE	130 U
4,6-DINITRO-2-METHYLPHENOL	130 U
4-BROMOPHENYL-PHENYLETHER	50 U
4-CHLORO-3-METHYLPHENOL	50 U
4-CHLOROANILINE	50 U
4-CHLOROPHENYL-PHENYLETHER	50 U
4-METHYLPHENOL	62
4-NITROANILINE	130 U
4-NITROPHENOL	130 U
ACENAPHTHENE	50 U
ACENAPHTHYLENE	50 U
ANTHRACENE	50 U
BENZO(A)ANTHRACENE	50 U
BENZO(A)PYRENE	50 U
BENZO(B)FLUORANTHENE	50 U
BENZO(G,H,I)PERYLENE	50 U
BENZO(K)FLUORANTHENE	50 U

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 OIL AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	FLOOR DRAIN
Sample ID	199HH510
Sample Date	08/07/1995
Matrix	SWATER
Semivolatile Organic Compounds (µg/L)	
BIS(2-CHLOROETHOXY)METHANE	50 U
BIS(2-CHLOROETHYL)ETHER	50 U
BIS(2-ETHYLHEXYL)PHTHALATE	86 UJ b
BUTYLBENZYLPHTHALATE	50 U
CARBAZOLE	50 UJ c
CHRYSENE	50 U
DI-N-BUTYLPHTHALATE	50 U
DI-N-OCTYLPHTHALATE	50 U
DIBENZ(A,H)ANTHRACENE	50 U
DIBENZOFURAN	50 U
DIETHYLPHTHALATE	50 U
DIMETHYLPHTHALATE	50 U
FLUORANTHENE	50 U
FLUORENE	50 U
HEXACHLOROBENZENE	50 U
HEXACHLOROBUTADIENE	50 U
HEXACHLOROCYCLOPENTADIENE	50 U
HEXACHLOROETHANE	50 U
INDENO(1,2,3-CD)PYRENE	50 U
ISOPHORONE	50 U
N-NITROSO-DI-N-PROPYLAMINE	50 U
N-NITROSODIPHENYLAMINE (1)	50 U
NAPHTHALENE	50 U
NITROBENZENE	50 U
PENTACHLOROPHENOL	130 U
PHENANTHRENE	50 U
PHENOL	14 J g
PYRENE	50 U
Metals (µg/L)	
Unfiltered	
ALUMINUM	29,100
ANTIMONY	9.3
ARSENIC	3.5 J g
BARIUM	754
BERYLLIUM	0.15 J g

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 OIL AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	FLOOR DRAIN
Sample ID	199HH510
Sample Date	08/07/1995
Matrix	SWATER
Metals (µg/L)	
Unfiltered	
CADMIUM	11.5
CALCIUM	96,600
CHROMIUM	45.6
COBALT	9.3 J g
COPPER	200
IRON	88,600
LEAD	405
MAGNESIUM	10,000
MANGANESE	1,160
MERCURY	1.1
MOLYBDENUM	0.9 U
NICKEL	30.8 J g
POTASSIUM	5,340
SELENIUM	4 J g
SILVER	1.2 J g
SODIUM	59,100
THALLIUM	2 U
VANADIUM	4.8 J g
ZINC	3,280 J j

APPENDIX C: ANALYTICAL RESULTS FOR SITE 09 OIL AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Notes:

b	Laboratory blank and common contamination problem.
c	Calibration criteria exceedance.
g	Quantification below reporting limit.
h	Holding time exceedance.
ID	Identification.
J	Estimated value.
j	Other qualification reasons.
mg/kg	Milligram per kilogram.
NAVSTA	Naval Station.
U	Nondetected.
µg/L	Microgram per liter.

APPENDIX D
SITE 10 ANALYTICAL DATA

SITE 10
SOIL ANALYTICAL RESULTS

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP001	07/10-HP002	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP004
Sample ID	199AA082	199AA083	199AA084	199AA085	199AA089	199AA090	199AA091
Sample Date	06/09/1995	06/09/1995	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50	1.25 - 1.50	7.25 - 7.75	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
1,1,2,2-TETRACHLOROETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
1,1,2-TRICHLOROETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
1,1-DICHLOROETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
1,1-DICHLOROETHENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
1,2-DICHLOROETHENE (TOTAL)	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
1,2-DICHLOROPROPANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
ACETONE	0.012 UJ b	0.017 UJ b	0.022 UJ b	0.029 UJ b	0.013 UJ b	0.025 UJ b	0.026 UJ b
BENZENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
BROMOFORM	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
BROMOMETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
CARBON DISULFIDE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
CARBON TETRACHLORIDE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP001	07/10-HP002	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP004
Sample ID	199AA082	199AA083	199AA084	199AA085	199AA089	199AA090	199AA091
Sample Date	06/09/1995	06/09/1995	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50	1.25 - 1.50	7.25 - 7.75	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
CHLOROETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
CHLOROFORM	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
CHLOROMETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
DIBROMOCHLOROMETHANE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.017 UJ b
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
TOLUENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
TRICHLOROETHENE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
XYLENE (TOTAL)	0.01 U	0.011 U	0.01 U	0.011 U	0.01 U	0.011 U	0.011 U
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP001	07/10-HP002	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP004
Sample ID	199AA082	199AA083	199AA084	199AA085	199AA089	199AA090	199AA091
Sample Date	06/09/1995	06/09/1995	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50	1.25 - 1.50	7.25 - 7.75	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	11 U	NA	NA	11 U
MOTOR OIL RANGE ORGANICS	NA	NA	NA	11 U	NA	NA	11 U
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
1,2-DICHLOROBENZENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
1,3-DICHLOROBENZENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
1,4-DICHLOROBENZENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	NA	0.37 U	NA	NA	0.36 U
2,4,5-TRICHLOROPHENOL	NA	NA	NA	0.94 U	NA	NA	0.91 U
2,4,6-TRICHLOROPHENOL	NA	NA	NA	0.37 U	NA	NA	0.36 U
2,4-DICHLOROPHENOL	NA	NA	NA	0.37 U	NA	NA	0.36 U
2,4-DIMETHYLPHENOL	NA	NA	NA	0.37 U	NA	NA	0.36 U
2,4-DINITROPHENOL	NA	NA	NA	0.94 U	NA	NA	0.91 U
2,4-DINITROTOLUENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
2,6-DINITROTOLUENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
2-CHLORONAPHTHALENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
2-CHLOROPHENOL	NA	NA	NA	0.37 U	NA	NA	0.36 U
2-METHYLNAPHTHALENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
2-METHYLPHENOL	NA	NA	NA	0.37 U	NA	NA	0.36 U
2-NITROANILINE	NA	NA	NA	0.94 U	NA	NA	0.91 U
2-NITROPHENOL	NA	NA	NA	0.37 U	NA	NA	0.36 U
3,3'-DICHLOROBENZIDINE	NA	NA	NA	0.37 U	NA	NA	0.36 U
3-NITROANILINE	NA	NA	NA	0.94 UJ c	NA	NA	0.91 UJ c
4,6-DINITRO-2-METHYLPHENOL	NA	NA	NA	0.94 U	NA	NA	0.91 U
4-BROMOPHENYL-PHENYLETHER	NA	NA	NA	0.37 U	NA	NA	0.36 U
4-CHLORO-3-METHYLPHENOL	NA	NA	NA	0.37 U	NA	NA	0.36 U
4-CHLOROANILINE	NA	NA	NA	0.37 U	NA	NA	0.36 U
4-CHLOROPHENYL-PHENYLETHER	NA	NA	NA	0.37 U	NA	NA	0.36 U
4-METHYLPHENOL	NA	NA	NA	0.37 U	NA	NA	0.36 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP001	07/10-HP002	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP004
Sample ID	199AA082	199AA083	199AA084	199AA085	199AA089	199AA090	199AA091
Sample Date	06/09/1995	06/09/1995	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50	1.25 - 1.50	7.25 - 7.75	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	NA	NA	NA	0.94 U	NA	NA	0.91 UJ c
4-NITROPHENOL	NA	NA	NA	0.94 U	NA	NA	0.91 U
ACENAPHTHENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
ACENAPHTHYLENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
ANTHRACENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
BENZO(A)ANTHRACENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
BENZO(A)PYRENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
BENZO(B)FLUORANTHENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
BENZO(G,H,I)PERYLENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
BENZO(K)FLUORANTHENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
BIS(2-CHLOROETHOXY)METHANE	NA	NA	NA	0.37 U	NA	NA	0.36 U
BIS(2-CHLOROETHYL)ETHER	NA	NA	NA	0.37 U	NA	NA	0.36 U
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	0.37 U	NA	NA	0.36 U
BUTYLBENZYLPHTHALATE	NA	NA	NA	0.37 U	NA	NA	0.36 U
CARBAZOLE	NA	NA	NA	0.37 U	NA	NA	0.36 U
CHRYSENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
DI-N-BUTYLPHTHALATE	NA	NA	NA	0.37 U	NA	NA	0.36 U
DI-N-OCTYLPHTHALATE	NA	NA	NA	0.37 U	NA	NA	0.36 U
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
DIBENZOFURAN	NA	NA	NA	0.37 U	NA	NA	0.36 U
DIETHYLPHTHALATE	NA	NA	NA	0.37 U	NA	NA	0.36 U
DIMETHYLPHTHALATE	NA	NA	NA	0.37 U	NA	NA	0.36 U
FLUORANTHENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
FLUORENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
HEXACHLOROBENZENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
HEXACHLOROBUTADIENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
HEXACHLOROCYCLOPENTADIENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
HEXACHLOROETHANE	NA	NA	NA	0.37 U	NA	NA	0.36 U
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
ISOPHORONE	NA	NA	NA	0.37 U	NA	NA	0.36 U
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	NA	0.37 U	NA	NA	0.36 U
N-NITROSODIPHENYLAMINE (1)	NA	NA	NA	0.37 U	NA	NA	0.36 U
NAPHTHALENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
NITROBENZENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
PENTACHLOROPHENOL	NA	NA	NA	0.94 U	NA	NA	0.91 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP001	07/10-HP002	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP004
Sample ID	199AA082	199AA083	199AA084	199AA085	199AA089	199AA090	199AA091
Sample Date	06/09/1995	06/09/1995	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50	1.25 - 1.50	7.25 - 7.75	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
PHENOL	NA	NA	NA	0.37 U	NA	NA	0.23 J g
PYRENE	NA	NA	NA	0.37 U	NA	NA	0.36 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.0034 U	0.0035 U	0.0035 U	0.0037 U	0.0035 U	0.0035 U	0.0019 J g
4,4'-DDE	0.0034 U	0.0035 U	0.0035 U	0.0037 U	0.0035 U	0.0035 U	0.013
4,4'-DDT	0.0034 U	0.0035 U	0.0035 U	0.0037 U	0.0035 U	0.0035 U	0.035
ALDRIN	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.0018 U
ALPHA-BHC	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.0018 U
ALPHA-CHLORDANE	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.006
AROCLOR-1016	0.034 U	0.035 U	0.035 U	0.037 U	0.035 U	0.035 U	0.036 U
AROCLOR-1221	0.068 U	0.071 U	0.069 U	0.075 U	0.069 U	0.071 U	0.073 U
AROCLOR-1232	0.034 U	0.035 U	0.035 U	0.037 U	0.035 U	0.035 U	0.036 U
AROCLOR-1242	0.034 U	0.035 U	0.035 U	0.037 U	0.035 U	0.035 U	0.036 U
AROCLOR-1248	0.034 U	0.035 U	0.035 U	0.037 U	0.035 U	0.035 U	0.036 U
AROCLOR-1254	0.034 U	0.035 U	0.035 U	0.037 U	0.035 U	0.035 U	0.036 U
AROCLOR-1260	0.034 U	0.035 U	0.035 U	0.037 U	0.035 U	0.035 U	0.036 U
BETA-BHC	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.0018 U
DELTA-BHC	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.0018 U
DIELDRIN	0.0034 U	0.0035 U	0.0035 U	0.0037 U	0.0035 U	0.0035 U	0.0036 U
ENDOSULFAN I	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.0018 U
ENDOSULFAN II	0.0034 U	0.0035 U	0.0035 U	0.0037 U	0.0035 U	0.0035 U	0.0036 U
ENDOSULFAN SULFATE	0.0034 U	0.0035 U	0.0035 U	0.0037 U	0.0035 U	0.0035 U	0.0036 U
ENDRIN	0.0034 U	0.0035 U	0.0035 U	0.0037 U	0.0035 U	0.0035 U	0.0036 U
ENDRIN ALDEHYDE	0.0034 U	0.0035 U	0.0035 U	0.0037 U	0.0035 U	0.0035 U	0.0036 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP001	07/10-HP002	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP004
Sample ID	199AA082	199AA083	199AA084	199AA085	199AA089	199AA090	199AA091
Sample Date	06/09/1995	06/09/1995	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50	1.25 - 1.50	7.25 - 7.75	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0034 U	0.0035 U	0.0035 U	0.0037 U	0.0035 U	0.0035 U	0.0036 U
GAMMA-BHC (LINDANE)	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.0018 U
GAMMA-CHLORDANE	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.006
HEPTACHLOR	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.0018 U
HEPTACHLOR EPOXIDE	0.0017 U	0.0018 U	0.0017 U	0.0019 U	0.0017 U	0.0018 U	0.0018 U
METHOXYCHLOR	0.017 U	0.018 U	0.017 U	0.019 U	0.017 U	0.018 U	0.018 U
TOXAPHENE	0.17 U	0.18 U	0.17 U	0.19 U	0.17 U	0.18 U	0.18 U
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	3.8	3.5	3.2	3.4	4.6	3.6	3.4
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP001	07/10-HP002	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP004
Sample ID	199AA082	199AA083	199AA084	199AA085	199AA089	199AA090	199AA091
Sample Date	06/09/1995	06/09/1995	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995
Sample Depth	1.25 - 1.75	7.00 - 7.50	1.25 - 1.50	7.25 - 7.75	1.30 - 2.00	3.30 - 4.00	6.30 - 7.00
Chlorinated Herbicides (mg/kg)							
2,4,5-T	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
2,4,5-TP (SILVEX)	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
2,4-D	0.049 U	0.051 U	0.051 U	0.053 U	0.051 U	0.052 U	0.052 U
2,4-DB	0.05 U	0.052 U	0.052 U	0.054 U	0.052 U	0.053 U	0.053 U
DALAPON	0.052 U	0.054 U	0.054 U	0.056 U	0.054 U	0.055 U	0.055 U
DICAMBA	0.005 U	0.012 J j	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
DICHLOROPROP	0.049 U	0.051 U	0.051 U	0.053 U	0.051 U	0.052 U	0.052 U
DINOSEB	0.025 UJ e	0.026 UJ e	0.026 UJ e	0.027 UJ e	0.026 UJ e	0.027 UJ e	0.026 UJ e
MCPA	4.9 U	5.1 U	5.1 U	5.3 U	5.1 U	5.2 U	5.2 U
MCPP	4.9 U	5.1 U	5.1 U	5.3 U	5.1 U	5.2 U	5.2 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP006	07/10-HP006	07/10-HP006	07/10-HP007	07/10-HP008	07/10-HP010	07/10-HP011
Sample ID	199AA095	199AA096	199AA097	199AA098	199AA103	199AA107	199AA110
Sample Date	06/13/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995	06/14/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00	1.30 - 2.00	7.25 - 7.75	1.00 - 1.50	1.25 - 1.75
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1,2,2-TETRACHLOROETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1,2-TRICHLOROETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1-DICHLOROETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1-DICHLOROETHENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,2-DICHLOROETHENE (TOTAL)	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,2-DICHLOROPROPANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	0.012 UJ b	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
ACETONE	0.034 UJ b	0.024 UJ b	0.029 UJ b	0.036 UJ b	0.031 UJ b	0.02 UJ b	0.011 UJ b
BENZENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
BROMOFORM	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
BROMOMETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
CARBON DISULFIDE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
CARBON TETRACHLORIDE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP006	07/10-HP006	07/10-HP006	07/10-HP007	07/10-HP008	07/10-HP010	07/10-HP011
Sample ID	199AA095	199AA096	199AA097	199AA098	199AA103	199AA107	199AA110
Sample Date	06/13/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995	06/14/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00	1.30 - 2.00	7.25 - 7.75	1.00 - 1.50	1.25 - 1.75
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
CHLOROETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
CHLOROFORM	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
CHLOROMETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
DIBROMOCHLOROMETHANE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	0.018 UJ b	0.016 UJ b	0.014 UJ b	0.02 UJ b	0.025 UJ b	0.015 UJ b	0.01 UJ b
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
TOLUENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
TRICHLOROETHENE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
XYLENE (TOTAL)	0.011 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP006	07/10-HP006	07/10-HP006	07/10-HP007	07/10-HP008	07/10-HP010	07/10-HP011
Sample ID	199AA095	199AA096	199AA097	199AA098	199AA103	199AA107	199AA110
Sample Date	06/13/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995	06/14/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00	1.30 - 2.00	7.25 - 7.75	1.00 - 1.50	1.25 - 1.75
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	10 U	10 U	100 U	260 U
MOTOR OIL RANGE ORGANICS	NA	NA	NA	10 U	10 U	330 Y	1,400 Y
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
1,2-DICHLOROBENZENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
1,3-DICHLOROBENZENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
1,4-DICHLOROBENZENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2,4,5-TRICHLOROPHENOL	NA	NA	NA	0.86 U	0.85 U	0.85 U	0.85 U
2,4,6-TRICHLOROPHENOL	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2,4-DICHLOROPHENOL	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2,4-DIMETHYLPHENOL	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2,4-DINITROPHENOL	NA	NA	NA	0.86 U	0.85 U	0.85 U	0.85 U
2,4-DINITROTOLUENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2,6-DINITROTOLUENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2-CHLORONAPHTHALENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2-CHLOROPHENOL	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2-METHYLNAPHTHALENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2-METHYLPHENOL	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
2-NITROANILINE	NA	NA	NA	0.86 U	0.85 U	0.85 U	0.85 U
2-NITROPHENOL	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
3,3'-DICHLOROBENZIDINE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
3-NITROANILINE	NA	NA	NA	0.86 UJ c	0.85 U	0.85 U	0.85 U
4,6-DINITRO-2-METHYLPHENOL	NA	NA	NA	0.86 U	0.85 U	0.85 U	0.85 U
4-BROMOPHENYL-PHENYLETHER	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
4-CHLORO-3-METHYLPHENOL	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
4-CHLOROANILINE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
4-CHLOROPHENYL-PHENYLETHER	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
4-METHYLPHENOL	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP006	07/10-HP006	07/10-HP006	07/10-HP007	07/10-HP008	07/10-HP010	07/10-HP011
Sample ID	199AA095	199AA096	199AA097	199AA098	199AA103	199AA107	199AA110
Sample Date	06/13/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995	06/14/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00	1.30 - 2.00	7.25 - 7.75	1.00 - 1.50	1.25 - 1.75
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	NA	NA	NA	0.86 UJ c	0.85 U	0.85 U	0.85 U
4-NITROPHENOL	NA	NA	NA	0.86 U	0.85 U	0.85 U	0.85 U
ACENAPHTHENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
ACENAPHTHYLENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
ANTHRACENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
BENZO(A)ANTHRACENE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
BENZO(A)PYRENE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
BENZO(B)FLUORANTHENE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
BENZO(G,H,I)PERYLENE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
BENZO(K)FLUORANTHENE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
BIS(2-CHLOROETHOXY)METHANE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
BIS(2-CHLOROETHYL)ETHER	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
BUTYLBENZYLPHTHALATE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
CARBAZOLE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
CHRYSENE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
DI-N-BUTYLPHTHALATE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
DI-N-OCTYLPHTHALATE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
DIBENZOFURAN	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
DIETHYLPHTHALATE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
DIMETHYLPHTHALATE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
FLUORANTHENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
FLUORENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
HEXACHLOROBENZENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
HEXACHLOROBUTADIENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
HEXACHLOROCYCLOPENTADIENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
HEXACHLOROETHANE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
ISOPHORONE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
N-NITROSODIPHENYLAMINE (1)	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
NAPHTHALENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
NITROBENZENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
PENTACHLOROPHENOL	NA	NA	NA	0.86 U	0.85 U	0.85 U	0.85 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP006	07/10-HP006	07/10-HP006	07/10-HP007	07/10-HP008	07/10-HP010	07/10-HP011
Sample ID	199AA095	199AA096	199AA097	199AA098	199AA103	199AA107	199AA110
Sample Date	06/13/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995	06/14/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00	1.30 - 2.00	7.25 - 7.75	1.00 - 1.50	1.25 - 1.75
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	NA	NA	NA	0.34 U	0.34 U	0.34 U	0.34 U
PHENOL	NA	NA	NA	0.32 J g	0.34 U	0.44	0.75
PYRENE	NA	NA	NA	0.34 U	0.34 U	0.34 UJ i	0.34 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.0035 U	0.0034 U	0.0035 U	NA	NA	NA	NA
4,4'-DDE	0.0028 J g	0.0034 U	0.0035 U	NA	NA	NA	NA
4,4'-DDT	0.0035 U	0.0034 U	0.0035 U	NA	NA	NA	NA
ALDRIN	0.0018 U	0.0017 U	0.0017 U	NA	NA	NA	NA
ALPHA-BHC	0.0018 U	0.0017 U	0.0017 U	NA	NA	NA	NA
ALPHA-CHLORDANE	0.0032	2.1	0.0009 J g	NA	NA	NA	NA
AROCLOR-1016	0.035 U	0.034 U	0.035 U	NA	NA	NA	NA
AROCLOR-1221	0.071 U	0.069 U	0.069 U	NA	NA	NA	NA
AROCLOR-1232	0.035 U	0.034 U	0.035 U	NA	NA	NA	NA
AROCLOR-1242	0.035 U	0.034 U	0.035 U	NA	NA	NA	NA
AROCLOR-1248	0.035 U	0.034 U	0.035 U	NA	NA	NA	NA
AROCLOR-1254	0.035 U	0.034 U	0.035 U	NA	NA	NA	NA
AROCLOR-1260	0.035 U	0.034 U	0.035 U	NA	NA	NA	NA
BETA-BHC	0.0018 U	0.0017 U	0.0017 U	NA	NA	NA	NA
DELTA-BHC	0.0018 U	0.0017 U	0.0017 U	NA	NA	NA	NA
DIELDRIN	0.0035 U	0.0034 U	0.0035 U	NA	NA	NA	NA
ENDOSULFAN I	0.0018 U	0.0017 U	0.0017 U	NA	NA	NA	NA
ENDOSULFAN II	0.0035 U	0.0034 U	0.0035 U	NA	NA	NA	NA
ENDOSULFAN SULFATE	0.0035 U	0.0034 U	0.0035 U	NA	NA	NA	NA
ENDRIN	0.0035 U	0.0034 U	0.0035 U	NA	NA	NA	NA
ENDRIN ALDEHYDE	0.0035 U	0.0034 U	0.0035 U	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP006	07/10-HP006	07/10-HP006	07/10-HP007	07/10-HP008	07/10-HP010	07/10-HP011
Sample ID	199AA095	199AA096	199AA097	199AA098	199AA103	199AA107	199AA110
Sample Date	06/13/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995	06/14/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00	1.30 - 2.00	7.25 - 7.75	1.00 - 1.50	1.25 - 1.75
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0035 U	0.0034 U	0.0035 U	NA	NA	NA	NA
GAMMA-BHC (LINDANE)	0.0018 U	0.0017 U	0.0017 U	NA	NA	NA	NA
GAMMA-CHLORDANE	0.0034	1.9	0.0011 J g	NA	NA	NA	NA
HEPTACHLOR	0.0018 U	0.14 J g	0.0017 U	NA	NA	NA	NA
HEPTACHLOR EPOXIDE	0.0021	0.0017 U	0.0017 U	NA	NA	NA	NA
METHOXYCHLOR	0.018 U	0.017 U	0.017 U	NA	NA	NA	NA
TOXAPHENE	0.18 U	0.17 U	0.17 U	NA	NA	NA	NA
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	2,620	2,900	4,560	6,070
ANTIMONY	NA	NA	NA	0.43 UJ e	0.43 UJ e	6.1 J e	2 J e
ARSENIC	NA	NA	NA	5	7.1	6.2	4.8
BARIUM	NA	NA	NA	6 J g	9.6 J g	59.7	61.1
BERYLLIUM	NA	NA	NA	0.02 U	0.03 UJ b	0.03 UJ b	0.02 U
CADMIUM	NA	NA	NA	0.04 U	0.04 U	0.1 UJ b	0.59 J g
CALCIUM	NA	NA	NA	11,300 J d	7,720 J d	6,660 J d	17,600 J d
CHROMIUM	NA	NA	NA	21.5	24.7	48.3	35
COBALT	NA	NA	NA	5.4 J g	6.4 J g	9.3 J g	7.4 J g
COPPER	NA	NA	NA	3.2 J g	2.9 J g	22.5	60
IRON	NA	NA	NA	9,400	11,700	13,200	13,600
LEAD	3.1	3.1	3.3	3.3	3.3	112	91.9
MAGNESIUM	NA	NA	NA	3,150	3,430	6,030	4,890
MANGANESE	NA	NA	NA	216 J e	210 J e	251 J e	289
MERCURY	NA	NA	NA	0.05 U	0.05 U	0.05 U	0.08 J g
MOLYBDENUM	NA	NA	NA	0.19 U	0.18 U	0.18 U	0.4 UJ b
NICKEL	NA	NA	NA	22	19	46.3	34.8
POTASSIUM	NA	NA	NA	548 J g	487 J g	779 J g	998 J j
SELENIUM	NA	NA	NA	0.7 U	0.7 U	0.7 U	0.7 U
SILVER	NA	NA	NA	0.12 UJ b	0.12 U	0.36 UJ b	0.47 UJ b
SODIUM	NA	NA	NA	194 J g	101 UJ b	103 UJ b	433 J g
THALLIUM	NA	NA	NA	0.41 U	0.41 U	0.41 U	0.41 U
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	14.8	18.7	22.4	26.2
ZINC	NA	NA	NA	16.4	18.1	331	138 J j
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP006	07/10-HP006	07/10-HP006	07/10-HP007	07/10-HP008	07/10-HP010	07/10-HP011
Sample ID	199AA095	199AA096	199AA097	199AA098	199AA103	199AA107	199AA110
Sample Date	06/13/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995	06/14/1995
Sample Depth	1.00 - 2.00	3.00 - 4.00	6.00 - 7.00	1.30 - 2.00	7.25 - 7.75	1.00 - 1.50	1.25 - 1.75
Chlorinated Herbicides (mg/kg)							
2,4,5-T	0.005 U	0.005 U	0.005 U	NA	NA	NA	NA
2,4,5-TP (SILVEX)	0.005 U	0.005 U	0.005 U	NA	NA	NA	NA
2,4-D	0.051 U	0.048 U	0.049 U	NA	NA	NA	NA
2,4-DB	0.052 U	0.049 U	0.05 U	NA	NA	NA	NA
DALAPON	0.054 U	0.052 U	0.052 U	NA	NA	NA	NA
DICAMBA	0.005 U	0.005 U	0.005 U	NA	NA	NA	NA
DICHLOROPROP	0.051 U	0.048 U	0.049 U	NA	NA	NA	NA
DINOSEB	0.026 UJ e	0.025 UJ e	0.025 UJ e	NA	NA	NA	NA
MCPA	5.1 U	4.8 U	4.9 U	NA	NA	NA	NA
MCPP	5.1 U	4.8 U	4.9 U	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP011	07/10-HP012	07/10-HP012	07/10-HP012	07/10-HP013	07/10-HP013	07/10-HP013
Sample ID	199AA111	199AA113B	199AA114B	199AA115B	199AA116B	199AA117B	199AA118B
Sample Date	06/14/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995
Sample Depth	3.75 - 4.00	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.01 U	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	0.01 U	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	0.01 U	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	0.01 U	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	0.01 U	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	0.01 U	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	0.01 U	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.01 U	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	0.01 U	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	0.01 U	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	0.01 U	NA	NA	NA	NA	NA	NA
ACETONE	0.012 UJ b	NA	NA	NA	NA	NA	NA
BENZENE	0.01 U	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	0.01 U	NA	NA	NA	NA	NA	NA
BROMOFORM	0.01 U	NA	NA	NA	NA	NA	NA
BROMOMETHANE	0.01 U	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	0.01 U	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	0.01 U	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP011	07/10-HP012	07/10-HP012	07/10-HP012	07/10-HP013	07/10-HP013	07/10-HP013
Sample ID	199AA111	199AA113B	199AA114B	199AA115B	199AA116B	199AA117B	199AA118B
Sample Date	06/14/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995
Sample Depth	3.75 - 4.00	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.01 U	NA	NA	NA	NA	NA	NA
CHLOROETHANE	0.01 U	NA	NA	NA	NA	NA	NA
CHLOROFORM	0.01 U	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	0.01 U	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.01 U	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	0.01 U	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.01 U	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	0.01 UJ b	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	0.01 U	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	0.01 U	NA	NA	NA	NA	NA	NA
TOLUENE	0.01 U	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.01 U	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	0.01 U	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	0.01 U	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	0.01 U	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP011	07/10-HP012	07/10-HP012	07/10-HP012	07/10-HP013	07/10-HP013	07/10-HP013
Sample ID	199AA111	199AA113B	199AA114B	199AA115B	199AA116B	199AA117B	199AA118B
Sample Date	06/14/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995
Sample Depth	3.75 - 4.00	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	10 U	36 Y	10 U	11 U	140 U	10 U	11 U
MOTOR OIL RANGE ORGANICS	10 U	83 Y	10 U	11 U	1,200 Y	10 U	11 U
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
1,2-DICHLOROBENZENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.18 U
1,3-DICHLOROBENZENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.18 U
1,4-DICHLOROBENZENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.18 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2,4,5-TRICHLOROPHENOL	0.87 U	0.84 U	0.87 U	0.92 U	0.94 U	0.84 U	0.89 U
2,4,6-TRICHLOROPHENOL	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2,4-DICHLOROPHENOL	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2,4-DIMETHYLPHENOL	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2,4-DINITROPHENOL	0.87 U	0.84 U	0.87 U	0.92 U	0.94 UJ c	0.84 U	0.89 U
2,4-DINITROTOLUENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2,6-DINITROTOLUENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2-CHLORONAPHTHALENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2-CHLOROPHENOL	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2-METHYLNAPHTHALENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2-METHYLPHENOL	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
2-NITROANILINE	0.87 U	0.84 U	0.87 U	0.92 U	0.94 U	0.84 U	0.89 U
2-NITROPHENOL	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
3,3'-DICHLOROBENZIDINE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
3-NITROANILINE	0.87 UJ c	0.84 U	0.87 U	0.92 U	0.94 U	0.84 U	0.89 U
4,6-DINITRO-2-METHYLPHENOL	0.87 U	0.84 U	0.87 U	0.92 U	0.94 U	0.84 U	0.89 U
4-BROMOPHENYL-PHENYLETHER	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
4-CHLORO-3-METHYLPHENOL	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
4-CHLOROANILINE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
4-CHLOROPHENYL-PHENYLETHER	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
4-METHYLPHENOL	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP011	07/10-HP012	07/10-HP012	07/10-HP012	07/10-HP013	07/10-HP013	07/10-HP013
Sample ID	199AA111	199AA113B	199AA114B	199AA115B	199AA116B	199AA117B	199AA118B
Sample Date	06/14/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995
Sample Depth	3.75 - 4.00	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.87 UJ c	0.84 U	0.87 U	0.92 U	0.94 U	0.84 U	0.89 U
4-NITROPHENOL	0.87 U	0.84 U	0.87 U	0.92 U	0.94 U	0.84 U	0.89 U
ACENAPHTHENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
ACENAPHTHYLENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
ANTHRACENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
BENZO(A)ANTHRACENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
BENZO(A)PYRENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
BENZO(B)FLUORANTHENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
BENZO(G,H,I)PERYLENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
BENZO(K)FLUORANTHENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
BIS(2-CHLOROETHOXY)METHANE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
BIS(2-CHLOROETHYL)ETHER	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.14 U
BUTYLBENZYLPHTHALATE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
CARBAZOLE	0.35 U	0.34 UJ c	0.35 UJ c	0.37 UJ c	0.37 U	0.33 UJ c	0.35 UJ c
CHRYSENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
DI-N-BUTYLPHTHALATE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
DI-N-OCTYLPHTHALATE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
DIBENZ(A,H)ANTHRACENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
DIBENZOFURAN	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
DIETHYLPHTHALATE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
DIMETHYLPHTHALATE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
FLUORANTHENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
FLUORENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
HEXACHLOROBENZENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
HEXACHLOROBUTADIENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
HEXACHLOROCYCLOPENTADIENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
HEXACHLOROETHANE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
INDENO(1,2,3-CD)PYRENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
ISOPHORONE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
N-NITROSO-DI-N-PROPYLAMINE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
N-NITROSODIPHENYLAMINE (1)	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
NAPHTHALENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
NITROBENZENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
PENTACHLOROPHENOL	0.87 U	0.84 U	0.87 U	0.92 U	0.94 U	0.84 U	0.89 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP011	07/10-HP012	07/10-HP012	07/10-HP012	07/10-HP013	07/10-HP013	07/10-HP013
Sample ID	199AA111	199AA113B	199AA114B	199AA115B	199AA116B	199AA117B	199AA118B
Sample Date	06/14/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995
Sample Depth	3.75 - 4.00	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
PHENOL	0.22 J g	0.34 U	0.33 J g	0.55	0.21 J g	0.66	1.6
PYRENE	0.35 U	0.34 U	0.35 U	0.37 U	0.37 U	0.33 U	0.35 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	NA	0.0034 U	0.0035 U	0.0037 U	0.0037 J gj	0.0033 U	0.0035 U
4,4'-DDE	NA	0.0034 U	0.0035 U	0.0037 U	0.0037 U	0.0033 U	0.0035 U
4,4'-DDT	NA	0.0041	0.0035 U	0.0037 U	0.0077	0.0033 U	0.0035 U
ALDRIN	NA	0.0017 U	0.0017 U	0.0018 U	0.0019 U	0.0017 U	0.0018 U
ALPHA-BHC	NA	0.0017 U	0.0017 U	0.0018 U	0.0019 U	0.0017 U	0.0018 U
ALPHA-CHLORDANE	NA	0.0016 J g	0.0017 U	0.0018 U	0.0049	0.0017 U	0.0018 U
AROCLOR-1016	NA	0.034 U	0.035 U	0.037 U	0.037 U	0.033 U	0.035 U
AROCLOR-1221	NA	0.067 U	0.069 U	0.073 U	0.075 U	0.067 U	0.071 U
AROCLOR-1232	NA	0.034 U	0.035 U	0.037 U	0.037 U	0.033 U	0.035 U
AROCLOR-1242	NA	0.034 U	0.035 U	0.037 U	0.037 U	0.033 U	0.035 U
AROCLOR-1248	NA	0.034 U	0.035 U	0.037 U	0.037 U	0.033 U	0.035 U
AROCLOR-1254	NA	0.034 U	0.035 U	0.037 U	0.037 U	0.033 U	0.035 U
AROCLOR-1260	NA	0.034 U	0.035 U	0.037 U	0.037 U	0.033 U	0.035 U
BETA-BHC	NA	0.0017 U	0.0017 U	0.0018 U	0.0019 U	0.0017 U	0.0018 U
DELTA-BHC	NA	0.0017 U	0.0017 U	0.0018 U	0.0019 U	0.0017 U	0.0018 U
DIELDRIN	NA	0.0034 U	0.0035 U	0.0037 U	0.0037 U	0.0033 U	0.0035 U
ENDOSULFAN I	NA	0.0017 U	0.0017 U	0.0018 U	0.0019 U	0.0017 U	0.0018 U
ENDOSULFAN II	NA	0.0034 U	0.0035 U	0.0037 U	0.0037 U	0.0033 U	0.0035 U
ENDOSULFAN SULFATE	NA	0.0034 U	0.0035 U	0.0037 U	0.0037 U	0.0033 U	0.0035 U
ENDRIN	NA	0.0034 U	0.0035 U	0.0037 U	0.0037 U	0.0033 U	0.0035 U
ENDRIN ALDEHYDE	NA	0.0034 U	0.0035 U	0.0037 U	0.0037 U	0.0033 U	0.0035 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP011	07/10-HP012	07/10-HP012	07/10-HP012	07/10-HP013	07/10-HP013	07/10-HP013
Sample ID	199AA111	199AA113B	199AA114B	199AA115B	199AA116B	199AA117B	199AA118B
Sample Date	06/14/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995
Sample Depth	3.75 - 4.00	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	NA	0.0034 U	0.0035 U	0.0037 U	0.0037 U	0.0033 U	0.0035 U
GAMMA-BHC (LINDANE)	NA	0.0017 U	0.0017 U	0.0018 U	0.0019 U	0.0017 U	0.0018 U
GAMMA-CHLORDANE	NA	0.0018	0.0017 U	0.0018 U	0.0048	0.0017 U	0.0018 U
HEPTACHLOR	NA	0.0017 U	0.0017 U	0.0018 U	0.0019 U	0.0017 U	0.0018 U
HEPTACHLOR EPOXIDE	NA	0.0017 U	0.0017 U	0.0018 U	0.0019 U	0.0017 U	0.0018 U
METHOXYCHLOR	NA	0.017 U	0.017 U	0.018 U	0.019 U	0.017 U	0.018 U
TOXAPHENE	NA	0.17 U	0.17 U	0.18 U	0.19 U	0.17 U	0.18 U
Metals (mg/kg)							
ALUMINUM	2,600	NA	NA	NA	NA	NA	NA
ANTIMONY	0.44 UJ e	NA	NA	NA	NA	NA	NA
ARSENIC	5.5	NA	NA	NA	NA	NA	NA
BARIUM	6.3 J g	NA	NA	NA	NA	NA	NA
BERYLLIUM	0.02 U	NA	NA	NA	NA	NA	NA
CADMIUM	0.04 U	NA	NA	NA	NA	NA	NA
CALCIUM	2,470 J d	NA	NA	NA	NA	NA	NA
CHROMIUM	22	NA	NA	52.4	NA	36.1	33.8
COBALT	5.5 J g	NA	NA	NA	NA	NA	NA
COPPER	3.2 J g	NA	NA	NA	NA	NA	NA
IRON	9,660	NA	NA	NA	NA	NA	NA
LEAD	2.8	NA	NA	NA	NA	NA	NA
MAGNESIUM	3,350	NA	NA	NA	NA	NA	NA
MANGANESE	162	NA	NA	NA	NA	NA	NA
MERCURY	0.05 U	NA	NA	NA	NA	NA	NA
MOLYBDENUM	0.19 U	NA	NA	NA	NA	NA	NA
NICKEL	25.4	NA	NA	NA	NA	NA	NA
POTASSIUM	521 J j	NA	NA	NA	NA	NA	NA
SELENIUM	0.71 U	NA	NA	NA	NA	NA	NA
SILVER	0.2 UJ b	NA	NA	NA	NA	NA	NA
SODIUM	95.3 UJ b	NA	NA	NA	NA	NA	NA
THALLIUM	0.42 U	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	16.2	NA	NA	NA	NA	NA	NA
ZINC	15.9 J j	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	0.05 U	NA	0.05 U	0.05 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP011	07/10-HP012	07/10-HP012	07/10-HP012	07/10-HP013	07/10-HP013	07/10-HP013
Sample ID	199AA111	199AA113B	199AA114B	199AA115B	199AA116B	199AA117B	199AA118B
Sample Date	06/14/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995	08/10/1995
Sample Depth	3.75 - 4.00	0.25 - 0.75	3.25 - 3.75	7.25 - 7.75	0.75 - 1.25	3.25 - 3.75	7.25 - 7.75
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB01	10-SB01	10-SB01	10-SB01	10-SB02	10-SB02	10-SB02
Sample ID	10SB01A	10SB11A	10SB01B	10SB01C	10SB02A	10SB02B	10SB02C
Sample Date	07/28/1992	07/28/1992	07/28/1992	07/28/1992	08/05/1992	08/05/1992	08/05/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
1,1,2,2-TETRACHLOROETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
1,1,2-TRICHLOROETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
1,1-DICHLOROETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
1,1-DICHLOROETHENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
1,2-DICHLOROETHENE (TOTAL)	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
1,2-DICHLOROPROPANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
ACETONE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 UJ b	0.013 U
BENZENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
BROMOFORM	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
BROMOMETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
CARBON DISULFIDE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
CARBON TETRACHLORIDE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB01	10-SB01	10-SB01	10-SB01	10-SB02	10-SB02	10-SB02
Sample ID	10SB01A	10SB11A	10SB01B	10SB01C	10SB02A	10SB02B	10SB02C
Sample Date	07/28/1992	07/28/1992	07/28/1992	07/28/1992	08/05/1992	08/05/1992	08/05/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
CHLOROETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
CHLOROFORM	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
CHLOROMETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
DIBROMOCHLOROMETHANE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	0.027 UJ b	0.01 UJ b	0.01 UJ b	0.032 UJ b	0.01 UJ b	0.01 UJ b	0.013 UJ b
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
TOLUENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
TRICHLOROETHENE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
XYLENE (TOTAL)	0.01 U	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.013 U
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB01	10-SB01	10-SB01	10-SB01	10-SB02	10-SB02	10-SB02
Sample ID	10SB01A	10SB11A	10SB01B	10SB01C	10SB02A	10SB02B	10SB02C
Sample Date	07/28/1992	07/28/1992	07/28/1992	07/28/1992	08/05/1992	08/05/1992	08/05/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	12.9 U	12.9 U	13 U	14.6 U	12.7 U	12.9 U	15.5 U
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
1,2-DICHLOROBENZENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
1,3-DICHLOROBENZENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
1,4-DICHLOROBENZENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2,4,5-TRICHLOROPHENOL	1.7 U	1.7 U	1.7 U	1.9 U	1.6 UJ h	1.6 U	2 U
2,4,6-TRICHLOROPHENOL	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2,4-DICHLOROPHENOL	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2,4-DIMETHYLPHENOL	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2,4-DINITROPHENOL	1.7 U	1.7 U	1.7 U	1.9 U	1.6 UJ h	1.6 U	2 U
2,4-DINITROTOLUENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2,6-DINITROTOLUENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2-CHLORONAPHTHALENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2-CHLOROPHENOL	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2-METHYLNAPHTHALENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2-METHYLPHENOL	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
2-NITROANILINE	1.7 U	1.7 U	1.7 U	1.9 U	1.6 UJ h	1.6 U	2 U
2-NITROPHENOL	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
3,3'-DICHLOROBENZIDINE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
3-NITROANILINE	1.7 U	1.7 U	1.7 U	1.9 U	1.6 UJ h	1.6 U	2 U
4,6-DINITRO-2-METHYLPHENOL	1.7 U	1.7 U	1.7 U	1.9 U	1.6 UJ h	1.6 U	2 U
4-BROMOPHENYL-PHENYLETHER	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
4-CHLORO-3-METHYLPHENOL	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
4-CHLOROANILINE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
4-CHLOROPHENYL-PHENYLETHER	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
4-METHYLPHENOL	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB01	10-SB01	10-SB01	10-SB01	10-SB02	10-SB02	10-SB02
Sample ID	10SB01A	10SB11A	10SB01B	10SB01C	10SB02A	10SB02B	10SB02C
Sample Date	07/28/1992	07/28/1992	07/28/1992	07/28/1992	08/05/1992	08/05/1992	08/05/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	1.7 U	1.7 U	1.7 U	1.9 U	1.6 R ch	1.6 U	2 U
4-NITROPHENOL	1.7 U	1.7 U	1.7 U	1.9 U	1.6 UJ h	1.6 U	2 U
ACENAPHTHENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
ACENAPHTHYLENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
ANTHRACENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
BENZO(A)ANTHRACENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
BENZO(A)PYRENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
BENZO(B)FLUORANTHENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
BENZO(G,H,I)PERYLENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
BENZO(K)FLUORANTHENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
BIS(2-CHLOROETHOXY)METHANE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
BIS(2-CHLOROETHYL)ETHER	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
BUTYLBENZYLPHTHALATE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
CARBAZOLE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
CHRYSENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
DI-N-BUTYLPHTHALATE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
DI-N-OCTYLPHTHALATE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
DIBENZ(A,H)ANTHRACENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
DIBENZOFURAN	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
DIETHYLPHTHALATE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
DIMETHYLPHTHALATE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
FLUORANTHENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
FLUORENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
HEXACHLOROBENZENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
HEXACHLOROBUTADIENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
HEXACHLOROCYCLOPENTADIENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
HEXACHLOROETHANE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
INDENO(1,2,3-CD)PYRENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
ISOPHORONE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
N-NITROSO-DI-N-PROPYLAMINE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
N-NITROSODIPHENYLAMINE (1)	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
NAPHTHALENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
NITROBENZENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
PENTACHLOROPHENOL	1.7 U	1.7 U	1.7 UJ a	1.9 U	1.6 UJ h	1.6 U	2 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB01	10-SB01	10-SB01	10-SB01	10-SB02	10-SB02	10-SB02
Sample ID	10SB01A	10SB11A	10SB01B	10SB01C	10SB02A	10SB02B	10SB02C
Sample Date	07/28/1992	07/28/1992	07/28/1992	07/28/1992	08/05/1992	08/05/1992	08/05/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
PHENOL	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
PYRENE	0.68 U	0.69 U	0.69 U	0.77 U	0.68 UJ h	0.68 U	0.83 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.0034 U	0.0034 U	0.0034 U	0.0039 U	0.0034 U	0.0034 U	0.0041 U
4,4'-DDE	0.0034 U	0.0034 U	0.0034 U	0.0039 U	0.0034 U	0.0034 U	0.0041 U
4,4'-DDT	0.0034 U	0.0034 U	0.0034 U	0.0039 U	0.0034 U	0.0034 U	0.0041 U
ALDRIN	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
ALPHA-BHC	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
ALPHA-CHLORDANE	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
AROCLOR-1016	0.0344 U	0.0344 U	0.0341 U	0.0388 U	0.0336 U	0.0336 U	0.0411 U
AROCLOR-1221	0.0698 U	0.0699 U	0.0692 U	0.0787 U	0.0682 U	0.0682 U	0.0835 U
AROCLOR-1232	0.0344 U	0.0344 U	0.0341 U	0.0388 U	0.0336 U	0.0336 U	0.0411 U
AROCLOR-1242	0.0344 U	0.0344 U	0.0341 U	0.0388 U	0.0336 U	0.0336 U	0.0411 U
AROCLOR-1248	0.0344 U	0.0344 U	0.0341 U	0.0388 U	0.0336 U	0.0336 U	0.0411 U
AROCLOR-1254	0.0344 U	0.0344 U	0.0341 U	0.0388 U	0.0336 U	0.0336 U	0.0411 U
AROCLOR-1260	0.0344 U	0.0344 U	0.0341 U	0.0388 U	0.0336 U	0.0336 U	0.0411 U
BETA-BHC	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
DELTA-BHC	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
DIELDRIN	0.0034 U	0.0034 U	0.0034 U	0.0039 U	0.0034 U	0.0034 U	0.0041 U
ENDOSULFAN I	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
ENDOSULFAN II	0.0034 U	0.0034 U	0.0034 U	0.0039 U	0.0034 U	0.0034 U	0.0041 U
ENDOSULFAN SULFATE	0.0034 U	0.0034 U	0.0034 U	0.0039 U	0.0034 U	0.0034 U	0.0041 U
ENDRIN	0.0034 U	0.0034 U	0.0034 U	0.0039 U	0.0034 U	0.0034 U	0.0041 U
ENDRIN ALDEHYDE	0.0034 U	0.0034 U	0.0034 U	0.0039 U	0.0034 U	0.0128 J d	0.0041 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB01	10-SB01	10-SB01	10-SB01	10-SB02	10-SB02	10-SB02
Sample ID	10SB01A	10SB11A	10SB01B	10SB01C	10SB02A	10SB02B	10SB02C
Sample Date	07/28/1992	07/28/1992	07/28/1992	07/28/1992	08/05/1992	08/05/1992	08/05/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0034 U	0.0034 U	0.0034 U	0.0039 U	0.0034 U	0.014 J d	0.0041 U
GAMMA-BHC (LINDANE)	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
GAMMA-CHLORDANE	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
HEPTACHLOR	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
HEPTACHLOR EPOXIDE	0.0018 U	0.0018 U	0.0018 U	0.002 U	0.0017 U	0.0017 U	0.0021 U
METHOXYCHLOR	0.0177 U	0.0177 U	0.0176 U	0.02 U	0.0173 U	0.0173 U	0.0212 U
TOXAPHENE	0.177 U	0.177 U	0.176 U	0.2 U	0.173 U	0.173 U	0.212 U
Metals (mg/kg)							
ALUMINUM	4,000	3,720	3,050	4,620	4,570	4,220	9,840
ANTIMONY	10 UJ e	10.1 UJ e	10 UJ e	11.3 UJ e	9.9 U	9.9 U	12.1 U
ARSENIC	4.6 J e	4.5 J e	5.2 J e	4.9 J e	5.9	5.7	7.7
BARIUM	10.4 J g	9 J g	8.4 J g	19 J g	10.7 J g	10.9 J g	28 J g
BERYLLIUM	0.21 U	0.21 U	0.21 U	0.23 U	0.21 J g	0.21 J g	0.25 J g
CADMIUM	0.62 U	0.63 U	0.63 U	0.7 U	0.62 U	0.62 U	0.76 U
CALCIUM	4,970 J d	4,190 J d	19,600 J d	9,070 J d	5,390 J d	11,900 J d	19,300 J d
CHROMIUM	31.6 J e	22.9 J e	19.2 J e	24.9 J e	31.1	89.5	46.7
COBALT	6.5 J g	6.7 J g	5.6 J g	8.9 J g	8.4 J g	8.6 J g	13.6
COPPER	6.2 J d	7.6 J d	6.7 J d	13.8 J d	6	8.6	7.3
IRON	13,300	13,800	11,300	16,800	15,900	16,700	24,900
LEAD	3.1 J de	3.9 J de	4.5 J de	6.4 J de	3.4	3	5.5
MAGNESIUM	3,370	3,240	2,970	4,030	5,100	9,360	7,110
MANGANESE	204 J e	273 J e	251 J e	319 J e	251 J e	416 J e	467 J e
MERCURY	0.1 U	0.11 U	0.1 U	0.12 U	0.1 U	0.1 U	0.13 U
MOLYBDENUM	2.1 U	2.1 U	2.1 U	2.3 U	2.1 U	2.1 U	2.5 U
NICKEL	32.5 J e	31.5 J e	28.5 J e	36.1 J e	47.1	93.2	59.3
POTASSIUM	622 J g	654 J g	531 J g	795 J g	714 J g	574 J g	1,280
SELENIUM	0.62 U	0.63 U	0.63 U	0.7 U	0.62 U	0.62 U	0.76 U
SILVER	1 U	1.1 U	1 U	1.6 J eg	1 U	1 U	1.8 J eg
SODIUM	172 J g	99.3 J g	295 J g	177 J g	108 J g	166 J g	363 J g
THALLIUM	0.62 U	0.63 U	0.63 U	0.7 U	0.62 U	0.62 U	0.76 U
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	19.4	19.8	15.7	25.8	23.7	23	39.1
ZINC	28.7	23.8	22.8	32.8	25.3	24.5	46.2
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB01	10-SB01	10-SB01	10-SB01	10-SB02	10-SB02	10-SB02
Sample ID	10SB01A	10SB11A	10SB01B	10SB01C	10SB02A	10SB02B	10SB02C
Sample Date	07/28/1992	07/28/1992	07/28/1992	07/28/1992	08/05/1992	08/05/1992	08/05/1992
Sample Depth	1.50 - 2.00	2.00 - 2.50	2.50 - 3.00	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	0.0247 U	0.0254 U	0.0302 U
2,4,5-TP (SILVEX)	NA	NA	NA	NA	0.0247 U	0.0254 U	0.0302 U
2,4-D	NA	NA	NA	NA	0.0989 U	0.102 U	0.121 U
2,4-DB	NA	NA	NA	NA	0.0494 U	0.0508 U	0.0604 U
DALAPON	NA	NA	NA	NA	0.0494 U	0.0508 U	0.0604 U
DICAMBA	NA	NA	NA	NA	0.0494 U	0.0508 U	0.0604 U
DICHLOROPROP	NA	NA	NA	NA	0.0989 U	0.102 U	0.121 U
DINOSEB	NA	NA	NA	NA	0.0247 U	0.0254 U	0.0302 U
MCPA	NA	NA	NA	NA	24.7 U	25.4 U	30.2 U
MCPP	NA	NA	NA	NA	24.7 U	25.4 U	30.2 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB03	10-SB03	10-SB03	10-SB04	10-SB04	10-SB04	10-SB05
Sample ID	10SB03A	10SB03B	10SB03C	10SB04A	10SB04B	10SB04C	30210SB05001
Sample Date	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	10/22/2002
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
1,1,2,2-TETRACHLOROETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
1,1,2-TRICHLOROETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
1,1-DICHLOROETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
1,1-DICHLOROETHENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
1,2-DICHLOROETHENE (TOTAL)	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
1,2-DICHLOROPROPANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
ACETONE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
BENZENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
BROMOFORM	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
BROMOMETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
CARBON DISULFIDE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
CARBON TETRACHLORIDE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB03	10-SB03	10-SB03	10-SB04	10-SB04	10-SB04	10-SB05
Sample ID	10SB03A	10SB03B	10SB03C	10SB04A	10SB04B	10SB04C	30210SB05001
Sample Date	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	10/22/2002
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
CHLOROETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
CHLOROFORM	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
CHLOROMETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
DIBROMOCHLOROMETHANE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	0.01 UJ b	0.01 UJ b	0.02 UJ b	0.01 UJ b	0.01 UJ b	0.013 UJ b	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
TOLUENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
TRICHLOROETHENE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
XYLENE (TOTAL)	0.01 U	0.01 U	0.012 U	0.01 U	0.01 U	0.012 U	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB03	10-SB03	10-SB03	10-SB04	10-SB04	10-SB04	10-SB05
Sample ID	10SB03A	10SB03B	10SB03C	10SB04A	10SB04B	10SB04C	30210SB05001
Sample Date	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	10/22/2002
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	0.50 - 2.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	12.7 U	13.4 U	15 U	13.2 U	13.3 U	185 JY c	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
1,2-DICHLOROBENZENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
1,3-DICHLOROBENZENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
1,4-DICHLOROBENZENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2,2'-OXYBIS(1-CHLOROPROPANE)	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2,4,5-TRICHLOROPHENOL	1.6 U	1.7 U	1.9 U	1.6 U	1.7 U	1.9 U	NA
2,4,6-TRICHLOROPHENOL	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2,4-DICHLOROPHENOL	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2,4-DIMETHYLPHENOL	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2,4-DINITROPHENOL	1.6 U	1.7 U	1.9 U	1.6 U	1.7 U	1.9 U	NA
2,4-DINITROTOLUENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2,6-DINITROTOLUENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2-CHLORONAPHTHALENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2-CHLOROPHENOL	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2-METHYLNAPHTHALENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2-METHYLPHENOL	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
2-NITROANILINE	1.6 U	1.7 U	1.9 U	1.6 U	1.7 U	1.9 U	NA
2-NITROPHENOL	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
3,3'-DICHLOROBENZIDINE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
3-NITROANILINE	1.6 U	1.7 U	1.9 U	1.6 U	1.7 U	1.9 U	NA
4,6-DINITRO-2-METHYLPHENOL	1.6 U	1.7 U	1.9 U	1.6 U	1.7 U	1.9 U	NA
4-BROMOPHENYL-PHENYLETHER	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
4-CHLORO-3-METHYLPHENOL	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
4-CHLOROANILINE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
4-CHLOROPHENYL-PHENYLETHER	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
4-METHYLPHENOL	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB03	10-SB03	10-SB03	10-SB04	10-SB04	10-SB04	10-SB05
Sample ID	10SB03A	10SB03B	10SB03C	10SB04A	10SB04B	10SB04C	30210SB05001
Sample Date	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	10/22/2002
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	1.6 U	1.7 U	1.9 U	1.6 U	1.7 U	1.9 U	NA
4-NITROPHENOL	1.6 U	1.7 U	1.9 U	1.6 U	1.7 U	1.9 U	NA
ACENAPHTHENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
ACENAPHTHYLENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
ANTHRACENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
BENZO(A)ANTHRACENE	0.68 U	0.69 U	0.38 J g	0.68 U	0.69 U	0.79 U	NA
BENZO(A)PYRENE	0.68 U	0.69 U	0.3 J g	0.68 U	0.69 U	0.79 U	NA
BENZO(B)FLUORANTHENE	0.68 U	0.69 U	0.27 J g	0.68 U	0.69 U	0.79 U	NA
BENZO(G,H,I)PERYLENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
BENZO(K)FLUORANTHENE	0.68 U	0.69 U	0.27 J g	0.68 U	0.69 U	0.79 U	NA
BIS(2-CHLOROETHOXY)METHANE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
BIS(2-CHLOROETHYL)ETHER	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
BIS(2-ETHYLHEXYL)PHTHALATE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
BUTYLBENZYLPHTHALATE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
CARBAZOLE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
CHRYSENE	0.68 U	0.69 U	0.52 J g	0.68 U	0.69 U	0.79 U	NA
DI-N-BUTYLPHTHALATE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
DI-N-OCTYLPHTHALATE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
DIBENZ(A,H)ANTHRACENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
DIBENZOFURAN	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
DIETHYLPHTHALATE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
DIMETHYLPHTHALATE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
FLUORANTHENE	0.68 U	0.69 U	1	0.68 U	0.69 U	0.79 U	NA
FLUORENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
HEXACHLOROBENZENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
HEXACHLOROBUTADIENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
HEXACHLOROCYCLOPENTADIENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
HEXACHLOROETHANE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
INDENO(1,2,3-CD)PYRENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
ISOPHORONE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
N-NITROSO-DI-N-PROPYLAMINE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
N-NITROSODIPHENYLAMINE (1)	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
NAPHTHALENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
NITROBENZENE	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
PENTACHLOROPHENOL	1.6 U	1.7 U	1.9 U	1.6 U	1.7 U	1.9 U	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB03	10-SB03	10-SB03	10-SB04	10-SB04	10-SB04	10-SB05
Sample ID	10SB03A	10SB03B	10SB03C	10SB04A	10SB04B	10SB04C	30210SB05001
Sample Date	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	10/22/2002
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.68 U	0.69 U	1	0.68 U	0.69 U	0.79 U	NA
PHENOL	0.68 U	0.69 U	0.8 U	0.68 U	0.69 U	0.79 U	NA
PYRENE	0.68 U	0.69 U	1	0.68 U	0.69 U	0.79 U	NA
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.0038	0.0035 U	0.004 U	0.0034 U	0.0035 UJ a	0.004 U	0.0049 J g
4,4'-DDE	0.0034 U	0.0035 U	0.004 U	0.0034 U	0.0035 UJ a	0.004 U	0.0021 J g
4,4'-DDT	0.0054 J c	0.0035 U	0.004 U	0.0034 U	0.0035 UJ a	0.004 U	0.014
ALDRIN	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.0013 U
ALPHA-BHC	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.00053 U
ALPHA-CHLORDANE	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.0033 J g
AROCLOR-1016	0.0337 U	0.0348 U	0.0403 U	0.0341 U	0.0347 UJ a	0.0396 U	NA
AROCLOR-1221	0.0684 U	0.0707 U	0.0818 U	0.0692 U	0.0704 UJ a	0.0804 U	NA
AROCLOR-1232	0.0337 U	0.0348 U	0.0403 U	0.0341 U	0.0347 UJ a	0.0396 U	NA
AROCLOR-1242	0.0337 U	0.0348 U	0.0403 U	0.0341 U	0.0347 UJ a	0.0396 U	NA
AROCLOR-1248	0.0337 U	0.0348 U	0.0403 U	0.0341 U	0.0347 UJ a	0.0396 U	NA
AROCLOR-1254	0.0337 U	0.0348 U	0.0403 U	0.0341 U	0.0347 UJ a	0.0396 U	NA
AROCLOR-1260	0.0337 U	0.0348 U	0.0403 U	0.0341 U	0.0347 UJ a	0.0396 U	NA
BETA-BHC	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.00077 U
DELTA-BHC	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.002 U
DIELDRIN	0.0034 U	0.0035 U	0.004 U	0.0034 U	0.0035 UJ a	0.004 U	0.0016 U
ENDOSULFAN I	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.00064 U
ENDOSULFAN II	0.0034 U	0.0035 U	0.004 U	0.0034 U	0.0035 UJ a	0.004 U	0.0012 U
ENDOSULFAN SULFATE	0.0034 U	0.0035 U	0.004 U	0.0034 U	0.0035 UJ a	0.004 U	0.00084 U
ENDRIN	0.0034 U	0.0035 U	0.004 U	0.0034 U	0.0035 UJ a	0.004 U	0.00069 U
ENDRIN ALDEHYDE	0.0034 U	0.0035 U	0.004 U	0.0034 U	0.0035 UJ a	0.004 U	0.0019 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB03	10-SB03	10-SB03	10-SB04	10-SB04	10-SB04	10-SB05
Sample ID	10SB03A	10SB03B	10SB03C	10SB04A	10SB04B	10SB04C	30210SB05001
Sample Date	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	10/22/2002
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	0.50 - 2.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0034 U	0.0035 U	0.004 U	0.0034 U	0.0035 UJ a	0.004 U	0.0014 U
GAMMA-BHC (LINDANE)	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.0013 U
GAMMA-CHLORDANE	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.0046 J g
HEPTACHLOR	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.00071 U
HEPTACHLOR EPOXIDE	0.0017 U	0.0018 U	0.0021 U	0.0018 U	0.0018 UJ a	0.002 U	0.00071 U
METHOXYCHLOR	0.0174 U	0.0179 U	0.0208 U	0.0176 U	0.0179 UJ a	0.0204 U	0.00084 U
TOXAPHENE	0.174 U	0.179 U	0.208 U	0.176 U	0.179 UJ a	0.204 U	0.088 U
Metals (mg/kg)							
ALUMINUM	5,050	4,000	7,190	3,530	3,340	6,130	NA
ANTIMONY	9.9 U	10.1 U	11.7 U	9.9 U	10 U	11.5 U	NA
ARSENIC	6.2	5	6.7	5.8	5.7	5.7	NA
BARIUM	12.6 J g	10.5 J g	29 J g	12.8 J g	7.1 J g	18.5 J g	NA
BERYLLIUM	0.21 J g	0.21 J g	0.24 J g	0.21 J g	0.21 J g	0.24 J g	NA
CADMIUM	0.62 U	0.63 U	0.73 U	0.62 U	0.63 U	0.72 U	NA
CALCIUM	5,890 J d	10,300 J d	38,000 J d	14,500 J d	4,950 J d	23,100 J d	NA
CHROMIUM	40.6	32.9	37	26.8	65.6	33.4	NA
COBALT	8.4 J g	7.1 J g	13.2	7 J g	8.4 J g	9.1 J g	NA
COPPER	6.6	9	16.8	5.4	3.8 J g	5.5 J g	NA
IRON	17,000	14,400	22,500	14,000	15,700	18,900	NA
LEAD	5.5	2.6	5.2	3.7	3	4.7	NA
MAGNESIUM	5,830	3,390	6,820	4,020	7,830	4,880	NA
MANGANESE	348 J e	270 J e	731 J e	310 J e	307 J e	661 J e	NA
MERCURY	0.1 U	0.1 U	0.12 U	0.1 U	0.1 U	0.12 U	NA
MOLYBDENUM	2.1 U	2.1 U	2.4 U	2.1 U	2.1 U	2.4 U	NA
NICKEL	38.5	30.6	55.8	32.8	78.5	38.2	NA
POTASSIUM	606 J g	538 J g	1,440	421 J g	468 J g	947 J g	NA
SELENIUM	0.62 U	0.63 U	0.73 U	0.62 U	0.63 U	0.72 U	NA
SILVER	1 U	1 U	1.2 U	1 U	1 U	1.2 U	NA
SODIUM	107 J g	147 J g	558 J g	166 J g	104 J g	300 J g	NA
THALLIUM	0.62 U	0.63 U	0.73 U	0.62 U	0.63 U	0.72 U	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	25.1	22.2	36.5	19.4	21.1	30.3	NA
ZINC	28.8	31.8	47.5	25.8	43.6	92.1	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB03	10-SB03	10-SB03	10-SB04	10-SB04	10-SB04	10-SB05
Sample ID	10SB03A	10SB03B	10SB03C	10SB04A	10SB04B	10SB04C	30210SB05001
Sample Date	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	08/05/1992	10/22/2002
Sample Depth	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	1.00 - 1.50	3.00 - 3.50	6.00 - 6.50	0.50 - 2.00
Chlorinated Herbicides (mg/kg)							
2,4,5-T	0.0252 U	0.026 U	0.0299 U	0.0255 U	0.0261 U	0.0292 U	NA
2,4,5-TP (SILVEX)	0.0252 U	0.026 U	0.0299 U	0.0255 U	0.0261 U	0.0292 U	NA
2,4-D	0.101 U	0.104 U	0.12 U	0.102 U	0.104 U	0.117 U	NA
2,4-DB	0.178	0.052 U	0.0598 U	0.0511 U	0.0522 U	0.0583 U	NA
DALAPON	0.0504 U	0.052 U	0.0598 U	0.105	0.0522 U	0.0583 U	NA
DICAMBA	0.0504 U	0.0674	0.0598 U	0.0511 U	0.0522 U	0.0583 U	NA
DICHLOROPROP	0.101 U	0.104 U	0.12 U	0.102 U	0.104 U	0.117 U	NA
DINOSEB	0.0252 U	0.026 U	0.0299 U	0.0255 U	0.0261 U	0.0292 U	NA
MCPA	25.2 U	26 U	29.9 U	25.5 U	26.1 U	29.2 U	NA
MCPP	25.2 U	26 U	29.9 U	25.5 U	26.1 U	29.2 U	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB05	10-SB05	10-SB06	10-SB06	10-SB06	10-SB07	10-SB07
Sample ID	30210SB05002	30210SB05003	30210SB06001	30210SB06002	30210SB06003	30210SB07001	30210SB07002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	2.50 - 4.00	6.00 - 8.00	0.50 - 2.00	3.50 - 5.00	6.50 - 8.00	0.50 - 2.00	3.50 - 4.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB05	10-SB05	10-SB06	10-SB06	10-SB06	10-SB07	10-SB07
Sample ID	30210SB05002	30210SB05003	30210SB06001	30210SB06002	30210SB06003	30210SB07001	30210SB07002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	2.50 - 4.00	6.00 - 8.00	0.50 - 2.00	3.50 - 5.00	6.50 - 8.00	0.50 - 2.00	3.50 - 4.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB05	10-SB05	10-SB06	10-SB06	10-SB06	10-SB07	10-SB07
Sample ID	30210SB05002	30210SB05003	30210SB06001	30210SB06002	30210SB06003	30210SB07001	30210SB07002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	2.50 - 4.00	6.00 - 8.00	0.50 - 2.00	3.50 - 5.00	6.50 - 8.00	0.50 - 2.00	3.50 - 4.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	NA	NA	NA	NA	NA
2,4,5-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4,6-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DIMETHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DINITROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DINITROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2,6-DINITROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-CHLORONAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2-METHYLNAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
2-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
2-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
2-NITROPHENOL	NA	NA	NA	NA	NA	NA	NA
3,3'-DICHLOROBENZIDINE	NA	NA	NA	NA	NA	NA	NA
3-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
4,6-DINITRO-2-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
4-BROMOPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	NA	NA
4-CHLORO-3-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
4-CHLOROANILINE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	NA	NA
4-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB05	10-SB05	10-SB06	10-SB06	10-SB06	10-SB07	10-SB07
Sample ID	30210SB05002	30210SB05003	30210SB06001	30210SB06002	30210SB06003	30210SB07001	30210SB07002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	2.50 - 4.00	6.00 - 8.00	0.50 - 2.00	3.50 - 5.00	6.50 - 8.00	0.50 - 2.00	3.50 - 4.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
4-NITROPHENOL	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHENE	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHYLENE	NA	NA	NA	NA	NA	NA	NA
ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
BENZO(A)ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
BENZO(A)PYRENE	NA	NA	NA	NA	NA	NA	NA
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
BENZO(G,H,I)PERYLENE	NA	NA	NA	NA	NA	NA	NA
BENZO(K)FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
BIS(2-CHLOROETHOXY)METHANE	NA	NA	NA	NA	NA	NA	NA
BIS(2-CHLOROETHYL)ETHER	NA	NA	NA	NA	NA	NA	NA
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	NA	NA	NA	NA
BUTYLBENZYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
CARBAZOLE	NA	NA	NA	NA	NA	NA	NA
CHRYSENE	NA	NA	NA	NA	NA	NA	NA
DI-N-BUTYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DI-N-OCTYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
DIBENZOFURAN	NA	NA	NA	NA	NA	NA	NA
DIETHYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DIMETHYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
FLUORENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROCYCLOPENTADIENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	NA	NA	NA	NA
ISOPHORONE	NA	NA	NA	NA	NA	NA	NA
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	NA	NA	NA	NA	NA
N-NITROSODIPHENYLAMINE (1)	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
NITROBENZENE	NA	NA	NA	NA	NA	NA	NA
PENTACHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB05	10-SB05	10-SB06	10-SB06	10-SB06	10-SB07	10-SB07
Sample ID	30210SB05002	30210SB05003	30210SB06001	30210SB06002	30210SB06003	30210SB07001	30210SB07002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	2.50 - 4.00	6.00 - 8.00	0.50 - 2.00	3.50 - 5.00	6.50 - 8.00	0.50 - 2.00	3.50 - 4.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	NA	NA	NA	NA	NA	NA	NA
PHENOL	NA	NA	NA	NA	NA	NA	NA
PYRENE	NA	NA	NA	NA	NA	NA	NA
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.00016 U	0.00017 U	0.0016 U	0.00016 U	0.00017 U	0.1	0.00016 U
4,4'-DDE	0.00026 U	0.00028 U	0.0026 U	0.00026 U	0.00028 U	0.049	0.00026 U
4,4'-DDT	0.00028 U	0.00019 U	0.0051 J g	0.00028 J g	0.00019 U	0.32	0.00054 UJ j
ALDRIN	0.00024 U	0.00026 U	0.0025 U	0.00024 U	0.00026 U	0.011 U	0.00025 U
ALPHA-BHC	0.00011 U	0.00012 U	0.0011 U	0.00011 U	0.00012 U	0.0011 U	0.00011 U
ALPHA-CHLORDANE	0.00011 U	0.00012 U	0.0031 J g	0.00028 J g	0.00012 U	0.3	0.00027 J g
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00016 U	0.00017 U	0.0016 U	0.00016 U	0.00017 U	0.0016 U	0.00016 U
DELTA-BHC	0.00038 U	0.00041 U	0.0039 U	0.00038 U	0.00041 U	0.0039 U	0.00039 U
DIELDRIN	0.00032 U	0.00034 U	0.0032 U	0.00032 U	0.00034 U	0.0082 UJ j	0.00032 U
ENDOSULFAN I	0.00013 U	0.00014 U	0.0013 U	0.00013 U	0.00014 U	0.015 U	0.00013 U
ENDOSULFAN II	0.00023 U	0.00025 U	0.0023 U	0.00023 U	0.00025 U	0.011 U	0.00023 U
ENDOSULFAN SULFATE	0.00017 U	0.00018 U	0.0017 U	0.00017 U	0.00018 U	0.011 U	0.00017 U
ENDRIN	0.00014 U	0.00015 U	0.0014 U	0.00014 U	0.00015 U	0.0014 U	0.00014 U
ENDRIN ALDEHYDE	0.00037 U	0.0004 U	0.0037 U	0.00037 U	0.00039 U	0.014	0.00037 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB05	10-SB05	10-SB06	10-SB06	10-SB06	10-SB07	10-SB07
Sample ID	30210SB05002	30210SB05003	30210SB06001	30210SB06002	30210SB06003	30210SB07001	30210SB07002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	2.50 - 4.00	6.00 - 8.00	0.50 - 2.00	3.50 - 5.00	6.50 - 8.00	0.50 - 2.00	3.50 - 4.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00017 U	0.00018 U	0.0017 U	0.00017 U	0.00018 U	0.0017 U	0.00017 U
GAMMA-BHC (LINDANE)	0.00025 U	0.00027 U	0.0026 U	0.00037 U	0.00027 U	0.0026 U	0.00026 U
GAMMA-CHLORDANE	0.00016 U	0.00017 U	0.0045 J g	0.00038 UJ j	0.00017 U	0.36	0.00038 UJ j
HEPTACHLOR	0.00014 U	0.00015 U	0.0014 U	0.00014 U	0.00015 U	0.041	0.00014 U
HEPTACHLOR EPOXIDE	0.00014 U	0.00016 U	0.0015 U	0.00014 U	0.00016 U	0.016	0.00015 U
METHOXYCHLOR	0.00017 U	0.00078 UJ j	0.0021 U	0.00017 U	0.00018 U	0.0017 U	0.00017 U
TOXAPHENE	0.0095 U	0.011 U	0.096 U	0.0095 U	0.011 U	0.53 U	0.0096 U
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB05	10-SB05	10-SB06	10-SB06	10-SB06	10-SB07	10-SB07
Sample ID	30210SB05002	30210SB05003	30210SB06001	30210SB06002	30210SB06003	30210SB07001	30210SB07002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	2.50 - 4.00	6.00 - 8.00	0.50 - 2.00	3.50 - 5.00	6.50 - 8.00	0.50 - 2.00	3.50 - 4.50
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB07	10-SB08	10-SB08	10-SB08	10-SB09	10-SB09	10-SB09
Sample ID	30210SB07003	30210SB08001	30210SB08002	30210SB08003	30210SB09001	30210SB09002	30210SB09003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	4.00 - 5.50	6.50 - 8.00	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB07	10-SB08	10-SB08	10-SB08	10-SB09	10-SB09	10-SB09
Sample ID	30210SB07003	30210SB08001	30210SB08002	30210SB08003	30210SB09001	30210SB09002	30210SB09003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	4.00 - 5.50	6.50 - 8.00	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB07	10-SB08	10-SB08	10-SB08	10-SB09	10-SB09	10-SB09
Sample ID	30210SB07003	30210SB08001	30210SB08002	30210SB08003	30210SB09001	30210SB09002	30210SB09003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	4.00 - 5.50	6.50 - 8.00	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	NA	NA	NA	NA	NA
2,4,5-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4,6-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DIMETHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DINITROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DINITROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2,6-DINITROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-CHLORONAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2-METHYLNAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
2-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
2-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
2-NITROPHENOL	NA	NA	NA	NA	NA	NA	NA
3,3'-DICHLOROBENZIDINE	NA	NA	NA	NA	NA	NA	NA
3-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
4,6-DINITRO-2-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
4-BROMOPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	NA	NA
4-CHLORO-3-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
4-CHLOROANILINE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	NA	NA
4-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB07	10-SB08	10-SB08	10-SB08	10-SB09	10-SB09	10-SB09
Sample ID	30210SB07003	30210SB08001	30210SB08002	30210SB08003	30210SB09001	30210SB09002	30210SB09003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	4.00 - 5.50	6.50 - 8.00	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
4-NITROPHENOL	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHENE	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHYLENE	NA	NA	NA	NA	NA	NA	NA
ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
BENZO(A)ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
BENZO(A)PYRENE	NA	NA	NA	NA	NA	NA	NA
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
BENZO(G,H,I)PERYLENE	NA	NA	NA	NA	NA	NA	NA
BENZO(K)FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
BIS(2-CHLOROETHOXY)METHANE	NA	NA	NA	NA	NA	NA	NA
BIS(2-CHLOROETHYL)ETHER	NA	NA	NA	NA	NA	NA	NA
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	NA	NA	NA	NA
BUTYLBENZYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
CARBAZOLE	NA	NA	NA	NA	NA	NA	NA
CHRYSENE	NA	NA	NA	NA	NA	NA	NA
DI-N-BUTYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DI-N-OCTYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
DIBENZOFURAN	NA	NA	NA	NA	NA	NA	NA
DIETHYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DIMETHYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
FLUORENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROCYCLOPENTADIENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	NA	NA	NA	NA
ISOPHORONE	NA	NA	NA	NA	NA	NA	NA
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	NA	NA	NA	NA	NA
N-NITROSODIPHENYLAMINE (1)	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
NITROBENZENE	NA	NA	NA	NA	NA	NA	NA
PENTACHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB07	10-SB08	10-SB08	10-SB08	10-SB09	10-SB09	10-SB09
Sample ID	30210SB07003	30210SB08001	30210SB08002	30210SB08003	30210SB09001	30210SB09002	30210SB09003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	4.00 - 5.50	6.50 - 8.00	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	NA	NA	NA	NA	NA	NA	NA
PHENOL	NA	NA	NA	NA	NA	NA	NA
PYRENE	NA	NA	NA	NA	NA	NA	NA
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.00016 U	0.0082	0.00016 U	0.00017 U	0.0066	0.0008 J g	0.00016 U
4,4'-DDE	0.00026 U	0.0048	0.00026 U	0.00027 U	0.0034	0.00026 U	0.00026 U
4,4'-DDT	0.00018 U	0.025	0.00033 UJ g	0.00019 U	0.0057	0.0011 J g	0.00018 U
ALDRIN	0.00025 U	0.00025 U	0.00025 U	0.00026 U	0.00025 U	0.00025 U	0.00025 U
ALPHA-BHC	0.00011 U	0.00011 U	0.00011 U	0.00012 U	0.00011 U	0.00011 U	0.00011 U
ALPHA-CHLORDANE	0.00012 U	0.0049	0.00012 U	0.00012 U	0.0014	0.00036 UJ g	0.00012 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00016 U	0.00016 U	0.00016 U	0.00017 U	0.00016 U	0.00016 U	0.00016 U
DELTA-BHC	0.00039 U	0.00039 U	0.00039 U	0.00041 U	0.00039 U	0.00039 U	0.00039 U
DIELDRIN	0.00033 U	0.00033 U	0.00032 U	0.00034 U	0.00032 U	0.00032 U	0.00033 U
ENDOSULFAN I	0.00013 U	0.0011 U	0.00013 U	0.00014 U	0.00013 U	0.00013 U	0.00013 U
ENDOSULFAN II	0.00023 U	0.00023 U	0.00023 U	0.00024 U	0.00023 U	0.00023 U	0.00023 U
ENDOSULFAN SULFATE	0.00017 U	0.0011 J g	0.00017 U	0.00018 U	0.00084 J g	0.00017 U	0.00017 U
ENDRIN	0.00014 U	0.00014 U	0.00014 U	0.00015 U	0.00014 U	0.00014 U	0.00014 U
ENDRIN ALDEHYDE	0.00037 U	0.00038 U	0.00037 U	0.00039 U	0.00037 U	0.00037 U	0.00038 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB07	10-SB08	10-SB08	10-SB08	10-SB09	10-SB09	10-SB09
Sample ID	30210SB07003	30210SB08001	30210SB08002	30210SB08003	30210SB09001	30210SB09002	30210SB09003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	4.00 - 5.50	6.50 - 8.00	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00017 U	0.00035 UJ g	0.00017 U	0.00018 U	0.00017 U	0.00017 U	0.00017 U
GAMMA-BHC (LINDANE)	0.00026 U	0.00064 U	0.00026 U	0.00027 U	0.00026 U	0.00026 U	0.00026 U
GAMMA-CHLORDANE	0.00016 U	0.0072	0.00016 U	0.00017 U	0.0021	0.00053 UJ g	0.00016 U
HEPTACHLOR	0.00015 U	0.00057 J g	0.00014 U	0.00015 U	0.00014 U	0.00015 U	0.00015 U
HEPTACHLOR EPOXIDE	0.00015 U	0.00015 U	0.00015 U	0.00015 U	0.00015 U	0.00015 U	0.00015 U
METHOXYCHLOR	0.00017 U	0.00017 U	0.00017 U	0.00018 U	0.00017 U	0.00017 U	0.00017 U
TOXAPHENE	0.0097 U	0.053 U	0.0096 U	0.011 U	0.021 U	0.0096 U	0.0097 U
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB07	10-SB08	10-SB08	10-SB08	10-SB09	10-SB09	10-SB09
Sample ID	30210SB07003	30210SB08001	30210SB08002	30210SB08003	30210SB09001	30210SB09002	30210SB09003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	4.00 - 5.50	6.50 - 8.00	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB10	10-SB10	10-SB10	10-SB11	10-SB11	10-SB11	10-SB12
Sample ID	30210SB10001	30210SB10002	30210SB10003	30210SB11001	30210SB11002	30210SB11003	30210SB12001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB10	10-SB10	10-SB10	10-SB11	10-SB11	10-SB11	10-SB12
Sample ID	30210SB10001	30210SB10002	30210SB10003	30210SB11001	30210SB11002	30210SB11003	30210SB12001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB10	10-SB10	10-SB10	10-SB11	10-SB11	10-SB11	10-SB12
Sample ID	30210SB10001	30210SB10002	30210SB10003	30210SB11001	30210SB11002	30210SB11003	30210SB12001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	NA	NA	NA	NA	NA
2,4,5-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4,6-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DIMETHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DINITROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DINITROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2,6-DINITROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-CHLORONAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2-METHYLNAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
2-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
2-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
2-NITROPHENOL	NA	NA	NA	NA	NA	NA	NA
3,3'-DICHLOROBENZIDINE	NA	NA	NA	NA	NA	NA	NA
3-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
4,6-DINITRO-2-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
4-BROMOPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	NA	NA
4-CHLORO-3-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
4-CHLOROANILINE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	NA	NA
4-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB10	10-SB10	10-SB10	10-SB11	10-SB11	10-SB11	10-SB12
Sample ID	30210SB10001	30210SB10002	30210SB10003	30210SB11001	30210SB11002	30210SB11003	30210SB12001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
4-NITROPHENOL	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHENE	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHYLENE	NA	NA	NA	NA	NA	NA	NA
ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
BENZO(A)ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
BENZO(A)PYRENE	NA	NA	NA	NA	NA	NA	NA
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
BENZO(G,H,I)PERYLENE	NA	NA	NA	NA	NA	NA	NA
BENZO(K)FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
BIS(2-CHLOROETHOXY)METHANE	NA	NA	NA	NA	NA	NA	NA
BIS(2-CHLOROETHYL)ETHER	NA	NA	NA	NA	NA	NA	NA
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	NA	NA	NA	NA
BUTYLBENZYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
CARBAZOLE	NA	NA	NA	NA	NA	NA	NA
CHRYSENE	NA	NA	NA	NA	NA	NA	NA
DI-N-BUTYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DI-N-OCTYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
DIBENZOFURAN	NA	NA	NA	NA	NA	NA	NA
DIETHYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DIMETHYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
FLUORENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROCYCLOPENTADIENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	NA	NA	NA	NA
ISOPHORONE	NA	NA	NA	NA	NA	NA	NA
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	NA	NA	NA	NA	NA
N-NITROSODIPHENYLAMINE (1)	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
NITROBENZENE	NA	NA	NA	NA	NA	NA	NA
PENTACHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB10	10-SB10	10-SB10	10-SB11	10-SB11	10-SB11	10-SB12
Sample ID	30210SB10001	30210SB10002	30210SB10003	30210SB11001	30210SB11002	30210SB11003	30210SB12001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	NA	NA	NA	NA	NA	NA	NA
PHENOL	NA	NA	NA	NA	NA	NA	NA
PYRENE	NA	NA	NA	NA	NA	NA	NA
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.043	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.00017 U	1
4,4'-DDE	0.05	0.00026 U	0.00026 U	0.00026 U	0.00026 U	0.00027 U	0.11 J g
4,4'-DDT	0.13	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00019 U	0.75
ALDRIN	0.0024 U	0.00024 U	0.00025 U	0.00025 U	0.00025 U	0.00026 U	0.0013 U
ALPHA-BHC	0.0011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00012 U	0.00053 U
ALPHA-CHLORDANE	0.023	0.0003 UJ g	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.17
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.0016 U	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.00017 U	0.00076 U
DELTA-BHC	0.0038 U	0.00038 U	0.00039 U	0.00039 U	0.00039 U	0.00041 U	0.002 U
DIELDRIN	0.0032 U	0.00032 U	0.00032 U	0.00032 U	0.00032 U	0.00034 U	0.0081 U
ENDOSULFAN I	0.011 U	0.00013 U	0.00013 U	0.00013 U	0.00013 U	0.00014 U	0.021 U
ENDOSULFAN II	0.0023 U	0.00023 U	0.00023 U	0.00023 U	0.00023 U	0.00024 U	0.023 U
ENDOSULFAN SULFATE	0.0058 J g	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.00018 U	0.39
ENDRIN	0.0014 U	0.00014 U	0.00014 U	0.00014 U	0.00014 U	0.00015 U	0.0074 U
ENDRIN ALDEHYDE	0.0037 U	0.00037 U	0.00037 U	0.00037 U	0.00037 U	0.00039 U	0.015

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB10	10-SB10	10-SB10	10-SB11	10-SB11	10-SB11	10-SB12
Sample ID	30210SB10001	30210SB10002	30210SB10003	30210SB11001	30210SB11002	30210SB11003	30210SB12001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0017 U	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.00018 U	0.00083 U
GAMMA-BHC (LINDANE)	0.0025 U	0.00025 U	0.00026 U	0.00026 U	0.00026 U	0.00027 U	0.0013 U
GAMMA-CHLORDANE	0.034	0.00043 UJ g	0.00016 U	0.00016 U	0.00016 U	0.00017 U	0.25
HEPTACHLOR	0.0019 J g	0.00014 U	0.00015 U	0.00014 U	0.00015 U	0.00015 U	0.0073
HEPTACHLOR EPOXIDE	0.0061 U	0.00014 U	0.00015 U	0.00015 U	0.00015 U	0.00015 U	0.0034 J g
METHOXYCHLOR	0.0017 U	0.00017 U	0.00037 UJ g	0.00017 U	0.00017 U	0.00018 U	0.0013 U
TOXAPHENE	0.45 U	0.0095 U	0.0096 U	0.0096 U	0.0097 U	0.011 U	0.49 U
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB10	10-SB10	10-SB10	10-SB11	10-SB11	10-SB11	10-SB12
Sample ID	30210SB10001	30210SB10002	30210SB10003	30210SB11001	30210SB11002	30210SB11003	30210SB12001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB12	10-SB12	10-SB13	10-SB13	10-SB13	10-SB14	10-SB14
Sample ID	30210SB12002	30210SB12003	30210SB13001	30210SB13002	30210SB13003	30210SB14001	30210SB14002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB12	10-SB12	10-SB13	10-SB13	10-SB13	10-SB14	10-SB14
Sample ID	30210SB12002	30210SB12003	30210SB13001	30210SB13002	30210SB13003	30210SB14001	30210SB14002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB12	10-SB12	10-SB13	10-SB13	10-SB13	10-SB14	10-SB14
Sample ID	30210SB12002	30210SB12003	30210SB13001	30210SB13002	30210SB13003	30210SB14001	30210SB14002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	NA	NA	NA	NA	NA
2,4,5-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4,6-TRICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DICHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DIMETHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DINITROPHENOL	NA	NA	NA	NA	NA	NA	NA
2,4-DINITROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2,6-DINITROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-CHLORONAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA
2-METHYLNAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
2-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
2-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
2-NITROPHENOL	NA	NA	NA	NA	NA	NA	NA
3,3'-DICHLOROBENZIDINE	NA	NA	NA	NA	NA	NA	NA
3-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
4,6-DINITRO-2-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
4-BROMOPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	NA	NA
4-CHLORO-3-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA
4-CHLOROANILINE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	NA	NA
4-METHYLPHENOL	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB12	10-SB12	10-SB13	10-SB13	10-SB13	10-SB14	10-SB14
Sample ID	30210SB12002	30210SB12003	30210SB13001	30210SB13002	30210SB13003	30210SB14001	30210SB14002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	NA	NA	NA	NA	NA	NA	NA
4-NITROPHENOL	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHENE	NA	NA	NA	NA	NA	NA	NA
ACENAPHTHYLENE	NA	NA	NA	NA	NA	NA	NA
ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
BENZO(A)ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
BENZO(A)PYRENE	NA	NA	NA	NA	NA	NA	NA
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
BENZO(G,H,I)PERYLENE	NA	NA	NA	NA	NA	NA	NA
BENZO(K)FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
BIS(2-CHLOROETHOXY)METHANE	NA	NA	NA	NA	NA	NA	NA
BIS(2-CHLOROETHYL)ETHER	NA	NA	NA	NA	NA	NA	NA
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	NA	NA	NA	NA
BUTYLBENZYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
CARBAZOLE	NA	NA	NA	NA	NA	NA	NA
CHRYSENE	NA	NA	NA	NA	NA	NA	NA
DI-N-BUTYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DI-N-OCTYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	NA	NA	NA	NA
DIBENZOFURAN	NA	NA	NA	NA	NA	NA	NA
DIETHYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
DIMETHYLPHTHALATE	NA	NA	NA	NA	NA	NA	NA
FLUORANTHENE	NA	NA	NA	NA	NA	NA	NA
FLUORENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROCYCLOPENTADIENE	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	NA	NA	NA	NA
ISOPHORONE	NA	NA	NA	NA	NA	NA	NA
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	NA	NA	NA	NA	NA
N-NITROSODIPHENYLAMINE (1)	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
NITROBENZENE	NA	NA	NA	NA	NA	NA	NA
PENTACHLOROPHENOL	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB12	10-SB12	10-SB13	10-SB13	10-SB13	10-SB14	10-SB14
Sample ID	30210SB12002	30210SB12003	30210SB13001	30210SB13002	30210SB13003	30210SB14001	30210SB14002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	NA	NA	NA	NA	NA	NA	NA
PHENOL	NA	NA	NA	NA	NA	NA	NA
PYRENE	NA	NA	NA	NA	NA	NA	NA
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.00055 J	0.00017 U	0.066	0.0018	0.00045 UJ j	0.00017 U	0.00016 U
4,4'-DDE	0.00026 U	0.00027 U	0.014	0.00026 U	0.00027 U	0.00027 U	0.00026 U
4,4'-DDT	0.00033 UJ g	0.00019 U	0.099	0.0027	0.00029 UJ g	0.00019 U	0.00018 U
ALDRIN	0.00025 U	0.00026 U	0.0021 U	0.00025 U	0.00025 U	0.00026 U	0.00025 U
ALPHA-BHC	0.00011 U	0.00012 U	0.00021 U	0.00011 U	0.00011 U	0.0011 U	0.00011 U
ALPHA-CHLORDANE	0.00012 U	0.00012 U	0.16	0.00076 J g	0.00012 U	0.0025	0.00012 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00016 U	0.00016 U	0.00031 U	0.00027 U	0.00016 U	0.00016 U	0.00016 U
DELTA-BHC	0.00039 U	0.0004 U	0.0021 U	0.00039 U	0.0004 U	0.0004 U	0.00039 U
DIELDRIN	0.00032 U	0.00034 U	0.00063 U	0.00032 U	0.00033 U	0.00033 U	0.00032 U
ENDOSULFAN I	0.00013 U	0.00014 U	0.0083 U	0.00013 U	0.00014 U	0.00014 U	0.00013 U
ENDOSULFAN II	0.00023 U	0.00024 U	0.0053 U	0.00023 U	0.00024 U	0.00024 U	0.00023 U
ENDOSULFAN SULFATE	0.00017 U	0.00018 U	0.023	0.00048 UJ g	0.00018 U	0.00018 U	0.00017 U
ENDRIN	0.00014 U	0.00015 U	0.00028 U	0.00014 U	0.00015 U	0.00015 U	0.00014 U
ENDRIN ALDEHYDE	0.00037 U	0.00039 U	0.00073 U	0.00037 U	0.00038 U	0.00038 U	0.00037 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB12	10-SB12	10-SB13	10-SB13	10-SB13	10-SB14	10-SB14
Sample ID	30210SB12002	30210SB12003	30210SB13001	30210SB13002	30210SB13003	30210SB14001	30210SB14002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00017 U	0.00018 U	0.00033 U	0.00017 U	0.00018 U	0.00018 U	0.00017 U
GAMMA-BHC (LINDANE)	0.00026 U	0.00027 U	0.0005 U	0.00026 U	0.00027 U	0.00027 U	0.00026 U
GAMMA-CHLORDANE	0.00016 U	0.00016 U	0.21	0.0011 U	0.00016 U	0.0089	0.00016 U
HEPTACHLOR	0.00014 U	0.00015 U	0.034	0.00048 UJ g	0.00015 U	0.0066	0.00038 UJ g
HEPTACHLOR EPOXIDE	0.00015 U	0.00015 U	0.013	0.00015 U	0.00055 J g	0.0019	0.00015 U
METHOXYCHLOR	0.00017 U	0.00018 U	0.0034 U	0.00017 U	0.00018 U	0.00018 U	0.00017 U
TOXAPHENE	0.0096 U	0.01 U	0.27 U	0.0097 U	0.0099 U	0.0099 U	0.0096 U
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB12	10-SB12	10-SB13	10-SB13	10-SB13	10-SB14	10-SB14
Sample ID	30210SB12002	30210SB12003	30210SB13001	30210SB13002	30210SB13003	30210SB14001	30210SB14002
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	3.00 - 4.50	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB14	10-SB15	10-SB15	10-SB15	10-SB16	10-SB16	10-SB16
Sample ID	30210SB14003	30210SB15001	30210SB15002	30210SB15003	30210SB16001	30210SB16002	30210SB16003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB14	10-SB15	10-SB15	10-SB15	10-SB16	10-SB16	10-SB16
Sample ID	30210SB14003	30210SB15001	30210SB15002	30210SB15003	30210SB16001	30210SB16002	30210SB16003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB14	10-SB15	10-SB15	10-SB15	10-SB16	10-SB16	10-SB16
Sample ID	30210SB14003	30210SB15001	30210SB15002	30210SB15003	30210SB16001	30210SB16002	30210SB16003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	NA	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
1,2-DICHLOROBENZENE	NA	0.019 U	0.019 U	0.02 U	0.019 U	0.019 U	0.02 U
1,3-DICHLOROBENZENE	NA	0.019 U	0.019 U	0.02 U	0.019 U	0.019 U	0.02 U
1,4-DICHLOROBENZENE	NA	0.018 U	0.019 U	0.019 U	0.018 U	0.019 U	0.02 U
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U
2,4,5-TRICHLOROPHENOL	NA	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.019 U
2,4,6-TRICHLOROPHENOL	NA	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U
2,4-DICHLOROPHENOL	NA	0.017 U	0.017 U	0.018 U	0.017 U	0.017 U	0.018 U
2,4-DIMETHYLPHENOL	NA	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.017 U
2,4-DINITROPHENOL	NA	0.12 U	0.12 U	0.13 U	0.12 U	0.12 U	0.13 U
2,4-DINITROTOLUENE	NA	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.017 U
2,6-DINITROTOLUENE	NA	0.017 U	0.017 U	0.017 U	0.016 U	0.017 U	0.017 U
2-CHLORONAPHTHALENE	NA	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U
2-CHLOROPHENOL	NA	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U
2-METHYLNAPHTHALENE	NA	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
2-METHYLPHENOL	NA	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.019 U
2-NITROANILINE	NA	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.019 U
2-NITROPHENOL	NA	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U
3,3'-DICHLOROBENZIDINE	NA	0.028 U	0.028 U	0.03 U	0.028 U	0.028 U	0.03 U
3-NITROANILINE	NA	0.18 U	0.19 U	0.19 U	0.18 U	0.19 U	0.2 U
4,6-DINITRO-2-METHYLPHENOL	NA	0.15 U	0.15 U	0.16 U	0.15 U	0.15 U	0.16 U
4-BROMOPHENYL-PHENYLETHER	NA	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U
4-CHLORO-3-METHYLPHENOL	NA	0.018 U	0.018 U	0.018 U	0.017 U	0.018 U	0.019 U
4-CHLOROANILINE	NA	0.073 J g	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U
4-CHLOROPHENYL-PHENYLETHER	NA	0.017 U	0.017 U	0.018 U	0.017 U	0.017 U	0.018 U
4-METHYLPHENOL	NA	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.019 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB14	10-SB15	10-SB15	10-SB15	10-SB16	10-SB16	10-SB16
Sample ID	30210SB14003	30210SB15001	30210SB15002	30210SB15003	30210SB16001	30210SB16002	30210SB16003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	NA	0.19 U	0.19 U	0.2 U	0.19 U	0.19 U	0.2 U
4-NITROPHENOL	NA	0.16 U	0.16 U	0.16 U	0.15 U	0.16 U	0.16 U
ACENAPHTHENE	NA	0.014 U	0.014 U	0.015 U	0.014 U	0.014 U	0.015 U
ACENAPHTHYLENE	NA	0.014 U	0.014 U	0.014 U	0.013 U	0.014 U	0.014 U
ANTHRACENE	NA	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U
BENZO(A)ANTHRACENE	NA	0.032 J g	0.013 U	0.014 U	0.016 J g	0.013 U	0.014 U
BENZO(A)PYRENE	NA	0.055	0.021 U	0.022 U	0.049 J g	0.021 U	0.022 U
BENZO(B)FLUORANTHENE	NA	0.06	0.018 U	0.019 U	0.072	0.018 U	0.019 U
BENZO(G,H,I)PERYLENE	NA	0.072	0.021 U	0.022 U	0.12	0.021 U	0.022 U
BENZO(K)FLUORANTHENE	NA	0.053	0.021 U	0.021 U	0.042 J g	0.021 U	0.022 U
BIS(2-CHLOROETHOXY)METHANE	NA	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	NA	0.013 U	0.013 U	0.013 U	0.012 U	0.013 U	0.013 U
BIS(2-ETHYLHEXYL)PHTHALATE	NA	0.35 UJ b	0.02 U	0.021 U	0.052 UJ b	0.02 U	0.021 U
BUTYLBENZYLPHTHALATE	NA	0.017 U	0.017 U	0.018 U	0.017 U	0.017 U	0.018 U
CARBAZOLE	NA	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U
CHRYSENE	NA	0.042 UJ b	0.013 U	0.013 U	0.02 UJ b	0.013 U	0.013 U
DI-N-BUTYLPHTHALATE	NA	0.028 UJ b	0.013 U	0.014 U	0.013 UJ b	0.013 U	0.014 U
DI-N-OCTYLPHTHALATE	NA	0.025 U	0.025 U	0.026 U	0.025 U	0.025 U	0.027 U
DIBENZ(A,H)ANTHRACENE	NA	0.032 J g	0.029 U	0.03 U	0.049 J g	0.029 U	0.03 U
DIBENZOFURAN	NA	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U
DIETHYLPHTHALATE	NA	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U
DIMETHYLPHTHALATE	NA	0.017 U	0.017 U	0.018 U	0.017 U	0.017 U	0.018 U
FLUORANTHENE	NA	0.027 UJ f	0.012 U	0.013 U	0.02 UJ b	0.012 U	0.013 U
FLUORENE	NA	0.014 U	0.014 U	0.015 U	0.014 U	0.014 U	0.015 U
HEXACHLOROBENZENE	NA	0.016 U	0.016 U	0.016 U	0.015 U	0.016 U	0.016 U
HEXACHLOROBUTADIENE	NA	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U
HEXACHLOROCYCLOPENTADIENE	NA	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U
HEXACHLOROETHANE	NA	0.023 U	0.023 U	0.024 U	0.023 U	0.023 U	0.024 U
INDENO(1,2,3-CD)PYRENE	NA	0.05 J g	0.041 U	0.043 U	0.061 J g	0.041 U	0.043 U
ISOPHORONE	NA	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U
N-NITROSO-DI-N-PROPYLAMINE	NA	0.02 U	0.02 U	0.021 U	0.02 U	0.02 U	0.021 U
N-NITROSODIPHENYLAMINE (1)	NA	0.019 U	0.019 U	0.02 U	0.019 U	0.019 U	0.02 U
NAPHTHALENE	NA	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U
NITROBENZENE	NA	0.027 U	0.028 U	0.029 U	0.027 U	0.027 U	0.029 U
PENTACHLOROPHENOL	NA	0.13 U	0.13 U	0.14 U	0.13 U	0.13 U	0.14 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB14	10-SB15	10-SB15	10-SB15	10-SB16	10-SB16	10-SB16
Sample ID	30210SB14003	30210SB15001	30210SB15002	30210SB15003	30210SB16001	30210SB16002	30210SB16003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	NA	0.022 UJ f	0.011 U	0.011 U	0.014 UJ f	0.011 U	0.011 U
PHENOL	NA	0.021 U	0.021 U	0.022 U	0.02 U	0.021 U	0.022 U
PYRENE	NA	0.034 UJ f	0.015 U	0.016 U	0.021 UJ f	0.015 U	0.016 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.00017 U	NA	NA	NA	NA	NA	NA
4,4'-DDE	0.00028 U	NA	NA	NA	NA	NA	NA
4,4'-DDT	0.00019 U	NA	NA	NA	NA	NA	NA
ALDRIN	0.00026 U	NA	NA	NA	NA	NA	NA
ALPHA-BHC	0.00012 U	NA	NA	NA	NA	NA	NA
ALPHA-CHLORDANE	0.00012 U	NA	NA	NA	NA	NA	NA
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00017 U	NA	NA	NA	NA	NA	NA
DELTA-BHC	0.00041 U	NA	NA	NA	NA	NA	NA
DIELDRIN	0.00034 U	NA	NA	NA	NA	NA	NA
ENDOSULFAN I	0.00014 U	NA	NA	NA	NA	NA	NA
ENDOSULFAN II	0.00025 U	NA	NA	NA	NA	NA	NA
ENDOSULFAN SULFATE	0.00018 U	NA	NA	NA	NA	NA	NA
ENDRIN	0.00015 U	NA	NA	NA	NA	NA	NA
ENDRIN ALDEHYDE	0.0004 U	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB14	10-SB15	10-SB15	10-SB15	10-SB16	10-SB16	10-SB16
Sample ID	30210SB14003	30210SB15001	30210SB15002	30210SB15003	30210SB16001	30210SB16002	30210SB16003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00018 U	NA	NA	NA	NA	NA	NA
GAMMA-BHC (LINDANE)	0.00027 U	NA	NA	NA	NA	NA	NA
GAMMA-CHLORDANE	0.00017 U	NA	NA	NA	NA	NA	NA
HEPTACHLOR	0.00015 U	NA	NA	NA	NA	NA	NA
HEPTACHLOR EPOXIDE	0.00016 U	NA	NA	NA	NA	NA	NA
METHOXYCHLOR	0.00018 U	NA	NA	NA	NA	NA	NA
TOXAPHENE	0.011 U	NA	NA	NA	NA	NA	NA
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB14	10-SB15	10-SB15	10-SB15	10-SB16	10-SB16	10-SB16
Sample ID	30210SB14003	30210SB15001	30210SB15002	30210SB15003	30210SB16001	30210SB16002	30210SB16003
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB17	10-SB17	10-SB17	10-SB18	10-SB18	10-SB18	10-SB19
Sample ID	30210SB17001	30210SB17002	30210SB17003	30210SB18001	30210SB18002	30210SB18003	30210SB19001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB17	10-SB17	10-SB17	10-SB18	10-SB18	10-SB18	10-SB19
Sample ID	30210SB17001	30210SB17002	30210SB17003	30210SB18001	30210SB18002	30210SB18003	30210SB19001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB17	10-SB17	10-SB17	10-SB18	10-SB18	10-SB18	10-SB19
Sample ID	30210SB17001	30210SB17002	30210SB17003	30210SB18001	30210SB18002	30210SB18003	30210SB19001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U	NA
1,2-DICHLOROBENZENE	0.019 U	0.019 U	0.021 U	0.019 U	0.019 U	0.02 U	NA
1,3-DICHLOROBENZENE	0.019 U	0.02 U	0.021 U	0.019 U	0.019 U	0.021 U	NA
1,4-DICHLOROBENZENE	0.018 U	0.019 U	0.02 U	0.018 U	0.018 U	0.02 U	NA
2,2'-OXYBIS(1-CHLOROPROPANE)	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U	NA
2,4,5-TRICHLOROPHENOL	0.018 U	0.019 U	0.02 U	0.018 U	0.018 U	0.019 U	NA
2,4,6-TRICHLOROPHENOL	0.015 U	0.016 U	0.017 U	0.015 U	0.015 U	0.016 U	NA
2,4-DICHLOROPHENOL	0.017 U	0.018 U	0.019 U	0.017 U	0.017 U	0.019 U	NA
2,4-DIMETHYLPHENOL	0.016 U	0.016 U	0.018 U	0.016 U	0.016 U	0.017 U	NA
2,4-DINITROPHENOL	0.12 U	0.12 U	0.13 U	0.12 U	0.12 U	0.13 U	NA
2,4-DINITROTOLUENE	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.017 U	NA
2,6-DINITROTOLUENE	0.016 U	0.017 U	0.018 U	0.016 U	0.016 U	0.018 U	NA
2-CHLORONAPHTHALENE	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.012 U	NA
2-CHLOROPHENOL	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.011 U	NA
2-METHYLNAPHTHALENE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U	NA
2-METHYLPHENOL	0.018 U	0.018 U	0.019 U	0.017 U	0.018 U	0.019 U	NA
2-NITROANILINE	0.018 U	0.018 U	0.02 U	0.018 U	0.018 U	0.019 U	NA
2-NITROPHENOL	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U	NA
3,3'-DICHLOROBENZIDINE	0.028 U	0.029 U	0.031 U	0.028 U	0.028 U	0.03 U	NA
3-NITROANILINE	0.18 U	0.19 U	0.2 U	0.18 U	0.18 U	0.2 U	NA
4,6-DINITRO-2-METHYLPHENOL	0.15 U	0.16 U	0.17 U	0.15 U	0.15 U	0.16 U	NA
4-BROMOPHENYL-PHENYLETHER	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U	NA
4-CHLORO-3-METHYLPHENOL	0.017 U	0.018 U	0.019 U	0.017 U	0.018 U	0.019 U	NA
4-CHLOROANILINE	0.015 U	0.016 U	0.017 U	0.015 U	0.015 U	0.016 U	NA
4-CHLOROPHENYL-PHENYLETHER	0.017 U	0.017 U	0.019 U	0.017 U	0.017 U	0.018 U	NA
4-METHYLPHENOL	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.019 U	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB17	10-SB17	10-SB17	10-SB18	10-SB18	10-SB18	10-SB19
Sample ID	30210SB17001	30210SB17002	30210SB17003	30210SB18001	30210SB18002	30210SB18003	30210SB19001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.19 U	0.19 U	0.21 U	0.19 U	0.19 U	0.2 U	NA
4-NITROPHENOL	0.15 U	0.16 U	0.17 U	0.15 U	0.15 U	0.17 U	NA
ACENAPHTHENE	0.014 U	0.015 U	0.016 U	0.014 U	0.014 U	0.015 U	NA
ACENAPHTHYLENE	0.013 U	0.014 U	0.03 J g	0.013 U	0.014 U	0.015 U	NA
ANTHRACENE	0.015 U	0.015 U	0.17	0.015 U	0.015 U	0.016 U	NA
BENZO(A)ANTHRACENE	0.013 U	0.013 U	0.29	0.013 U	0.013 U	0.014 U	NA
BENZO(A)PYRENE	0.041 J g	0.021 U	0.3	0.021 U	0.021 U	0.022 U	NA
BENZO(B)FLUORANTHENE	0.041 J g	0.019 U	0.16	0.018 U	0.018 U	0.02 U	NA
BENZO(G,H,I)PERYLENE	0.12	0.022 U	0.25	0.021 U	0.021 U	0.028 J g	NA
BENZO(K)FLUORANTHENE	0.031 J g	0.021 U	0.25	0.02 U	0.02 U	0.022 U	NA
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U	NA
BIS(2-CHLOROETHYL)ETHER	0.012 U	0.013 U	0.014 U	0.012 U	0.012 U	0.013 U	NA
BIS(2-ETHYLHEXYL)PHTHALATE	0.03 UJ b	0.02 U	0.021 U	0.019 U	0.02 U	0.021 U	NA
BUTYLBENZYLPHTHALATE	0.017 U	0.018 U	0.019 U	0.017 U	0.017 U	0.019 U	NA
CARBAZOLE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U	NA
CHRYSENE	0.013 U	0.015 UJ b	0.31	0.012 U	0.013 U	0.015 UJ b	NA
DI-N-BUTYLPHTHALATE	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U	NA
DI-N-OCTYLPHTHALATE	0.025 U	0.026 U	0.028 U	0.025 U	0.025 U	0.027 U	NA
DIBENZ(A,H)ANTHRACENE	0.063	0.03 U	0.032 U	0.028 U	0.029 U	0.031 U	NA
DIBENZOFURAN	0.013 U	0.013 U	0.014 U	0.012 U	0.013 U	0.014 U	NA
DIETHYLPHTHALATE	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U	NA
DIMETHYLPHTHALATE	0.017 U	0.018 U	0.019 U	0.017 U	0.017 U	0.019 U	NA
FLUORANTHENE	0.012 U	0.019 UJ b	0.54	0.012 U	0.012 U	0.013 U	NA
FLUORENE	0.014 U	0.014 U	0.055 J g	0.014 U	0.014 U	0.015 U	NA
HEXACHLOROBENZENE	0.015 U	0.016 U	0.017 U	0.015 U	0.016 U	0.017 U	NA
HEXACHLOROBUTADIENE	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U	NA
HEXACHLOROCYCLOPENTADIENE	0.013 U	0.014 U	0.015 U	0.013 U	0.013 U	0.014 U	NA
HEXACHLOROETHANE	0.023 U	0.023 U	0.025 U	0.022 U	0.023 U	0.024 U	NA
INDENO(1,2,3-CD)PYRENE	0.088	0.042 U	0.25	0.04 U	0.04 U	0.044 U	NA
ISOPHORONE	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.016 U	NA
N-NITROSO-DI-N-PROPYLAMINE	0.02 U	0.021 U	0.022 U	0.02 U	0.02 U	0.022 U	NA
N-NITROSODIPHENYLAMINE (1)	0.019 U	0.019 U	0.021 U	0.019 U	0.019 U	0.02 U	NA
NAPHTHALENE	0.015 U	0.016 U	0.017 U	0.015 U	0.015 U	0.016 U	NA
NITROBENZENE	0.027 U	0.028 U	0.03 U	0.027 U	0.027 U	0.029 U	NA
PENTACHLOROPHENOL	0.13 U	0.14 U	0.15 U	0.13 U	0.13 U	0.14 U	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB17	10-SB17	10-SB17	10-SB18	10-SB18	10-SB18	10-SB19
Sample ID	30210SB17001	30210SB17002	30210SB17003	30210SB18001	30210SB18002	30210SB18003	30210SB19001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.011 U	0.02 UJ f	0.61	0.011 U	0.011 U	0.012 U	NA
PHENOL	0.02 U	0.021 U	0.023 U	0.02 U	0.02 U	0.022 U	NA
PYRENE	0.015 U	0.025 UJ f	0.68	0.015 U	0.015 U	0.017 UJ f	NA
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	NA	NA	NA	NA	NA	NA	0.00016 U
4,4'-DDE	NA	NA	NA	NA	NA	NA	0.00026 U
4,4'-DDT	NA	NA	NA	NA	NA	NA	0.00018 U
ALDRIN	NA	NA	NA	NA	NA	NA	0.00025 U
ALPHA-BHC	NA	NA	NA	NA	NA	NA	0.00011 U
ALPHA-CHLORDANE	NA	NA	NA	NA	NA	NA	0.00012 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	NA	NA	NA	NA	NA	NA	0.00025 U
DELTA-BHC	NA	NA	NA	NA	NA	NA	0.00039 U
DIELDRIN	NA	NA	NA	NA	NA	NA	0.00032 U
ENDOSULFAN I	NA	NA	NA	NA	NA	NA	0.00013 U
ENDOSULFAN II	NA	NA	NA	NA	NA	NA	0.00023 U
ENDOSULFAN SULFATE	NA	NA	NA	NA	NA	NA	0.00017 U
ENDRIN	NA	NA	NA	NA	NA	NA	0.00014 U
ENDRIN ALDEHYDE	NA	NA	NA	NA	NA	NA	0.00037 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB17	10-SB17	10-SB17	10-SB18	10-SB18	10-SB18	10-SB19
Sample ID	30210SB17001	30210SB17002	30210SB17003	30210SB18001	30210SB18002	30210SB18003	30210SB19001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	NA	NA	NA	NA	NA	NA	0.00017 U
GAMMA-BHC (LINDANE)	NA	NA	NA	NA	NA	NA	0.00026 U
GAMMA-CHLORDANE	NA	NA	NA	NA	NA	NA	0.00016 U
HEPTACHLOR	NA	NA	NA	NA	NA	NA	0.00014 U
HEPTACHLOR EPOXIDE	NA	NA	NA	NA	NA	NA	0.00015 U
METHOXYCHLOR	NA	NA	NA	NA	NA	NA	0.00017 U
TOXAPHENE	NA	NA	NA	NA	NA	NA	0.0096 U
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB17	10-SB17	10-SB17	10-SB18	10-SB18	10-SB18	10-SB19
Sample ID	30210SB17001	30210SB17002	30210SB17003	30210SB18001	30210SB18002	30210SB18003	30210SB19001
Sample Date	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/22/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB19	10-SB19	10-SB20	10-SB20	10-SB20	10-SB21	10-SB21
Sample ID	30210SB19002	30210SB19003	30210SB20001	30210SB20002	30210SB20003	30210SB21001	30210SB21002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB19	10-SB19	10-SB20	10-SB20	10-SB20	10-SB21	10-SB21
Sample ID	30210SB19002	30210SB19003	30210SB20001	30210SB20002	30210SB20003	30210SB21001	30210SB21002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB19	10-SB19	10-SB20	10-SB20	10-SB20	10-SB21	10-SB21
Sample ID	30210SB19002	30210SB19003	30210SB20001	30210SB20002	30210SB20003	30210SB21001	30210SB21002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	0.012 U	0.014 U
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	0.019 U	0.022 U
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	0.019 U	0.022 U
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	0.018 U	0.021 U
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	NA	NA	NA	0.015 U	0.017 U
2,4,5-TRICHLOROPHENOL	NA	NA	NA	NA	NA	0.018 U	0.021 U
2,4,6-TRICHLOROPHENOL	NA	NA	NA	NA	NA	0.015 U	0.018 U
2,4-DICHLOROPHENOL	NA	NA	NA	NA	NA	0.017 U	0.02 U
2,4-DIMETHYLPHENOL	NA	NA	NA	NA	NA	0.016 U	0.019 U
2,4-DINITROPHENOL	NA	NA	NA	NA	NA	0.12 U	0.14 U
2,4-DINITROTOLUENE	NA	NA	NA	NA	NA	0.016 U	0.018 U
2,6-DINITROTOLUENE	NA	NA	NA	NA	NA	0.016 U	0.019 U
2-CHLORONAPHTHALENE	NA	NA	NA	NA	NA	0.011 U	0.012 U
2-CHLOROPHENOL	NA	NA	NA	NA	NA	0.011 U	0.012 U
2-METHYLNAPHTHALENE	NA	NA	NA	NA	NA	0.012 U	0.014 U
2-METHYLPHENOL	NA	NA	NA	NA	NA	0.018 U	0.02 U
2-NITROANILINE	NA	NA	NA	NA	NA	0.018 U	0.021 U
2-NITROPHENOL	NA	NA	NA	NA	NA	0.015 U	0.017 U
3,3'-DICHLOROBENZIDINE	NA	NA	NA	NA	NA	0.028 U	0.033 U
3-NITROANILINE	NA	NA	NA	NA	NA	0.18 U	0.21 U
4,6-DINITRO-2-METHYLPHENOL	NA	NA	NA	NA	NA	0.15 U	0.18 U
4-BROMOPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	0.013 U	0.015 U
4-CHLORO-3-METHYLPHENOL	NA	NA	NA	NA	NA	0.018 U	0.02 U
4-CHLOROANILINE	NA	NA	NA	NA	NA	0.015 U	0.018 U
4-CHLOROPHENYL-PHENYLETHER	NA	NA	NA	NA	NA	0.017 U	0.02 U
4-METHYLPHENOL	NA	NA	NA	NA	NA	0.018 U	0.021 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB19	10-SB19	10-SB20	10-SB20	10-SB20	10-SB21	10-SB21
Sample ID	30210SB19002	30210SB19003	30210SB20001	30210SB20002	30210SB20003	30210SB21001	30210SB21002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	NA	NA	NA	NA	NA	0.19 U	0.22 U
4-NITROPHENOL	NA	NA	NA	NA	NA	0.15 U	0.18 U
ACENAPHTHENE	NA	NA	NA	NA	NA	0.014 U	0.017 U
ACENAPHTHYLENE	NA	NA	NA	NA	NA	0.014 U	0.016 U
ANTHRACENE	NA	NA	NA	NA	NA	0.015 U	0.017 U
BENZO(A)ANTHRACENE	NA	NA	NA	NA	NA	0.013 U	0.015 U
BENZO(A)PYRENE	NA	NA	NA	NA	NA	0.021 U	0.024 U
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	NA	0.018 J g	0.021 U
BENZO(G,H,I)PERYLENE	NA	NA	NA	NA	NA	0.021 U	0.025 U
BENZO(K)FLUORANTHENE	NA	NA	NA	NA	NA	0.02 U	0.024 U
BIS(2-CHLOROETHOXY)METHANE	NA	NA	NA	NA	NA	0.012 U	0.014 U
BIS(2-CHLOROETHYL)ETHER	NA	NA	NA	NA	NA	0.012 U	0.015 U
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	NA	NA	NA	0.02 U	0.023 U
BUTYLBENZYLPHTHALATE	NA	NA	NA	NA	NA	0.017 U	0.02 U
CARBAZOLE	NA	NA	NA	NA	NA	0.012 U	0.014 U
CHRYSENE	NA	NA	NA	NA	NA	0.013 U	0.015 U
DI-N-BUTYLPHTHALATE	NA	NA	NA	NA	NA	0.013 U	0.015 U
DI-N-OCTYLPHTHALATE	NA	NA	NA	NA	NA	0.025 U	0.029 U
DIBENZ(A,H)ANTHRACENE	NA	NA	NA	NA	NA	0.029 U	0.033 U
DIBENZOFURAN	NA	NA	NA	NA	NA	0.013 U	0.015 U
DIETHYLPHTHALATE	NA	NA	NA	NA	NA	0.015 U	0.017 U
DIMETHYLPHTHALATE	NA	NA	NA	NA	NA	0.017 U	0.02 U
FLUORANTHENE	NA	NA	NA	NA	NA	0.012 U	0.014 U
FLUORENE	NA	NA	NA	NA	NA	0.014 U	0.016 U
HEXACHLOROBENZENE	NA	NA	NA	NA	NA	0.016 U	0.018 U
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	0.015 U	0.017 U
HEXACHLOROCYCLOPENTADIENE	NA	NA	NA	NA	NA	0.013 U	0.015 U
HEXACHLOROETHANE	NA	NA	NA	NA	NA	0.023 U	0.026 U
INDENO(1,2,3-CD)PYRENE	NA	NA	NA	NA	NA	0.04 U	0.047 U
ISOPHORONE	NA	NA	NA	NA	NA	0.015 U	0.017 U
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	NA	NA	NA	0.02 U	0.023 U
N-NITROSODIPHENYLAMINE (1)	NA	NA	NA	NA	NA	0.019 U	0.022 U
NAPHTHALENE	NA	NA	NA	NA	NA	0.015 U	0.018 U
NITROBENZENE	NA	NA	NA	NA	NA	0.027 U	0.032 U
PENTACHLOROPHENOL	NA	NA	NA	NA	NA	0.13 U	0.15 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB19	10-SB19	10-SB20	10-SB20	10-SB20	10-SB21	10-SB21
Sample ID	30210SB19002	30210SB19003	30210SB20001	30210SB20002	30210SB20003	30210SB21001	30210SB21002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	NA	NA	NA	NA	NA	0.011 U	0.012 U
PHENOL	NA	NA	NA	NA	NA	0.02 U	0.024 U
PYRENE	NA	NA	NA	NA	NA	0.015 U	0.017 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.0018 J g	0.00016 U	0.00016 U	0.00016 U	0.00016 U	NA	NA
4,4'-DDE	0.0026 U	0.00026 U	0.00026 U	0.00026 U	0.00026 U	NA	NA
4,4'-DDT	0.002 J g	0.00018 U	0.00018 U	0.00018 U	0.00018 U	NA	NA
ALDRIN	0.0025 U	0.00025 U	0.00025 U	0.00025 U	0.00025 U	NA	NA
ALPHA-BHC	0.0011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	NA	NA
ALPHA-CHLORDANE	0.0018 J g	0.00012 U	0.00012 U	0.00012 U	0.00012 U	NA	NA
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.0016 U	0.00018 U	0.00016 U	0.00016 U	0.00016 U	NA	NA
DELTA-BHC	0.0039 U	0.00039 U	0.00039 U	0.00039 U	0.00039 U	NA	NA
DIELDRIN	0.0032 U	0.00033 U	0.00032 U	0.00032 U	0.00032 U	NA	NA
ENDOSULFAN I	0.0013 U	0.00013 U	0.00013 U	0.00013 U	0.00013 U	NA	NA
ENDOSULFAN II	0.0023 U	0.00023 U	0.00023 U	0.00023 U	0.00023 U	NA	NA
ENDOSULFAN SULFATE	0.0017 U	0.00017 U	0.00017 U	0.00017 U	0.00017 U	NA	NA
ENDRIN	0.0014 U	0.00014 U	0.00014 U	0.00014 U	0.00014 U	NA	NA
ENDRIN ALDEHYDE	0.0037 U	0.00038 U	0.00037 U	0.00037 U	0.00037 U	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB19	10-SB19	10-SB20	10-SB20	10-SB20	10-SB21	10-SB21
Sample ID	30210SB19002	30210SB19003	30210SB20001	30210SB20002	30210SB20003	30210SB21001	30210SB21002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.0017 U	0.00017 U	0.00017 U	0.00017 U	0.00017 U	NA	NA
GAMMA-BHC (LINDANE)	0.0026 U	0.00026 U	0.00026 U	0.00026 U	0.00026 U	NA	NA
GAMMA-CHLORDANE	0.0026 J g	0.00016 U	0.00016 U	0.00016 U	0.00016 U	NA	NA
HEPTACHLOR	0.0015 U	0.00015 U	0.00014 U	0.00014 U	0.00014 U	NA	NA
HEPTACHLOR EPOXIDE	0.0015 U	0.00015 U	0.00015 U	0.0016	0.00045 UJ g	NA	NA
METHOXYCHLOR	0.0017 U	0.00017 U	0.00017 U	0.00017 U	0.00017 U	NA	NA
TOXAPHENE	0.096 U	0.0097 U	0.0096 U	0.0095 U	0.0095 U	NA	NA
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB19	10-SB19	10-SB20	10-SB20	10-SB20	10-SB21	10-SB21
Sample ID	30210SB19002	30210SB19003	30210SB20001	30210SB20002	30210SB20003	30210SB21001	30210SB21002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB21	10-SB22	10-SB22	10-SB22	10-SB23	10-SB23	10-SB23
Sample ID	30210SB21003	30210SB22001	30210SB22002	30210SB22003	30210SB23001	30210SB23002	30210SB23003
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	NA	NA	NA
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	NA	NA	NA
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	NA
ACETONE	NA	NA	NA	NA	NA	NA	NA
BENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMOFORM	NA	NA	NA	NA	NA	NA	NA
BROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	NA
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB21	10-SB22	10-SB22	10-SB22	10-SB23	10-SB23	10-SB23
Sample ID	30210SB21003	30210SB22001	30210SB22002	30210SB22003	30210SB23001	30210SB23002	30210SB23003
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
CHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
CHLOROFORM	NA	NA	NA	NA	NA	NA	NA
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	NA
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TOLUENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB21	10-SB22	10-SB22	10-SB22	10-SB23	10-SB23	10-SB23
Sample ID	30210SB21003	30210SB22001	30210SB22002	30210SB22003	30210SB23001	30210SB23002	30210SB23003
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U
1,2-DICHLOROBENZENE	0.019 U	0.019 U	0.019 U	0.02 U	0.019 U	0.019 U	0.022 U
1,3-DICHLOROBENZENE	0.019 U	0.019 U	0.019 U	0.021 U	0.019 U	0.019 U	0.022 U
1,4-DICHLOROBENZENE	0.019 U	0.019 U	0.018 U	0.02 U	0.018 U	0.019 U	0.021 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.015 U	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.017 U
2,4,5-TRICHLOROPHENOL	0.018 U	0.018 U	0.018 U	0.02 U	0.018 U	0.018 U	0.021 U
2,4,6-TRICHLOROPHENOL	0.015 U	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.017 U
2,4-DICHLOROPHENOL	0.017 U	0.017 U	0.017 U	0.019 U	0.017 U	0.017 U	0.02 U
2,4-DIMETHYLPHENOL	0.016 U	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.018 U
2,4-DINITROPHENOL	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.12 U	0.14 U
2,4-DINITROTOLUENE	0.016 U	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.018 U
2,6-DINITROTOLUENE	0.017 U	0.017 U	0.016 U	0.018 U	0.016 U	0.017 U	0.019 U
2-CHLORONAPHTHALENE	0.011 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.012 U
2-CHLOROPHENOL	0.011 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.012 U
2-METHYLNAPHTHALENE	0.012 U	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U
2-METHYLPHENOL	0.018 U	0.018 U	0.017 U	0.019 U	0.018 U	0.018 U	0.02 U
2-NITROANILINE	0.018 U	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.02 U
2-NITROPHENOL	0.015 U	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.017 U
3,3'-DICHLOROBENZIDINE	0.028 U	0.028 U	0.028 U	0.031 U	0.028 U	0.028 U	0.032 U
3-NITROANILINE	0.19 U	0.19 U	0.18 U	0.2 U	0.18 U	0.19 U	0.21 U
4,6-DINITRO-2-METHYLPHENOL	0.15 U	0.15 U	0.15 U	0.17 U	0.15 U	0.15 U	0.17 U
4-BROMOPHENYL-PHENYLETHER	0.013 U	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.015 U
4-CHLORO-3-METHYLPHENOL	0.018 U	0.018 U	0.017 U	0.019 U	0.017 U	0.018 U	0.02 U
4-CHLOROANILINE	0.015 U	0.015 U	0.015 U	0.017 U	0.015 U	0.015 U	0.018 U
4-CHLOROPHENYL-PHENYLETHER	0.017 U	0.017 U	0.017 U	0.018 U	0.017 U	0.017 U	0.019 U
4-METHYLPHENOL	0.018 U	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.02 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB21	10-SB22	10-SB22	10-SB22	10-SB23	10-SB23	10-SB23
Sample ID	30210SB21003	30210SB22001	30210SB22002	30210SB22003	30210SB23001	30210SB23002	30210SB23003
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.19 U	0.19 U	0.19 U	0.2 U	0.19 U	0.19 U	0.22 U
4-NITROPHENOL	0.16 U	0.16 U	0.15 U	0.17 U	0.15 U	0.16 U	0.18 U
ACENAPHTHENE	0.014 U	0.014 U	0.014 U	0.015 U	0.014 U	0.014 U	0.016 U
ACENAPHTHYLENE	0.014 U	0.014 U	0.013 U	0.015 U	0.013 U	0.014 U	0.015 U
ANTHRACENE	0.041 J g	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.017 U
BENZO(A)ANTHRACENE	0.087	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.015 U
BENZO(A)PYRENE	0.091	0.021 U	0.021 U	0.023 U	0.021 U	0.021 U	0.024 U
BENZO(B)FLUORANTHENE	0.055	0.018 U	0.018 U	0.02 J g	0.02 J g	0.018 U	0.021 U
BENZO(G,H,I)PERYLENE	0.07	0.021 U	0.021 U	0.023 U	0.056	0.021 U	0.024 U
BENZO(K)FLUORANTHENE	0.065	0.02 U	0.02 U	0.022 U	0.02 U	0.021 U	0.023 U
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U
BIS(2-CHLOROETHYL)ETHER	0.013 U	0.013 U	0.012 U	0.014 U	0.012 U	0.013 U	0.014 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.02 U	0.02 U	0.019 U	0.049 UJ b	0.053 UJ b	0.02 U	0.022 U
BUTYLBENZYLPHTHALATE	0.017 U	0.017 U	0.017 U	0.019 U	0.017 U	0.017 U	0.02 U
CARBAZOLE	0.012 U	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.014 U
CHRYSENE	0.093	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U
DI-N-BUTYLPHTHALATE	0.013 U	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.015 U
DI-N-OCTYLPHTHALATE	0.025 U	0.025 U	0.025 U	0.027 U	0.025 U	0.025 U	0.029 U
DIBENZ(A,H)ANTHRACENE	0.031 J g	0.029 U	0.028 U	0.031 U	0.029 U	0.029 U	0.033 U
DIBENZOFURAN	0.013 U	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U
DIETHYLPHTHALATE	0.015 U	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.017 U
DIMETHYLPHTHALATE	0.017 U	0.017 U	0.017 U	0.019 U	0.017 U	0.017 U	0.02 U
FLUORANTHENE	0.18	0.012 U	0.022 J g	0.013 U	0.012 U	0.012 U	0.022 J g
FLUORENE	0.014 U	0.014 U	0.014 U	0.015 U	0.014 U	0.014 U	0.016 U
HEXACHLOROBENZENE	0.016 U	0.016 U	0.015 U	0.017 U	0.015 U	0.016 U	0.018 U
HEXACHLOROBUTADIENE	0.015 U	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.017 U
HEXACHLOROCYCLOPENTADIENE	0.013 U	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.015 U
HEXACHLOROETHANE	0.023 U	0.023 U	0.022 U	0.025 U	0.023 U	0.023 U	0.026 U
INDENO(1,2,3-CD)PYRENE	0.068 J g	0.041 U	0.04 U	0.044 U	0.04 U	0.041 U	0.046 U
ISOPHORONE	0.015 U	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.017 U
N-NITROSO-DI-N-PROPYLAMINE	0.02 U	0.02 U	0.02 U	0.022 U	0.02 U	0.02 U	0.023 U
N-NITROSODIPHENYLAMINE (1)	0.019 U	0.019 U	0.019 U	0.021 U	0.019 U	0.019 U	0.022 U
NAPHTHALENE	0.015 U	0.015 U	0.015 U	0.017 U	0.015 U	0.015 U	0.018 U
NITROBENZENE	0.027 U	0.027 U	0.027 U	0.03 U	0.027 U	0.027 U	0.031 U
PENTACHLOROPHENOL	0.13 U	0.13 U	0.13 U	0.14 U	0.13 U	0.13 U	0.15 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB21	10-SB22	10-SB22	10-SB22	10-SB23	10-SB23	10-SB23
Sample ID	30210SB21003	30210SB22001	30210SB22002	30210SB22003	30210SB23001	30210SB23002	30210SB23003
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.17	0.011 U	0.011 U	0.012 U	0.014 J	0.011 U	0.012 U
PHENOL	0.021 U	0.021 U	0.02 U	0.022 U	0.02 U	0.021 U	0.024 U
PYRENE	0.23	0.015 U	0.019 J g	0.016 U	0.015 U	0.015 U	0.028 J g
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA
ALDRIN	NA	NA	NA	NA	NA	NA	NA
ALPHA-BHC	NA	NA	NA	NA	NA	NA	NA
ALPHA-CHLORDANE	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	NA	NA	NA	NA	NA	NA	NA
DELTA-BHC	NA	NA	NA	NA	NA	NA	NA
DIELDRIN	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN I	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN II	NA	NA	NA	NA	NA	NA	NA
ENDOSULFAN SULFATE	NA	NA	NA	NA	NA	NA	NA
ENDRIN	NA	NA	NA	NA	NA	NA	NA
ENDRIN ALDEHYDE	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB21	10-SB22	10-SB22	10-SB22	10-SB23	10-SB23	10-SB23
Sample ID	30210SB21003	30210SB22001	30210SB22002	30210SB22003	30210SB23001	30210SB23002	30210SB23003
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	NA	NA	NA	NA	NA	NA	NA
GAMMA-BHC (LINDANE)	NA	NA	NA	NA	NA	NA	NA
GAMMA-CHLORDANE	NA	NA	NA	NA	NA	NA	NA
HEPTACHLOR	NA	NA	NA	NA	NA	NA	NA
HEPTACHLOR EPOXIDE	NA	NA	NA	NA	NA	NA	NA
METHOXYCHLOR	NA	NA	NA	NA	NA	NA	NA
TOXAPHENE	NA	NA	NA	NA	NA	NA	NA
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
TIN	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB21	10-SB22	10-SB22	10-SB22	10-SB23	10-SB23	10-SB23
Sample ID	30210SB21003	30210SB22001	30210SB22002	30210SB22003	30210SB23001	30210SB23002	30210SB23003
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB24	10-SB24	10-SB24	10-SB25	10-SB25	10-SB25	10-SB26
Sample ID	30210SB24001	30210SB24002	30210SB24003	30210SB25001	30210SB25002	30210SB25003	30210SB26001
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.05 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,1-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,1-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	0.0052 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	0.0052 U
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
1,2-DICHLOROETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	0.0052 U
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	0.0052 U
2-BUTANONE	NA	NA	NA	NA	NA	NA	0.01 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	0.0052 U
2-HEXANONE	NA	NA	NA	NA	NA	NA	0.01 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	0.0052 U
4-METHYL-2-PENTANONE	NA	NA	NA	NA	NA	NA	0.01 U
ACETONE	NA	NA	NA	NA	NA	NA	0.021 U
BENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
BROMODICHLOROMETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
BROMOFORM	NA	NA	NA	NA	NA	NA	0.0052 U
BROMOMETHANE	NA	NA	NA	NA	NA	NA	0.01 U
CARBON DISULFIDE	NA	NA	NA	NA	NA	NA	0.0052 U
CARBON TETRACHLORIDE	NA	NA	NA	NA	NA	NA	0.0052 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB24	10-SB24	10-SB24	10-SB25	10-SB25	10-SB25	10-SB26
Sample ID	30210SB24001	30210SB24002	30210SB24003	30210SB25001	30210SB25002	30210SB25003	30210SB26001
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.05 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
CHLOROETHANE	NA	NA	NA	NA	NA	NA	0.01 U
CHLOROFORM	NA	NA	NA	NA	NA	NA	0.0052 U
CHLOROMETHANE	NA	NA	NA	NA	NA	NA	0.01 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	0.0052 U
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	0.0052 U
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	0.0052 U
ETHYLBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
FREON 11	NA	NA	NA	NA	NA	NA	0.0052 U
FREON 113	NA	NA	NA	NA	NA	NA	0.0052 U
FREON 12	NA	NA	NA	NA	NA	NA	0.01 U
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	0.0052 U
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
M,P-XYLENES	NA	NA	NA	NA	NA	NA	0.0052 U
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	0.0052 U
METHYLENE CHLORIDE	NA	NA	NA	NA	NA	NA	0.021 U
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
NAPHTHALENE	NA	NA	NA	NA	NA	NA	0.0052 U
O-XYLENE	NA	NA	NA	NA	NA	NA	0.0052 U
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	0.0052 U
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
STYRENE	NA	NA	NA	NA	NA	NA	0.0052 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	0.0052 U
TETRACHLOROETHENE	NA	NA	NA	NA	NA	NA	0.0052 U
TOLUENE	NA	NA	NA	NA	NA	NA	0.0052 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	0.0052 U
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	0.0052 U
TRICHLOROETHENE	NA	NA	NA	NA	NA	NA	0.0052 U
VINYL ACETATE	NA	NA	NA	NA	NA	NA	0.052 U
VINYL CHLORIDE	NA	NA	NA	NA	NA	NA	0.01 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	4.3 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB24	10-SB24	10-SB24	10-SB25	10-SB25	10-SB25	10-SB26
Sample ID	30210SB24001	30210SB24002	30210SB24003	30210SB25001	30210SB25002	30210SB25003	30210SB26001
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.05 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	4.3 U
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	0.4 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.012 U	0.012 U
1,2-DICHLOROBENZENE	0.019 U	0.019 U	0.02 U	0.019 U	0.019 U	0.019 U	0.019 U
1,3-DICHLOROBENZENE	0.019 U	0.019 U	0.021 U	0.019 U	0.02 U	0.02 U	0.019 U
1,4-DICHLOROBENZENE	0.018 U	0.019 U	0.02 U	0.019 U	0.019 U	0.019 U	0.018 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.015 U	0.015 U
2,4,5-TRICHLOROPHENOL	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.018 U	0.018 U
2,4,6-TRICHLOROPHENOL	0.015 U	0.015 U	0.016 U	0.015 U	0.016 U	0.016 U	0.015 U
2,4-DICHLOROPHENOL	0.017 U	0.017 U	0.019 U	0.017 U	0.018 U	0.018 U	0.017 U
2,4-DIMETHYLPHENOL	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.016 U	0.016 U
2,4-DINITROPHENOL	0.12 U	0.12 U	0.13 U	0.12 U	0.12 U	0.12 U	0.12 U
2,4-DINITROTOLUENE	0.016 U	0.016 U	0.017 U	0.016 U	0.016 U	0.016 U	0.016 U
2,6-DINITROTOLUENE	0.016 U	0.017 U	0.018 U	0.017 U	0.017 U	0.017 U	0.016 U
2-CHLORONAPHTHALENE	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U
2-CHLOROPHENOL	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U
2-METHYLNAPHTHALENE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.012 U	0.012 U
2-METHYLPHENOL	0.017 U	0.018 U	0.019 U	0.018 U	0.018 U	0.018 U	0.017 U
2-NITROANILINE	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.018 U	0.018 U
2-NITROPHENOL	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.015 U	0.015 U
3,3'-DICHLOROBENZIDINE	0.028 U	0.028 U	0.03 U	0.028 U	0.029 U	0.029 U	0.028 U
3-NITROANILINE	0.18 U	0.19 U	0.2 U	0.19 U	0.19 U	0.19 U	0.18 U
4,6-DINITRO-2-METHYLPHENOL	0.15 U	0.15 U	0.16 U	0.15 U	0.16 U	0.16 U	0.15 U
4-BROMOPHENYL-PHENYLETHER	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.013 U	0.013 U
4-CHLORO-3-METHYLPHENOL	0.017 U	0.018 U	0.019 U	0.018 U	0.018 U	0.018 U	0.017 U
4-CHLOROANILINE	0.015 U	0.015 U	0.016 U	0.015 U	0.016 U	0.016 U	0.015 U
4-CHLOROPHENYL-PHENYLETHER	0.017 U	0.017 U	0.018 U	0.017 U	0.017 U	0.017 U	0.017 U
4-METHYLPHENOL	0.018 U	0.018 U	0.019 U	0.018 U	0.018 U	0.018 U	0.018 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB24	10-SB24	10-SB24	10-SB25	10-SB25	10-SB25	10-SB26
Sample ID	30210SB24001	30210SB24002	30210SB24003	30210SB25001	30210SB25002	30210SB25003	30210SB26001
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.05 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.19 U	0.19 U	0.2 U	0.19 U	0.19 U	0.19 U	0.19 U
4-NITROPHENOL	0.15 U	0.16 U	0.17 U	0.16 U	0.16 U	0.16 U	0.15 U
ACENAPHTHENE	0.014 U	0.014 U	0.015 U	0.014 U	0.015 U	0.015 U	0.014 U
ACENAPHTHYLENE	0.013 U	0.014 U	0.015 U	0.014 U	0.014 U	0.014 U	0.013 U
ANTHRACENE	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.015 U	0.015 U
BENZO(A)ANTHRACENE	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.013 U	0.013 U
BENZO(A)PYRENE	0.021 U	0.021 U	0.022 U	0.021 U	0.021 U	0.021 U	0.021 U
BENZO(B)FLUORANTHENE	0.018 U	0.018 U	0.02 U	0.018 U	0.019 U	0.019 U	0.018 U
BENZO(G,H,I)PERYLENE	0.021 U	0.021 U	0.024 J g	0.021 U	0.022 U	0.022 U	0.021 U
BENZO(K)FLUORANTHENE	0.02 U	0.02 U	0.022 U	0.02 U	0.021 U	0.021 U	0.02 U
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.012 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	0.012 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.012 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.019 U	0.02 U	0.021 U	0.02 U	0.02 U	0.02 U	0.019 U
BUTYLBENZYLPHTHALATE	0.017 U	0.017 U	0.019 U	0.017 U	0.018 U	0.018 U	0.017 U
CARBAZOLE	0.012 U	0.012 U	0.013 U	0.012 U	0.012 U	0.012 U	0.012 U
CHRYSENE	0.012 U	0.013 U	0.015 J g	0.013 U	0.013 U	0.013 U	0.012 U
DI-N-BUTYLPHTHALATE	0.013 U	0.013 U	0.014 U	0.013 U	0.013 U	0.013 U	0.013 U
DI-N-OCTYLPHTHALATE	0.025 U	0.025 U	0.027 U	0.025 U	0.026 U	0.026 U	0.025 U
DIBENZ(A,H)ANTHRACENE	0.028 U	0.029 U	0.031 U	0.029 U	0.029 U	0.029 U	0.028 U
DIBENZOFURAN	0.012 U	0.013 U	0.014 U	0.013 U	0.013 U	0.013 U	0.012 U
DIETHYLPHTHALATE	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.015 U	0.015 U
DIMETHYLPHTHALATE	0.017 U	0.017 U	0.019 U	0.017 U	0.018 U	0.018 U	0.017 U
FLUORANTHENE	0.029 UJ f	0.012 U	0.043 UJ f	0.012 U	0.013 U	0.013 U	0.012 U
FLUORENE	0.014 U	0.014 U	0.015 U	0.014 U	0.014 U	0.014 U	0.014 U
HEXACHLOROBENZENE	0.015 U	0.016 U	0.017 U	0.016 U	0.016 U	0.016 U	0.015 U
HEXACHLOROBUTADIENE	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.015 U	0.015 U
HEXACHLOROCYCLOPENTADIENE	0.013 U	0.013 U	0.014 U	0.013 U	0.014 U	0.014 U	0.013 U
HEXACHLOROETHANE	0.022 U	0.023 U	0.024 U	0.023 U	0.023 U	0.023 U	0.022 U
INDENO(1,2,3-CD)PYRENE	0.04 U	0.041 U	0.043 U	0.041 U	0.041 U	0.041 U	0.04 U
ISOPHORONE	0.015 U	0.015 U	0.016 U	0.015 U	0.015 U	0.015 U	0.015 U
N-NITROSO-DI-N-PROPYLAMINE	0.02 U	0.02 U	0.022 U	0.02 U	0.021 U	0.021 U	0.02 U
N-NITROSODIPHENYLAMINE (1)	0.019 U	0.019 U	0.02 U	0.019 U	0.019 U	0.019 U	0.019 U
NAPHTHALENE	0.015 U	0.015 U	0.016 U	0.015 U	0.016 U	0.016 U	0.015 U
NITROBENZENE	0.027 U	0.027 U	0.029 U	0.027 U	0.028 U	0.028 U	0.027 U
PENTACHLOROPHENOL	0.13 U	0.13 U	0.14 U	0.13 U	0.14 U	0.14 U	0.13 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB24	10-SB24	10-SB24	10-SB25	10-SB25	10-SB25	10-SB26
Sample ID	30210SB24001	30210SB24002	30210SB24003	30210SB25001	30210SB25002	30210SB25003	30210SB26001
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.05 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.023 UJ f	0.011 U	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U
PHENOL	0.02 U	0.021 U	0.022 U	0.021 U	0.021 U	0.021 U	0.02 U
PYRENE	0.035 J g	0.015 U	0.05 J g	0.015 U	0.015 U	0.015 U	0.015 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	0.00084 U
AROCLOR-1221	NA	NA	NA	NA	NA	NA	0.00084 U
AROCLOR-1232	NA	NA	NA	NA	NA	NA	0.00084 U
AROCLOR-1242	NA	NA	NA	NA	NA	NA	0.00084 U
AROCLOR-1248	NA	NA	NA	NA	NA	NA	0.00084 U
AROCLOR-1254	NA	NA	NA	NA	NA	NA	0.00084 U
AROCLOR-1260	NA	NA	NA	NA	NA	NA	0.00084 U
Pesticides							
4,4'-DDD	NA	NA	NA	NA	NA	NA	0.00016 U
4,4'-DDE	NA	NA	NA	NA	NA	NA	0.00025 U
4,4'-DDT	NA	NA	NA	NA	NA	NA	0.00018 U
ALDRIN	NA	NA	NA	NA	NA	NA	0.00024 U
ALPHA-BHC	NA	NA	NA	NA	NA	NA	0.00011 U
ALPHA-CHLORDANE	NA	NA	NA	NA	NA	NA	0.00011 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	NA	NA	NA	NA	NA	NA	0.00015 U
DELTA-BHC	NA	NA	NA	NA	NA	NA	0.00038 U
DIELDRIN	NA	NA	NA	NA	NA	NA	0.00032 U
ENDOSULFAN I	NA	NA	NA	NA	NA	NA	0.00013 U
ENDOSULFAN II	NA	NA	NA	NA	NA	NA	0.00023 U
ENDOSULFAN SULFATE	NA	NA	NA	NA	NA	NA	0.00017 U
ENDRIN	NA	NA	NA	NA	NA	NA	0.00014 U
ENDRIN ALDEHYDE	NA	NA	NA	NA	NA	NA	0.00036 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB24	10-SB24	10-SB24	10-SB25	10-SB25	10-SB25	10-SB26
Sample ID	30210SB24001	30210SB24002	30210SB24003	30210SB25001	30210SB25002	30210SB25003	30210SB26001
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.05 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	NA	NA	NA	NA	NA	NA	0.00017 U
GAMMA-BHC (LINDANE)	NA	NA	NA	NA	NA	NA	0.00025 U
GAMMA-CHLORDANE	NA	NA	NA	NA	NA	NA	0.00015 U
HEPTACHLOR	NA	NA	NA	NA	NA	NA	0.00014 U
HEPTACHLOR EPOXIDE	NA	NA	NA	NA	NA	NA	0.00014 U
METHOXYCHLOR	NA	NA	NA	NA	NA	NA	0.00017 U
TOXAPHENE	NA	NA	NA	NA	NA	NA	0.0094 U
Metals (mg/kg)							
ALUMINUM	NA	NA	NA	NA	NA	NA	2,600
ANTIMONY	NA	NA	NA	NA	NA	NA	0.08 UJ be
ARSENIC	NA	NA	NA	NA	NA	NA	6.4
BARIUM	NA	NA	NA	NA	NA	NA	5.7 J d
BERYLLIUM	NA	NA	NA	NA	NA	NA	0.09 J g
CADMIUM	NA	NA	NA	NA	NA	NA	0.03 J g
CALCIUM	NA	NA	NA	NA	NA	NA	6,970 J d
CHROMIUM	NA	NA	NA	NA	NA	NA	40.5 J d
COBALT	NA	NA	NA	NA	NA	NA	4.6
COPPER	NA	NA	NA	NA	NA	NA	3.62
IRON	NA	NA	NA	NA	NA	NA	10,400
LEAD	NA	NA	NA	NA	NA	NA	2.45 J d
MAGNESIUM	NA	NA	NA	NA	NA	NA	3,670
MANGANESE	NA	NA	NA	NA	NA	NA	178 J e
MERCURY	NA	NA	NA	NA	NA	NA	0.01 J g
MOLYBDENUM	NA	NA	NA	NA	NA	NA	0.13 J d
NICKEL	NA	NA	NA	NA	NA	NA	22.6
POTASSIUM	NA	NA	NA	NA	NA	NA	490 J j
SELENIUM	NA	NA	NA	NA	NA	NA	0.2 U
SILVER	NA	NA	NA	NA	NA	NA	0.011 J g
SODIUM	NA	NA	NA	NA	NA	NA	277 J j
THALLIUM	NA	NA	NA	NA	NA	NA	0.014 J g
TIN	NA	NA	NA	NA	NA	NA	2 U
VANADIUM	NA	NA	NA	NA	NA	NA	14.1
ZINC	NA	NA	NA	NA	NA	NA	13.7
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB24	10-SB24	10-SB24	10-SB25	10-SB25	10-SB25	10-SB26
Sample ID	30210SB24001	30210SB24002	30210SB24003	30210SB25001	30210SB25002	30210SB25003	30210SB26001
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.05 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB26	10-SB26	10-SB27	10-SB27	10-SB27	10-SB28	10-SB28
Sample ID	30210SB26002	30210SB26003	30210SB27001	30210SB27002	30210SB27003	30210SB28001	30210SB28002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,1,1-TRICHLOROETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,1,2,2-TETRACHLOROETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,1,2-TRICHLOROETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,1-DICHLOROETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,1-DICHLOROETHENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,1-DICHLOROPROPENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,2,3-TRICHLOROBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,2,3-TRICHLOROPROPANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,2,4-TRICHLOROBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,2,4-TRIMETHYLBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,2-DIBROMO-3-CHLOROPROPANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,2-DIBROMOETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,2-DICHLOROBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,2-DICHLOROETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,3,5-TRIMETHYLBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,3-DICHLOROBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,3-DICHLOROPROPANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
1,4-DICHLOROBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
2,2-DICHLOROPROPANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
2-BUTANONE	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U	0.0099 U
2-CHLOROTOLUENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
2-HEXANONE	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U	0.0099 U
4-CHLOROTOLUENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
4-METHYL-2-PENTANONE	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U	0.0099 U
ACETONE	0.023 UJ b	0.023 UJ b	0.021 U	0.023 U	0.022 UJ b	0.02 U	0.02 U
BENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
BROMOBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
BROMOCHLOROMETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
BROMODICHLOROMETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
BROMOFORM	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
BROMOMETHANE	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U	0.0099 U
CARBON DISULFIDE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
CARBON TETRACHLORIDE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB26	10-SB26	10-SB27	10-SB27	10-SB27	10-SB28	10-SB28
Sample ID	30210SB26002	30210SB26003	30210SB27001	30210SB27002	30210SB27003	30210SB28001	30210SB28002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
CHLOROETHANE	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U	0.0099 U
CHLOROFORM	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
CHLOROMETHANE	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U	0.0099 U
CIS-1,2-DICHLOROETHENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
CIS-1,3-DICHLOROPROPENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
DIBROMOCHLOROMETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
DIBROMOMETHANE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
ETHYLBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
FREON 11	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
FREON 113	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
FREON 12	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U	0.0099 U
HEXACHLOROBUTADIENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
ISOPROPYLBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
M,P-XYLENES	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
METHYL-TERT-BUTYL ETHER	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
METHYLENE CHLORIDE	0.023 U	0.023 U	0.021 U	0.023 U	0.022 U	0.02 U	0.02 UJ b
N-BUTYLBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
N-PROPYLBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
NAPHTHALENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
O-XYLENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
PARA-ISOPROPYL TOLUENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
SEC-BUTYLBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
STYRENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
TERT-BUTYLBENZENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
TETRACHLOROETHENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
TOLUENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
TRANS-1,2-DICHLOROETHENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
TRANS-1,3-DICHLOROPROPENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
TRICHLOROETHENE	0.0058 U	0.0057 U	0.0053 U	0.0057 U	0.0056 U	0.0051 U	0.005 U
VINYL ACETATE	0.058 U	0.057 U	0.053 U	0.057 U	0.056 U	0.051 U	0.05 U
VINYL CHLORIDE	0.012 U	0.011 U	0.011 U	0.011 U	0.011 U	0.01 U	0.0099 U
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	4.3 U	4.4 U	4.3 U	4.3 U	4.4 U	34 H	4.5 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB26	10-SB26	10-SB27	10-SB27	10-SB27	10-SB28	10-SB28
Sample ID	30210SB26002	30210SB26003	30210SB27001	30210SB27002	30210SB27003	30210SB28001	30210SB28002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	4.4 U	4.4 U	4.4 U	4.4 U	4.4 U	390 M	25 M
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.4 U	0.23 U	0.31 U	0.22 UJ e	0.22 U	0.22 U	0.22 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
1,2-DICHLOROBENZENE	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
1,3-DICHLOROBENZENE	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.02 U	0.02 U
1,4-DICHLOROBENZENE	0.018 U	0.019 U	0.018 U	0.018 U	0.019 U	0.019 U	0.019 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U
2,4,5-TRICHLOROPHENOL	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.019 U
2,4,6-TRICHLOROPHENOL	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.016 U
2,4-DICHLOROPHENOL	0.017 U	0.018 U	0.017 U	0.017 U	0.018 U	0.018 U	0.018 U
2,4-DIMETHYLPHENOL	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U
2,4-DINITROPHENOL	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U
2,4-DINITROTOLUENE	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U	0.016 U
2,6-DINITROTOLUENE	0.016 U	0.017 U	0.016 U	0.016 U	0.017 U	0.017 U	0.017 U
2-CHLORONAPHTHALENE	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U
2-CHLOROPHENOL	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U	0.011 U
2-METHYLNAPHTHALENE	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
2-METHYLPHENOL	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U
2-NITROANILINE	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U
2-NITROPHENOL	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U
3,3'-DICHLOROBENZIDINE	0.028 U	0.029 U	0.028 U	0.028 U	0.029 U	0.029 U	0.029 U
3-NITROANILINE	0.18 U	0.19 U	0.18 U	0.18 U	0.19 U	0.19 U	0.19 U
4,6-DINITRO-2-METHYLPHENOL	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.15 U	0.16 U
4-BROMOPHENYL-PHENYLETHER	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U
4-CHLORO-3-METHYLPHENOL	0.017 U	0.018 U	0.017 U	0.017 U	0.018 U	0.018 U	0.018 U
4-CHLOROANILINE	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.016 U	0.016 U
4-CHLOROPHENYL-PHENYLETHER	0.017 U	0.017 U	0.017 U	0.017 U	0.017 U	0.017 U	0.017 U
4-METHYLPHENOL	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U	0.018 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB26	10-SB26	10-SB27	10-SB27	10-SB27	10-SB28	10-SB28
Sample ID	30210SB26002	30210SB26003	30210SB27001	30210SB27002	30210SB27003	30210SB28001	30210SB28002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U	0.19 U
4-NITROPHENOL	0.15 U	0.16 U	0.15 U	0.15 U	0.16 U	0.16 U	0.16 U
ACENAPHTHENE	0.014 U	0.014 U	0.014 U	0.014 U	0.014 U	0.015 U	0.015 U
ACENAPHTHYLENE	0.013 U	0.014 U	0.013 U	0.013 U	0.014 U	0.014 U	0.014 U
ANTHRACENE	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U
BENZO(A)ANTHRACENE	0.013 U	0.017 J g	0.013 U	0.028 J g	0.013 U	0.013 U	0.024 J g
BENZO(A)PYRENE	0.021 U	0.021 U	0.021 U	0.032 J g	0.021 U	0.021 U	0.022 J g
BENZO(B)FLUORANTHENE	0.018 U	0.024 J g	0.019 J g	0.032 J g	0.018 U	0.018 U	0.019 U
BENZO(G,H,I)PERYLENE	0.021 U	0.021 U	0.021 U	0.023 J g	0.021 U	0.051 J g	0.022 U
BENZO(K)FLUORANTHENE	0.02 U	0.021 U	0.02 U	0.037 J g	0.021 U	0.021 U	0.027 J g
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
BIS(2-CHLOROETHYL)ETHER	0.012 U	0.013 U	0.012 U	0.012 U	0.013 U	0.013 U	0.013 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.02 U	0.02 U	0.11 UJ b	12	0.037 UJ b	0.02 U	0.02 U
BUTYLBENZYLPHTHALATE	0.017 U	0.017 U	0.017 U	0.017 U	0.017 U	0.018 U	0.018 U
CARBAZOLE	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
CHRYSENE	0.013 U	0.018 J g	0.013 U	0.026 J g	0.013 U	0.013 U	0.022 J g
DI-N-BUTYLPHTHALATE	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U
DI-N-OCTYLPHTHALATE	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.026 U	0.026 U
DIBENZ(A,H)ANTHRACENE	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U
DIBENZOFURAN	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U
DIETHYLPHTHALATE	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U
DIMETHYLPHTHALATE	0.017 U	0.018 U	0.017 U	0.017 U	0.018 U	0.018 U	0.018 U
FLUORANTHENE	0.012 U	0.012 U	0.012 U	0.035 J g	0.012 U	0.016 J g	0.051 J g
FLUORENE	0.014 U	0.014 U	0.014 U	0.014 U	0.014 U	0.014 U	0.014 U
HEXACHLOROBENZENE	0.016 U	0.016 U	0.015 U	0.016 U	0.016 U	0.016 U	0.016 U
HEXACHLOROBUTADIENE	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U
HEXACHLOROCYCLOPENTADIENE	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.014 U	0.014 U
HEXACHLOROETHANE	0.023 U	0.023 U	0.023 U	0.023 U	0.023 U	0.023 U	0.023 U
INDENO(1,2,3-CD)PYRENE	0.04 U	0.041 U	0.04 U	0.04 U	0.041 U	0.041 U	0.041 U
ISOPHORONE	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U
N-NITROSO-DI-N-PROPYLAMINE	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.021 U
N-NITROSODIPHENYLAMINE (1)	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U	0.019 U
NAPHTHALENE	0.015 U	0.015 U	0.015 U	0.015 U	0.015 U	0.016 U	0.016 U
NITROBENZENE	0.027 U	0.028 U	0.027 U	0.027 U	0.028 U	0.028 U	0.028 U
PENTACHLOROPHENOL	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.14 U	0.14 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB26	10-SB26	10-SB27	10-SB27	10-SB27	10-SB28	10-SB28
Sample ID	30210SB26002	30210SB26003	30210SB27001	30210SB27002	30210SB27003	30210SB28001	30210SB28002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.011 U	0.011 U	0.011 U	0.02 J g	0.011 U	0.013 J g	0.037 J g
PHENOL	0.02 U	0.021 U	0.02 U	0.02 U	0.021 U	0.021 U	0.021 U
PYRENE	0.015 U	0.015 U	0.015 U	0.039 J g	0.015 U	0.021 J g	0.054
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.00084 U	0.00086 U	0.00084 U	0.00084 U	0.00086 U	0.00086 U	0.00087 U
AROCLOR-1221	0.00084 U	0.00086 U	0.00084 U	0.00084 U	0.00086 U	0.00086 U	0.00087 U
AROCLOR-1232	0.00084 U	0.00086 U	0.00084 U	0.00084 U	0.00086 U	0.00086 U	0.00087 U
AROCLOR-1242	0.00084 U	0.00086 U	0.00084 U	0.00084 U	0.00086 U	0.00086 U	0.00087 U
AROCLOR-1248	0.00084 U	0.00086 U	0.00084 U	0.00084 U	0.00086 U	0.00086 U	0.00087 U
AROCLOR-1254	0.00084 U	0.00086 U	0.00084 U	0.00084 U	0.00086 U	0.00086 U	0.00087 U
AROCLOR-1260	0.00084 U	0.00086 U	0.00084 U	0.00084 U	0.00086 U	0.00086 U	0.00087 U
Pesticides							
4,4'-DDD	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.0016 U	0.00016 U
4,4'-DDE	0.00026 U	0.00026 U	0.00025 U	0.00026 U	0.00026 U	0.0026 U	0.00026 U
4,4'-DDT	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.0018 U	0.00018 U
ALDRIN	0.00024 U	0.00025 U	0.00024 U	0.00024 U	0.00025 U	0.0025 U	0.00025 U
ALPHA-BHC	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.0011 U	0.00011 U
ALPHA-CHLORDANE	0.00011 U	0.00012 U	0.00011 U	0.00011 U	0.00012 U	0.0012 U	0.00012 U
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
BETA-BHC	0.00016 U	0.00016 U	0.00015 U	0.00016 U	0.00016 U	0.0016 U	0.00016 U
DELTA-BHC	0.00038 U	0.00039 U	0.00038 U	0.00038 U	0.00039 U	0.0039 U	0.00039 U
DIELDRIN	0.00032 U	0.00032 U	0.00032 U	0.00032 U	0.00032 U	0.0033 U	0.00033 U
ENDOSULFAN I	0.00013 U	0.00013 U	0.00013 UJ c	0.00013 UJ c	0.00013 UJ c	0.0013 UJ c	0.00013 UJ c
ENDOSULFAN II	0.00023 U	0.00023 U	0.00023 U	0.00023 U	0.00025 UJ b	0.0023 U	0.00023 U
ENDOSULFAN SULFATE	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.0017 U	0.00017 U
ENDRIN	0.00014 U	0.00014 U	0.00014 U	0.00014 U	0.00014 U	0.0014 U	0.00014 U
ENDRIN ALDEHYDE	0.00037 U	0.00037 U	0.00037 U	0.00037 U	0.00037 U	0.0037 U	0.00038 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB26	10-SB26	10-SB27	10-SB27	10-SB27	10-SB28	10-SB28
Sample ID	30210SB26002	30210SB26003	30210SB27001	30210SB27002	30210SB27003	30210SB28001	30210SB28002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.00028 U	0.0017 U	0.00017 U
GAMMA-BHC (LINDANE)	0.00025 U	0.00026 U	0.00025 U	0.00025 U	0.00026 U	0.0026 U	0.00026 U
GAMMA-CHLORDANE	0.00016 U	0.00016 U	0.00015 U	0.00016 U	0.00016 U	0.0016 U	0.00016 U
HEPTACHLOR	0.00014 U	0.00015 U	0.00014 U	0.00014 U	0.00015 U	0.0015 U	0.00015 U
HEPTACHLOR EPOXIDE	0.00014 U	0.00015 U	0.00014 U	0.00014 U	0.00015 U	0.0015 U	0.00015 U
METHOXYCHLOR	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.0017 U	0.00017 U
TOXAPHENE	0.0095 U	0.0096 U	0.0094 U	0.0095 U	0.0096 U	0.097 U	0.0097 U
Metals (mg/kg)							
ALUMINUM	3,250	2,880	7,400	3,000	3,220	2,980	3,690
ANTIMONY	0.07 UJ be	0.06 UJ be	0.11 J e	0.1 UJ be	0.1 UJ be	0.11 J e	0.08 UJ be
ARSENIC	7	6	5	6.6	12.7	5.9	6
BARIUM	5.4 J d	5 J d	14.1 J d	13.1 J d	7.6 J d	8.5 J d	7.3 J d
BERYLLIUM	0.1 J g	0.07 J g	0.18 J g	0.1 J g	0.09 J g	0.11 J g	0.11 J g
CADMIUM	0.04 J g	0.03 J g	0.13	0.05 J g	0.03 J g	0.05 J g	0.03 J g
CALCIUM	4,510 J d	6,710 J d	6,630	7,980	15,600	5,340	4,960
CHROMIUM	36.8 J d	16 J d	33.4 J d	21.4 J d	37.1 J d	24.9 J d	20.9 J d
COBALT	4.7	4.3	7.3	4.7	5.4	5.2	5.4
COPPER	3.31	3.26	14.8	3.24	3.38	3.87	3.24
IRON	11,200	9,890	17,000	11,000	12,500	10,900	11,700
LEAD	2.35 J d	2.42 J d	4.48	2.78	2.32	3.22	2.82
MAGNESIUM	3,770	2,660	5,950	3,420	6,330	3,920	3,180
MANGANESE	191 J e	182 J e	201 J e	239 J e	337 J e	185 J e	174 J e
MERCURY	0.01 J g	0.01 U	0.03	0.01 U	0.01 J g	0.01 J g	0.01 J g
MOLYBDENUM	0.17 J d	0.14 J d	0.19	0.18	0.12	0.11	0.19
NICKEL	27.9	17.2	39	26	45	32	24
POTASSIUM	570 J j	448 J j	1,420	586	572	491	576
SELENIUM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
SILVER	0.012 J g	0.01 J g	0.046	0.016 J g	0.15 J g	0.015 J g	0.015 J g
SODIUM	245 J j	191 J j	730	319	327	117	114
THALLIUM	0.052	0.015 J g	0.057	0.04	0.012 J g	0.028	0.025
TIN	2.1 U	2.1 U	2 U	2.1 U	2.1 U	2.1 U	2.1 U
VANADIUM	16.9	14.2	28.8	15.5	18.5	16.4	17.5
ZINC	15.5	14.4	34.2	16	16.3	16.1	17.6
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB26	10-SB26	10-SB27	10-SB27	10-SB27	10-SB28	10-SB28
Sample ID	30210SB26002	30210SB26003	30210SB27001	30210SB27002	30210SB27003	30210SB28001	30210SB28002
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002	10/23/2002
Sample Depth	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB28	10-SB29	10-SB29	10-SB29	SS-6-01	SS-6-02	SS-6-03
Sample ID	30210SB28003	30210SB29001	30210SB29002	30210SB29003	041TC014	041TC013	041TC012
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	01/29/1997	01/29/1997	01/29/1997
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	7.50 - 8.00	8.00 - 9.00	8.00 - 9.00
Volatile Organic Compounds (mg/kg)							
1,1,1,2-TETRACHLOROETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,1,2,2-TETRACHLOROETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,1,2-TRICHLOROETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,1-DICHLOROETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,1-DICHLOROETHENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,1-DICHLOROPROPENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,2,3-TRICHLOROBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,2,3-TRICHLOROPROPANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,2,4-TRICHLOROBENZENE	0.0064 UJ c	0.0055 UJ c	0.0052 UJ c	0.006 UJ c	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,2-DIBROMOETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,2-DICHLOROBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,2-DICHLOROETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROPROPANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,3-DICHLOROBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,3-DICHLOROPROPANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
1,4-DICHLOROBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
2,2-DICHLOROPROPANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
2-BUTANONE	0.013 U	0.011 U	0.01 U	0.012 U	NA	NA	NA
2-CHLOROTOLUENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
2-HEXANONE	0.013 U	0.011 U	0.01 U	0.012 U	NA	NA	NA
4-CHLOROTOLUENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
4-METHYL-2-PENTANONE	0.013 U	0.011 U	0.01 U	0.012 U	NA	NA	NA
ACETONE	0.026 U	0.022 U	0.021 U	0.024 U	NA	NA	NA
BENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	0.0006 U	0.0006 U	0.0006 U
BROMOBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
BROMOCHLOROMETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
BROMODICHLOROMETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
BROMOFORM	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
BROMOMETHANE	0.013 U	0.011 U	0.01 U	0.012 U	NA	NA	NA
CARBON DISULFIDE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
CARBON TETRACHLORIDE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB28	10-SB29	10-SB29	10-SB29	SS-6-01	SS-6-02	SS-6-03
Sample ID	30210SB28003	30210SB29001	30210SB29002	30210SB29003	041TC014	041TC013	041TC012
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	01/29/1997	01/29/1997	01/29/1997
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	7.50 - 8.00	8.00 - 9.00	8.00 - 9.00
Volatile Organic Compounds (mg/kg)							
CHLOROBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
CHLOROETHANE	0.013 U	0.011 U	0.01 U	0.012 U	NA	NA	NA
CHLOROFORM	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
CHLOROMETHANE	0.013 U	0.011 U	0.01 U	0.012 U	NA	NA	NA
CIS-1,2-DICHLOROETHENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
DIBROMOCHLOROMETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
DIBROMOMETHANE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
ETHYLBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	0.0006 U	0.0006 U	0.0006 U
FREON 11	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
FREON 113	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
FREON 12	0.013 U	0.011 U	0.01 U	0.012 U	NA	NA	NA
HEXACHLOROBUTADIENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
ISOPROPYLBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
M,P-XYLENES	0.0064 U	0.0055 U	0.0052 U	0.006 U	0.001 U	0.001 U	0.001 U
METHYL-TERT-BUTYL ETHER	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
METHYLENE CHLORIDE	0.026 U	0.022 U	0.021 U	0.024 U	NA	NA	NA
N-BUTYLBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
N-PROPYLBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
NAPHTHALENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
O-XYLENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	0.0006 UJ c	0.0006 UJ c	0.0006 UJ c
PARA-ISOPROPYL TOLUENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
SEC-BUTYLBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
STYRENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
TERT-BUTYLBENZENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
TETRACHLOROETHENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
TOLUENE	0.002 J g	0.00068 J g	0.0052 U	0.006 U	0.0006 U	0.0006 U	0.0006 U
TRANS-1,2-DICHLOROETHENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
TRICHLOROETHENE	0.0064 U	0.0055 U	0.0052 U	0.006 U	NA	NA	NA
VINYL ACETATE	0.064 U	0.055 U	0.052 U	0.06 U	NA	NA	NA
VINYL CHLORIDE	0.013 U	0.011 U	0.01 U	0.012 U	NA	NA	NA
XYLENE (TOTAL)	NA	NA	NA	NA	NA	NA	NA
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	4.5 U	4.4 U	4.5 U	4.5 U	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB28	10-SB29	10-SB29	10-SB29	SS-6-01	SS-6-02	SS-6-03
Sample ID	30210SB28003	30210SB29001	30210SB29002	30210SB29003	041TC014	041TC013	041TC012
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	01/29/1997	01/29/1997	01/29/1997
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	7.50 - 8.00	8.00 - 9.00	8.00 - 9.00
Petroleum Hydrocarbons (mg/kg)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	4.6 M	4.5 U	4.5 U	4.5 U	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	12 U	12 U	11 U
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	9.9 J g	12 U	11 U
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	0.24 U	0.19 U	0.26 U	0.24 U	0.12 U	0.12 U	0.11 U
Semivolatile Organic Compounds (mg/kg)							
1,2,4-TRICHLOROBENZENE	0.012 U	0.012 U	0.012 U	0.012 U	0.39 U	0.4 U	0.37 U
1,2-DICHLOROBENZENE	0.02 U	0.019 U	0.019 U	0.02 U	0.19 U	0.2 U	0.18 U
1,3-DICHLOROBENZENE	0.02 U	0.02 U	0.02 U	0.02 U	0.19 U	0.2 U	0.18 U
1,4-DICHLOROBENZENE	0.019 U	0.019 U	0.019 U	0.019 U	0.19 U	0.2 U	0.18 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.016 U	0.015 U	0.015 U	0.015 U	0.39 U	0.4 U	0.37 U
2,4,5-TRICHLOROPHENOL	0.019 U	0.018 U	0.018 U	0.019 U	0.99 U	1 U	0.93 U
2,4,6-TRICHLOROPHENOL	0.016 U	0.015 U	0.016 U	0.016 U	0.39 U	0.4 U	0.37 U
2,4-DICHLOROPHENOL	0.018 U	0.018 U	0.018 U	0.018 U	0.39 U	0.4 U	0.37 U
2,4-DIMETHYLPHENOL	0.017 U	0.016 U	0.016 U	0.017 U	0.39 U	0.4 U	0.37 U
2,4-DINITROPHENOL	0.12 U	0.12 U	0.12 U	0.12 U	0.99 U	1 U	0.93 U
2,4-DINITROTOLUENE	0.016 U	0.016 U	0.016 U	0.016 U	0.39 U	0.4 U	0.37 U
2,6-DINITROTOLUENE	0.017 U	0.017 U	0.017 U	0.017 U	0.39 U	0.4 U	0.37 U
2-CHLORONAPHTHALENE	0.011 U	0.011 U	0.011 U	0.011 U	0.39 U	0.4 U	0.37 U
2-CHLOROPHENOL	0.011 U	0.011 U	0.011 U	0.011 U	0.39 U	0.4 U	0.37 U
2-METHYLNAPHTHALENE	0.012 U	0.012 U	0.012 U	0.012 U	0.39 U	0.4 U	0.37 U
2-METHYLPHENOL	0.018 U	0.018 U	0.018 U	0.018 U	0.39 U	0.4 U	0.37 U
2-NITROANILINE	0.019 U	0.018 U	0.018 U	0.018 U	0.99 U	1 U	0.93 U
2-NITROPHENOL	0.015 U	0.015 U	0.015 U	0.015 U	0.39 U	0.4 U	0.37 U
3,3'-DICHLOROBENZIDINE	0.029 U	0.029 U	0.029 U	0.029 U	0.39 U	0.4 U	0.37 U
3-NITROANILINE	0.19 U	0.19 U	0.19 U	0.19 U	0.99 U	1 U	0.93 U
4,6-DINITRO-2-METHYLPHENOL	0.16 U	0.15 U	0.16 U	0.16 U	0.99 UJ c	1 UJ c	0.93 UJ c
4-BROMOPHENYL-PHENYLETHER	0.014 U	0.013 U	0.013 U	0.013 U	0.39 U	0.4 U	0.37 U
4-CHLORO-3-METHYLPHENOL	0.018 U	0.018 U	0.018 U	0.018 U	0.39 U	0.4 U	0.37 U
4-CHLOROANILINE	0.016 U	0.016 U	0.016 U	0.016 U	0.39 U	0.4 U	0.37 U
4-CHLOROPHENYL-PHENYLETHER	0.018 U	0.017 U	0.017 U	0.018 U	0.39 U	0.4 U	0.37 U
4-METHYLPHENOL	0.018 U	0.018 U	0.018 U	0.018 U	0.39 U	0.4 U	0.37 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB28	10-SB29	10-SB29	10-SB29	SS-6-01	SS-6-02	SS-6-03
Sample ID	30210SB28003	30210SB29001	30210SB29002	30210SB29003	041TC014	041TC013	041TC012
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	01/29/1997	01/29/1997	01/29/1997
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	7.50 - 8.00	8.00 - 9.00	8.00 - 9.00
Semivolatile Organic Compounds (mg/kg)							
4-NITROANILINE	0.2 U	0.19 U	0.19 U	0.2 U	0.99 U	1 U	0.93 U
4-NITROPHENOL	0.16 U	0.16 U	0.16 U	0.16 U	0.99 U	1 U	0.93 U
ACENAPHTHENE	0.015 U	0.014 U	0.015 U	0.015 U	0.39 U	0.4 U	0.37 U
ACENAPHTHYLENE	0.014 U	0.014 U	0.014 U	0.014 U	0.39 U	0.4 U	0.37 U
ANTHRACENE	0.053 J g	0.015 U	0.015 U	0.015 U	0.39 U	0.4 U	0.37 U
BENZO(A)ANTHRACENE	0.042 J g	0.013 U	0.013 U	0.014 U	0.39 U	0.4 U	0.37 U
BENZO(A)PYRENE	0.039 J g	0.021 U	0.021 U	0.022 U	0.39 U	0.4 U	0.37 U
BENZO(B)FLUORANTHENE	0.023 J g	0.018 U	0.019 U	0.019 U	0.39 U	0.4 U	0.37 U
BENZO(G,H,I)PERYLENE	0.023 J g	0.022 U	0.022 U	0.022 U	0.39 U	0.4 U	0.37 U
BENZO(K)FLUORANTHENE	0.039 J g	0.021 U	0.021 U	0.021 U	0.39 U	0.4 U	0.37 U
BIS(2-CHLOROETHOXY)METHANE	0.012 U	0.012 U	0.012 U	0.012 U	0.39 U	0.4 U	0.37 U
BIS(2-CHLOROETHYL)ETHER	0.013 U	0.013 U	0.013 U	0.013 U	0.39 U	0.4 U	0.37 U
BIS(2-ETHYLHEXYL)PHTHALATE	0.02 U	0.02 U	0.02 U	0.039 UJ b	0.39 UJ b	0.4 UJ b	0.37 UJ b
BUTYLBENZYLPHTHALATE	0.018 U	0.018 U	0.018 U	0.018 U	0.39 U	0.4 U	0.37 U
CARBAZOLE	0.012 U	0.012 U	0.012 U	0.012 U	0.39 U	0.4 U	0.37 U
CHRYSENE	0.073	0.013 U	0.013 U	0.013 U	0.39 U	0.4 U	0.37 U
DI-N-BUTYLPHTHALATE	0.013 U	0.013 U	0.013 U	0.013 U	0.39 U	0.4 U	0.37 U
DI-N-OCTYLPHTHALATE	0.026 U	0.026 U	0.026 U	0.026 U	0.39 U	0.4 U	0.37 U
DIBENZ(A,H)ANTHRACENE	0.03 U	0.029 U	0.029 U	0.03 U	0.39 U	0.4 U	0.37 U
DIBENZOFURAN	0.013 U	0.013 U	0.013 U	0.013 U	0.39 U	0.4 U	0.37 U
DIETHYLPHTHALATE	0.016 U	0.015 U	0.015 U	0.015 U	0.39 U	0.4 U	0.37 U
DIMETHYLPHTHALATE	0.018 U	0.018 U	0.018 U	0.018 U	0.39 U	0.4 U	0.37 U
FLUORANTHENE	0.065	0.013 U	0.013 U	0.026 J g	0.39 U	0.4 U	0.37 U
FLUORENE	0.014 U	0.014 U	0.014 U	0.014 U	0.39 U	0.4 U	0.37 U
HEXACHLOROBENZENE	0.016 U	0.016 U	0.016 U	0.016 U	0.39 UJ c	0.4 UJ c	0.37 UJ c
HEXACHLOROBUTADIENE	0.016 U	0.015 U	0.015 U	0.015 U	0.39 UJ c	0.4 UJ c	0.37 UJ c
HEXACHLOROCYCLOPENTADIENE	0.014 U	0.014 U	0.014 U	0.014 U	0.39 UJ c	0.4 UJ c	0.37 UJ c
HEXACHLOROETHANE	0.024 U	0.023 U	0.023 U	0.023 U	0.39 U	0.4 U	0.37 U
INDENO(1,2,3-CD)PYRENE	0.042 U	0.041 U	0.041 U	0.042 U	0.39 U	0.4 U	0.37 U
ISOPHORONE	0.015 U	0.015 U	0.015 U	0.015 U	0.39 U	0.4 U	0.37 U
N-NITROSO-DI-N-PROPYLAMINE	0.021 U	0.02 U	0.021 U	0.021 U	0.39 U	0.4 U	0.37 U
N-NITROSODIPHENYLAMINE (1)	0.02 U	0.019 U	0.019 U	0.02 U	0.39 U	0.4 U	0.37 U
NAPHTHALENE	0.016 U	0.016 U	0.016 U	0.016 U	0.39 U	0.4 U	0.37 U
NITROBENZENE	0.028 U	0.028 U	0.028 U	0.028 U	0.39 U	0.4 U	0.37 U
PENTACHLOROPHENOL	0.14 U	0.14 U	0.14 U	0.14 U	0.99 U	1 U	0.93 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB28	10-SB29	10-SB29	10-SB29	SS-6-01	SS-6-02	SS-6-03
Sample ID	30210SB28003	30210SB29001	30210SB29002	30210SB29003	041TC014	041TC013	041TC012
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	01/29/1997	01/29/1997	01/29/1997
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	7.50 - 8.00	8.00 - 9.00	8.00 - 9.00
Semivolatile Organic Compounds (mg/kg)							
PHENANTHRENE	0.05 J g	0.011 U	0.011 U	0.011 U	0.39 U	0.4 U	0.37 U
PHENOL	0.021 U	0.021 U	0.021 U	0.021 U	0.39 U	0.4 U	0.37 U
PYRENE	0.092	0.015 U	0.015 U	0.029 J g	0.39 U	0.4 U	0.37 U
PCBs/Pesticides (mg/kg)							
PCBs							
AROCLOR-1016	0.00088 U	0.00086 U	0.00087 U	0.00088 U	NA	NA	NA
AROCLOR-1221	0.00088 U	0.00086 U	0.00087 U	0.00088 U	NA	NA	NA
AROCLOR-1232	0.00088 U	0.00086 U	0.00087 U	0.00088 U	NA	NA	NA
AROCLOR-1242	0.00088 U	0.00086 U	0.00087 U	0.00088 U	NA	NA	NA
AROCLOR-1248	0.00088 U	0.00086 U	0.00087 U	0.00088 U	NA	NA	NA
AROCLOR-1254	0.00088 U	0.00086 U	0.00087 U	0.00088 U	NA	NA	NA
AROCLOR-1260	0.00088 U	0.00086 U	0.00087 U	0.00088 U	NA	NA	NA
Pesticides							
4,4'-DDD	0.00017 U	0.00016 U	0.00016 U	0.00017 U	0.00078 U	0.0008 U	0.00074 U
4,4'-DDE	0.00027 U	0.00026 U	0.00026 U	0.00027 U	0.00078 U	0.0008 U	0.00074 U
4,4'-DDT	0.00019 U	0.00018 U	0.00018 U	0.00018 UJ c	0.00078 U	0.0008 U	0.00074 U
ALDRIN	0.00025 U	0.00025 U	0.00025 U	0.00025 U	0.0004 U	0.00041 U	0.00038 U
ALPHA-BHC	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.0004 U	0.00041 U	0.00038 U
ALPHA-CHLORDANE	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.0004 U	0.00041 U	0.00038 U
AROCLOR-1016	NA	NA	NA	NA	0.0078 U	0.008 U	0.0074 U
AROCLOR-1221	NA	NA	NA	NA	0.016 U	0.016 U	0.015 U
AROCLOR-1232	NA	NA	NA	NA	0.0078 U	0.008 U	0.0074 U
AROCLOR-1242	NA	NA	NA	NA	0.0078 U	0.008 U	0.0074 U
AROCLOR-1248	NA	NA	NA	NA	0.0078 U	0.008 U	0.0074 U
AROCLOR-1254	NA	NA	NA	NA	0.0078 U	0.008 U	0.0074 U
AROCLOR-1260	NA	NA	NA	NA	0.0078 U	0.008 U	0.0074 U
BETA-BHC	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.0004 U	0.00041 U	0.00038 U
DELTA-BHC	0.0004 U	0.00039 U	0.00039 U	0.0004 U	0.0004 U	0.00041 U	0.00038 U
DIELDRIN	0.00033 U	0.00032 U	0.00033 U	0.00033 U	0.00078 U	0.0008 U	0.00074 U
ENDOSULFAN I	0.00014 UJ c	0.00013 UJ c	0.00013 UJ c	0.00014 U	0.0004 U	0.00041 U	0.00038 U
ENDOSULFAN II	0.00024 U	0.00023 U	0.00023 U	0.00024 U	0.00078 U	0.0008 U	0.00074 U
ENDOSULFAN SULFATE	0.00018 U	0.00017 U	0.00017 U	0.00018 U	0.00078 U	0.0008 U	0.00074 U
ENDRIN	0.00015 U	0.00014 U	0.00014 U	0.00015 U	0.00078 U	0.0008 U	0.00074 U
ENDRIN ALDEHYDE	0.00038 U	0.00037 U	0.00038 U	0.00038 U	0.00078 U	0.0008 U	0.00074 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB28	10-SB29	10-SB29	10-SB29	SS-6-01	SS-6-02	SS-6-03
Sample ID	30210SB28003	30210SB29001	30210SB29002	30210SB29003	041TC014	041TC013	041TC012
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	01/29/1997	01/29/1997	01/29/1997
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	7.50 - 8.00	8.00 - 9.00	8.00 - 9.00
PCBs/Pesticides (mg/kg)							
Pesticides							
ENDRIN KETONE	0.00017 U	0.00017 U	0.00017 U	0.00017 U	0.00078 U	0.0008 U	0.00074 U
GAMMA-BHC (LINDANE)	0.00026 U	0.00026 U	0.00026 U	0.00026 U	0.0004 U	0.00041 U	0.00038 U
GAMMA-CHLORDANE	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.0004 U	0.00041 U	0.00038 U
HEPTACHLOR	0.00015 U	0.00015 U	0.00015 U	0.00015 U	0.0004 U	0.00041 U	0.00038 U
HEPTACHLOR EPOXIDE	0.00015 U	0.00015 U	0.00015 U	0.00015 U	0.0004 U	0.00041 U	0.00038 U
METHOXYCHLOR	0.00018 U	0.00017 U	0.00017 U	0.00018 UJ c	0.004 U	0.0041 U	0.0038 U
TOXAPHENE	0.0099 U	0.0097 U	0.0097 U	0.0098 U	0.04 U	0.041 U	0.038 U
Metals (mg/kg)							
ALUMINUM	3,320	3,100	2,820	2,690	3,770	6,710	3,480
ANTIMONY	0.12 J e	0.08 UJ be	0.1 UJ be	0.09 UJ be	0.37 UJ e	0.57 J e	0.37 UJ e
ARSENIC	6.8	4.8	5.6	11.3	5.3	6.1	8
BARIUM	10.8 J d	8.7 J d	8.8 J d	7.5 J d	7.4	13.3	8.3
BERYLLIUM	0.11 J g	0.09 J g	0.1 J g	0.11 J g	0.19 U	0.2 U	0.18 U
CADMIUM	0.04 J g	0.04 J g	0.04 J g	0.08 J g	0.28	0.43	0.33
CALCIUM	13,900	15,200	15,100	13,200	6,700	10,400	7,710
CHROMIUM	47 J d	35.4 J d	22.2 J d	18.1 J d	22.1 J j	28.5 J j	22 J j
COBALT	6.2	5.8	4.8	4.9	5.9 UJ b	7.5	5.3 UJ b
COPPER	5.62	3.65	3.13	6.06	3.6 UJ b	10.7 J e	3.9 UJ b
IRON	14,800	12,000	11,000	10,600	12,100	15,300	11,600
LEAD	2.98	2.77	2.42	5.33	2.6 J de	3.6 J de	3.1 J de
MAGNESIUM	7,120	5,010	3,700	2,970	3,880	5,470	3,800
MANGANESE	309 J e	327 J e	275 J e	299 J e	211	197	212
MERCURY	0.01 J g	0.01 J g	0.01 J g	0.01 J g	0.05 U	0.05 U	0.05 U
MOLYBDENUM	0.15	0.07	0.08	0.2	11.6	14.1	11.6
NICKEL	58.9	48	23.6	22.1	29.2	33.2	30.2
POTASSIUM	533	473	498	483	714	1,110	656
SELENIUM	0.2 U	0.2 U	0.2 U	0.4 U	0.44 J e	0.41 UJ e	0.37 UJ e
SILVER	0.015 J g	0.013 J g	0.013 J g	0.012 J g	0.66 UJ b	0.99 UJ b	0.88 UJ b
SODIUM	213	196	207	201	666 J j	1,220 J j	876 J j
THALLIUM	0.026	0.015 J g	0.019 J g	0.037 J g	0.39	0.94	1.1
TIN	2.1 U	2.1 U	2.1 U	2.1 U	NA	NA	NA
VANADIUM	20.9	16.7	15.5	14.2	18.1	26.3	17.1
ZINC	18	17.2	14.9	15.6	19.2	26.9	16.6
Hexavalent Chromium (mg/kg)							
HEXAVALENT CHROMIUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	10-SB28	10-SB29	10-SB29	10-SB29	SS-6-01	SS-6-02	SS-6-03
Sample ID	30210SB28003	30210SB29001	30210SB29002	30210SB29003	041TC014	041TC013	041TC012
Sample Date	10/23/2002	10/23/2002	10/23/2002	10/23/2002	01/29/1997	01/29/1997	01/29/1997
Sample Depth	6.00 - 7.50	0.50 - 2.00	3.50 - 5.00	6.00 - 7.50	7.50 - 8.00	8.00 - 9.00	8.00 - 9.00
Chlorinated Herbicides (mg/kg)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SOIL SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Notes:

a	Surrogate recovery problem.
b	Laboratory blank and common contamination problem.
c	Calibration criteria exceedance.
d	Duplicate precision problem.
e	Matrix spike/LCS recovery problem.
f	Field blank contamination.
g	Quantification below reporting limit.
H	Chromatographic pattern is in the heavier hydrocarbon end of the analyte's range in the standard.
h	Holding time exceedance.
i	Internal standard exceedance.
ID	Identification.
J	Estimated value.
j	Other qualification reasons.
LCS	Laboratory control sample.
M	Chromatographic pattern resembles motor oil.
mg/kg	Milligram per kilogram.
NA	Not analyzed.
NAVSTA	Naval Station.
R	Result rejected during quality assurance review.
SG	Silica Gel.
U	Nondetected.
Y	Chromatographic pattern resembles hydrocarbon fuel pattern and was quantitated using the standard it resembled most.

SITE 10
GROUNDWATER ANALYTICAL RESULTS

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP006	07/10-HP009	07/10-HP011
Sample ID	199AA529	199AA530	199AA533	199AA534	199AA536	199AA539	199AA541
Sample Date	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995
Volatile Organic Compounds (µg/L)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-TETRACHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-TRICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DICHLOROETHENE (TOTAL)	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DICHLOROPROPANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	4 U	4 U	4 U	4 U	4 U	4 U	4 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	4 U	4 U	4 U	4 U	4 U	4 U	4 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	4 U	4 U	4 U	4 U	4 U	4 U	4 U
ACETONE	4 UJ c	4 UJ c	4 UJ c	4 UJ c	4 UJ c	4 UJ c	4 UJ c
BENZENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BROMOFORM	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BROMOMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CARBON DISULFIDE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CARBON TETRACHLORIDE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP006	07/10-HP009	07/10-HP011
Sample ID	199AA529	199AA530	199AA533	199AA534	199AA536	199AA539	199AA541
Sample Date	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995
Volatile Organic Compounds (µg/L)							
CHLOROBENZENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CHLOROFORM	0.5 UJ b	0.5 U	0.5 UJ b	0.5 UJ b	2	0.5 U	0.5 U
CHLOROMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
DIBROMOCHLOROMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	0.5 U	0.5 U	0.5 UJ b	0.5 U	0.5 U	0.5 U	0.5 U
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TOLUENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
XYLENE (TOTAL)	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP006	07/10-HP009	07/10-HP011
Sample ID	199AA529	199AA530	199AA533	199AA534	199AA536	199AA539	199AA541
Sample Date	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	NA	NA	0.1 U	0.1 U	NA	0.1 U	0.1 U
MOTOR OIL RANGE ORGANICS	NA	NA	0.1 U	0.1 U	NA	0.086 JY g	0.086 JY g
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)							
1,2,4-TRICHLOROBENZENE	NA	NA	10 U	10 U	NA	10 U	10 U
1,2-DICHLOROBENZENE	NA	NA	5 U	5 U	NA	5 U	5 U
1,3-DICHLOROBENZENE	NA	NA	5 U	5 U	NA	5 U	5 U
1,4-DICHLOROBENZENE	NA	NA	5 U	5 U	NA	5 U	5 U
2,2'-OXYBIS(1-CHLOROPROPANE)	NA	NA	10 U	10 U	NA	10 U	10 U
2,4,5-TRICHLOROPHENOL	NA	NA	25 U	25 U	NA	25 U	25 U
2,4,6-TRICHLOROPHENOL	NA	NA	10 U	10 U	NA	10 U	10 U
2,4-DICHLOROPHENOL	NA	NA	10 U	10 U	NA	10 U	10 U
2,4-DIMETHYLPHENOL	NA	NA	10 U	10 U	NA	10 U	10 U
2,4-DINITROPHENOL	NA	NA	25 U	25 U	NA	25 U	25 U
2,4-DINITROTOLUENE	NA	NA	10 U	10 U	NA	10 U	10 U
2,6-DINITROTOLUENE	NA	NA	10 U	10 U	NA	10 U	10 U
2-CHLORONAPHTHALENE	NA	NA	10 U	10 U	NA	10 U	10 U
2-CHLOROPHENOL	NA	NA	10 U	10 U	NA	10 U	10 U
2-METHYLNAPHTHALENE	NA	NA	10 U	10 U	NA	10 U	10 U
2-METHYLPHENOL	NA	NA	10 U	10 U	NA	10 U	10 U
2-NITROANILINE	NA	NA	25 U	25 U	NA	25 U	25 U
2-NITROPHENOL	NA	NA	10 U	10 U	NA	10 U	10 U
3,3'-DICHLOROBENZIDINE	NA	NA	10 U	10 U	NA	10 U	10 U
3-NITROANILINE	NA	NA	25 UJ c	25 U	NA	25 UJ c	25 UJ c
4,6-DINITRO-2-METHYLPHENOL	NA	NA	25 U	25 U	NA	25 U	25 U
4-BROMOPHENYL-PHENYLETHER	NA	NA	10 U	10 U	NA	10 U	10 U
4-CHLORO-3-METHYLPHENOL	NA	NA	10 U	10 U	NA	10 U	10 U
4-CHLOROANILINE	NA	NA	10 U	10 U	NA	10 U	10 U
4-CHLOROPHENYL-PHENYLETHER	NA	NA	10 U	10 U	NA	10 U	10 U
4-METHYLPHENOL	NA	NA	10 U	10 U	NA	10 U	10 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP006	07/10-HP009	07/10-HP011
Sample ID	199AA529	199AA530	199AA533	199AA534	199AA536	199AA539	199AA541
Sample Date	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995
Semivolatile Organic Compounds (µg/L)							
4-NITROANILINE	NA	NA	25 U	25 U	NA	25 U	25 U
4-NITROPHENOL	NA	NA	25 U	25 U	NA	25 U	25 U
ACENAPHTHENE	NA	NA	10 U	10 U	NA	10 U	10 U
ACENAPHTHYLENE	NA	NA	10 U	10 U	NA	10 U	10 U
ANTHRACENE	NA	NA	10 U	10 U	NA	10 U	10 U
BENZO(A)ANTHRACENE	NA	NA	10 U	10 U	NA	10 U	10 U
BENZO(A)PYRENE	NA	NA	10 U	10 U	NA	10 U	10 U
BENZO(B)FLUORANTHENE	NA	NA	10 U	10 U	NA	10 U	10 U
BENZO(G,H,I)PERYLENE	NA	NA	10 U	10 U	NA	10 U	10 U
BENZO(K)FLUORANTHENE	NA	NA	10 U	10 U	NA	10 U	10 U
BIS(2-CHLOROETHOXY)METHANE	NA	NA	10 U	10 U	NA	10 U	10 U
BIS(2-CHLOROETHYL)ETHER	NA	NA	10 U	10 U	NA	10 U	10 U
BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	4 U	4 U	NA	4 U	16 UJ b
BUTYLBENZYLPHTHALATE	NA	NA	10 U	10 U	NA	10 U	10 U
CARBAZOLE	NA	NA	10 U	10 U	NA	10 U	10 U
CHRYSENE	NA	NA	10 U	10 U	NA	10 U	10 U
DI-N-BUTYLPHTHALATE	NA	NA	10 U	10 U	NA	10 U	10 U
DI-N-OCTYLPHTHALATE	NA	NA	10 U	10 U	NA	10 U	10 U
DIBENZ(A,H)ANTHRACENE	NA	NA	10 U	10 U	NA	10 U	10 U
DIBENZOFURAN	NA	NA	10 U	10 U	NA	10 U	10 U
DIETHYLPHTHALATE	NA	NA	10 U	10 U	NA	10 U	10 U
DIMETHYLPHTHALATE	NA	NA	10 U	10 U	NA	10 U	10 U
FLUORANTHENE	NA	NA	10 U	10 U	NA	10 U	10 U
FLUORENE	NA	NA	10 U	10 U	NA	10 U	10 U
HEXACHLOROBENZENE	NA	NA	10 U	10 U	NA	10 U	10 U
HEXACHLOROBUTADIENE	NA	NA	10 U	10 U	NA	10 U	10 U
HEXACHLOROCYCLOPENTADIENE	NA	NA	10 U	10 U	NA	10 U	10 U
HEXACHLOROETHANE	NA	NA	10 U	10 U	NA	10 U	10 U
INDENO(1,2,3-CD)PYRENE	NA	NA	10 U	10 U	NA	10 U	10 U
ISOPHORONE	NA	NA	10 U	10 U	NA	10 U	10 U
N-NITROSO-DI-N-PROPYLAMINE	NA	NA	10 U	10 U	NA	10 U	10 U
N-NITROSODIPHENYLAMINE (1)	NA	NA	10 U	10 U	NA	10 U	10 U
NAPHTHALENE	NA	NA	10 U	10 U	NA	10 U	10 U
NITROBENZENE	NA	NA	10 U	10 U	NA	10 U	10 U
PENTACHLOROPHENOL	NA	NA	25 U	25 U	NA	25 U	25 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP006	07/10-HP009	07/10-HP011
Sample ID	199AA529	199AA530	199AA533	199AA534	199AA536	199AA539	199AA541
Sample Date	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995
Semivolatile Organic Compounds (µg/L)							
PHENANTHRENE	NA	NA	10 U	10 U	NA	10 U	10 U
PHENOL	NA	NA	10 U	10 U	NA	10 U	10 U
PYRENE	NA	NA	10 U	10 U	NA	10 U	10 U
PCBs/Pesticides (µg/L)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
4,4'-DDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
4,4'-DDT	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
ALDRIN	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	NA	NA
ALPHA-BHC	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	NA	NA
ALPHA-CHLORDANE	0.05 U	0.05 U	0.05 U	0.05 U	0.12	NA	NA
AROCLOR-1016	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA
AROCLOR-1221	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA
AROCLOR-1232	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA
AROCLOR-1242	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA
AROCLOR-1248	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA
AROCLOR-1254	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA
AROCLOR-1260	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA
BETA-BHC	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	NA	NA
DELTA-BHC	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	NA	NA
DIELDRIN	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
ENDOSULFAN I	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	NA	NA
ENDOSULFAN II	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
ENDOSULFAN SULFATE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
ENDRIN	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
ENDRIN ALDEHYDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP006	07/10-HP009	07/10-HP011
Sample ID	199AA529	199AA530	199AA533	199AA534	199AA536	199AA539	199AA541
Sample Date	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995
PCBs/Pesticides (µg/L)							
Pesticides							
ENDRIN KETONE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
GAMMA-BHC (LINDANE)	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	NA	NA
GAMMA-CHLORDANE	0.05 U	0.05 U	0.05 U	0.05 U	0.1	NA	NA
HEPTACHLOR	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	NA	NA
HEPTACHLOR EPOXIDE	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	NA	NA
METHOXYCHLOR	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA
TOXAPHENE	3 U	3 U	3 U	3 U	3 U	NA	NA
Metals (µg/L)							
Unfiltered							
ALUMINUM	NA	NA	NA	NA	NA	142	612 J d
ANTIMONY	NA	NA	NA	NA	NA	2.1 U	2.1 U
ARSENIC	NA	NA	NA	NA	NA	10	2.8 U
BARIUM	NA	NA	NA	NA	NA	2.2 J g	4.4 J g
BERYLLIUM	NA	NA	NA	NA	NA	0.1 U	0.1 U
CADMIUM	NA	NA	NA	NA	NA	0.2 U	0.2 U
CALCIUM	NA	NA	NA	NA	NA	36,600	52,800
CHROMIUM	NA	NA	NA	NA	NA	1.8 U	1.8 U
COBALT	NA	NA	NA	NA	NA	0.55 J g	0.75 UJ b
COPPER	NA	NA	NA	NA	NA	1.8 J g	2.4 UJ b
IRON	NA	NA	NA	NA	NA	295	905 J e
LEAD	5.3 UJ bd	1.6 UJ bd	1.3 UJ d	1.4 UJ bd	1.5 U	1.5 U	2.8 UJ b
MAGNESIUM	NA	NA	NA	NA	NA	17,500	11,400
MANGANESE	NA	NA	NA	NA	NA	334	26.3
MERCURY	NA	NA	NA	NA	NA	0.1 U	0.1 U
MOLYBDENUM	NA	NA	NA	NA	NA	3.7 UJ b	3 UJ b
NICKEL	NA	NA	NA	NA	NA	3.3 U	4.6 J g
POTASSIUM	NA	NA	NA	NA	NA	26,400	10,100 J j
SELENIUM	NA	NA	NA	NA	NA	3.4 U	3.4 U
SILVER	NA	NA	NA	NA	NA	0.6 U	0.6 U
SODIUM	NA	NA	NA	NA	NA	23,600	13,800
THALLIUM	NA	NA	NA	NA	NA	2 U	2 U
VANADIUM	NA	NA	NA	NA	NA	5 J g	3.6 J g
ZINC	NA	NA	NA	NA	NA	10.9 J g	21.2 UJ b
Filtered							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP001	07/10-HP002	07/10-HP004	07/10-HP004	07/10-HP006	07/10-HP009	07/10-HP011
Sample ID	199AA529	199AA530	199AA533	199AA534	199AA536	199AA539	199AA541
Sample Date	06/09/1995	06/09/1995	06/13/1995	06/13/1995	06/13/1995	06/14/1995	06/14/1995
Metals (µg/L)							
Filtered							
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Chlorinated Herbicides (µg/L)							
2,4,5-T	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
2,4,5-TP (SILVEX)	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NA	NA
2,4-D	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	NA	NA
2,4-DB	1 U	1 U	1 U	1 U	1 U	NA	NA
DALAPON	1 U	1 U	1 U	1 U	1 U	NA	NA
DICAMBA	0.09 U	0.09 U	0.09 U	0.09 U	0.09 U	NA	NA
DICHLOROPROP	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	NA	NA
DINOSEB	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ e	NA	NA
MCPA	93 U	93 U	93 U	93 U	93 U	NA	NA
MCPP	94 U	94 U	94 U	94 U	94 U	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP012	07/10-HP013	07/10-HP014	07/10-HP015	07/10-MW01	07/10-MW01	07/10-MW01
Sample ID	199AA542B	199AA543B	199AA544B	199AA545B	199Q4023	199Q5008	199Q6008
Sample Date	08/10/1995	08/10/1995	08/10/1995	08/10/1995	12/08/1995	02/26/1996	06/10/1996
Volatile Organic Compounds (µg/L)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
1,1,2,2-TETRACHLOROETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
1,1,2-TRICHLOROETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHENE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,2-DICHLOROETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
1,2-DICHLOROETHENE (TOTAL)	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
1,2-DICHLOROPROPANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA	NA
2-BUTANONE	NA	NA	NA	NA	4 U	4 UJ c	4 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
2-HEXANONE	NA	NA	NA	NA	4 U	4 R c	4 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	NA	NA	NA	NA	4 U	4 U	4 U
ACETONE	NA	NA	NA	NA	4 U	4 UJ c	4 U
BENZENE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	NA	NA	NA
BROMODICHLOROMETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
BROMOFORM	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
BROMOMETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
CARBON DISULFIDE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
CARBON TETRACHLORIDE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP012	07/10-HP013	07/10-HP014	07/10-HP015	07/10-MW01	07/10-MW01	07/10-MW01
Sample ID	199AA542B	199AA543B	199AA544B	199AA545B	199Q4023	199Q5008	199Q6008
Sample Date	08/10/1995	08/10/1995	08/10/1995	08/10/1995	12/08/1995	02/26/1996	06/10/1996
Volatile Organic Compounds (µg/L)							
CHLOROBENZENE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
CHLOROETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
CHLOROFORM	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
CHLOROMETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
DIBROMOCHLOROMETHANE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
FREON 11	NA	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
M,P-XYLENES	NA	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	NA	NA	NA	NA	NA
METHYLENE CHLORIDE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
STYRENE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	NA	NA	NA	NA	0.5 U	0.5 U	0.09 J g
TOLUENE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	NA	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
VINYL ACETATE	NA	NA	NA	NA	NA	NA	NA
VINYL CHLORIDE	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
XYLENE (TOTAL)	NA	NA	NA	NA	0.5 U	0.5 U	0.5 U
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP012	07/10-HP013	07/10-HP014	07/10-HP015	07/10-MW01	07/10-MW01	07/10-MW01
Sample ID	199AA542B	199AA543B	199AA544B	199AA545B	199Q4023	199Q5008	199Q6008
Sample Date	08/10/1995	08/10/1995	08/10/1995	08/10/1995	12/08/1995	02/26/1996	06/10/1996
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	0.49 Y	0.06 JY g	0.1 U	0.1 U	0.1 U	0.12 Y	0.1 U
MOTOR OIL RANGE ORGANICS	0.15 Y	0.21 Y	0.087 JY g	0.1 U	0.1 U	0.27 Y	0.1 U
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)							
1,2,4-TRICHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-DICHLOROBENZENE	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,3-DICHLOROBENZENE	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,4-DICHLOROBENZENE	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2,2'-OXYBIS(1-CHLOROPROPANE)	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4,5-TRICHLOROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	25 U
2,4,6-TRICHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4-DICHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4-DIMETHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,4-DINITROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	25 U
2,4-DINITROTOLUENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2,6-DINITROTOLUENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-CHLORONAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-CHLOROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-METHYLNAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-NITROANILINE	25 U	25 U	25 U	25 U	25 U	25 U	25 U
2-NITROPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	10 U
3,3'-DICHLOROBENZIDINE	10 U	10 U	10 U	10 U	10 U	10 UJ c	10 U
3-NITROANILINE	25 U	25 U	25 U	25 U	25 U	25 U	25 U
4,6-DINITRO-2-METHYLPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	25 U
4-BROMOPHENYL-PHENYLETHER	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-CHLORO-3-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-CHLOROANILINE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-CHLOROPHENYL-PHENYLETHER	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-METHYLPHENOL	10 U	10 U	10 U	10 U	10 U	10 U	10 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP012	07/10-HP013	07/10-HP014	07/10-HP015	07/10-MW01	07/10-MW01	07/10-MW01
Sample ID	199AA542B	199AA543B	199AA544B	199AA545B	199Q4023	199Q5008	199Q6008
Sample Date	08/10/1995	08/10/1995	08/10/1995	08/10/1995	12/08/1995	02/26/1996	06/10/1996
Semivolatile Organic Compounds (µg/L)							
4-NITROANILINE	25 U	25 U	25 U	25 U	25 U	25 U	25 U
4-NITROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	25 U
ACENAPHTHENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
ACENAPHTHYLENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(A)ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(A)PYRENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(B)FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(G,H,I)PERYLENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BENZO(K)FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BIS(2-CHLOROETHOXY)METHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BIS(2-CHLOROETHYL)ETHER	10 U	10 U	10 U	10 U	10 U	10 U	10 U
BIS(2-ETHYLHEXYL)PHTHALATE	4 U	4 U	4 U	4 U	4 U	4 U	4 U
BUTYLBENZYLPHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
CARBAZOLE	10 UJ c	10 UJ c	10 UJ c	10 UJ c	10 U	10 U	10 U
CHRYSENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
DI-N-BUTYLPHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
DI-N-OCTYLPHTHALATE	10 U	10 U	10 U	10 U	10 U	10 UJ c	10 U
DIBENZ(A,H)ANTHRACENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
DIBENZOFURAN	10 U	10 U	10 U	10 U	10 U	10 U	10 U
DIETHYLPHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
DIMETHYLPHTHALATE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
FLUORANTHENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
FLUORENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
HEXACHLOROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
HEXACHLOROBUTADIENE	10 UJ c	10 UJ c	10 UJ c	10 UJ c	10 U	10 U	10 U
HEXACHLOROCYCLOPENTADIENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
HEXACHLOROETHANE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
INDENO(1,2,3-CD)PYRENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
ISOPHORONE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
N-NITROSO-DI-N-PROPYLAMINE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
N-NITROSODIPHENYLAMINE (1)	10 U	10 U	10 U	10 U	10 U	10 U	10 U
NAPHTHALENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
NITROBENZENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
PENTACHLOROPHENOL	25 U	25 U	25 U	25 U	25 U	25 U	25 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP012	07/10-HP013	07/10-HP014	07/10-HP015	07/10-MW01	07/10-MW01	07/10-MW01
Sample ID	199AA542B	199AA543B	199AA544B	199AA545B	199Q4023	199Q5008	199Q6008
Sample Date	08/10/1995	08/10/1995	08/10/1995	08/10/1995	12/08/1995	02/26/1996	06/10/1996
Semivolatile Organic Compounds (µg/L)							
PHENANTHRENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
PHENOL	10 U	10 U	10 U	10 U	10 U	10 U	10 U
PYRENE	10 U	10 U	10 U	10 U	10 U	10 U	10 U
PCBs/Pesticides (µg/L)							
PCBs							
AROCLOR-1016	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA	NA
Pesticides							
4,4'-DDD	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U
4,4'-DDE	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U
4,4'-DDT	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U
ALDRIN	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U
ALPHA-BHC	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U
ALPHA-CHLORDANE	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U
AROCLOR-1016	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
AROCLOR-1221	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
AROCLOR-1232	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
AROCLOR-1242	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
AROCLOR-1248	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
AROCLOR-1254	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
AROCLOR-1260	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
BETA-BHC	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U
DELTA-BHC	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U
DIELDRIN	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U
ENDOSULFAN I	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U
ENDOSULFAN II	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U
ENDOSULFAN SULFATE	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U
ENDRIN	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U
ENDRIN ALDEHYDE	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP012	07/10-HP013	07/10-HP014	07/10-HP015	07/10-MW01	07/10-MW01	07/10-MW01
Sample ID	199AA542B	199AA543B	199AA544B	199AA545B	199Q4023	199Q5008	199Q6008
Sample Date	08/10/1995	08/10/1995	08/10/1995	08/10/1995	12/08/1995	02/26/1996	06/10/1996
PCBs/Pesticides (µg/L)							
Pesticides							
ENDRIN KETONE	0.1 U	0.1 U	NA	NA	0.1 U	0.1 U	0.1 U
GAMMA-BHC (LINDANE)	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U
GAMMA-CHLORDANE	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U
HEPTACHLOR	0.05 U	0.05 U	NA	NA	0.05 U	0.05 U	0.05 U
HEPTACHLOR EPOXIDE	0.01 U	0.01 U	NA	NA	0.01 U	0.01 U	0.01 U
METHOXYCHLOR	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
TOXAPHENE	3 U	3 U	NA	NA	3 U	3 U	3 U
Metals (µg/L)							
Unfiltered							
ALUMINUM	NA	NA	NA	NA	6,570	39,900	9,610
ANTIMONY	NA	NA	NA	NA	3 U	2.8 UJ b	1.2 U
ARSENIC	NA	NA	NA	NA	23.1	36	29.5
BARIUM	NA	NA	NA	NA	26.7 J g	116 J g	38.1 J g
BERYLLIUM	NA	NA	NA	NA	0.1 U	0.1 U	0.1 U
CADMIUM	NA	NA	NA	NA	0.2 U	0.2 U	0.3 U
CALCIUM	NA	NA	NA	NA	59,800	185,000	71,200
CHROMIUM	NA	NA	NA	NA	22.4	119	27.2
COBALT	NA	NA	NA	NA	5.5 J g	33.1 J g	11 J g
COPPER	NA	NA	NA	NA	10 UJ b	59.9	20.6 J g
IRON	NA	NA	NA	NA	12,300	55,300	14,400
LEAD	NA	NA	NA	NA	8.9	36.8	14.2
MAGNESIUM	NA	NA	NA	NA	38,100	92,200	37,900
MANGANESE	NA	NA	NA	NA	374	3,350	1,330
MERCURY	NA	NA	NA	NA	0.1 U	0.58	0.11 J g
MOLYBDENUM	NA	NA	NA	NA	5.3 UJ b	3.9 J g	2.7 J g
NICKEL	NA	NA	NA	NA	23.6 J g	115	30 J g
POTASSIUM	NA	NA	NA	NA	34,000	43,800	31,800
SELENIUM	NA	NA	NA	NA	3.9 UJ d	2.3 U	2.2 U
SILVER	NA	NA	NA	NA	0.7 U	0.5 U	0.7 U
SODIUM	NA	NA	NA	NA	269,000	776,000	210,000
THALLIUM	NA	NA	NA	NA	1.9 UJ e	3.8 J g	1.8 UJ b
VANADIUM	NA	NA	NA	NA	25.7 J g	118	31.2 J g
ZINC	NA	NA	NA	NA	48.9	298	66.5 UJ b
Filtered							
ALUMINUM	NA	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-HP012	07/10-HP013	07/10-HP014	07/10-HP015	07/10-MW01	07/10-MW01	07/10-MW01
Sample ID	199AA542B	199AA543B	199AA544B	199AA545B	199Q4023	199Q5008	199Q6008
Sample Date	08/10/1995	08/10/1995	08/10/1995	08/10/1995	12/08/1995	02/26/1996	06/10/1996
Metals (µg/L)							
Filtered							
ANTIMONY	NA	NA	NA	NA	NA	NA	NA
ARSENIC	NA	NA	NA	NA	NA	NA	NA
BARIUM	NA	NA	NA	NA	NA	NA	NA
BERYLLIUM	NA	NA	NA	NA	NA	NA	NA
CADMIUM	NA	NA	NA	NA	NA	NA	NA
CALCIUM	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	NA	NA	NA	NA	NA	NA	NA
COBALT	NA	NA	NA	NA	NA	NA	NA
COPPER	NA	NA	NA	NA	NA	NA	NA
IRON	NA	NA	NA	NA	NA	NA	NA
LEAD	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	NA	NA	NA	NA	NA	NA	NA
MANGANESE	NA	NA	NA	NA	NA	NA	NA
MERCURY	NA	NA	NA	NA	NA	NA	NA
MOLYBDENUM	NA	NA	NA	NA	NA	NA	NA
NICKEL	NA	NA	NA	NA	NA	NA	NA
POTASSIUM	NA	NA	NA	NA	NA	NA	NA
SELENIUM	NA	NA	NA	NA	NA	NA	NA
SILVER	NA	NA	NA	NA	NA	NA	NA
SODIUM	NA	NA	NA	NA	NA	NA	NA
THALLIUM	NA	NA	NA	NA	NA	NA	NA
VANADIUM	NA	NA	NA	NA	NA	NA	NA
ZINC	NA	NA	NA	NA	NA	NA	NA
Chlorinated Herbicides (µg/L)							
2,4,5-T	NA	NA	NA	NA	0.095 U	0.098 U	0.095 U
2,4,5-TP (SILVEX)	NA	NA	NA	NA	0.095 U	0.098 U	0.095 U
2,4-D	NA	NA	NA	NA	0.94 U	0.97 U	0.94 U
2,4-DB	NA	NA	NA	NA	0.95 U	0.98 U	0.95 U
DALAPON	NA	NA	NA	NA	2.3 U	2.4 UJ e	2.3 U
DICAMBA	NA	NA	NA	NA	0.094 U	0.097 U	0.094 U
DICHLOROPROP	NA	NA	NA	NA	0.94 U	0.97 U	0.94 U
DINOSEB	NA	NA	NA	NA	0.47 U	0.48 U	0.47 UJ e
MCPA	NA	NA	NA	NA	93 U	96 U	93 U
MCPP	NA	NA	NA	NA	94 U	97 U	94 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-MW01	07/10-MW01	10-MW02	10-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7008	196Q4001	30210GW02001	30210GW03001	199Q4055	199Q5025	199Q6025
Sample Date	09/04/1996	11/02/1998	10/30/2002	10/30/2002	11/21/1995	02/26/1996	06/10/1996
Volatile Organic Compounds (µg/L)							
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	1 U	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
1,1,2,2-TETRACHLOROETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
1,1,2-TRICHLOROETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROETHENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
1,1-DICHLOROPROPENE	NA	NA	NA	1 U	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	1 U	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	1 U	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	1 U	NA	NA	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	1 U	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	1 U	NA	NA	NA
1,2-DIBROMOETHANE	NA	NA	NA	1 U	NA	NA	NA
1,2-DICHLOROBENZENE	NA	NA	NA	1 U	NA	NA	NA
1,2-DICHLOROETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
1,2-DICHLOROETHENE (TOTAL)	0.5 U	NA	NA	NA	0.5 U	0.5 U	0.5 U
1,2-DICHLOROPROPANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	1 U	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	1 U	NA	NA	NA
1,3-DICHLOROPROPANE	NA	NA	NA	1 U	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	1 U	NA	NA	NA
2,2-DICHLOROPROPANE	NA	NA	NA	1 U	NA	NA	NA
2-BUTANONE	4 U	2 R c	NA	10 U	4 U	4 UJ c	4 U
2-CHLOROTOLUENE	NA	NA	NA	1 U	NA	NA	NA
2-HEXANONE	4 U	2 U	NA	10 U	4 R c	4 R c	4 U
4-CHLOROTOLUENE	NA	NA	NA	1 U	NA	NA	NA
4-METHYL-2-PENTANONE	4 U	2 U	NA	10 U	4 U	4 U	4 U
ACETONE	4 U	2 R c	NA	10 UJ b	4 U	4 UJ c	4 U
BENZENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
BROMOBENZENE	NA	NA	NA	1 U	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	1 U	NA	NA	NA
BROMODICHLOROMETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
BROMOFORM	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
BROMOMETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
CARBON DISULFIDE	0.4 J g	2 UJ c	NA	1 U	0.5 U	0.3 J g	0.5 U
CARBON TETRACHLORIDE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-MW01	07/10-MW01	10-MW02	10-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7008	196Q4001	30210GW02001	30210GW03001	199Q4055	199Q5025	199Q6025
Sample Date	09/04/1996	11/02/1998	10/30/2002	10/30/2002	11/21/1995	02/26/1996	06/10/1996
Volatile Organic Compounds (µg/L)							
CHLOROBENZENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
CHLOROETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
CHLOROFORM	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
CHLOROMETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
CIS-1,2-DICHLOROETHENE	NA	0.5 U	NA	1 U	NA	NA	NA
CIS-1,3-DICHLOROPROPENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
DIBROMOCHLOROMETHANE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
DIBROMOMETHANE	NA	NA	NA	1 U	NA	NA	NA
ETHYLBENZENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
FREON 11	NA	NA	NA	1 U	NA	NA	NA
FREON 113	NA	NA	NA	5 U	NA	NA	NA
FREON 12	NA	NA	NA	1 U	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	1 U	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	1 U	NA	NA	NA
M,P-XYLENES	NA	NA	NA	1 U	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	0.5 U	NA	1 U	NA	NA	NA
METHYLENE CHLORIDE	0.5 U	0.5 U	NA	10 UJ b	0.5 U	0.5 U	0.5 U
N-BUTYLBENZENE	NA	NA	NA	1 U	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	1 U	NA	NA	NA
NAPHTHALENE	NA	NA	NA	1 U	NA	NA	NA
O-XYLENE	NA	NA	NA	1 U	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	1 U	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	1 U	NA	NA	NA
STYRENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
TERT-BUTYLBENZENE	NA	NA	NA	1 U	NA	NA	NA
TETRACHLOROETHENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
TOLUENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
TRANS-1,2-DICHLOROETHENE	NA	0.5 U	NA	1 U	NA	NA	NA
TRANS-1,3-DICHLOROPROPENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
VINYL ACETATE	NA	NA	NA	10 U	NA	NA	NA
VINYL CHLORIDE	0.5 U	0.5 U	NA	1 U	0.5 U	0.5 U	0.5 U
XYLENE (TOTAL)	0.5 U	0.5 U	NA	NA	0.5 U	0.5 U	0.5 U
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
DIESEL RANGE ORGANICS	NA	0.12 U	NA	0.045 U	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-MW01	07/10-MW01	10-MW02	10-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7008	196Q4001	30210GW02001	30210GW03001	199Q4055	199Q5025	199Q6025
Sample Date	09/04/1996	11/02/1998	10/30/2002	10/30/2002	11/21/1995	02/26/1996	06/10/1996
Petroleum Hydrocarbons (mg/L)							
Diesel/Motor Oil Range (extractables) - SG							
MOTOR OIL RANGE ORGANICS	NA	0.24 UJ b	NA	0.03 U	NA	NA	NA
Diesel/Motor Oil Range (extractables)							
DIESEL RANGE ORGANICS	0.1 U	NA	NA	NA	0.052 JY g	0.053 JY g	0.1 U
MOTOR OIL RANGE ORGANICS	0.093 JY g	NA	NA	NA	0.17 Y	0.12 Y	0.1 U
Gasoline Range (purgeables)							
GASOLINE RANGE ORGANICS	NA	NA	NA	0.05 UJ a	0.087 Y	0.026 JY g	0.047 JY g
Semivolatile Organic Compounds (µg/L)							
1,2,4-TRICHLOROBENZENE	10 U	NA	NA	0.016 U	10 U	10 U	10 U
1,2-DICHLOROBENZENE	5 U	NA	NA	0.015 U	5 U	5 U	5 U
1,3-DICHLOROBENZENE	5 U	NA	NA	0.011 U	5 U	5 U	5 U
1,4-DICHLOROBENZENE	5 U	NA	NA	0.014 U	5 U	5 U	5 U
2,2'-OXYBIS(1-CHLOROPROPANE)	10 U	NA	NA	0.017 U	10 U	10 U	10 U
2,4,5-TRICHLOROPHENOL	25 U	NA	NA	0.026 U	25 U	25 U	25 U
2,4,6-TRICHLOROPHENOL	10 U	NA	NA	0.037 U	10 U	10 U	10 U
2,4-DICHLOROPHENOL	10 U	NA	NA	0.024 U	10 U	10 U	10 U
2,4-DIMETHYLPHENOL	10 U	NA	NA	0.32 U	10 U	10 U	10 U
2,4-DINITROPHENOL	25 U	NA	NA	0.53 U	25 U	25 U	25 U
2,4-DINITROTOLUENE	10 U	NA	NA	0.02 U	10 U	10 U	10 U
2,6-DINITROTOLUENE	10 U	NA	NA	0.0088 U	10 U	10 U	10 U
2-CHLORONAPHTHALENE	10 U	NA	NA	0.016 U	10 U	10 U	10 U
2-CHLOROPHENOL	10 U	NA	NA	0.015 U	10 U	10 U	10 U
2-METHYLNAPHTHALENE	10 U	NA	NA	0.012 U	10 U	10 U	10 U
2-METHYLPHENOL	10 U	NA	NA	0.06 U	10 U	10 U	10 U
2-NITROANILINE	25 U	NA	NA	0.015 U	25 U	25 U	25 U
2-NITROPHENOL	10 U	NA	NA	0.014 U	10 U	10 U	10 U
3,3'-DICHLOROBENZIDINE	10 U	NA	NA	0.43 U	10 U	10 UJ c	10 U
3-NITROANILINE	25 U	NA	NA	0.23 U	25 U	25 U	25 U
4,6-DINITRO-2-METHYLPHENOL	25 U	NA	NA	0.013 U	25 U	25 U	25 U
4-BROMOPHENYL-PHENYLETHER	10 U	NA	NA	0.018 U	10 U	10 U	10 U
4-CHLORO-3-METHYLPHENOL	10 U	NA	NA	0.029 U	10 U	10 U	10 U
4-CHLOROANILINE	10 U	NA	NA	0.018 U	10 U	10 U	10 U
4-CHLOROPHENYL-PHENYLETHER	10 U	NA	NA	0.0085 U	10 U	10 U	10 U
4-METHYLPHENOL	10 U	NA	NA	0.051 U	10 U	10 U	10 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-MW01	07/10-MW01	10-MW02	10-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7008	196Q4001	30210GW02001	30210GW03001	199Q4055	199Q5025	199Q6025
Sample Date	09/04/1996	11/02/1998	10/30/2002	10/30/2002	11/21/1995	02/26/1996	06/10/1996
Semivolatile Organic Compounds (µg/L)							
4-NITROANILINE	25 U	NA	NA	0.17 U	25 U	25 U	25 U
4-NITROPHENOL	25 U	NA	NA	0.54 U	25 U	25 U	25 U
ACENAPHTHENE	10 U	NA	NA	0.0088 U	10 U	10 U	10 U
ACENAPHTHYLENE	10 U	NA	NA	0.011 U	10 U	10 U	10 U
ANTHRACENE	10 U	NA	NA	0.015 U	10 U	10 U	10 U
BENZO(A)ANTHRACENE	10 U	NA	NA	0.012 U	10 U	10 U	10 U
BENZO(A)PYRENE	10 U	NA	NA	0.016 U	10 U	10 U	10 U
BENZO(B)FLUORANTHENE	10 U	NA	NA	0.02 U	10 U	10 U	10 U
BENZO(G,H,I)PERYLENE	10 U	NA	NA	0.017 U	10 U	10 U	10 U
BENZO(K)FLUORANTHENE	10 U	NA	NA	NA	10 U	10 U	10 U
BIS(2-CHLOROETHOXY)METHANE	10 U	NA	NA	0.012 U	10 U	10 U	10 U
BIS(2-CHLOROETHYL)ETHER	10 U	NA	NA	0.015 U	10 U	10 U	10 U
BIS(2-ETHYLHEXYL)PHTHALATE	4 U	NA	NA	0.27 U	4 U	4 U	4 U
BUTYLBENZYLPHTHALATE	10 U	NA	NA	0.026 U	10 U	10 U	10 U
CARBAZOLE	10 U	NA	NA	0.013 U	10 U	10 U	10 U
CHRYSENE	10 U	NA	NA	0.014 U	10 U	10 U	10 U
DI-N-BUTYLPHTHALATE	10 U	NA	NA	0.039 UJ b	10 U	10 U	10 U
DI-N-OCTYLPHTHALATE	10 U	NA	NA	0.032 U	10 U	10 UJ c	10 U
DIBENZ(A,H)ANTHRACENE	10 U	NA	NA	0.031 U	10 U	10 U	10 U
DIBENZOFURAN	10 U	NA	NA	0.014 U	10 U	10 U	10 U
DIETHYLPHTHALATE	10 U	NA	NA	0.043 UJ b	10 U	10 U	10 U
DIMETHYLPHTHALATE	10 U	NA	NA	0.013 U	10 U	10 U	10 U
FLUORANTHENE	10 U	NA	NA	0.031 J g	10 U	10 U	10 U
FLUORENE	10 U	NA	NA	0.012 U	10 U	10 U	10 U
HEXACHLOROBENZENE	10 U	NA	NA	0.015 U	10 U	10 U	10 U
HEXACHLOROBUTADIENE	10 U	NA	NA	0.02 U	10 U	10 U	10 U
HEXACHLOROCYCLOPENTADIENE	10 U	NA	NA	0.041 U	10 U	10 U	10 U
HEXACHLOROETHANE	10 U	NA	NA	0.019 U	10 U	10 U	10 U
INDENO(1,2,3-CD)PYRENE	10 U	NA	NA	0.024 U	10 U	10 U	10 U
ISOPHORONE	10 U	NA	NA	0.0085 U	10 U	10 U	10 U
N-NITROSO-DI-N-PROPYLAMINE	10 U	NA	NA	0.033 U	10 U	10 U	10 U
N-NITROSODIPHENYLAMINE (1)	10 U	NA	NA	0.028 U	10 U	10 U	10 U
NAPHTHALENE	10 U	NA	NA	0.012 U	10 U	10 U	10 U
NITROBENZENE	10 U	NA	NA	0.0074 U	10 U	10 U	10 U
PENTACHLOROPHENOL	25 U	NA	NA	0.029 U	25 U	25 U	25 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-MW01	07/10-MW01	10-MW02	10-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7008	196Q4001	30210GW02001	30210GW03001	199Q4055	199Q5025	199Q6025
Sample Date	09/04/1996	11/02/1998	10/30/2002	10/30/2002	11/21/1995	02/26/1996	06/10/1996
Semivolatile Organic Compounds (µg/L)							
PHENANTHRENE	10 U	NA	NA	0.055 UJ b	10 U	10 U	10 U
PHENOL	10 U	NA	NA	0.11 J g	10 U	10 U	10 U
PYRENE	10 U	NA	NA	0.034 J g	10 U	10 U	10 U
PCBs/Pesticides (µg/L)							
PCBs							
AROCLOR-1016	NA	NA	0.022 U	0.022 U	NA	NA	NA
AROCLOR-1221	NA	NA	0.041 U	0.041 U	NA	NA	NA
AROCLOR-1232	NA	NA	0.06 U	0.06 U	NA	NA	NA
AROCLOR-1242	NA	NA	0.036 U	0.036 U	NA	NA	NA
AROCLOR-1248	NA	NA	0.018 U	0.018 U	NA	NA	NA
AROCLOR-1254	NA	NA	0.018 U	0.018 U	NA	NA	NA
AROCLOR-1260	NA	NA	0.027 U	0.027 U	NA	NA	NA
Pesticides							
4,4'-DDD	0.1 U	NA	0.0052 U	0.0052 U	NA	NA	NA
4,4'-DDE	0.1 U	NA	0.0083 U	0.0083 U	NA	NA	NA
4,4'-DDT	0.1 U	NA	0.0051 U	0.0051 U	NA	NA	NA
ALDRIN	0.05 U	NA	0.0034 U	0.0034 U	NA	NA	NA
ALPHA-BHC	0.05 U	NA	0.0055 U	0.0055 U	NA	NA	NA
ALPHA-CHLORDANE	0.05 U	NA	0.0061 U	0.0061 U	NA	NA	NA
AROCLOR-1016	0.5 U	NA	NA	NA	NA	NA	NA
AROCLOR-1221	0.5 U	NA	NA	NA	NA	NA	NA
AROCLOR-1232	0.5 U	NA	NA	NA	NA	NA	NA
AROCLOR-1242	0.5 U	NA	NA	NA	NA	NA	NA
AROCLOR-1248	0.5 U	NA	NA	NA	NA	NA	NA
AROCLOR-1254	0.5 U	NA	NA	NA	NA	NA	NA
AROCLOR-1260	0.5 U	NA	NA	NA	NA	NA	NA
BETA-BHC	0.05 U	NA	0.0042 U	0.0042 U	NA	NA	NA
DELTA-BHC	0.05 U	NA	0.005 U	0.005 U	NA	NA	NA
DIELDRIN	0.1 U	NA	0.0068 U	0.0068 U	NA	NA	NA
ENDOSULFAN I	0.05 U	NA	0.0055 U	0.0055 U	NA	NA	NA
ENDOSULFAN II	0.1 U	NA	0.0059 U	0.0059 U	NA	NA	NA
ENDOSULFAN SULFATE	0.1 U	NA	0.0067 U	0.0067 U	NA	NA	NA
ENDRIN	0.1 U	NA	0.0047 U	0.0047 U	NA	NA	NA
ENDRIN ALDEHYDE	0.1 U	NA	0.0047 U	0.0047 U	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-MW01	07/10-MW01	10-MW02	10-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7008	196Q4001	30210GW02001	30210GW03001	199Q4055	199Q5025	199Q6025
Sample Date	09/04/1996	11/02/1998	10/30/2002	10/30/2002	11/21/1995	02/26/1996	06/10/1996
PCBs/Pesticides (µg/L)							
Pesticides							
ENDRIN KETONE	0.1 U	NA	0.0061 U	0.0061 U	NA	NA	NA
GAMMA-BHC (LINDANE)	0.05 U	NA	0.0042 U	0.0042 U	NA	NA	NA
GAMMA-CHLORDANE	0.05 U	NA	0.02 U	0.0075 U	NA	NA	NA
HEPTACHLOR	0.05 U	NA	0.0049 U	0.0049 U	NA	NA	NA
HEPTACHLOR EPOXIDE	0.01 U	NA	0.0084 U	0.0084 U	NA	NA	NA
METHOXYCHLOR	0.5 U	NA	0.0069 U	0.0069 U	NA	NA	NA
TOXAPHENE	3 U	NA	0.05 U	0.05 U	NA	NA	NA
Metals (µg/L)							
Unfiltered							
ALUMINUM	3,280 J ej	NA	NA	349	84,200	10,700	22,700
ANTIMONY	2.6 UJ b	NA	NA	0.48 J g	4.3 J g	2 UJ b	1.2 U
ARSENIC	27.8	NA	NA	14.8	80	15.2	35.5
BARIUM	13.7 J g	NA	NA	16.3	204	37.3 J g	77 J g
BERYLLIUM	0.1 U	NA	NA	0.4 U	0.36 J g	0.1 U	0.25 UJ b
CADMIUM	0.3 U	NA	NA	1 U	0.2 U	0.2 U	0.3 U
CALCIUM	44,000	NA	NA	81,200	164,000	46,500	78,600
CHROMIUM	9.7 J g	NA	NA	3.6 J g	338	42	78.3
COBALT	3 J g	NA	NA	2 U	83.2	11.3 J g	30.4 J g
COPPER	9.3 J g	NA	NA	0.9 U	167	20.2 J g	46.8
IRON	4,460	NA	NA	1,030	176,000	18,200	39,700
LEAD	3	NA	NA	0.427	138	16.8	60
MAGNESIUM	28,500	NA	NA	82,300	78,500	17,900	28,400
MANGANESE	359	NA	NA	628	2,740	840	1,520
MERCURY	0.1 U	NA	NA	0.1 U	1.3 J e	0.1 U	0.22
MOLYBDENUM	4.4 J g	NA	NA	5.43	5.5 UJ b	2.4 UJ b	1 J g
NICKEL	12 J g	NA	NA	1.1 J g	298	35.9 J g	74.3
POTASSIUM	31,500	NA	NA	45,900	44,300	15,400	20,700
SELENIUM	3.9 U	NA	NA	1 U	3.9 U	2.3 U	2.2 U
SILVER	0.4 U	NA	NA	0.35 J g	0.7 U	0.5 U	0.7 U
SODIUM	192,000	NA	NA	619,000	46,900	13,900	17,100
THALLIUM	1.8 U	NA	NA	0.08 U	1.9 U	1.9 U	1.7 U
VANADIUM	12.2 J g	NA	NA	6 U	291	36.4 J g	77.3
ZINC	52.3	NA	NA	5.1 J g	479	73	145
Filtered							
ALUMINUM	NA	31.1 J g	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	07/10-MW01	07/10-MW01	10-MW02	10-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7008	196Q4001	30210GW02001	30210GW03001	199Q4055	199Q5025	199Q6025
Sample Date	09/04/1996	11/02/1998	10/30/2002	10/30/2002	11/21/1995	02/26/1996	06/10/1996
Metals (µg/L)							
Filtered							
ANTIMONY	NA	2.1 U	NA	NA	NA	NA	NA
ARSENIC	NA	20.6	NA	NA	NA	NA	NA
BARIUM	NA	3.4 UJ f	NA	NA	NA	NA	NA
BERYLLIUM	NA	0.3 U	NA	NA	NA	NA	NA
CADMIUM	NA	0.4 U	NA	NA	NA	NA	NA
CALCIUM	NA	37,500	NA	NA	NA	NA	NA
CHROMIUM	NA	0.9 U	NA	NA	NA	NA	NA
COBALT	NA	1 J g	NA	NA	NA	NA	NA
COPPER	NA	1.5 UJ f	NA	NA	NA	NA	NA
IRON	NA	19.9 U	NA	NA	NA	NA	NA
LEAD	NA	1.9 U	NA	NA	NA	NA	NA
MAGNESIUM	NA	30,800	NA	NA	NA	NA	NA
MANGANESE	NA	5.7 J g	NA	NA	NA	NA	NA
MERCURY	NA	0.1 U	NA	NA	NA	NA	NA
MOLYBDENUM	NA	4.5 J g	NA	NA	NA	NA	NA
NICKEL	NA	1.4 J g	NA	NA	NA	NA	NA
POTASSIUM	NA	33,300 J j	NA	NA	NA	NA	NA
SELENIUM	NA	2.1 UJ e	NA	NA	NA	NA	NA
SILVER	NA	1.2 U	NA	NA	NA	NA	NA
SODIUM	NA	224,000	NA	NA	NA	NA	NA
THALLIUM	NA	1.1 U	NA	NA	NA	NA	NA
VANADIUM	NA	3.8 UJ b	NA	NA	NA	NA	NA
ZINC	NA	7.8 UJ b	NA	NA	NA	NA	NA
Chlorinated Herbicides (µg/L)							
2,4,5-T	0.095 U	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	0.095 U	NA	NA	NA	NA	NA	NA
2,4-D	0.94 U	NA	NA	NA	NA	NA	NA
2,4-DB	0.95 U	NA	NA	NA	NA	NA	NA
DALAPON	2.3 U	NA	NA	NA	NA	NA	NA
DICAMBA	0.094 U	NA	NA	NA	NA	NA	NA
DICHLOROPROP	0.94 U	NA	NA	NA	NA	NA	NA
DINOSEB	0.47 U	NA	NA	NA	NA	NA	NA
MCPA	93 U	NA	NA	NA	NA	NA	NA
MCPP	94 U	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7025	199Q7052	196Q2058	196Q4086	284Q3119	284Q8134
Sample Date	09/04/1996	09/04/1996	05/21/1998	11/17/1998	05/26/2000	10/30/2001
Volatile Organic Compounds (µg/L)						
1,1,1,2-TETRACHLOROETHANE	NA	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
1,1,2,2-TETRACHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
1,1,2-TRICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
1,1-DICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
1,1-DICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
1,1-DICHLOROPROPENE	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	NA	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	NA	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	NA	NA	NA	NA	1 U	NA
1,2,4-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	NA	NA	NA	NA	1 U	NA
1,2-DIBROMOETHANE	NA	NA	NA	NA	1 U	NA
1,2-DICHLOROBENZENE	NA	NA	NA	NA	1 U	NA
1,2-DICHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-DICHLOROETHENE (TOTAL)	0.5 U	0.5 U	0.5 U	NA	NA	NA
1,2-DICHLOROPROPANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
1,3,5-TRIMETHYLBENZENE	NA	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	NA	NA	NA	NA	1 U	NA
1,3-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA
1,4-DICHLOROBENZENE	NA	NA	NA	NA	1 U	NA
2,2-DICHLOROPROPANE	NA	NA	NA	NA	NA	NA
2-BUTANONE	4 U	4 U	2 R c	2 R c	5 U	6.3 U
2-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA
2-HEXANONE	4 U	4 U	2 R c	2 U	5 U	2 U
4-CHLOROTOLUENE	NA	NA	NA	NA	NA	NA
4-METHYL-2-PENTANONE	4 U	4 U	2 R c	2 U	5 U	2 U
ACETONE	4 U	4 U	2 R c	2 R c	5 U	6.2 R c
BENZENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
BROMOBENZENE	NA	NA	NA	NA	NA	NA
BROMOCHLOROMETHANE	NA	NA	NA	NA	1 U	NA
BROMODICHLOROMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
BROMOFORM	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
BROMOMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 UJ c
CARBON DISULFIDE	0.5 U	0.5 U	2 U	2 UJ c	1 U	2 U
CARBON TETRACHLORIDE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7025	199Q7052	196Q2058	196Q4086	284Q3119	284Q8134
Sample Date	09/04/1996	09/04/1996	05/21/1998	11/17/1998	05/26/2000	10/30/2001
Volatile Organic Compounds (µg/L)						
CHLOROBENZENE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
CHLOROETHANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
CHLOROFORM	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
CHLOROMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
CIS-1,2-DICHLOROETHENE	NA	NA	NA	0.5 U	1 U	2 U
CIS-1,3-DICHLOROPROPENE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	0.5 U
DIBROMOCHLOROMETHANE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
DIBROMOMETHANE	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
FREON 11	NA	NA	NA	NA	NA	NA
FREON 113	NA	NA	NA	NA	NA	NA
FREON 12	NA	NA	NA	NA	NA	NA
HEXACHLOROBUTADIENE	NA	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	NA	NA	NA	NA	NA	0.5 U
M,P-XYLENES	NA	NA	NA	NA	NA	NA
METHYL-TERT-BUTYL ETHER	NA	NA	2	4 J c	1 U	1 J g
METHYLENE CHLORIDE	0.5 U	0.5 U	0.5 U	0.5 U	2 U	2 U
N-BUTYLBENZENE	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	NA	NA	NA	NA	NA	NA
NAPHTHALENE	NA	NA	NA	NA	NA	NA
O-XYLENE	NA	NA	NA	NA	NA	NA
PARA-ISOPROPYL TOLUENE	NA	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	NA	NA	NA	NA	NA	NA
STYRENE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
TERT-BUTYLBENZENE	NA	NA	NA	NA	NA	NA
TETRACHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
TOLUENE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
TRANS-1,2-DICHLOROETHENE	NA	NA	NA	0.5 U	1 U	2 U
TRANS-1,3-DICHLOROPROPENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
VINYL ACETATE	NA	NA	NA	NA	NA	2 U
VINYL CHLORIDE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
XYLENE (TOTAL)	0.5 U	0.5 U	0.5 U	0.5 U	1 U	2 U
Petroleum Hydrocarbons (mg/L)						
Diesel/Motor Oil Range (extractables) - SG						
DIESEL RANGE ORGANICS	NA	NA	NA	0.12 U	0.1 U	0.3 DJ g

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7025	199Q7052	196Q2058	196Q4086	284Q3119	284Q8134
Sample Date	09/04/1996	09/04/1996	05/21/1998	11/17/1998	05/26/2000	10/30/2001
Petroleum Hydrocarbons (mg/L)						
Diesel/Motor Oil Range (extractables) - SG						
MOTOR OIL RANGE ORGANICS	NA	NA	NA	0.24 U	0.1 U	0.5 U
Diesel/Motor Oil Range (extractables)						
DIESEL RANGE ORGANICS	0.1 U	0.1 U	NA	NA	NA	NA
MOTOR OIL RANGE ORGANICS	0.055 JY g	0.1 U	NA	NA	NA	NA
Gasoline Range (purgeables)						
GASOLINE RANGE ORGANICS	0.047 JY g	0.049 JY g	NA	0.03 JZ g	0.05 U	0.05 U
Semivolatile Organic Compounds (µg/L)						
1,2,4-TRICHLOROBENZENE	10 U	10 U	NA	NA	1 U	2 U
1,2-DICHLOROBENZENE	5 U	5 U	NA	NA	1 U	2 U
1,3-DICHLOROBENZENE	5 U	5 U	NA	NA	1 U	2 U
1,4-DICHLOROBENZENE	5 U	5 U	NA	NA	1 U	2 U
2,2'-OXYBIS(1-CHLOROPROPANE)	10 U	10 U	NA	NA	1 UJ c	2 U
2,4,5-TRICHLOROPHENOL	25 U	25 U	NA	NA	2 U	5 U
2,4,6-TRICHLOROPHENOL	10 U	10 U	NA	NA	1 U	2 U
2,4-DICHLOROPHENOL	10 U	10 U	NA	NA	1 U	2 U
2,4-DIMETHYLPHENOL	10 U	10 U	NA	NA	1 UJ c	2 U
2,4-DINITROPHENOL	25 U	25 U	NA	NA	2 UJ c	5 R c
2,4-DINITROTOLUENE	10 U	10 U	NA	NA	1 U	2 U
2,6-DINITROTOLUENE	10 U	10 U	NA	NA	1 U	2 U
2-CHLORONAPHTHALENE	10 U	10 U	NA	NA	1 U	2 U
2-CHLOROPHENOL	10 U	10 U	NA	NA	1 U	2 U
2-METHYLNAPHTHALENE	10 U	10 U	NA	NA	1 U	2 U
2-METHYLPHENOL	10 U	10 U	NA	NA	1 U	2 U
2-NITROANILINE	25 U	25 U	NA	NA	2 U	5 U
2-NITROPHENOL	10 U	10 U	NA	NA	1 U	2 U
3,3'-DICHLOROBENZIDINE	10 U	10 U	NA	NA	1 U	3 U
3-NITROANILINE	25 U	25 U	NA	NA	2 UJ c	5 UJ c
4,6-DINITRO-2-METHYLPHENOL	25 U	25 U	NA	NA	2 UJ c	5 UJ c
4-BROMOPHENYL-PHENYLETHER	10 U	10 U	NA	NA	1 U	2 U
4-CHLORO-3-METHYLPHENOL	10 U	10 U	NA	NA	1 U	2 U
4-CHLOROANILINE	10 U	10 U	NA	NA	1 U	3 U
4-CHLOROPHENYL-PHENYLETHER	10 U	10 U	NA	NA	1 U	2 U
4-METHYLPHENOL	10 U	10 U	NA	NA	1 UJ e	2 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7025	199Q7052	196Q2058	196Q4086	284Q3119	284Q8134
Sample Date	09/04/1996	09/04/1996	05/21/1998	11/17/1998	05/26/2000	10/30/2001
Semivolatile Organic Compounds (µg/L)						
4-NITROANILINE	25 U	25 U	NA	NA	2 UJ c	5 UJ c
4-NITROPHENOL	25 U	25 U	NA	NA	2 UJ c	8 R c
ACENAPHTHENE	10 U	10 U	NA	NA	1 U	2 U
ACENAPHTHYLENE	10 U	10 U	NA	NA	1 U	2 U
ANTHRACENE	10 U	10 U	NA	NA	1 U	2 U
BENZO(A)ANTHRACENE	10 U	10 U	NA	NA	1 U	2 U
BENZO(A)PYRENE	10 U	10 U	NA	NA	1 U	2 U
BENZO(B)FLUORANTHENE	10 U	10 U	NA	NA	1 U	2 U
BENZO(G,H,I)PERYLENE	10 U	10 U	NA	NA	1 U	2 U
BENZO(K)FLUORANTHENE	10 U	10 U	NA	NA	1 U	2 U
BIS(2-CHLOROETHOXY)METHANE	10 U	10 U	NA	NA	1 U	2 U
BIS(2-CHLOROETHYL)ETHER	10 U	10 U	NA	NA	1 U	2 U
BIS(2-ETHYLHEXYL)PHTHALATE	4 U	4 U	NA	NA	1 U	2 UJ b
BUTYLBENZYLPHTHALATE	10 U	10 U	NA	NA	1 U	2 UJ c
CARBAZOLE	10 U	10 U	NA	NA	1 U	3 UJ c
CHRYSENE	10 U	10 U	NA	NA	1 U	2 U
DI-N-BUTYLPHTHALATE	10 U	10 U	NA	NA	1 U	2 U
DI-N-OCTYLPHTHALATE	10 U	10 U	NA	NA	1 U	2 U
DIBENZ(A,H)ANTHRACENE	10 U	10 U	NA	NA	1 U	2 U
DIBENZOFURAN	10 U	10 U	NA	NA	1 U	2 U
DIETHYLPHTHALATE	10 U	10 U	NA	NA	1 U	2 U
DIMETHYLPHTHALATE	10 U	10 U	NA	NA	1 U	2 U
FLUORANTHENE	10 U	10 U	NA	NA	1 U	2 U
FLUORENE	10 U	10 U	NA	NA	1 U	2 U
HEXACHLOROBENZENE	10 U	10 U	NA	NA	1 UJ c	2 U
HEXACHLOROBUTADIENE	10 U	10 U	NA	NA	1 U	2 U
HEXACHLOROCYCLOPENTADIENE	10 U	10 U	NA	NA	1 U	4 U
HEXACHLOROETHANE	10 U	10 U	NA	NA	1 U	2 U
INDENO(1,2,3-CD)PYRENE	10 U	10 U	NA	NA	1 U	2 U
ISOPHORONE	10 U	10 U	NA	NA	1 U	2 U
N-NITROSO-DI-N-PROPYLAMINE	10 U	10 U	NA	NA	1 U	2 U
N-NITROSODIPHENYLAMINE (1)	10 U	10 U	NA	NA	1 U	3 UJ c
NAPHTHALENE	10 U	10 U	NA	NA	1 U	2 U
NITROBENZENE	10 U	10 U	NA	NA	1 U	2 U
PENTACHLOROPHENOL	25 U	25 U	NA	NA	2 U	5 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7025	199Q7052	196Q2058	196Q4086	284Q3119	284Q8134
Sample Date	09/04/1996	09/04/1996	05/21/1998	11/17/1998	05/26/2000	10/30/2001
Semivolatile Organic Compounds (µg/L)						
PHENANTHRENE	10 U	10 U	NA	NA	1 U	2 U
PHENOL	10 U	10 U	NA	NA	1 U	2 U
PYRENE	10 U	10 U	NA	NA	1 U	2 U
PCBs/Pesticides (µg/L)						
PCBs						
AROCLOR-1016	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA
Pesticides						
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA
ALDRIN	NA	NA	NA	NA	NA	NA
ALPHA-BHC	NA	NA	NA	NA	NA	NA
ALPHA-CHLORDANE	NA	NA	NA	NA	NA	NA
AROCLOR-1016	NA	NA	NA	NA	NA	NA
AROCLOR-1221	NA	NA	NA	NA	NA	NA
AROCLOR-1232	NA	NA	NA	NA	NA	NA
AROCLOR-1242	NA	NA	NA	NA	NA	NA
AROCLOR-1248	NA	NA	NA	NA	NA	NA
AROCLOR-1254	NA	NA	NA	NA	NA	NA
AROCLOR-1260	NA	NA	NA	NA	NA	NA
BETA-BHC	NA	NA	NA	NA	NA	NA
DELTA-BHC	NA	NA	NA	NA	NA	NA
DIELDRIN	NA	NA	NA	NA	NA	NA
ENDOSULFAN I	NA	NA	NA	NA	NA	NA
ENDOSULFAN II	NA	NA	NA	NA	NA	NA
ENDOSULFAN SULFATE	NA	NA	NA	NA	NA	NA
ENDRIN	NA	NA	NA	NA	NA	NA
ENDRIN ALDEHYDE	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7025	199Q7052	196Q2058	196Q4086	284Q3119	284Q8134
Sample Date	09/04/1996	09/04/1996	05/21/1998	11/17/1998	05/26/2000	10/30/2001
PCBs/Pesticides (µg/L)						
Pesticides						
ENDRIN KETONE	NA	NA	NA	NA	NA	NA
GAMMA-BHC (LINDANE)	NA	NA	NA	NA	NA	NA
GAMMA-CHLORDANE	NA	NA	NA	NA	NA	NA
HEPTACHLOR	NA	NA	NA	NA	NA	NA
HEPTACHLOR EPOXIDE	NA	NA	NA	NA	NA	NA
METHOXYCHLOR	NA	NA	NA	NA	NA	NA
TOXAPHENE	NA	NA	NA	NA	NA	NA
Metals (µg/L)						
Unfiltered						
ALUMINUM	4,850 J ej	5,520 J ej	NA	NA	16.3 U	52.9 UJ b
ANTIMONY	2.6 UJ b	2.6 UJ b	NA	NA	4.6 U	6.1 UJ b
ARSENIC	22.2	24.2	NA	NA	9 J g	12.1
BARIUM	18.7 J g	20.4 J g	NA	NA	10.7 U	4.9 J g
BERYLLIUM	0.1 U	0.1 U	NA	NA	0.3 U	0.15 U
CADMIUM	0.3 U	0.3 U	NA	NA	0.3 U	0.23 U
CALCIUM	40,700	40,000	NA	NA	55,300	56,700
CHROMIUM	17.8	20	NA	NA	2.2 U	0.57 UJ b
COBALT	5.3 J g	5.6 J g	NA	NA	3 U	0.41 U
COPPER	12.8 J g	11.6 J g	NA	NA	2.1 U	1.6 U
IRON	8,600	9,350	NA	NA	24.9 U	41.5
LEAD	9.1	7.5	NA	NA	2.3 U	0.78 U
MAGNESIUM	20,800	21,000	NA	NA	16,100	20,900
MANGANESE	402	404	NA	NA	2.4 J g	9.2 UJ f
MERCURY	0.1 U	0.1 U	NA	NA	0.14 J g	0.17 UJ f
MOLYBDENUM	2.3 J g	3.4 J g	NA	NA	1.5 U	2.7 UJ b
NICKEL	18.6 J g	20.1 J g	NA	NA	2.9 U	2.1 UJ b
POTASSIUM	23,100	23,700	NA	NA	16,100	17,300
SELENIUM	3.9 U	3.9 U	NA	NA	4 U	2.2 J g
SILVER	0.4 U	0.4 U	NA	NA	1.9 U	0.28 U
SODIUM	28,000	27,200	NA	NA	13,100	21,300
THALLIUM	2.5 UJ b	1.8 U	NA	NA	3.9 U	0.99 U
VANADIUM	19.7 J g	21.8 J g	NA	NA	4.7 J g	5.2
ZINC	75.6	49.3	NA	NA	2.2 J g	59.8 UJ f
Filtered						
ALUMINUM	NA	NA	NA	73.4 UJ b	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03	14-MW03
Sample ID	199Q7025	199Q7052	196Q2058	196Q4086	284Q3119	284Q8134
Sample Date	09/04/1996	09/04/1996	05/21/1998	11/17/1998	05/26/2000	10/30/2001
Metals (µg/L)						
Filtered						
ANTIMONY	NA	NA	NA	2.1 U	NA	NA
ARSENIC	NA	NA	NA	12.6	NA	NA
BARIUM	NA	NA	NA	2.1 J g	NA	NA
BERYLLIUM	NA	NA	NA	0.47 UJ b	NA	NA
CADMIUM	NA	NA	NA	0.4 U	NA	NA
CALCIUM	NA	NA	NA	34,900	NA	NA
CHROMIUM	NA	NA	NA	0.9 U	NA	NA
COBALT	NA	NA	NA	1 U	NA	NA
COPPER	NA	NA	NA	1.1 U	NA	NA
IRON	NA	NA	NA	19.9 U	NA	NA
LEAD	NA	NA	NA	2.6 UJ b	NA	NA
MAGNESIUM	NA	NA	NA	11,500	NA	NA
MANGANESE	NA	NA	NA	4.1 UJ b	NA	NA
MERCURY	NA	NA	NA	0.32 U	NA	NA
MOLYBDENUM	NA	NA	NA	1.1 UJ b	NA	NA
NICKEL	NA	NA	NA	1.5 J g	NA	NA
POTASSIUM	NA	NA	NA	15,600	NA	NA
SELENIUM	NA	NA	NA	2.1 U	NA	NA
SILVER	NA	NA	NA	1.2 U	NA	NA
SODIUM	NA	NA	NA	13,000	NA	NA
THALLIUM	NA	NA	NA	1.1 U	NA	NA
VANADIUM	NA	NA	NA	5.1 UJ b	NA	NA
ZINC	NA	NA	NA	4.3 UJ b	NA	NA
Chlorinated Herbicides (µg/L)						
2,4,5-T	NA	NA	NA	NA	NA	NA
2,4,5-TP (SILVEX)	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA
DALAPON	NA	NA	NA	NA	NA	NA
DICAMBA	NA	NA	NA	NA	NA	NA
DICHLOROPROP	NA	NA	NA	NA	NA	NA
DINOSEB	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 GROUNDWATER SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Notes:

a	Surrogate recovery problem.
b	Laboratory blank and common contamination problem.
c	Calibration criteria exceedance.
D	Chromatographic pattern resembles diesel.
d	Duplicate precision problem.
e	Matrix spike/LCS recovery problem.
f	Field blank contamination.
g	Quantification below reporting limit.
ID	Identification.
J	Estimated value.
j	Other qualification reasons.
LCS	Laboratory control sample.
mg/L	Milligram per liter.
NA	Not analyzed.
NAVSTA	Naval Station.
R	Result rejected during quality assurance review.
SG	Silica Gel.
TPH	Total petroleum hydrocarbons.
U	Nondetected.
Y	Chromatographic pattern resembles hydrocarbon fuel pattern and was quantitated using the standard it resembled most.
Z	Chromatographic pattern does not resemble TPH fuel pattern (individual peaks).
µg/L	Microgram per liter.

SITE 10
SEDIMENT AND DRAIN ANALYTICAL RESULTS

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C	CATCH BASIN
Sample ID	199AA566	199AA567
Sample Date	07/05/1995	07/05/1995
Matrix	SEDIMENT	SEDIMENT
Volatile Organic Compounds (mg/kg)		
1,1,1-TRICHLOROETHANE	0.015 U	2.8 U
1,1,2,2-TETRACHLOROETHANE	0.015 U	2.8 U
1,1,2-TRICHLOROETHANE	0.015 U	2.8 U
1,1-DICHLOROETHANE	0.015 U	2.8 U
1,1-DICHLOROETHENE	0.015 U	2.8 U
1,2-DICHLOROETHANE	0.015 U	2.8 U
1,2-DICHLOROETHENE (TOTAL)	0.015 U	2.8 U
1,2-DICHLOROPROPANE	0.015 U	2.8 U
2-BUTANONE	0.015 U	2.8 U
2-HEXANONE	0.015 U	2.8 U
4-METHYL-2-PENTANONE	0.015 U	2.8 U
ACETONE	0.021 UJ b	2.8 UJ b
BENZENE	0.015 U	2.8 U
BROMODICHLOROMETHANE	0.015 U	2.8 U
BROMOFORM	0.015 U	2.8 U
BROMOMETHANE	0.015 U	2.8 U
CARBON DISULFIDE	0.015 U	2.8 U
CARBON TETRACHLORIDE	0.015 U	2.8 U
CHLOROBENZENE	0.015 U	2.8 U
CHLOROETHANE	0.015 U	2.8 U
CHLOROFORM	0.015 U	2.8 U
CHLOROMETHANE	0.015 U	2.8 U
CIS-1,3-DICHLOROPROPENE	0.015 U	2.8 U
DIBROMOCHLOROMETHANE	0.015 U	2.8 U
ETHYLBENZENE	0.015 U	25
METHYLENE CHLORIDE	0.015 U	2.8 U
STYRENE	0.015 U	2.8 U
TETRACHLOROETHENE	0.015 U	2.8 U
TOLUENE	0.015 U	42
TRANS-1,3-DICHLOROPROPENE	0.015 U	2.8 U
TRICHLOROETHENE	0.015 U	2.8 U
VINYL CHLORIDE	0.015 U	2.8 U
XYLENE (TOTAL)	0.015 U	160 J i
Petroleum Hydrocarbons (mg/kg)		
Diesel/Motor Oil Range (extractables)		
DIESEL RANGE ORGANICS	760 U	1,100 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C	CATCH BASIN
Sample ID	199AA566	199AA567
Sample Date	07/05/1995	07/05/1995
Matrix	SEDIMENT	SEDIMENT
Petroleum Hydrocarbons (mg/kg)		
Diesel/Motor Oil Range (extractables)		
MOTOR OIL RANGE ORGANICS	5,700 Y	19,000 Y
Gasoline Range (purgeables)		
GASOLINE RANGE ORGANICS	46 Y	850 Y
Semivolatile Organic Compounds (mg/kg)		
1,2,4-TRICHLOROBENZENE	0.51 UJ h	22 U
1,2-DICHLOROBENZENE	0.51 UJ h	22 U
1,3-DICHLOROBENZENE	0.51 UJ h	22 U
1,4-DICHLOROBENZENE	0.51 UJ h	22 U
2,2'-OXYBIS(1-CHLOROPROPANE)	0.51 UJ h	22 U
2,4,5-TRICHLOROPHENOL	1.3 UJ h	56 U
2,4,6-TRICHLOROPHENOL	0.51 UJ h	22 U
2,4-DICHLOROPHENOL	0.51 UJ h	22 U
2,4-DIMETHYLPHENOL	0.51 UJ h	22 U
2,4-DINITROPHENOL	1.3 UJ ch	56 U
2,4-DINITROTOLUENE	0.51 UJ ch	22 U
2,6-DINITROTOLUENE	0.51 UJ h	22 U
2-CHLORONAPHTHALENE	0.51 UJ h	22 U
2-CHLOROPHENOL	0.51 UJ h	22 U
2-METHYLNAPHTHALENE	0.51 UJ h	22 U
2-METHYLPHENOL	0.51 UJ h	22 U
2-NITROANILINE	1.3 UJ h	56 U
2-NITROPHENOL	0.51 UJ h	22 U
3,3'-DICHLOROBENZIDINE	0.51 UJ h	22 U
3-NITROANILINE	1.3 UJ h	56 U
4,6-DINITRO-2-METHYLPHENOL	1.3 UJ ch	56 U
4-BROMOPHENYL-PHENYLETHER	0.51 UJ ch	22 U
4-CHLORO-3-METHYLPHENOL	0.51 UJ h	22 U
4-CHLOROANILINE	0.51 UJ h	22 U
4-CHLOROPHENYL-PHENYLETHER	0.51 UJ ch	22 U
4-METHYLPHENOL	0.51 UJ h	12 J g
4-NITROANILINE	1.3 UJ ch	56 U
4-NITROPHENOL	1.3 UJ ch	56 U
ACENAPHTHENE	0.51 UJ h	22 U
ACENAPHTHYLENE	0.51 UJ h	22 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C	CATCH BASIN
Sample ID	199AA566	199AA567
Sample Date	07/05/1995	07/05/1995
Matrix	SEDIMENT	SEDIMENT
Semivolatile Organic Compounds (mg/kg)		
ANTHRACENE	0.51 UJ ch	22 U
BENZO(A)ANTHRACENE	0.51 UJ h	22 U
BENZO(A)PYRENE	0.51 UJ h	22 U
BENZO(B)FLUORANTHENE	0.51 UJ h	22 U
BENZO(G,H,I)PERYLENE	0.51 UJ h	22 U
BENZO(K)FLUORANTHENE	0.51 UJ h	22 U
BIS(2-CHLOROETHOXY)METHANE	0.51 UJ h	22 U
BIS(2-CHLOROETHYL)ETHER	0.51 UJ h	22 U
BIS(2-ETHYLHEXYL)PHTHALATE	3.7 J h	22 UJ b
BUTYLBENZYLPHTHALATE	37 J h	22 U
CARBAZOLE	0.51 UJ ch	22 U
CHRYSENE	0.51 UJ h	22 U
DI-N-BUTYLPHTHALATE	0.51 UJ ch	22 U
DI-N-OCTYLPHTHALATE	0.5 J h	22 U
DIBENZ(A,H)ANTHRACENE	0.51 UJ h	22 U
DIBENZOFURAN	0.51 UJ ch	22 U
DIETHYLPHTHALATE	0.51 UJ ch	22 U
DIMETHYLPHTHALATE	0.51 UJ h	22 U
FLUORANTHENE	0.51 UJ ch	22 U
FLUORENE	0.51 UJ ch	22 U
HEXACHLOROBENZENE	0.51 UJ ch	22 U
HEXACHLOROBUTADIENE	0.51 UJ h	22 U
HEXACHLOROCYCLOPENTADIENE	0.51 UJ h	22 U
HEXACHLOROETHANE	0.51 UJ h	22 U
INDENO(1,2,3-CD)PYRENE	0.51 UJ h	22 U
ISOPHORONE	0.51 UJ h	22 U
N-NITROSO-DI-N-PROPYLAMINE	0.51 UJ h	22 U
N-NITROSODIPHENYLAMINE (1)	0.51 UJ ch	22 UJ c
NAPHTHALENE	0.51 UJ h	22 U
NITROBENZENE	0.51 UJ h	22 U
PENTACHLOROPHENOL	1.3 UJ ch	56 U
PHENANTHRENE	0.51 UJ ch	22 U
PHENOL	0.51 UJ h	22 U
PYRENE	0.51 UJ h	22 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C	CATCH BASIN
Sample ID	199AA566	199AA567
Sample Date	07/05/1995	07/05/1995
Matrix	SEDIMENT	SEDIMENT
PCBs/Pesticides (mg/kg)		
Pesticides		
4,4'-DDD	0.67	0.037 U
4,4'-DDE	0.079 J g	0.019 J g
4,4'-DDT	0.1 U	0.037 U
ALDRIN	0.051 U	0.019 U
ALPHA-BHC	0.051 U	0.019 U
ALPHA-CHLORDANE	0.038 J g	0.019 U
AROCLOR-1016	0.51 U	0.19 U
AROCLOR-1221	0.51 U	0.19 U
AROCLOR-1232	0.51 U	0.19 U
AROCLOR-1242	0.51 U	0.19 U
AROCLOR-1248	0.51 U	0.19 U
AROCLOR-1254	0.51 U	0.19 U
AROCLOR-1260	0.51 U	0.19 U
BETA-BHC	0.051 U	0.043
DELTA-BHC	0.051 U	0.019 U
DIELDRIN	0.1 U	0.037 U
ENDOSULFAN I	0.051 U	0.019 U
ENDOSULFAN II	0.1 U	0.037 U
ENDOSULFAN SULFATE	0.1 U	0.037 U
ENDRIN	0.1 U	0.037 U
ENDRIN ALDEHYDE	0.1 U	0.037 U
ENDRIN KETONE	0.1 U	0.037 U
GAMMA-BHC (LINDANE)	0.051 U	0.019 U
GAMMA-CHLORDANE	0.042 J g	0.019 U
HEPTACHLOR	0.051 U	0.019 U
HEPTACHLOR EPOXIDE	0.01 U	0.0037 U
METHOXYCHLOR	0.51 U	0.19 U
TOXAPHENE	3 U	1.1 U
Metals (mg/kg)		
Unfiltered		
LEAD	183 J d	97.7 J d
Chlorinated Herbicides (mg/kg)		
2,4,5-T	0.006 U	0.009 U
2,4,5-TP (SILVEX)	0.006 U	0.009 U
2,4-D	0.064 U	0.089 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C	CATCH BASIN
Sample ID	199AA566	199AA567
Sample Date	07/05/1995	07/05/1995
Matrix	SEDIMENT	SEDIMENT
Chlorinated Herbicides (mg/kg)		
2,4-DB	0.065 U	0.09 U
DALAPON	0.068 U	0.094 U
DICAMBA	0.006 U	0.14
DICHLOROPROP	0.064 U	0.089 U
DINOSEB	0.032 U	0.045 U
MCPA	6.4 U	8.9 U
MCPP	6.4 U	8.9 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C
Sample ID	199AA565
Sample Date	07/05/1995
Matrix	SWATER
Volatile Organic Compounds (µg/L)	
1,1,1-TRICHLOROETHANE	0.5 U
1,1,2,2-TETRACHLOROETHANE	0.5 U
1,1,2-TRICHLOROETHANE	0.5 U
1,1-DICHLOROETHANE	0.5 U
1,1-DICHLOROETHENE	0.5 U
1,2-DICHLOROETHANE	0.5 U
1,2-DICHLOROETHENE (TOTAL)	0.5 U
1,2-DICHLOROPROPANE	0.5 U
2-BUTANONE	17 UJ b
2-HEXANONE	4 U
4-METHYL-2-PENTANONE	4 U
ACETONE	11 UJ b
BENZENE	8
BROMODICHLOROMETHANE	0.5 U
BROMOFORM	0.5 U
BROMOMETHANE	0.5 U
CARBON DISULFIDE	0.5 UJ b
CARBON TETRACHLORIDE	0.5 U
CHLOROBENZENE	0.5 U
CHLOROETHANE	0.5 U
CHLOROFORM	1
CHLOROMETHANE	0.5 U
CIS-1,3-DICHLOROPROPENE	0.5 U
DIBROMOCHLOROMETHANE	0.5 U
ETHYLBENZENE	7
METHYLENE CHLORIDE	0.5 U
STYRENE	0.5 U
TETRACHLOROETHENE	0.5 U
TOLUENE	34 J h
TRANS-1,3-DICHLOROPROPENE	0.5 U
TRICHLOROETHENE	0.5 U
VINYL CHLORIDE	0.5 U
XYLENE (TOTAL)	37
Petroleum Hydrocarbons (mg/L)	
Diesel/Motor Oil Range (extractables)	
DIESEL RANGE ORGANICS	1.3 Y

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C
Sample ID	199AA565
Sample Date	07/05/1995
Matrix	SWATER
Petroleum Hydrocarbons (mg/L)	
Diesel/Motor Oil Range (extractables)	
MOTOR OIL RANGE ORGANICS	1.1 Y
Gasoline Range (purgeables)	
GASOLINE RANGE ORGANICS	0.48 Y
Semivolatile Organic Compounds (µg/L)	
1,2,4-TRICHLOROBENZENE	10 U
1,2-DICHLOROBENZENE	5 U
1,3-DICHLOROBENZENE	5 U
1,4-DICHLOROBENZENE	5 U
2,2'-OXYBIS(1-CHLOROPROPANE)	10 U
2,4,5-TRICHLOROPHENOL	25 U
2,4,6-TRICHLOROPHENOL	10 U
2,4-DICHLOROPHENOL	10 U
2,4-DIMETHYLPHENOL	10 U
2,4-DINITROPHENOL	25 U
2,4-DINITROTOLUENE	10 U
2,6-DINITROTOLUENE	10 U
2-CHLORONAPHTHALENE	10 U
2-CHLOROPHENOL	10 U
2-METHYLNAPHTHALENE	10 U
2-METHYLPHENOL	10 U
2-NITROANILINE	25 U
2-NITROPHENOL	10 U
3,3'-DICHLOROBENZIDINE	10 UJ i
3-NITROANILINE	25 U
4,6-DINITRO-2-METHYLPHENOL	25 UJ i
4-BROMOPHENYL-PHENYLETHER	10 UJ i
4-CHLORO-3-METHYLPHENOL	10 U
4-CHLOROANILINE	10 U
4-CHLOROPHENYL-PHENYLETHER	10 U
4-METHYLPHENOL	17
4-NITROANILINE	25 U
4-NITROPHENOL	25 U
ACENAPHTHENE	10 U
ACENAPHTHYLENE	10 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C
Sample ID	199AA565
Sample Date	07/05/1995
Matrix	SWATER
Semivolatile Organic Compounds (µg/L)	
ANTHRACENE	10 UJ i
BENZO(A)ANTHRACENE	10 UJ i
BENZO(A)PYRENE	10 UJ i
BENZO(B)FLUORANTHENE	10 UJ i
BENZO(G,H,I)PERYLENE	10 UJ i
BENZO(K)FLUORANTHENE	10 UJ i
BIS(2-CHLOROETHOXY)METHANE	10 U
BIS(2-CHLOROETHYL)ETHER	10 U
BIS(2-ETHYLHEXYL)PHTHALATE	30 UJ b
BUTYLBENZYLPHTHALATE	10 UJ i
CARBAZOLE	10 UJ ci
CHRYSENE	10 UJ i
DI-N-BUTYLPHTHALATE	10 UJ i
DI-N-OCTYLPHTHALATE	10 UJ i
DIBENZ(A,H)ANTHRACENE	10 U
DIBENZOFURAN	10 U
DIETHYLPHTHALATE	10 UJ b
DIMETHYLPHTHALATE	10 U
FLUORANTHENE	10 UJ i
FLUORENE	10 U
HEXACHLOROBENZENE	10 UJ i
HEXACHLOROBUTADIENE	10 U
HEXACHLOROCYCLOPENTADIENE	10 U
HEXACHLOROETHANE	10 U
INDENO(1,2,3-CD)PYRENE	10 UJ i
ISOPHORONE	10 U
N-NITROSO-DI-N-PROPYLAMINE	10 U
N-NITROSODIPHENYLAMINE (1)	10 UJ i
NAPHTHALENE	6 J g
NITROBENZENE	10 U
PENTACHLOROPHENOL	25 UJ i
PHENANTHRENE	10 UJ i
PHENOL	10 U
PYRENE	10 UJ i

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C
Sample ID	199AA565
Sample Date	07/05/1995
Matrix	SWATER
PCBs/Pesticides (µg/L)	
Pesticides	
4,4'-DDD	0.1 U
4,4'-DDE	0.1 U
4,4'-DDT	0.1 U
ALDRIN	0.05 U
ALPHA-BHC	0.05 U
ALPHA-CHLORDANE	0.05 U
AROCLOR-1016	0.5 U
AROCLOR-1221	0.5 U
AROCLOR-1232	0.5 U
AROCLOR-1242	0.5 U
AROCLOR-1248	0.5 U
AROCLOR-1254	0.5 U
AROCLOR-1260	0.5 U
BETA-BHC	0.05 U
DELTA-BHC	0.05 U
DIELDRIN	0.1 U
ENDOSULFAN I	0.05 U
ENDOSULFAN II	0.1 U
ENDOSULFAN SULFATE	0.1 U
ENDRIN	0.1 U
ENDRIN ALDEHYDE	0.1 U
ENDRIN KETONE	0.1 U
GAMMA-BHC (LINDANE)	0.05 U
GAMMA-CHLORDANE	0.05 U
HEPTACHLOR	0.05 U
HEPTACHLOR EPOXIDE	0.01 U
METHOXYCHLOR	0.5 U
TOXAPHENE	3 U
Metals (µg/L)	
Unfiltered	
LEAD	12.8 UJ b
Chlorinated Herbicides (µg/L)	
2,4,5-T	0.1 U
2,4,5-TP (SILVEX)	0.1 U
2,4-D	0.9 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location ID	CATCH BASIN #C
Sample ID	199AA565
Sample Date	07/05/1995
Matrix	SWATER
Chlorinated Herbicides (µg/L)	
2,4-DB	1 U
DALAPON	1 U
DICAMBA	0.09 U
DICHLOROPROP	0.9 U
DINOSEB	0.5 U
MCPA	93 U
MCPP	94 U

APPENDIX D: ANALYTICAL RESULTS FOR SITE 10 SEDIMENT AND DRAIN SAMPLES (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Notes:

b	Laboratory blank and common contamination problem.
c	Calibration criteria exceedance.
d	Duplicate precision problem.
g	Quantification below reporting limit.
h	Holding time exceedance.
i	Internal standard exceedance.
ID	Identification.
J	Estimated value.
mg/kg	Milligram per kilogram.
mg/L	Milligram per liter.
NAVSTA	Naval Station.
U	Nondetected.
Y	Chromatographic pattern resembles hydrocarbon fuel pattern and was quantitated using the standard it resembled most.
µg/L	Microgram per liter.

APPENDIX E
QUALITY CONTROL SUMMARY REPORTS

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Curtis & Tompkins
Data Reviewer:	SFH/DAT
Review Date:	12/17/02

Sample Delivery Group (SDG) No.: 161429

Sample Nos.:	30209SB06001	30210SB27001	30210SB29001
	30209SB06002	30210SB27002	30210SB29002
	30209SB06003	30210SB27003	30210SB29003
	30210SB26001*	30210SB28001	30210TB30001
	30210SB26002	30210SB28002	
	30210SB26003	30210SB28003*	

* Full Validation Sample

Matrix: Soil, Water

Collection Date(s): 10/23/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) document "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), (EPA 2001). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses" (August 2001), and the document entitled " TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
VOA	✓	✓	Pg. 6	N/A	✓	Pg. 6	Pg. 7	✓	Pg. 7	Pg. 7
TPHP	✓	Pg. 9	Pg. 9	N/A	✓	Pg. 9	✓	N/A	Pg. 9	✓

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30210SB26001 and 30210SB28003.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control
VOA	✓	✓	✓	Pg. 8	Pg. 8	✓	N/A	N/A
TPHP	N/A	N /A	Pg. 10	Pg. 10	N/A	✓	N/A	N/A

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers found are described below.

DATA ASSESSMENT

CLP VOLATILE ORGANIC ANALYSIS

I. Matrix Spike / Matrix Spike Duplicate (MS/MSD)

A. The recoveries outside the QC limits are listed below.

Sample ID	Compound	%R	QC Limits
161442-007 Sp.	Trichloroethene	193/193	62-137
	Toluene	6/2	59-139

The data was not affected by the recoveries outside the QC limits, since the spiked sample was not in this data package.

II. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Methylene chloride in samples 30210SB28002 and 30210TB30001.
- Acetone in samples 30210SB26002, 30210SB26003, 30210SB27003, 30209SB0602, 30209SB06003 and 30210TB30001.
- 2-Butanone in sample 30210TB30001.

Methylene chloride, acetone and 2-butanone are considered common laboratory contaminants when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

B. Due to method blank contamination, the following result is considered nondetected (UJb).

- MTBE in sample 30210TB30001.

The following compounds were detected in the associated method blanks at the concentrations noted below.

Compound	Blank ID	Concentration
Methylene Chloride	MB 10/25/02(S)	0.55 ug/kg
Acetone	MB 10/24/02(W)	0.4 ug/L
MTBE		0.3 ug/L
1,2,4-Trichlorobenzene		0.3 ug/L
Naphthalene		0.2 ug/L
1,2,3-Trichlorobenzene		0.3 ug/L

Detected results less than 5x the maximum blank contamination were qualified.

III. Calibrations

A. Due to continuing calibration problems, the following nondetected results are qualified as estimated (UJc).

- Bromomethane in sample 30210TB30001.
- 1,2,4-Trichlorobenzene in samples 30210SB28003, 30210SB29001, 30210SB29002, 30210SB29003 and 30209SB06001.

The following continuing calibrations had percent differences (%D) of >25%.

Calibration Date	Compound	%D
10/24/02 10:50	1,2,4-Trichlorobenzene	32
10/24/02 11:36	Bromomethane	-38

IV. Field Duplicate

A. There were no field duplicate samples for this parameter.

V. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Toluene in samples 30210SB28003 and 30210SB29001.
- Carbon disulfide in sample 30209SB06003.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Samples 30210SB26001 and 30210SB28003.

VI. GC/MS Tuning

A. The ion abundance criteria were met for the bromofluorobenzene (BFB) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VII. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VIII. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported

detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

IX. Tentatively Identified Compounds (TICs)

A. There were no TICs.

X. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPH PURGEABLES ANALYSIS

I. Surrogate Recovery

A. Due to a surrogate recovery problem, the following nondetected result is qualified as estimated (UJa).

- Gasoline in sample 30209SB06001.

The surrogate outside the QC limits is listed below.

Sample ID	Surrogate	%R	QC Limits
30209SB06001	Bromofluorobenzene(FID)	62	75-125

Low recoveries indicate that nondetected results may be biased low.

II. Matrix Spike / Matrix Spike Duplicate (MS/MSD)

A. Due to an accuracy problem in the MS/MSD analysis, the following nondetected result is qualified as estimated (UJe).

- Gasoline in sample 30210SB27002.

The recovery outside the QC limits is listed below.

Sample ID	Compound	%R	QC Limits
30210SB27002 Sp.	Gasoline	62	70-130

This outlier affected only the spiked sample. False nondetects for gasoline may have been reported.

III. Blank Contamination

A. The following compound was detected in the associated method blank at the concentration noted below.

Compound	Blank ID	Concentration
Gasoline	MB 10/24/02(W)	45 ug/L

The data was not affected by the blank level, since the sample result was nondetected.

IV. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Samples 30210SB26001 and 30210SB28003.

V. Compound Quantitation and Reported Detection Limits

A. There were no positive results for samples 30210SB26001 and 30210SB28003. The reported detection limits were higher than the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

VI. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to continuing calibration problems in the volatile analysis, five samples were qualified as estimated for 1,2,4-trichlorobenzene and one for bromomethane. Volatiles were also qualified due to blank contamination and results below the CRQL.

B. Due to a surrogate recovery problem in the TPHP analysis, one sample was qualified as estimated for gasoline. Due to an accuracy problem in the MS/MSD analysis, one sample was qualified as estimated for gasoline.

C. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Curtis & Tompkins
Data Reviewer:	SFH/DAT
Review Date:	12/19/02

Sample Delivery Group (SDG) No.: 161466

Sample Nos.:			
	30209SB07001	30209SB13001*	30209SB18001
	30209SB07002*	30209SB13002	30209SB18002
	30209SB07003	30209SB13003	30209SB18003
	30209SB08001	30209SB14001	30209SB19001
	30209SB08002	30209SB14002	30209SB19002
	30209SB08003	30209SB14003	30209SB19003
	30209SB10001	30209SB15001	30209SB20001
	30209SB10002	30209SB15002	30209SB20002*
	30209SB10003	30209SB15003	30209SB20003
	30209SB11001	30209SB16001	30209SB21001
	30209SB11002	30209SB16002	30209SB21002
	30209SB11003	30209SB16003*	30209SB21003
	30209SB12001	30209SB17001	30209TB10001
	30209SB12002	30209SB17002	30209TB10002
	30209SB12003	30209SB17003	

* Full Validation Sample

Matrix: Soil, Water

Collection Date(s): 10/24/02 and 10/25/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) document "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), (EPA 2001). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses" (August 2001), and the document entitled " TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
VOA	✓	✓	✓	N/A	✓	Pg. 6	Pg. 7	✓	Pg. 7	Pg. 7,8
TPHP	✓	Pg. 9	Pg. 9	N/A	✓	Pg. 9	✓	N/A	Pg. 10	✓

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209SB07002, 30209SB13001, 30209SB16003 and 30209SB20002.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control
VOA	✓	✓	✓	Pg. 8	Pg. 8	✓	N/A	N/A
TPHP	N/A	N /A	Pg. 10	Pg. 10	N/A	✓	N/A	N/A

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers found are described below.

DATA ASSESSMENT

CLP VOLATILE ORGANIC ANALYSIS

I. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Methylene chloride in samples 30209SB07002, 30209SB07003, 30209SB08001, 30209SB08002, 30209SB08003, 30209SB10001, 30209SB10002, 30209SB10003, 30209SB11001, 30209SB11002, 30209SB11003, 30209SB12003, 30209SB13001, 30209SB13002, 30209SB13003, 30209SB14001, 30209SB14002, 30209SB16002, 30209SB19002, 30209SB19003, 30209SB20001, 30209SB20002, 30209SB20003, 30209SB21001, 30209SB21002, 30209SB21003, 30209TB10001 and 30209TB10002.
- Acetone in samples 30209SB10002, 30209SB14002, 30209SB14003, 30209SB15001, 30209SB15002, 30209SB15003, 30209SB16001, 30209SB16002, 30209SB16003, 30209SB17001, 30209SB17002, 30209SB17003, 30209SB18001, 30209SB18002, 30209SB18003, 30209SB19001, 30209SB19002, 30209SB19003, 30209SB20001, 30209SB20002, 30209SB20003, 30209TB10001 and 30209TB10002.

Methylene chloride and acetone are considered common laboratory contaminants when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

B. Due to method blank contamination, the following results are considered nondetected (UJb).

- Bromomethane in samples 30209SB14003, 30209SB15001, 30209SB15003, 30209SB16002, 30209SB16003, 30209SB17001 and 30209SB17002.
- Carbon disulfide in samples 30209SB15001 and 30209SB15003.

The following compounds were detected in the associated method blanks at the concentrations noted below.

Compound	Blank ID	Concentration
Methylene Chloride	MB QC194069(S)	0.74 ug/kg
Methylene Chloride	MB QC193962(S)	0.33 ug/kg
Methylene Chloride	MB QC194198(S)	0.32 ug/kg
Methylene Chloride	MB QC194199(S)	0.42 ug/kg
Bromomethane	MB QC194179(S)	1.3 ug/kg
Acetone		3.1 ug/kg
Carbon Disulfide		0.43 ug/kg
2-Butanone		0.5 ug/kg
Bromomethane	MB QC194180(S)	1.5 ug/kg
Acetone		2.0 ug/kg
Methylene Chloride	MB QC194397(W)	0.2 ug/L
MTBE		0.1 ug/L

Detected results less than 5x the maximum blank contamination were qualified.

II. Calibrations

A. Due to continuing calibration problems, the following nondetected results are qualified as estimated (UJc).

- Vinyl acetate in samples 30209SB07001, 30209SB07002, 30209SB07003, 30209SB08001, 30209SB08002, 30209SB08003, 30209SB10001, 30209SB10002, 30209SB10003, 30209SB11001, 30209SB11002, 30209SB11003, 30209SB12001, 30209SB12002, 30209SB12003 and 30209SB13001.
- Freon 12 in samples 30209SB14003, 30209SB15001, 30209SB15002, 30209SB15003, 30209SB16001, 30209SB16002, 30209SB16003, 30209SB17001, 30209SB17002, 30209SB17003, 30209SB18001, 30209SB18002, 30209SB18003 and 30209SB19001.
- Carbon disulfide and vinyl acetate in samples 30209SB13002, 30209SB13003, 30209SB14001, 30209SB14002, 30209SB19002, 30209SB19003, 30209SB20001, 30209SB20002, 30209SB20003, 30209SB21001, 30209SB21002 and 30209SB21003.

The following continuing calibrations had percent differences (%D) of >25%.

Calibration Date	Compound	%D
10/25/02 15:47	Vinyl Acetate	42
10/29/02 18:19	Freon 12	37
10/28/02 18:02	Carbon Disulfide	-31
	Vinyl Acetate	34
10/29/02 11:10	Freon 12	28
10/29/02 11:36	Carbon Disulfide	-31
	Vinyl Acetate	31
10/29/02 17:40	Carbon Disulfide	-31
	Vinyl Acetate	34

III. Field Duplicate

A. There were no field duplicate samples for this parameter.

IV. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Toluene and 4-methyl-2-pentanone in sample 30209SB20001.
- Carbon disulfide in samples 30209SB16002, 30209SB17001, 30209SB18001, 30209SB18002 and 30209SB18003.
- MTBE in sample 30209SB16003.
- Propylbenzene, sec-butylbenzene and n-butylbenzene in sample 30209SB07003.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Samples 30209SB07002, 30209SB13001, 30209SB16003 and 30209SB20002.

V. GC/MS Tuning

A. The ion abundance criteria were met for the bromofluorobenzene (BFB) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VI. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VII. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

VIII. Tentatively Identified Compounds (TICs)

A. There were no TICs.

IX. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPH PURGEABLES ANALYSIS

I. Surrogate Recovery

A. Due to surrogate recovery problems, the following nondetected results are qualified as estimated (UJa).

- Gasoline in samples 30209SB11001, 30209SB14001, 30209SB16001 and 30209SB21001.

The surrogates outside the QC limits are listed below.

Sample ID	Surrogate	%R	QC Limits
30209SB11001	Bromofluorobenzene(FID)	62	75-125
30209SB14001	Bromofluorobenzene(FID)	66	75-125
30209SB16001	Bromofluorobenzene(FID)	74	75-125
30209SB21001	Bromofluorobenzene(FID)	60	75-125

Low recoveries indicate that nondetected results may be biased low.

B. Due to a surrogate recovery problem, the following detected result is qualified as estimated (Ja).

- Gasoline in sample 30209SB07003.

The surrogate outside the QC limits is listed below.

Sample ID	Surrogate	%R	QC Limits
30209SB07003	Bromofluorobenzene(FID)	137	75-125

High percent recoveries indicate that detected results may be biased high.

II. Matrix Spike / Matrix Spike Duplicate (MS/MSD)

A. There was no MS/MSD for soils, due to insufficient sample.

III. Blank Contamination

A. Due to method blank contamination, the following results are considered nondetected (UJb).

- Gasoline in samples 30209TB10001 and 30209TB10002.

The following compound was detected in the associated method blank at the concentration noted below.

Compound	Blank ID	Concentration
Gasoline	MB 10/26/02(W)	35 ug/L

Detected results less than 5x the maximum blank contamination were qualified.

IV. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Samples 30209SB07002, 30209SB13001, 30209SB16003 and 30209SB20002.

V. Compound Quantitation and Reported Detection Limits

A. There were no positive results for samples 30209SB07002, 30209SB13001, 30209SB16003 and 30209SB20002. The reported detection limits were higher than the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

VI. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to continuing calibration problems in the volatile analysis, sixteen samples were qualified as estimated for vinyl acetate, fourteen for Freon 12 and twelve for carbon disulfide and vinyl acetate. Volatiles were also qualified due to blank contamination and results below the CRQL.

B. Due to surrogate recovery problems in the TPHP analysis, five samples were qualified as estimated for gasoline. TPHP samples were also qualified due to blank contamination.

C. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Curtis & Tompkins
Data Reviewer:	SFH/DAT
Review Date:	1/10/03

Sample Delivery Group (SDG) No.: 161589

Sample Nos.:	30209GW01001*	30209GW06001
	30209GW02001	30209GW20001
	30209GW03001	30210GW03001
	30209GW04001	30210TB30005
	30209GW05001	

* Full Validation Sample

Matrix: Water

Collection Date(s): 10/30/02 and 10/31/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) document "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses" (August 2001), and the document entitled " TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
VOA	✓	✓	✓	N/A	✓	Pg. 6	Pg. 6	✓	Pg. 6	Pg. 6
TPHP	✓	Pg. 8	✓	N/A	✓	✓	✓	N/A	Pg. 8	✓

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209GW01001.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control
VOA	✓	✓	Pg. 7	Pg. 7	Pg. 7	✓	N/A	N/A
TPHP	N/A	N /A	Pg. 8	✓	N/A	✓	N/A	N/A

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers found are described below.

DATA ASSESSMENT

CLP VOLATILE ORGANIC ANALYSIS

I. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Methylene chloride in samples 30209GW03001, 30209GW20001, 30209GW01001, 30209GW02001, 30209GW05001, 30209GW06001, 30209GW04001, 30210GW03001 and 30210TB30005.
- Acetone in samples 30209GW03001, 30209GW02001, 30209GW06001, 30209GW04001, 30210GW03001 and 30210TB30005.

Methylene chloride and acetone are considered common laboratory contaminants when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

II. Calibrations

A. Due to a continuing calibration problem, the following nondetected results are qualified as estimated (UJc).

- 2,2-Dichloropropane in samples 30209GW03001 and 30209GW20001.

The following continuing calibration had percent differences (%D) of >25%.

Calibration Date	Compound	%D
11/8/02 10:08	2,2-Dichloropropane	-34

III. Field Duplicate

A. There were no RPDs obtained for field duplicate samples 30209GW01001/30209GW20001, since sample results were nondetected.

IV. Other Qualifications

A. The following results are qualified as estimated (Jg).

- MTBE in samples 30209GW03001, 30209GW02001, 30209GW04001 and 30209GW05001.
- m,p-Xylenes in sample 30209GW05001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30209GW01001.

V. GC/MS Tuning

A. The ion abundance criteria were met for the bromofluorobenzene (BFB) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VI. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VII. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30209GW01001. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

VIII. Tentatively Identified Compounds (TICs)

A. There were no TICs.

IX. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPH PURGEABLES ANALYSIS

I. Surrogate Recovery

A. Due to surrogate recovery problems, the following nondetected results are qualified as estimated (UJa).

- Gasoline in samples 30209GW03001, 30209GW01001, 30209GW04001, 30210GW03001 and 30210TB30005.

The surrogates outside the QC limits are listed below.

Sample ID	Surrogate	%R	QC Limits
30209GW03001	Bromofluorobenzene(FID)	71	75-125
30209GW01001	Bromofluorobenzene(FID)	74	75-125
30210GW03001	Bromofluorobenzene(FID)	74	75-125
30209GW04001	Bromofluorobenzene(FID)	74	75-125
30210TB30005	Bromofluorobenzene(FID)	72	75-125

Low recoveries indicate that nondetected results may be biased low.

II. Field Duplicate

A. There were no RPDs obtained for field duplicate samples 30209GW01001/30209GW20001, since sample results were nondetected.

Full Validation Criteria for Sample 30209GW01001.

III. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30209GW01001. The reported detection limits met the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to a continuing calibration problem in the volatile analysis, two samples were qualified as estimated for 2,2-dichloropropane. Volatiles were also qualified due to blank contamination and results below the CRQL.

B. Due to surrogate recovery problems in the TPHP analysis, five samples were qualified as estimated for gasoline.

C. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Curtis & Tompkins
Data Reviewer:	SFH/DAT
Review Date:	1/9/03

Sample Delivery Group (SDG) No.: 161620

Sample Nos.:	30209GW10007	30209SB22003	30209SB24003
	30209SB05004	30209SB23001	30209SB25001
	30209SB05005*	30209SB23002	30209SB25002
	30209SB05006	30209SB23003*	30209SB25003
	30209SB22001	30209SB24001	30209TB10006
	30209SB22002	30209SB24002	

* Full Validation Sample

Matrix: Soil, Water

Collection Date(s): 11/1/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) document "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses" (August 2001), and the document entitled " TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
VOA	✓	✓	✓	N/A	✓	Pg. 6	Pg. 7	Pg. 7	Pg. 8	Pg. 8
TPHP	✓	Pg. 10	✓	N/A	✓	✓	✓	N/A	Pg. 10	✓

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209SB23003 and 30209SB05005.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control
VOA	✓	✓	✓	Pg. 8	Pg. 9	✓	N/A	N/A
TPHP	N/A	N /A	✓	Pg. 10	N/A	✓	N/A	N/A

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers found are described below.

DATA ASSESSMENT

CLP VOLATILE ORGANIC ANALYSIS

I. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Methylene chloride in samples 30209TB10006, 30209GW10007, 30209SB22001, 30209SB22003, 30209SB24001, 30209SB24002, 30209SB24003, 30209SB25001, 30209SB25002, 30209SB25003 and 30209SB05005.
- Acetone in samples 30209TB10006, 30209SB22001, 30209SB22002, 30209SB22003, 30209SB23001, 30209SB23002, 30209SB23003, 30209SB24001, 30209SB24002, 30209SB24003, 30209SB25001, 30209SB25002, 30209SB25003, 30209SB05004, 30209SB05005 and 30209SB05006.
- 2-Butanone in samples 3020923003 and 30209SB05004.

Methylene chloride, acetone and 2-butanone are considered common laboratory contaminants when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

B. The following compounds were detected in the associated method blanks at the concentrations noted below.

Compound	Blank ID	Concentration
Methylene Chloride	MB 11/12/02(W)	0.2 ug/L
Methylene Chloride	MB 11/5/02(S)	1.4 ug/kg
Bromomethane	MB 11/5/02(S)	2.8 ug/kg
Acetone		2.4 ug/kg
Bromomethane	MB 11/6/02(S)	2.6 ug/kg
Acetone		1.7 ug/kg
Bromomethane	MB 11/6/02(S)	2.4 ug/kg
Acetone		1.9 ug/kg

The data was not affected by the blank levels, since sample results were nondetected.

C. The following compounds were detected in the associated trip blank and equipment rinsate at the concentrations noted below.

Compound	Blank ID	Concentration
MTBE	30209TB10006(TB)	0.1 ug/L
Chloroform	30209GW10007(ER)	12 ug/L
Bromodichloromethane		2.2 ug/L
Dibromochloromethane		0.3 ug/L
Bromoform		0.1 ug/L

The data was not affected by the blank levels, since sample results were nondetected.

II. Calibrations

A. Due to continuing calibration problems, the following nondetected results are qualified as estimated (UJc).

- Freon 12, trichlorofluoromethane and 2,2-dichloropropane in sample 30209SB0505.

The following continuing calibration had percent differences (%D) of >25%.

Calibration Date	Compound	%D
11/5/02 11:44	Freon 12	31
	Trichlorofluoromethane	26
	2,2-Dichloropropane	27

III. Internal Standards

A. Due to severe internal standard problems, the following nondetected results are rejected (Ri).

- All compounds quantitated using pentafluorobenzene, 1,4-difluorobenzene, chlorobenzene-d5 and 1,4-dichlorobenzene-d4 in sample 30209SB25003.

The internal standard area counts in the sample listed above were less than one quarter of the reference standard and are listed below.

Sample	Internal Standard	Value	QC Limits
30209SB25003	Pentafluorobenzene	19652	543967-2175868
	1,4-Difluorobenzene	32118	866710-3466842
	Chlorobenzene-d5	29050	698151-2792604
	1,4-Dichlorobenzene-d4	7666	273623-1094492

Internal standard area counts of less than 25% of the standard area count may indicate a severe loss in instrument sensitivity.

B. Due to an internal standard problem, the following nondetected results are qualified as estimated (UJi).

- All compounds quantitated using 1,4-dichlorobenzene-d4 in sample 30209SB05004.

The internal standard area count in the sample listed above was less than one half of the reference standard and is listed below.

Sample	Internal Standard	Value	QC Limits
30209SB05004	1,4-Dichlorobenzene-d4	7666	273623-1094492

Internal standard area counts of less than 50% of the standard area count may indicate a loss in instrument sensitivity.

IV. Field Duplicate

A. There were no field duplicate samples for this parameter.

V. Other Qualifications

A. The following results are qualified as estimated (Jg).

- MTBE in sample 30209TB10006.
- Carbon disulfide in samples 30209SB23003 and 30209SB05004.
- Dibromochloromethane and bromoform in sample 30209GW10007.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Samples 30209SB23003 and 30209SB05005.

VI. GC/MS Tuning

A. The ion abundance criteria were met for the bromofluorobenzene (BFB) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VII. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VIII. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

IX. Tentatively Identified Compounds (TICs)

A. The TICs were not reported for sample 30209SB23003 and there were no TICs for sample 30209SB05005.

X. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPH PURGEABLES ANALYSIS

I. Surrogate Recovery

A. Due to surrogate recovery problems, the following nondetected results are qualified as estimated (UJa).

- Gasoline in samples 30209SB05004 and 30209SB05006.

The surrogates outside the QC limits are listed below.

Sample ID	Surrogate	%R	QC Limits
30209SB05004	Bromofluorobenzene(FID)	71	75-125
30209SB05006	Bromofluorobenzene(FID)	74	75-125

Low recoveries indicate that nondetected results may be biased low.

II. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Samples 30209SB23003 and 30209SB05005.

III. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were higher than the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to severe internal standard problems in the volatile analysis, all compounds quantitated using pentafluorobenzene, 1,4-difluorobenzene, chlorobenzene-d5 and 1,4-dichlorobenzene-d4 in sample 30209SB25003 were rejected.

B. Due to continuing calibration problems in the volatile analysis, one sample was qualified as estimated for Freon 12, trichlorofluoromethane and 2,2-dichloropropane. Due to an internal standard problem, one sample was qualified as estimated for all compounds quantitated using 1,4-dichlorobenzene-d4. Volatiles were also qualified due to blank contamination and results below the CRQL.

C. Due to surrogate recovery problems in the TPHP analysis, two samples were qualified as estimated for gasoline.

D. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Rejected sample results (R) are unusable for all purposes. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. The high number of qualifications made to the data indicate several analytical and/or matrix problems that limit the usability of the data.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Curtis & Tompkins
Data Reviewer:	SFH/DAT
Review Date:	1/10/03

Sample Delivery Group (SDG) No.: 161622

Sample Nos.: 30209GW07001*
30209TB1007

* Full Validation Sample

Matrix: Water

Collection Date(s): 11/4/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) document "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses" (August 2001), and the document entitled " TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
VOA	✓	✓	Pg. 6	N/A	✓	Pg. 6	Pg. 6	✓	Pg. 6	✓
TPHP	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 8	✓

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209GW07001.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control
VOA	✓	✓	Pg. 7	Pg. 7	Pg. 7	✓	N/A	N/A
TPHP	N/A	N /A	Pg. 8	✓	N/A	✓	N/A	N/A

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers found are described below.

DATA ASSESSMENT

CLP VOLATILE ORGANIC ANALYSIS

I. Matrix Spike / Matrix Spike Duplicate (MS/MSD)

A. There was no MS/MSD, due to insufficient sample.

II. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Methylene chloride and acetone in sample 30209TB1007.

Methylene chloride and acetone are considered common laboratory contaminants when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

III. Calibrations

A. Due to a continuing calibration problem, the following nondetected results are qualified as estimated (UJc).

- Freon 12 in samples 30209GW07001 and 30209TB1007.

The following continuing calibration had a percent difference (%D) of >25%.

Calibration Date	Compound	%D
11/13/02 10:56	Freon 12	41

IV. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Sample 30209GW07001.

V. GC/MS Tuning

A. The ion abundance criteria were met for the bromofluorobenzene (BFB) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VI. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VII. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30209GW07001. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

VIII. Tentatively Identified Compounds (TICs)

A. There were no TICs.

IX. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPH PURGEABLES ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Sample 30209GW07001.

II. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30209GW07001. The reported detection limits met the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

III. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to a continuing calibration problem in the volatile analysis, two samples were qualified as estimated for Freon 12. Volatiles were also qualified due to blank contamination.

B. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Curtis & Tompkins
Data Reviewer:	SFH/DAT
Review Date:	1/13/03

Sample Delivery Group (SDG) No.: 162068

Sample Nos.: 30211BS01003
30211BS01004
30211BS02003
30211TB12001

* There was no sample for full validation

Matrix: Soil, Water

Collection Date(s): 11/19/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) document "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999). In addition, the TtEMI document "Data Validation Guidelines for Non-CLP Organic Analyses" (August 2001), and the document entitled " TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
TPHP	✓	✓	Pg. 5	N/A	✓	Pg. 5	✓	N/A	Pg. 5	Pg. 5

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

DATA ASSESSMENT

TPH PURGEABLES ANALYSIS

I. Matrix Spike / Matrix Spike Duplicate (MS/MSD)

A. There was no MS/MSD for soils, due to insufficient sample.

II. Blank Contamination

A. Due to method blank contamination, the following result is considered nondetected (UJb).

- Gasoline in sample 30211TB12001.

The following compound was detected in the associated method blank at the concentration noted below.

Compound	Blank ID	Concentration, ug/L
Gasoline	MB 11/21/02	29

Detected results <5x the maximum blank contamination were qualified.

III. Field Duplicate

A. There were no field duplicate samples for this parameter.

IV. Other Qualifications

A. There was insufficient sample to perform percent moisture analysis. All results are reported on an as received basis.

There were no samples for full validation.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. TPHP samples were qualified due to blank contamination.

B. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Curtis & Tompkins
Data Reviewer:	SFH/DAT
Review Date:	1/13/03

Sample Delivery Group (SDG) No.: 162099

Sample Nos.: 30211BS03003
30211BS03004*
30211BS03005
30211TB12002

* Full Validation Sample

Matrix: Soil, Water

Collection Date(s): 11/20/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) document "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999). In addition, the TtEMI document "Data Validation Guidelines for Non-CLP Organic Analyses" (August 2001), and the document entitled " TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
TPHP	✓	✓	✓	N/A	✓	Pg. 6	✓	N/A	Pg. 6	Pg. 6

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30211BS03004.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control
TPHP	N/A	N /A	✓	Pg. 6	N/A	✓	N/A	N/A

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers found are described below.

DATA ASSESSMENT

TPH PURGEABLES ANALYSIS

I. Blank Contamination

A. Due to method blank contamination, the following result is considered nondetected (UJb).

- Gasoline in sample 30211TB12002.

The following compound was detected in the associated method blank at the concentration noted below.

Compound	Blank ID	Concentration, ug/L
Gasoline	MB 11/21/02	29

Detected results <5x the maximum blank contamination were qualified.

II. Field Duplicate

A. There were no field duplicate samples for this parameter.

III. Other Qualifications

A. The following result is qualified as estimated (Jg).

- Gasoline in sample 30211BS03004.

Detected results reported below the RL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30211BS03004.

IV. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated with the proper dilution factors, weights, volumes and percent moisture used to calculate the sample results. The sample was correctly quantitated. The reported detection limits did not met the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. TPHP samples were qualified due to blank contamination and a result below the RL.

B. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.

DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No:	G0069302B0201
Laboratory:	Columbia Analytical Services
Data Reviewer:	TS/DAT
Review Date:	12/17/02

Sample Delivery Group (SDG) No.: K2207607

Sample Nos.:

30210SB05001	30210SB07002	30210SB09003
30210SB05002	30210SB07003	30210SB10001
30210SB05003	30210SB08001	30210SB10002
30210SB06001	30210SB08002	30210SB10003*
30210SB06002	30210SB08003	30210SB11001
30210SB06003	30210SB09001	30210SB11002
30210SB07001*	30210SB09002	

* Full Validation Samples

Matrix: Soil

Collection Date(s): 10/22/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (February 1994). In addition, other specified criteria in EPA methods were used. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. Cursory validation parameters are indicated by an asterisk (*).

CLP Organic Parameters

* Holding times
* GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
Pesticide/PCB	✓	✓	✓	N/A	✓	✓	Pg. 6	N/A	Pg. 6	Pg. 7

Notes:
✓ Indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30210SB07001 and 30210SB10003

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control
Pesticide/PCB	N/A	Pg. 6	✓	Pg. 7	N/A	Pg. 7	N/A	N/A

Notes:
✓ Indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers found are described below.

DATA ASSESSMENT

PESTICIDE/PCB ANALYSIS

I. Calibrations

A. Method 8081A was used for analysis. There was no resolution check mixture analyzed.

II. Field Duplicate

A. There were no field duplicates associated with this data package.

III. Compound Identification

A. Due to confirmation problems, the following results are considered nondetected (UJj).

- Methoxychlor in sample 30210SB05003.
- gamma-Chlordane in sample 30210SB06002.
- Dieldrin in sample 30210SB07001.
- 4,4'-DDT in sample 30210SB07002.

The result reported was detected below the MRL, and a percent difference (%D) greater than 50% was noted in the analyte concentration between the quantitation column and the confirmation column. Further review of the data and chromatograms determined that the result reported was a false positive. The %Ds are listed below.

Analysis	Compound	%D
30210SB05003	Methoxychlor	51.6
30210SB06002	gamma-Chlordane	62.1
30210SB07001	Dieldrin	52.3
30210SB07002	4,4'-DDT	57.1

B. Due to identification problems, the following results were raised to the Method Reporting Limits (MRL) and are reported as nondetected (UJg).

- 4,4'-DDE in sample 30210SB05001.
- gamma-Chlordane, alpha-chlordane and 4,4'-DDT in sample 30210SB06001.
- Heptachlor epoxide, and endrin aldehyde in sample 30210SB07001DL.
- Endrin ketone in sample 30210SB08001.
- Heptachlor and heptachlor epoxide in sample 30201SB08001DL.
- 4,4'-DDT in sample 30210SB08002.
- gamma-Chlordane and alpha-chlordane in samples 30210SB10002 and 30201SB09002.
- Heptachlor in sample 30210SB10001.
- Methoxychlor in sample 30210SB10003.

The result reported was less than 1/2 the MRL. It is the opinion of the reviewer that the positive results reported by the laboratory for the compounds listed above are both qualitatively and quantitatively unacceptable.

IV. Other Qualifications

A. The following results are qualified as estimated (Jg).

- gamma-Chlordane, alpha-chlordane and 4,4'-DDD in sample 30210SB05001.
- Heptachlor and 4,4'-DDE in sample 30210SB07001DL.
- Heptachlor and endosulfan sulfate in sample 30210SB08001.
- Endosulfan sulfate in samples 30210SB09001, 30210SB10001 and 30210SB08001DL.
- 4,4'-DDD and 4,4'-DDT in sample 30210SB09002.

Detected results reported below the MRL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

V. Other

A. Due to analyte concentrations exceeding the highest calibrator, samples 30210SB07001 and 30210SB08001 were reanalyzed at a dilution. Dilution results should replace original results for any concentration exceeding the highest calibrator.

B. Although correct on the EDD, the following samples were misidentified throughout the data package and on the Form 1s:

Data Package Label	Correct ID
30210SB01001	30210SB10001
30210SB01002	30210SB10002
30210SB01003	30210SB10003
30210SB01101	30210SB11001
30210SB01102	30210SB11002

Full Validation Criteria for Samples 30210SB07001 and 30210SB10003.

VI. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were found to be correctly quantitated. The laboratory used its own detection limits. They reflect any dilutions, weights, volumes, and percent moisture.

VII. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

B. Clean-up of the samples was performed by gel permeation chromatography. The laboratory did not perform a recovery check.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods. Although non-CLP method 8081A was used for analysis, the results were validated using CLP criteria.

II. Usability

A. Due to confirmation problems in the pesticide analysis, four samples were qualified as nondetected for target analytes. Due to results reported at less than one-half the MRL, ten samples were qualified as nondetected for target analytes. Due to results reported below the MRL, six samples were qualified as estimated for target analytes.

B Due to analyte concentrations exceeding the highest calibrator, samples 30210SB07001 and 30210SB08001 were reanalyzed at a dilution. Dilution results should replace original results for any concentration exceeding the highest calibrator.

C. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.

TETRA TECH EM INC.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No:	G0069302B0201
Laboratory:	Columbia Analytical Services Inc.
Data Reviewer:	TS/DAT
Review Date:	12/19/02

Sample Delivery Group (SDG) No.: K2207608

Sample Nos.:

30210SB11003	30210SB14002	30210SB17001*
30210SB12001	30210SB14003	30210SB17002
30210SB12002	30210SB15001	30210SB17003
30210SB12003	30210SB15002	30210SB18001
30210SB13001	30210SB15003	30210SB18002
30210SB13002*	30210SB16001	30210SB18003
30210SB13003	30210SB16002	
30210SB14001	30210SB16003	

* Full Validation Samples

Matrix: Soil

Collection Date(s): 10/22/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), In addition, the TtEMI document "Data Validation Guidelines for CLP Organic Analyses," and the document entitled “TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work” (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. Cursory validation parameters are indicated by an asterisk (*).

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
SVOA	✓	✓	✓	N/A	✓	Pg. 6	✓	✓	Pg 6	Pg. 6
Pesticide/PCB	✓	✓	✓	N/A	✓	✓	Pg. 8	N/A	Pg. 8	Pg. 8

Notes:
✓ Indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30210SB13002 and 30210SB17001.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control
SVOA	✓	✓	✓	Pg 7	Pg. 7	✓	N/A	N/A
Pesticide/PCB	N/A	Pg. 8	✓	Pg 9	N/A	✓	N/A	N/A

Notes:
✓ Indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers found are described below.

DATA ASSESSMENT

CLP SEMIVOLATILE ORGANIC ANALYSIS

I. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Di-n-butylphthalate in samples 30210SB15001 and 30210SB16001.
- bis(2-Ethylhexyl)phthalate in samples 30210SB15001, 30210SB16001 and 30210SB17001.

Di-n-butylphthalate and bis(2-ethylhexyl)phthalate are considered common laboratory contaminants when found at levels less than 5x the CRQL in environmental samples and not found in the associated blanks.

B. Due to method blank contamination, the following results are considered nondetected (UJb).

- Fluoranthene in samples 30210SB16001 and 30210SB17002.
- Chrysene in samples 30210SB15001, 30210SB16001, 30210SB17002 and 30210SB18003.

The following compounds were detected in the associated method blanks at the concentrations noted below.

Compound	Blank ID	Concentration, mg/kg
Fluoranthene	KWG0208649-6	0.018
Chrysene	"	0.014

Detected results less than 5x the blank contamination were qualified.

II. Field Duplicate

A. There were no field duplicates associated with this data package.

III. Other Qualifications

A. The following results are qualified as estimated (Jg).

- 4-Chloroaniline, phenanthrene, benz(a)anthracene, indeno(1,2,3-cd)pyrene, and dibenz(a,h)anthracene in sample 30210SB15001.
- Phenanthrene, pyrene, benz(a)anthracene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene and dibenz(a,h,)anthracene in sample 30210SB16001.
- Benzo(b)fluoranthene, benzo(k)fluoranthene and benzo(a)pyrene in sample 30210SB17001.
- Phenanthrene in sample 30210SB17002.
- Acenaphthylene and fluorene in sample 30210SB17003.
- Pyrene and benzo(g,h,i)perylene in sample 30210SB18003.

Detected results reported below the MRL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30210SB17001.

IV. GC/MS Tuning

A. The ion abundance criteria were met for the decafluorotriphenylphosphine (DFTPP) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

V. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VI. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were found to be correctly quantitated. The reported detection limits were consistent with the contract required report limits for all compounds except the PAHs and indeno(1,2,3-cd)pyrene. They were lower for these compounds. The detection limits reflect the dilutions, weights, volumes, and percent moisture.

VII. Tentatively Identified Compounds (TICs)

A. The sample spectra and library searches were evaluated. TIC results were recalculated and found to be correct. The following TICs were qualified as 'NJ":

- Unknown, RT 29.29, 0.15 mg/kg and Unknown, RT 33.08, 0.26 mg/kg in sample 30210SB17001.

VIII. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP PESTICIDE/PCB ANALYSIS

I. Calibrations

A. Method 8081A was used for analysis. There was no resolution check mixture analyzed.

II. Field Duplicate

A. There were no field duplicates associated with this data package.

III. Compound Identification

A. Due to confirmation problems, the following results are considered nondetected (UJj).

- 4,4'-DDD in sample 30210SB13003.
- Methoxychlor in sample 30210SB13001.

The result reported was detected below the CRQL, and a percent difference (%D) greater than 50% was noted in the analyte concentration between the quantitation column and the confirmation column. Further review of the data and chromatograms determined that the result reported was a false positive. The %Ds are listed below.

Analysis	Compound	%D
30210SB13003	4,4'-DDD	85.7
30210SB13001	Methoxychlor	50.1

B. Due to identification problems, the following results were raised to the Method Reporting Limits (MRL) and are reported as nondetected (UJg). {for pesticide results < 1/2 the MRL}

- Endosulfan I and endosulfan II in sample 30210SB12001DL.
- 4,4'-DDT in samples 30210SB13003 and 30210SB12002.
- Endosulfan I, dieldrin and endosulfan II in sample 30210SB13001DL.
- Heptachlor and endosulfan sulfate in sample 30210SB13002.
- Heptachlor in sample 30210SB14002.

The result reported was less than 1/2 the MRL. It is the opinion of the reviewer that the positive results reported by the laboratory for the compounds listed above are both qualitatively and quantitatively unacceptable.

IV. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Heptachlor epoxide in samples 30210SB13003 and 30210SB12001.
- 4,4'-DDE in sample 30210SB12001DL.
- Heptachlor epoxide, 4,4'-DDE and toxaphene in sample 30210SB13001DL.

- alpha-Chlordane in sample 30210SB13002.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

V. Other

A. Due to analyte concentrations exceeding the highest calibrator, samples 30210SB12001 and 30210SB13001 were reanalyzed at a dilution. Dilution results should replace original results for any concentration exceeding the highest calibrator.

Full Validation Criteria for Sample 30210SB13002.

VI. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were found to be correctly quantitated. The laboratory used its own detection limits. They reflect any dilutions, weights, volumes, and percent moisture.

VII. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

B. Clean-up of the samples was performed by gel permeation chromatography. The laboratory did not perform a recovery check.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods. Although non-CLP methods 8081A and 8270C were used for analysis, the results were validated using CLP criteria.

II. Usability

A. Due to common laboratory contamination in the semivolatile analysis, three samples were qualified as nondetected for bis(2-ethylhexyl)phthalate and two samples were qualified as nondetected for di-n-butylphthalate. Due to method blank contamination in the semivolatile analysis, four samples were qualified as nondetected for chrysene and two samples were qualified as nondetected for fluoranthene. Six samples were qualified as estimated for results reported below the MRL.

B. Due to compound identification problems in the pesticide analysis, one sample was qualified as nondetected for 4,4'-DDD and methoxychlor. Due to results reported at less than one-half the MRL in the pesticide analysis, five samples were qualified as nondetected for target analytes. Five samples were qualified as estimated for results reported below the MRL.

C. Due to analyte concentrations exceeding the highest calibrator in the pesticide analysis, samples 30210SB12001 and 30210SB13001 were reanalyzed at a dilution. Dilution results should replace original results for any concentration exceeding the highest calibrator.

D. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of qualifiers added to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical Services, Inc.
Data Reviewer:	SFH/DAT
Review Date:	12/23/02

Sample Delivery Group (SDG) No.: K2207661

Sample Nos.:	30210SB19001	30210SB22001	30210SB25001
	30210SB19002	30210SB22002	30210SB25002
	30210SB19003	30210SB22003	30210SB25003
	30210SB20001	30210SB23001	30210SB26001*
	30210SB20002	30210SB23002	30210SB26002
	30210SB20003	30210SB23003	30210SB26003
	30210SB21001	30210SB24001	
	30210SB21002*	30210SB24002	
	30210SB21003	30210SB24003	

* Full Validation Sample

Matrix: Soil

Collection Date(s): 10/23/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), "USEPA Contract Laboratory National Functional Guidelines for Low Concentration Organic Data (EPA 2001), and "USEPA Contract Laboratory Program National Functional Guidelines For Inorganic Data Review" (February 1994). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for CLP Inorganic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses," (August 2001), and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike *
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

CLP Inorganic Parameters

* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike
* Laboratory control sample or blank spike
Field duplicates
* Matrix duplicates
  ICP interference check sample
  GFAA quality control
* ICP serial dilution
  Sample result verification
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
SVOA	✓	✓	✓	N/A	✓	Pg. 6	✓	✓	Pg. 6	Pg. 6
Pesticides	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 8	Pg. 8
Metals	✓	N/A	Pg. 9	Pg. 9	Pg. 9	Pg. 9	✓	N/A	Pg. 10	Pg. 11
TPHE	✓	N/A	✓	N/A	✓	✓	✓	N/A	Pg. 13	✓
PCBs	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 12	✓

Note: ✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30210SB21001 and 30210SB26001.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control	
SVOA	✓	✓	Pg. 7	Pg. 7	Pg. 7	✓	N/A	N/A	
Metals	N/A	N/A	✓	Pg. 11	N/A	✓	Pg. 11	Pg. 11	
Pesticides	N/A	N/A	Pg. 8	Pg. 8	N/A	✓	N/A	N/A	
TPHE	N/A	N/A	Pg. 13	Pg. 13	N/A	✓	N/A	N/A	
PCBs	N/A	N/A	Pg. 12	Pg. 12	N/A	✓	N/A	N/A	

Note: ✓indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

DATA ASSESSMENT

CLP SEMIVOLATILE ORGANIC ANALYSIS

I. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Bis (2-ethylhexyl)phthalate in samples 30210SB22003 and 30210SB23001.

Bis(2-ethylhexyl)phthalate is considered a common laboratory contaminant when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

II. Field Duplicate

A. There were no field duplicate samples for this parameter.

III. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Benzo(b)fluoranthene in samples 30210SB21001, 30210SB22003 and 30210SB23001.
- Anthracene, indeno(1,2,3-cd)pyrene and dibenz(a,h)anthracene in sample 30210SB21003.
- Fluoranthene and pyrene in samples 30210SB22002, 30210SB23003 and 30210SB24003.
- Phenanthrene, pyrene and fluoranthene in sample 30210SB24001.
- Chrysene and benzo(g,h,i)perylene in sample 30210SB24003.
- Benz(a)anthracene, chrysene and benzo(b)fluoranthene in sample 30210SB26003.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Samples 30210SB21002 and 302010SB26001.

IV. GC/MS Tuning

A. The ion abundance criteria were met for the decafluorotriphenylphosphine (DFTPP) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

V. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VI. Compound Quantitation and Reported Detection Limits

A. There were no positive results for samples 30210SB21002 and 30210SB26001. The reported detection limits were not consistent(some lower) with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

VII. Tentatively Identified Compounds (TICs)

A. The sample spectra and library searches were evaluated. TIC results were recalculated and found to be correct. The following TIC was qualified as "tentatively identified" (NJ).

- TIC-28.88RT-"Unknown Alkane" in sample 30210SB21002.

VIII. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP PESTICIDES ORGANIC ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

II. Compound Identification

A. Due to identification problems, the following results were raised to the Contract Required Quantitation Limit (CRQL) and are reported as nondetected (UJg). (For pesticide results <1/2 the CRQL).

- Heptachlor epoxide in sample 30210SB20003.
- 4,4'-DDD, 4,4'-DDT, gamma-chlordane and alpha-chlordane in sample 30210SB19002.

The result reported was < 1/2 the CRQL. It is the opinion of the reviewer that the positive results reported by the laboratory for the compounds listed above are both qualitatively and quantitatively unacceptable.

Full Validation Criteria for Sample 30210SB26001.

III. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30210SB26001. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

B. A GPC cleanup was performed on the samples, but no recoveries were reported.

CLP METALS ANALYSIS

I. Blank Contamination

A. Due to calibration and method blank contamination, the following results are considered nondetected (UJb).

- Antimony in samples 30210SB26001, 30210SB26002 and 30210SB26003.

The following metals were detected in the associated calibration and method blanks at the concentrations noted below.

Analyte	Blank ID	Concentration
Aluminum	PBS	7.9 mg/kg
Antimony	PBS	0.03 mg/kg
Iron	PBS	0.4 mg/kg
Molybdenum	PBS	0.02 mg/kg
Tin	PBS	3.2 mg/kg

Detected results less than 5x the maximum blank contamination were qualified. The data was not affected by the other blank levels, since sample results were greater than 5x the maximum blank contamination or nondetected.

II. Matrix Spike (MS)

A. Due to an accuracy problem in the MS analysis, the following detected results were qualified as estimated (Je).

- Manganese in samples 30210SB26001, 30210SB26002 and 30210SB26003.

The recovery outside of the QC limits is listed below.

Sample ID	Analyte	%R	QC Limits
30210SB26002 Sp.	Manganese	219	75-125%

Spike recoveries above 125% indicate the detected results may be biased high.

III. Matrix Duplicate (MD)

A. Due to precision problems in the matrix duplicate analysis, the following detected results are qualified as estimated (Jd).

- Barium, calcium, chromium, lead and molybdenum in samples 30210SB26001, 30210SB26002 and 30210SB26003.

The following analytes had relative percent differences (RPD) outside the QC limits.

Sample ID	Analyte	%RPD	Absolute Difference	MRL
30210SB26002 Dup.	Barium	60		5 ug/L
	Calcium	43		50 ug/L
	Chromium	50		10 ug/L
	Lead	49		0.10 ug/L
	Molybdenum		0.08 mg/kg	0.04 ug/L

IV. Laboratory Control Sample (LCS)

A. Due to a problem in the LCS, the following nondetected results are qualified as estimated (UJe).

- Antimony in samples 30210SB26001, 30210SB26002 and 30210SB26003.

The result obtained in the analysis of the LCS was not within control limits as shown below.

LCS ID	Analyte	%R	QC Limits
LCS (S)	Antimony	59	80-120

False nondetects may have been reported.

V. ICP Serial Dilution

A. Due to ICP serial dilution problems, the following detected results are qualified as estimated (Jj).

- Potassium and sodium in samples 30210SB26001, 30210SB26002 and 30210SB26003.

The percent difference between the original sample results and the serial dilution results were outside the QC limits of 10% for analyte concentrations greater than 50x the IDL as shown below.

Sample ID	Analyte	Original Concentration	50x IDL	%D
30210SB26002	Potassium	2790 ug/L	1500 ug/L	22
	Sodium	1200 ug/L	1000 ug/L	14

VI. Field Duplicate

A. There were no field duplicate samples for this parameter.

VII. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Beryllium, cadmium, mercury, silver and thallium in sample 30210SB26001.

- Beryllium, cadmium, mercury and silver in sample 30210SB26002.
- Beryllium, cadmium, silver and thallium in sample 30210SB26003.

Results above the IDL but below the CRDL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30210SB26001.

VIII. Analyte Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The internal standards used in ICP-MS were within control limits.

IX. Graphite Furnace Atomic Absorption (GFAA) Analysis

A. There was no furnace analysis.

X. ICP Interference Check Sample

A. The ICSAB percent recoveries were within the control limits. There were no spectral interferences.

PCB ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Sample 30210SB26001.

II. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30210SB26001. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

III. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

B. A Florisil cleanup was performed on the samples, but no recoveries were reported.

TPHE ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Sample 30210SB26001.

II. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30210SB26001. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

III. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Semivolatiles were qualified due to blank contamination and results below the CRQL.

B. Due to identification problems in the pesticide analysis, one sample was qualified as estimated for heptachlor epoxide and one sample for 4,4'-DDD, 4,4'-DDT, gamma-chlordane and alpha-chlordane.

C. Due to an accuracy problem in the matrix spike for the metals' analysis, three samples were qualified as estimated for manganese. Due to a precison problem in the duplicate analysis, three samples were qualified as estimated for barium, calcium, chromium, lead and molybdenum. Due to ICP serial dilution problems, three samples were qualified as estimated for potassium and sodium. Due to an LCS problem, three samples were qualified as estimated for antimony. Metals were also qualified due to blank contamination and results between the IDL and CRDL.

D. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of made to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical Services, Inc.
Data Reviewer:	SFH/SMM/DAT
Review Date:	1/2/03

Sample Delivery Group (SDG) No.: K2207666

Sample Nos.:	30209GW10001	30209SB06003	30210SB28002
	30209SB05001	30210GW30001	30210SB28003
	30209SB05002*	30210SB27001	30210SB29001
	30209SB05003	30210SB27002	30210SB29002
	30209SB06001	30210SB27003	30210SB29003
	30209SB06002	30210SB28001	

* Full Validation Sample

Matrix: Soil, water

Collection Date(s): 10/22/02 and 10/23/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), "USEPA Contract Laboratory National Functional Guidelines for Low Concentration Organic Data (EPA 2001), and "USEPA Contract Laboratory Program National Functional Guidelines For Inorganic Data Review" (February 1994). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for CLP Inorganic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses," (August 2001), and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike *
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

CLP Inorganic Parameters

* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike
* Laboratory control sample or blank spike
Field duplicates
* Matrix duplicates
  ICP interference check sample
  GFAA quality control
* ICP serial dilution
  Sample result verification
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
VOA	✓	✓	✓	N/A	✓	Pg. 6	Pg. 6	✓	Pg. 6	Pg. 6
SVOA	✓	✓	✓	N/A	Pg. 7	Pg. 7	✓	✓	Pg. 8	Pg. 8
Pesticides	✓	✓	✓	N/A	✓	Pg. 10	Pg. 10	N/A	Pg. 10	✓
Metals	✓	N/A	Pg. 12	Pg. 13	Pg. 13	Pg. 12	✓	N/A	Pg. 13	Pg. 13
TPHP	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 17	✓
TPHE	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 16	Pg. 16
PCBs	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 15	Pg. 15

Note: ✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209SB05002 and 30210SB28003.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control	
SVOA	✓	✓	✓	Pg. 9	Pg. 9	✓	N/A	N/A	
Pesticides	N/A	N/A	Pg. 10	Pg. 10	N/A	✓	N/A	N/A	
Metals	N/A	N/A	✓	Pg. 14	N/A	✓	Pg. 14	Pg. 14	
TPHE	N/A	N/A	✓	Pg. 16	N/A	✓	N/A	N/A	
PCBs	N/A	N/A	Pg. 15	Pg. 15	N/A	✓	N/A	N/A	

Note: ✓indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

DATA ASSESSMENT

CLP VOLATILE ORGANIC ANALYSIS

I. Blank Contamination

A. Due to common laboratory contamination, the following result is considered nondetected (UJb).

- Methylene chloride in sample 30209GW10001.

Methylene chloride is considered a common laboratory contaminant when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

B. The following compound was detected in the associated equipment rinsate at the concentration noted below.

Compound	Blank ID	Concentration, ug/L
Bromomethane	30209GW10001	0.26

The data was not affected by the blank level, since the equipment rinsate is the only sample.

II. Calibration

A. Due to a severe calibration problem, the following nondetected result is rejected (Rc).

- 4-Methyl-2-pentanone in sample 30209GW10001.

The relative response factor (RRF) for 4-methyl-2-pentanone was 0.00835, which did not meet the QC limit of >0.01.

III. Field Duplicate

A. There were no field duplicate samples for this parameter.

IV. Other Qualifications

A. The following result is qualified as estimated (Jg).

- Bromomethane in sample 30209GW10001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

There were no samples for full validation.

CLP SEMIVOLATILE ORGANIC ANALYSIS

I. Blank Spike or Laboratory Control Spike (LCS)

A. Due to a problem in the LCS analysis, the following nondetected results are qualified as estimated (UJe).

- 4-Chloroaniline in samples 30209GW10001 and 30210GW30001.

The result obtained in the analysis of the LCS was not within the control limits as shown below.

LCS ID	Compound	%R	QC Limits
LCS 11/1/02	4-Chloroaniline	28	29-104

False nondetects may have been reported.

II. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Bis (2-ethylhexyl)phthalate in samples 30210SB27001, 30210SB27003 and 30210SB29003
- Di-n-butylphthalate in samples 30209GW10001 and 30210GW30001.
- Dimethylphthalate and diethylphthalate in sample 30209GW10001.

Bis(2-ethylhexyl)phthalate, di-n-butylphthalate, dimethylphthalate and diethylphthalate are considered common laboratory contaminants when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

B. The following compounds were detected in the associated method blank at the concentrations noted below.

Compound	Blank ID	Concentration, ug/L
Phenol	MB 11/1/02	0.14
Diethylphthalate	MB 11/1/02	0.028
Pentachlorophenol	MB 11/1/02	0.077
Di-n-butylphthalate	MB 11/1/02	0.028

The data was not affected by the blank levels, since sample results were nondetected.

C. The following compounds were detected in the associated equipment rinsates at the concentrations noted below.

Compound	Blank ID	Concentration, ug/L
Phenol	30209GW10001	0.34
Pentachlorophenol	30209GW10001	0.1
Pentachlorophenol	30210GW30001	0.13
4-Chloro-3-methylphenol	30210GW30001	0.043
Phenanthrene	30210GW30001	0.034
Fluoranthene	30210GW30001	0.031
Pyrene	30210GW30001	0.021

The data was not affected by the blank levels, since sample results were >5x the maximum blank contamination or nondetected.

III. Field Duplicate

A. There were no field duplicate samples for this parameter.

IV. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene, phenanthrene, fluoranthene, pyrene and benzo(g,h,i)perylene in samples 30209SB06001 and 30210SB27002.
- Benzo(b)fluoranthene in sample 30210SB27001.
- Benzo(a)anthracene, phenanthrene and chrysene in sample 30210SB27002DL.
- Phenanthrene, fluoranthene, pyrene and benzo(g,h,i)perylene in sample 30210SB28001.
- Fluoranthene and pyrene in sample 30210SB29003.
- Benzo(k)fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene, phenanthrene and fluoranthene in sample 30210SB28002.
- Benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)anthracene, benzo(a)pyrene, phenanthrene, anthracene and benzo(g,h,i)perylene in sample 30210SB28003.
- Phenol and pentachlorophenol in sample 30209GW10001.
- 4-Chloro-3-methylphenol, pentachlorophenol, phenanthrene, fluoranthene and pyrene in sample 30210GW30001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

B. Sample 30210SB27002 was diluted due to bis(2-ethylhexyl)phthalate over the calibration range. The original result for bis(2-ethylhexyl)phthalate should be replaced by the dilution result.

Full Validation Criteria for Sample 30210SB28003.

V. GC/MS Tuning

A. The ion abundance criteria were met for the decafluorotriphenylphosphine (DFTPP) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VI. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VII. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent(some lower) with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

VIII. Tentatively Identified Compounds (TICs)

A. There were no TICs.

IX. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP PESTICIDES ORGANIC ANALYSIS

I. Blank Contamination

A. Due to method blank contamination, the following result is considered nondetected (UJb).

- Endosulfan II in sample 30210SB27003.

The following compound was detected in the associated method blank at the concentration noted below.

Compound	Blank ID	Concentration, ug/Kg
Endosulfan II	MB 11/18/02	0.34

The data was not affected by the blank level, since the equipment rinsate is the only sample.

II. Calibration

A. Due to continuing calibration problems, the following nondetected results are qualified as estimated (UJc).

- 4,4'-DDT and methoxychlor in samples 30209SB06001, 30209SB06002, 30209SB06003 and 30210SB29003.
- Endosulfan I in samples 30210SB27001, 30210SB27002, 30210SB27003, 30210SB28001, 30210SB28002, 30210SB28003, 30210SB29001 and 30210SB29002.

The following continuing calibrations had percent differences (%D) of >15%.

Calibration Date	Compound	%D
11/14/02 8:44	4,4'-DDT (Col. 1)	-24
	Methoxychlor (Col. 1)	-28
11/18/02 20:44	Endosulfan I (Col. 1)	-16

III. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Sample 30210SB28003.

IV. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30210SB28003. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

B. A GPC cleanup was performed on the samples, but no recoveries were reported.

CLP METALS ANALYSIS

I. Blank Contamination

A. Due to calibration and method blank contamination, the following results are considered nondetected (UJb).

- Antimony in samples 30209SB06002, 30209SB06003, 30210SB27002, 30210SB27003, 30210SB28002, 30210SB29001, 30210SB29002 and 30210SB29003.
- Tin in sample 30209SB06002.

The following metals were detected in the associated calibration and method blanks at the concentrations noted below.

Analyte	Blank ID	Concentration
Antimony	PBS	0.02 mg/kg
Tin	PBS	2.9 mg/kg
Molybdenum	CCB	0.06 ug/L
Chromium	CCB	2.5 ug/L
Thallium	CCB	0.008 ug/L
Nickel	CCB	1.0 ug/L
Antimony	CCB	0.08 ug/L
Calcium	30209GW10001	36.6 ug/L
Iron	30209GW10001	7.9 ug/L
Magnesium	30209GW10001	20.1 ug/L
Zinc	30209GW10001	2.4 ug/L

Only detected results less than 5x the maximum blank contamination were qualified. The data was not affected by the other blank levels, since sample results were greater than 5x the maximum blank contamination or reported as nondetected.

II. Matrix Spike (MS)

A. Due to an accuracy problem in the MS analysis, the following detected results are qualified as estimated (Je).

- Manganese in samples 30209SB06001, 30209SB06002, 30209SB06003, 30210SB27001, 30210SB27002, 30210SB27003, 30210SB28001, 30210SB28002, 30210SB28003, 30210SB29001, 30210SB29002 and 30210SB29003.

The recovery outside of the QC limits is listed below.

Sample ID	Analyte	%R	QC Limits
30210SB27002S	Manganese	188	75-125%

Spike recovery greater than 125% indicates a possible high bias in detected results.

III. Matrix Duplicate (MD)

A. Due to precision problems in the matrix duplicate analysis, the following detected results are qualified as estimated (Jd).

- Barium and chromium in samples 30209SB06001, 30209SB06002, 30209SB06003, 30210SB27001, 30210SB27002, 30210SB27003, 30210SB28001, 30210SB28002, 30210SB28003, 30210SB29001, 30210SB29002 and 30210SB29003.

The following analytes had relative percent differences (RPD) outside the QC limits.

Sample ID	Analyte	%RPD	Absolute Difference	MRL
30210SB27002D	Barium	82	N/A	5.0 ug/L
	Antimony	73	N/A	0.10 ug/L

IV. Blank Spike or Laboratory Control Sample (LCS)

A. Due to a recovery problem in the LCS analysis, the following detected and nondetected results are qualified as estimated (Je/UJe).

- Antimony in samples 30209SB06001, 30209SB06002, 30209SB06003, 30210SB27001, 30210SB27002, 30210SB27003, 30210SB28001, 30210SB28002, 30210SB28003, 30210SB29001, 30210SB29002 and 30210SB29003.

The recovery outside of the QC limits is listed below.

Sample ID	Analyte	%R	QC Limits
LCS soil	Antimony	65	80-120%

Spike recovery below QC limits indicates a possible low bias in detected and nondetected results.

V. Field Duplicate

A. There were no field duplicate samples for this parameter.

VI. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Calcium, iron and zinc in sample 30209GW10001.
- Beryllium, cadmium and silver in samples 30209SB06002 and 30210SB27002
- Beryllium, cadmium, mercury and silver in samples 30209SB06003, 30210SB28001, 30210SB28002 and 30210SB28003.
- Beryllium, cadmium, mercury, silver and thallium in samples 30210SB27003, 30210SB29001, 30210SB29002 and 30210SB29003.
- Beryllium in sample 30209SB06001.

Results above the IDL but below the CRDL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Samples 30209SB05002 and 30210SB28003.

VII. Analyte Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

VIII. Graphite Furnace Atomic Absorption (GFAA) Analysis

A. There was no furnace analysis required in this sample group.

IX. ICP Interference Check Sample

A. The ICSAB percent recoveries were within the control limits.

Positive and negative results greater than the IDL for analytes that should not be present were detected in the ICSA solution. However, spectral interference was not suspected in either sample requiring full validation criteria.

PCB ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

II. Other Qualifications

A. The following result is qualified as estimated (Jg).

- Aroclor 1260 in sample 30209SB06001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30210SB28003.

III. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30210SB28003. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

IV. System Performance

A. The sample was evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPHE ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

II. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Diesel in sample 30209SB06001.
- Motor oil in samples 30209SB0602, 30210SB28002RE and 30210SB28003.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

B. Due to baseline problems, sample 30210SB28002 was reanalyzed for motor oil as 30210SB28002RE. The original analysis should be used for diesel and the "RE" analysis should be used for motor oil.

Full Validation Criteria for Sample 30210SB28003.

III. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IV. System Performance

A. The sample was evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPHP ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

There was no full validation required for this parameter.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to a severe problem in the volatile analysis, 4-methyl-2-pentanone was rejected in sample 30209GW10001.

B. Volatiles were also qualified due to blank contamination and a result below the CRQL.

C. Due to a LCS problem in the semivolatile analysis, two samples were qualified as estimated for 4-chloroaniline. Semivolatiles were also qualified due to blank contamination and results below the CRQL.

D. Due to continuing calibration problems in the pesticide analysis, four samples were qualified as estimated for 4,4'-DDT and methoxychlor and seven samples for endosulfan II. Pesticides were also qualified due to blank contamination.

E. Due to an accuracy problem in the matrix spike for the metals' analysis, twelve samples were qualified as estimated for manganese. Due to precison problems in the duplicate analysis, twelve samples were qualified as estimated for barium and chromium. Due to LCS recovery problems, twelve samples were qualified as estimated for antimony. Several metals samples were also qualified due to blank contamination and results reported between the IDL and CRDL.

F. One sample in the PCB analysis was qualified as estimated due to a detected result reported below the CRQL.

G. Four samples in the TPHE analysis were qualified due to detected results reported below the CRQL. Sample 30210SB28002 was reanalyzed for motor oil as 30210SB28002RE. The original analysis should be used for diesel and the reanalyzed result should be used for motor oil. The contract lab reported a baseline drift in the original analysis affecting the motor oil result.

H. Semivolatile sample 30210sB27002 was diluted due to bis(2-ethylhexyl)phthalte over the calibration range. The original result for bis(2-ethylhexyl)phthalate should be replaced by the dilution result.

I. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Rejected sample results (R) are unusable for all purposes. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. The high number of qualifications made to the data indicate several analytical and/or matrix problems that limit the usability of the data.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical
Data Reviewer:	TS/DAT
Review Date:	12/26/02

Sample Delivery Group (SDG) No.: K2207689

Sample Nos:

30209GW10003	30209SB10001	30209SB20001
30209SB07001	30209SB10002	30209SB20002*
30209SB07002*	30209SB10003	30209SB20003
30209SB07003	30209SB18003	30209SB21001
30209SB08001	30209SB19001	30209SB21002
30209SB08002	30209SB19002	30209SB21003
30209SB08003	30209SB19003	

* Full Validation Sample

Matrix: Soil, Water

Collection Date(s): 12/26/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), "USEPA Contract Laboratory National Functional Guidelines for Low Concentration Organic Data" (EPA 2001), and "USEPA Contract Laboratory Program National Functional Guidelines For Inorganic Data Review" (February 1994). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for CLP Inorganic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses," and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike *
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

CLP Inorganic Parameters

* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike
* Laboratory control sample or blank spike
  Field duplicates
* Matrix duplicates
  ICP interference check sample
  GFAA quality control
* ICP serial dilution
  Sample result verification
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

Non-CLP Organic and Inorganic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
VOA	✓	Pg. 6	✓	N/A	✓	Pg. 6	Pg. 6	✓	Pg. 6	Pg. 7
SVOA	✓	Pg. 8	✓	N/A	✓	Pg. 8	✓	Pg. 9	Pg. 9	Pg. 10
Pesticide	✓	✓	✓	N/A	✓	Pg. 12	Pg. 12	N/A	Pg. 12	Pg. 13
PCB	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 14	Pg. 14
Metals	✓	✓	Pg. 15	Pg. 16	Pg. 17	Pg. 16	✓	N/A	Pg. 18	Pg. 18
TPHE	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 19	Pg. 19
TPHP	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 20	✓

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209SB07002 and 30209SB20002

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control
SVOA	✓	✓	✓	Pg. 11	Pg. 11	✓	N/A	N/A
Pesticide	N/A	N/A	✓	Pg. 13	N/A	✓	N/A	N/A
PCB	N/A	N/A	✓	✓	N/A	✓	N/A	N/A
Metals	N/A	N/A	✓	Pg. 18	N/A	✓	✓	N/A
TPHE	N/A	N/A	✓	Pg. 19	N/A	✓	N/A	N/A

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers found are described below.

DATA ASSESSMENT

METHOD 8260B VOLATILE ORGANIC ANALYSIS

I. Surrogate Recovery

A. Due to surrogate recovery problems, the following detected results are qualified as estimated (Ja).

- Chloroform and bromodichloromethane in sample 30209GW10003.

The surrogates outside of QC limits are listed below.

Sample ID	Surrogate	%R	QC Limits
30209GW10003	Toluene-d8	111	88-110

High percent recoveries indicate that detected results may be biased high.

II. Blank Contamination

A. Due to common laboratory contamination, the following result is considered nondetected (UJb).

- Methylene chloride in sample 30209SB10003.

Methylene chloride is considered a common laboratory contaminant when found at levels less than 5x the MRL in environmental samples and not found in the associated blanks.

III. Calibrations

A. Due to continuing calibration problems, the following nondetected result is qualified as estimated (UJc).

- Methyl tert-butyl ether in sample 30209SB10003.

The following continuing calibration had a percent difference (%D) of >25%.

Calibration Date	Compound	%D
11/7/02	methyl tert-butyl ether	-35.0

IV. Field Duplicate

A. There are no field duplicates associated with this data package.

V. Other Qualifications.

A. The following result is qualified as estimated (Jg).

- Dibromochloromethane in sample 30209GW10003.

Detected results reported below the MRL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

There are no samples for full validation in the CLP-volatile analysis.

METHOD 8270C SEMIVOLATILE ORGANIC ANALYSIS

I. Surrogate Recovery

A. Due to surrogate recovery problems, the following detected results are estimated and the nondetected results are rejected (Ja/Ra).

- All target analytes in sample 30209SB07003.

The surrogates outside of QC limits are listed below.

Sample ID	Surrogate	%R	QC Limits
30209SB07003	2-Fluorobiphenyl	0	30-115
"	2,4,6-Tribromophenol	0	19-22

Surrogate recoveries <10% show a severe analytical deficiency. Detected results may be biased low and false nondetects may have been reported.

II. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Di-n-butylphthalate in samples 30209SB08002 and 30209SB10003.
- bis(2-Ethylhexyl)phthalate in samples 30209SB18003 and 30209SB10002

Di-n-butylphthalate and bis(2-ethylhexyl)phthalate are considered common laboratory contaminants when found at levels less than 5x the MRL in environmental samples and not found in the associated blanks.

B. Due to method blank contamination, the following results are considered nondetected (UJb).

- Pentachlorophenol in sample 30209GW10003.

The following compounds were detected in the associated method blanks at the concentrations noted below.

Compound	Blank ID	Concentration,	
Phenol	KWG0208661-3	0.14	µg/L
Diethylphthalate	"	0.028	µg/L
Pentachlorophenol	"	0.077	µg/L
Di-n-butyl phthalate	"	0.028	µg/L
Bis-(2-ethylhexyl)phthalate	"	0.021	mg/kg

The data was only affected by the pentachlorophenol contamination. Other associated sample results were not detected.

C. Due to field, trip, and equipment rinsate blank contamination, the following results are considered nondetected (UJf).

- Phenanthrene in samples 30209SB19001 and 30209SB21001.

The following analytes were detected in the associated field, trip, and equipment rinsate blanks at the concentrations noted below.

Blank ID	Compound	Concentration, µg/L
30209GW10003	Dibenzofuran	0.037
	Fluorene	0.076
	Phenanthrene	0.44
	Anthracene	0.046
	Fluoranthene	0.28
	Pyrene	0.22
	Chrysene	0.048
	Carbazole	0.035
30209GW10002	Phenol	0.46
	Naphthalene	0.033
	Phenanthrene	0.042
	Fluoranthene	0.06
	Pyrene	0.045

Detected results less than 5x the maximum blank contamination were qualified.

III. Internal Standards

A. The following internal standard area counts were less than one quarter of the reference standard.

Sample	Internal Standard	Value	QC Limits
30209SB07003	Acenaphthene-d10	0	60589 – 242354
"	Phenanthrene-d10	0	101435 - 405740

The data was not qualified for the area counts outside QC limits, since undetected results were previously rejected and there were no detected results associated with these internal standards.

IV. Field Duplicate

A. There were no field duplicates associated with this data package.

V. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Dibenzofuran, fluorene, anthracene, benz(a)anthracene, chrysene and carbazole in sample 30209GW10003.
- Benzo(g,h,i)perylene in sample 30209SB18003.
- Fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene and benzo(g,h,i)perylene in sample 30209SB19001.
- Fluoranthene, benz(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene and indeno(1,2,3-cd)perylene in sample 30209SB21001.
- Fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene and dibenz(a,h)anthracene in sample 30209SB07001.
- Phenanthrene, fluoranthene, benz(a)anthracene and benzo(b)fluoranthene in sample 30209SB07002.
- Dibenz(a,h)anthracene in sample 30209SB07003.
- Dibenzofuran, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene and benzo(g,h,i)perylene in sample 30209SB07003DL.
- Benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene and benzo(g,h,i)perylene in sample 30209SB10002.

Detected results reported below the MRL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

VI. Other

A. Due to surrogate recovery problems and internal standard area count problems, sample 30209SB07003 was reanalyzed at a dilution with greatly improved results. Since original undetected sample results were rejected, the dilution results should be used for all target analytes.

Full Validation Criteria for Samples 30209SB07002 and 30209SB20002.

VII. GC/MS Tuning

A. The ion abundance criteria were met for the decafluorotriphenylphosphine (DFTPP) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VIII. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

IX. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were partially consistent with the contract required report limits. Some of the compounds had lower MRLs. They reflect any dilutions, weights, volumes, and percent moisture.

X. Tentatively Identified Compounds (TICs)

A. The sample spectra and library searches were evaluated. TIC results were recalculated and found to be correct. The following TICs were qualified as estimated, (NJ).

- Unknown alkane, RT28.87 in sample 30209SB07002.
- Unknown alkane, RT28.92 in sample 30209SB20002.

XI. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

METHOD 8081A PESTICIDE ANALYSIS

I. Blank Contamination

A. The following compounds were detected in the associated method blanks at the concentrations noted below.

Compound	Blank ID	Concentration, µg/kg
Endosulfan I	KWG029019-4	0.23
alpha-Chlordane“	0.23	
Endrin	“	0.51

The data was not affected by the blank contamination, since associated sample results were not detected.

II. Calibrations

A. There was no resolution check mixture analyzed.

III. Field Duplicate

A. There were no field duplicates associated with this data package.

IV. Compound Identification

A. Due to confirmation problems, the following results are considered nondetected (UJj).

- 4,4’-DDT in samples 30209SB07002 and 30209SB10001.

The result reported was detected below the MRL, and a percent difference (%D) greater than 50% was noted in the analyte concentration between the quantitation column and the confirmation column. Further review of the chromatograms determined that the result reported was a false positive. The %Ds are listed below.

Sample ID	Compound	%D
30209SB07002	4,4’-DDT	129
30209SB10001	4,4’-DDT	58

B. Due to identification problems, the following results were raised to the Contract Required Quantitation Limit (MRL) and are reported as nondetected (UJg).

- Endosulfan I in sample 30209SB21002.

The result reported was less than 1/2 the MRL. It is the opinion of the reviewer that the positive results reported by the laboratory for the compounds listed above are both qualitatively and quantitatively unacceptable.

V. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Endosulfan sulfate in sample 30209SB07003.

Detected results reported below the MRL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Samples 30209SB07002 and 30209SB10002.

VI. Compound Quantitation and Reported Detection Limits

A. There were no positive results. The reported detection limits were laboratory detection limits. They reflect any dilutions, weights, volumes, and percent moisture.

VII. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

B. A GPC clean-up was performed on the samples. No recoveries were reported.

METHOD 8082 PCB ANALYSIS

I. Field Duplicate

A. There are no field duplicates associated with this data package.

II. Compound Identification

A. Due to identification problems, the following results were raised to the Contract Required Quantitation Limit (MRL) and are reported as nondetected (UJg).

- Aroclor 1260 in samples 30209SB07001, 30209SB07002, 30209SB19001 and 30209SB20001.

The result reported was less than 1/2 the MRL. It is the opinion of the reviewer that the positive results reported by the laboratory for the compounds listed above are both qualitatively and quantitatively unacceptable.

Full Validation Criteria for Samples 30209SB07002 and 30209SB20002.

III. Compound Quantitation and Reported Detection Limits

A. There were no positive results. The reported detection limits were consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

B. A GPC clean-up was performed on the samples. No recoveries were reported

METALS ANALYSIS

I. Blank Contamination

A. Due to calibration and method blank contamination, the following results are considered nondetected (UJb).

- Antimony in samples 30209SB08001, 30209SB08002, 30209SB08003, 30209SB10002, 30209SB10003, 30209SB18003, 30209SB19002, 30209SB19003, 30209SB20001, 30209SB20002, 30209SB20003, 30209SB21002 and 30209SB21003.
- Tin in samples 30209SB18003, 30209SB19003, 30209SB20002, 30209SB20003, 30209SB21002, 30209SB08001, 30209SB08003, 30209SB10002, 30209SB10003, 30209SB19001, 30209SB21001 30209SB07002 and 30209SB07003.

The following metals were detected in the associated calibration and method blanks at the concentrations noted below.

Blank ID	Analyte	Concentration, mg/kg
PBS	Aluminum	7.3
	Antimony	0.02
	Calcium	2
	Iron	1.1
	Magnesium	3.4
	Molybdenum	0.01
	Tin	3.6
ICB	Thallium	0.008
CCB	Nickel	2.4
	Potassium	34

Detected results less than 5x the maximum blank contamination were qualified.

B. Due to field, trip, and equipment rinsate blank contamination, the following results are considered nondetected (UJf).

- Molybdenum in samples 30209SB20002, 30209SB20003, 30209SB21002, 30209SB21003, 30209SB08001, 30209SB08002, 30209SB08003, 30209SB10003, 30209SB07002, 30209SB07003 and 30209SB07001.

The following analytes were detected in the associated field, trip, and equipment rinsate blanks at the concentrations noted below.

Blank ID	Analyte	Concentration, µg/L
30209GW10003	Calcium	89.3
	Iron	9.2
	Magnesium	34.7
	Molybdenum	0.25
	Sodium	62.3
30209GW10002	Calcium	34.7
	Lead	0.197
	Magnesium	31.1
	Molybdenum	0.52

Detected results less than 5x the maximum blank contamination were qualified.

II. Matrix Spike (MS)

A. Due to accuracy problems in the MS analysis, the following detected and nondetected results are qualified as estimated (Je/UJe).

- Antimony in samples 30209SB07001, 30209SB07002, 30209SB07003, 30209SB08001, 30209SB08002, 30209SB08003, 30209SB10001, 30209SB10002, 30209SB10003, 30209SB18003, 30209SB19001, 30209SB19002, 30209SB19003, 30209SB20001, 30209SB20002, 30209SB20003, 30209SB21001, 30209SB21002 and 30209SB21003.

The recoveries outside the QC limits are listed below.

Sample ID	Analyte	%R	QC Limits
30209SB18003	Antimony	63	75 - 125%

Spike recoveries between 30-74% indicate that detects may be biased low and false nondetects may have been reported.

III. Matrix Duplicate

A. Due to precision problems in the matrix duplicate analysis, the following detected and nondetected results are qualified as estimated (Jd/UJd).

- Lead and molybdenum in sample 30209GW10003.

The following analytes had relative percent differences (RPD) outside the QC limits.

Duplicate Sample ID	Analyte	RPD

K2207692-004D	Lead	40
"	Molybdenum	22

IV. Laboratory Control Sample (LCS)

A. Due to a problem in the LCS, the following detected and nondetected results are qualified as estimated (Je/UJe).

- Antimony in samples 30209SB07001, 30209SB07002, 30209SB07003, 30209SB08001, 30209SB08002, 30209SB08003, 30209SB10001, 30209SB10002, 30209SB10003, 30209SB18003, 30209SB19001, 30209SB19002, 30209SB19003, 30209SB20001, 30209SB20002, 30209SB20003, 30209SB21001, 30209SB21002 and 30209SB21003.

The result obtained in the analysis of the LCS was not within the control limits as shown below.

LCS ID	Analyte	%R	QC Limits
K2207689	Antimony	67	80 - 120%

Detected results may be biased low and false nondetects may have been reported.

V. ICP Serial Dilution

A. Due to ICP serial dilution problems, the following detected and nondetected results are qualified as estimated (Jj/UJj).

- Nickel and potassium in samples 30209SB07001, 30209SB07002, 30209SB07003, 30209SB08001, 30209SB08002, 30209SB08003, 30209SB10001, 30209SB10002, 30209SB10003, 30209SB18003, 30209SB19001, 30209SB19002, 30209SB19003, 30209SB20001, 30209SB20002, 30209SB20003, 30209SB21001, 30209SB21002 and 30209SB21003.

The percent difference between the original sample result and the serial dilution result was outside the QC limits of 10% for analyte concentrations greater than 50x the IDL as shown below.

Sample ID	Analyte	Original Concentration	50x IDL	%D
30209SB21001L	Nickel	191	75	10.1
"	Potassium	2830	1500	12.0

VI. Field Duplicate

A. There were no field duplicates associated with this data package.

VII. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Iron, molybdenum, and sodium in sample 30209GW10003.
- Beryllium, cadmium and silver in samples 30209SB10003, 30209SB10002, 30209SB08003, 30209SB08002, 30209SB21003, 30209SB21002, 30209SB20002, 30209SB19003 and 30209SB18003.
- Beryllium in samples 30209SB07001, 30209SB21001, 30209SB19002 and 30209SB19001.
- Beryllium, mercury and silver in samples 30209SB07003, 30209SB07002 and 30209SB20001.
- Beryllium and cadmium in sample 30209SB20003.
- Beryllium and silver in sample 30209SB08001.
- Beryllium, mercury, potassium and selenium in sample 30209SB10001.

Results above the IDL but below the CRDL are considered qualitatively acceptable but quantitatively unreliable due to uncertainties in the analytical precision near the limit of detection.

Full Validation Criteria for Samples 30209SB07002 and 30209SB20002.

VIII. Analyte Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits They reflect any dilutions, weights, volumes, and percent moisture.

IX. Graphite Furnace Atomic Absorption (GFAA) Analysis

A. There was no furnace analysis.

X. ICP Interference Check Sample

A. The ICSAB percent recoveries were within QC limits. The concentrations of Al, Ca, Fe, and Mg in the samples were less than 50% of their respective levels in the ICS solution.

TPH EXTRACTABLE ANALYSIS

I. Field Duplicate

A. There were no field duplicates associated with this data package.

II. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Motor oil in samples 30209SB20003, 30209SB21002, 30209SB07002, 30209SB07003DL, 30209SB08002 and 30209SB10001.
- Diesel in sample 30209SB08001.

Detected results reported below the RL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

III. Other

A. Due to diesel results exceeding the calibration range, sample 30209SB07003 was reanalyzed at a dilution. Dilution results should replace original results for diesel range organics.

Full Validation Criteria for Samples 30209SB07002 and 30209SB20002.

IV. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits for diesel results were consistent with the contract required report limits. The reported detection limits for motor oil were not consistent with the contract required report limits. Detection limits reflect any dilutions, weights, volumes, and percent moisture.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPH PURGEABLE ANALYSIS

I. Field Duplicates

A. There were no field duplicates associated with this data package.

There were no samples for full validation in the TPHP analysis.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to surrogate recoveries below 10 percent in the semivolatile analysis, the nondetected results for all target analytes in sample 30209SB07003 were rejected.

B. Due to surrogate recovery problems in the volatile analysis, one sample was qualified as estimated for chloroform and bromodichloromethane. Due to common laboratory contamination in the volatile analysis, one sample was qualified as nondetected for methylene chloride. Due to continuing calibration problems in the volatile analysis, one sample was qualified as estimated for methyl-tert-butyl ether. Due to results reported below the CRQL in the volatile analysis, one sample was qualified as estimated for dibromochloromethane.

C. Due to surrogate recovery problems in the semivolatile analysis, one sample was qualified as estimated for all detected results. Due to common laboratory contamination in the semivolatile analysis, two samples were qualified as nondetected for di-n-butylphthalate and bis(2-ethylhexyl) phthalate. Due to method blank contamination in the volatile analysis, one sample was qualified as nondetected for pentachlorophenol. Due to field blank contamination in the semivolatile analysis, two samples were qualified as nondetected for target analytes. Nine samples were qualified as estimated for results reported below the CRQL in the semivolatile analysis.

D. Due to confirmation problems in the pesticide analysis, two samples were nondetected for 4,4'-DDT. Due to results reported at less than ½ the CRQL in the pesticide analysis, one sample was qualified as nondetected for endosulfan I. Due to results reported below the CRQL in the pesticide analysis, one sample was qualified as estimated for endosulfan sulfate.

E. Due to results reported at less than ½ the CRQL in the PCB analysis, four samples were qualified as nondetected for Aroclor 1260.

F. Due to blank contamination in the metals analysis, thirteen samples were qualified as nondetected for antimony and tin. Due to field blank contamination in the metals analysis, eleven samples were qualified as nondetected for molybdenum. Due to matrix spike and laboratory spike problems in the metals analysis, nineteen samples were qualified as estimated for antimony. Due to duplicate problems in the metals analysis, one sample was qualified as estimated for lead and molybdenum. Due to ICP serial dilution problems in the metals analysis, nineteen samples were qualified as estimated for nickel and potassium. Twenty metals samples were qualified as estimated for results reported between the IDL and the CRDL.

G. Seven samples in the TPHE analysis were qualified as estimated for results reported below the CRQL.

H. Due to surrogate recovery problems and internal standard area count problems in the semivolatile analysis, sample 30209SB07003 was reanalyzed at a dilution with greatly improved results. Since

original undetected sample results were rejected, the dilution results should be used for all target analytes.

I. Due to results exceeding the calibration range in the TPHE analysis, sample 30209SB07003 was reanalyzed at a dilution. Dilution results should replace original results for diesel range organics.

J. Two TICs in the semivolatile analysis were qualified as estimated.

K. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Rejected sample results (R) are unusable for all purposes. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general the small number of qualifiers added to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical Services, Inc.
Data Reviewer:	SFH/DAT
Review Date:	12/26/02

Sample Delivery Group (SDG) No.: K2207690

Sample Nos.:	30209SB12001	30209SB14002	30209SB16003*
	30209SB12002	30209SB14003	30209SB17001
	30209SB12003	30209SB15001	30209SB17002
	30209SB13001*	30209SB15002	30209SB17003
	30209SB13002	30209SB15003	30209SB18001
	30209SB13003	30209SB16001	30209SB18002
	30209SB14001	30209SB16002	

* Full Validation Sample

Matrix: Soil

Collection Date(s): 10/25/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), "USEPA Contract Laboratory National Functional Guidelines for Low Concentration Organic Data (EPA 2001), and "USEPA Contract Laboratory Program National Functional Guidelines For Inorganic Data Review" (February 1994). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for CLP Inorganic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses," (August 2001), and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

CLP Inorganic Parameters

* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
  ICP interference check sample
  GFAA quality control
* ICP serial dilution
  Sample result verification
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
SVOA	✓	✓	✓	N/A	✓	Pg. 6	✓	✓	Pg. 6	Pg. 6
Pesticides	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 8	Pg. 8
Metals	✓	N/A	Pg. 10	Pg. 11	✓	Pg. 10	✓	N/A	Pg. 11	Pg. 11,12
TPHE	✓	N/A	✓	N/A	✓	Pg. 14	✓	N/A	Pg. 14	✓
PCBs	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 13	Pg. 13

Note: ✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209SB13001 and 30209SB16003.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control	
SVOA	✓	✓	✓	Pg. 7	Pg. 7	✓	N/A	N/A	
Metals	N/A	N/A	✓	Pg. 12	N/A	✓	Pg. 12	Pg. 12	
Pesticides	N/A	N/A	✓	Pg. 9	N/A	✓	N/A	N/A	
TPHE	N/A	N/A	✓	Pg. 14	N/A	✓	N/A	N/A	
PCBs	N/A	N/A	Pg. 13	Pg. 13	N/A	✓	N/A	N/A	

Note: ✓indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text

DATA ASSESSMENT

CLP SEMIVOLATILE ORGANIC ANALYSIS

I. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Bis (2-ethylhexyl)phthalate in samples 30209SB12001, 30209SB12002, 30209SB14002, 30209SB15002 and 30209SB15003.

Bis(2-ethylhexyl)phthalate is considered a common laboratory contaminant when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

II. Field Duplicate

A. There were no field duplicate samples for this parameter.

III. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Benzo(b)fluoranthene, benzo(k)fluoranthene, benz(a)anthracene, chrysene, benzo(a)pyrene and benzo(g,h,i)perylene in sample 30209SB12002.
- Benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene and benzo(g,h,i)perylene in samples 30209SB14001 and 30209SB15002.
- Benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)anthracene, fluoranthene, phenanthrene, chrysene and benzo(a)pyrene in sample 30209SB14002.
- Benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, pyrene, fluoranthene, benzo(a)pyrene and benzo(g,h,i)perylene in sample 30209SB13001.
- Naphthalene, phenanthrene and chrysene in sample 30209SB12001.
- Fluorantene, pyrene, benzo(a)anthracene and chrysene in sample 30209SB15001.
- Chrysene in sample 30209SB16002.
- Phenanthrene in sample 30209SB18002.
- Indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene and benzo(g,h,i)perylene in sample 30209SB16003.
- Indeno(1,2,3-cd)pyrene, anthracene and benzo(b)fluoranthene in sample 30209SB17001.
- Fluoranthene, pyrene, chrysene, benzo(a)pyrene and benzo(g,h,i)perylene in sample 30209SB18001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Samples 30209SB13001 and 30209SB16003.

IV. GC/MS Tuning

A. The ion abundance criteria were met for the decafluorotriphenylphosphine (DFTPP) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

V. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VI. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent (some lower) with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

VII. Tentatively Identified Compounds (TICs)

A. The sample spectra and library searches were evaluated. TIC results were recalculated and found to be correct. The following TICs were qualified as "tentatively identified" (NJ).

- TICs-24.84RT, 26.50RT, 27.57RT, 28.86RT and 29.85RT -"Unknown Alkane" in sample 30209SB13001.
- All TICs in sample 30209SB16003.

VIII. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP PESTICIDES ORGANIC ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

II. Compound Identification

A. Due to confirmation problems, the following results are considered nondetected (UJj).

- Methoxychlor in sample 30209SB15001.
- gamma-Chlordane in sample 30209SB12001.

The result reported was detected below the CRQL and a percent difference (%D) greater than 50% was noted in the analyte concentration between the quantitation column and the confirmation column. Further review of the data determined that the result reported was a false positives. The %Ds are listed below.

Sample ID	Compound	%D
30209SB15001	Methoxychlor	79.5
30209SB12001	gamma-Chlordane	51.7

B. Due to identification problems, the following results were raised to the Contract Required Quantitation Limit (CRQL) and are reported as nondetected (UJg). (For pesticide results <1/2 the CRQL).

- Endosulfan I in samples 30209SB14003 and 30209SB14002.
- 4,4'-DDE and alpha-chlordane in sample 30209SB12001.
- 4,4'-DDD and endrin aldehyde in sample 30209SB16003.
- Methoxychlor in sample 30209SB17002.
- 4,4'-DDD and methoxychlor in sample 30209SB12002.

The result reported was < 1/2 the CRQL. It is the opinion of the reviewer that the positive results reported by the laboratory for the compounds listed above are both qualitatively and quantitatively unacceptable.

III. Other Qualifications

A. The following results are qualified as estimated (Jg).

- 4,4'-DDD and endosulfan sulfate in sample 30209SB12001.
- 4,4'-DDD in sample 30209SB16002.
- 4,4'-DDT in sample 30209SB16003.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Samples 30209SB13001 and 30209SB16003.

IV. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

B. A GPC cleanup was performed on the samples, but no recoveries were reported.

CLP METALS ANALYSIS

I. Blank Contamination

A. Due to calibration and method blank contamination, the following results are considered nondetected (UJb).

- Antimony in samples 30209SB17002, 30209SB17003 and 30209SB18002.
- Molybdenum in samples 30209SB18002, 30209SB13002, 30209SB13003, 30209SB16002 and 30209SB16003.
- Tin in samples 30209SB17003, 30209SB14003, 30209SB16002 and 30209SB18001.

The following metals were detected in the associated calibration and method blanks at the concentrations noted below.

Analyte	Blank ID	Concentration
Antimony	PBS	0.01 mg/kg
Molybdenum	PBS	0.02 mg/kg
Tin	PBS	3.3 mg/kg
Sodium	PBS	7.7 mg/kg
Zinc	PBS	0.2 mg/kg
Chromium	CCB	1.7 ug/L
Copper	CCB	0.08 ug/L
Iron	CCB	2.1 ug/L
Thallium	CCB	0.009 ug/L

Detected results less than 5x the maximum blank contamination were qualified. The data was not affected by the other blank levels, since sample results were greater than 5x the maximum blank contamination or not associated.

II. Matrix Spike (MS)

A. Due to an accuracy problem in the MS analysis, the following detected and nondetected results were qualified as estimated (Je/UJe).

- Antimony in samples 30209SB12001, 30209SB12002, 30209SB12003, 30209SB13001, 30209SB13002, 30209SB13003, 30209SB14001, 30209SB14002, 30209SB14003, 30209SB15001, 30209SB15002, 30209SB15003, 30209SB16001, 30209SB16002, 30209SB16003, 30209SB17001, 30209SB17002, 30209SB17003, 30209SB18001 and 30209SB18002.

The recovery outside of the QC limits is listed below.

Sample ID	Analyte	%R	QC Limits
30209SB12002 Sp.	Antimony	69	75-125%

Spike recoveries between 30-74 % indicate the detects may be biased low and false nondetects may have been reported.

III. Matrix Duplicate (MD)

A. Due to precision problems in the matrix duplicate analysis, the following detected and nondetected results are qualified as estimated (Jd/UJd).

- Potassium in samples 30209SB12001, 30209SB12002, 30209SB12003, 30209SB13001, 30209SB13002, 30209SB13003, 30209SB14001, 30209SB14002, 30209SB14003, 30209SB15001, 30209SB15002, 30209SB15003, 30209SB16001, 30209SB16002, 30209SB16003, 30209SB17001, 30209SB17002, 30209SB17003, 30209SB18001 and 30209SB18002.

The following analytes had relative percent differences (RPD) outside the QC limits.

Sample ID	Analyte	%RPD	Absolute Difference	MRL
30209SB12002 Dup.	Barium	52		5.0 ug/L
	Antimony	39		0.10 ug/L
	Molybdenum	44		0.04 ug/L

IV. ICP Serial Dilution

A. Due to an ICP serial dilution problem, the following detected results are qualified as estimated (Jj).

- Potassium in samples 30209SB12001, 30209SB12002, 30209SB12003, 30209SB13001, 30209SB13002, 30209SB13003, 30209SB14001, 30209SB14002, 30209SB14003, 30209SB15001, 30209SB15002, 30209SB15003, 30209SB16001, 30209SB16002, 30209SB16003, 30209SB17001, 30209SB17002, 30209SB17003, 30209SB18001 and 30209SB18002.

The percent difference between the original sample result and the serial dilution result was outside the QC limits of 10% for analyte concentrations greater than 50x the IDL as shown below.

Sample ID	Analyte	Original Concentration	50x IDL	%D
30209SB18001	Potassium	3140 ug/L	1500 ug/L	12

V. Field Duplicate

A. There were no field duplicate samples for this parameter.

VI. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Beryllium, cadmium, mercury and silver in samples 30209SB12002, 30209SB12003, 30209SB13002, 30209SB16003 and 30209SB17003.

- Beryllium, cadmium and silver in samples 30209SB13003, 30209SB14001 and 30209SB18002.
- Beryllium, cadmium and mercury in sample 30209SB14002.
- Beryllium, mercury and silver in samples 30209SB15002 and 30209SB15003.
- Beryllium and silver in sample 30209SB16002.
- Beryllium and mercury in samples 30209SB14003 and 30209SB15001.
- Beryllium and selenium in samples 30209SB18001 and 30209SB12001.
- Beryllium and cadmium in sample 30209SB13001.
- Beryllium in samples 30209SB16001, 30209SB17001 and 30209SB17002.

Results above the IDL but below the CRDL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

B. The internal standard used for the analysis of antimony and silver was high. No corrective action was taken.

Full Validation Criteria for Samples 30209SB13001 and 30209SB16003.

VII. Analyte Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

VIII. Graphite Furnace Atomic Absorption (GFAA) Analysis

A. There was no furnace analysis.

IX. ICP Interference Check Sample

A. The ICSAB percent recoveries were within the control limits. Due to spectral interferences, the following detected and nondetected results are qualified as estimated (Jj/UJj).

- Barium, cobalt, sodium, tin and zinc in samples 30209SB13001 and 30209SB16003.

Positive and negative results greater than the IDL for analytes that should not be present were detected in the ICSA solution. Further evaluation of the sample indicates that spectral interferences may exist due to a high concentration of iron.

PCB ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

II. Compound Identification

A. Due to an identification problem, the following result was raised to the Contract Required Quantitation Limit (CRQL) and are reported as nondetected (UJg). (For pesticide results <1/2 the CRQL).

- Aroclor 1260 in sample 30209SB18001.

The result reported was < 1/2 the CRQL. It is the opinion of the reviewer that the positive result reported by the laboratory for the compound listed above are both qualitatively and quantitatively unacceptable.

Full Validation Criteria for Samples 30209SB13001 and 30209SB16003.

III. Compound Quantitation and Reported Detection Limits

A. There were no positive results for samples 30209SB13001 and 30209SB16003. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

B. A cleanup was performed on the samples, but no recoveries were reported.

TPHE ANALYSIS

I. Blank Contamination

A. Due to method blank contamination, the following results are considered nondetected (UJb).

- Diesel in samples 30209SB12002, 30209SB13001, 30209SB14001, 30209SB14002, 30209SB15001, 30209SB15002, 30209SB16001, 30209SB17001 and 30209SB17002.
- Motor oil in samples 30209SB12002, 30209SB13001, 30209SB14001, 30209SB14002, 30209SB15001, 30209SB15002, 30209SB16001, 30209SB17001 and 30209SB18001.

The following compounds were detected in the associated method blank at the concentrations noted below.

Analyte	Blank ID	Concentration
Diesel	MB 11/13/02	9.8 mg/kg
Motor Oil	MB 11/13/02	15 mg/kg

Detected results less than 5x the blank contamination were qualified.

II. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Samples 30209SB13001 and 30209SB16003.

III. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Semivolatiles were qualified due to blank contamination, TICs and results below the CRQL.

B. Due to identification problems in the pesticide analysis, two samples were considered nondetected for endosulfan I, one for methoxychlor, one for 4,4'-DDE and alpha-chlordane and one for 4,4'-DDD and endrin aldehyde. Due to confirmation problems, one sample was considered nondetected for methoxychlor and one for gamma-chlordane. Pesticides were also qualified due to results below the CRQL.

C. Due to an accuracy problem in the matrix spike for the metals' analysis, twenty samples were qualified as estimated for antimony. Due to precision problems in the duplicate analysis, twenty samples were qualified as estimated for antimony, barium and molybdenum. Due to ICP serial dilution problems, twenty samples were qualified as estimated for antimony, barium and molybdenum. Due to spectral interferences, two samples were qualified as estimated for barium, cobalt, sodium, tin and zinc. Metals were also qualified due to blank contamination and results between the IDL and CRDL.

D. Due to an identification problem in the PCB analysis, one sample was reported as nondetected for aroclor-1260.

E. TPHE samples were qualified due to blank contamination.

F. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of made to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical
Data Reviewer:	TS/DAT
Review Date:	1/3/03
Sample Delivery Group (SDG) No.:	K2207692
Sample Nos:	30209GW10002 30209SB11001 30209SB11002 30209SB11003 There are no samples for full validation
Matrix:	Soil, Water
Collection Date(s):	10/24/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), "USEPA Contract Laboratory National Functional Guidelines for Low Concentration Organic Data" (EPA 2001), and "USEPA Contract Laboratory Program National Functional Guidelines For Inorganic Data Review" (February 1994). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for CLP Inorganic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses," and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike *
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

CLP Inorganic Parameters

* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike
* Laboratory control sample or blank spike
  Field duplicates
* Matrix duplicates
  ICP interference check sample
  GFAA quality control
* ICP serial dilution
  Sample result verification
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

Non-CLP Organic and Inorganic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
VOA	✓	✓	✓	N/A	✓	Pg. 5	Pg. 5	✓	Pg. 5	Pg. 5
SVOA	✓	✓	✓	N/A	✓	Pg. 6	✓	✓	Pg. 6	Pg. 7
Pesticide	✓	✓	✓	N/A	✓	Pg. 8	Pg. 8	N/A	Pg. 8	Pg. 8
PCB	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 9	✓
Metals	✓	✓	Pg. 10	Pg. 11	Pg. 11	Pg. 10	✓	N/A	Pg. 12	Pg. 12
TPHE	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 13	Pg. 13
TPHP	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 14	✓

Notes:
✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis.
If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed.
The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

DATA ASSESSMENT

METHOD 8260B VOLATILE ORGANIC ANALYSIS

I. Blank Contamination

A. Due to common laboratory contamination, the following result is considered nondetected (UJb).

- Methylene chloride in sample 30209GW10002

Methylene chloride is considered a common laboratory contaminant when found at levels less than 5x the MRL in environmental samples and not found in the associated blanks.

II. Calibrations

A. Due to severe calibration problems, the following nondetected result is rejected (Rc).

- 4-Methyl-2-pentanone in sample 30209GW10002.

The relative response factor (RRF) for 4-methyl-2-pentanone was 0.008, which did not meet the QC limit of >0.01 for volatile poor performers.

III. Field Duplicate

A. There are no field duplicates associated with this data package.

IV. Other qualifications.

A. The following result is qualified as estimated (Jg).

- Methyl-tert-butyl ether in sample 30209GW10002.

Detected results reported below the MRL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

There are no samples for full validation in the CLP-volatile analysis.

METHOD 8270C SEMIVOLATILE ORGANIC ANALYSIS

I. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Dimethylphthalate, diethylphthalate and di-n-butylphthalate in sample 30209GW10002.

Dimethylphthalate, di-n-butylphthalate and diethylphthalate are considered common laboratory contaminants when found at levels less than 5x the MRL in environmental samples and not found in the associated blanks.

B. Due to method blank contamination, the following results are considered nondetected (UJb).

- Phenol and pentachlorophenol in sample 30209GW10002.
- Benzo(g,h,i)perylene in samples 30209SB11001, 30209SB11002 and 30209SB11003.

The following compounds were detected in the associated method blanks at the concentrations noted below.

Compound	Blank ID	Concentration	
Phenol	KWG0208661-3	0.14	µg/L
Diethylphthalate	"	0.028	µg/L
Pentachlorophenol	"	0.077	µg/L
Di-n-butyl phthalate	"	0.028	µg/L
Benzo(g,h,i)perylene	KWG0209533-4	0.029	mg/kg

The data was not affected by the diethylphthalate and di-n-butylphthalate contamination, since associated sample results were not detected.

C. The following compounds were detected in the associated equipment rinsate blank at the concentrations noted below.

Compound	Blank ID	Concentration µg/ml
Naphthalene	30209SB10002	0.0148
Phenanthrene	"	0.0188
Fluoranthene	"	0.0268
Pyrene	"	0.0201

The data was not affected by the equipment rinsate blank contamination, since associated sample results were above the action level or not detected.

II. Field Duplicate

A. There were no field duplicates associated with this data package.

III. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Naphthalene, phenanthrene, fluoranthene and pyrene in sample 30209GW10002.
- Phenanthrene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene and benzo(a)pyrene in sample 30209SB11001.
- Fluoranthene and pyrene in sample 30209SB11002.
- Indeno(1,2,3-cd)pyrene in sample 30209SB11003.

Detected results reported below the MRL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

There are no samples for full validation in the semivolatile parameter.

METHOD 8081A PESTICIDE ANALYSIS

I. Blank Contamination

A. The following compound was detected in the associated method blank at the concentration noted below.

Compound	Blank ID	Concentration, µg/kg
Endosulfan II	KWG0208901-4	0.34

The data was not affected by the blank contamination, since associated sample results were not detected.

II. Calibrations

A. Due to continuing calibration problems, the following nondetected result is qualified as estimated (UJc).

- Methoxychlor in samples 30209SB11001, 30209SB11002 and 30209SB11003.

The following continuing calibrations had percent differences (%D) of >25%.

Calibration Date	Compound	%D	
11/14/02	Methoxychlor	-28	(DB-XLB)

B. There was no resolution check mixture analyzed.

III. Field Duplicate

A. There were no field duplicates associated with this data package.

IV. Compound Identification

A. Due to confirmation problems, the following results are considered nondetected (UJj).

- Endrin ketone in sample 30209SB11001.

The result reported was detected below the MRL, and a percent difference (%D) greater than 50% was noted in the analyte concentration between the quantitation column and the confirmation column. Further review of the chromatograms determined that the result reported was a false positive. The %Ds are listed below.

Sample ID	Compound	%D
30209SB11001	Endrin Ketone	89.7

There are no samples for full validation in the pesticide parameter.

METHOD 8082 PCB ANALYSIS

I. Field Duplicate

A. There are no field duplicates associated with this data package.

There are no samples for full validation in the PCB parameter.

METALS ANALYSIS

I. Blank Contamination

A. Due to calibration and method blank contamination, the following results are considered nondetected (UJb).

- Antimony and molybdenum in samples 30209SB11002 and 30209SB11003.
- Molybdenum in sample 30209SB11001.

The following metals were detected in the associated calibration and method blanks at the concentrations noted below.

Blank ID	Analyte	Concentration, mg/kg
PBS	Aluminum	7.9
	Antimony	0.03
	Iron	0.4
	Molybdenum	0.2
	Tin	3.2

The following metals were detected in the associated equipment rinsate at the concentrations noted below.

Sample ID	Analyte	ug/L
30209GW10002	Calcium	34.7
	Lead	0.197
	Magnesium	31.1
	Molybdenum	0.52

Detected results less than 5x the maximum blank contamination were qualified.

II. Matrix Spike (MS)

A. Due to accuracy problems in the MS analysis, the following detected and nondetected results are qualified as estimated (Je/UJe).

- Antimony and chromium in samples 30209SB11001, 30209SB11002 and 30209SB11003.

The recoveries outside the QC limits are listed below.

Sample ID	Analyte	%R	QC Limits
Batch QC2	Antimony	74	75 - 125%
"	Chromium	60	75 - 125%

Spike recoveries between 30-74% indicate that detects may be biased low and false nondetects may have been reported.

B. Due to accuracy problems in the MS analysis, the following detected results are qualified as estimated (Je).

- Manganese in samples 30209SB11001, 30209SB11002 and 30209SB11003.

The recoveries outside the QC limits are listed below.

Sample ID	Analyte	%R	QC Limits
Batch QC2	Manganese	219	75 – 125%

Spike recoveries above 125% indicate that detected results may be biased high.

III. Matrix Duplicate

A. Due to precision problems in the matrix duplicate analysis, the following detected and nondetected results are qualified as estimated (Jd/UJd).

- Lead and molybdenum in sample 30209GW10002.
- Barium, calcium, chromium, lead, molybdenum and thallium in samples 30209SB11001, 30209SB11002 and 30209SB11003.

The following analytes had relative percent differences (RPD) outside the QC limits.

Duplicate Sample ID	Analyte	RPD
30209GW10002D	Lead	40
"	Molybdenum	22
Batch QC2	Barium	60
"	Calcium	43
"	Chromium	50
"	Lead	49
"	Molybdenum	62
"	Thallium	71

IV. Laboratory Control Sample (LCS)

A. Due to a problem in the LCS, the following detected and nondetected results are qualified as estimated (Je/UJe).

- Antimony in samples 30209SB11001, 30209SB11002 and 30209SB11003.

The result obtained in the analysis of the LCS was not within the control limits as shown below.

LCS ID	Analyte	%R	QC Limits
LCS	Antimony	59	80 - 120%

Detected results may be biased low and false nondetects may have been reported.

V. ICP Serial Dilution

A. Due to ICP serial dilution problems, the following detected results are qualified as estimated (Jj).

- Potassium and sodium in samples 30209SB11001, 30209SB11002 and 30209SB11003.

The percent difference between the original sample result and the serial dilution result was outside the QC limits of 10% for analyte concentrations greater than 50x the IDL as shown below.

Sample ID	Analyte	Original Concentration	50x IDL	%D
30209SB26002L	Potassium	2790	1500	22
"	Sodium	1200	1000	12

VI. Field Duplicate

A. There were no field duplicates associated with this data package.

VII. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Calcium and lead in sample 30209GW10002.
- Beryllium in sample 30209SB11001.
- Beryllium and silver in samples 30209SB11002 and 30209SB11003.

Results above the IDL but below the CRDL are considered qualitatively acceptable but quantitatively unreliable due to uncertainties in the analytical precision near the limit of detection.

There were no samples for full validation in the metals parameter.

TPH EXTRACTABLE ANALYSIS

I. Field Duplicate

A. There were no field duplicates associated with this data package.

II. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Diesel in sample 30209SB11001.
- Diesel and motor oil in sample 30209SB11003.

Detected results reported below the RL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

There are no samples for full validation in the TPHE parameter.

TPH PURGEABLE ANALYSIS

I. Field Duplicates

A. There were no field duplicates associated with this data package.

There were no samples for full validation in the TPHP analysis.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to severe calibration problems in the volatile analysis, sample 30209GW10002 was qualified as rejected for 4-methyl-2-pentanone.

B. Due to common laboratory contamination in the volatile analysis, one sample was qualified as nondetected for methylene chloride. Due to results reported below the MRL in the volatile analysis, one sample was qualified as estimated for methyl-tert-butyl ether.

C. Due to common laboratory contamination in the semivolatile analysis, one sample was qualified as nondetected for three phthalates. Due to method blank contamination in the semivolatile analysis, one sample was qualified as nondetected for phenol and pentachlorophenol and three samples were qualified as nondetected for benzo(g,h,i)perylene. Four samples in the semivolatile analysis were qualified as estimated for results reported below the MRL.

D. Due to calibration problems in the pesticide analysis, one sample was qualified as estimated for methoxychlor. Due to confirmation problems in the pesticide analysis, one sample was qualified as nondetected for endrin ketone.

E. Due to blank contamination problems in the metals analysis, three samples were qualified as nondetected for molybdenum and two samples were qualified as nondetected for antimony. Due to matrix spike problems in the metals analysis, three samples were qualified as estimated for antimony, manganese and chromium. Due to matrix duplicate problems in the metals analysis, four samples were qualified as estimated for target analytes. Due to problems in the laboratory spike metals analysis, three samples were qualified as estimated for antimony. Due to serial dilution problems in the metals analysis, three samples were qualified as estimated for potassium and sodium. Three metals samples were qualified as estimated for results reported between the MDL and the MRL.

F. Two TPHE samples were qualified as estimated for results reported below the MRL.

G. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Rejected sample results (R) are unusable for all purposes. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general the small number of qualifiers added to the organic data indicate high usability. The high number of qualifications made to the inorganic data indicate several analytical and/or matrix problems that limit the usability of the data.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical Services, Inc.
Data Reviewer:	SFH/DAT
Review Date:	1/16/03

Sample Delivery Group (SDG) No.: K2207817

Sample Nos.:	30209GW01001*	30209GW04001	30209GW20001
	30209GW02001	30209GW05001	30210GW02001
	30209GW03001	30209GW06001	30210GW03001

* Full Validation Sample

Matrix: Water

Collection Date(s): 10/30/02 and 10/31/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), "USEPA Contract Laboratory National Functional Guidelines for Low Concentration Organic Data (EPA 2001), and "USEPA Contract Laboratory Program National Functional Guidelines For Inorganic Data Review" (February 1994). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for CLP Inorganic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses," (August 2001), and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike *
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

CLP Inorganic Parameters

* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike
* Laboratory control sample or blank spike
  Field duplicates
* Matrix duplicates
  ICP interference check sample
  GFAA quality control
* ICP serial dilution
  Sample result verification
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
SVOA	✓	✓	Pg. 6	N/A	✓	Pg. 6	✓	✓	Pg. 7	Pg. 7
Pesticides	✓	✓	✓	N/A	✓	✓	Pg. 9	N/A	Pg. 9	Pg. 9
Metals	✓	N/A	✓	✓	✓	Pg. 11	✓	N/A	Pg. 11	Pg. 11
TPHE	✓	✓	✓	N/A	✓	Pg. 14	✓	N/A	Pg. 14	✓
PCBs	✓	Pg. 13	✓	N/A	✓	✓	✓	N/A	Pg. 13	✓

Note: ✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209GW01001.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control	
SVOA	✓	✓	✓	Pg. 8	Pg. 8	✓	N/A	N/A	
Metals	N/A	N/A	✓	Pg. 12	N/A	✓	Pg. 12	Pg. 12	
Pesticides	N/A	N/A	Pg. 9	Pg. 9	N/A	✓	N/A	N/A	
TPHE	N/A	N/A	Pg. 14	✓	N/A	✓	N/A	N/A	
PCBs	N/A	N/A	Pg. 13	Pg. 13	N/A	✓	N/A	N/A	

Note: ✓indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text

DATA ASSESSMENT

CLP SEMIVOLATILE ORGANIC ANALYSIS

I. Matrix Spike / Matrix Spike Duplicate (MS/MSD)

A. Due to accuracy problems in the MS/MSD analysis, the following nondetected results are qualified as estimated (UJe).

- 1,4-Dichlorobenzene, N-nitroso-di-n-propylamine and 1,2,4-trichlorobenzene in sample 30209GW03001.

The recoveries outside the QC limits are listed below.

Sample ID	Compound	%R	QC Limits
30209GW03001 Sp.	1,4-Dichlorobenzene	22	36-97
	N-Nitroso-di-n-propylamine	39	41-116
	1,2,4-Trichlorobenzene	25	39-98

These outliers affected only the spiked sample. False nondetects may have been reported.

II. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Bis(2-ethylhexyl)phthalate in samples 30209GW20001 and 30209GW02001.
- Diethylphthalate in samples 30209GW03001, 30209GW20001, 30209GW01001, 30209GW02001, 30209GW05001, 30209GW06001, 30209GW04001 and 30210GW03001.
- Di-n-butylphthalate in samples 30209GW03001, 30209GW01001, 30209GW02001, 30209GW05001, 30209GW06001, 30209GW04001 and 30210GW03001.
- Butylbenzylphthalate in sample 30209GW02001.

Bis(2-ethylhexyl)phthalate, butylbenzylphthalate, diethylphthalate and di-n-butylphthalate are considered common laboratory contaminants when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

B. Due to method blank contamination, the following results are considered nondetected (UJb).

- Phenanthrene in samples 30209GW03001, 30209GW02001, 30209GW05001, 30210GW03001 and 30209GW06001.

The following compounds were detected in the associated method blank at the concentrations noted below.

Compound	Blank ID	Concentration, ug/L
Phenanthrene	MB 11/7/02	0.012
Di-n-butylphthalate		0.18

Detected results <5x the maximum blank contamination were qualified. The data was not affected by the di-n-butylphthalate blank level, since sample results were nondetected.

III. Field Duplicate

A. The following RPD was obtained for field duplicate samples 30209GW01001/30209GW20001:

- Naphthalene(200%)

For water samples, the field RPD is ±25%. The data are not qualified on the basis of field duplicate results.

IV. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Naphthalene, 2-methylnaphthalene and pyrene in sample 30209GW05001.
- Naphthalene, 2-methylnaphthalene and 2-nitrophenol in sample 30209GW02001.
- Naphthalene and 2-nitrophenol in sample 30209GW06001.
- Naphthalene in sample 30209GW01001.
- 2-Methylnaphthalene in sample 30209GW03001.
- Phenol, fluoranthene and pyrene in sample 30210GW03001.
- Acenaphthene, dibenzofuran, fluorene and pyrene in sample 30209GW04001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30209GW01001.

V. GC/MS Tuning

A. The ion abundance criteria were met for the decafluorotriphenylphosphine (DFTPP) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VI. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VII. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

VIII. Tentatively Identified Compounds (TICs)

A. There were no TICs reported.

IX. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP PESTICIDES ORGANIC ANALYSIS

I. Calibrations

A. The following continuing calibrations have percent differences (%D) of >15%.

Calibration Date	Compound	%D
11/12/02	alpha-BHC(Col. 2)	20
	gamma-BHC(Col. 2)	18
	delta-BHC(Col. 2)	19
	Aldrin(Col. 2)	16
	Dieldrin(Col. 2)	16
	Endrin(Col. 2)	17
	Toxaphene(Col. 2)	18
11/11/02	alpha-BHC(Col. 2)	16

The data was not affected by the high %Ds, since the results were nondetected and taken from column 1.

II. Field Duplicate

A. There were no RPDs obtained for field duplicate samples 30209GW01001/30209GW20001, since sample results were nondetected.

III. Other Qualifications

A. The following result is qualified as estimated (Jg).

- alpha-Chlordane in sample 30209GW05001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30209GW01001.

IV. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30209GW01001. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP METALS ANALYSIS

I. Blank Contamination

A. Due to calibration and method blank contamination, the following results are considered nondetected (UJb).

- Aluminum in samples 30209GW02001, 30209GW06001 and 30209GW04001.

The following metals were detected in the associated calibration and method blanks at the concentrations noted below.

Analyte	Blank ID	Concentration
Antimony	ICB	0.04 ug/L
Silver	ICB	0.02 ug/L
Molybdenum	CCB	0.01 ug/L
Aluminum	CCB	41 ug/L
Lead	CCB	-0.0088 ug/L

Detected results less than 5x the maximum blank contamination were qualified. The data was not affected by the other blank levels, since sample results were greater than 5x the maximum blank contamination or nondetected.

II. Field Duplicate

A. The following RPDs were obtained for field duplicate samples 0209GW01001/30209GW20001:

- Barium(11.8%), calcium(6.6%), iron(53.7%), lead(40.5%), magnesium(6.3%), manganese(200%), molybdenum(9.7%), potassium(1.9%), silver(22%), sodium(3.6%), zinc(200%), antimony(200%) and nickel(200%).

For water samples, the field RPD is ±25%. The data are not qualified on the basis of field duplicate results.

III. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Antimony, arsenic, nickel, zinc and silver in sample 30209GW03001.
- Antimony, barium, iron, lead, nickel and silver in sample 30209GW20001.
- Barium, iron, lead, manganese, zinc and silver in sample 30209GW01001.
- Lead, nickel, zinc and silver in sample 30209GW02001.
- Antimony, arsenic, silver and vanadium in sample 30209GW05001.
- Antimony, lead, nickel and silver in sample 30209GW06001.
- Silver and zinc in sample 30209GW04001.
- Antimony, chromium, nickel, silver and zinc in sample 3021003001.

Results above the IDL but below the CRDL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30209GW01001.

IV. Analyte Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The internal standards used in the ICP-MS analysis were within QC limits.

V. Graphite Furnace Atomic Absorption (GFAA) Analysis

A. There was only one sample spiked in this data package. Sample 30209GW01001 had no analytical spikes for any of the furnace analytes. No corrective action was taken.

VI. ICP Interference Check Sample

A. The ICSAB percent recoveries were within the control limits. No spectral interferences were detected.

PCB ANALYSIS

I. Surrogate Recovery

A. Due to a surrogate recovery problem, the following nondetected results are qualified as estimated (UJa).

- All PCBs in sample 30209GW06001.

The surrogate outside of QC limits is listed below.

Sample ID	Surrogate	%R	QC Limits
30209GW06001	Decafluorobiphenyl	48	60-140

Low recoveries indicate that nondetects may be biased low.

II. Field Duplicate

A. There were no RPDs obtained for field duplicate samples 30209GW01001/30209GW20001, since sample results were nondetected.

Full Validation Criteria for Sample 30209GW01001.

III. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30209GW01001. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPHE ANALYSIS

I. Blank Contamination

A. The following compounds were detected in the associated method blank at the concentrations noted below.

Compound	Blank ID	Concentration, ug/L
Diesel	MB 11/16/02	81
Motor Oil		61

The data was not affected by the blank levels, since sample results were nondetected.

II. Field Duplicate

A. There were no RPDs obtained for field duplicate samples 30209GW01001/30209GW20001, since sample results were nondetected.

Full Validation Criteria for Sample 30209GW01001.

III. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30209GW01001. The reported detection limits were consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to accuracy problems in the semivolatile MS/MSD analysis, one sample was qualified as estimated for 1,4-dichlorobenzene, N-nitroso-di-n-propylamine and 1,2,4-trichlorobenzene. Semivolatiles were also qualified due to blank contamination and results below the CRQL.

B. Pesticides were qualified due to a result below the CRQL.

C. Metals were qualified due to blank contamination and results between the IDL and CRDL.

D. Due to a surrogate recovery problem in the PCB analysis, one sample was qualified as estimated for all PCBs.

E. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of made to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical Services, Inc.
Data Reviewer:	SFH/DAT
Review Date:	1/15/03

Sample Delivery Group (SDG) No.: K2207880

Sample Nos.:	30209GW10007	30209SB22003	30209SB24003
	30209SB05004	30209SB23001	30209SB25001
	30209SB05005*	30209SB23002	30209SB25002
	30209SB05006	30209SB23003*	30209SB25003
	30209SB22001	30209SB24001	
	30209SB22002	30209SB24002	

* Full Validation Sample

Matrix: Soil, water

Collection Date(s): 11/1/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), "USEPA Contract Laboratory National Functional Guidelines for Low Concentration Organic Data (EPA 2001), and "USEPA Contract Laboratory Program National Functional Guidelines For Inorganic Data Review" (February 1994). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for CLP Inorganic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses," (August 2001), and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

CLP Inorganic Parameters

* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
  ICP interference check sample
  GFAA quality control
* ICP serial dilution
  Sample result verification
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
SVOA	✓	✓	✓	N/A	Pg. 6	Pg. 6	✓	Pg. 7	Pg. 7	Pg. 7
Pesticides	✓	✓	✓	N/A	✓	✓	Pg. 9	N/A	Pg. 9	Pg. 9
Metals	✓	N/A	Pg. 12	Pg. 11	✓	Pg. 11	✓	N/A	Pg. 12	Pg. 13
TPHE	✓	Pg. 15	Pg. 15	N/A	✓	Pg. 15	✓	N/A	Pg. 16	Pg. 16
PCBs	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 14	✓

Note: ✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209SB05005 and 30209SB23003.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control	
SVOA	✓	✓	✓	Pg. 8	Pg. 8	✓	N/A	N/A	
Metals	N/A	N/A	✓	Pg. 13	N/A	✓	Pg. 13	Pg. 13	
Pesticides	N/A	N/A	Pg. 10	Pg. 10	N/A	✓	N/A	N/A	
TPHE	N/A	N/A	✓	Pg. 16	N/A	✓	N/A	N/A	
PCBs	N/A	N/A	Pg. 14	Pg. 14	N/A	✓	N/A	N/A	

Note: ✓indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text

DATA ASSESSMENT

CLP SEMIVOLATILE ORGANIC ANALYSIS

I. Blank Spike or Laboratory Control Spike (LCS)

A. Due to a problem in the LCS analysis, the following nondetected result is qualified as estimated (UJe).

- 3,3'-Dichlorobenzidine in sample 30209GW10007.

The result obtained in the analysis of the LCS was not within the control limits as shown below.

LCS ID	Compound	%R	QC Limits
LCS 11/13/02	3,3'-Dichlorobenzidine	0	25-111

False nondetects may have been reported.

II. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Bis (2-ethylhexyl)phthalate in samples 30209SB25002 and 30209SB05005.
- Diethylphthalate, di-n-butylphthalate and bis(2-ethylhexyl)phthalate in sample 30209GW10007.

Bis(2-ethylhexyl)phthalate, diethylphthalate and di-n-butylphthalate are considered common laboratory contaminants when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

B. The following compounds were detected in the associated method blank at the concentrations noted below.

Compound	Blank ID	Concentration, ug/L
Diethylphthalate	MB 11/13/02	0.034
Di-n-butylphthalate		0.036

The data was not affected by the blank levels, since sample results were nondetected.

C. The following compounds were detected in the associated equipment rinsate blank at the concentrations noted below.

Compound	Blank ID	Concentration, ug/L
Phenanthrene	30209GW10007(ER)	0.034
Fluoranthene		0.043
Pyrene		0.026

The data was not affected by the blank levels, since sample results were >5x the maximum blank contamination.

III. Internal Standards

A. Due to an internal standard problem, the following detected and nondetected results are qualified as estimated (Ji/UJi).

- All compounds quantitated using phenanthrene-d10 in sample 30209SB23003.

Internal standard area counts of less than 50% of the standard area count may indicate a loss of instrument sensitivity.

IV. Field Duplicate

A. There were no field duplicate samples for this parameter.

V. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Benzo(b)fluoranthene, benzo(k)fluoranthene, benz(a)anthracene, 1,4-dichlorobenzene and benzo(g,h,i)perylene in sample 30209SB23003.
- Benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, benzo(a)anthracene, chrysene, pyrene and fluoranthene in sample 30209SB25001.
- Benzo(b)fluoranthene, benzo(g,h,i)perylene, pyrene, benzo(a)anthracene, chrysene, phenanthrene and fluoranthene in sample 30209SB05004.
- Benzo(a)anthracene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, phenanthrene and fluoranthene in sample 30209SB22001.
- Naphthalene, 2-methylnaphthalene, acenaphthene, dibenzofuran, chrysene, fluoranthene and pyrene in sample 30209SB23003DL.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

B. Sample 30209SB2003 was diluted due to an internal standard area outside QC limits. The results for the diluted sample should be used, since all internal standard areas were within QC limits.

Full Validation Criteria for Samples 30209SB05005 and 30209SB23003DL.

VI. GC/MS Tuning

A. The ion abundance criteria were met for the decafluorotriphenylphosphine (DFTPP) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VII. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VIII. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IX. Tentatively Identified Compounds (TICs)

A. The sample spectra and library searches were evaluated. TIC results were recalculated and found to be correct. The following TICs were qualified as "tentatively identified" (NJ).

- TICs-10.91RT, 11.01RT, 11.12RT, 11.18RT, 11.98RT, 12.92RT, 13.01RT, 13.17RT, 13.40RT, 13.47RT, 13.66RT, 13.80RT, 14.60RT, 14.95RT, 15.05RT, 15.45RT, 15.51RT, 15.74RT, 17.20RT, 17.40RT and 18.64RT in sample 30209SB23003DL.

X. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP PESTICIDES ORGANIC ANALYSIS

I. Calibrations

A. Due to a continuing calibration problem, the following nondetected result is qualified as estimated (UJc).

- Endrin aldehyde in sample 30209SB23003.

The following continuing calibrations has percent differences (%D) of >15%.

Calibration Date	Compound	%D
11/12/02	alpha-BHC(Col. 2)	20
	gamma-BHC(Col. 2)	18
	delta-BHC(Col. 2)	19
	Aldrin(Col. 2)	16
	Dieldrin(Col. 2)	16
	Endrin(Col. 2)	17
	Toxaphene(Col. 2)	18
12/2/02	4,4'-DDT(Col. 2)	-17
	Endrin Aldehyde(Col. 1)	-16

II. Field Duplicate

A. There were no field duplicate samples for this parameter.

III. Compound Identification

A. Due to a confirmation problem, the following result is considered nondetected (UJj).

- 4,4'-DDT in sample 30209SB05004.

The result reported was detected below the CRQL and a percent difference (%D) greater than 50% was noted in the analyte concentration between the quantitation column and the confirmation column. Further review of the data determined that the result reported was a false positive. The %Ds are listed below.

Sample ID	Compound	%D
30209SB05004	4,4'-DDT	114

Full Validation Criteria for Samples 30209SB05005 and 30209SB23003.

IV. Compound Quantitation and Reported Detection Limits

A. There were no positive results for samples 30209SB05005 and 30209SB23003. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP METALS ANALYSIS

I. Blank Contamination

A. Due to calibration and method blank contamination, the following results are considered nondetected (UJb).

- Antimony in sample 30209SB05005.
- Mercury in sample 30209SB22001.
- Tin in samples 30209SB23003, 30209SB24002, 30209SB25002 and 30209SB05005.

The following metals were detected in the associated calibration and method blanks at the concentrations noted below.

Analyte	Blank ID	Concentration
Sodium	PBS	11.4 mg/kg
Zinc	PBS	0.3 mg/kg
Tin	PBS	2.8 mg/kg
Antimony	ICB	0.04 ug/L, 0.068 ug/L
Molybdenum	ICB	0.01 ug/L
Nickel	ICB	-1.7 ug/L
Silver	ICB	0.01 ug/L
Iron	ICB	-4.0 ug/L
Lead	CCB	-0.005 ug/L

Detected results less than 5x the maximum blank contamination were qualified. The data was not affected by the other blank levels, since sample results were greater than 5x the maximum blank contamination, nondetected or not associated.

II. Matrix Spike (MS)

A. Due to an accuracy problem in the MS analysis, the following nondetected result was qualified as estimated (UJe).

- Silver in sample 30209GW10007.

The recovery outside of the QC limits is listed below.

Sample ID	Analyte	%R	QC Limits
K2207901-001 Sp.	Silver	74	75-125%

Spike recoveries between 30-74 % indicate that false nondetects may have been reported.

III. Matrix Duplicate (MD)

A. Due to precision problems in the matrix duplicate analysis, the following detected results are qualified as estimated (Jd).

- Calcium and sodium in samples 30209SB05004, 30209SB05005, 30209SB05006, 30209SB22001, 30209SB22002, 30209SB22003, 30209SB23001, 30209SB23002, 30209SB23003, 30209SB24001, 30209SB24002, 30209SB24003, 30209SB25001, 30209SB25002 and 30209SB25003.

The following analytes had relative percent differences (RPD) outside the QC limits.

Sample ID	Analyte	%RPD	MRL
30209SB22002 Dup.	Calcium	109	50 ug/L
	Sodium	42	100 ug/L

IV. ICP Serial Dilution

A. Due to an ICP serial dilution problem, the following detected results are qualified as estimated (Jj).

- Potassium in samples 30209SB05004, 30209SB05005, 30209SB05006, 30209SB22001, 30209SB22002, 30209SB22003, 30209SB23001, 30209SB23002, 30209SB23003, 30209SB24001, 30209SB24002, 30209SB24003, 30209SB25001, 30209SB25002 and 30209SB25003.

The percent difference between the original sample result and the serial dilution result was outside the QC limits of 10% for analyte concentrations greater than 50x the IDL as shown below.

Sample ID	Analyte	Original Concentration	50x IDL	%D
30209SB24001	Potassium	3740 ug/L	1500 ug/L	16

V. Field Duplicate

A. There were no field duplicate samples for this parameter.

VI. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Antimony, beryllium, cadmium, mercury and silver in samples 30209SB22003, 30209SB23003, 30209SB24003, 30209SB25001, 30209SB25002, 30209SB25003 and 30209SB05006.
- Beryllium, cadmium and antimony in sample 30209SB22001.
- Beryllium and silver in sample 30209SB05005.
- Antimony, beryllium, cadmium and silver in sample 30209SB22002.
- Beryllium in samples 30209SB05004, 30209SB24001 and 30209SB24002.
- Antimony, beryllium, mercury and silver in sample 30209SB23002.
- Beryllium, cadmium and mercury in sample 30209SB23001.

Results above the IDL but below the CRDL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Samples 30209SB05005 and 30209SB23003.

VII. Analyte Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture.

VIII. Graphite Furnace Atomic Absorption (GFAA) Analysis

A. There was no furnace analysis.

IX. ICP Interference Check Sample

A. The ICSAB percent recoveries were within the control limits. No spectral interferences were detected.

PCB ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Samples 30209SB05005 and 30209SB23003.

II. Compound Quantitation and Reported Detection Limits

A. There were no positive results for samples 30209SB05005 and 30209SB23003. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

III. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPHE ANALYSIS

I. Surrogate Recovery

A. Due to surrogate recovery problems, the following detected results are qualified as estimated (Ja).

- Motor oil in sample 30209SB23003.
- Diesel and motor oil in sample 30209SB23003DL.

The surrogates outside QC limits are listed below.

Sample ID	Surrogate	%R	QC Limits
30209SB23003	o-Terphenyl	222	60-140
30209SB23003DL	o-Terphenyl	192	60-140

High percent recoveries indicate that detected results may be biased high.

II. Matrix Spike / Matrix Spike Duplicate (MS/MSD)

A. Due to accuracy problems in the MS/MSD analysis, the following detected result is qualified as estimated (Je).

- Motor oil in sample 30209SB24001.

The recovery outside the QC limits is listed below.

Sample ID	Compound	%R	RPD	QC Limits
30209SB24001 Sp.	Motor Oil	430	110	50-150/50

This outlier affected only the spiked sample. Spike recoveries above the QC limit indicate that detects may be biased high for motor oil.

III. Blank Contamination

A. The following compounds were detected in the associated method blank at the concentrations noted below.

Compound	Blank ID	Concentration, ug/L
Diesel	MB 11/16/02	81
Motor Oil		61

The data was not affected by the blank levels, since sample results were nondetected.

IV. Field Duplicate

A. There were no field duplicate samples for this parameter.

V. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Motor oil in samples 30209SB24001, 30209SB25001, 30209SB25002, 30209SB25003 and 30209SB05005.

Detected results reported below the RL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

B. Diesel in sample 30209SB23003 is shown as nondetected due to a software glitch. Sample 30209SB23003 was diluted and the diluted result for diesel should be used.

Full Validation Criteria for Samples 30209SB05005, 30209SB23003 and 30209SB23003DL.

VI. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

VII. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to a problem in the semivolatile LCS analysis, one sample was qualified as estimated for 3,3'-dichlorobenzidine. Due to an internal standard problem, one sample was qualified as estimated for all compounds quantitated using phenanthrene-d10. Semivolatiles were also qualified due to blank contamination, TICs and results below the CRQL.

B. Due to a continuing calibration problem in the pesticide analysis, one sample was qualified as estimated for endrin aldehyde. Due to a confirmation problem, one sample was considered nondetected for 4,4'-DDT.

C. Due to an accuracy problem in the matrix spike for the metals' analysis, one sample was qualified as estimated for silver. Due to precision problems in the duplicate analysis, sixteen samples were qualified as estimated for calcium and sodium. Due to an ICP serial dilution problem, sixteen samples were qualified as estimated for potassium. Metals were also qualified due to blank contamination and results between the IDL and CRDL.

D. Due to surrogate recovery problems in the TPHE analysis, two samples were qualified as estimated for motor oil and one for diesel. Due to accuracy problems in the MS/MSD analysis, one sample was qualified as estimated for motor oil. TPHE samples were qualified due to results below the RL.

E. Semivolatile sample 30209SB2003 was diluted due to an internal standard area outside QC limits. The results for the diluted sample should be used, since all internal standard areas were within QC limits.

F. Diesel in sample 30209SB23003 is shown as nondetected due to a software glitch. Sample 30209SB23003 was diluted and the diluted result for diesel should be used.

G. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of made to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical Services, Inc.
Data Reviewer:	SFH/DAT
Review Date:	1/20/03

Sample Delivery Group (SDG) No.: K2207901

Sample Nos.:	30209GW07001*	30211BS04001
	30211BS01001	30211BS04002
	30211BS01002	30211BS05001*
	30211BS02001	30211BS05002
	30211BS02002	30211GW20001

* Full Validation Sample

Matrix: Water

Collection Date(s): 11/3/02 and 11/4/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) documents "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999), "USEPA Contract Laboratory National Functional Guidelines for Low Concentration Organic Data (EPA 2001), and "USEPA Contract Laboratory Program National Functional Guidelines For Inorganic Data Review" (February 1994). In addition, the TtEMI documents "Data Validation Guidelines for CLP Organic Analyses," "Data Validation Guidelines for CLP Inorganic Analyses," "Data Validation Guidelines for Non-CLP Organic Analyses," (August 2001), and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

CLP Organic Parameters

* Holding times
  GC/MS instrument performance check
* Initial and continuing calibrations
* Blanks
* Surrogate recovery
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Internal standard performance
  Target compound identification
  Tentatively identified compounds
  Compound quantitation
  Reported detection limits
  System performance
* Overall assessment of data for the SDG

CLP Inorganic Parameters

* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
  ICP interference check sample
  GFAA quality control
* ICP serial dilution
  Sample result verification
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
SVOA	✓	✓	Pg. 6	N/A	Pg. 6	Pg. 6	✓	✓	Pg. 6	Pg. 6
Pesticides	✓	✓	✓	N/A	✓	✓	Pg. 8	N/A	Pg. 8	Pg. 8
Metals	✓	N/A	Pg. 10	Pg. 10	✓	Pg. 10	✓	N/A	Pg. 10	Pg. 11
TPHE	✓	✓	✓	N/A	✓	Pg. 14	✓	N/A	Pg. 14	✓
PCBs	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 13	Pg. 13

Note: ✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30209GW07001 and 30211BS05001.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control	
SVOA	✓	✓	✓	Pg. 7	Pg. 7	✓	N/A	N/A	
Metals	N/A	N/A	✓	Pg. 11	N/A	✓	Pg. 12	Pg. 11	
Pesticides	N/A	N/A	✓	Pg. 8	N/A	✓	N/A	N/A	
TPHE	N/A	N/A	Pg. 14	✓	N/A	✓	N/A	N/A	
PCBs	N/A	N/A	✓	Pg. 13	N/A	✓	N/A	N/A	

Note: ✓indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text

DATA ASSESSMENT

CLP SEMIVOLATILE ORGANIC ANALYSIS

I. Matrix Spike / Matrix Spike Duplicate (MS/MSD)

A. There was no MS/MSD for this parameter.

II. Blank Spike or Laboratory Control Spike (LCS)

A. The result obtained in the analysis of the LCS was not within the control limits as shown below.

LCS ID	Compound	%RPD	QC Limits
LCS 11/13/02	2,4-Dimethylphenol	61	30%

The data was not affected by the high RPD, since the percent recoveries were within QC limits.

III. Blank Contamination

A. Due to common laboratory contamination, the following results are considered nondetected (UJb).

- Diethylphthalate, di-n-butylphthalate and butylbenzylphthalate in sample 30209GW07001.

Butylbenzylphthalate, diethylphthalate and di-n-butylphthalate are considered common laboratory contaminants when found at a level less than 5x the CRQL in environmental samples and not found in the associated blanks.

IV. Field Duplicate

A. There were no field duplicate samples for this parameter.

V. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Phenol, pentachlorophenol and phenanthrene in sample 30209GW07001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30209GW07001.

VI. GC/MS Tuning

A. The ion abundance criteria were met for the decafluorotriphenylphosphine (DFTPP) GC/MS performance checks. The samples were analyzed within 12 hours of the associated performance check.

VII. Target Compound List (TCL) Identification

A. The relative retention times, mass spectra, and peak identifications of the samples were evaluated. Target compound identification was considered to be correct.

VIII. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IX. Tentatively Identified Compounds (TICs)

A. There were no TICs reported.

X. System Performance

A. The samples were evaluated for reconstructed ion chromatogram (RIC) baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP PESTICIDES ORGANIC ANALYSIS

I. Calibrations

A. Due to continuing calibration problems, the following detected and nondetected results are qualified as estimated (Jc/UJc).

- Endosulfan I and gamma-BHC in sample 30209GW07001.

The following continuing calibrations has percent differences (%D) of >15%.

Calibration Date	Compound	%D
11/19/02	alpha-BHC(Col. 2)	18
	gamma-BHC(Col. 2)	18
	delta-BHC(Col. 2)	19
	Aldrin(Col. 2)	18
	Dieldrin(Col. 2)	16
	Endrin(Col. 2)	17
	Toxaphene(Col. 2)	30
	4,4'-DDE(Col. 2)	21
11/19/02	Endosulfan I (Col. 1)	-16

II. Field Duplicate

A. There were no field duplicate samples for this parameter.

III. Other Qualifications

A. The following result is qualified as estimated (Jg).

- gamma-BHC in sample 30209GW07001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection

Full Validation Criteria for Sample 30209GW07001.

IV. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

CLP METALS ANALYSIS

I. Blank Contamination

A. The following metals were detected in the associated calibration blanks at the concentrations noted below.

Analyte	Blank ID	Concentration
Antimony	ICB	0.04 ug/L
Molybdenum	ICB	0.01 ug/L
Nickel	ICB	-1.7 ug/L
Silver	ICB	0.01 ug/L
Lead	CCB	-0.0073 ug/L

The data was not affected by the blank levels, since sample results were greater than 5x the maximum blank contamination or not associated.

II. Matrix Spike (MS)

A. Due to an accuracy problem in the MS analysis, the following nondetected result was qualified as estimated (UJe).

- Silver in sample 30209GW07001.

The recovery outside of the QC limits is listed below.

Sample ID	Analyte	%R	QC Limits
30209GW07001 Sp.	Silver	74	75-125%

Spike recoveries between 30-74 % indicate that false nondetects may have been reported.

III. Matrix Duplicate (MD)

A. Due to a precision problem in the matrix duplicate analysis, the following nondetected result is qualified as estimated (UJd).

- Cadmium in sample 30209GW07001.

The following analyte had a relative percent difference (RPD) outside the QC limits.

Sample ID	Analyte	%RPD	MRL
30209GW07001 Dup.	Cadmium	200	1.00 ug/L

IV. Field Duplicate

A. There were no field duplicate samples for this parameter.

V. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Antimony, arsenic, cobalt, lead, nickel, silver and zinc in sample 30209GW07001.

Results above the IDL but below the CRDL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30209GW07001.

VI. Analyte Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The internal standards used in the ICP-MS analysis were within QC limits.

VII. Graphite Furnace Atomic Absorption (GFAA) Analysis

A. Due to analytical spike recovery problems, the following nondetected results are qualified as estimated (UJe).

- Selenium and copper in sample 30209GW07001.

The analytical spike recovery results did not meet the 85-115% recovery criteria for accuracy. The percent recovery for each analyte is presented below.

Sample	Analyte	%Recovery
30209GW07001	Selenium	79
	Copper	78.5

The analytical spike recovery results in the sample listed above show an analytical deficiency. Low analytical spike results indicate possible false nondetects.

VIII. ICP Interference Check Sample

A. The ICSAB percent recoveries were within the control limits. Due to spectral interferences, the following detected results are qualified as estimated (Jj).

- Nickel and zinc in sample 30209GW07001.

Positive and negative results greater than the IDL for analytes that should not be present were detected in the ICSA solution. Further evaluation of the sample indicates that spectral interference may exist due to high concentrations of calcium and magnesium.

PCB ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

II. Compound Identification

A. Due to identification problems, the following results were raised to the Contract Required Quantitation Limit (CRQL) and are reported as nondetected (UJg). (For pesticide results <1/2 the CRQL).

- Aroclor 1260 in samples 30211BS02002 and 30211BS05002.

The results reported were < 1/2 the CRQL. It is the opinion of the reviewer that the positive results reported by the laboratory for the compound listed above are both qualitatively and quantitatively unacceptable.

III. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Aroclor-1260 in samples 30211BS02001 and 30211BS05001.

Detected results reported below the CRQL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection

Full Validation Criteria for Samples 30209GW07001 and 30211BS05001.

IV. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPHE ANALYSIS

I. Blank Contamination

A. The following compounds were detected in the associated method blank at the concentrations noted below.

Compound	Blank ID	Concentration, ug/L

Diesel	MB 11/16/02	81
Motor Oil		61

The data was not affected by the blank levels, since sample results were nondetected.

II. Field Duplicate

A. There were no field duplicate samples for this parameter.

Full Validation Criteria for Sample 30209GW07001.

III. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30209GW07001. The reported detection limits were consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Semivolatiles were qualified due to blank contamination and results below the CRQL.

B. Due to continuing calibration problems in the pesticide analysis, one sample was qualified as estimated for endosulfan I and gamma-BHC. Pesticides were also qualified due to a result below the CRQL.

C. Due to an accuracy problem in the matrix spike for the metals' analysis, one sample was qualified as estimated for silver. Due to a precision problem in the duplicate analysis, one sample was qualified as estimated for cadmium. Due to analytical spike recovery problems, one sample was qualified as estimated for selenium and copper. Due to spectral interferences, one sample was qualified as estimated for nickel and zinc. Metals were also qualified due to results between the IDL and CRDL.

D. Due to compound identification problems in the PCB analysis, two samples are reported as nondetected for aroclor-1260. PCB samples were qualified due to results below the RL.

E. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of made to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical Services, Inc.
Data Reviewer:	SFH/DAT
Review Date:	1/17/03

Sample Delivery Group (SDG) No.: K2207982

Sample Nos.: 30211BS03001 30211BS03002*

* Full Validation Sample

Matrix: Soil

Collection Date(s): 11/4/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) document "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999). In addition, the TtEMI document "Data Validation Guidelines for Non-CLP Organic Analyses," (August 2001), and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
PCBs	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 6	Pg. 6

Note: ✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30211BS03002.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control	
PCBs	N/A	N/A	✓	Pg. 6	N/A	✓	N/A	N/A	

Note: ✓indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

DATA ASSESSMENT

PCB ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

II. Other Qualifications

A. The following result is qualified as estimated (Jg).

- Aroclor-1260 in sample 30211BS03002.

Detected results reported below the RL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30211BS03002.

III. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

IV. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. A PCB sample was qualified due to a result below the RL.

B. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of made to the data indicate high usability.

Tetra Tech EM Inc.
DATA VALIDATION REPORT

Site:	Treasure Island
Contract Task Order (CTO) No.:	G0069-302B0302
Laboratory:	Columbia Analytical Services, Inc.
Data Reviewer:	SFH/DAT
Review Date:	1/21/03

Sample Delivery Group (SDG) No.: K2208475

Sample Nos.:	30211BS01003	30211BS03004*
	30211BS01004	30211BS03005
	30211BS02003	30211GW20009
	30211BS03003	

* Full Validation Sample

Matrix: Soil, water

Collection Date(s): 11/19/02 and 11/20/02

The data were qualified according to the U.S. Environmental Protection Agency (EPA) document "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review" (October 1999). In addition, the TtEMI document "Data Validation Guidelines for Non-CLP Organic Analyses," (August 2001), and the document entitled "TtEMI Comprehensive Long-term Environmental Action Navy II Analytical Services Statement of Work" (May 2000) were used along with other specified criteria in EPA methods. Data validation requirements are presented below.

I certify that all data validation criteria outlined in the above referenced documents were assessed, and any qualifications made to the data were in accordance with those documents.

Certified by

DATA VALIDATION REQUIREMENTS

Full validation includes all parameters listed below. An asterisk (*) indicates cursory validation parameters.

Non-CLP Organic Parameters

* Method compliance
* Holding times
* Initial and continuing calibrations
* Blanks
* Matrix spike/matrix spike duplicate
* Laboratory control sample or blank spike
* Field duplicates
* Matrix duplicates
* Surrogate recovery
  Analyte quantitation
  Reported detection limits
* Overall assessment of data for the SDG

DATA VALIDATION QUALIFIERS AND CODES

Data Validation Qualifiers

UJ Estimated nondetected result

J Estimated detected result

R Rejected result

NJ Tentatively Identified Compound (TIC)

Data Validation Qualifier Codes

a Surrogate recovery exceedance

b Laboratory method blank and common blank contamination

c Calibration exceedance

d Duplicate precision exceedance

e Matrix spike/laboratory control sample (LCS) recovery exceedance

f Field blank contamination

g Quantification below reporting limit

h Holding time exceedance

i Internal standard exceedance

j Other qualifications

TABLE 1
CURSORY DATA VALIDATION SUMMARY

Analysis	Holding Times	Surrogates	MS/MSD	Matrix Duplicates	LCS	Blanks	Calibrations	Internal Standards	Field Duplicates	Other
PCBs	✓	✓	✓	N/A	✓	✓	✓	N/A	Pg. 6	Pg. 6
TPHE	✓	✓	✓	N/A	✓	Pg. 7	✓	N/A	Pg. 7	Pg. 7

Note: ✓ indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

TABLE 2
FULL DATA VALIDATION SUMMARY
Sample(s) 30211BS03004.

Analysis	GC/MS Tuning	Target Compound List Identification	Compound or Analyte Quantification	Reported Detection Limits	Tentatively Identified Compounds	System Performance	Interference Check Sample	Graphite Furnace Quality Control	
PCBs	N/A	N/A	Pg. 6	Pg. 6	N/A	✓	N/A	N/A	
TPHE	N/A	N/A	✓	Pg. 8	N/A	✓	N/A	N/A	

Note: ✓indicates that all quality control criteria were met for the parameter as specified in the prescribed methods and data validation guidelines.
N/A indicates the parameter is not applicable to an analysis. If criteria were not met and the data were qualified, a page number is indicated where the qualification is detailed. The data were evaluated for all validation criteria and were found to be in control except where noted. Any outliers are described in the text.

DATA ASSESSMENT

PCB ANALYSIS

I. Field Duplicate

A. There were no field duplicate samples for this parameter.

II. Compound Identification

A. Due to confirmation problems, the following results are considered nondetected (UJj).

- Aroclor-1254 in samples 30211BS02003 and 30211BS03005.

The results reported were detected below the CRQL and a percent difference (%D) greater than 50% was noted in the analyte concentration between the quantitation column and the confirmation column. Further review of the data determined that the result reported was a false positive. The %Ds are listed below.

Sample ID	Compound	%D
30211BS02003	Aroclor-1254	80
30211BS03005	Aroclor-1254	56

III. Other Qualifications

A. The following result is qualified as estimated (Jg).

- Aroclor-1254 in sample 30211BS03004.

Detected results reported below the RL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30211BS03004.

IV. Compound Quantitation and Reported Detection Limits

A. There were no positive results for sample 30211BS03004. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

TPHE ANALYSIS

I. Blank Contamination

A. Due to method blank contamination, the following result is considered nondetected (UJb).

- Motor oil in sample 30211BS02003.

The following compound was detected in the associated method blank at the concentration noted below.

Compound	Blank ID	Concentration, mg/kg
Motor Oil	MB 12/5/02	4.8

Detected results less than 5x the maximum blank contamination were qualified.

B. Due to equipment rinsate blank contamination, the following result is considered nondetected (UJf).

- Motor oil in sample 30211BS03005.

The following compound was detected in the associated equipment rinsate blank at the concentration noted below.

Compound	Blank ID	Concentration, ug/L
Motor Oil	30211GW20009(ER)	39

Detected results less than 5x the maximum blank contamination were qualified.

II. Field Duplicate

A. There were no field duplicate samples for this parameter.

III. Other Qualifications

A. The following results are qualified as estimated (Jg).

- Motor oil in sample 30211GW20009.
- Diesel in sample 30211BS02003.

Detected results reported below the RL are considered to be qualitatively acceptable, but quantitatively unreliable due to the uncertainty in analytical precision near the limit of detection.

Full Validation Criteria for Sample 30211BS03004.

IV. Compound Quantitation and Reported Detection Limits

A. Sample results were recalculated, with the proper dilution factors, weights, volumes, and percent moisture used to calculate the sample results. The samples were correctly quantitated. The reported detection limits were not consistent with the contract required report limits and reflect any dilutions, weights, volumes, and percent moisture. The MRLs should be used instead of the MDLs to qualify the sample results.

V. System Performance

A. The samples were evaluated for baseline shifts, extraneous peaks, loss of resolution, and peak tailing. No system degradation was noted.

OVERALL ASSESSMENT OF DATA

I. Method Compliance and Additional Comments

A. All analyses were conducted within all specifications of the requested methods.

II. Usability

A. Due to confirmation problems in the PCB analysis, aroclor-1254 was reported as nondetected for two samples. A PCB sample was also qualified due to a result below the RL.

B. TPHE samples were qualified due to blank contamination and results below the RL.

C. The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Estimated sample results (J) are usable only for limited purposes. Based upon the cursory and full data validation all other results are considered valid and usable for all purposes. In general, the absence of rejected data and the small number of made to the data indicate high usability.

APPENDIX F
ESTIMATION OF BACKGROUND AND AMBIENT METALS CONCENTRATIONS IN SOILS

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN I)
Northern and Central California, Nevada, and Utah
Number N62474-88-D-5086
Contract Task Order 0199

Prepared For

DEPARTMENT OF THE NAVY
Ernesto Galang, Remedial Project Manager
Engineering Field Activity West
Naval Facilities Engineering Command
San Bruno, California

TECHNICAL MEMORANDUM
ESTIMATION OF BACKGROUND AND AMBIENT METAL CONCENTRATIONS IN SOILS

NAVAL STATION TREASURE ISLAND
SAN FRANCISCO, CALIFORNIA

June 19, 1996

Prepared By

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1.0 INTRODUCTION

PRC Environmental Management, Inc. (PRC) received Contract Task Order (CTO) No. 0199 from the U.S. Department of the Navy, Engineering Field Activity West (EFA West) under Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62474-88-D-5086 to perform a remedial investigation/feasibility study (RI/FS) at Naval Station Treasure Island (NAVSTA TI), in San Francisco, California. As part of the remedial investigation, PRC was tasked to establish ambient levels of metals in soil at NAVSTA TI.

In March 1994, PRC prepared a draft proposed approach for establishing ambient levels in soils at NAVSTA TI (PRC 1994a). Using that document as a basis for discussion, the Navy, the U.S. Environmental Protection Agency (EPA), the California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC), and the Regional Water Quality Control Board (RWQCB) met to refine the approach. In August 1994, PRC prepared a draft revised proposed approach to establish background and ambient levels in soils to address the comments and concerns voiced at those meetings (PRC 1994b).

During the November 6, 1995 meeting, EPA and DTSC recommended that background and ambient metal concentrations at NAVSTA TI be evaluated using the estimation procedures that were recently applied at other Navy installations. The objective of this technical memorandum is to present estimated background and ambient levels of metals in soils at NAVSTA TI obtained by incorporating current regulatory comments and procedures of estimation recommended by DTSC.

1.1 PURPOSE

Establishing background conditions is a component of the remedial investigation (RI). The purpose of establishing background or ambient concentrations is to have a basis to assess whether the detection of a chemical constituent indicates site-related contamination or may be attributed to naturally occurring or non-site-related anthropogenic (that is, man-made) sources. The distinction between site-related and non-site-related levels of constituents is necessary because the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and California State Water Resources Control Board

(SWRCB) Resolution No. 92-49 (4) prohibits remedial action of constituents below background and ambient levels (CERCLA 1986; SWRCB 1992).

To distinguish the terms "background" and "ambient," the following definitions apply. For simplicity, the concentrations of inorganic chemicals that are present in soil as part of the undisturbed natural conditions of the area will be referred to as "background." The concentrations of inorganic chemicals that are present in soil altered by human activities, as is the case with land made of artificial fill, will be referred to as "ambient." Both terms relate to concentrations of inorganics that are non-site-related.

1.2 APPROACH

NAVSTA TI comprises two connected islands in San Francisco Bay: Treasure Island (TI) and Yerba Buena Island (YBI). NAVSTA TI in this document refers to all of TI and most of YBI with the exception of the U.S. Coast Guard. When only one of the islands is specifically discussed (that is, TI or YBI) the associated text applies only to that island and not to the entire naval station.

Based on two previous reports (PRC 1994a; 1994b), the Navy and regulatory agencies agreed to evaluate non-site-related inorganics at YBI and TI differently. Four sites at YBI are located on naturally occurring soils; therefore, a background sampling plan was prepared and background samples were collected and analyzed to determine the background levels of inorganic constituents in these naturally occurring soils. Unlike the four YBI sites, the sites on TI and Site 11 on YBI are located on artificial fill (Figure 1 and 2). Thus, at artificial fill sites the estimation of ambient concentrations entails use of site-specific soil metals data collected for the RI.

To highlight the difference between metal concentrations in soils at each island, the term "background" is used specifically for naturally occurring soils at YBI and "ambient" for artificial fill at TI and Site 11 on YBI. The estimated background concentration levels at YBI and ambient concentration levels at TI and Site 11 on YBI will be used in the baseline human health risk assessment, ecological risk assessment, and remedial investigation of the NAVSTA TI Installation Restoration Program sites.

1.3 REPORT ORGANIZATION

This report is organized into the following sections. Section 2.0 discusses Yerba Buena Island geology and the rationale used in determining the location and number of background samples. Section 3.0 describes the San Francisco Bay sediments used as fill in building all of TI. In addition, Section 3.0 discusses Treasure Island geology and provides an overview of pollutant sources for Bay sediments. Section 4.0 explains the statistical procedures that were used to estimate background or ambient concentration levels metals in soil. The results of the estimation are summarized in Section 5.0 and Tables 1 and 2. The attachment contains an overview of the statistical tests and formulae used.

2.0 DETERMINATION OF BACKGROUND IN NATURALLY OCCURRING SOILS AT YERBA BUENA ISLAND

This section describes the process of defining background conditions at YBI. It summarizes the YBI geology and criteria used to determine the location and number of background samples collected on YBI. Site 8 (Army Point Sludge Disposal Area), Site 16 (Clipper Cove Tank Farm), and Sites 28 and 29 (West Side and East Side On- and Off-Ramps) were included in this background evaluation because of the location on naturally occurring soils (Figures 1 through 3). Although on YBI, Site 11 is located on fill and is therefore included in Section 3.0 in the discussion of the TI sites. The description of procedures used in estimating background levels of metals in soils at YBI is provided in Section 4.0.

2.1 YERBA BUENA ISLAND GEOLOGY

YBI is a natural island of about 147 acres, consisting of four geologic units (listed from youngest to oldest): landslide debris, artificial fill, colluvium/eolian sands, and the Franciscan Assemblage (Figures 2 and 3). The youngest geologic unit at YBI is landslide debris resulting from the downslope movement of unstable clayey, silty sand. Small landslide areas can be found at various locations on YBI; the largest area is found on the northern side. Artificial fill is along the eastern shoreline of YBI and is discussed in greater detail in Section 3.0.

Colluvium/eolian sands are unconsolidated native deposits on Yerba Buena Island. These deposits consist of fine- to medium-grained sand with minor amounts of sandy silt, clay, and gravel interbeds. Exposed over approximately 70 percent of the island, the sands vary in thickness from a few inches to 50 feet. The sands have been identified as several different units, including the Colma Formation (Blake and others 1974), colluvium derived from the Franciscan Assemblage (Radbruch 1957), and colluvium/dense eolian sands (Dames and Moore 1949; unpublished CalTrans boring logs).

Interbedded sandstone and shale of the Franciscan Assemblage form the bedrock that unconformably underlies the landslide debris, artificial fill, and Colma Formation of YBI. Although the Franciscan Assemblage is a melange of several sedimentary and metamorphic rock types, it appears consistent in structure and composition at YBI. Shale and sandstone outcrops of the Franciscan Assemblage at YBI generally trend from southeast to northwest and dip northeast (Dames and Moore 1988).

Based on two maps prepared by the U.S. Geological Survey (Radbruch 1957; Blake 1974), the four sites are entirely or partially underlain by the shales and sandstones of the Franciscan Assemblage. Sites 8 and 16 are shown to be entirely on Franciscan Assemblage, and Sites 28 and 29 are partially on Franciscan Assemblage. The two maps differ in their interpretation of the non-Franciscan portions. The maps indicate that the non-Franciscan portions of Sites 28 and 29 are either Colma Formation, a marine sand (Blake 1974), or reworked colluvium from the Franciscan Assemblage shale and sandstone (Radbruch 1957). Based on site observation, Sites 8 and 16 appear not to be directly on shale or sandstone outcrops, but on soils that may justifiably be called reworked colluvium because of the inclusion of rock fragments or the proximity to rock outcrops. Sandy soils observed at Sites 28 and 29 also appeared frequently to be more of a colluvium than a pure sand because of the inclusion of rock fragments.

The geologic map review and site observations were used in identifying the background soil sampling locations, as discussed in the following section.

2.2 BACKGROUND SAMPLING

The method to determine background levels at Sites 8, 16, 28, and 29 began by identifying locations on YBI that are geologically similar to those four sites and are not affected by industrial activities including Navy operations. Next, a statistically sufficient number of background soil samples was estimated. Both

Navy and regulatory agencies as members of the Base Realignment and Closure Cleanup Team (BRAC) were involved in making final decisions on background sampling locations and the number of the soil samples to be taken.

For the purpose of defining background, Sites 08, 16, 28, and 29 (Figures 1 and 3) were assumed to be geologically similar and characterized by a mix of Franciscan-derived colluvium and small amounts of marine sands. Some mixing may have occurred due to natural landsliding or road and highway construction. Selection of background sites was based on this interpretation and on the determination that little or no industrial activities have occurred. In general, the background sites are located off Forest Road near the summit of YBI and in the field off Macalla Road. Another key characteristic of the location of these sites is that they are at a higher elevation than, or generally upwind of, the San Francisco-Oakland Bay Bridge which is considered to be a potential source of contamination at Sites 28 and 29. Figure 3 shows the background soil sampling locations.

The approach used to determine the number of samples sufficient for background evaluation is described in detail in the previously submitted revised proposed approach for establishing background and ambient levels in soils (PRC 1994b). This approach was based on EPA guidelines (EPA 1989b). The number of background samples collected was calculated using specified data quality objectives of the investigation, the shape of the distribution, and the number of soils or lithologies represented (assumed to be one, as supported by the discussion in Section 2.1). As a result of calculations, 21 samples were found sufficient to represent background on YBI.

Considering both the limited area available for background sampling (that is, areas where the colluvium occurs, where little or no industrial activities have occurred, and, in general, at higher elevations or upwind of the San Francisco-Oakland Bay Bridge) and the spatial distribution desired for statistical analysis, 21 discrete samples were collected from 21 borings at 13 background locations. One boring was performed at five of the locations, and two borings were performed at eight of the locations. Where two borings were performed at the same location, the soil borings were drilled a minimum of 10 feet apart. Of the 21 soil borings, 11 had samples collected from depths of 0.5 and 1.0 foot, and 10 had samples collected from depths of 3 to 5 feet, near the interface between the colluvium and the bedrock. For the purposes of statistical analysis, the resulting spatial distribution of background samples was considered random and the variation of metal concentrations both spatially and with depth was expected to be small.

Metals that are considered essential nutrients for human health (calcium, iron, magnesium, potassium, and sodium) were excluded from the background level estimation; the 19 remaining metals with 21 observations each were analyzed to estimate their background levels at YBI. The procedures and the results of the background estimation are summarized in Sections 4.0 and 5.0.

3.0 EVALUATION OF AMBIENT CONDITIONS IN ARTIFICIAL FILL AT TREASURE ISLAND AND YERBA BUENA ISLAND

Unlike the four YBI sites which are located on naturally occurring soils, the sites on TI and Site 11 on YBI are located on fill (Figures 1 through 3). The fill material for TI was obtained primarily from San Francisco Bay sediments. The following two sections provide a summary of the TI geology and a discussion of Bay sediments, the source of the fill used to build TI.

3.1 TREASURE ISLAND GEOLOGY

TI is a man-made island, approximately 403 acres in size, consisting primarily of sediments dredged from San Francisco Bay. TI was constructed on the Yerba Buena Shoals, a sand spit extending north and northwest of YBI. Underlying the Yerba Buena Shoals are Bay Mud sediments.

The sediments used for construction of TI consisted primarily of sand with lesser amounts of silt, clay, and gravel. Based on the depth of the Yerba Buena Shoals and the average elevation at TI of 10 feet above MSL, the fill thickness at TI ranges from 16 feet in the southwestern corner to over 28 feet in the northeastern corner. Based on over 100 soil borings drilled to a maximum depth of 10 feet below ground surface, the fill consists of layered dredge sand with frequent shell fragments and occasional clay balls. The sand is predominantly fine-grained with small localized areas of medium-to-coarse-grained sand and some gravel (Lee 1969). Soil borings performed during the Phase I RI confirm these descriptions of the fill material (PRC 1993).

Since the source of TI fill was sediments from the San Francisco Bay dredged from areas surrounding the island, the geology, sedimentation rates, and preexisting pollutant sources of Bay sediments should be considered. The following subsection provides a brief discussion of these topics.

3.2 GEOLOGY AND POLLUTANT SOURCES OF BAY SEDIMENTS

Bay sediments are primarily alluvial deposits classified as Older Bay Mud Formation, Sand Deposits, and Younger Bay Mud Formation. The Older Bay Mud Formation is composed of firm clay with varying amounts of silt, sand, and gravel. The upper portion of the Older Bay Mud is interfingered with sand layers. The Sand Deposits are generally localized units of fine sand that grade into a sandy silt and clayey-sandy clay. The Sand Deposits may or may not be covered by the Younger Bay Mud Formation. The Younger Bay Mud Formation overlies the Older Bay Mud Formation and Sand Deposits and consists of soft, plastic, silty clay, clayey silt with minor organic material and clayey fine sand (U.S. Army Corps of Engineers [COE] 1979).

Sources of the sand used for fill material for TI include both the Sand Deposits as shoals on the Bay floor and the Sand Deposits beneath a cover of the Younger Bay Mud. The Sand Deposits on the Bay floor occur in and adjacent to existing current channels throughout the Bay. The largest area of the Sand Deposits covered by the Younger Bay Mud which was used as fill is along the east side of the San Francisco Bay between Point Richmond and Bay Farm Island (Goldman 1969).

Sediment deposition in the San Francisco Bay is a dynamic system in which sediment inflow, outflow, and redistribution are dependent on numerous variables, including the accumulation process, particle size, and energy gradients. Generally, the Bay experiences cycles of both deposition and erosion, with the greatest deposition having taken place during the hydraulic mining era of the Sierra Nevada mountains. Net annual deposition of sediment in the Bay is estimated to range from 2.4 to 5.2 million cubic yards (COE 1979).

Pollutants in Bay sediments, such as trace metals, salts, and organic materials, have come from both natural and anthropogenic sources. Solid and dissolved waste materials are introduced to the Bay from municipal sewage and industrial waste outfall, storm drains and surface runoff, aerial fallout, overboard discharge from vessels, agricultural drainage, upland mining practices and erosion, and leaching from adjacent waste disposal sites. The pollutants may be the sediments themselves, or they may be dissolved

compounds that sorb to sediments before or after entry into the Bay (COE 1979). The following overview briefly identifies the major pollutant sources for Bay sediments:

Urban sewage is a primary source for halogenated organic compounds in San Francisco Bay; industrial effluent contains a broad range of synthetic organic chemicals and trace metals such as lead, mercury, and cadmium.

Storm water runoff from urban and agricultural areas adjacent to the Bay contains suspended solids, heavy metals, oil and grease, and pesticides.

Aerial fallout delivers residues from motor vehicle and aircraft exhaust (heavy metals and hydrocarbons) and particulate matter from industrial and domestic smokestacks and chimneys.

Solid waste disposal sites add contamination to the Bay from direct dumping and leaching of refuse, garbage, and sewage sludge.

Discharge from vessels (such as recreational or commercial) on the Bay can introduce various contaminants. Accidental oil spills occur during collisions between vessels and shore structures. Anti-fouling paints used on vessels contain a range of metals, including copper, mercury, zinc, lead, and chromium, which leach to the Bay.

Trace metals in Bay sediments are derived in part from parent formations transported by the Bay's extensive drainage system. Consequently, trace elements, including mercury, zinc, lead, cadmium, and copper, are naturally deposited in the Bay. Trace elements in sediments derived from parent formations are bound within the chemical structure of individual particles, attached directly to the particles, or bound within the structure of conglomerated particles. The greatest period of deposition of upland sediments in the Bay occurred during the hydraulic mining era of the Sierra Nevada mountains (COE 1979).

In summary, because the source of TI fill was sediments of different origins and since these sediments were affected to some degree by numerous pollutant sources in the Bay, concentrations of metals at TI are expected to be highly variable. Metals that are considered essential nutrients for human health (calcium, iron, magnesium, potassium, and sodium) were excluded from the ambient level estimation; the 19 remaining metals with over 200 observations each were analyzed to estimate the ambient levels in artificial fill at NAVSTA TI. The procedures and the results of the ambient estimation are summarized in Sections 4.0 and 5.0.

4.0 ESTIMATION METHODOLOGY

Statistical procedures consistent with EPA and DTSC guidance documents (EPA 1989a; DTSC 1992, 1994) and current practices in the environmental industry were used to establish background or ambient soil concentrations of metals. Accordingly, statistically based tolerance limits were used. A tolerance limit is a value for which only a small probability exists (such as 5 percent) that a portion of the population exceeds a specified limit (for example, the 95th percentile of the distribution). When defining a reasonable upper level of the background or ambient concentrations for a site, a one-sided tolerance limit is used. DTSC recommends to use the 80th percent lower confidence limit on the 95th percentile ($LCL_{80,95}$) of the distribution. The $LCL_{80,95}$ is the minimum value of the range within which one can be 80 percent confident that the true 95th percentile falls. The $LCL_{80,95}$ is encouraged for use if the data set size is below 50. For small data sets (that is, with less than 50 data points), the $LCL_{80,95}$ provides more conservative estimate than the 95th percentile. With the increase of the data set size, the relative difference between $LCL_{80,95}$ and the 95th percentile itself becomes very small; therefore, the 95th percentile may be used as an estimated upper level of the background or ambient metal concentrations.

A step-by-step approach for estimating background or ambient metal concentration levels was formulated as follows:

Step 1	Query the database of phase II RI soil analytical results for all metals except essential nutrients. Account for each nondetected result by substituting a value of one half the reported detection limit.
Step 2	Use probability plots to explore the data and exclude outliers from the metal data sets. Test the distribution of the resulting ambient data sets.
Step 3	To estimate the background or ambient levels for data sets less than 50 values use a nonparametric formula in calculating the 80 percent lower confidence limit on the 95th percentile; for data sets greater than 50 values use distribution-dependent formulae to calculate 95th percentile of the distribution.

The evaluation was performed for all the metals in the phase II RI soil data set, excluding calcium, iron, magnesium, potassium, and sodium which are essential nutrients. Only the phase II RI data were used to estimate ambient metal concentrations in artificial fill at TI because combining phase I and phase II soil analytical results was found to be inappropriate for metals with a large number of nondetects. Over 70 percent of soil analytical results for eight of nineteen metals being estimated were reported as nondetected.

Due to the differences in analytical detection limits of phase I and phase II data, the reported detection limits were higher during the phase I RI; therefore, combining the data from both phases is inappropriate because it would result in a systematic error. Additionally, phase I and phase II RI data were not combined for metals that were detected in the majority of samples because the phase II RI data set is sufficiently large to derive reliable estimates (over 200 observations for each metal) and, more importantly, because the phase II RI data provided laterally and vertically a larger and more uniform spatial coverage of TI. Because Site 11 (YBI landfill) is a potential source of metal contamination, the Site 11 data were not included in the data set for TI. For YBI, the data included the 21 background samples collected and analyzed during the phase II RI.

Thus, the data set for naturally occurring soils at YBI was small, with only 21 concentration values for each metal. The data set for artificial fill at TI contained over 200 concentration values for each metal. Different evaluation procedures were used for each data set. The following three subsections describe briefly the statistical methods that were used to estimate background or ambient concentration levels for metals in soil. A more detailed description of specific procedures and formulae is given in the attachment.

4.1 DATA SET PREPARATION

Before upper limits of the background or ambient metal concentrations could be calculated, most of the data sets required special preparation. Preparation procedures included steps to account for the nondetectable results and to perform exploratory data analysis using probability plots and histograms.

The process of estimating background or ambient metal concentrations must account for analytical results reported as nondetect. Similar to the treatment of nondetectable results in the risk assessment, a value of one-half the reported detection limit was substituted for each nondetect data point. For several metals, including antimony, beryllium, cadmium, mercury, molybdenum, selenium, silver, and thallium, nondetect results constitute a significant percentage (nearly 50 percent or more) of the data set (see Tables 1 and 2). The silver and thallium data sets for YBI entirely consist of nondetectable results (see Table 1).

For graphical analysis of soil metal data, the probability plots and histograms were prepared with Geo-EAS geostatistical software (EPA 1991). The probability plot is a graph of the ranked variable values, plotted against their cumulative percentiles. The vertical axis is scaled in units of the variable (metal

concentrations), and the horizontal axis is scaled in units of cumulative percent. If the normal probability plot is a straight line, it is evidence of underlying normal distribution. A straight line on a lognormal probability plot (for which the vertical axis is scaled in units of the logarithm of the metal concentrations) suggests that the lognormal distribution is a better model. The histogram provides a more detailed look at a data set, while presenting an overall shape of the data set distribution (that is, whether it is symmetrical or skewed and unimodal or polymodal). Figure 4 is an example of probability plots and histograms.

To evaluate whether it was necessary to transform a specific data set to logarithms in order to approximate a normal distribution or to aid in visualizing the data, summary statistics, including the mean, standard deviation, coefficient of variation, skewness, and kurtosis were calculated. In particular, the values of skewness and kurtosis were useful indicators of the need for data set transformation. The skewness coefficient sums the deviations from the mean raised to the third power and indicates the asymmetry of the data set distribution. A normal distribution has a skewness coefficient of 0. The kurtosis coefficient sums the deviations from the mean raised to the fourth power and indicates the peakedness of the data set distribution. A normal distribution has a kurtosis coefficient of 3.

Two types of data distributions were observed after completion of the data transformations described above: (1) a normal distribution that appeared as a bell-shaped histogram or a straight line on a probability plot and (2) a bimodal (or polymodal) distribution that appeared as two (or multiple) bells on a histogram plot or a line that changes slope on a probability plot. Bimodal distributions were observed for many metals with a significant percentage of nondetectable results. For example, arsenic concentrations in artificial fill have a bimodal distribution (see Figure 4); the lower mode is due to the presence of nondetects. When the histogram of metal concentrations showed multiple bells (on the probability plot that corresponded to the slope changes of the line), the multiple bells were generally attributed to the variation in lithology of the subsurface materials.

The preparation procedures for each metal concentrations data set were completed after excluding anomalously high or low values and testing the distribution as described in Section 4.2.

4.2 EXCLUSION OF OUTLIERS AND NORMALITY TESTING

In performing frequency distribution analysis, a few metal concentration data points may be found at concentrations significantly greater or lower than the main population. These outliers can be initially identified on histograms and probability plots but are defined more rigorously as concentrations greater than three times the standard deviation from the mean (for normally or lognormally distributed data). The outliers were removed from the data sets in order to reduce their impact on the estimates of background or ambient levels. It should be noted that because the data points considered as anomalously high concentrations may also represent extreme values of actual ambient concentrations, their exclusion may lead to conservative (that is, low) estimates of ambient levels. The simultaneous exclusion of anomalously low or nondetect values from the data sets may partially compensate for this bias. Figure 4 illustrates the procedure used to exclude outliers. Tables 1 and 2 provide information on the number of the data points excluded from each metal data set.

After exclusion of outliers from the background or ambient data sets, a probability plot was prepared for each metal of interest to confirm the effectiveness of the preparation procedures and to proceed with rigorous testing of the data set distribution. This testing was important for data sets with more than 50 values (that is, all of the artificial fill data sets) in order to determine the applicable formula for calculating the 95th percentile.

As described in detail in the attachment, the assumption of normality was tested using Wilk's *W*-test for data sets with 50 or fewer values and with D'Agostino's *D*-test for data sets with more than 50 values (Gilbert 1987). Normality testing was conducted using an automated algorithm developed by PRC in the FOXPRO database environment. If results of this testing for both original and logarithmically transformed data were negative, nonparametric techniques were applied to estimate the background or ambient levels; if the data were found to be normally or lognormally distributed, parametric techniques were applied. However, in the case of data sets with less than 50 values (that is, background data set from naturally occurring soils on YBI, except for antimony), nonparametric techniques were used. For those data sets, statistical tables that would provide factors necessary to calculate confidence limits parametrically were not available; results were not expected to be significantly different with either method.

4.3 CALCULATION OF BACKGROUND AND AMBIENT METAL CONCENTRATION LEVELS

At YBI, all metal data sets from naturally occurring soils were small, with the exception of antimony, so the upper levels of background concentrations were estimated using a nonparametric formula to calculate the $LCL_{80,95}$. The procedure to determine the datum that corresponds to the calculated $LCL_{80,95}$ is designed for data sets with greater than 20 data points (Gilbert 1987). This condition was satisfied for all the YBI metal data sets except for lead and zinc (Table 1). For simplicity, the estimation procedure used for these two metals was the same as for others. It was expected this would have no significant effect on the resulting estimates.

As a result of quality assurance/quality control data validation of the background sampling data from YBI, all analytical results for antimony were rejected; therefore, site-specific antimony data, excluding Site 11 data, was used for background estimation. Based on results of the distribution testing, a background concentration level for antimony was calculated as the 95th percentile of the distribution using the nonparametric formula.

At TI, the metal data sets from artificial fill were large and required the exclusion of outliers for most of metals (Table 2). The ambient levels were estimated using distribution-dependent formulae to find the strict 95th percentile. These formulae are presented in the attachment.

5.0 SUMMARY OF FINDINGS

The background concentration levels in naturally occurring soils at YBI and ambient concentration levels in artificial fill at NAVSTA TI estimated for metals in soils as described in Section 4.0 are presented in Tables 1 and 2. The tables include EPA Region IX PRGs for comparison purposes. The estimated levels for arsenic and beryllium exceeded this criterion, as indicated in the tables by an asterisk.

Probability plots that support the estimations are shown on Figures 5 through 40. The plots include only the data points that remained in the data set after the exclusion of outliers; the number of data points used corresponds to the data set size column shown in Tables 1 and 2. The plots also provide summary statistics including the mean, standard deviation, coefficient of variation, skewness, and kurtosis. The population of nondetectable results is indicated on the plots as ND where significant. The type of underlying data set distribution (normal, lognormal, and nonparametric) is also noted. For some data sets with nonparametric distribution, the plots are given in logarithmic scale to facilitate their examination.

FIGURES

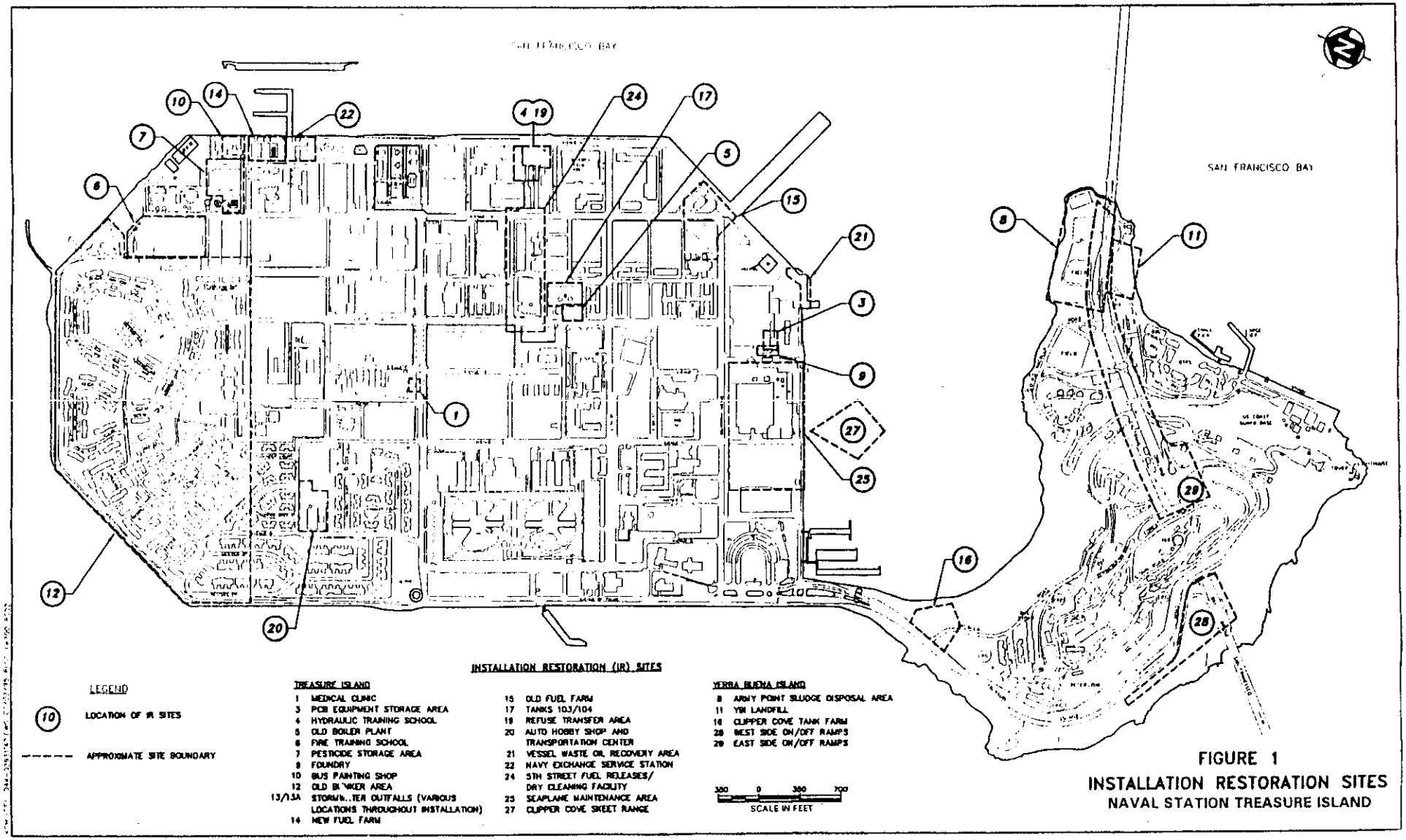
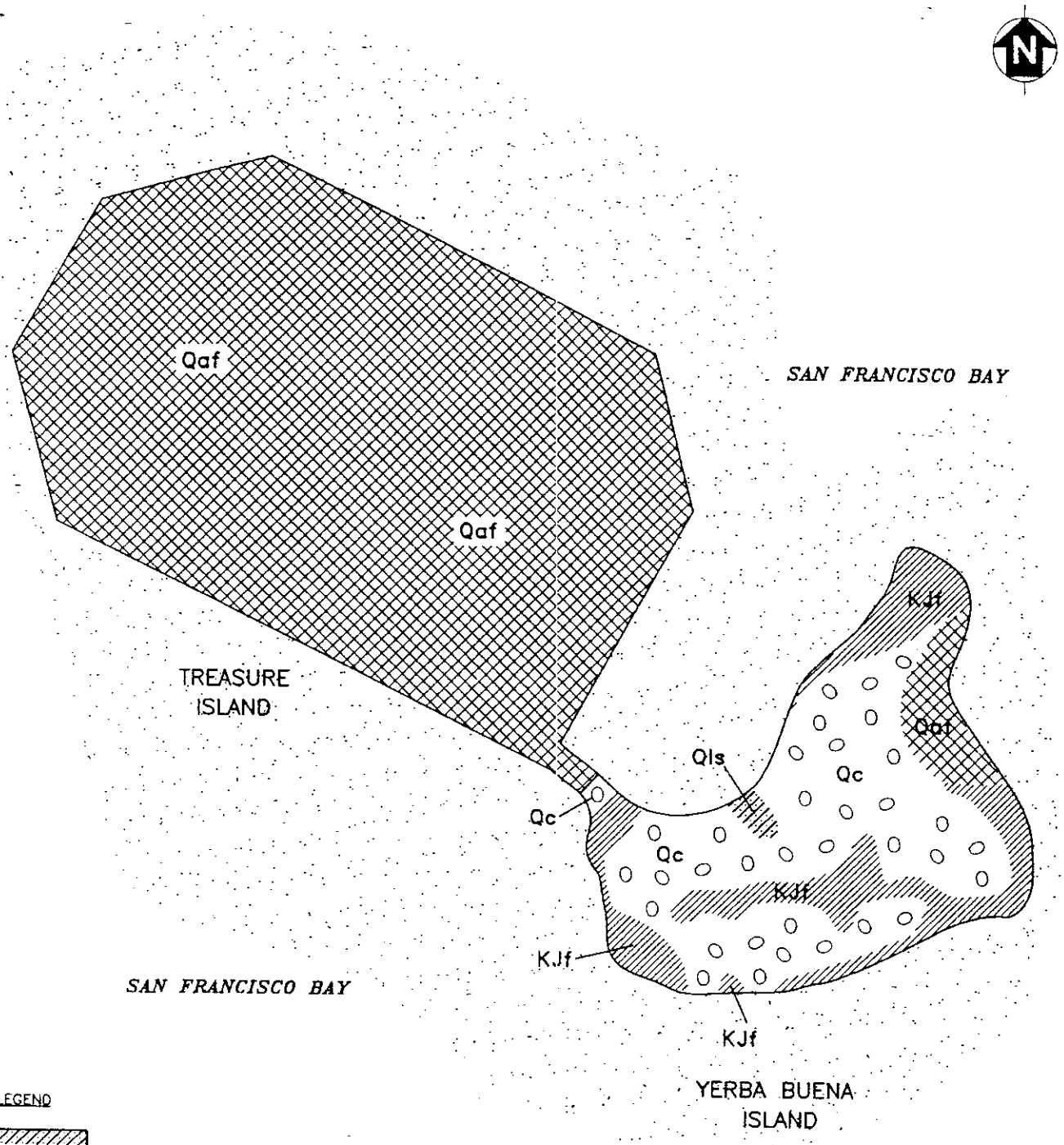


FIGURE 1
INSTALLATION RESTORATION SITES
NAVAL STATION TREASURE ISLAND



LEGEND

- Qls — LANDSLIDE DEBRIS
- Qaf — ARTIFICIAL FILL (SAND, CLAY, OR MISCELLANEOUS REFUSE)
- Qc — COLLUVIUM/EOLIAN SANDS (SAND WITH MINOR SANDY SILT, CLAY, AND GRAVEL INTERBEDS)
- KJf — FRANCISCAN ASSEMBLAGE (SANDSTONE AND SHALE)

COMPILED FROM:
DAMES AND MOORE (1988)
BLAKE AND OTHERS (1974)
RADBRUCH (1957)

1/8 0 1/8 1/4
SCALE IN MILES

KCH(SF):(044-0199)RI-GEO.DWG - 05\17\96:R005

FIGURE 2
GEOLOGIC MAP
NAVAL STATION TREASURE ISLAND

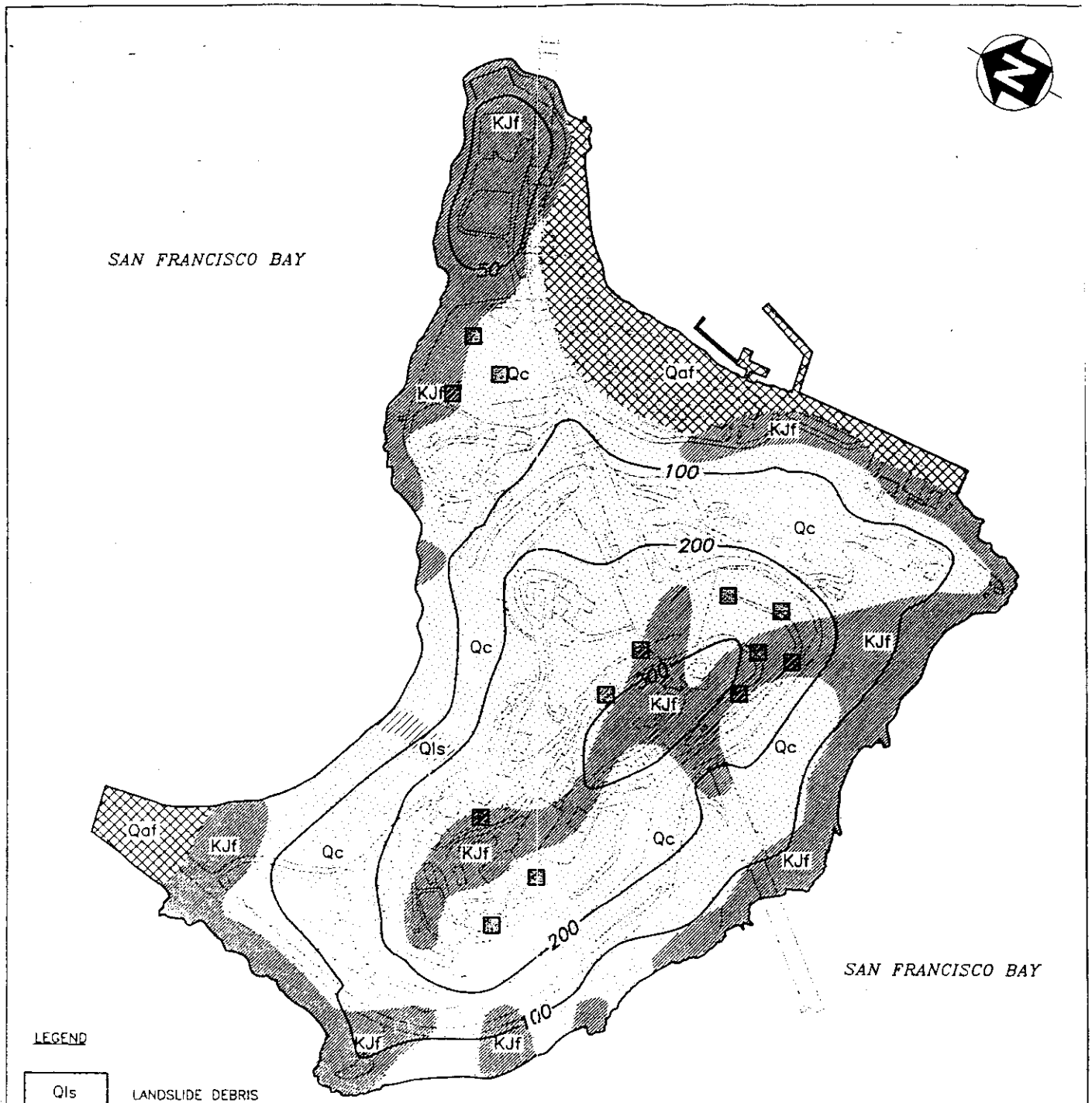
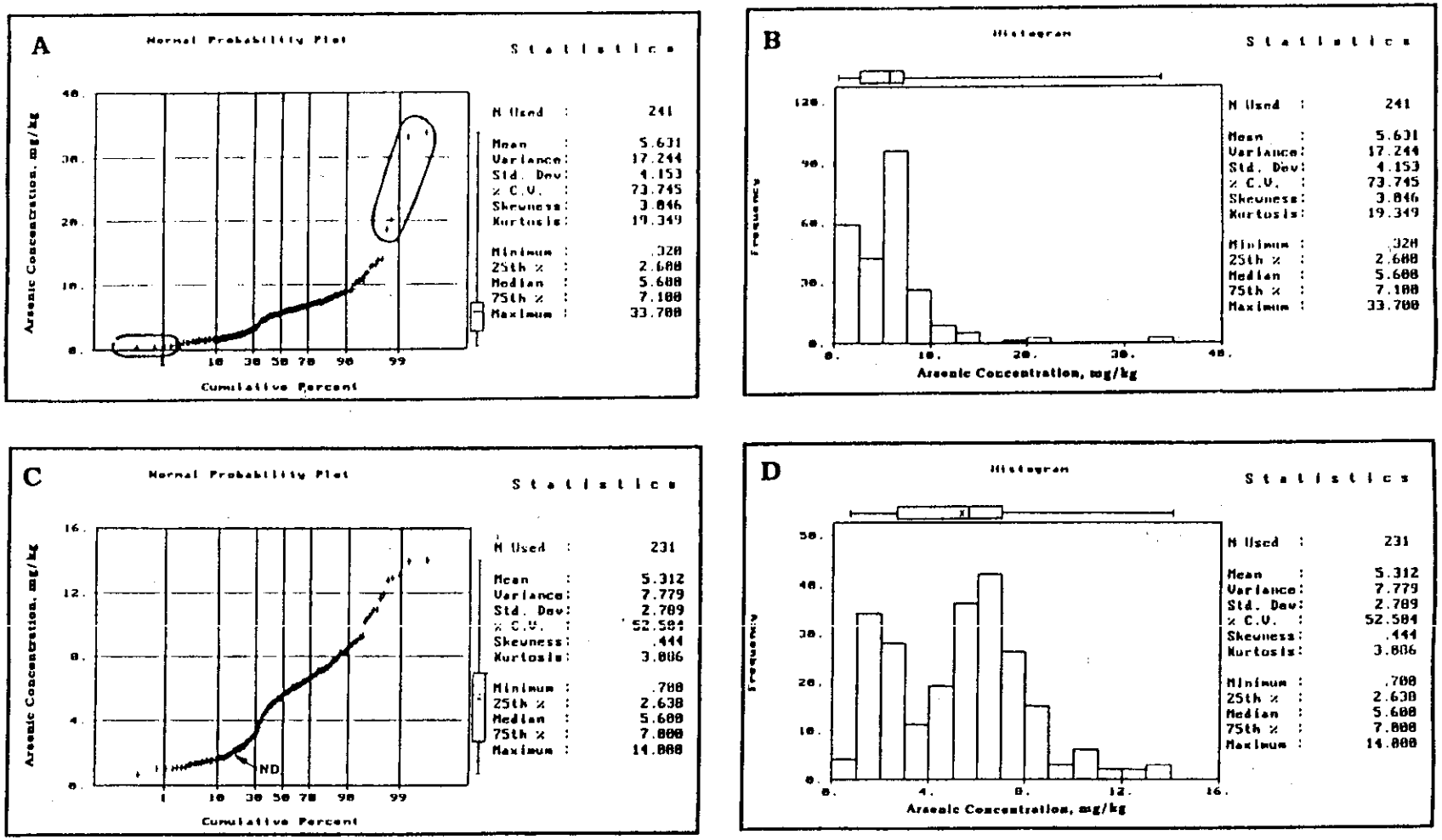
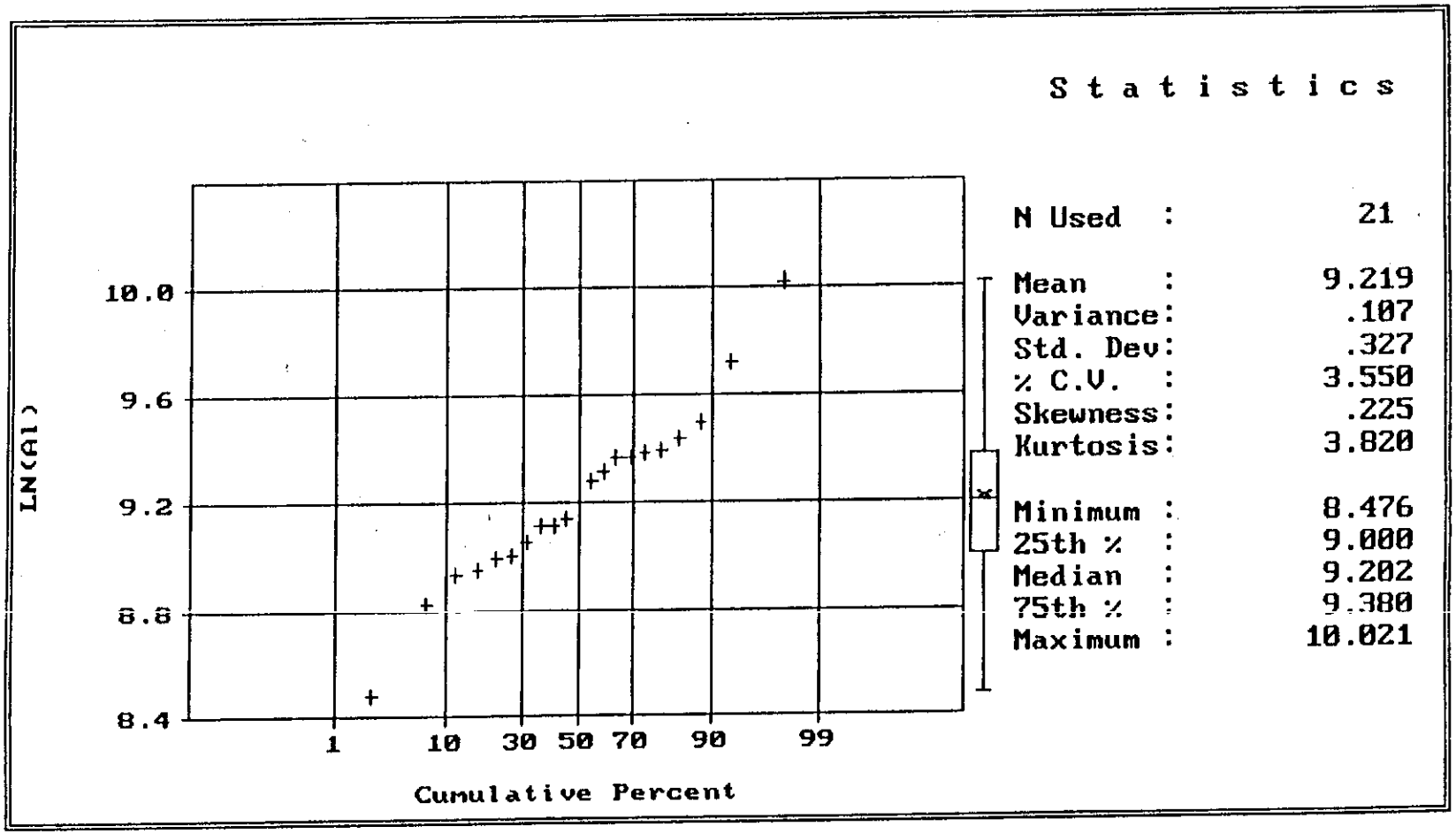


FIGURE 3
BACKGROUND SAMPLING LOCATIONS
YERBA BUENA ISLAND



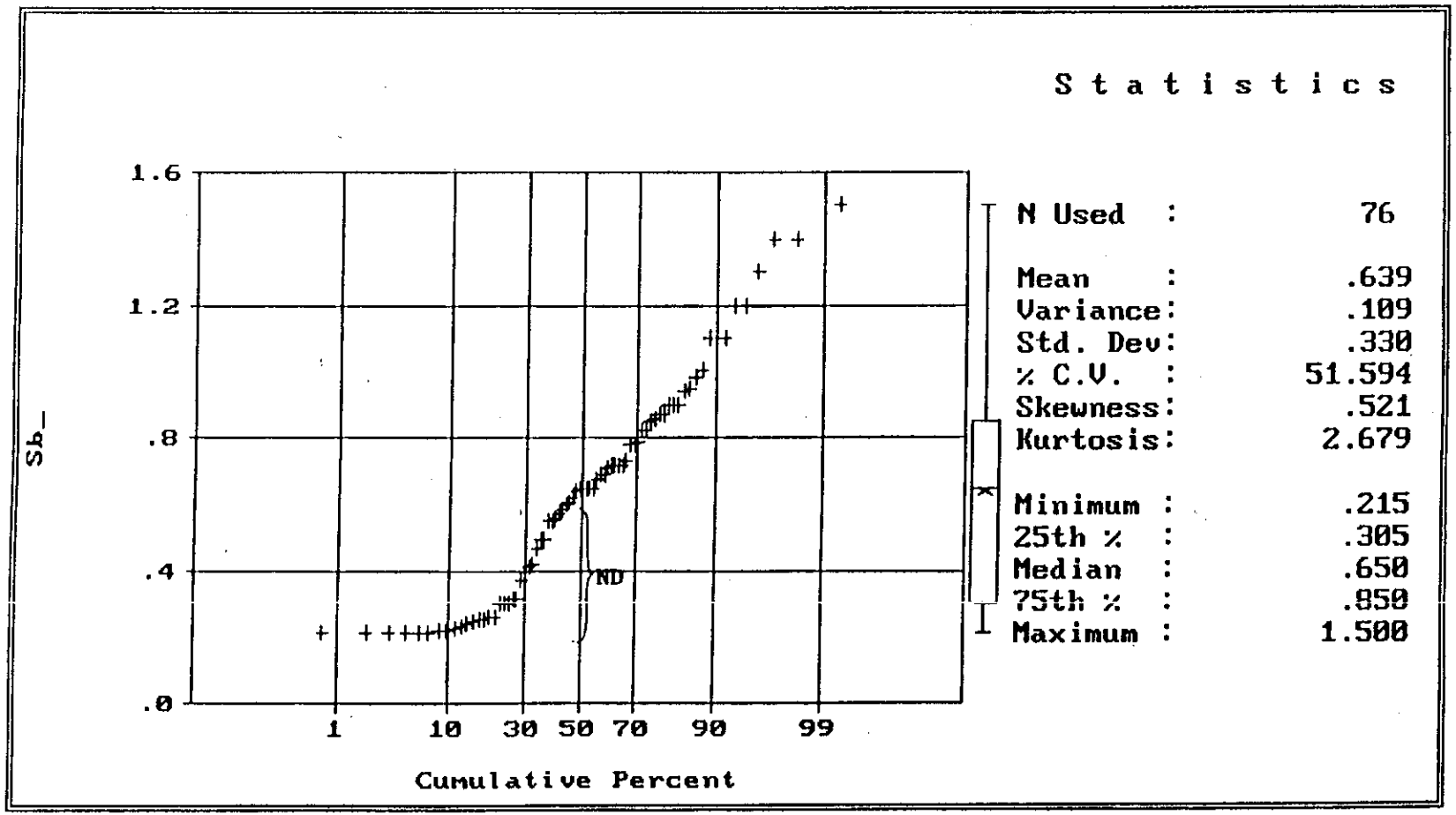
Notes: Plots A and B illustrate respectively an initial probability plot and a histogram used to identify anomalously high and low concentrations (shown as circled points on plot A). Plots C and D illustrate the resulting data set after exclusion of outliers. Approximately 14 percent of values in the resulting data set represent nondetectable results (ND); these nondetectable results correspond to a separate bell in the histogram (plot D).

FIGURE 4
EXAMPLE OF THE AMBIENT DATA SET
PREPARATION THROUGH EXCLUSION OF OUTLIERS
NAVAL STATION TREASURE ISLAND



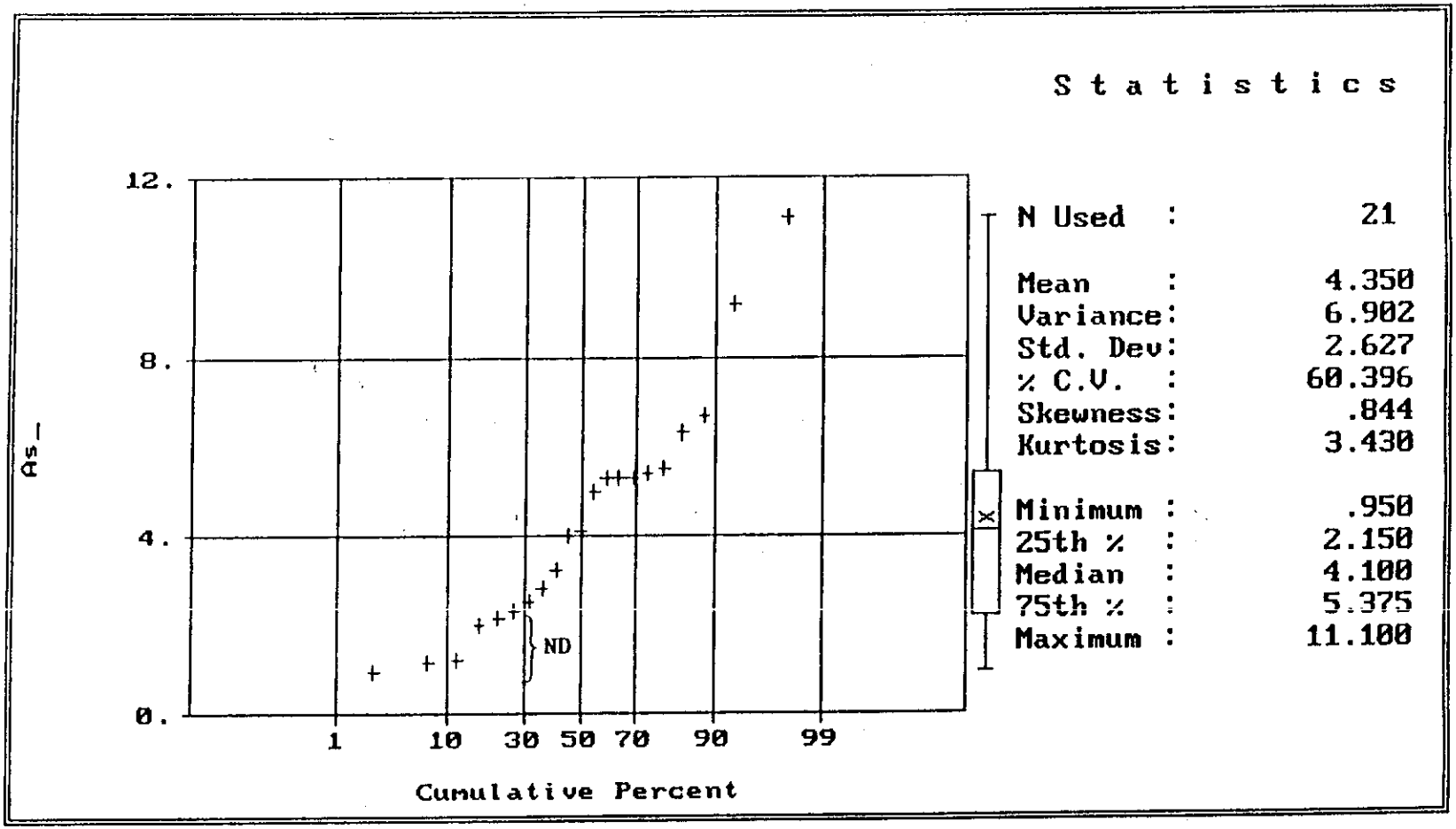
Note: The data set distribution is lognormal.

FIGURE 5
PROBABILITY PLOT OF BACKGROUND ALUMINUM
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



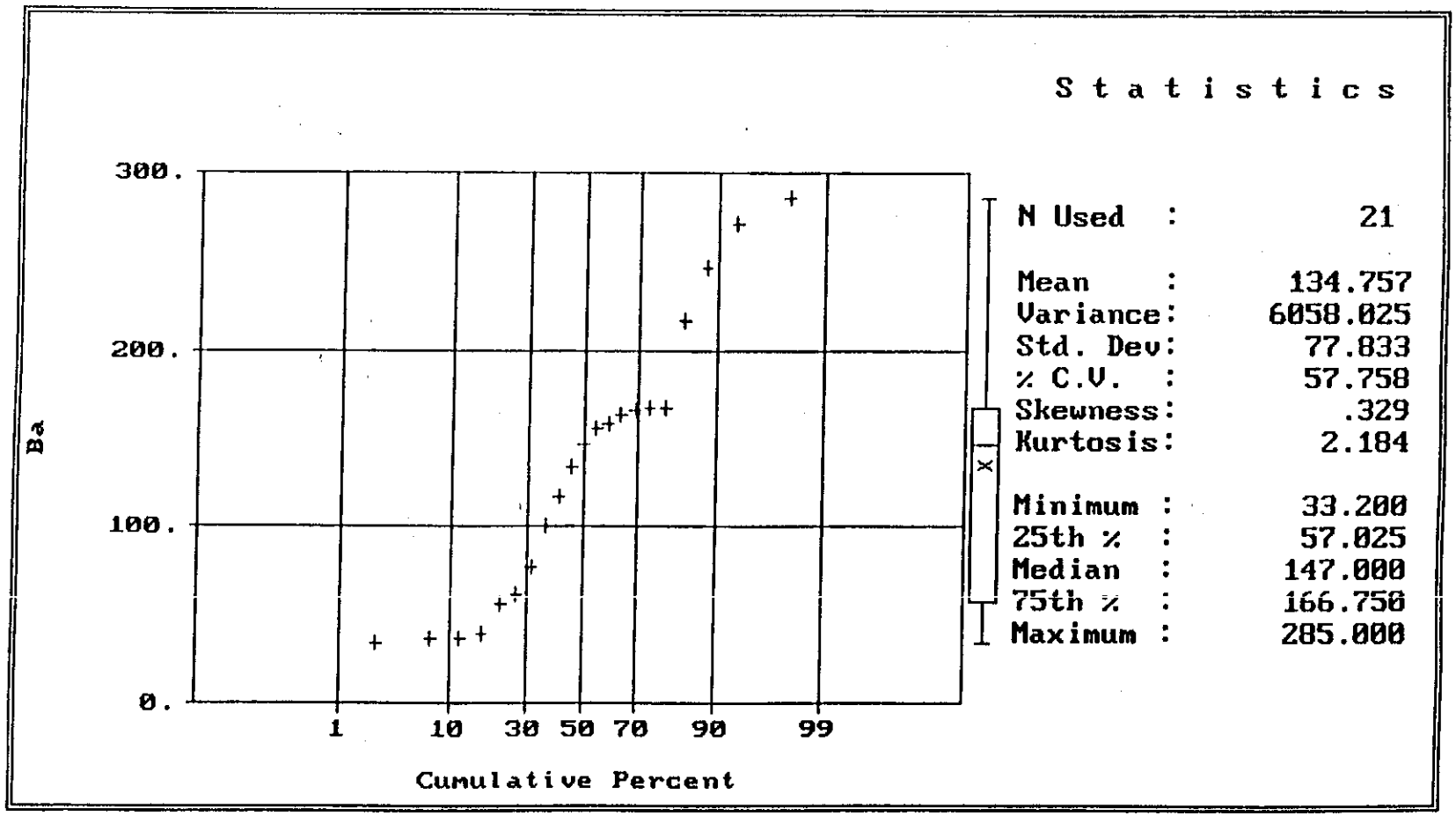
Note: The data set distribution is nonparametric.

FIGURE 6
PROBABILITY PLOT OF BACKGROUND ANTIMONY
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



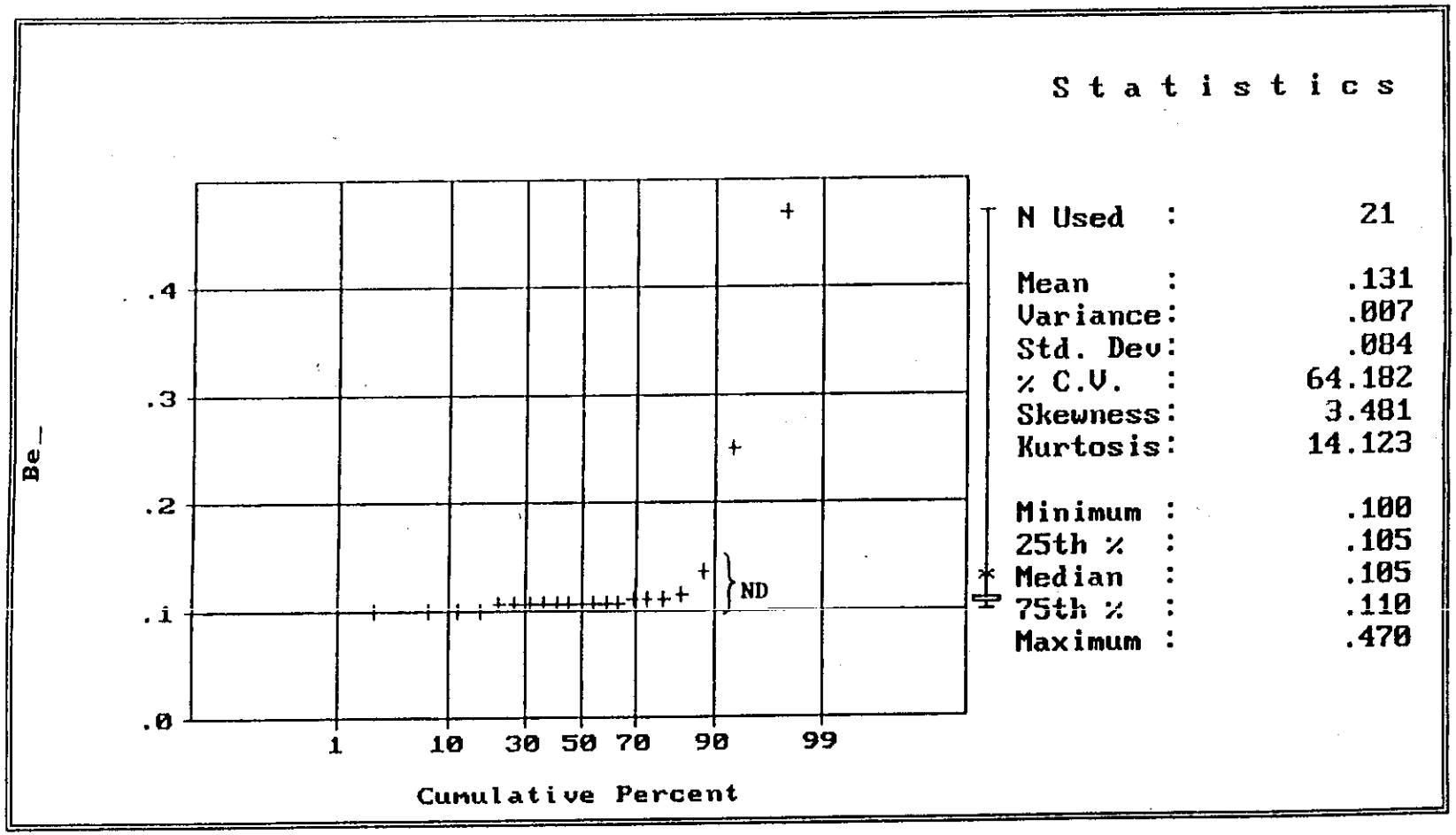
Note: The data set distribution is nonparametric.

FIGURE 7
PROBABILITY PLOT OF BACKGROUND ARSENIC
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



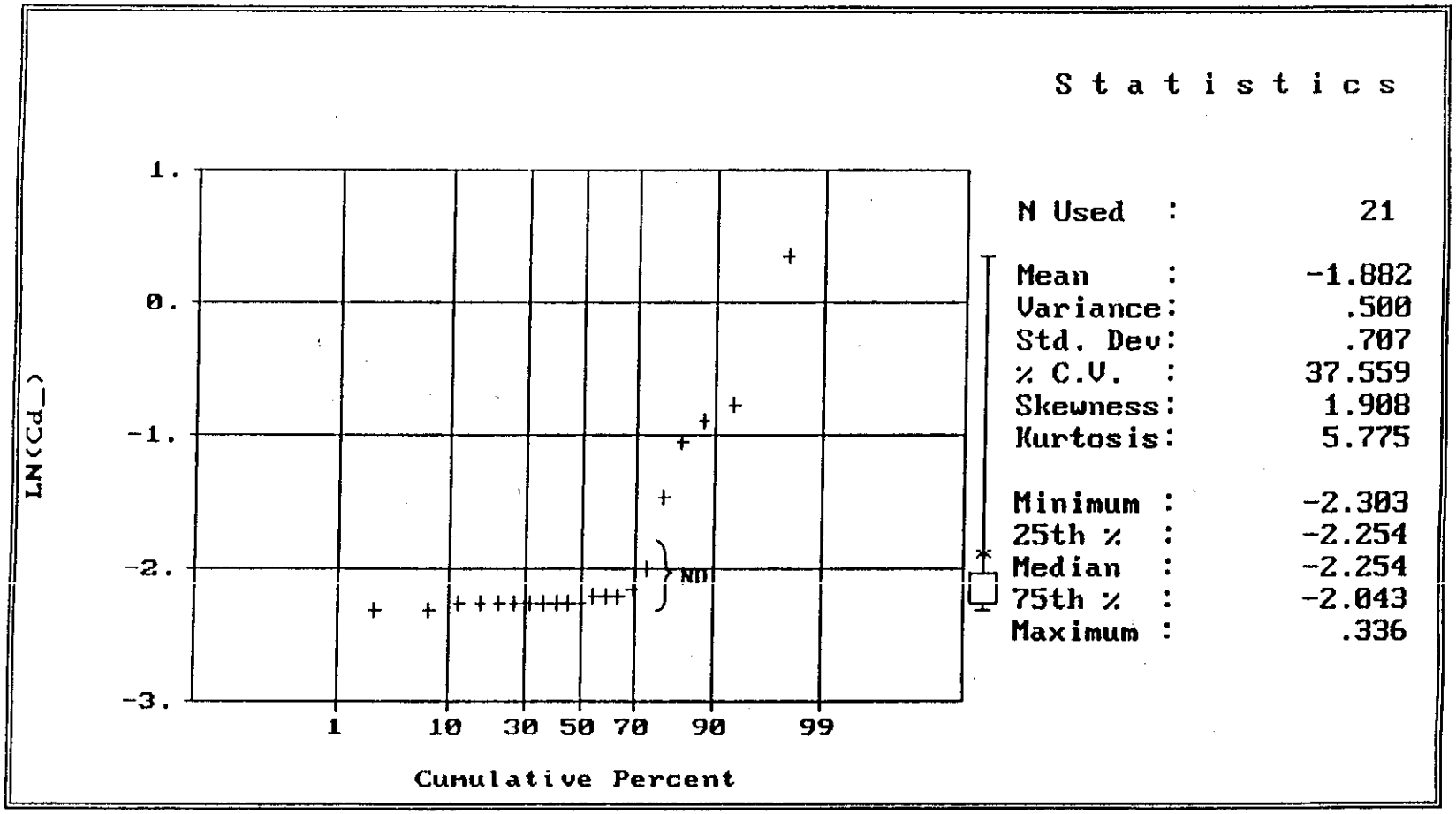
Note: The data set distribution is nonparametric.

FIGURE 8
PROBABILITY PLOT OF BACKGROUND BARIUM
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



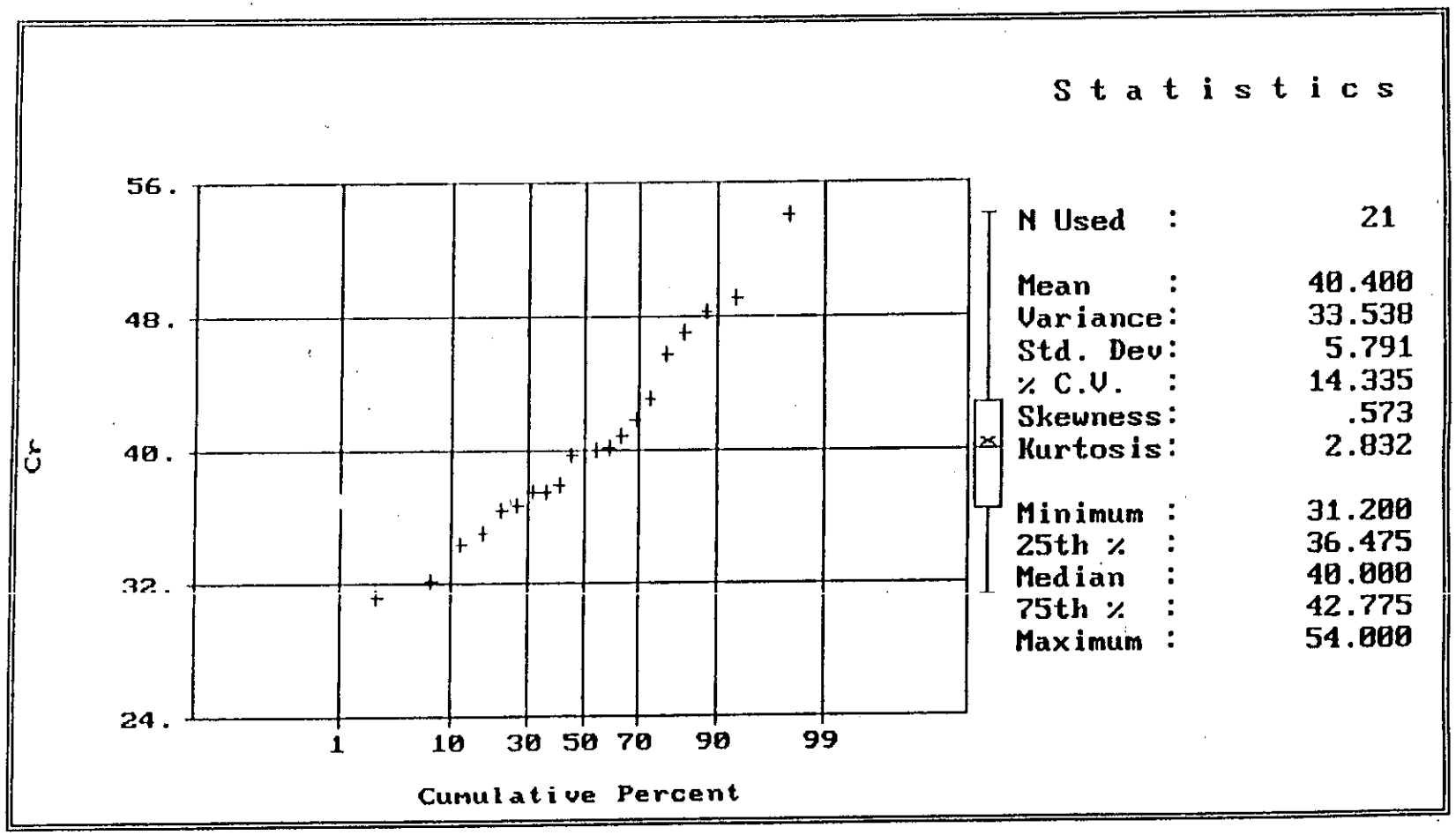
Note: The data set distribution is nonparametric.

FIGURE 9
PROBABILITY PLOT OF BACKGROUND BERYLLIUM
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



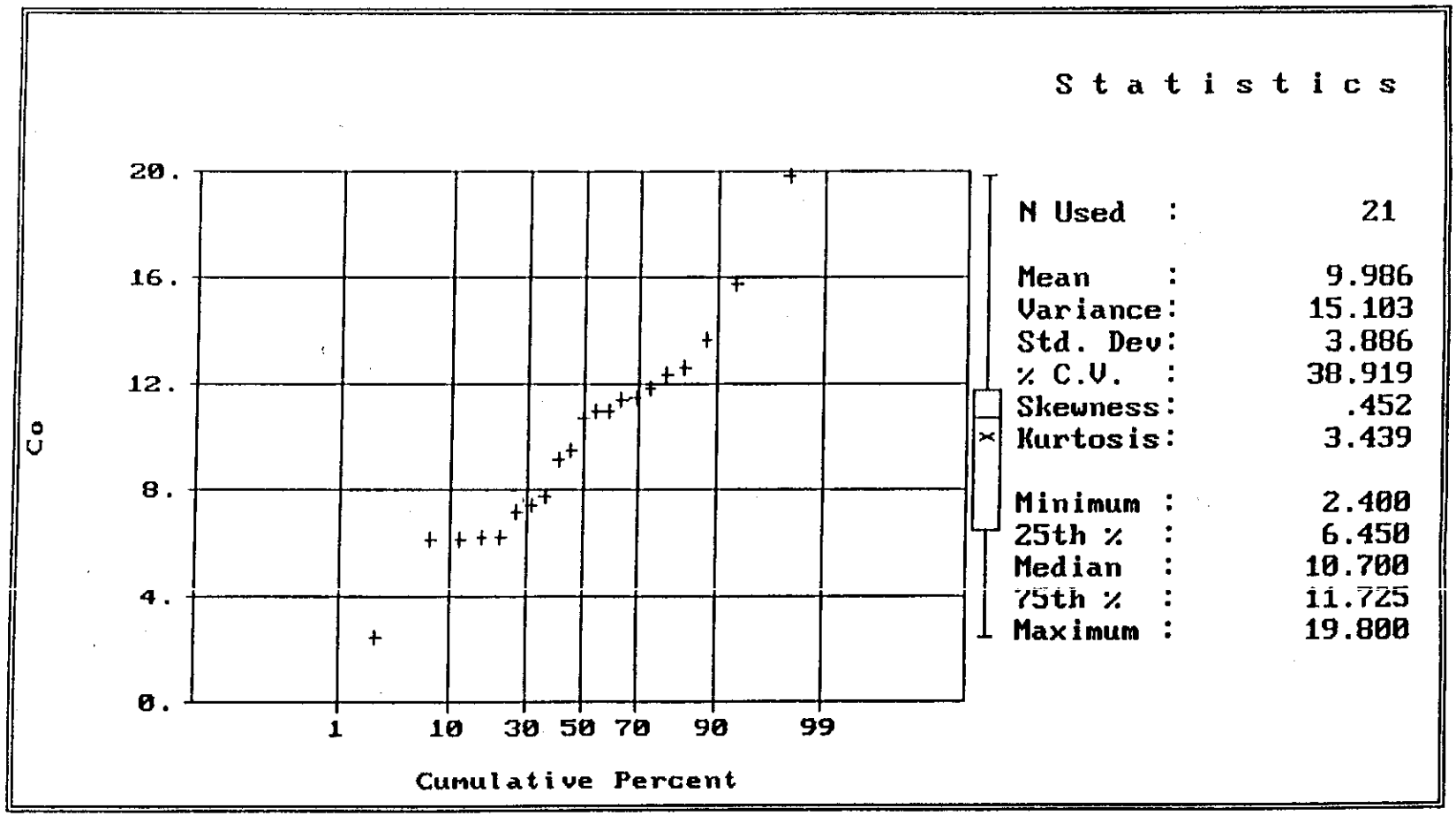
Note: The data set distribution is nonparametric.

FIGURE 10
PROBABILITY PLOT OF BACKGROUND CADMIUM
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



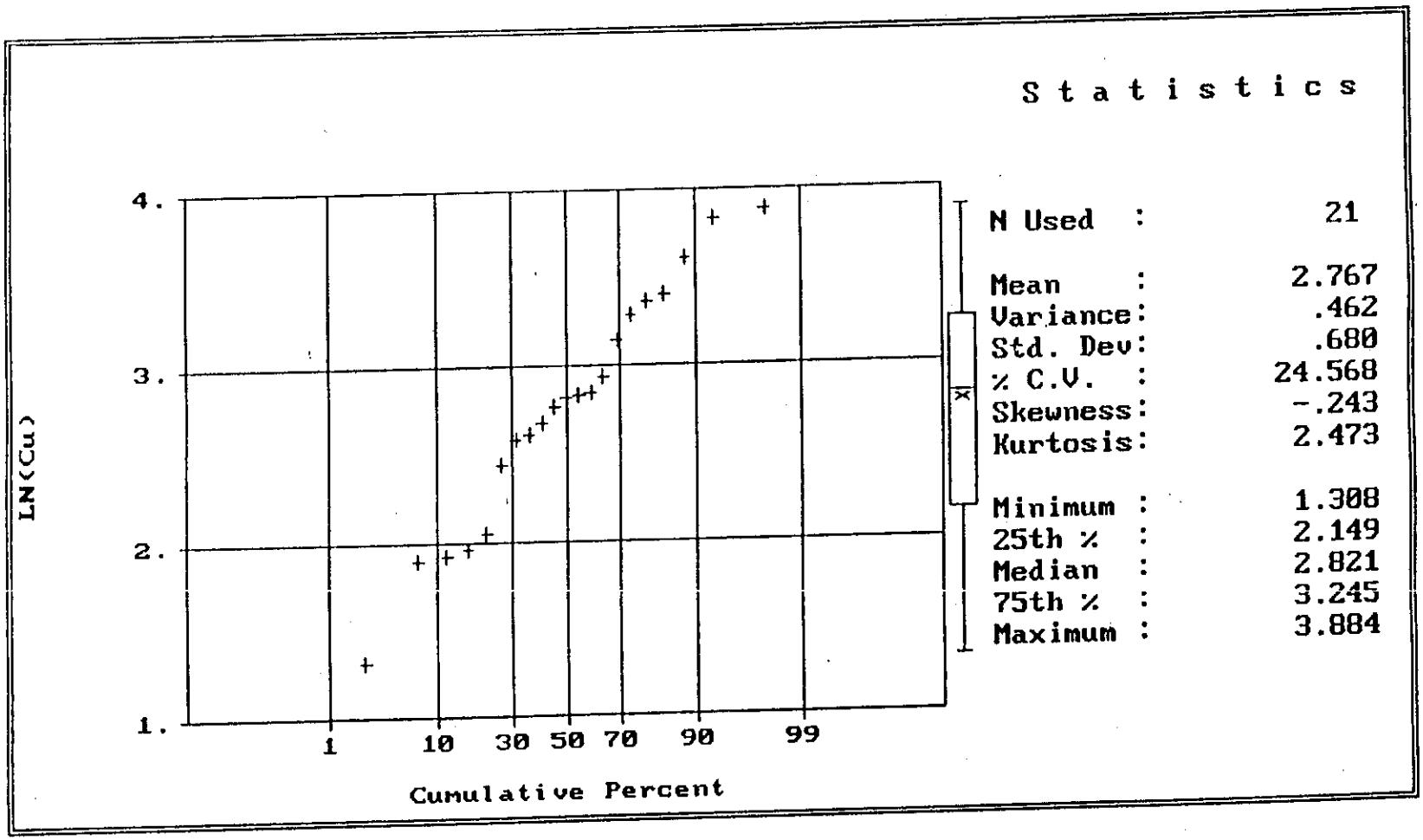
Note: The data set distribution is normal.

FIGURE 11
PROBABILITY PLOT OF BACKGROUND CHROMIUM
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



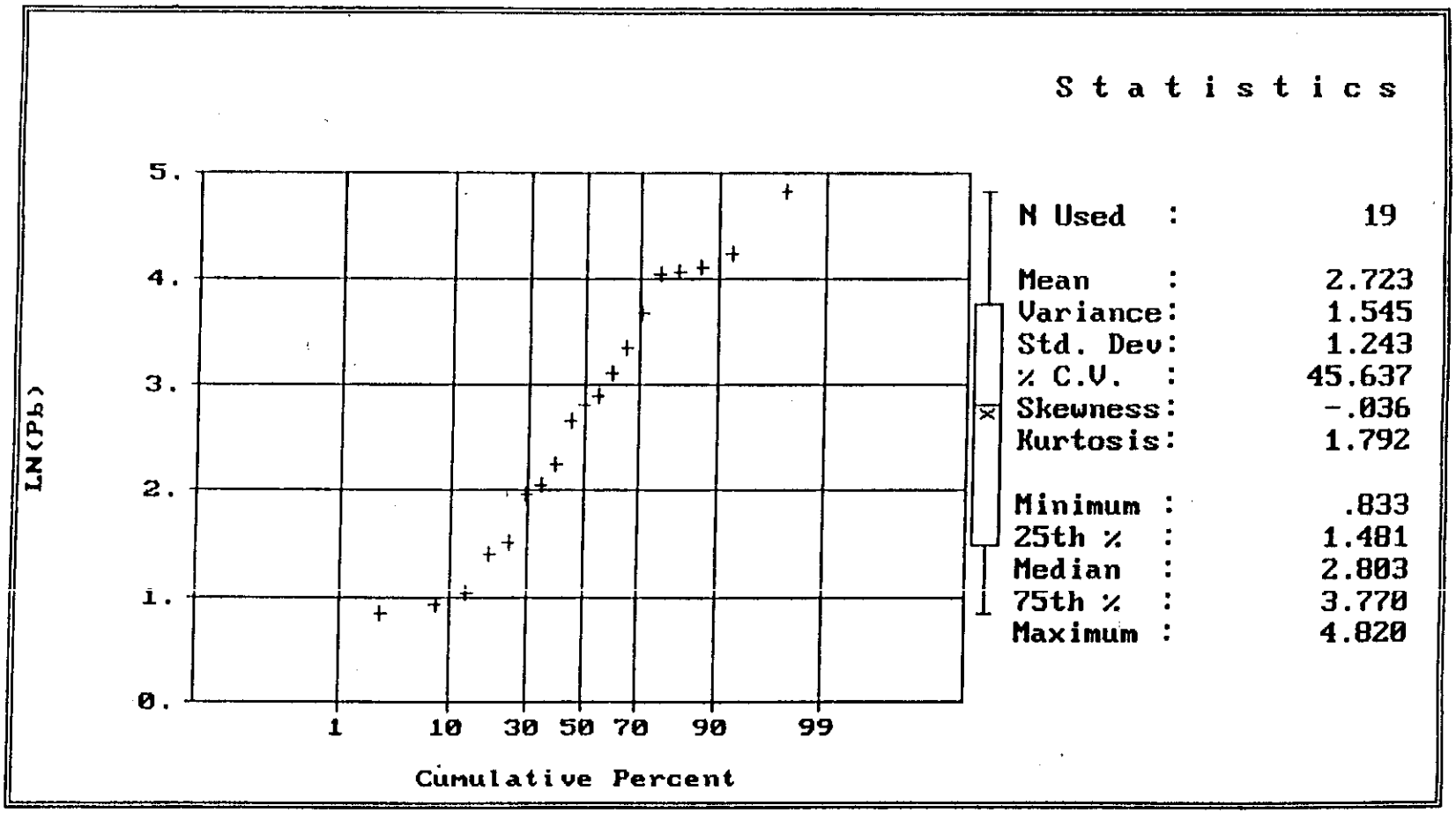
Note: The data set distribution is normal.

FIGURE 12
PROBABILITY PLOT OF BACKGROUND COBALT
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



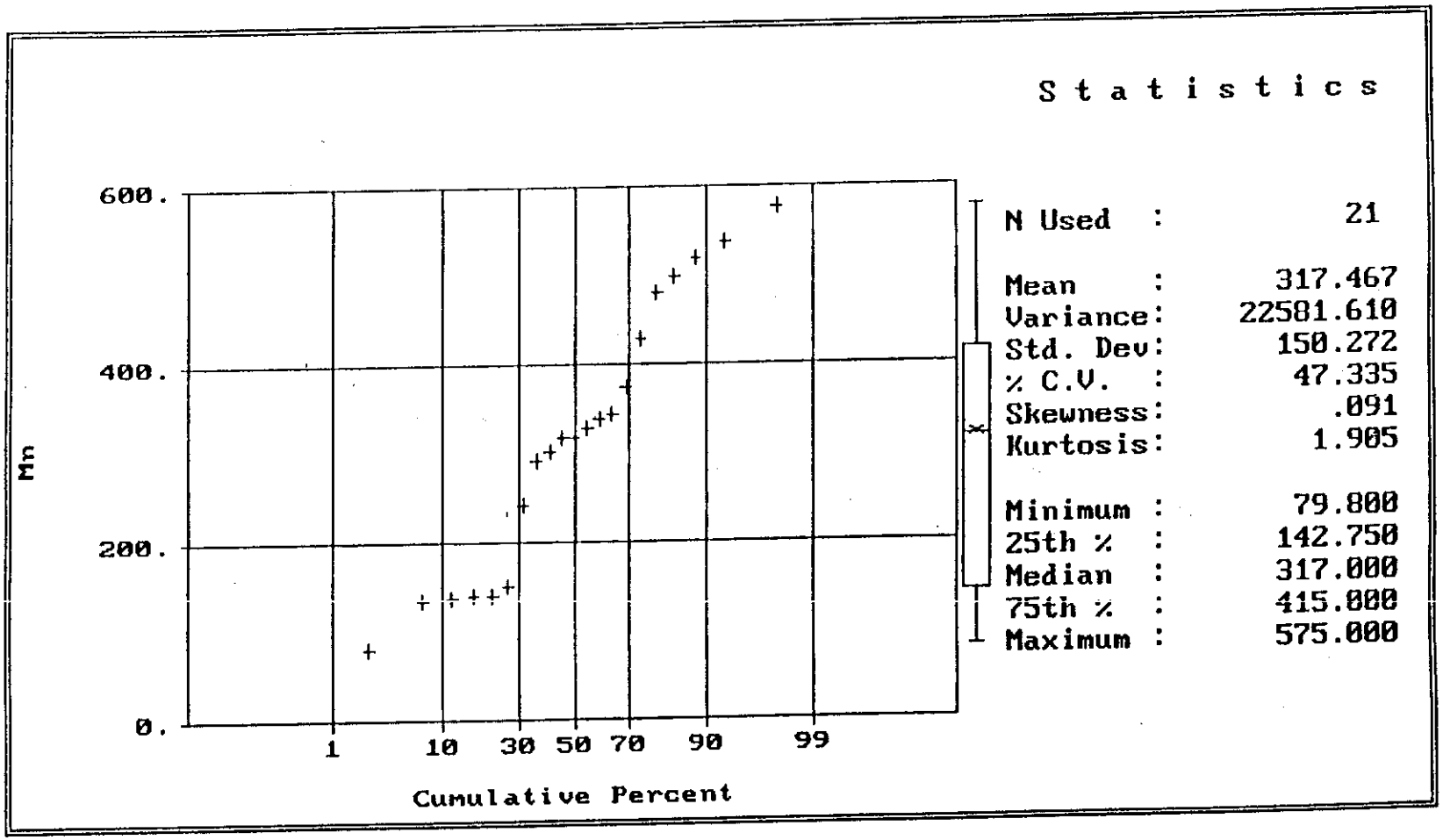
Note: The data set distribution is lognormal.

FIGURE 13
PROBABILITY PLOT OF BACKGROUND COPPER
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



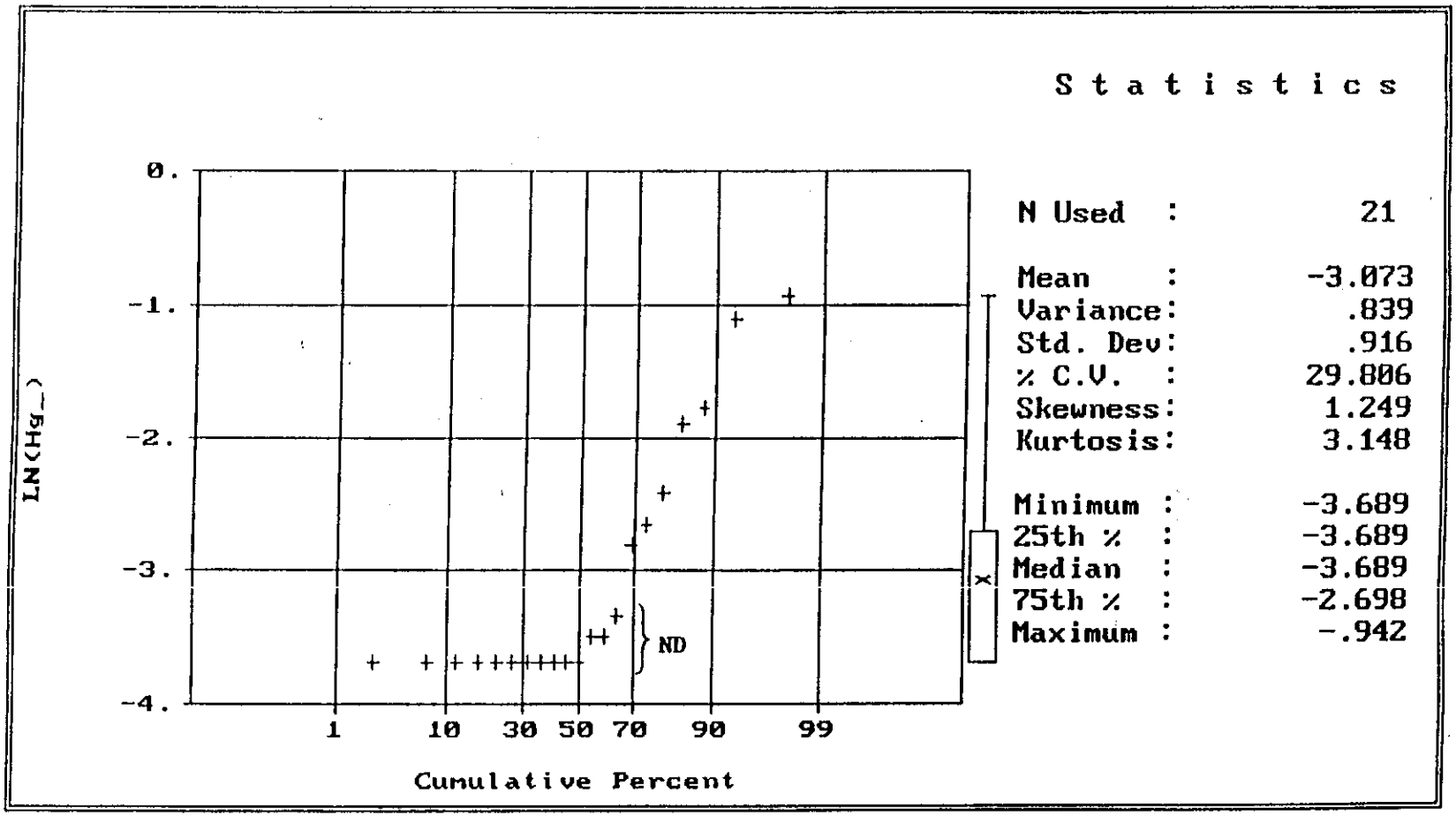
Note: The data set distribution is lognormal.

FIGURE 14
PROBABILITY PLOT OF BACKGROUND LEAD
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



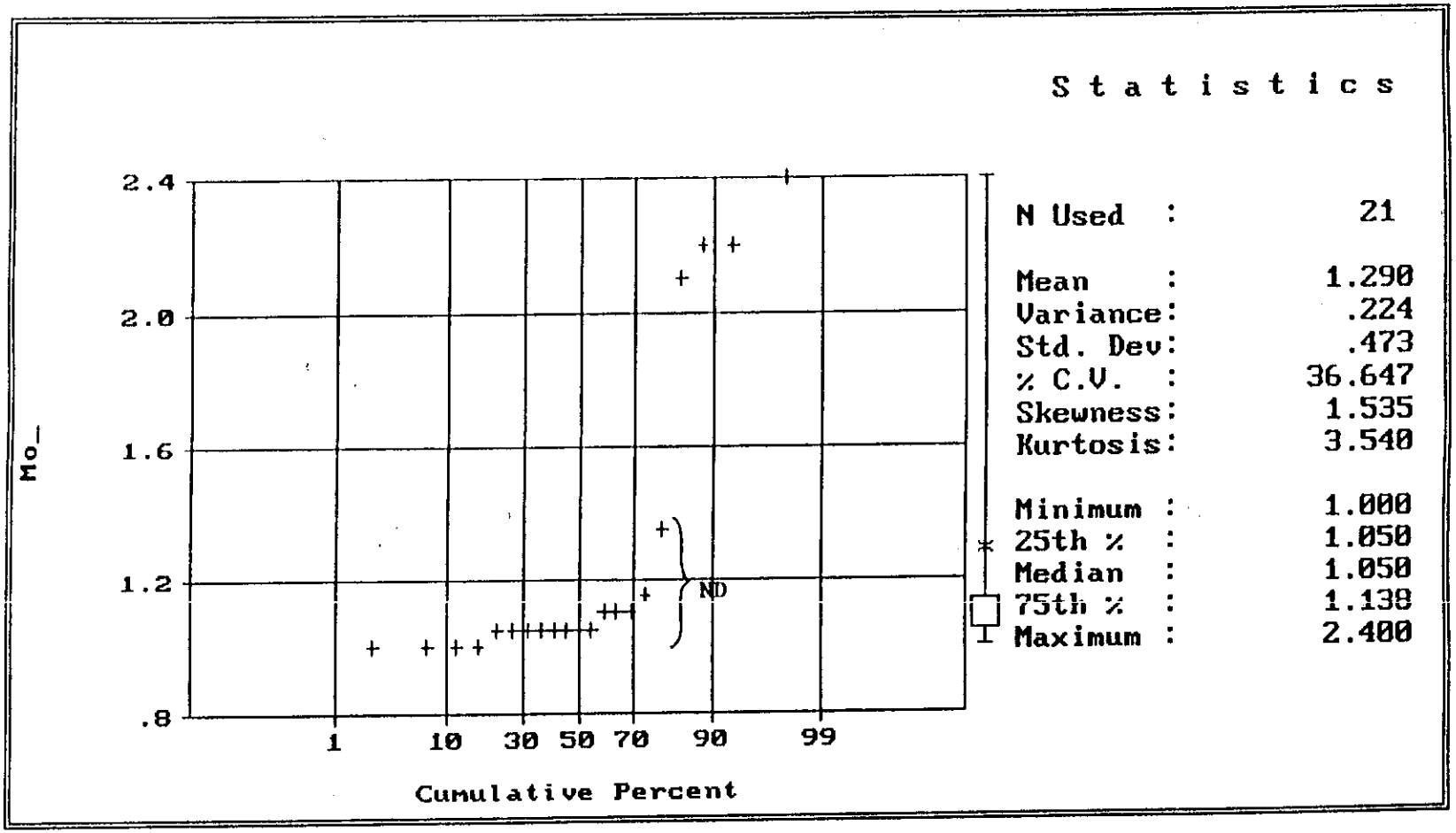
Note: The data set distribution is nonparametric.

FIGURE 15
PROBABILITY PLOT OF BACKGROUND MANGANESE
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



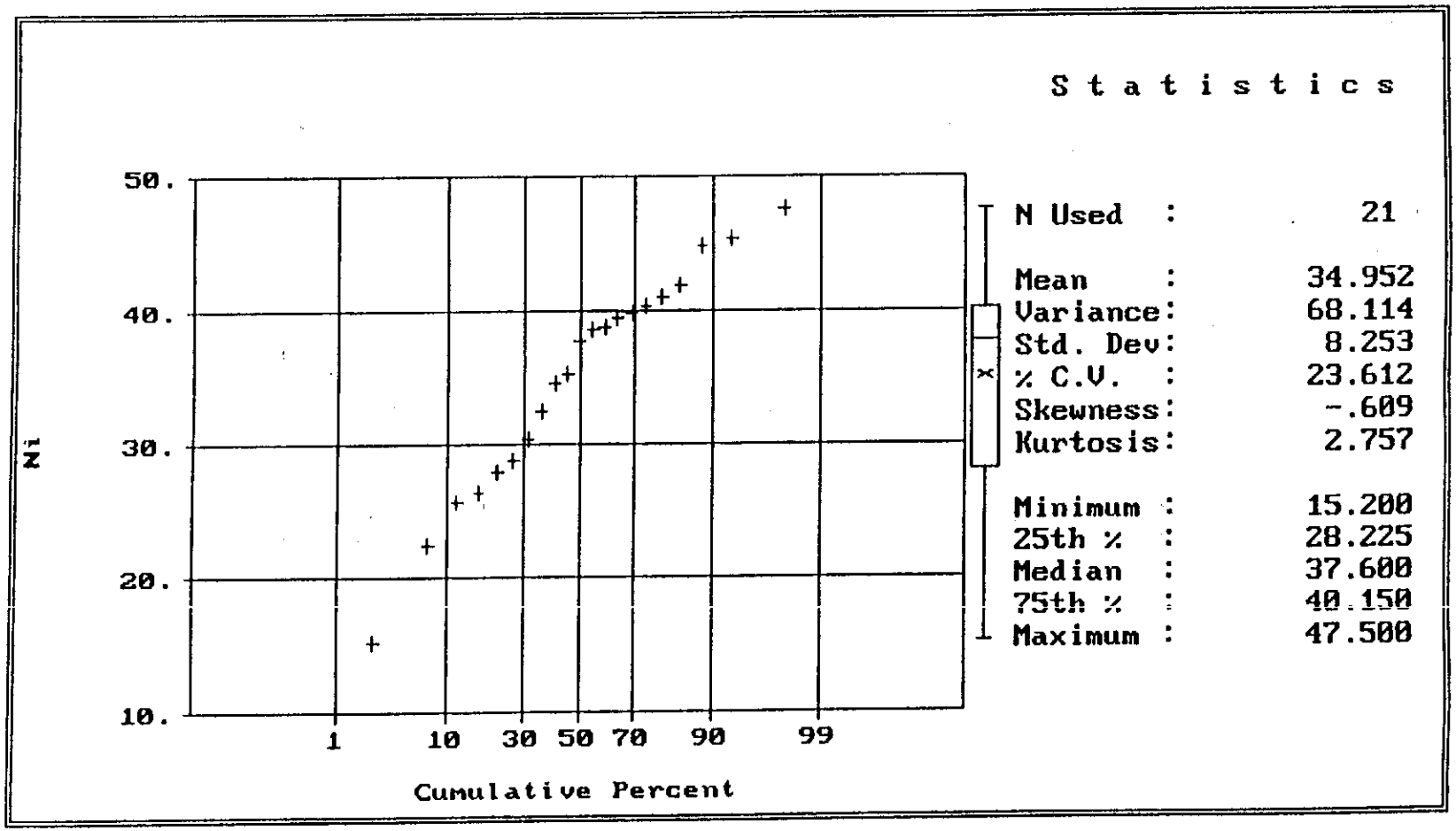
Note: The data set distribution is nonparametric.

FIGURE 16
PROBABILITY PLOT OF BACKGROUND MERCURY
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



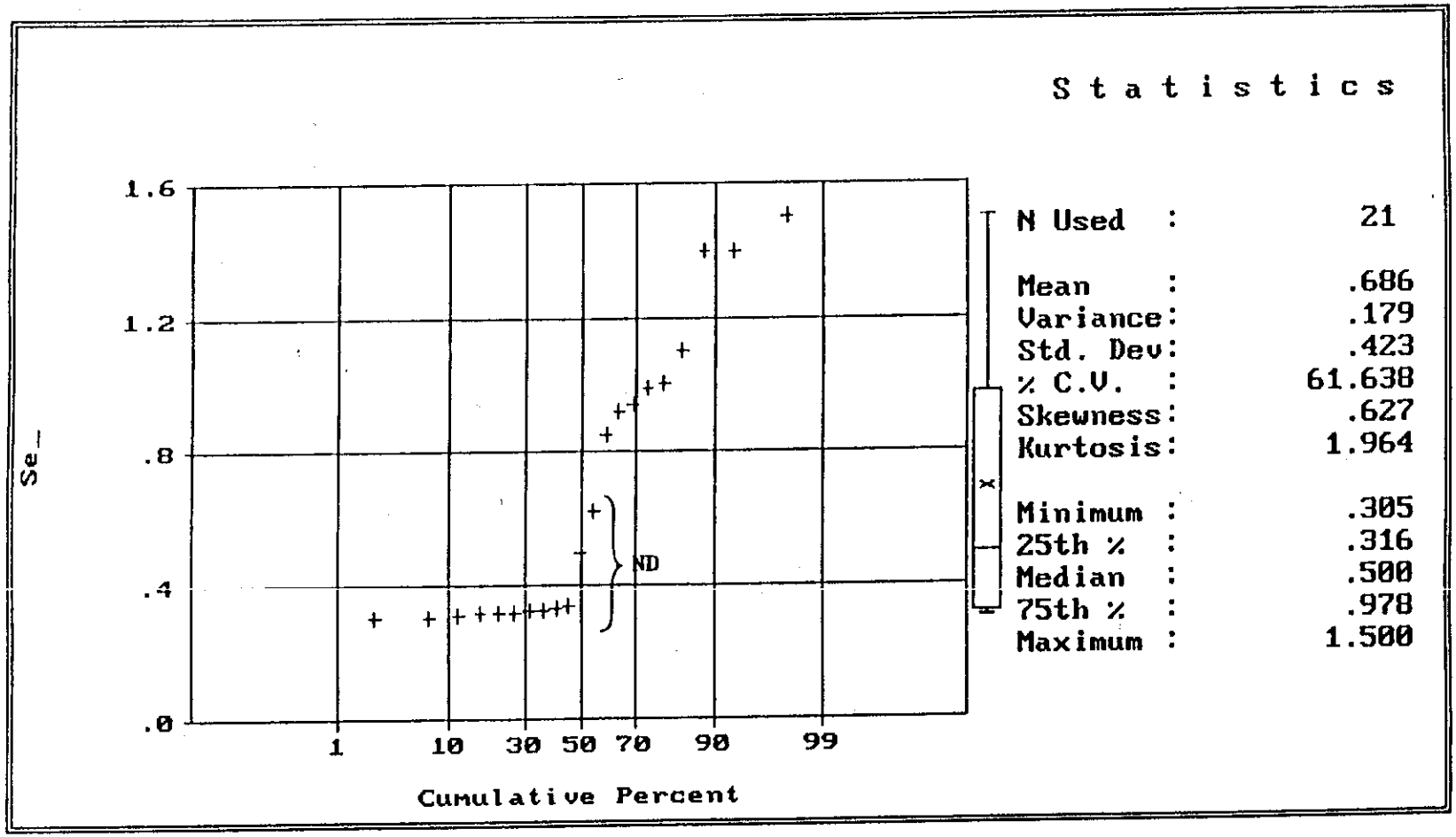
Note: The data set distribution is nonparametric.

FIGURE 17
PROBABILITY PLOT OF BACKGROUND MOLYBDENUM
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



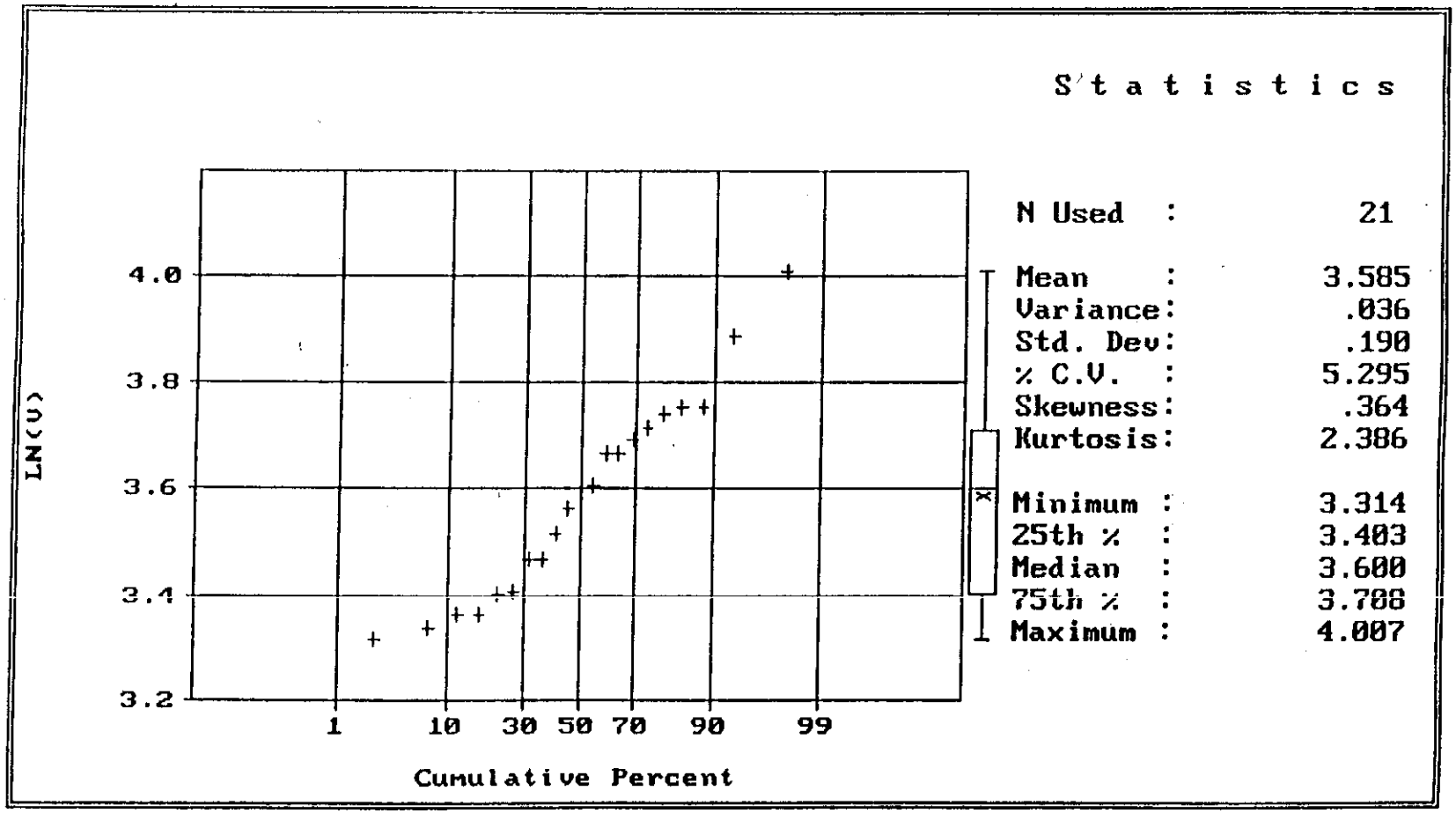
Note: The data set distribution is normal.

FIGURE 18
PROBABILITY PLOT OF BACKGROUND NICKEL
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



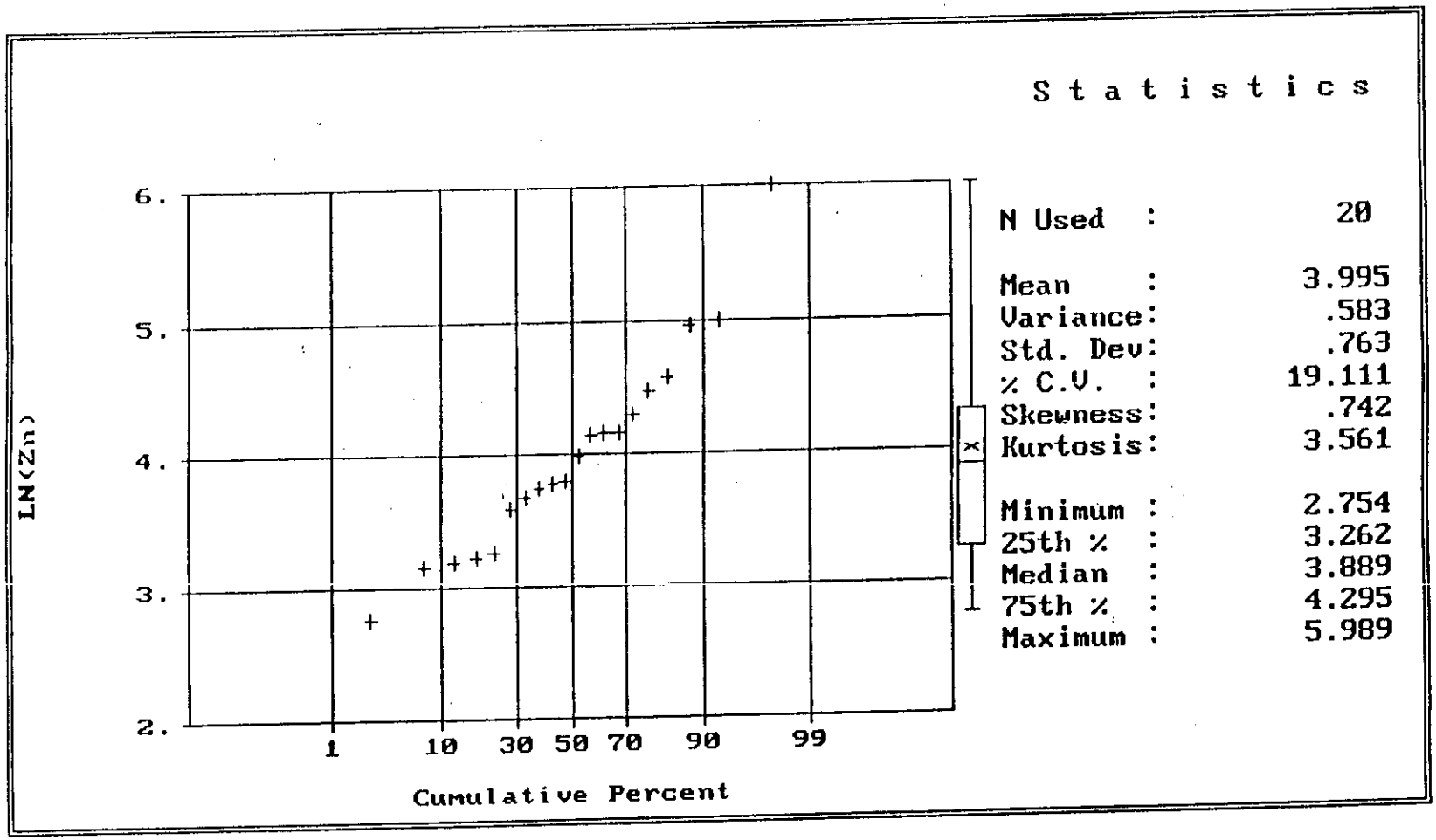
Note: The data set distribution is nonparametric.

FIGURE 19
PROBABILITY PLOT OF BACKGROUND SELENIUM
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



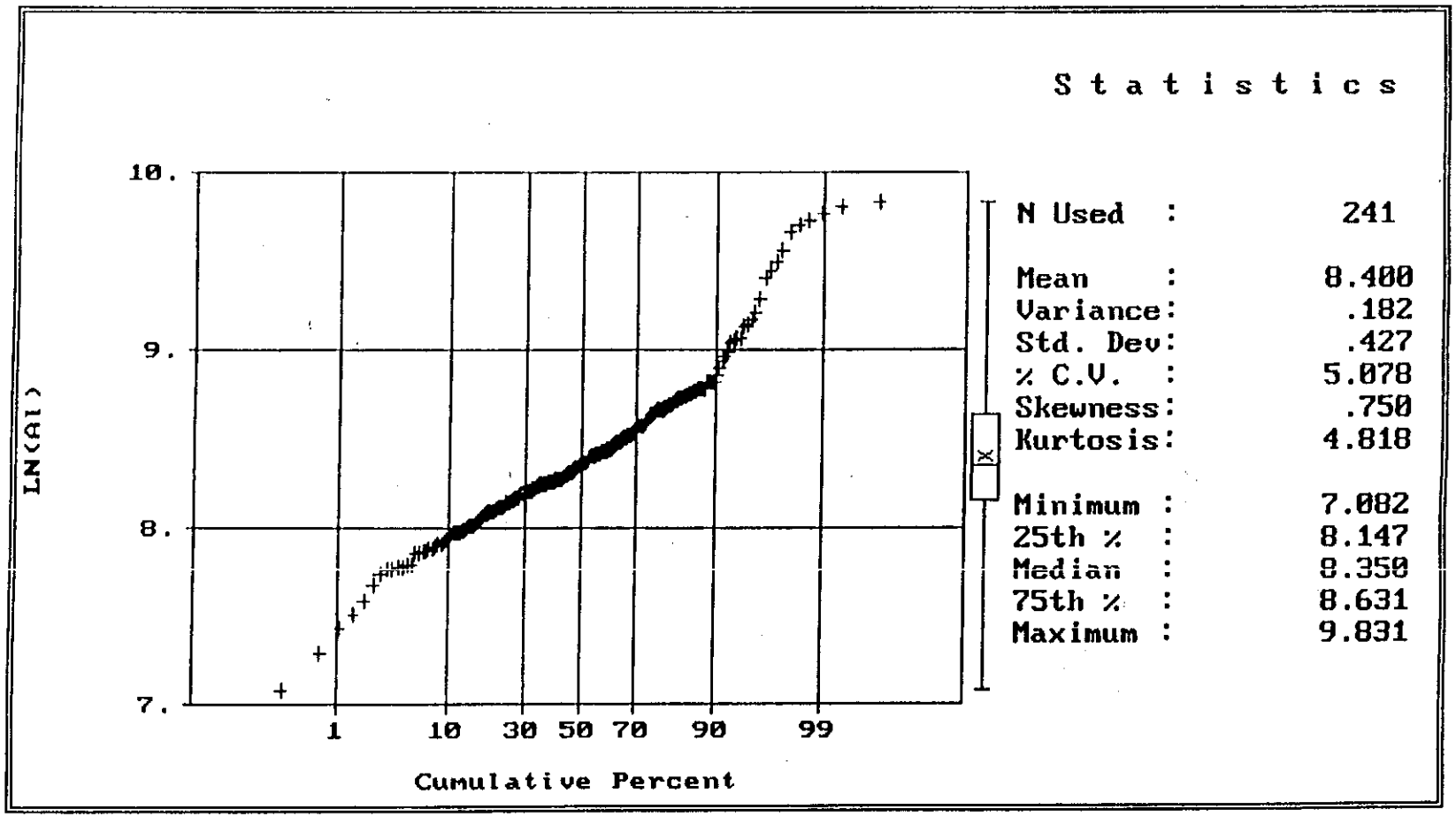
Note: The data set distribution is lognormal.

FIGURE 20
PROBABILITY PLOT OF BACKGROUND VANADIUM
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



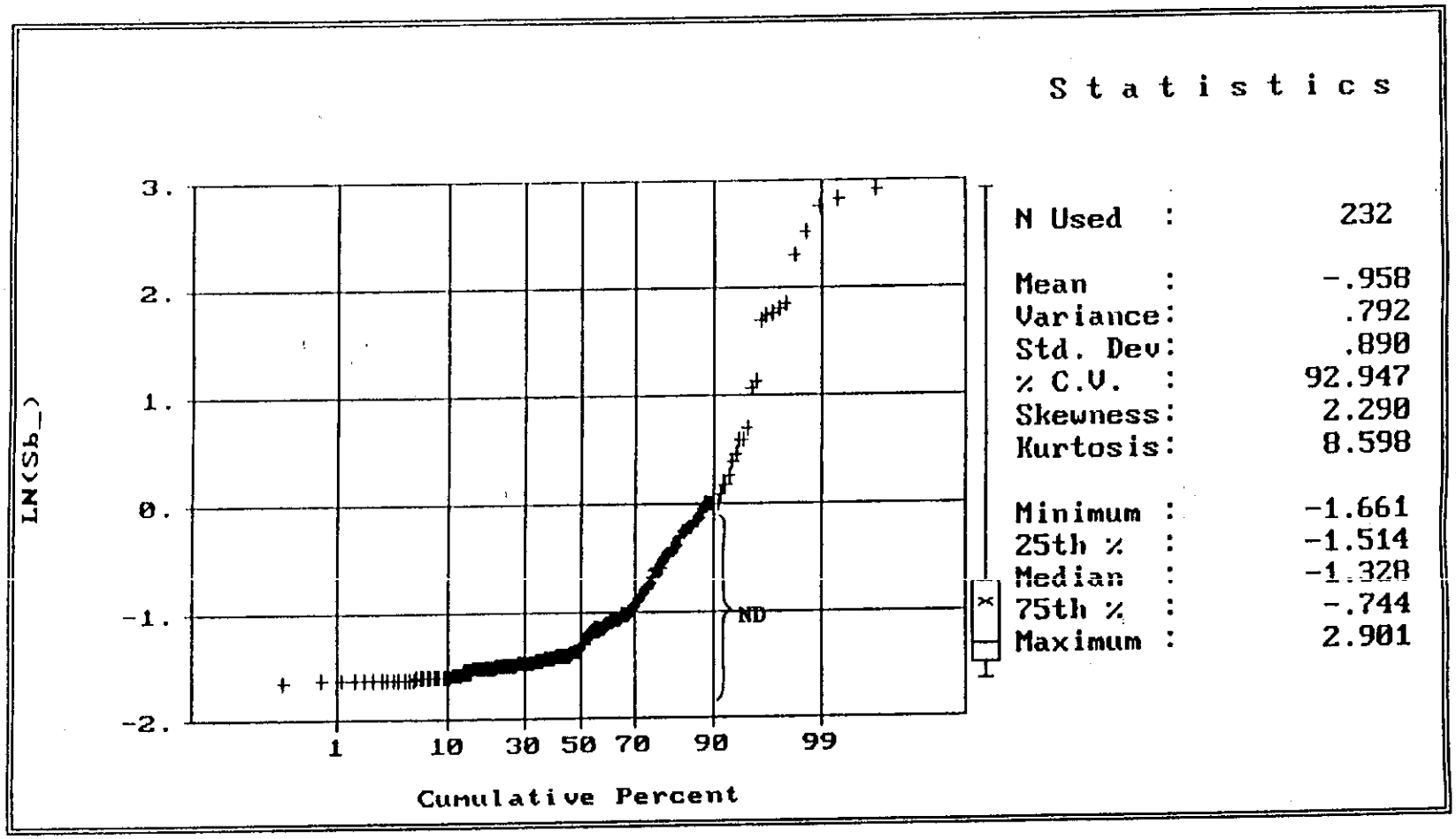
Note: The data set distribution is lognormal.

FIGURE 21
PROBABILITY PLOT OF BACKGROUND ZINC
CONCENTRATIONS IN NATURALLY OCCURRING SOILS
YERBA BUENA ISLAND



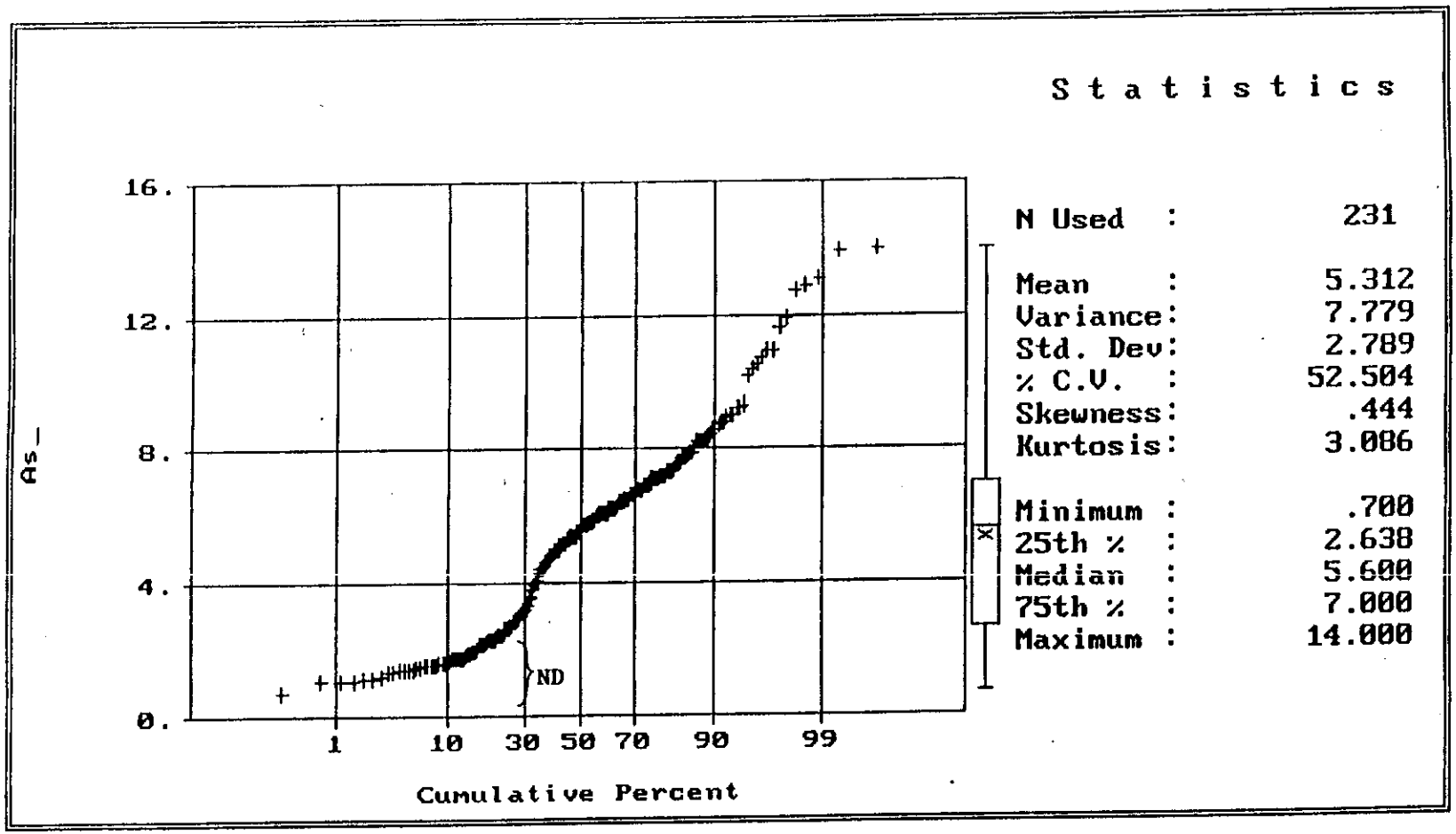
Note: The data set distribution is nonparametric.

FIGURE 22
PROBABILITY PLOT OF AMBIENT ALUMINUM
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



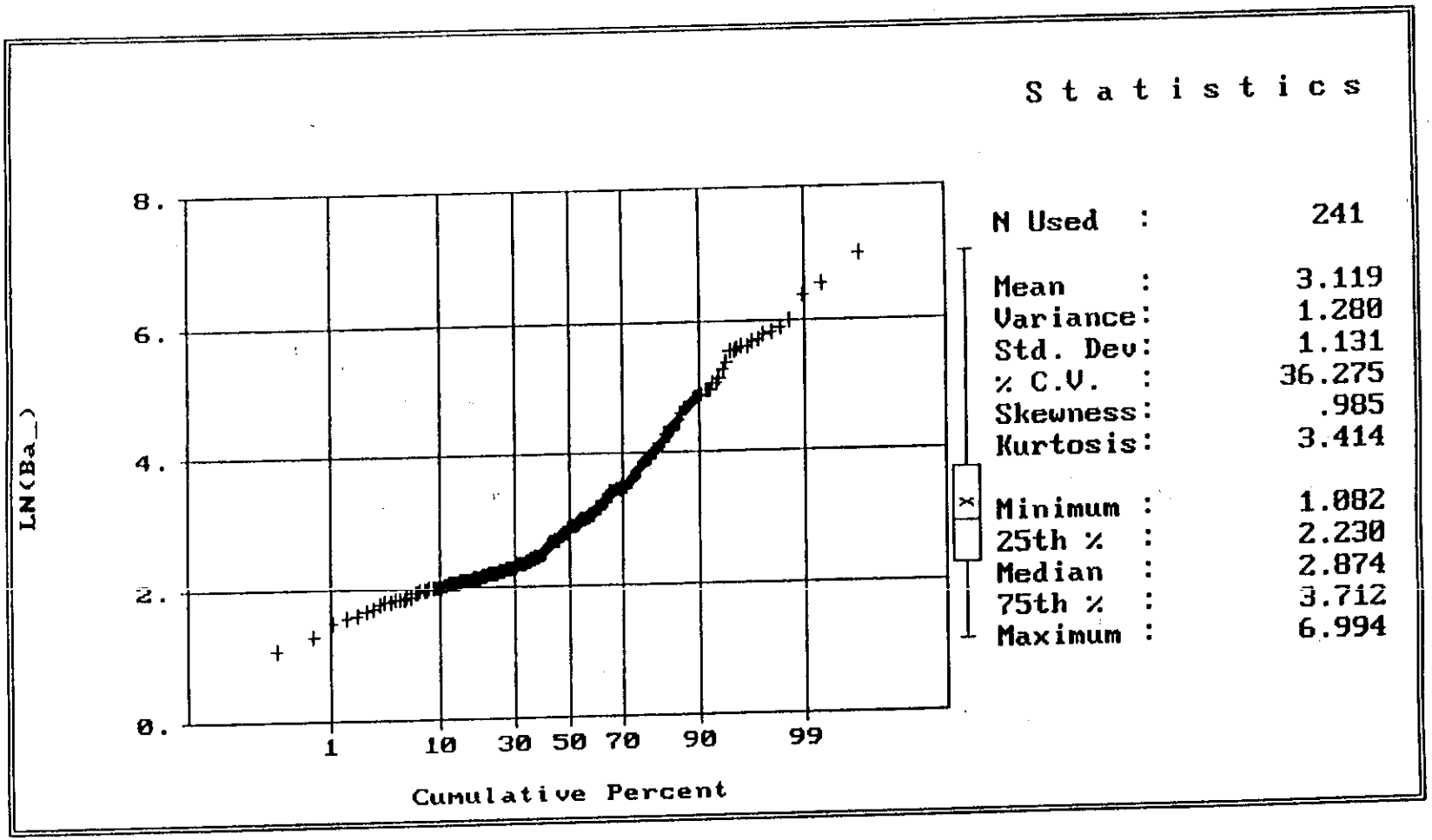
Note: The data set distribution is nonparametric.

FIGURE 23
PROBABILITY PLOT OF AMBIENT ANTIMONY
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



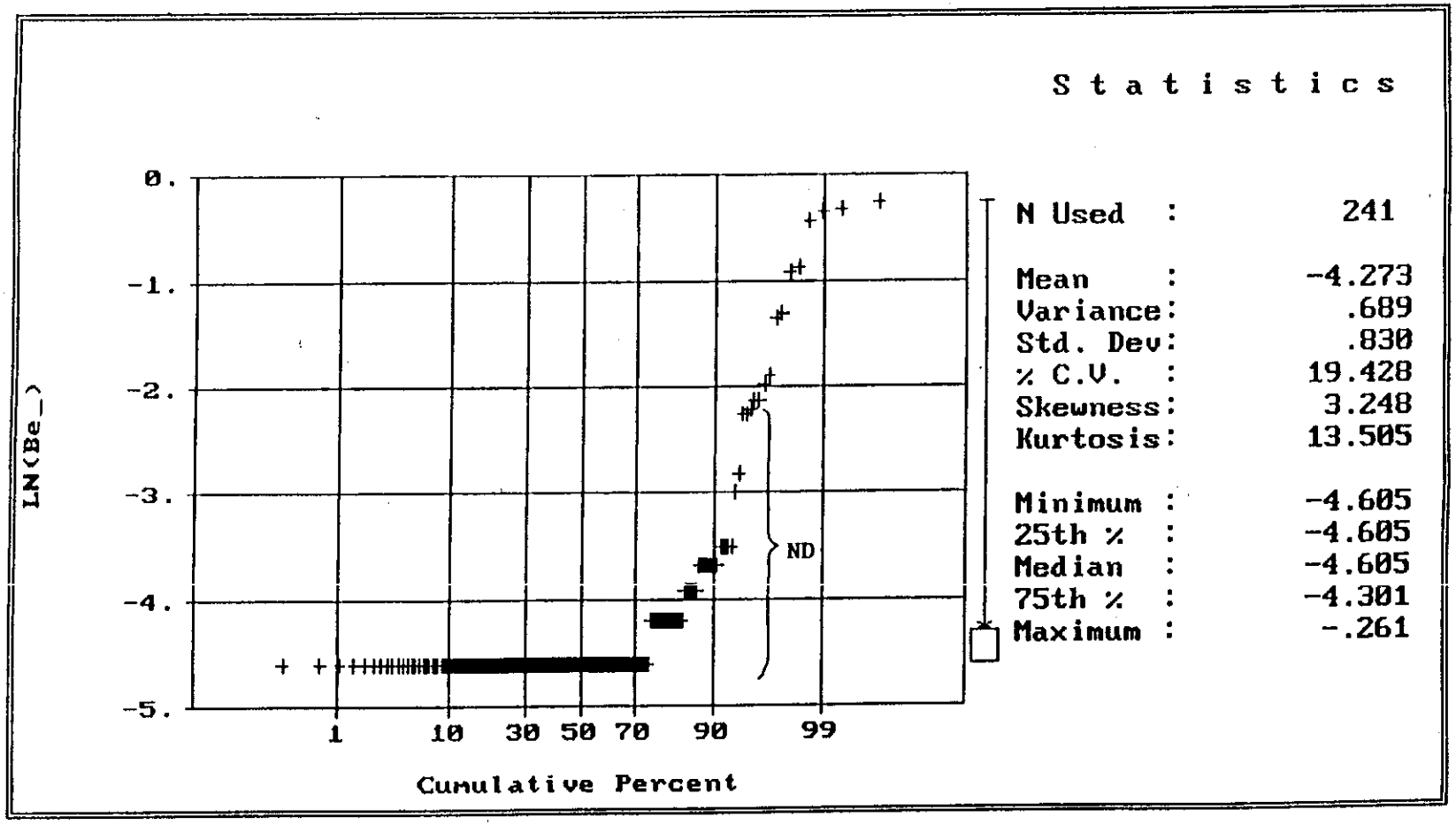
Note: The data set distribution is nonparametric.

FIGURE 24
PROBABILITY PLOT OF AMBIENT ARSENIC
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



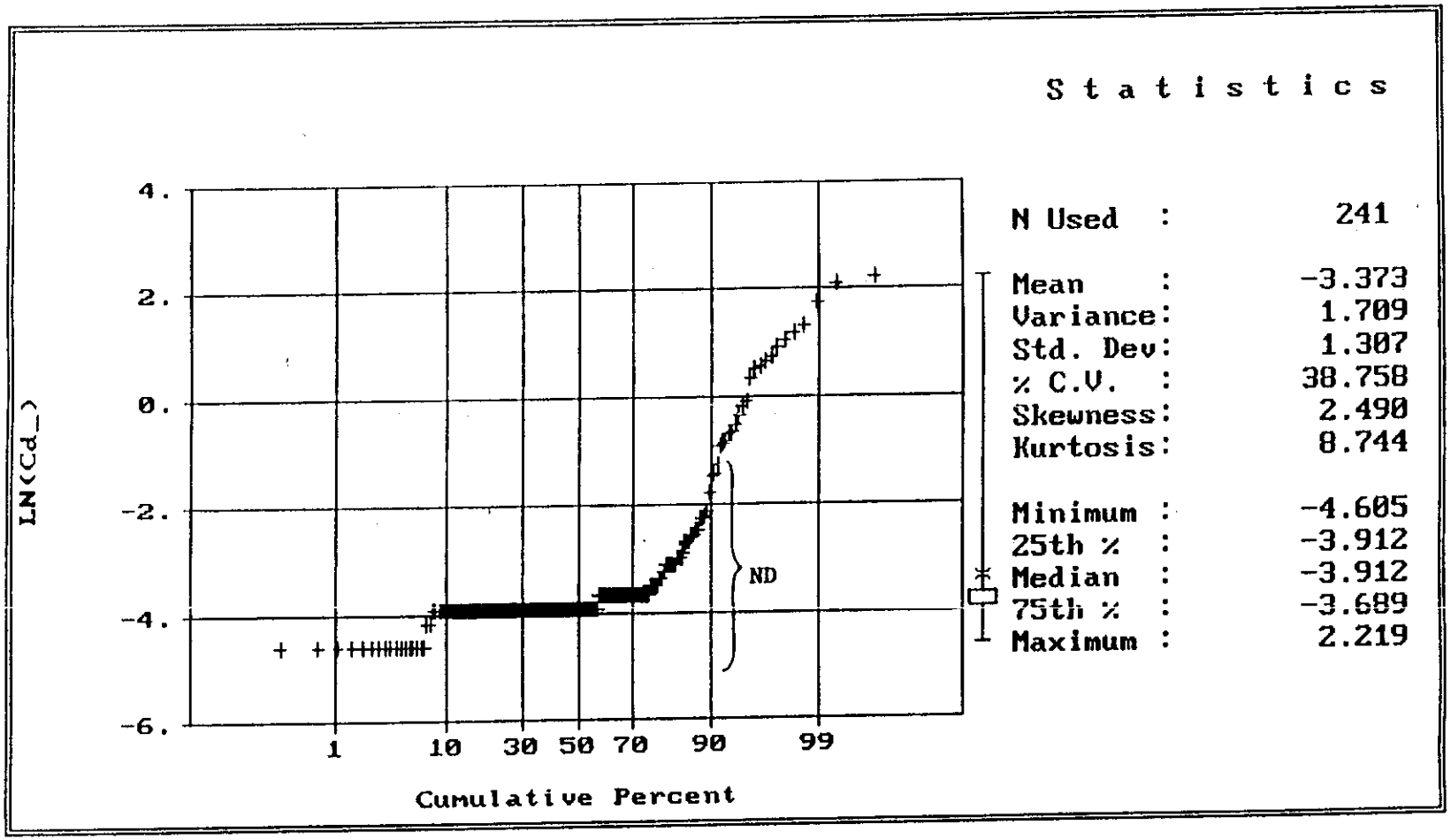
Note: The data set distribution is nonparametric.

FIGURE 25
PROBABILITY PLOT OF AMBIENT BARIUM
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



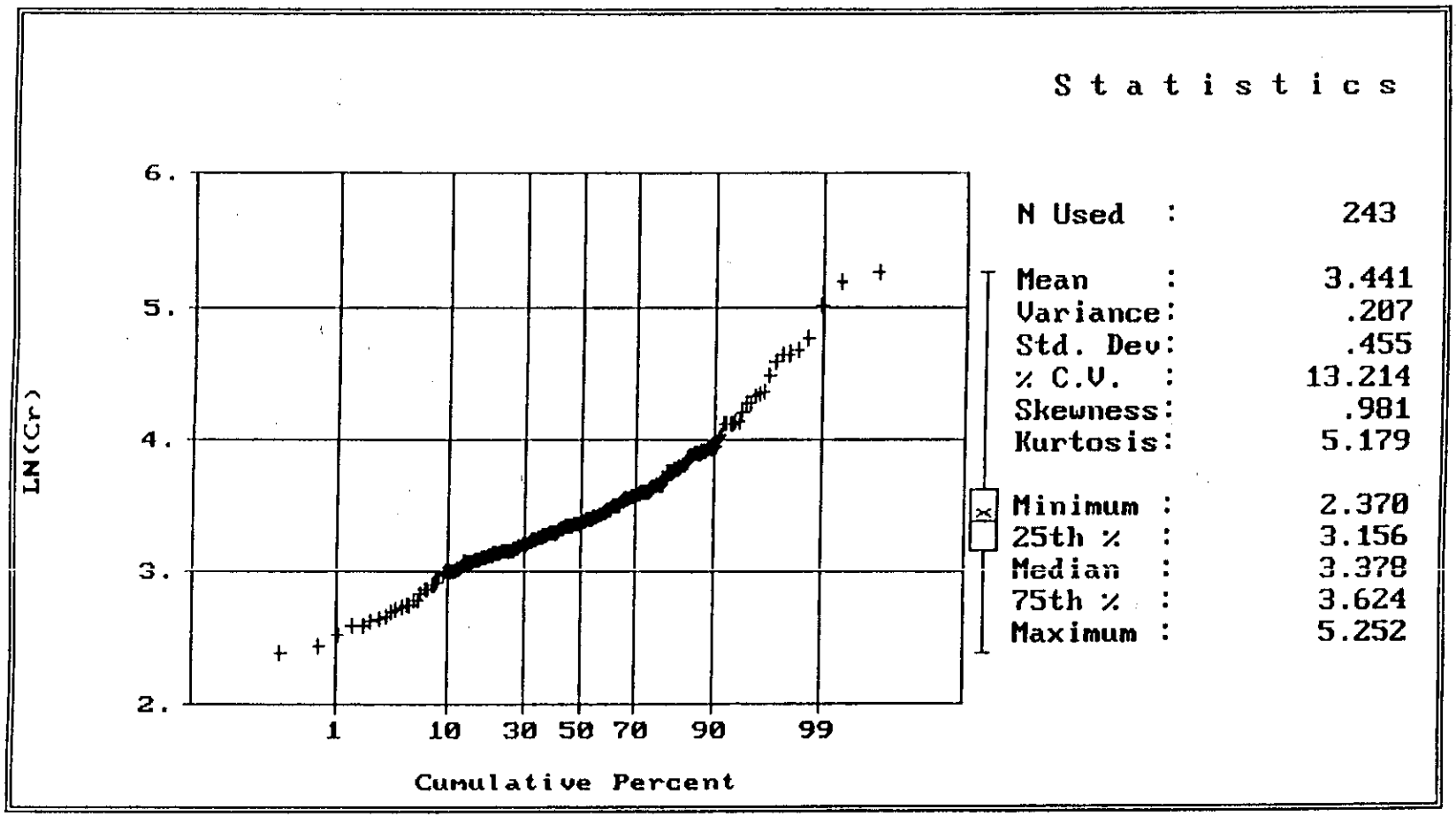
Note: The data set distribution is nonparametric.

FIGURE 26
PROBABILITY PLOT OF AMBIENT BERYLLIUM
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



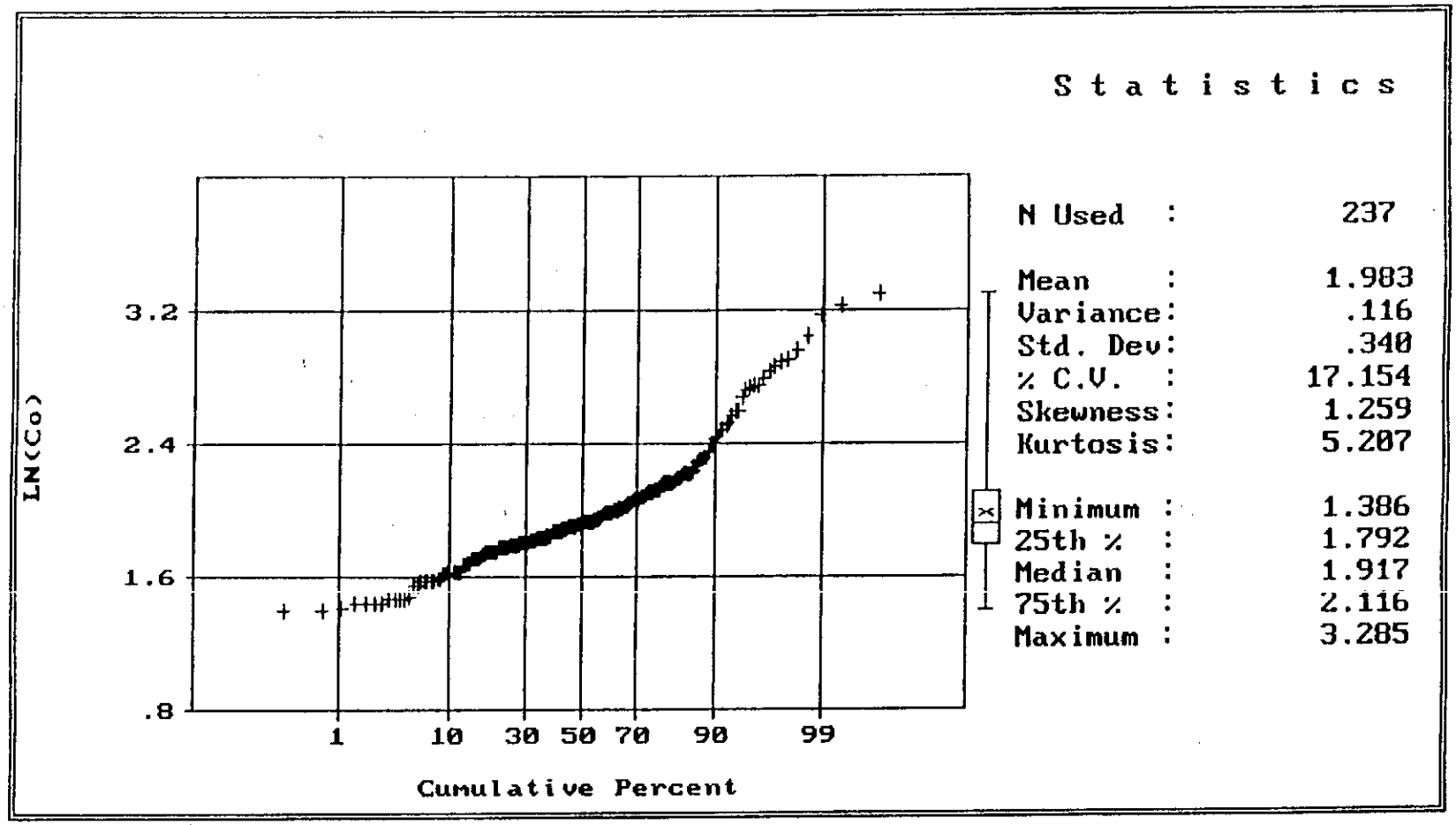
Note: The data set distribution is nonparametric.

FIGURE 27
PROBABILITY PLOT OF AMBIENT CADMIUM
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



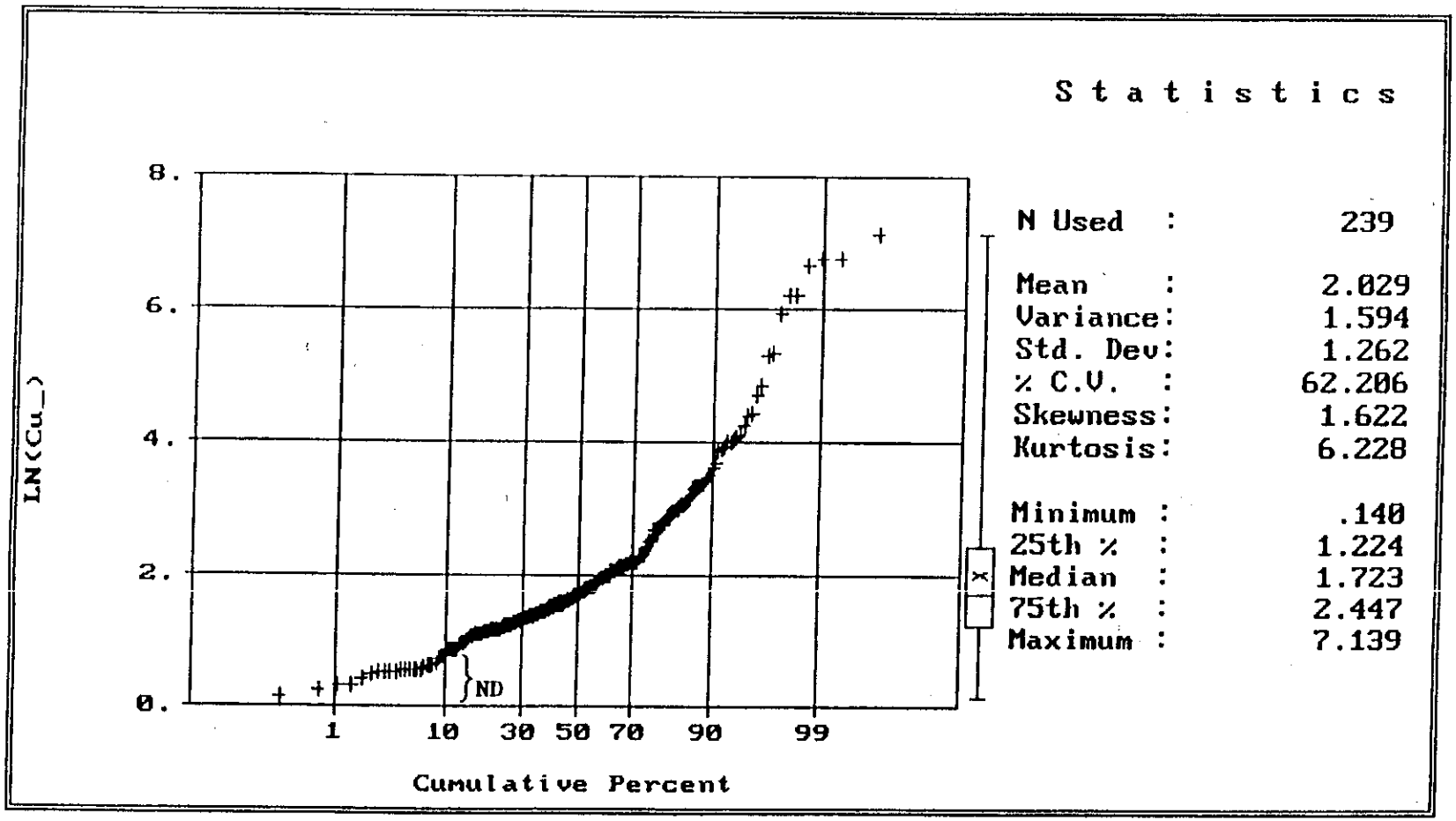
Note: The data set distribution is nonparametric.

FIGURE 28
PROBABILITY PLOT OF AMBIENT CHROMIUM
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



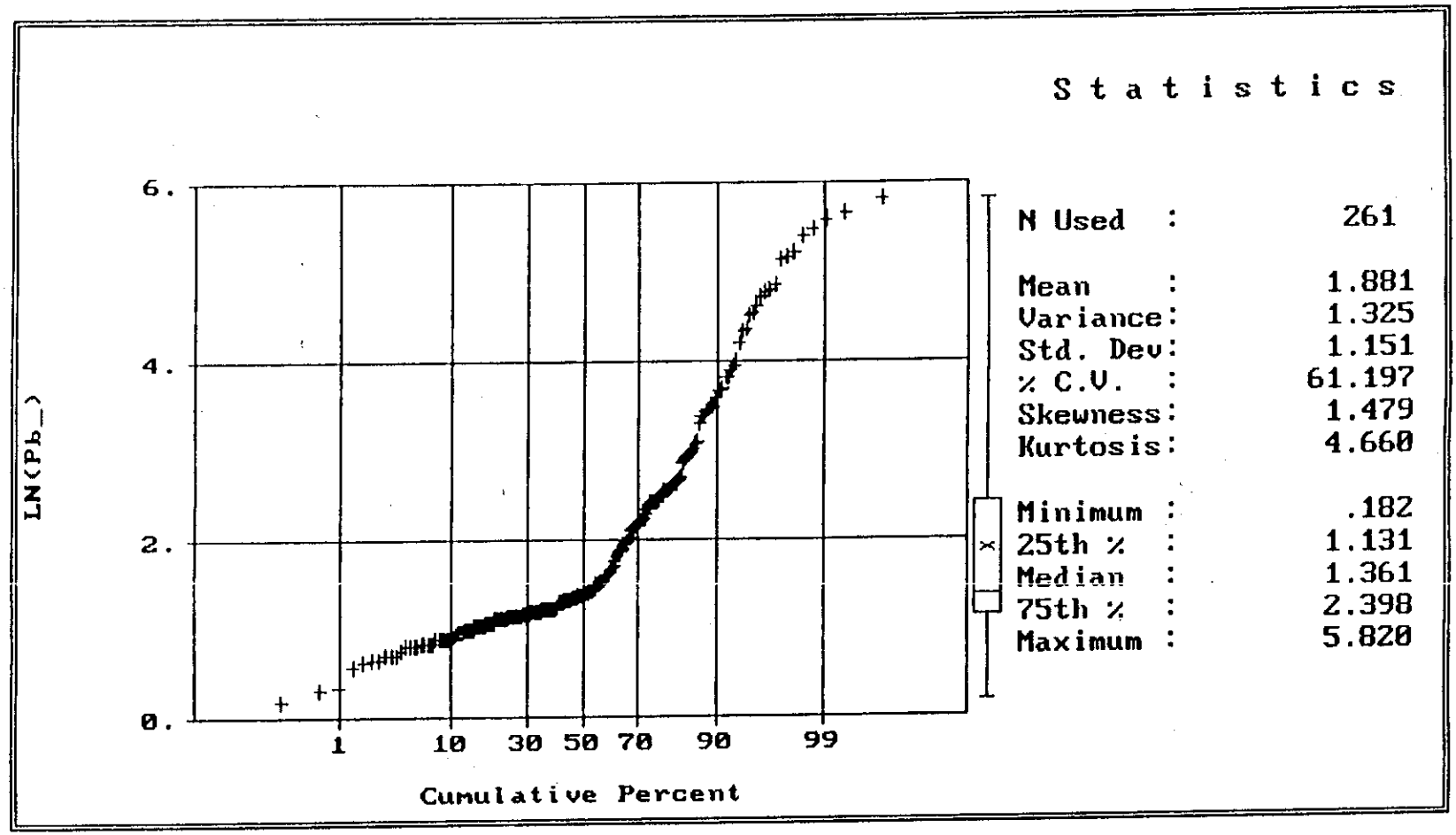
Note: The data set distribution is nonparametric.

FIGURE 29
PROBABILITY PLOT OF AMBIENT COBALT
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



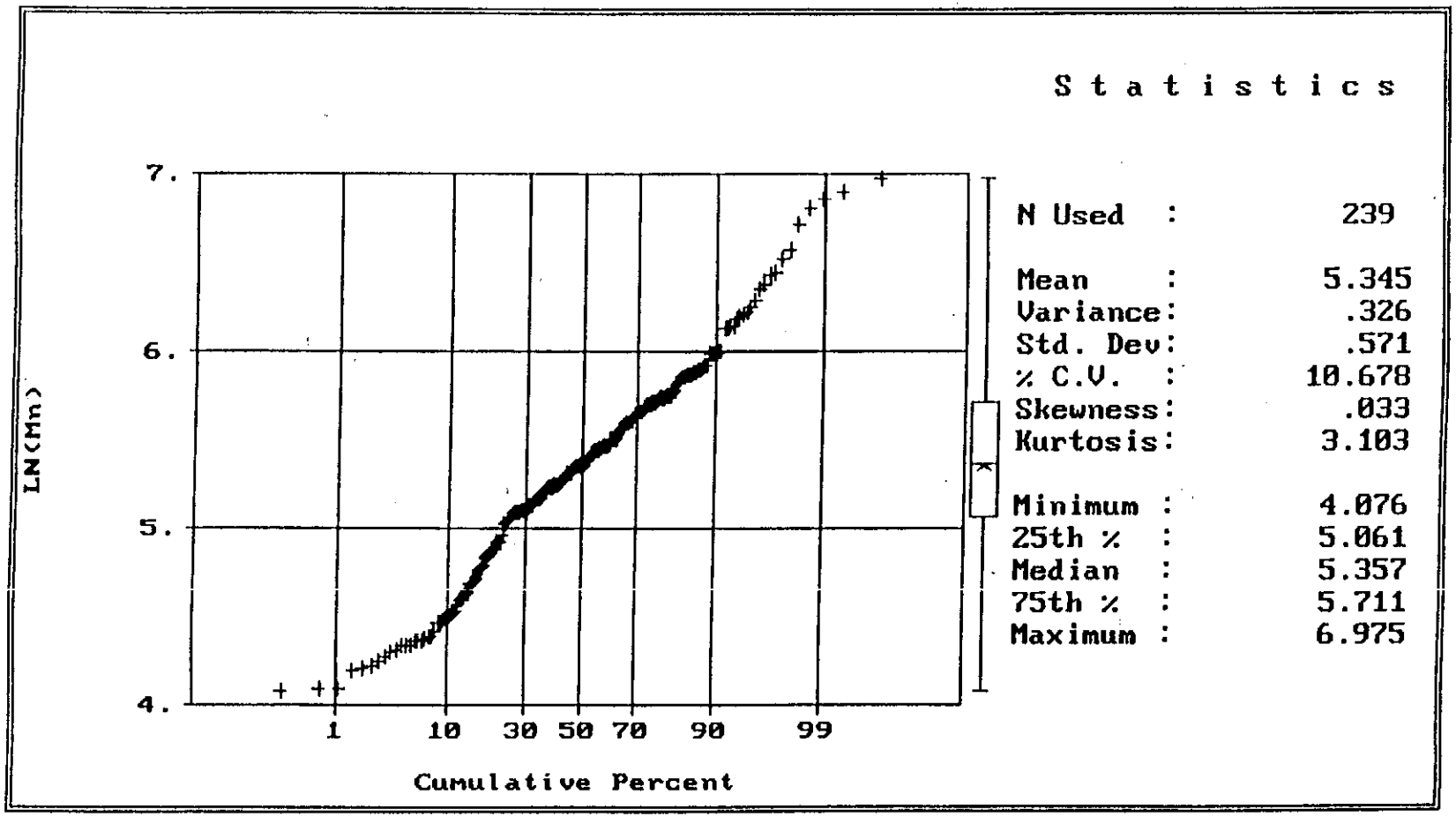
Note: The data set distribution is nonparametric.

FIGURE 30
PROBABILITY PLOT OF AMBIENT COPPER
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



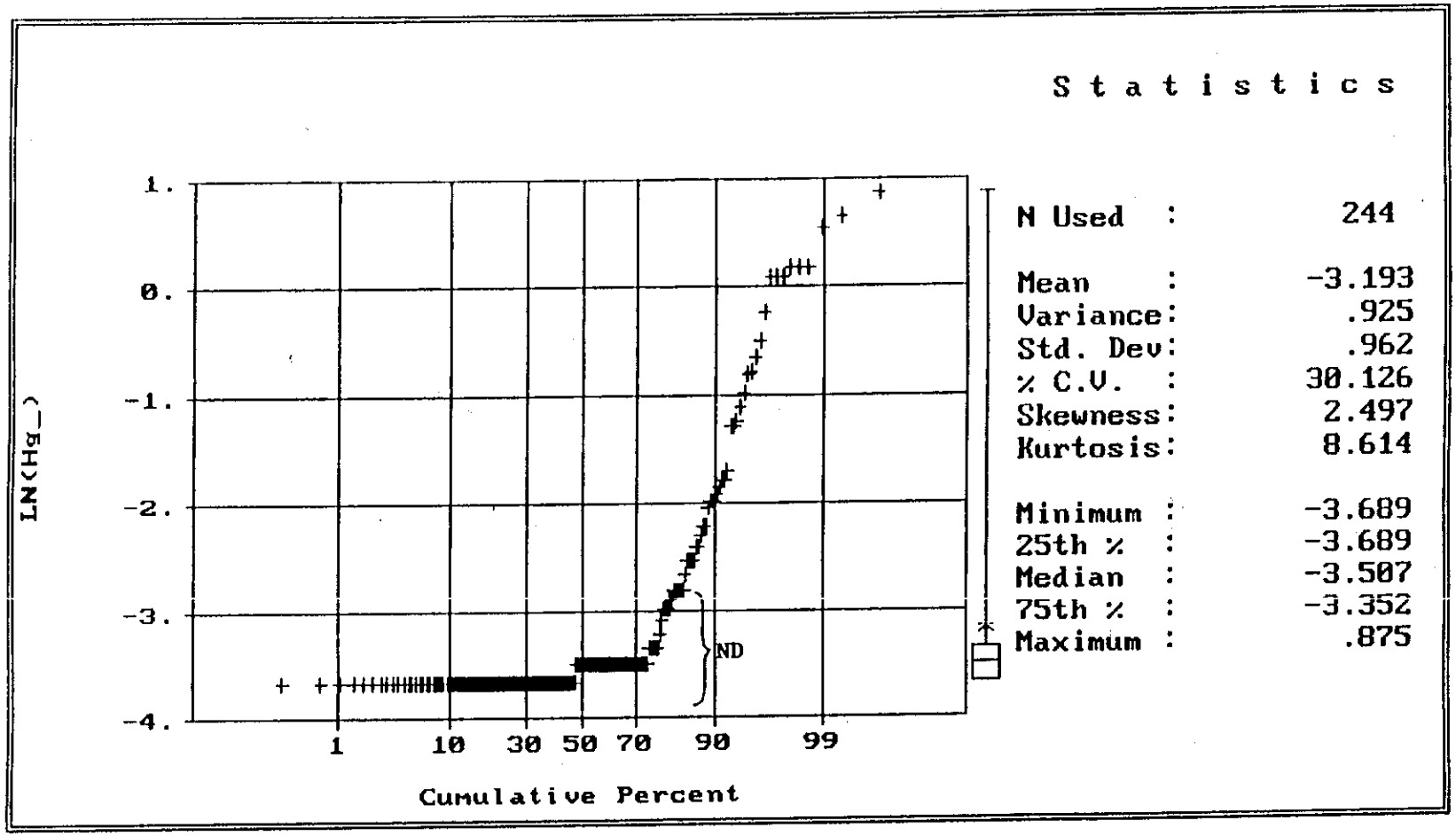
Note: The data set distribution is nonparametric.

FIGURE 31
PROBABILITY PLOT OF AMBIENT LEAD
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



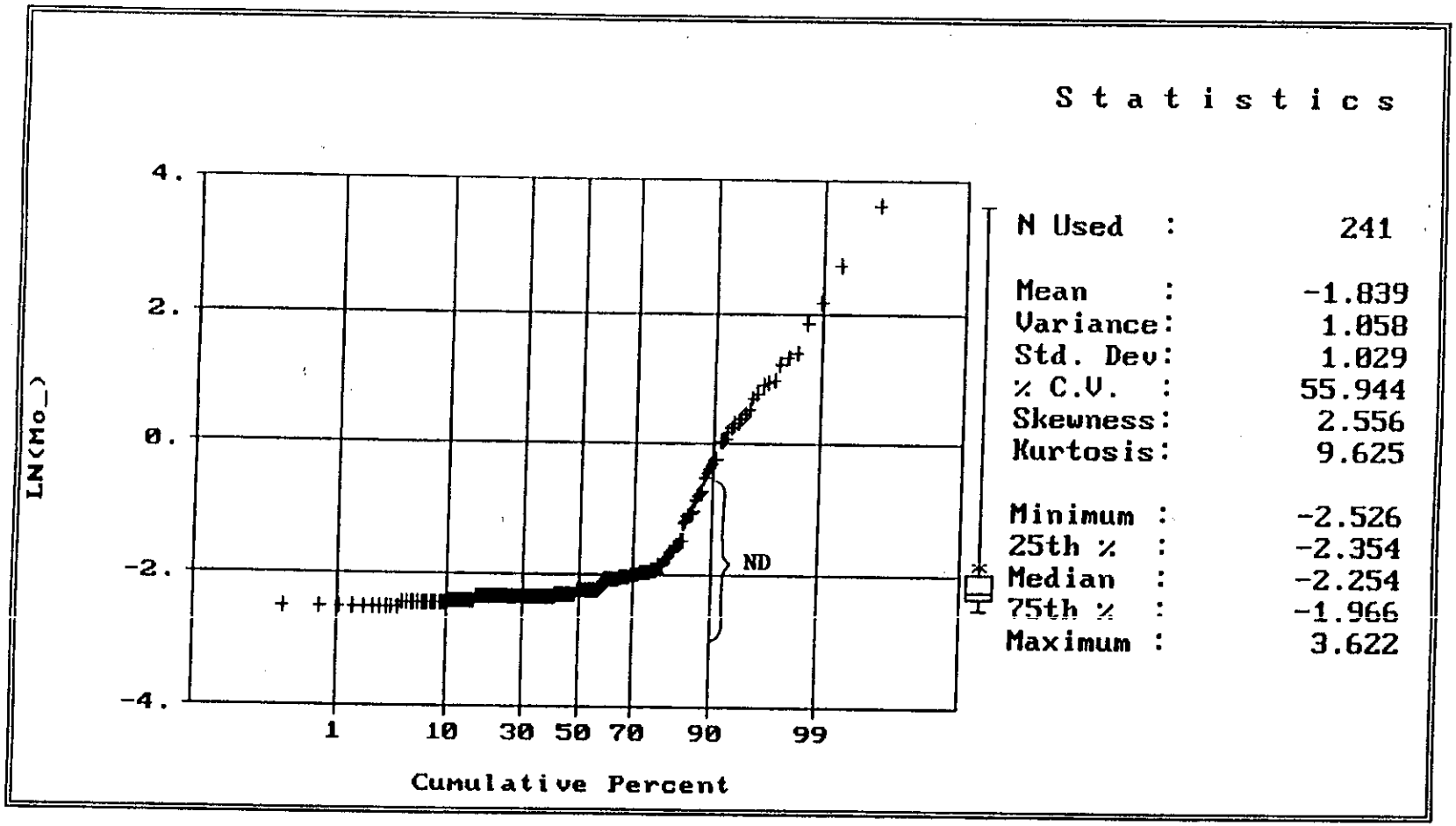
Note: The data set distribution is lognormal.

FIGURE 32
PROBABILITY PLOT OF AMBIENT MANGANESE
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



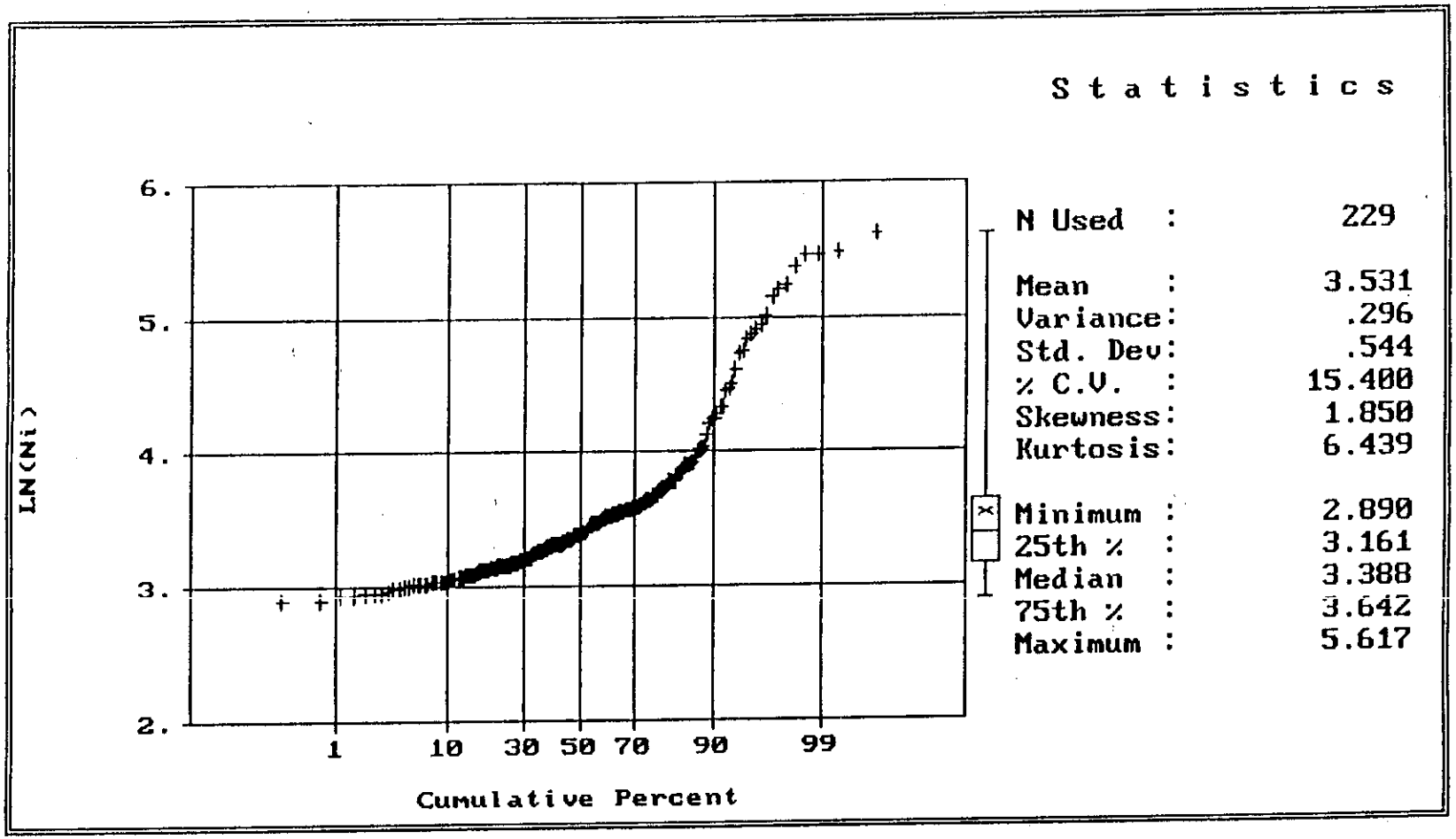
Note: The data set distribution is nonparametric.

FIGURE 33
PROBABILITY PLOT OF AMBIENT MERCURY
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



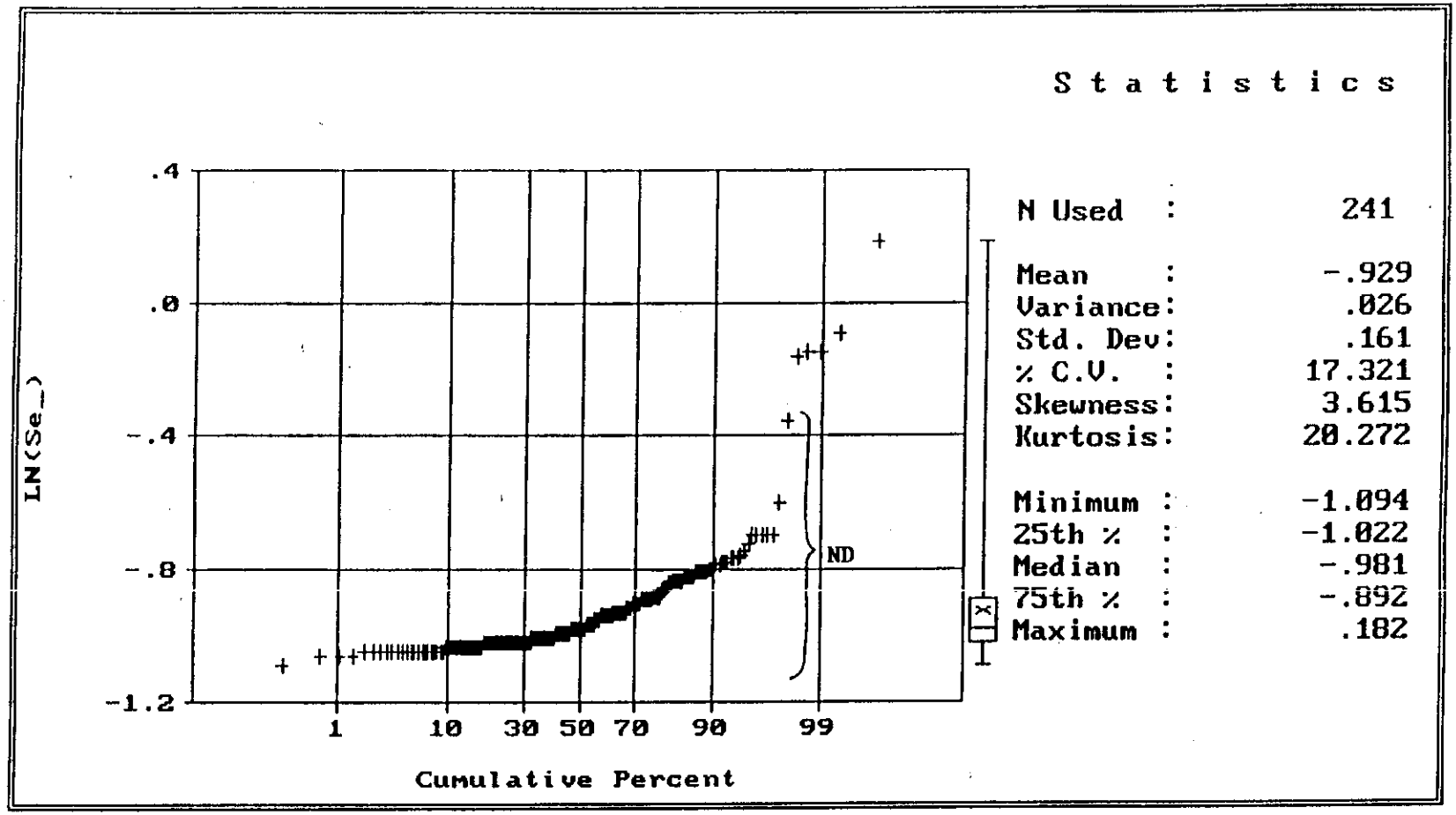
Note: The data set distribution is nonparametric.

FIGURE 34
PROBABILITY PLOT OF AMBIENT MOLYBDENUM
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



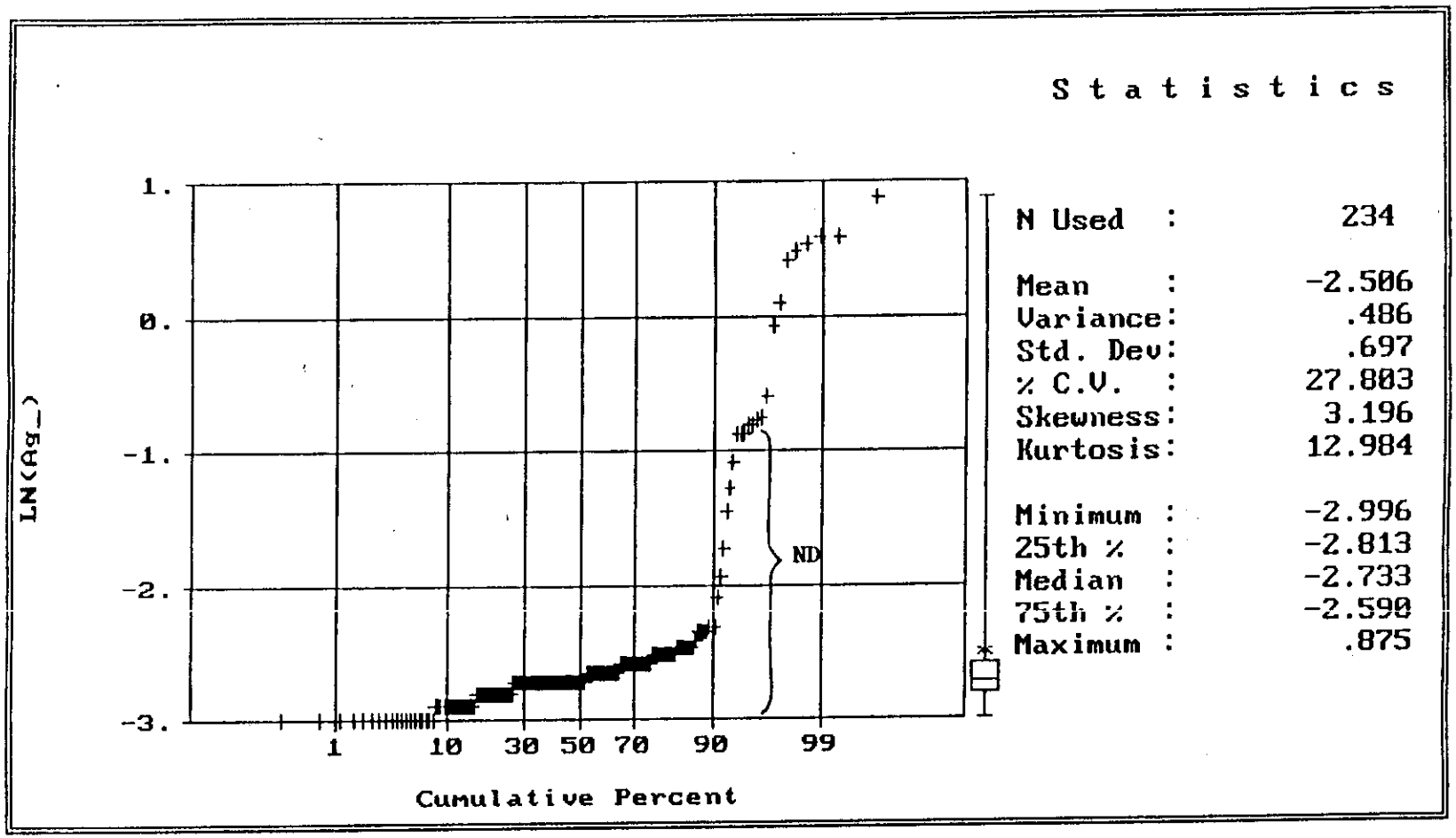
Note: The data set distribution is nonparametric.

FIGURE 35
PROBABILITY PLOT OF AMBIENT NICKEL
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



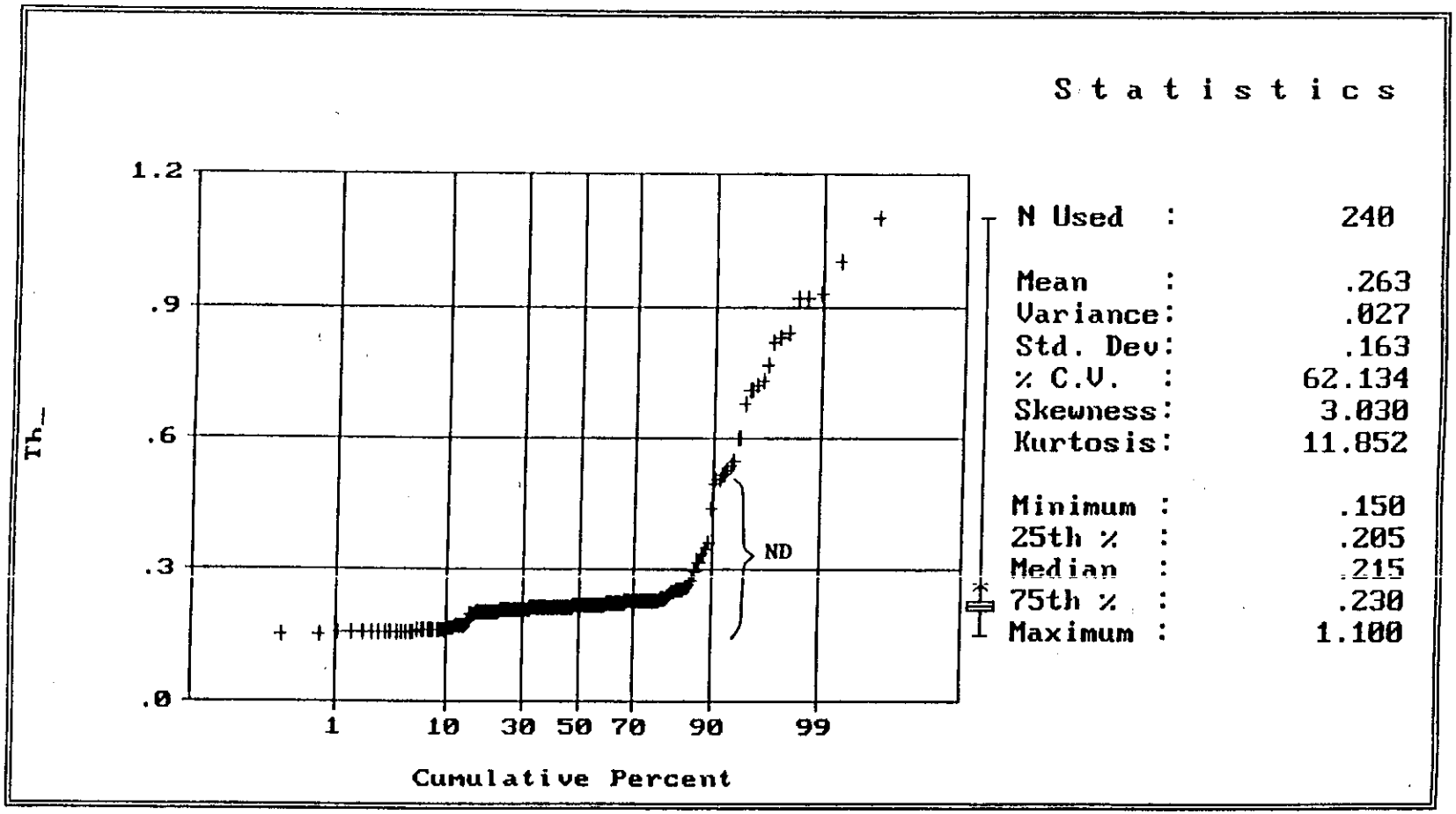
Note: The data set distribution is nonparametric.

FIGURE 36
PROBABILITY PLOT OF AMBIENT SELENIUM
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



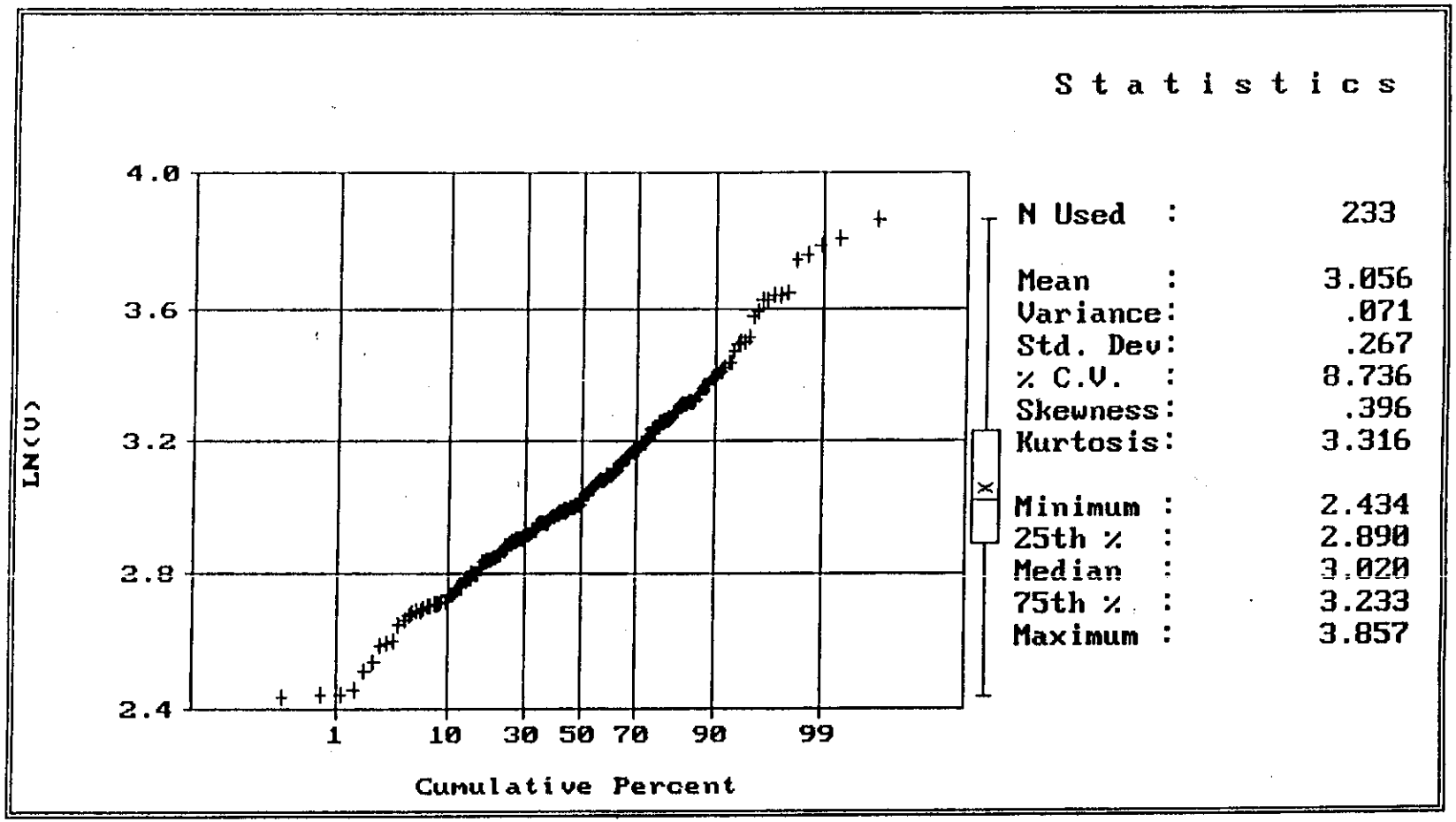
Note: The data set distribution is nonparametric.

FIGURE 37
PROBABILITY PLOT OF AMBIENT SILVER
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



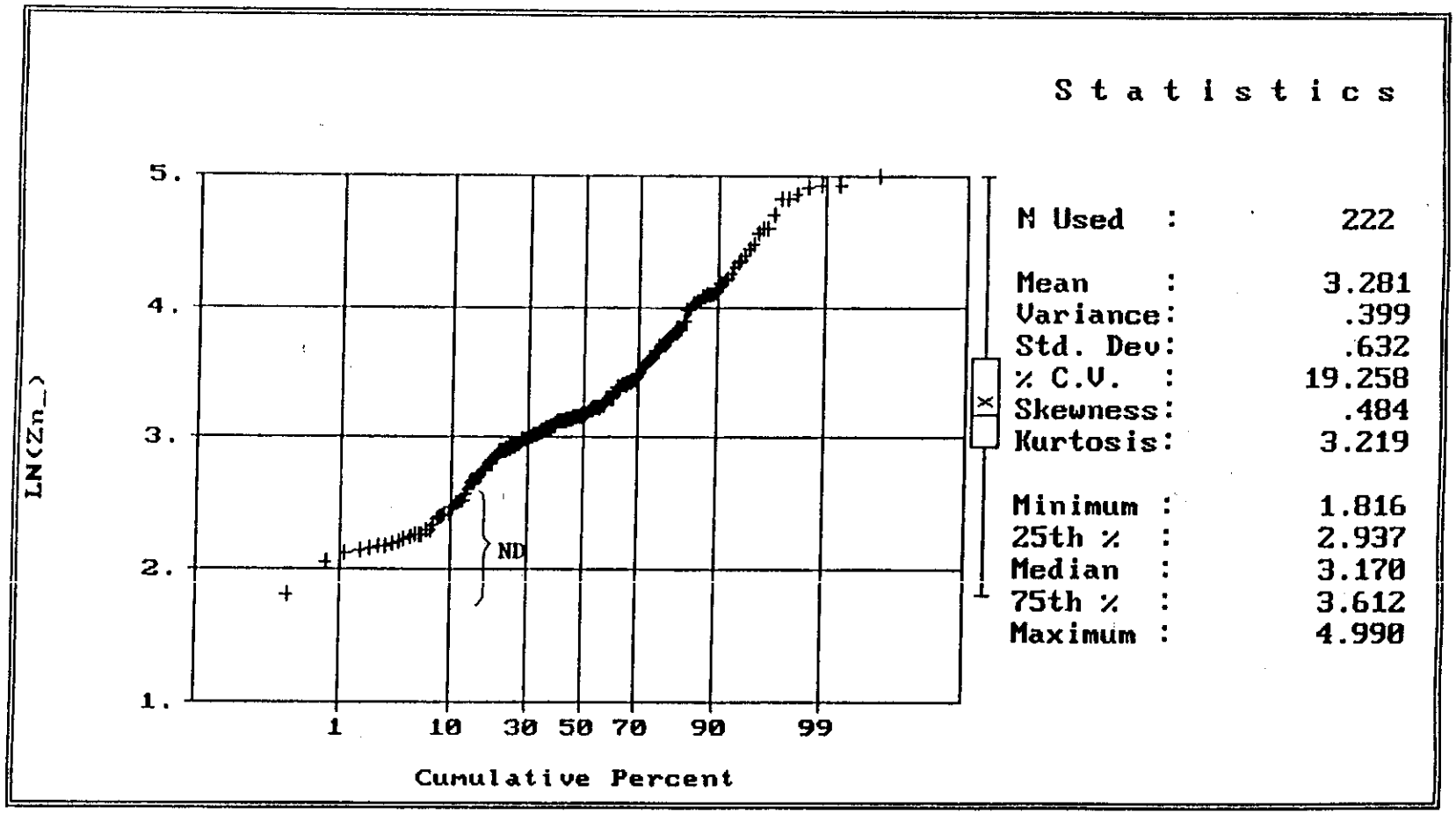
Note: The data set distribution is nonparametric.

FIGURE 38
PROBABILITY PLOT OF AMBIENT THALLIUM
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



Note: The data set distribution is lognormal.

FIGURE 39
PROBABILITY PLOT OF AMBIENT VANADIUM
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND



Note: The data set distribution is nonparametric.

FIGURE 40
PROBABILITY PLOT OF AMBIENT ZINC
CONCENTRATIONS IN ARTIFICIAL FILL
NAVAL STATION TREASURE ISLAND

TABLES

TABLE 1. BACKGROUND METAL CONCENTRATIONS IN SOILS. YERBA BUENA ISLAND

Metal	Number of Detections/ Samples Analyzed	Values Excluded		Background Data Set Size[a]	Background Data Set Distribution	Soil Metal Concentration Statistics for Ambient Data Sets (mg/kg)						U.S. EPA PRG[c] (mg/kg)
		Too Low	Too High			Minimum Detected	Maximum detected[b]	Mean/50th percentile[c]	Standard Deviation	Coefficient of Variation	**80% LCL on the 95th percentile[d] (Background Level)**	
Aluminum	21/21	0	0	21	Lognormal	4,800.0	22,500.0	10,641.32	3,576.09	0.04	**17,000**	77,000
Antimony[f]	43/78	0	2	76	Nonparametric	0.22	1.5	0.65	N/A	N/A	**1.3**	31
Arsenic	16/21	0	0	21	Nonparametric	2.3	11.1	4.10	N/A	N/A	**9***	0.38
Barium	21/21	0	0	21	Nonparametric	33.2	285.0	147.00	N/A	N/A	**270**	5,300
Beryllium	2/21	0	0	21	Nonparametric	0.25	0.47	0.11	N/A	N/A	**0.26***	0.14
Cadmium	5/21	0	0	21	Nonparametric	0.23	1.4	0.11	N/A	N/A	**0.49**	9.0[g]/38
Chromium	21/21	0	0	21	Normal	31.2	54.0	40.40	5.79	0.14	**49**	210[h]
Cobalt	21/21	0	0	21	Normal	2.4	19.8	9.99	3.89	0.39	**16**	4,600
Copper	21/21	0	0	21	Lognormal	3.7	48.6	20.04	15.36	0.25	**46**	2,800
Lead	21/21	0	3	18	Lognormal	2.3	68.8	32.97	63.31	0.46	**63**	130[g]/400
Manganese	21/21	0	0	21	Nonparametric	79.8	575.0	317.00	N/A	N/A	**540**	3,200
Mercury	7/21	0	0	21	Nonparametric	0.06	0.39	0.03	N/A	N/A	**0.33**	23[i]
Molybdenum	4/21	0	0	21	Nonparametric	2.1	2.4	1.05	N/A	N/A	**2.2**	380
Nickel	21/21	0	0	21	Normal	15.2	47.5	34.95	8.25	0.23	**45**	150[g]/1,500
Selenium	9/21	0	0	21	Nonparametric	0.62	1.5	0.50	N/A	N/A	**1.4**	380
Silver	0/21	0	0	21	Nonparametric	N/A	N/A	N/A	N/A	N/A	**DL[j]**	380
Thallium	0/21	0	0	21	Nonparametric	N/A	N/A	N/A	N/A	N/A	**DL[j]**	5.4[k]
Vanadium	21/21	0	0	21	Lognormal	27.5	55.0	36.71	7.03	0.05	**49**	540
Zinc	21/21	0	1	20	Lognormal	15.7	399.0	72.71	64.68	0.19	**170**	23,000

TABLE 1
(Continued)

Notes:

a The background data set consists of both detected and nondetected results after exclusion of anomalously high values. Nondetected results are represented by values of one-half of the detection limit.

b The maximum detected concentration in the background data set after exclusion of anomalously high values.

c Mean values for normal distribution are the arithmetic means. Mean values for lognormal distribution were estimated using simple estimator (Gilbert 1987). Mean values for nonparametric distributions were estimated as the 50th percentile of the background data set.

d The 80th percent lower confidence limit on the 95th percentile of the distribution was calculated using a nonparametric formula. Results were rounded to two significant figures.

e U.S. Environmental Protection Agency (EPA) Region IX preliminary remediation goals (PRG) for residential use (EPA 1995). Listed PRG for manganese is based on the recently revised value of the oral Reference Dose (EPA 1996).

f A background concentration level was calculated as the 95th percentile of the distribution using a nonparametric formula. Since antimony results were rejected in all but one background samples, metal data from Yerba Buena Island sites (except Site 11) were used.

g California Environmental Protection Agency PRGs (listed as Cal-modified PRGs in EPA 1995)

h The PRG for total chromium, which assumes a one to six ratio of chromium VI/chromium III, is listed although chromium VI was not detected at Yerba Buena Island.

i PRG for mercuric chloride

j The background level was set at the detection limit.

k PRG for thallic oxide

DL Detection limit

N/A Not available

* The background level exceeds the PRG.

TABLE 2. AMBIENT METAL CONCENTRATIONS IN ARTIFICIAL FILL. TREASURE ISLAND

Metal	Number of Detections/ Samples Analyzed	Values Excluded		Ambient Data Set Size[a]	Ambient Data Set Distribution	Soil Metal Concentration Statistics for Ambient Data Sets (mg/kg)						
		Too Low	Too High			Minimum Detected[b]	Maximum Detected[c]	Mean/50th Percentile[d]	Standard Deviation	Coefficient of Variance	95th percentile[e] (Ambient Level)	U.S. EPA PRG[f] (mg/kg)
Aluminum	241/241	0	0	241	Nonparametric	1190.0	18,600.0	4,230.18	N/A	N/A	**9,900**	77,000
Antimony	53/237	0	5	232	Nonparametric	0.45	18.2	0.27	N/A	N/A	**2.9**	31
Arsenic	207/241	5	5	231	Nonparametric	1.1	14.0	5.60	N/A	N/A	**10**[*]	0.38
Barium	238/241	0	0	241	Nonparametric	4.7	393.0	17.71	N/A	N/A	**260**	5,300
Beryllium	12/241	0	0	241	Nonparametric	0.02	0.77	0.01	N/A	N/A	**0.12**	0.14
Cadmium	24/241	0	0	241	Nonparametric	0.07	9.2	0.02	N/A	N/A	**1.4**	9.0[g]/38
Chromium	247/247	2	2	243	Nonparametric	10.7	191.0	29.31	N/A	N/A	**75**	210[h]
Cobalt	241/241	2	2	237	Nonparametric	4.0	26.7	6.80	N/A	N/A	**16**	4,600
Copper	214/241	1	1	239	Nonparametric	1.9	1260.0	5.60	N/A	N/A	**85**	2,800
Lead	221/234	0	7	227	Nonparametric	1.2	51.4	3.90	N/A	N/A	**21**[i]	130[g]/400
Manganese	241/241	1	1	239	Lognormal	56.9	1360.0	246.66	153.13	0.11	**550**	3,200
Mercury	51/246	1	1	244	Nonparametric	0.03	2.4	0.03	N/A	N/A	**0.51**	23[j]
Molybdenum	27/241	0	0	241	Nonparametric	0.21	37.4	0.10	N/A	N/A	**2.0**	380
Nickel	241/241	6	6	229	Nonparametric	18.0	275.0	29.61	N/A	N/A	**133**	150[g]/1,500
Selenium	5/241	0	0	241	Nonparametric	0.85	1.2	0.37	N/A	N/A	**0.5**[k]	380
Silver	20/241	0	7	234	Nonparametric	0.28	2.4	0.07	N/A	N/A	**0.45**	380
Thallium	24/241	0	1	240	Nonparametric	0.44	1.1	0.22	N/A	N/A	**0.71**	5.4[l]
Vanadium	241/241	4	4	233	Lognormal	11.4	47.3	22.01	5.97	0.08	**33**	540
Zinc	209/241	0	19	222	Nonparametric	11.2	147.0	23.81	N/A	N/A	**94**	23,000

TABLE 2
(Continued)

Notes:

a The ambient data set consists of both detected and nondetected results after exclusion of anomalously high and low values. Nondetected results are represented by values of one-half of the detection limit.

b The minimum detected concentration in the ambient data set after exclusion of anomalously low values

c The maximum detected concentration in the ambient data set after exclusion of anomalously high values

d Mean values for normal distribution are the arithmetic means. Mean values for lognormal distribution were estimated using simple estimator (Gilbert 1987). Mean values for nonparametric distributions were estimated as the 50th percentile of the background data set.

e The 95th percentile of the distribution was calculated using distribution-dependent formulae. Results were rounded to two significant figures.

f U.S. Environmental Protection Agency (EPA) Region IX preliminary remediation goals (PRG) for residential use (EPA 1995). Listed PRG for manganese is based on the recently revised value of the oral Reference Dose (EPA 1996).

g California Environmental Protection Agency PRGs (listed as Cal-modified PRGs in EPA 1995)

h The PRG for total chromium, which assumes a one to six ratio of chromium VI/chromium III

i The ambient level for lead was estimated excluding the Site 12 soil samples which were considered to be affected by contamination.

j PRG for mercuric chloride

k The ambient level for selenium is less than minimum detected result because of large proportion of nondetected results in the data set (see note "a" regarding nondetected results).

l PRG for thallic oxide

* The ambient level exceeds the PRG.

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REFERENCES

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ATTACHMENT

OVERVIEW OF STATISTICAL METHODS

1.0 INTRODUCTION

This attachment provides an overview of the statistical methods used to estimate ambient metal concentrations. Section 2.0 indicates the way the distributions of the data sets were tested for normality. Sections 3.0 and 4.0 describe procedures for finding estimators of the mean concentration and the 80 percent lower confidence limit on the 95th percentile ($LCL_{80,95}$) or strict 95th percentile using distribution-dependent formulae. The description of methods in this attachment is adopted from the book by R.O. Gilbert *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand publishers, 1987.

2.0 NORMALITY TESTS

In conjunction with histograms and probability plots that allow qualitative analysis, the assumption of normality is tested using Wilk's *W*-test for data sets with 50 or fewer values and D'Agostino's *D*-test for data set with more than 50 values (Gilbert 1987).

For data sets with n less than or equal to 50, the *W*-test is used to test a null hypothesis that a sample population has a normal distribution as follows:

Step 1 Compute the denominator d of the W test statistic for n values:

$$d = \sum_{i=1}^{n} (x_i - \bar{x})^2$$

Step 2 Rank the data from minimum to maximum to obtain the sample order statistics:

$$x_1 \leq x_2 \leq \ldots \leq x_k \ldots \leq x_n$$

Step 3 Compute k.

where,

$k = n/2$ if n is even
$k = (n\text{-}1)/2$ if n is odd

Step 4 Find coefficients $a_1, a_2, \ldots a_k$ for n observations from Table A6 (Gilbert 1987).

Step 5 Compute the W statistic:

$$W = \frac{1}{d} \left[\sum_{i=1}^{k} a_i \left(x_{[n-i+1]} - x_{[i]} \right) \right]^2$$

Step 6 If W is less than the quantile in Table A7 (Gilbert 1987) for a given significance level, then the null hypothesis that the population is normally distributed can be rejected.

If normality is not confirmed through the W-test, then the test is conducted on the logarithms of the data. If both normal and lognormal assumptions are rejected, then the nonparametric techniques must be used in estimating ambient limits.

For data sets with n greater than or equal to 50, the D-test is used to test a null hypothesis that a sample population has a normal distribution as follows:

Step 1 Rank the data from minimum to maximum to obtain the sample order statistics:

$$x_1 \leq x_2 \leq \ldots \leq x_k \ldots \leq x_n$$

Step 2 Compute the statistic:

$$D = \frac{\sum_{i=1}^{n} \left[i - \frac{1}{2} (n + 1) \right] x_{[i]}}{n^2 s}$$

Where,

$$s = \left[\frac{1}{n} \sum_{i=1}^{n} \left(x_i - \bar{x} \right)^2 \right]^{1/2}$$

Step 3 Transform D to the statistic Y by the following computation:

$$Y = \frac{D - 0.28209479}{0.02998598/\sqrt{n}}$$

If n is large and the data are drawn from a normal distribution, the expected value of Y is zero. For nonnormal distributions, Y will tend to be either less than or greater than zero, depending on the particular distribution. This fact necessitates a two-tailed test (step 4).

Step 4 Reject at the α significance level the null hypothesis that the n data were drawn from a normal distribution if Y is less than the $\alpha/2$ quantile or greater than the 1 - $\alpha/2$ quantile of the distribution Y. These quantiles are given in Table A8 (Gilbert 1987) for selected values of n between 50 and 1,000.

If normality is not confirmed through the D-test, then the test is conducted on the logarithms of the data. If both normal and lognormal assumptions are rejected, then nonparametric techniques must be used in estimating ambient limits.

3.0 AMBIENT LIMITS ESTIMATION FOR SMALL DATA SETS

For small data sets (those containing less than 50 values), the ambient limits are estimated as the 80 percent lower confidence limit on the 95th percentile of the distribution. If n is greater than 20, then a nonparametric formula (Gilbert 1987) is used as follows:

Step 1 Rank the data from minimum to maximum to obtain the sample order statistics:

$$x_1 \leq x_2 \leq \ldots \leq x_k \ldots \leq x_n$$

Step2 Calculate l:

$$l = p\,(n + 1) - Z_{1-\alpha}\sqrt{np(1 - p)}$$

Where,

p = 0.95
α = 0.20 = significance level
n = number of values in the data set
$Z_{1-\alpha}$ = $Z_{0.80}$ = 0.845, as obtained from Table A-1 (Gilbert 1987)

The simplified formula is as follows:

$$l = 0.95\,(n + 1) - 0.184\sqrt{n}$$

Step 3 If the calculated l is an integer, then the $LCL_{80,95}$ is the lth largest datum (among the ranked concentrations) in the data set. If l is not an integer, then estimate the $LCL_{80,95}$ by linear interpolation between the two concentrations closest to l.

4.0 AMBIENT LIMITS ESTIMATION FOR LARGE DATA SETS

For data sets with more than 50 values, ambient limits are estimated as the strict 95th percentile using distribution-dependent formulae (Gilbert 1987). The procedures for calculating the ambient limits for large data sets with normal, lognormal and nonparametric distributions are presented in sections 4.1 through 4.3.

4.1 AMBIENT LIMITS FOR CALCULATION NORMAL DISTRIBUTIONS

For normally distributed data, the mean, $\bar{x}$, and standard deviation, s, are first calculated:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad \text{and} \qquad s = \sqrt{\frac{\sum_{i=1}^{n} \left(x_i - \bar{x} \right)^2}{n - 1}}$$

Where,

n = the total number of data points in the data set
x_i = an individual data point

In general, the pth percentile (quantile), x_p, can be estimated by the following computation:

$$\hat{x}_{p} = \bar{x} + Z_p \, s$$

Where,

Z_p = the pth quantile of the standard normal distribution (obtained from Table A-1 [Gilbert 1987])

Because $Z_{0.95}$ is equal to 1.645, the 95th percentile concentration is calculated as follows:

$$\hat{x}_{p} = \bar{x} + 1.645 \, s$$

4.2 AMBIENT LIMITS FOR CALCULATION LOGNORMAL DISTRIBUTIONS

Evaluation of lognormally distributed data is a three-step operation:

Step 1 The data set is "transformed" by finding the logarithm of each value, x_i:

$$y_i = \ln x_i$$

Step 2 The lognormal mean and standard deviation, $\bar{y}$ and s_y, are calculated from the transformed data:

$$\bar{y} = \frac{\sum_{x=i}^{n} y_i}{n} \qquad \text{and} \qquad s_y = \sqrt{\frac{\sum_{i=1}^{n} \left(y_i - \bar{y} \right)^2}{n - 1}}$$

Step 3 The 95th percentile concentration is calculated as follows:

$$\hat{x}_{0.95} = \exp\left(\bar{y} + 1.645\ s_y\right)$$

4.3 AMBIENT LIMITS ESTIMATION FOR NONPARAMETRIC DISTRIBUTIONS

Ambient limits are estimated as the 95th percentile using a nonparametric formula (Gilbert 1987) as follows:

Step 1 Rank the data from minimum to maximum to obtain the sample order statistics:

$$x_1 \le x_2 \le \ldots \le x_k \ldots \le x_n$$

Step 2 Calculate the kth value that corresponds to the 95th percentile as follows:

$$k = p\,(n + 1) = 0.95\,(n+1)$$

Step 3 If k is an integer, then the estimated pth percentile, x_p, is the kth largest datum (concentration) in the data set. If k is not an integer, then x_p is obtained by linear interpolation between the two closest concentrations corresponding to k.

APPENDIX G
ESTIMATION OF AMBIENT CONCENTRATIONS OF METALS IN GROUNDWATER

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order 284

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DEPARTMENT OF THE NAVY
Southwest Division
Naval Facilities Engineering Command
San Diego, California

FINAL TECHNICAL MEMORANDUM ESTIMATION OF AMBIENT CONCENTRATIONS OF METALS IN GROUNDWATER

NAVAL STATION TREASURE ISLAND
SAN FRANCISCO, CALIFORNIA

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ABBREVIATIONS AND ACRONYMS

CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COPC	Chemical of potential concern
CTO	Contract Task Order
DTSC	Department of Toxic Substances Control
DQO	Data quality objectives
EPA	U.S. Environmental Protection Agency
FSP	Field sampling plan
IR	Installation Restoration
mg/L	Milligrams per liter
µg/L	Micrograms per liter
NAVSTA TI	Naval Station Treasure Island
RI	Remedial investigation
RWQCB	Regional Water Quality Control Board
TDS	Total dissolved solids
TI	Treasure Island
TSS	Total suspended solids
TtEMI	Tetra Tech EM Inc.
YBI	Yerba Buena Island

1.0 INTRODUCTION

Tetra Tech EM Inc. (TtEMI) received Contract Task Order (CTO) No. 284 under Comprehensive Long-term Environmental Action Navy (CLEAN II) Contract No. N62474-94-D-7609 from the Department of the Navy (Navy), Naval Facilities Engineering Command, Southwest Division (SWDIV) and Engineering Field Activity West, to conduct facilitywide interim groundwater monitoring at Installation Restoration (IR) Program sites at the former Naval Station Treasure Island (NAVSTA TI) in San Francisco, California. One of the tasks under this CTO in 2000 was to implement a study to establish ambient concentrations of metals in groundwater. This metals study included: (1) development of the data quality objectives (DQO), (2) groundwater sampling from wells not impacted by site contamination, and (3) establishing ambient concentrations of metals in groundwater at NAVSTA TI.

The DQOs for this study are described in the addendum to the field sampling plan (FSP) and quality assurance project plan (QAPP) for the facilitywide groundwater monitoring program (TtEMI 2000a). The details of groundwater sampling conducted in 2000 are provided in the interim groundwater status report (TtEMI 2000b). This technical memorandum presents the results of estimating ambient concentrations of metals in groundwater at NAVSTA TI. The estimated ambient concentrations are intended for use in the baseline human health risk assessment, ecological risk assessment, and the remedial investigation (RI) of the IR sites at NAVSTA TI. The approach for estimating the upper limits of ambient metals concentrations in groundwater documented in this technical memorandum follows an approach similar to the one developed for Mare Island (PRC 1996).

In this document, Section 1.0 discusses the purpose of the evaluation and contains information on the site location and background. Section 2.0 introduces the study's approach. Section 3.0 describes how the collected data were evaluated and how the ambient data set was formed. Section 4.0 provides the details on the statistical analysis of metals data. Section 5.0 summarizes the findings of the evaluation of ambient concentrations of metals in groundwater. The results of the estimation are presented in Tables 1 through 4 and Figures 2 through 35. Section 6.0 lists all references cited in this document. Appendix A provides an overview of statistical methods used. Appendix B lists the analytical data for selected wells. Appendix C presents the Navy's responses to agency comments on the draft technical memorandum.

1.1 PURPOSE

The purpose of the study was to collect representative analytical data for groundwater and to estimate the ambient concentrations of metals in groundwater at NAVSTA TI. Metals in groundwater may be naturally occurring or may result from site activities and other anthropogenic sources (human activities such as atmospheric fallout that are unrelated to operations at NAVSTA TI). Metals that occur naturally in groundwater or result from other anthropogenic sources should not be identified as chemicals of potential concern (COPC) for individual IR sites because they may be present throughout the facility and are unrelated to site-specific activities. Therefore, it is necessary to estimate ambient levels for metals in groundwater to distinguish between contamination caused by the Navy and concentrations resulting from natural or anthropogenic sources.

The term "background" is typically used to describe naturally occurring levels of inorganic constituents in groundwater. However, some metals concentrations in groundwater may not be naturally occurring, but are unrelated to Navy activities at NAVSTA TI. For example, lead contamination may be related to atmospheric deposition of lead from leaded gasoline and mercury contamination in the San Francisco Bay area may be related to mining activities in the Sierra Nevada. Such metals concentrations are referred to as "ambient." In this document, the term "ambient" combines both naturally occurring and anthropogenic chemicals and is used to describe levels of inorganic constituents in groundwater that are unrelated to Navy activities.

Ambient concentrations of metals in groundwater are expected to vary both temporally and spatially at NAVSTA TI. These inherent variations in metals concentrations can potentially arise from several factors, including: (1) variations in soil characteristics and lithology of the vadose zone; (2) variations in lithology of the saturated zone; (3) variations in geochemical conditions in groundwater (pH, oxidation-reduction potential, salinity, cation exchange capacity of an aquifer); (4) seasonal infiltration of precipitation; and (5) evapotranspiration, which tends to concentrate inorganic chemicals in the groundwater.

Because ambient concentrations of metals in groundwater vary over space and time, it is appropriate to consider ambient concentrations as a distribution of values rather than a single value. For the purpose of screening potential COPCs, a single value (a high value of the ambient distribution) is sometimes used to determine if metals in groundwater at a site are higher than ambient concentrations. However, a more reliable determination can be made by statistically comparing two distributions (site data versus ambient data) using two-sample tests such as the Wilcoxon Rank Sum (WRS) test and Quantile test (Gilbert 1987;

U.S. Environmental Protection Agency [EPA] 1998; Navy 1999) or using more sophisticated procedures such as prediction intervals and control charts (Gibbons 1994) on a site-by-site basis. In this technical memorandum, a single value - the 95th percentile of ambient concentrations - is derived for simple screening purposes.

The best method of estimating ambient metal concentrations is to statistically analyze a reasonably large population of metals data for samples collected from areas that are not affected by metals contamination. Although a large amount of data was obtained as part of groundwater monitoring conducted at the IR sites since late 1980s, most of the metals data came from samples collected from contaminated or potentially contaminated areas and could not be reliably used. Moreover, most analytical data for metals came from unfiltered samples collected with bailers (a method that would bias metal concentrations high); little data was available from filtered samples. For this ambient metals study, a more robust, low-flow sampling methodology was used (Puls and Barcelona 1994) to collect four quarters of groundwater samples from wells considered to be unaffected by site contamination.

1.2 SITE LOCATION AND BACKGROUND

NAVSTA TI, now referred to as Treasure Island, is located in San Francisco Bay midway between San Francisco and Oakland, California (Figure 2-1). Naval station operations were formerly conducted on two islands connected by a causeway: Treasure Island (TI) proper, which is approximately 403 acres, and Yerba Buena Island (YBI), which is approximately 147 acres. TI is a manmade island constructed of sediment dredged from San Francisco Bay. YBI is a natural island that mostly consists of relatively impermeable bedrock.

The groundwater at Treasure Island is under unconfined conditions at an average depth of approximately 5 feet below grade. Groundwater flows radially from the center of the island toward the shoreline (TtEMI 1999). Fresh groundwater (containing less than 3,000 milligrams per liter [mg/L] of total dissolved solids [TDS] is present within only a thin lens at TI. Shallow groundwater within the interior portions of the island is fresh water that is recharged through rainfall, irrigation, and pipe leakage and is not subject to saltwater intrusion. The top of the transition zone from fresh water to salt water (greater than 10,000 mg/L) occurs throughout inland portions of TI, between depths of 15 to 30 feet below ground surface (bgs). However, the depth of the transition zone between fresh water and salt water will shift vertically as a result of seasonal and other factors. Within near-shore areas throughout the perimeter of the island, fresh groundwater grades laterally into a zone of physical mixing, where groundwater and Bay water are mixed

because of tidal fluctuations. The zone of physical mixing may extend from the shoreline to a distance of about 50 to 250 feet inland shore.

Military activity at the former naval station on YBI dates back to 1866 (Mare Island Naval Shipyard 1995). During World War II, NAVSTA TI became a major naval facility, processing and training thousands of military personnel. In 1993, NAVSTA TI was designated for closure under the federal Base Realignment and Closure (BRAC) program, with the intent of transferring the property and facilities to neighboring communities as expeditiously as possible and with minimal adverse effect on the local economy. NAVSTA TI was subsequently closed on September 30, 1997.

Potential impacts to groundwater as a result of releases from operations when NAVSTA TI was an active base are being studied under the facilitywide groundwater monitoring program. Figure 1 shows the locations of 17 IR sites where groundwater has been sampled and evaluated for potential site-related contaminants. Background information on each site is presented in the groundwater status reports for NAVSTA TI (TtEMI 1999; 2000b).

Since the late 1980s, groundwater monitoring has been conducted at NAVSTA TI in an effort to characterize contamination that may have been caused by past activities at the IR sites. In support of remedial activities at NAVSTA TI, a total of 105 groundwater monitoring wells currently are maintained at the IR sites. In addition to these 105 current IR site monitoring wells, the Navy maintains 37 monitoring wells under a separate remedial program at various former underground storage tank (UST) sites at NAVSTA TI.

2.0 APPROACH

The approach used in the ambient metals study included the following steps:

1) Identify wells not affected by contamination originating from sites and collect four quarters of groundwater samples using low-flow techniques, analyze the samples, and compile new data

2) Compare newly collected metals data with previous data

3) Evaluate variability and trends in metal concentrations and compile the ambient data set

4) Conduct statistical data analysis and estimate the upper limits of the ambient concentrations of metals in TI groundwater

Because limited historic data are available to evaluate ambient concentrations, additional four quarters of metals data from the existing monitoring wells were collected. A number of wells and the sampling frequency was determined using the DQO process developed for this study (TtEMI 2000a). Four consecutive quarters of data (covering both wet and dry periods of the year) were expected to adequately represent seasonal variability of metal concentrations. The number of samples required was estimated based on the coefficient of variation calculated using previous metals data and statistical performance objectives to achieve a specified precision and confidence level at a defined minimum detectable relative difference (EPA 1989). As detailed in the FSP (TtEMI 2000a, Section 4.6), approximately 100 samples were found to be sufficient for meeting the study goals.

Low-flow purging and sampling techniques (Puls and Barcelona 1995) were used in the ambient metals study. These techniques provide samples that are representative of the 'mobile' load of metals present (dissolved and colloid-associated). The groundwater samples were collected using dedicated bladder pumps and were analyzed for total metals (TtEMI 2000a). Also, samples were analyzed for total suspended solids (TSS) to evaluate whether high concentrations of suspended particles were present in a particular sample.

3.0 WELL SELECTION AND DATA SET EVALUATION

The decisions identified in the DQO process developed for the ambient metals study were as follows:

1) Are the wells selected for this ambient metals study representative of ambient groundwater conditions at NAVSTA TI?

2) Is one year of quarterly sampling adequate to address possible seasonal effects in groundwater chemistry?

3) Do concentrations of metals in wells selected for this ambient study exhibit temporal and spatial trends?

4) Is the proposed number of samples adequate to characterize the chemistry of ambient groundwater?

The following sections discuss how the data set for ambient metals was developed and provide the answers to the questions above.

3.1 WELL SELECTION

The first step in determining ambient conditions was to define the existing wells that are unaffected by contamination originating from IR sites. The sources of groundwater contamination at sites have not been attributed to historical operations involving metals (TtEMI 1999). Although most of the existing groundwater monitoring wells at NAVSTA TI were installed to evaluate potential site-related chemical releases, many of these wells showed no evidence of groundwater contamination based on quarterly sampling events conducted since the late 1980s. The selection of unaffected wells was based on (1) knowledge of historical operations and source areas and observations documented in the groundwater status report for NAVSTA TI (TtEMI 1999), and (2) the groundwater monitoring and sampling summary report at UST sites (AGS 2000). As a result of the selection process, 26 existing monitoring wells were identified for use in the ambient metals study (Figure 1). These 26 wells are as follows: 01-MW01, 06-MW09, 06-MW20, 12-MW03, 12-MW04, 12-MW09, 14-MW04, 15-MW03, 17-MW01, 20-MW01, 20-MW05, 21-MW01, 22-MW05, 24-MW01, 24-MW03, 25-MW01, 143-MW2, 180C-MW2, 201-MW3, 227-MW1, 227-MW2, 227-MW3, 368A-MW2, 368A-MW3, 368B-MW1, and 368B-MW3.

The following two specific decisions were addressed in the data evaluation process:

(a) If shallow wells are upgradient or cross-gradient from known sources of contamination, exhibit no or little historic contamination with organic chemicals, and have low concentrations of TDS and low TSS values (no saltwater intrusion, low levels of suspended solids), then include these wells in the ambient metals study.

(b) If shallow wells exhibit contamination with organic chemicals or have high TDS and TSS values (indicating saltwater intrusion or high levels of suspended solids), then eliminate these wells from the ambient metals study.

The newly collected and previous data for the 26 wells selected for this study are presented in Appendix B. Because these wells show little or no evidence of contamination with organic chemicals, they were considered suitable to estimate the ambient concentrations of metals in groundwater across the facility. The spatial distribution of selected wells is uniform throughout TI and is representative of various site conditions (Figure 1).

The groundwater samples from wells 143-MW2 and 180C-MW2 had relatively high TDS values (as much as 8,060 mg/L in October 2000). These wells are partly screened in the transition zone from fresh to brackish groundwater. With the exception of sodium and potassium, the metals data from these wells were

found to be similar to metals data from other wells selected for the ambient metals study. Thus, the metals data from these wells were retained in the data set.

Because the groundwater samples from well 24-MW03 were found to contain high levels of TSS (as much as 35 mg/L versus the average value of 2 mg/L), metals data from this well were excluded from further consideration. The highest (or second-highest) concentrations of iron, manganese, copper, and lead were detected in this well (see Appendix B). Most of metals data from this well, however, were found to be similar to metals data from other wells selected for the ambient metals study.

3.2 COMPARISON OF METALS DATA FROM DIFFERENT SAMPLING PROCEDURES

Since the late 1980s, a number of environmental studies have been conducted at NAVSTA TI in an effort to characterize contamination that may have been caused by past activities at the IR sites. By 1998, 90 monitoring wells were installed and sampled as a result of the RI program (TtEMI 1999). Before 1998, metals samples from the quarterly groundwater sampling events were not filtered. As a result, only total metals concentrations are available before 1998. Both filtered and unfiltered samples of groundwater were collected during the 1998 quarterly sampling events and were analyzed for metals (Appendix B).

Groundwater samples obtained before 1998 were collected with bailers and were not filtered prior to analysis. Unfiltered samples typically contain suspended particles. Metals detected in unfiltered samples reflect not only the metals in solution, which are mobile in the subsurface environment, but also the metals associated with the suspended particles, which are not mobile under typical groundwater flow conditions. Therefore, the metals data from unfiltered samples were not considered in this study.

Field filtering of the samples is designed to remove particles from the sample prior to analysis. Analytical results from filtered samples provide metals concentrations that are considered to be representative of dissolved metals present in groundwater. However, most groundwater data available for NAVSTA TI consists of metals data from unfiltered samples. Filtered samples from one or two quarters of 1998 were available only from ten wells that were considered to contain little or no impact from site contamination.

Although filtered samples provide metals concentrations that are more representative of dissolved metals present in groundwater than unfiltered samples, filtration of a sample may cause a number of unintended changes to occur (such as oxidation or aeration). This may lead to filtration-induced artifacts during

sample analysis and uncertainty in the results. In addition, filtering may eliminate some colloid-associated metals. Additionally, the use of a standard 0.45-micron filter yields a sample that contains "dissolved" metals, based on an operational definition. Colloidal particles range in size from about 5 nanometers up to about 0.2 microns (Hem 1992), so some colloids still pass through the standard 0.45-micron filter (the pores in this filter size represent the nominal size of bacteria, which is why this filter size became widely used in the first place).

To eliminate any possible artifacts associated with field filtering of groundwater samples, a more robust low-flow purging and sampling technique (Puls and Barcelona 1995) was used in the ambient metals study. This technique provides unfiltered samples that are representative of the "mobile" load of metals present (dissolved and colloid-associated). The groundwater samples were collected using dedicated bladder pumps and were analyzed for total metals (TtEMI 2000b). Also, samples were analyzed for TSS to evaluate whether high concentrations of suspended particles were present in a particular sample. Results from the TSS analysis assisted in the assessment of outliers and in the interpretation of the metals data.

The frequently detected metals, such as arsenic, barium, manganese, magnesium, and molybdenum, were selected for the comparison of analytical results from filtered samples collected in 1998 and "low-flow" samples obtained in present study. The comparison was conducted using the WRS test at a 5 percent level of significance.

The WRS test is conducted to test whether measurements from one population tend to be consistently larger (or smaller) than those from another population. This test is a nonparametric version of the Student's t-test (Gilbert, 1987), which compares means of two normally distributed populations. The WRS test compares the distributions of two data sets on the basis of the order (or rank) of the data values, rather than on their magnitudes. The WRS test was used for data sets comparison because it provides a greater statistical power when one or both data sets are not normally distributed or have nondetects.

Except for barium and molybdenum, the results of the WRS test showed no significant difference in metal concentrations coming from filtered and "low-flow" unfiltered samples. Barium concentrations resulting from low-flow procedure are almost threefold higher than from filtered samples (the difference in means is 12.5 versus 4.5 micrograms per liter [µg/L], respectively). Molybdenum concentrations from "low-flow" samples are somewhat higher than from filtered samples (the difference in means is 3.9 versus 2.2 µg/L, respectively). The results of the WRS tests are summarized in Table 1. Figure 2 presents the box and

whisker plots of metal concentrations from filtered samples and "low-flow" unfiltered samples. The details of the box and whisker plots are explained in Section 3.2.3 of Appendix A.

The results of this evaluation suggest that all metals data resulting from the low-flow purging and sampling technique are generally comparable to previous filtered metals data collected in 1998 sampling events summarized in the groundwater status report for NAVSTA TI (TtEMI 1999). For the two metals that showed significant statistical difference based on the WRS test, the absolute magnitude of the difference is only slight. Therefore, the previous analytical data from filtered samples from the wells selected for the ambient metals study can be used to expand current metals data sets.

3.3 COMPARISON OF METALS DATA FROM WET AND DRY PERIODS

The issue of quantifying the magnitude of seasonal variation in metal concentrations was considered based on statistical significance. Although the seasonal variation of metal concentrations in groundwater was not expected to be large, some wet season concentrations appeared to be different from dry season concentrations in absolute values. One way of quantifying such a difference would be to compare the wet season data from all 26 selected wells against the dry season data using the WRS test. If the difference is found to be statistically insignificant at a 5 percent level of significance, then the decision of collecting no more data can be taken. If there is a statistically significant difference between the wet season and dry season concentrations for some metals, then professional judgment should be used to decide whether additional data should be collected to better represent wet and dry periods. The magnitude of the seasonal variation and data on climate and groundwater geochemistry also should be considered to support the decision-making process.

The following two specific decisions were addressed in the evaluation of seasonal variability in metals concentrations in groundwater:

(a) If, based on one year of quarterly sampling, seasonal variation in metal concentrations is found to be insignificant, then collect no more data.

(b) If seasonal variation in metal concentrations is found to be statistically significant, then evaluate the magnitude of the variation and use professional judgment to decide whether additional data should be collected.

The frequently detected metals (such as arsenic, barium, magnesium, manganese, and molybdenum) were selected for the evaluation of seasonal variability of concentrations. Data for samples collected in May

2000 were used to represent the wet period and data for samples collected in August and October 2000 represented the dry period. The comparison was conducted using the WRS test at a 5 percent level of significance. Except for molybdenum, the results of the WRS test showed no significant difference in metal concentrations of the wet and dry periods. The molybdenum concentrations in the dry period samples were found to be somewhat higher than in the wet period samples (the difference in means is 3.8 versus 5.4 µg/L, respectively). The results of the WRS tests are summarized in Table 2. Figure 3 presents the box and whisker plots of metal concentrations from samples collected during wet and dry periods.

For arsenic, barium, magnesium, and manganese, the WRS tests showed no significant difference between the metal concentrations of the dry and the wet periods. Although the molybdenum concentrations in the dry period samples appear to be higher than in the wet period samples, the magnitude of the difference is small. An increase in metals concentrations during the dry period may be related to evapotranspiration, which tends to concentrate chemicals in shallow groundwater (if the rate of evapotranspiration is greater than the rate of recharge, as is the case during the dry season at TI). Based on the results of this evaluation, no additional data are proposed to further evaluate the seasonal variability of metals data.

3.4 EVALUATION OF SPATIAL AND TEMPORAL TRENDS

The question of detecting possible temporal and spatial trends is (for simplicity) considered in relation to the potential influence of contaminant sources (assuming that contamination creates a stronger "signal" than a seasonal variation). The well that is downgradient from an active source may show an increasing or decreasing trend in chemical concentrations. Depending on the source strength, the monotonic trend can have a large or small magnitude. If the trend exists, it can be masked by analytical variation in the data. Because the wells selected for the ambient metals study were located upgradient or cross-gradient from the known sources of contamination, the changes in metals concentrations due to potential contaminant sources were not expected to be significant.

The following two specific decisions were addressed in the evaluation of temporal and spatial trends in metals data:

(a) If metals concentrations in selected background wells do not exhibit temporal or spatial trends, (or evidence of contamination), then include sample data for these wells in the ambient data set.

(b) If metals concentrations in selected background wells exhibit temporal or spatial trends, then exclude these wells from the ambient metals study.

It is difficult to quantify trends using only four quarters of data. Therefore, the previous metals data from filtered samples were used to extend the records for selected metals that were frequently detected (arsenic, barium, magnesium, manganese, and molybdenum). The previous metals data from filtered samples were available only from ten out of 26 wells. The time sequence plots for all selected wells are presented on Figures 4 through 13.

Trends in the metals concentrations were evaluated using the nonparametric Mann-Kendall test (Gilbert 1987). The test examines whether concentrations monotonically increase or decrease with time. It is a rank-based procedure, resistant to the influence of extremes.

With the exception of a few wells, the metals concentrations were not found to exhibit consistent temporal trends. No temporal trends in arsenic concentrations were detected in any of the wells. Upward trends in concentrations of barium were found in well 201-MW03 and a downward trend in barium concentrations was detected in well 17-MW01 (Figure 10). Upward trends in concentrations of magnesium were found in wells 21-MW01, 22-MW05, and 201-MW03 (Figures 6 and 11) and a downward trend in magnesium concentrations was detected only in well 180C-MW2 (Figure 11). Upward trends in concentrations of manganese were found in well 17-MW01 and a downward trend in manganese concentrations was detected in well 368A-MW3 (Figure 12). An upward trend in concentrations of molybdenum was found only in well 24-MW01 (Figure 13).

The 1998 and 2000 data indicate that long-term variability of metals concentrations is relatively small (see Figures 4 through 8). The processes of evapotranspiration and annual variations in local geochemical conditions are likely responsible for a short-term variability in metals concentrations. In most of cases, the magnitude of annual variation was found to be very low. The detected upward trends can be attributed to the concentrating effects of the evapotranspiration. A fresh-water lens that exists in the uppermost portion of the sandy aquifer is thickest during the winter months and gradually shrinks thereafter (TtEMI 1999). Evapotranspiration contributes to the shrinking of the fresh-water lens and tends to increase the concentrations of metals during the dry season.

The detected downward trends are probably related to local geochemical conditions. The observed temporal trends in metals concentrations appear to be unrelated to any sources of contamination. No spatial trends were identified in metals concentrations between the wells selected for the ambient metals study.

Based on the evaluation process described in Section 3.0, it follows that data from this ambient metals study appear to encompass the range of background chemistry, and the number of wells appears to be adequate for characterizing the background chemistry of shallow groundwater at NAVSTA TI. Collecting additional data to further evaluate seasonal variability and temporal trends in metals data is not proposed. The data set is considered adequate to proceed with the estimation of the upper limits of ambient metals concentrations in groundwater.

The resulting data set for ambient metals included the data from 25 wells that were sampled four times in 2000. The analytical results from duplicate samples were available for several wells and were averaged with the data from the original (primary) samples. In addition, the metals data from filtered samples were available from 10 out of 25 wells that were sampled once or twice in 1998. These data also were included in the ambient metals data set. As a result, each metal data set contained up to 112 discrete concentrations (Table 3).

4.0 ESTIMATION OF AMBIENT METALS CONCENTRATIONS

Statistical procedures consistent with EPA, Department of Toxic Substances Control (DTSC), and the Navy guidance documents (EPA 1989, 1998; DTSC 1992, 1994; 1996; Navy 1998, 1999) were used to estimate ambient metals concentrations of in groundwater. The statistical analysis consisted of four steps. First, nondetected data were substituted with appropriate numerical values. Second, outliers were identified and evaluated for possible exclusion from the data set. Third, data sets for metals were tested for normality or lognormality. Finally, the data were plotted with an appropriate scale, the detected data points were approximated with a best-fitting straight line, and estimated ambient concentrations were determined from the plotted data using a resulting regression equation. If the data had a nonparametric distribution, ambient concentrations were determined using an analytical formula (Gilbert 1987). Each of these steps is discussed separately below.

4.1 TREATMENT OF NONDETECTED DATA

Most of metals in groundwater at NAVSTA TI have a low frequency of detection (Table 3). Therefore, it was important to adequately account for the nondetected analytical results (nondetects) when estimating ambient metals concentrations. Typically, nondetects are assigned numerical values equal to one-half of the reported detection limit, which varies from sample to sample due to dilution factors and variations in analytical instrument response.

Based on the guidance document (Navy 1999), using a small value below the minimal detected result was considered a more appropriate substitution of the nondetects. The following considerations supported this decision: (1) the reported detection limits have an inherent variability, (2) different reported detection limits were used by the laboratories in 2000 (higher limits were used in the first sampling event than in the three subsequent events) and (3) the reported detection limits were sometimes significantly higher than detected results (Appendix B). Therefore, the nondetected results in the ambient data set were replaced by a dummy value to act as a placeholder on the probability plots discussed in Section 4.2.

For individual metal, the dummy value was set as a small value just below the minimum detected concentration. Such replacement of nondetects resulted in a graphical presentation, which represents the most likely separation of the detected concentrations from those, which fall below the detection limit. Probability plots show the detected concentrations as solid circles and the nondetected results as hollow circles (Figures 14 through 35).

4.2 EXCLUSION OF OUTLIERS

In any population, a few values may be significantly higher than the main population, and can cause disproportionate statistical effects, especially in estimates of the mean and standard deviation. To avoid these disproportionate effects, values that were significantly higher than others were identified as outliers and were excluded from the concentration data set before estimating ambient concentrations.

Outliers in the data sets were initially identified using probability plots. A probability plot is a graph of values, ordered from lowest to highest and plotted against a standard normal distribution function. The vertical axis is scaled in units of the variable (in this case, concentration), and the horizontal axis is scaled in units of the normal distribution function (normal quantile). The vertical scale can be plotted either as a linear scale (concentration vs. normal quantile) or as a logarithmic scale (the logarithm of concentration vs. normal quantile). Populations of data that plot as a straight line in a linear concentration scale are referred to as normally distributed, and populations that plot as a straight line in a logarithmic scale are referred to as lognormally distributed.

Probability plots were constructed at an appropriate scale (normal or lognormal) for 22 of the 24 metals concentration data sets (Figures 14 through 35). Because antimony had no detected results and mercury had fewer than three detected results, no plots were prepared for these metals. Outliers were first visually identified as values that plotted at a significant distance from the straight line that the majority of the data

clustered along, and were removed from the data sets based on the results of more rigorous outlier tests such as Rosner's and Dixon's tests (Navy 1999). Additional data (such as TDS and TSS concentrations) were also used to decide on the disposition of the identified outliers. Removal of high-concentration outliers from an 'ambient' data set addressed the anomalies in metal concentrations that might not be representative of true ambient conditions and that are not necessarily related to site contamination. Removal of high-value outliers is a conservative treatment for the ambient data set because it lowers the estimate of the mean. Table 3 provides information on the number of data points excluded from each metal data set.

4.3 NORMALITY TESTING

Once outliers had been excluded, the data sets were subjected to normality testing to objectively evaluate the distribution of the data. Normality testing is an analytical technique used to judge whether the data set is distributed normally or lognormally. If the results of the statistical tests indicate that data are not normally or lognormally distributed, the data are typically designated as nonparametric or distribution free.

A standard procedure used to test the assumption of normality is the D'Agostino test (for data sets larger than 50 data points) and the Shapiro-Wilk test (for data sets with 3 to 50 data points) (Gilbert 1987). The results of normality testing for metals with low detection frequencies show nonparametric distribution. When the normality testing for such metals was conducted on detected concentrations only, the lognormal or normal distribution were obtained. Although many metals in nature display a lognormal distribution, some metals may show a normal distribution. There might be exceptions, however, with some metals exhibiting nonparametric distributions. Normality testing was not performed for the two metals with less than three reported detections. Table 3 lists the underlying distribution for each metal tested. The details of both tests are provided in Appendix A.

4.4 CALCULATION OF THE UPPER LIMITS

After treating nondetected values and removing outliers from the data sets as described previously, a probability plot was prepared for each metal of interest to estimate ambient concentrations. Because a population of more than 50 data points was available for each metal, the 95th percentile of the distribution was used as an estimate of the upper level of ambient concentrations, as recommended by the EPA (1989).

The upper bound ambient concentrations were evaluated based on a regression equation describing the best fitting line through the detected data. Probability plots for each metal are presented as Figures 14 through 35. For each metal with normal or lognormal distribution, the figures also show the regression equations and squared correlation coefficients (R^2). In all cases, the squared coefficients of correlation are greater than 0.85, indicating that the regression line is a very good fit to the data.

Because the population distribution for sodium was found to be nonparametric, a different technique was used to estimate the 95th percentile. For this metal, an analytical formula given by Gilbert (1987) was used to estimate the ambient concentrations. The details of calculating the 95th percentiles using regression equations and an analytical formula are given in Appendix A. Estimated ambient concentrations, statistical features of the data sets, and toxicity-based screening criteria groundwater (TtEMI 2000b) are listed in Table 3.

Table 4 compares estimated ambient concentrations of metals in shallow groundwater at NAVSTA TI with those at other installations in the Bay Area. The hydrogeologic conditions at Treasure Island are comparable to Mare Island (shallow groundwater in artificial fill material) but not to Hunters Point. However, the data from Hunters Point are used to show more extreme ambient conditions in the Bay Area. The estimated ambient concentrations at NAVSTA TI appear significantly lower than the estimated ambient concentrations at other installations (Table 4).

5.0 SUMMARY OF FINDINGS

Estimated ambient concentrations for metals in shallow groundwater at NAVSTA TI are presented in Table 3. The estimated 95th percentile of ambient concentrations of arsenic, copper, manganese, and silver exceeded the toxicity-based screening criteria for groundwater (TtEMI 2000b). The ambient levels for antimony, beryllium, cadmium, chromium, mercury, and selenium were estimated to be at or below the minimum reported detection limits (with the detection limit for mercury exceeding the toxicity-based screening criterion for groundwater). It is assumed that any detected concentration for these metals exceeds the estimated ambient level.

The 95th percentile included in this technical memorandum is proposed as an upper bound of ambient concentrations of metals in groundwater at NAVSTA TI for simple screening purposes. Because 5 percent of ambient concentrations are expected to exceed the 95th percentile threshold, screening metals data

against the estimated 95th percentiles of ambient concentrations will be used only as a preliminary step when identifying the COPCs at sites. Whether the metals retained after this step are COPCs will be determined by more rigorous statistical comparison of two distributions (site data versus ambient data). The comparison of site data versus ambient data will be conducted using two-population tests such as WRS test and Quantile test (EPA 1998; Navy 1999) or other appropriate tests as dictated by the data set sizes, detection frequency of a metal, and data distribution. A discussion in Appendix A provides further details on site-to-ambient comparisons.

The statistical comparison tests can be conducted when at least three samples from a site are available. However, the power of the tests will be limited and the results of the tests will be evaluated based on professional judgement. The groundwater monitoring is ongoing at the sites; the required data are being collected to ensure that an adequate number of samples from sites is available to assess whether site concentrations exceed ambient.

6.0 REFERENCES

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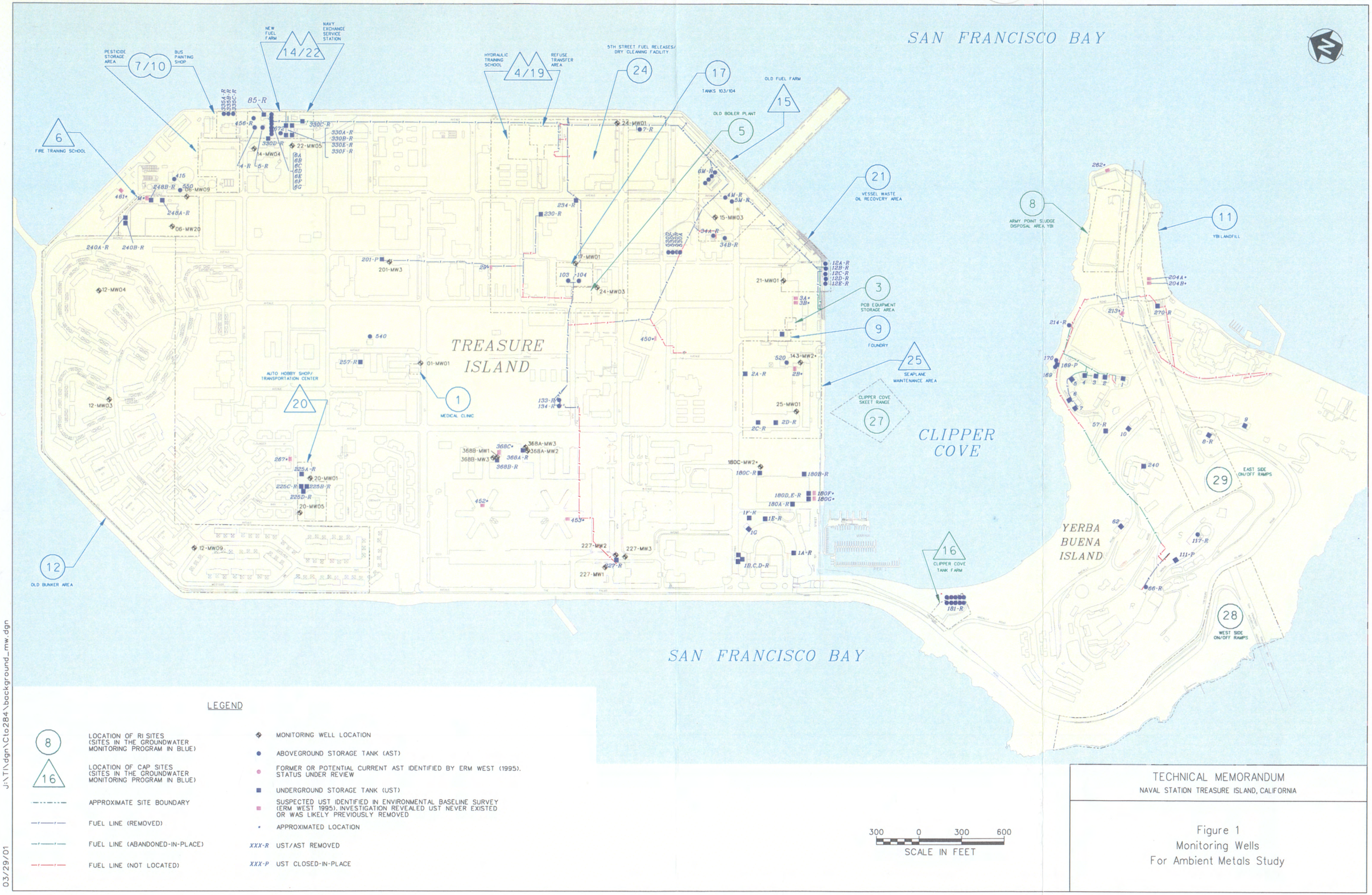
FIGURES



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TECHNICAL MEMORANDUM
NAVAL STATION TREASURE ISLAND, CALIFORNIA

Figure 1
Monitoring Wells
For Ambient Metals Study

DS.0284.16541

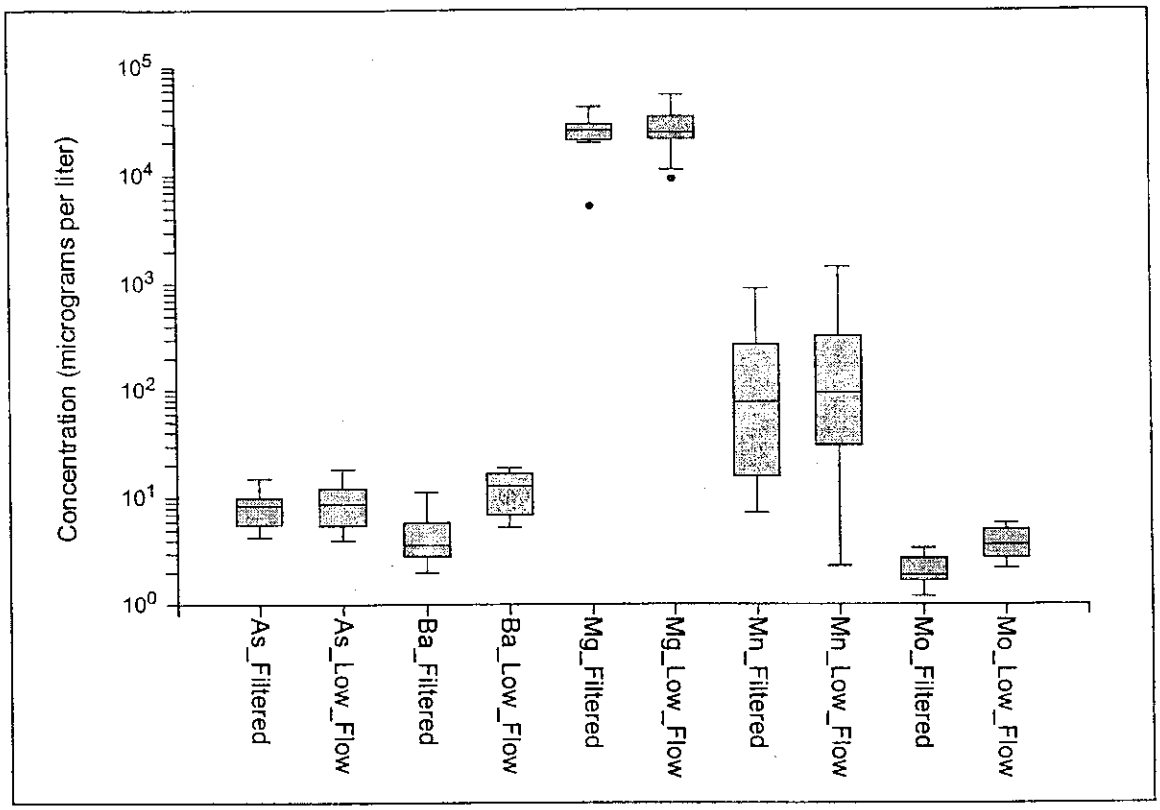


Figure 2. Box and Whisker Plots of Arsenic, Barium, Magnesium, Manganese, and Molybdenum Concentrations from Filtered Samples and "Low Flow" Unfiltered Samples.

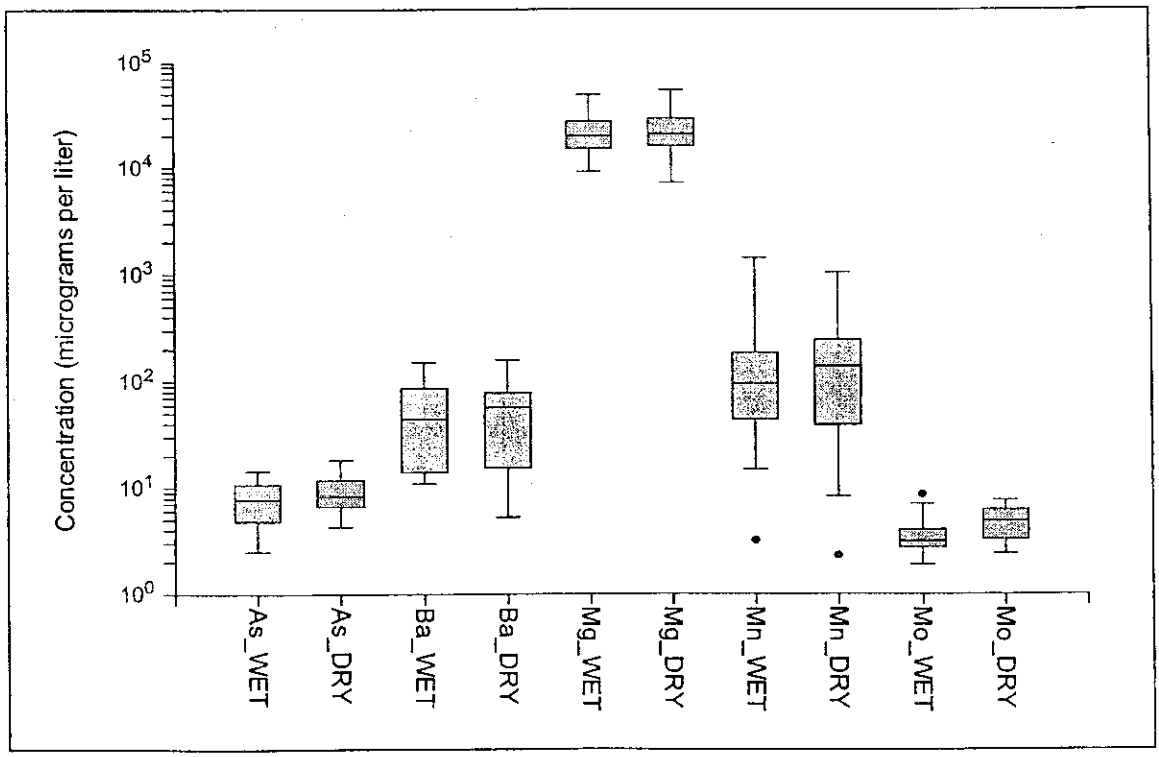
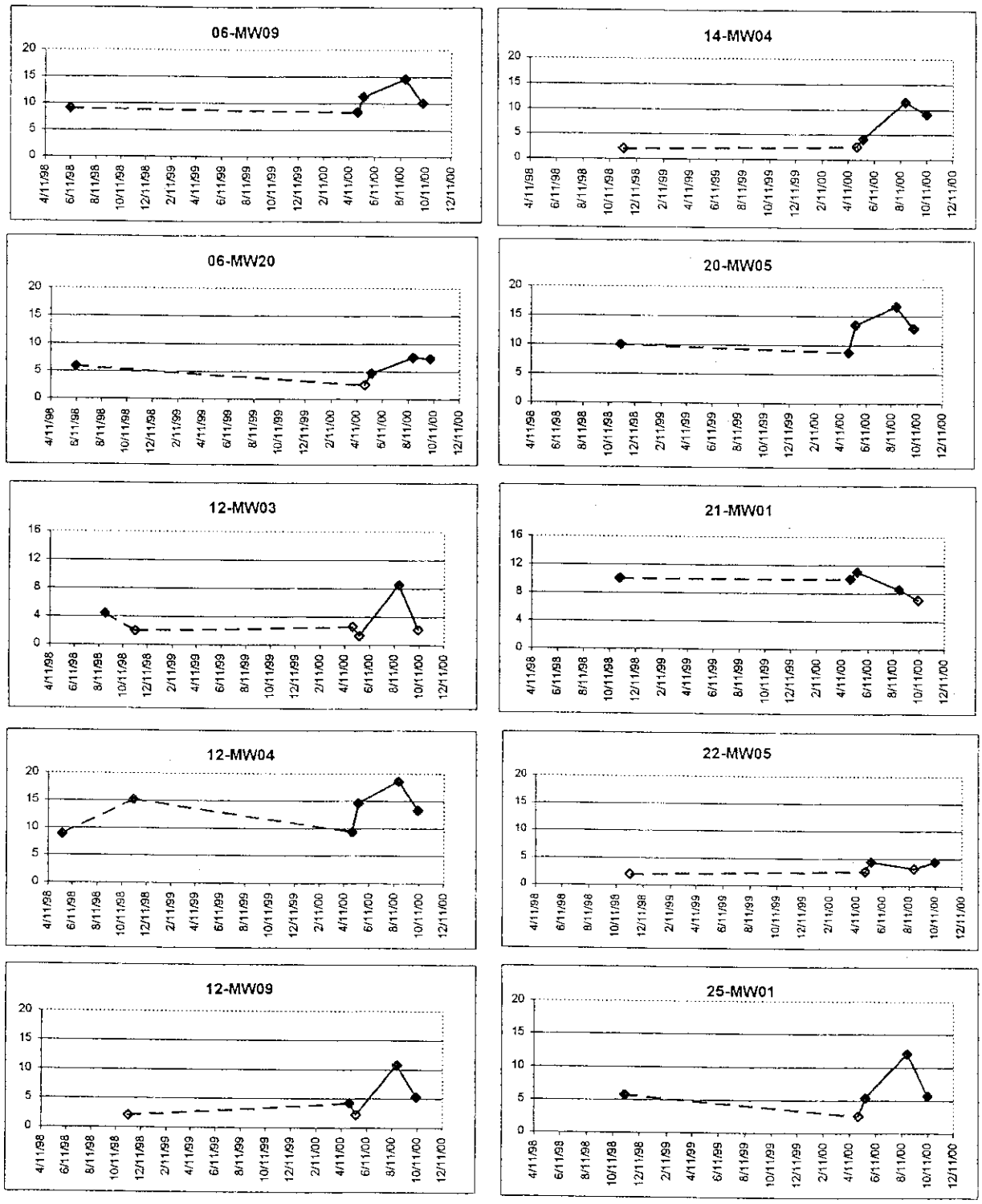


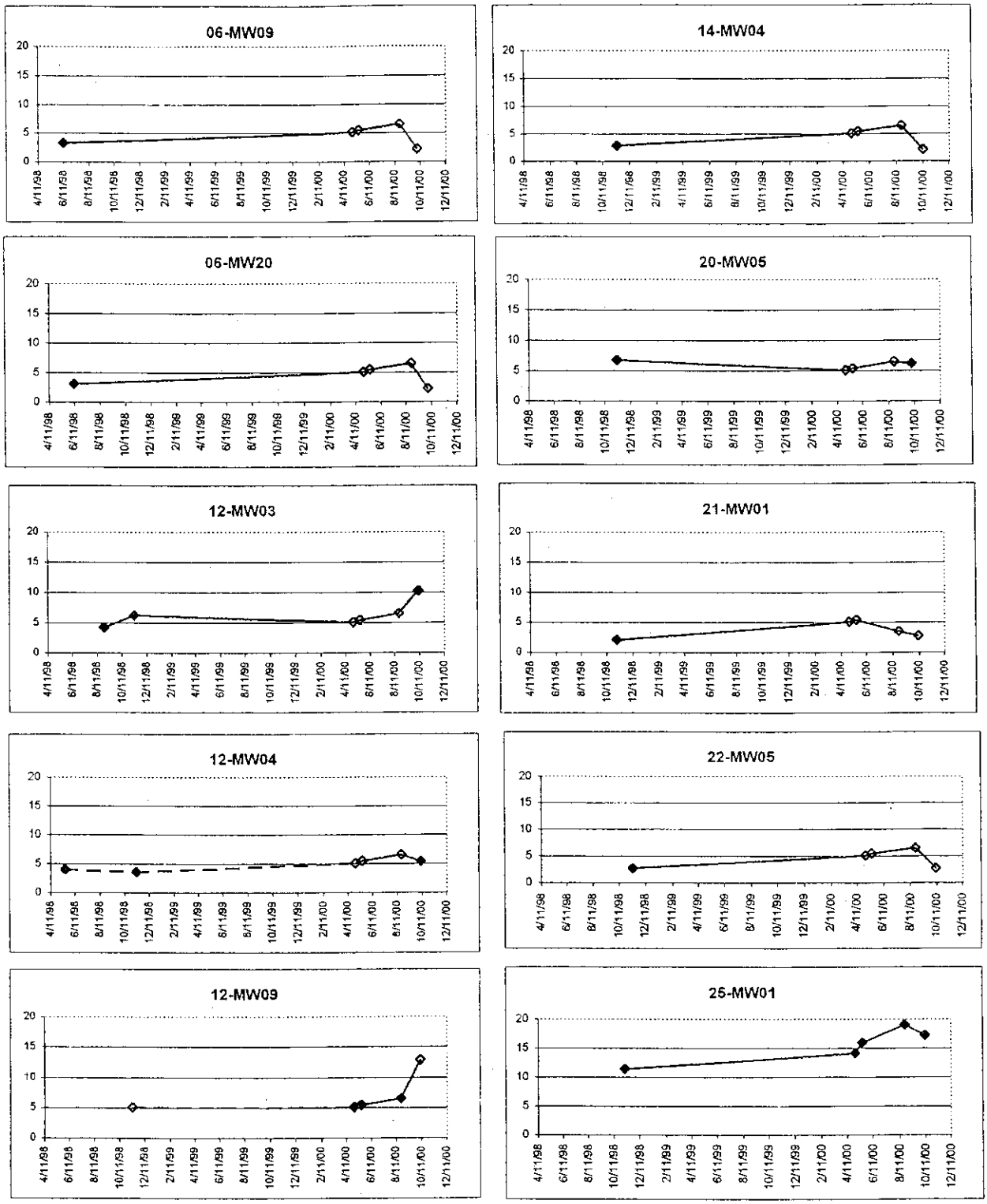
Figure 3. Box and Whisker Plots of Arsenic, Barium, Magnesium, Manganese, and Molybdenum Concentrations from Samples Collected During Wet and Dry Periods.



Notes: Vertical axis = concentrations (microgams per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

Figure 4. Time Sequence Plots of Arsenic Concentrations for Wells With 1998 and 2000 Data

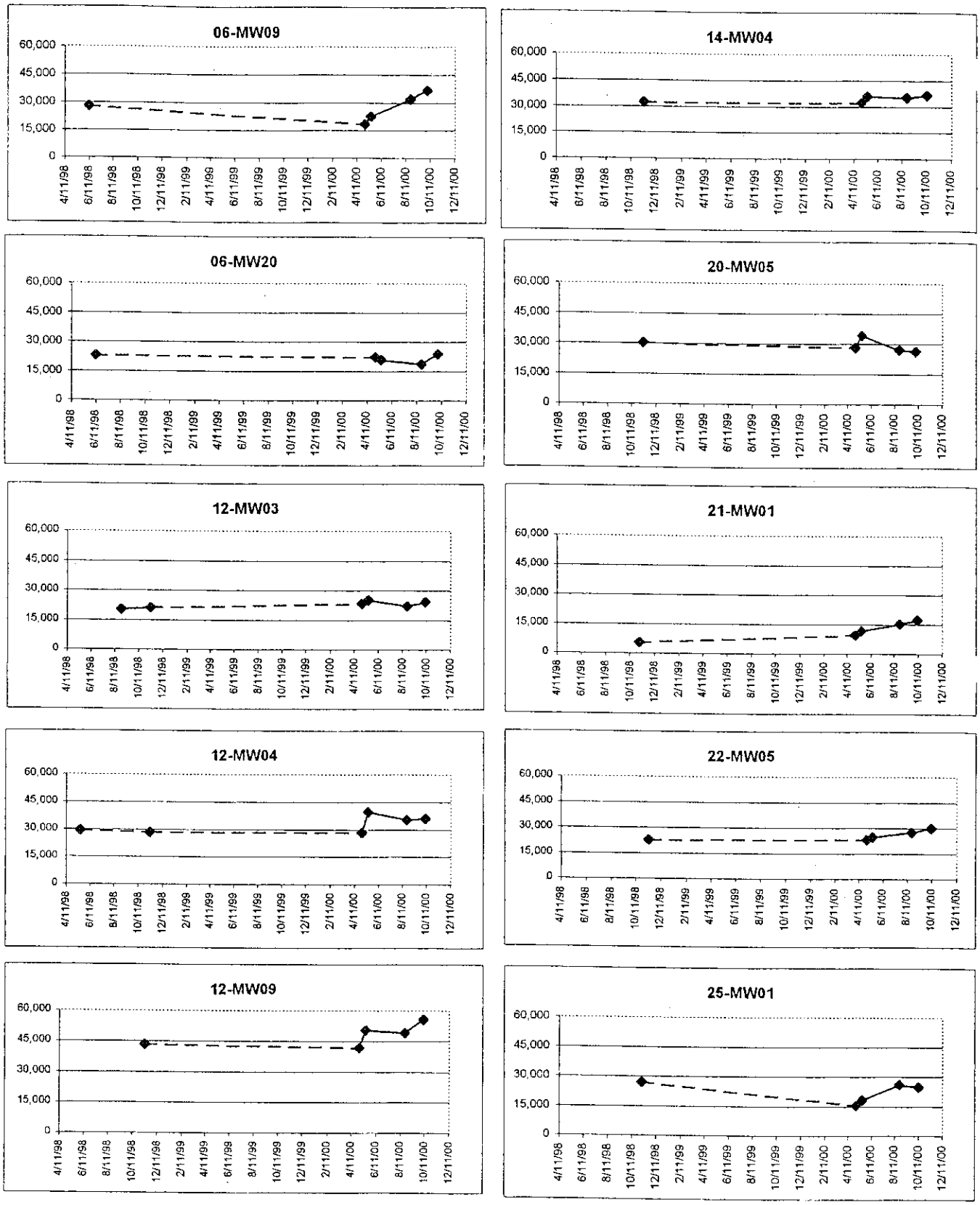
DS.0284.16541



Notes: Vertical axis = concentrations (microgams per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

Figure 5. Time Sequence Plots of Barium Concentrations for Wells With 1998 and 2000 Data

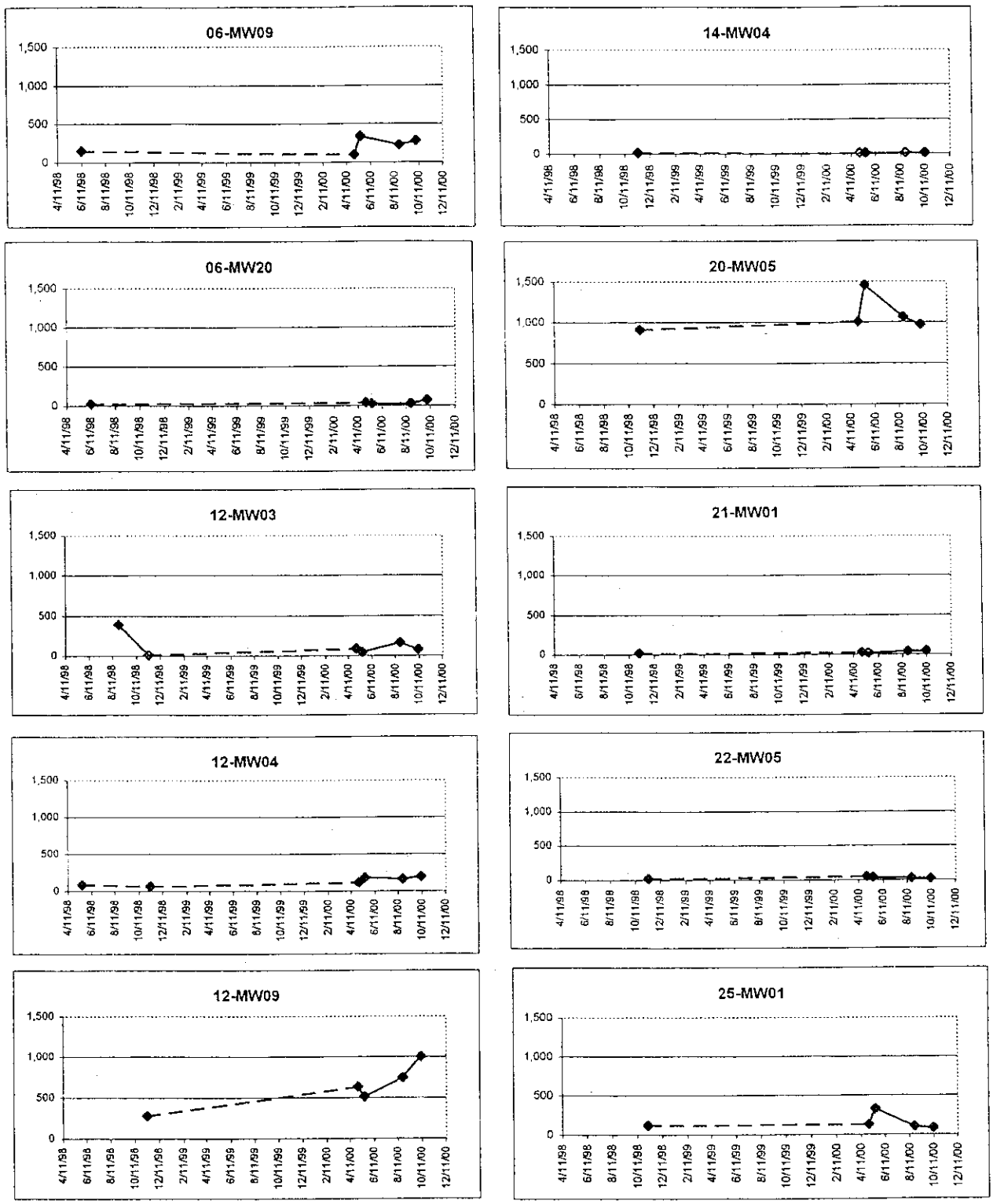
DS.0284.16541



Notes: Vertical axis = concentrations (microgams per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

Figure 6. Time Sequence Plots of Magnesium Concentrations for Wells With 1998 and 2000 Data

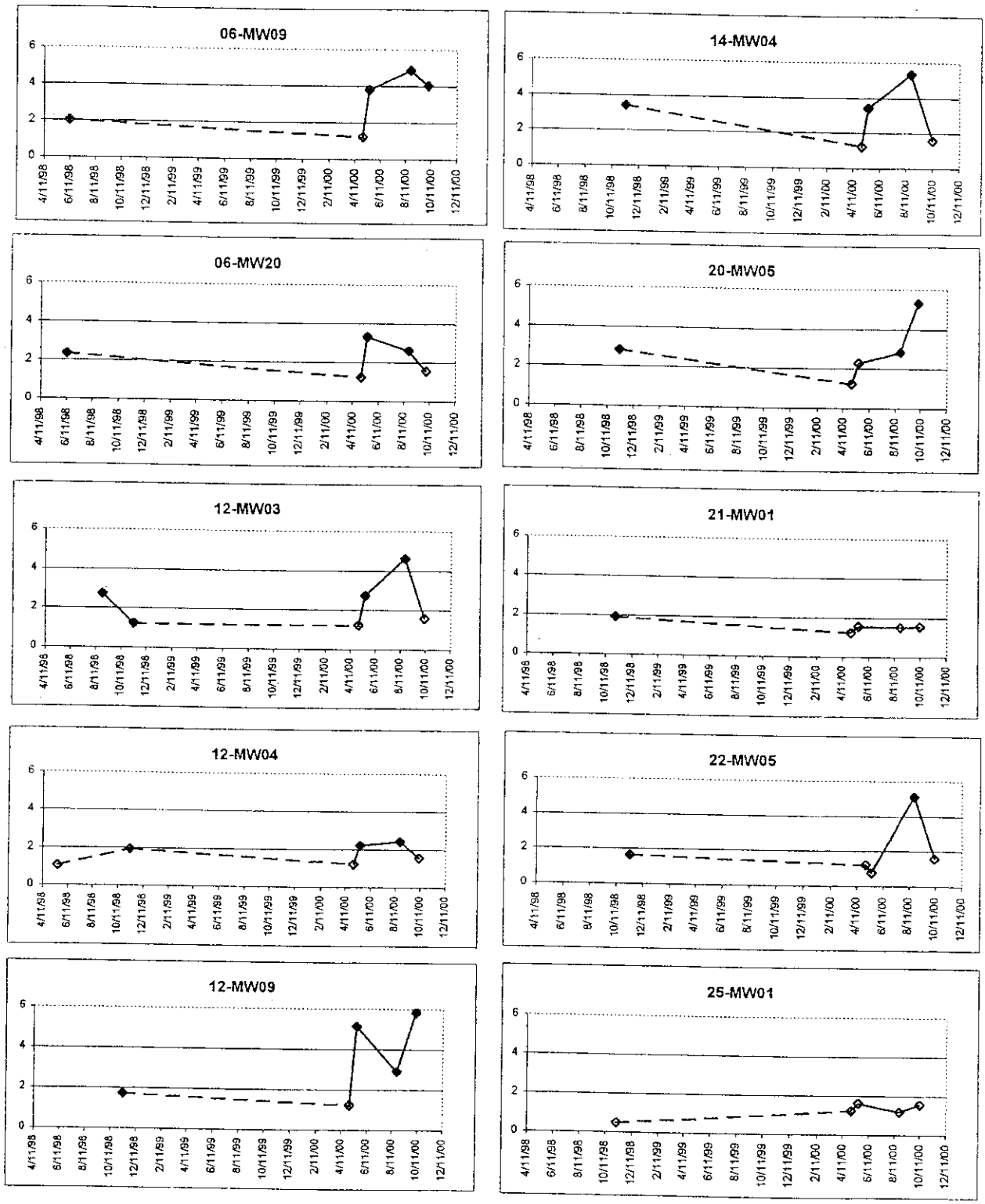
DS.0284.16541



Notes: Vertical axis = concentrations (microgams per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

Figure 7. Time Sequence Plots of Manganese Concentrations for Wells With 1998 and 2000 Data

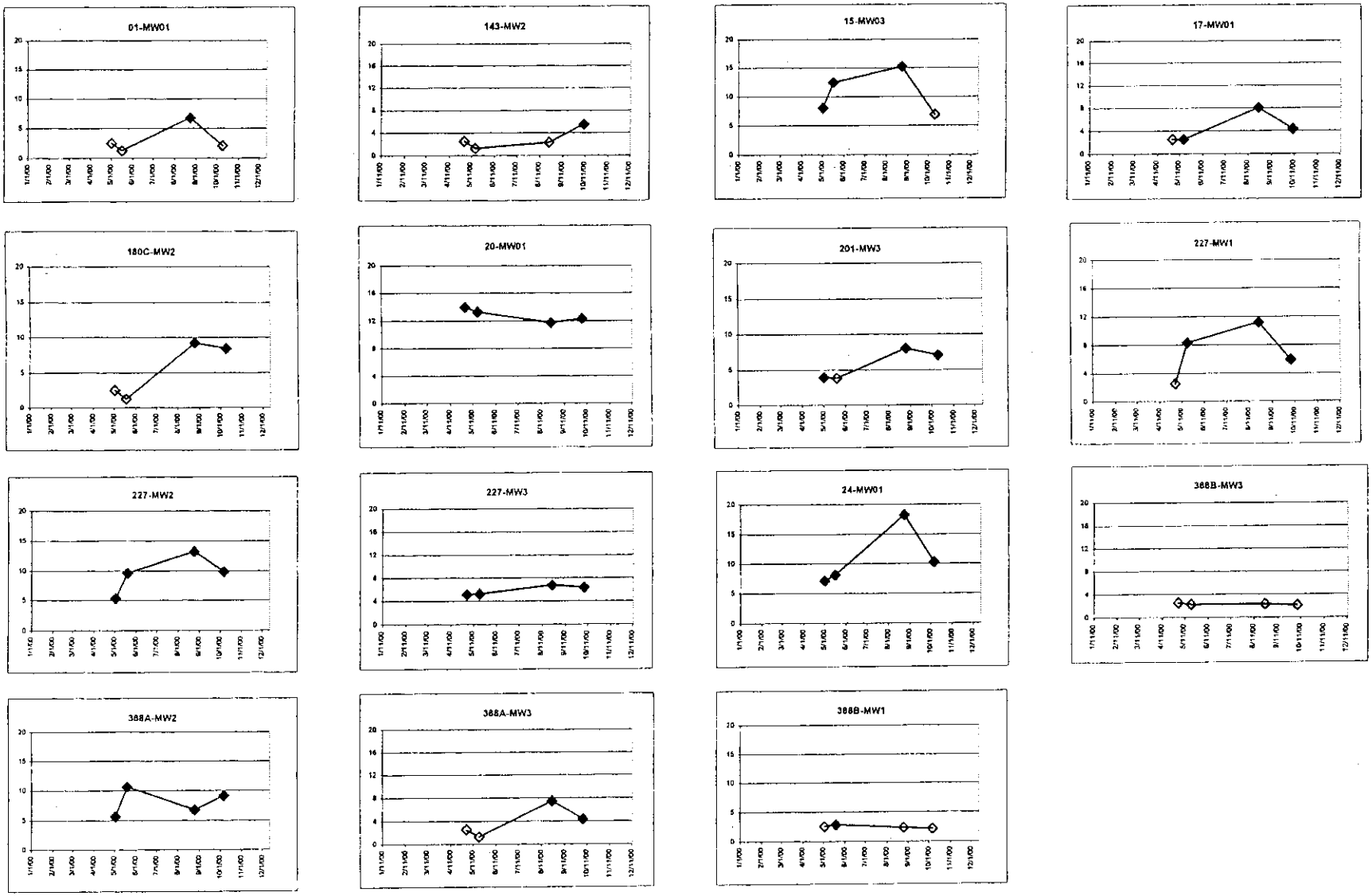
DS.0284.16541



Notes: Vertical axis = concentrations (microgams per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

Figure 8. Time Sequence Plots of Molybdenum Concentrations for Wells With 1998 and 2000 Data

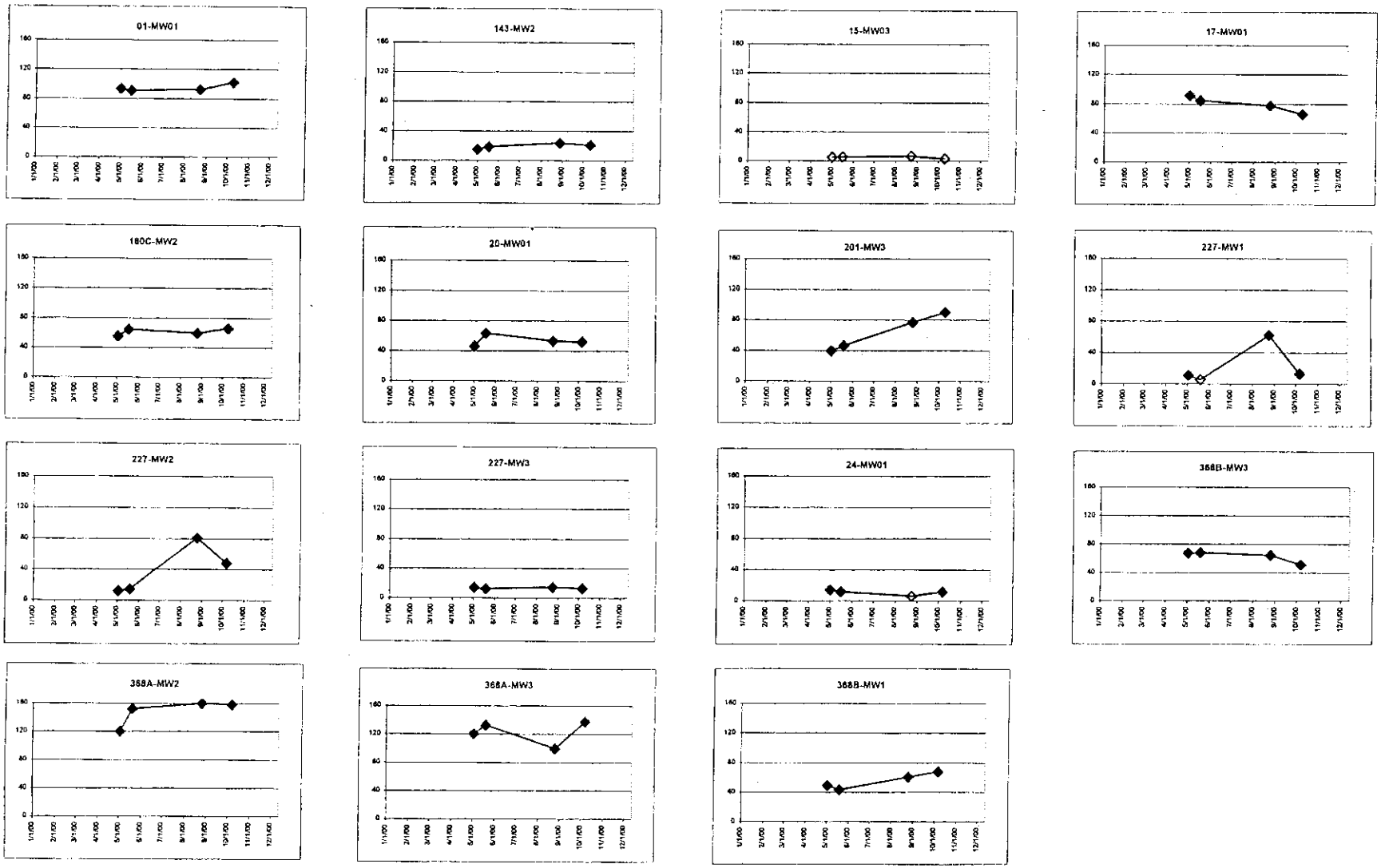
DS.0284.16541



Notes: Vertical axis = concentrations (micrograms per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

Figure 9. Time Sequence Plots of Arsenic Concentrations for Wells With Only 2000 Data

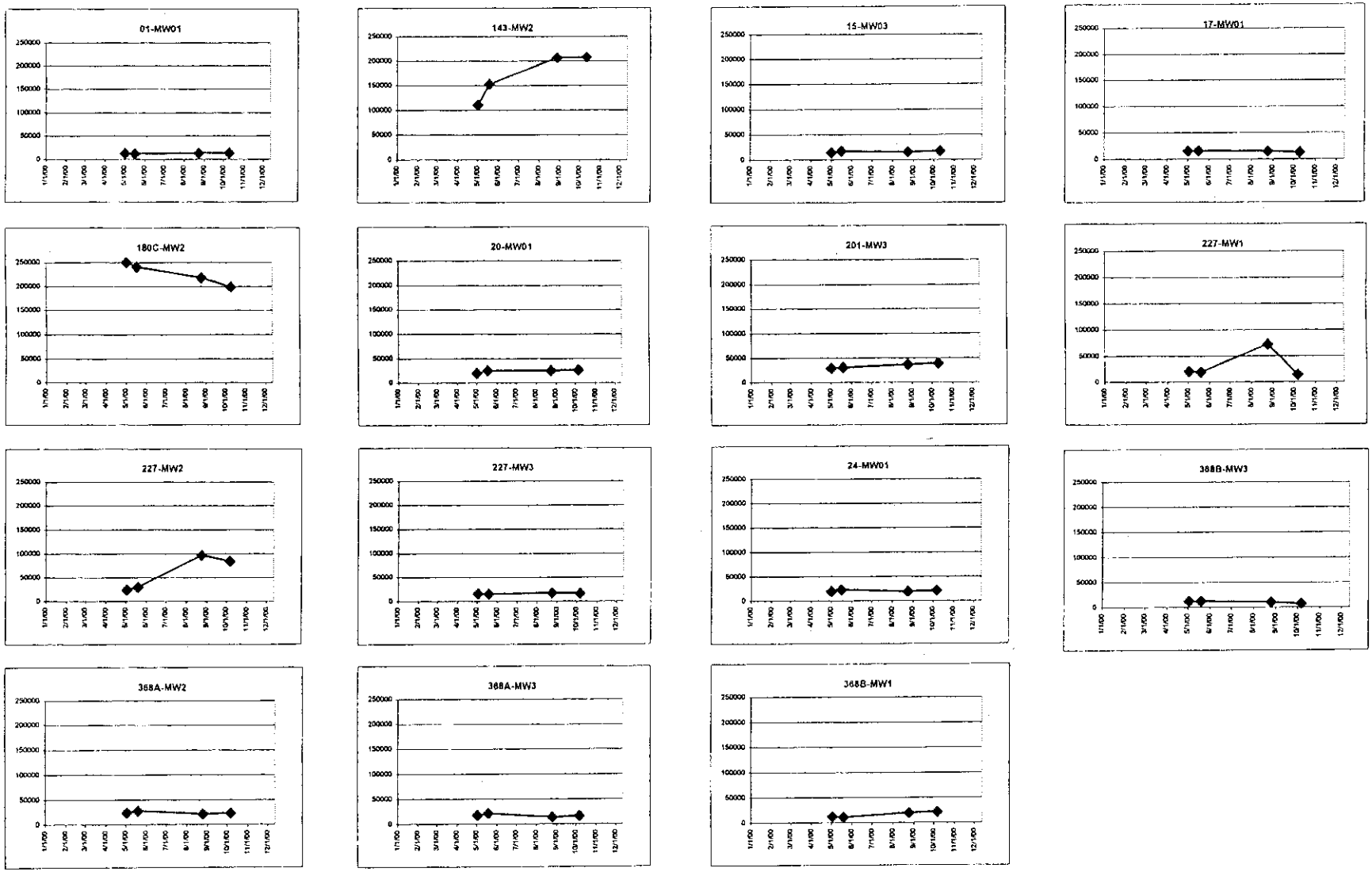
DS.0284.16541



Notes: Vertical axis = concentrations (microgams per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

Figure 10. Time Sequence Plots of Barium Concentrations for Wells With Only 2000 Data

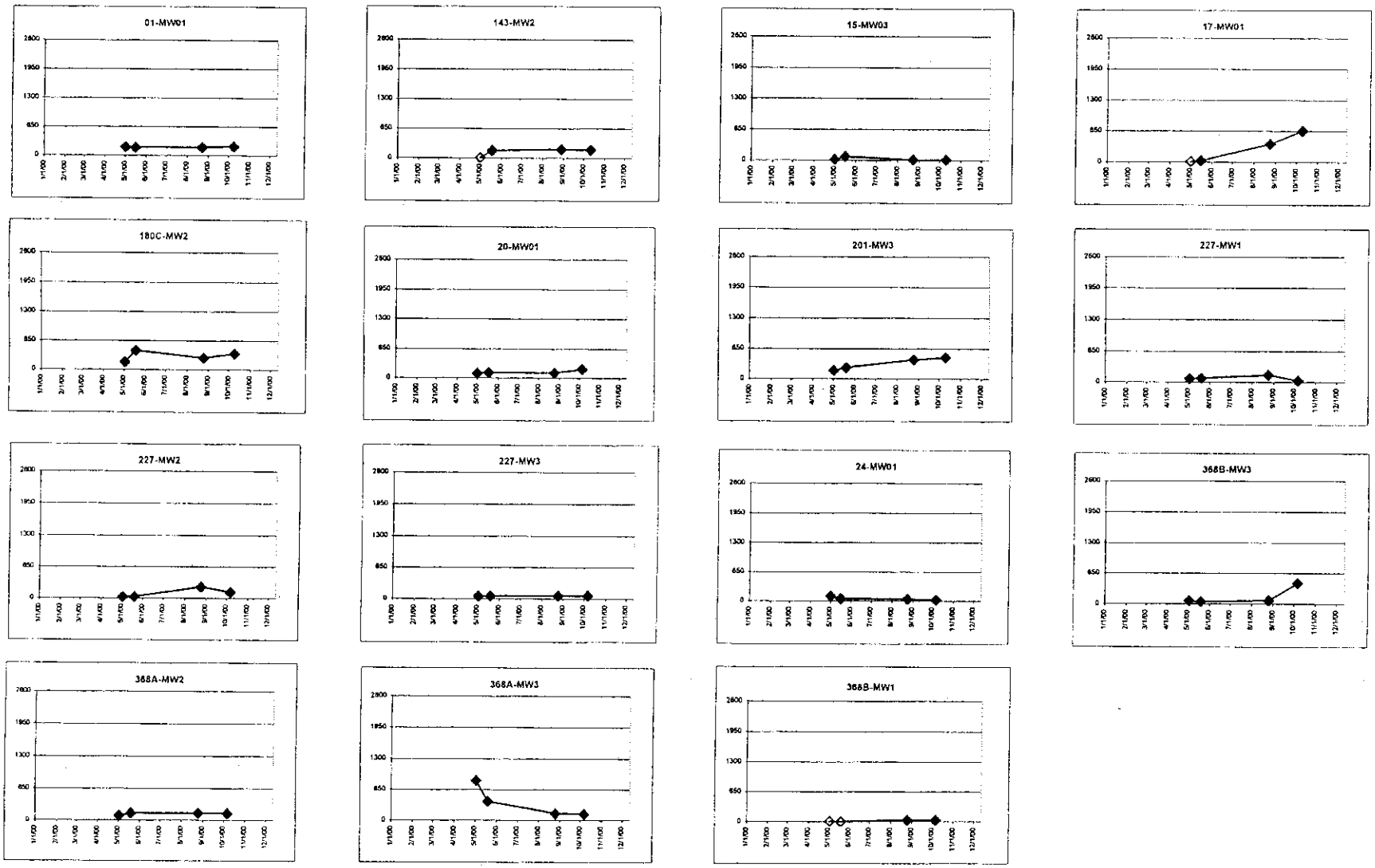
DS.0284.16541



Notes: Vertical axis = concentrations (micrograms per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

Figure 11. Time Sequence Plots of Magnesium Concentrations for Wells With Only 2000 Data

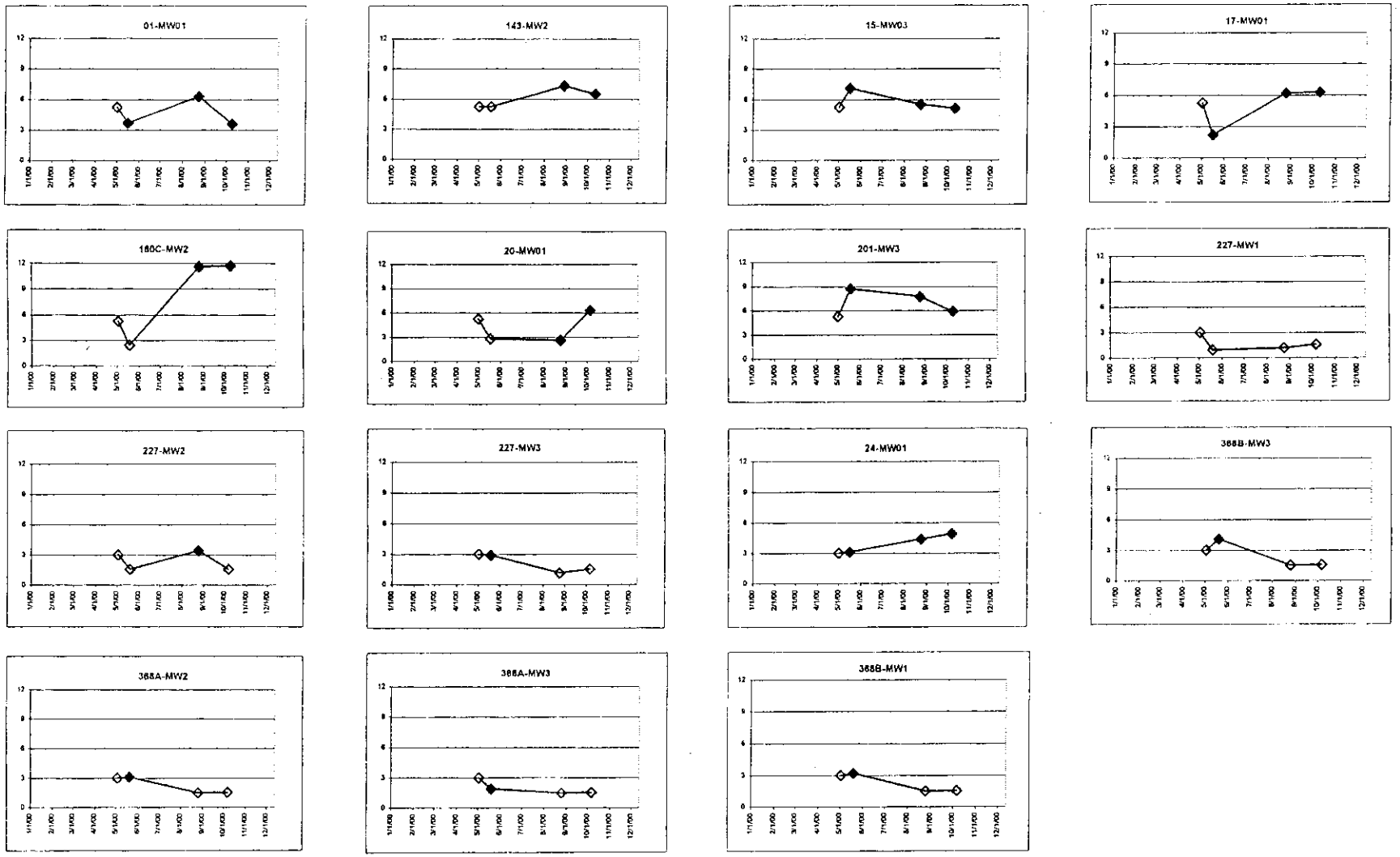
DS.0284.16541



Notes: Vertical axis = concentrations (microgams per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

Figure 12. Time Sequence Plots of Manganese Concentrations for Wells With Only 2000 Data

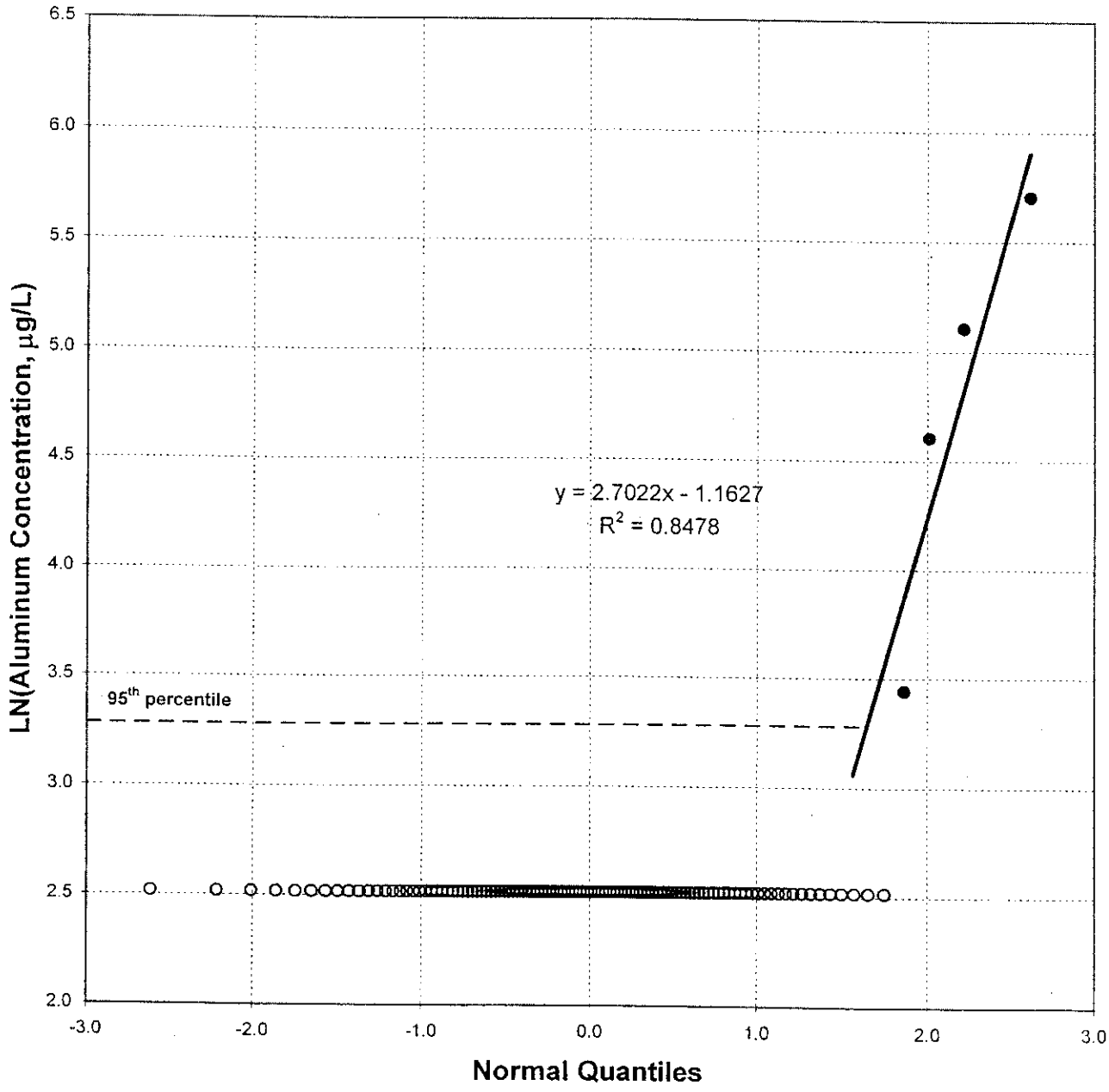
DS.0284.16541



Notes: Vertical axis = concentrations (micrograms per liter); horizontal axis = time (months).
Solid diamonds = detected results; hollow diamonds = nondetected results.

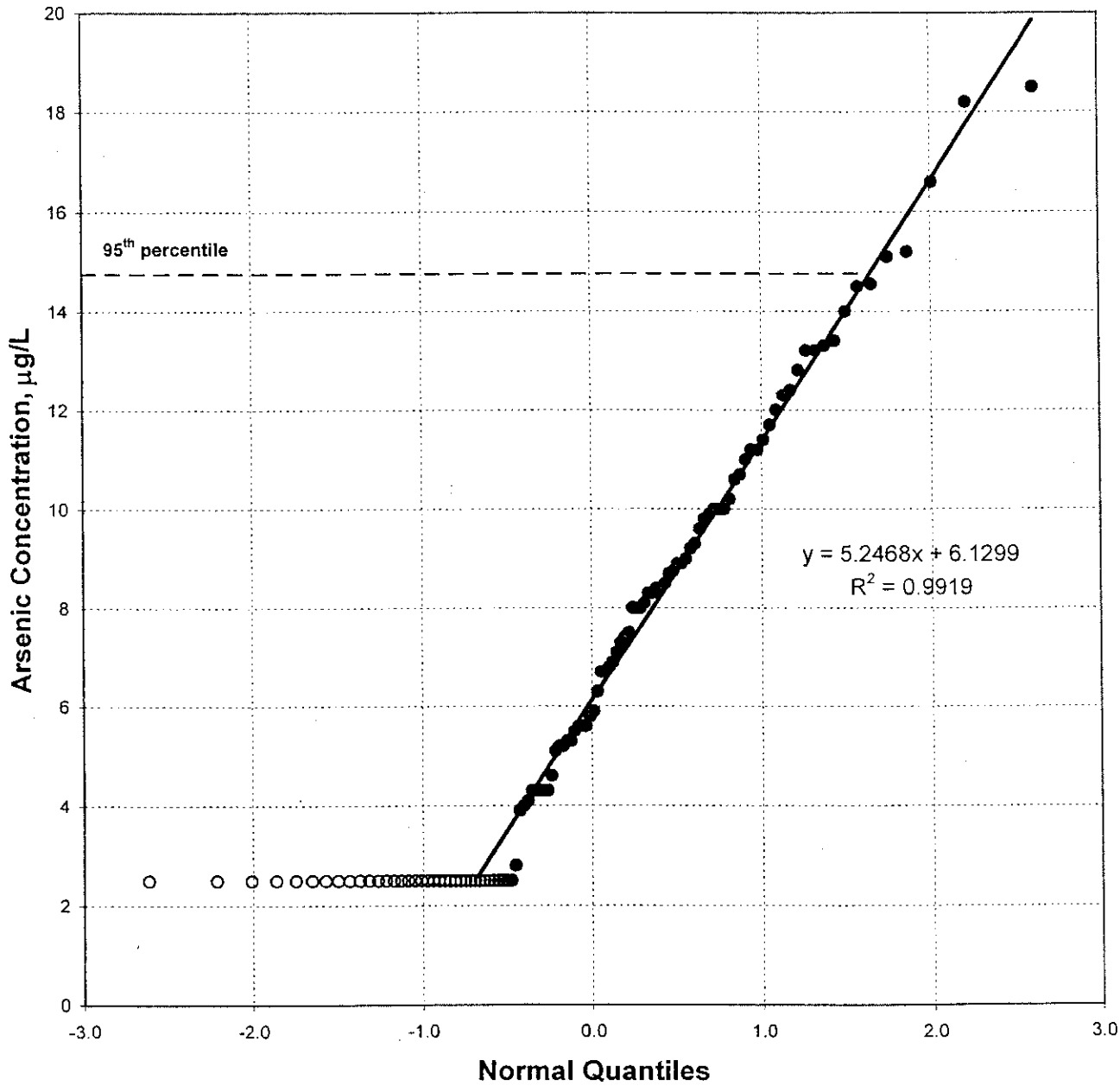
Figure 13. Time Sequence Plots of Molydenum Concentrations for Wells With Only 2000 Data

DS.0284.16541



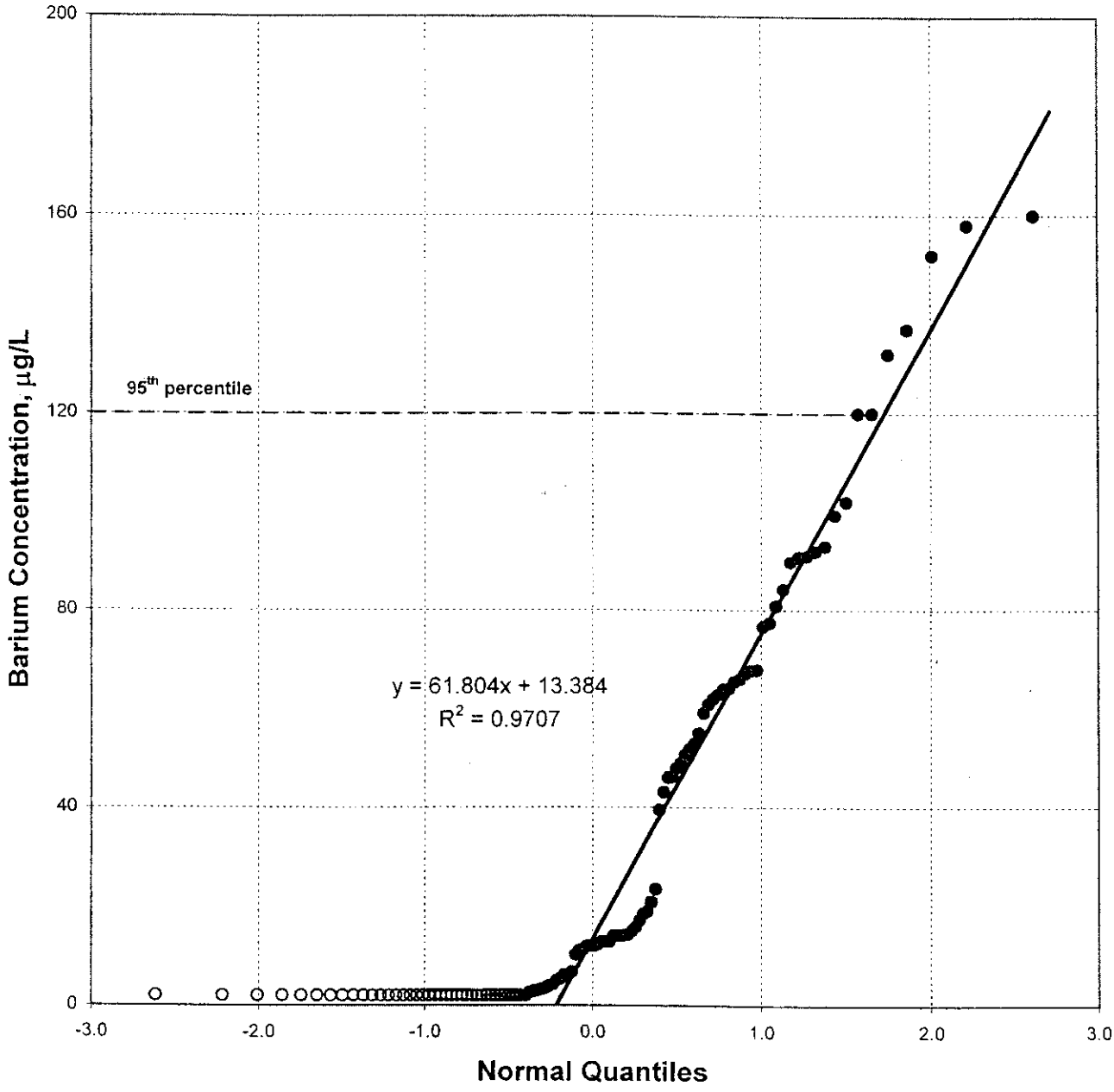
Notes: Distribution of detected aluminum concentrations is lognormal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 14. Probability Plot of Aluminum Concentrations DS.0284.16541



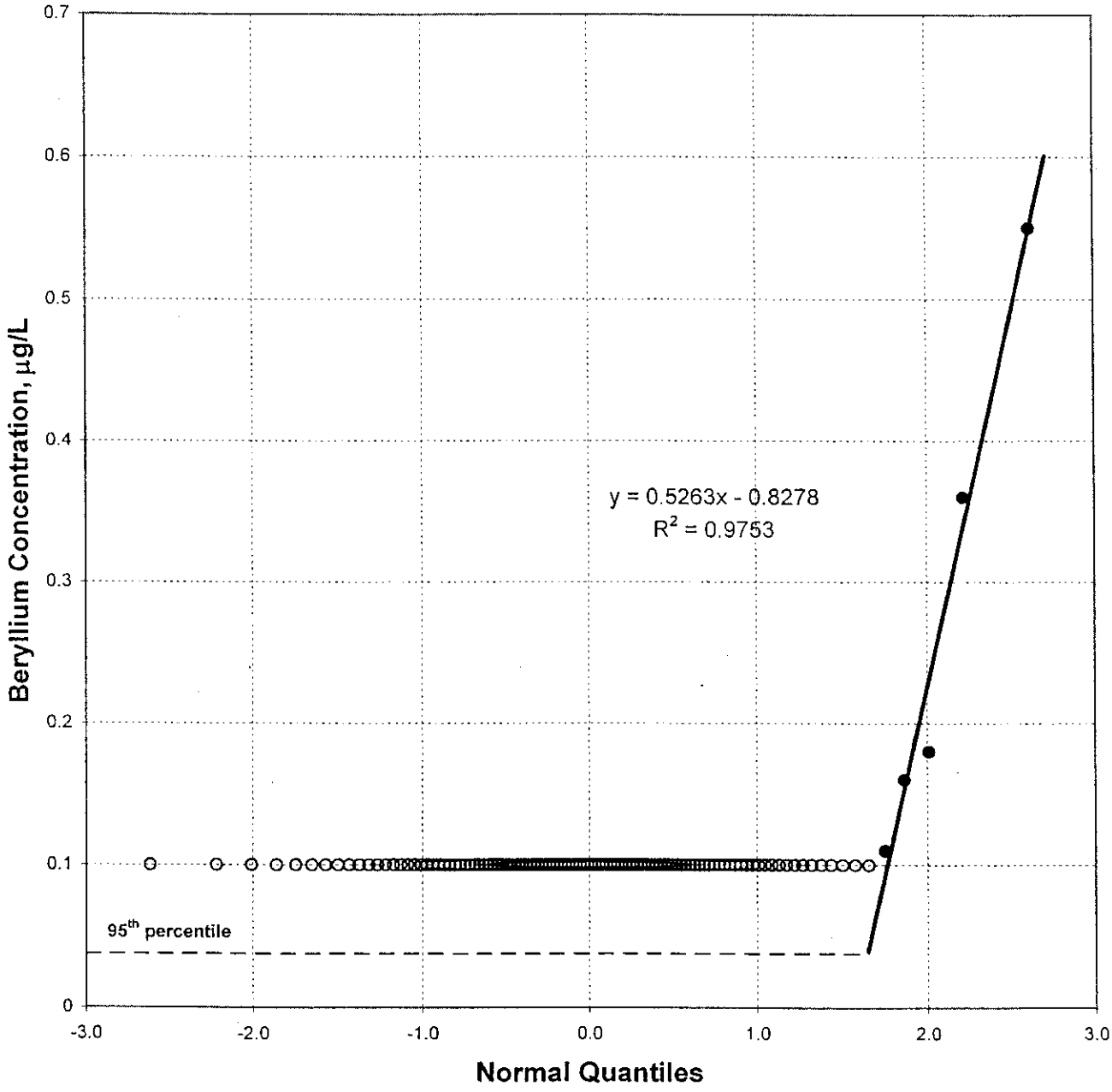
Notes: Distribution of detected arsenic concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 15. Probability Plot of Arsenic Concentrations DS.0284.16541



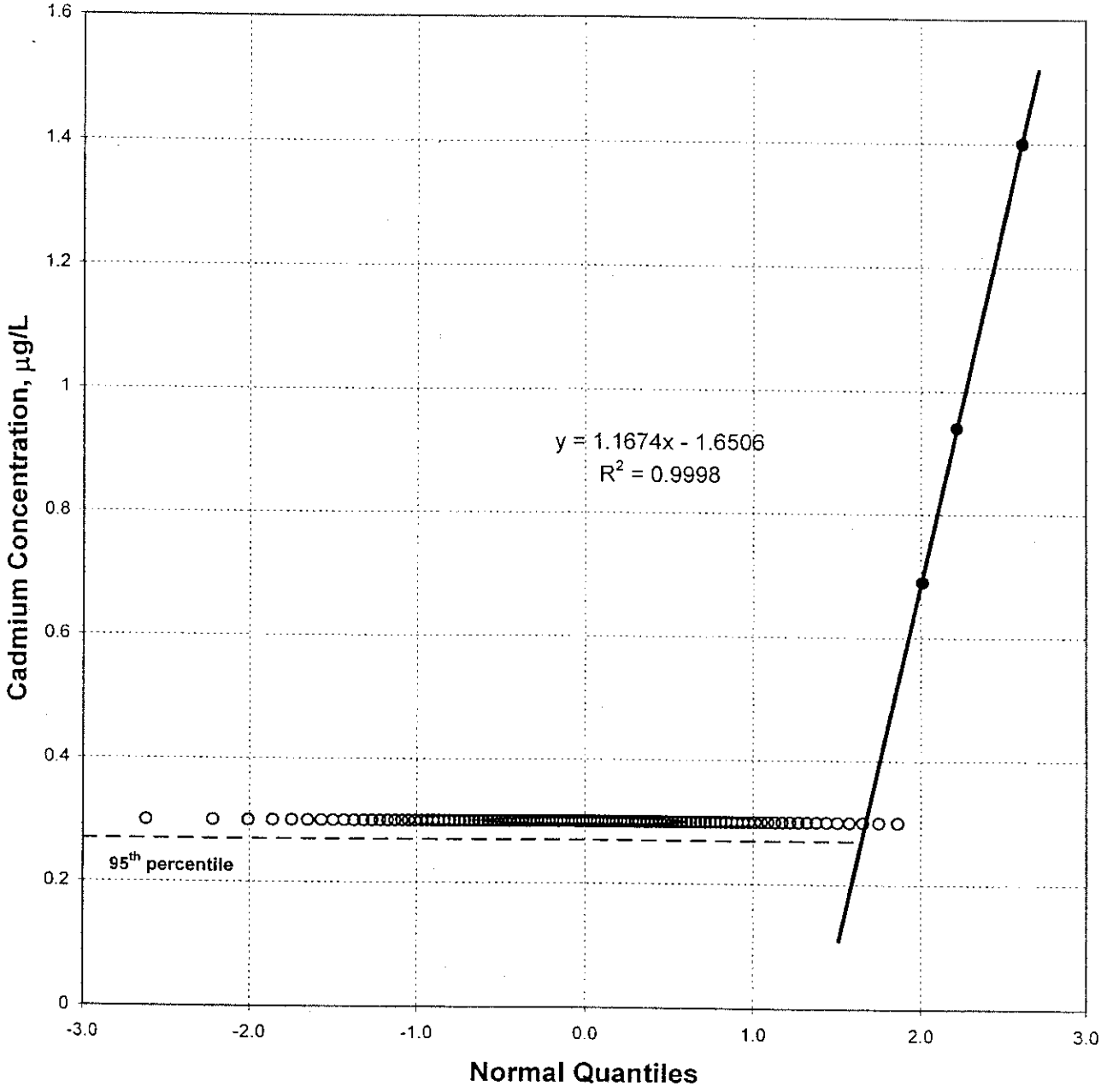
Notes: Distribution of detected barium concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 16. Probability Plot of Barium Concentrations DS.0284.16541



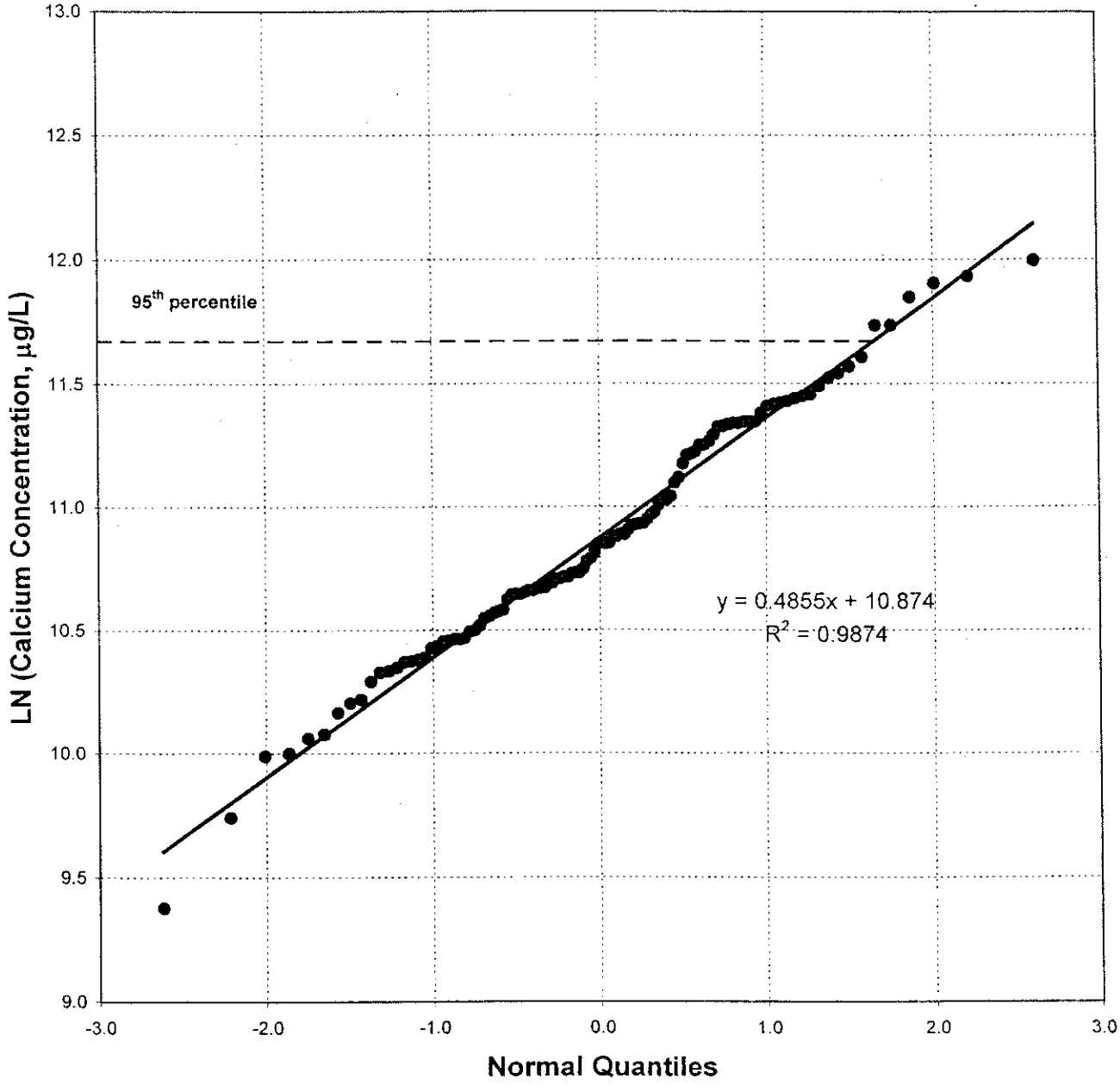
Notes: Distribution of detected beryllium concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 17. Probability Plot of Beryllium Concentrations DS.0284.16541



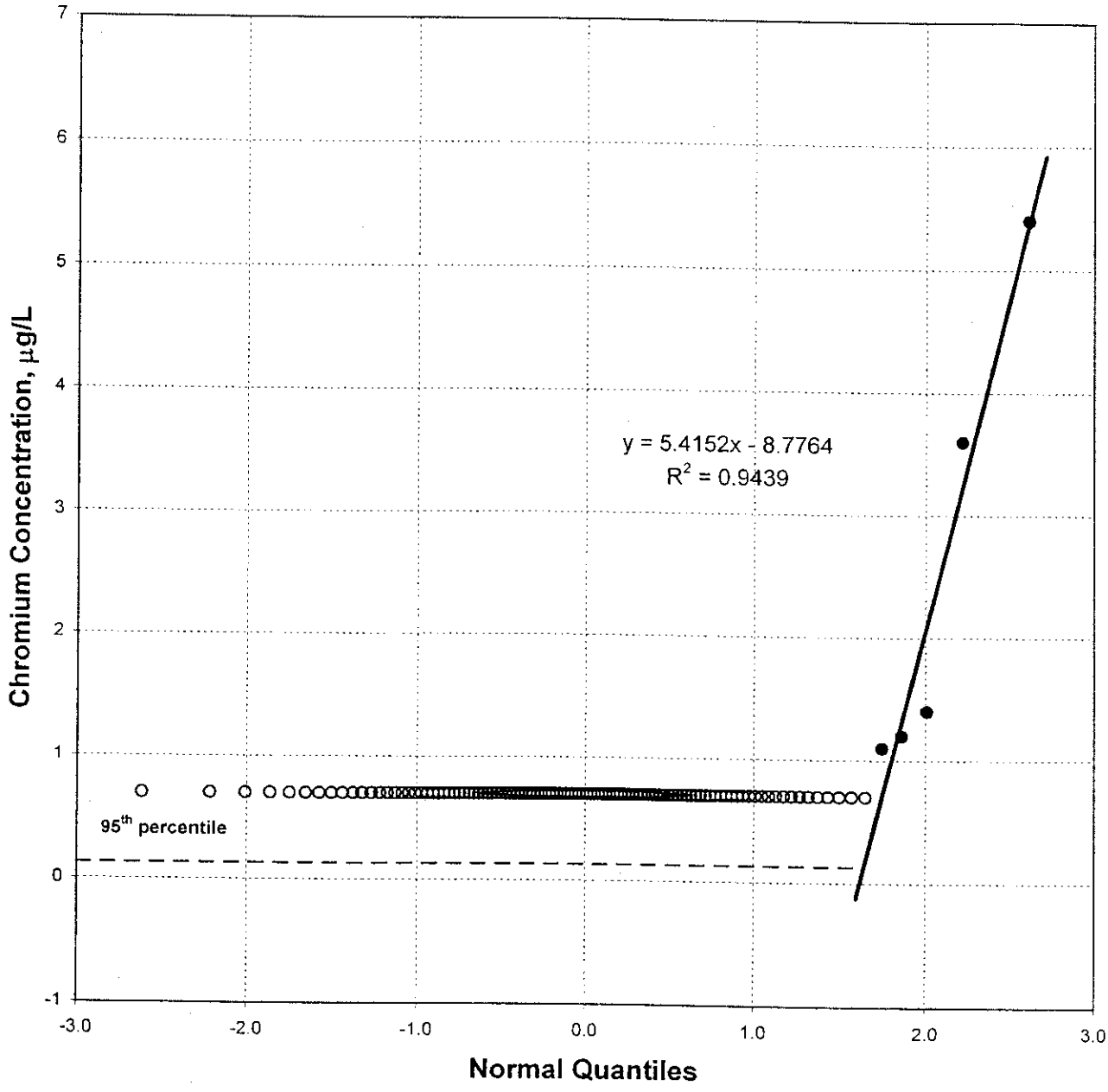
Notes: Distribution of detected cadmium concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 18. Probability Plot of Cadmium Concentrations DS.0284.16541



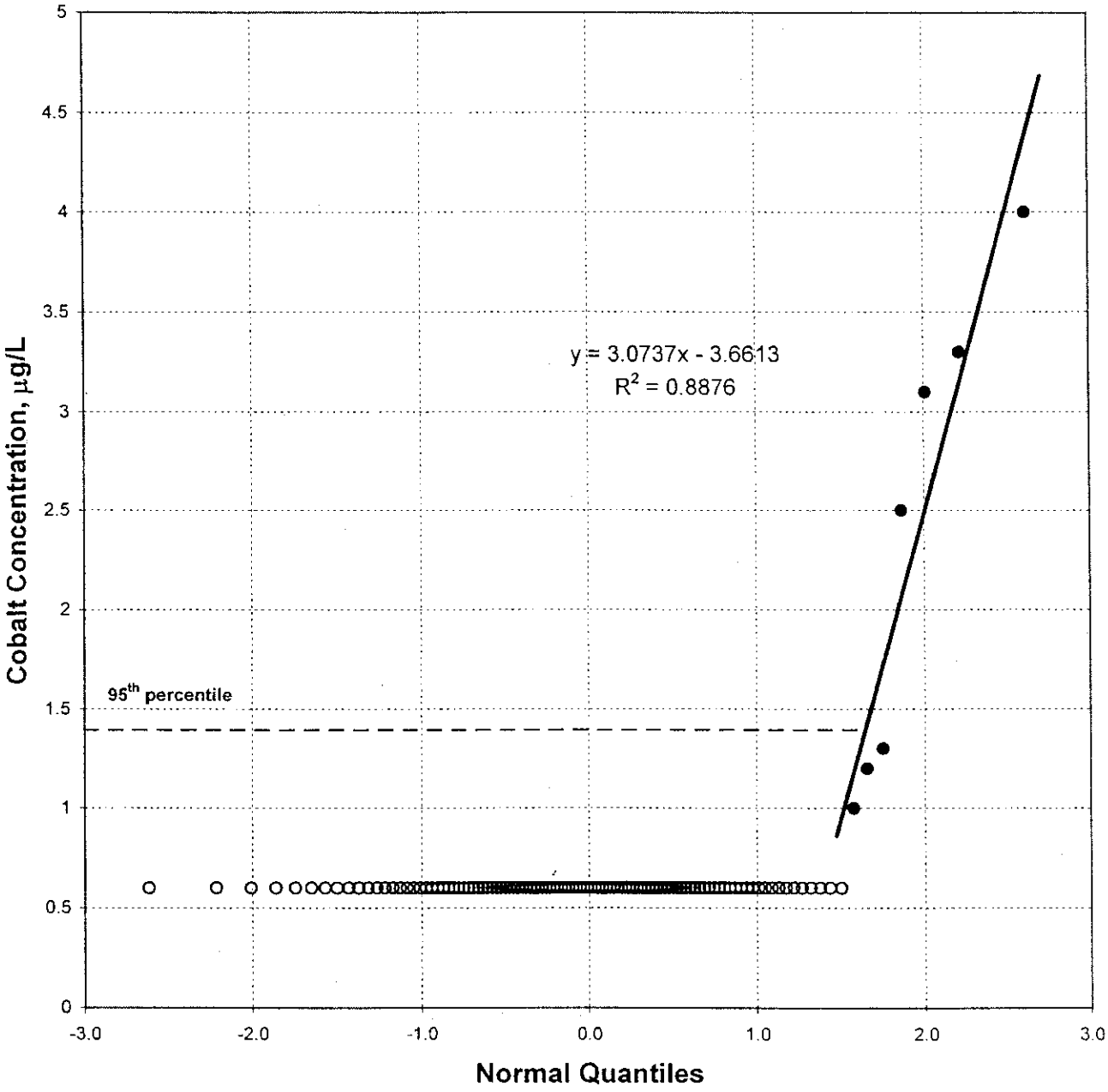
Notes: Distribution of calcium concentrations is lognormal.

Figure 19. Probability Plot of Calcium Concentrations DS.0284.16541



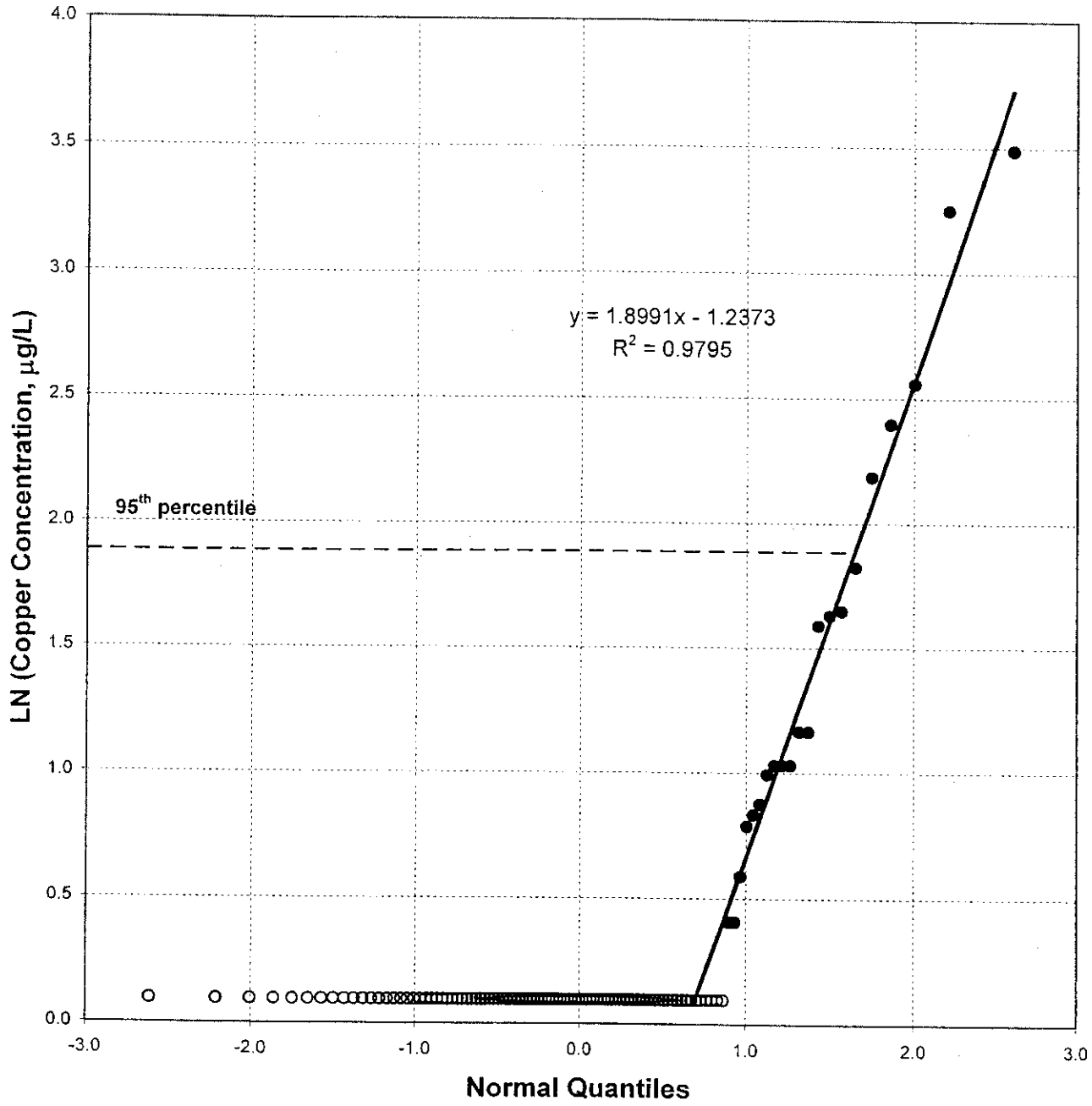
Notes: Distribution of detected chromium concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 20. Probability Plot of Chromium Concentrations DS.0284.16541



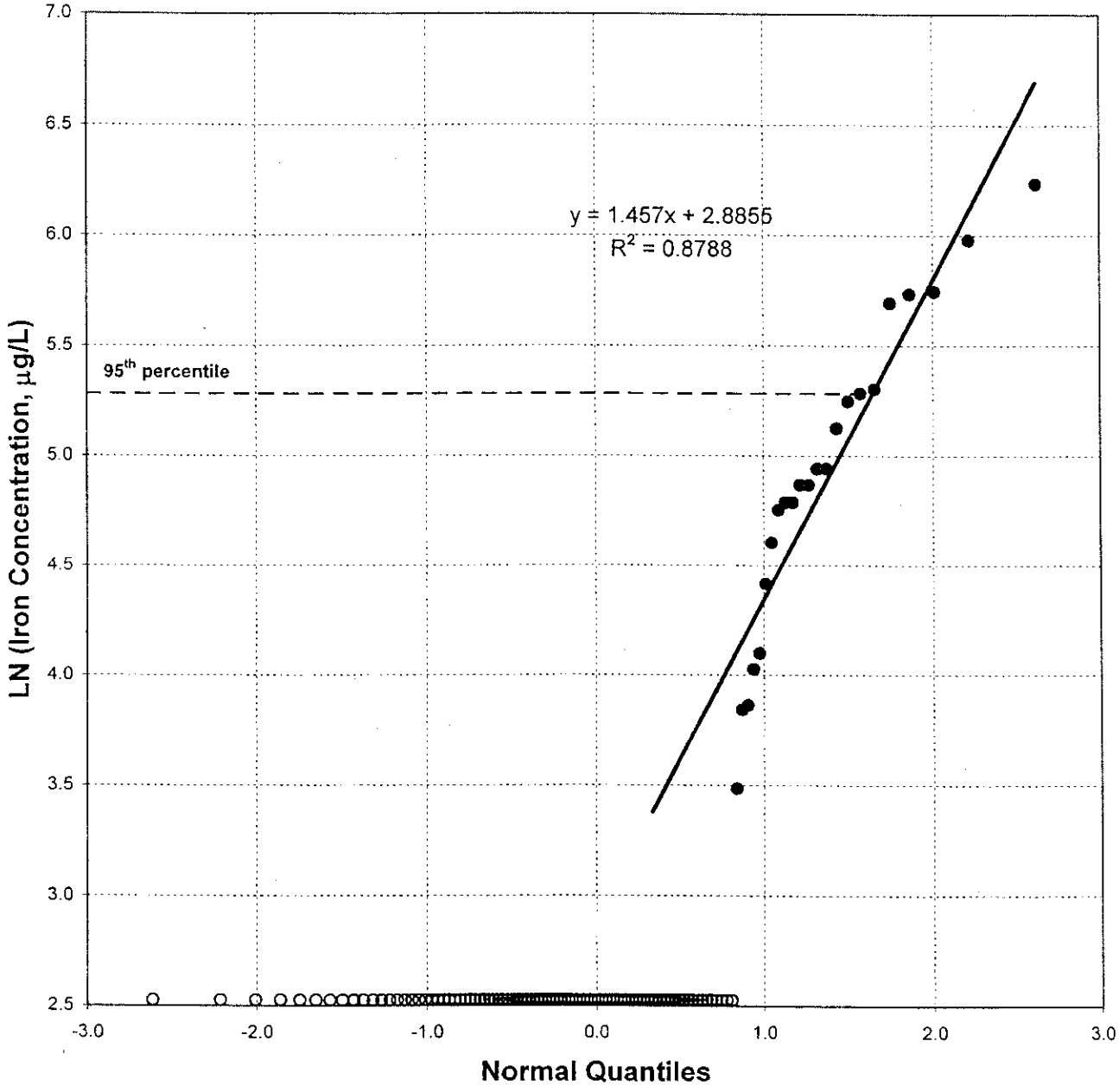
Notes: Distribution of detected cobalt concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 21. Probability Plot of Cobalt Concentrations DS.0284.16541



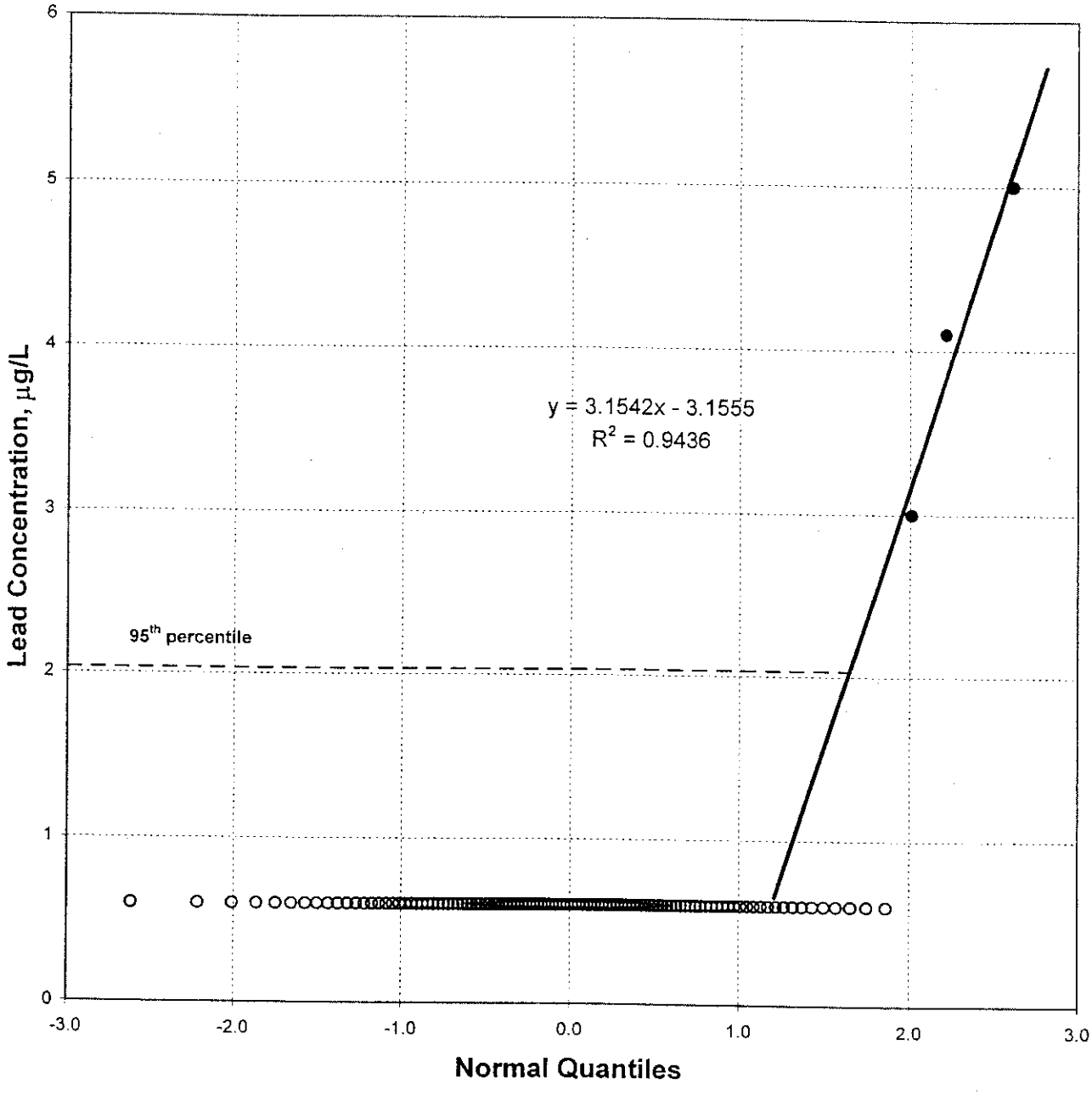
Notes: Distribution of detected copper concentrations is lognormal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 22. Probability Plot of Copper Concentrations DS.0284.16541



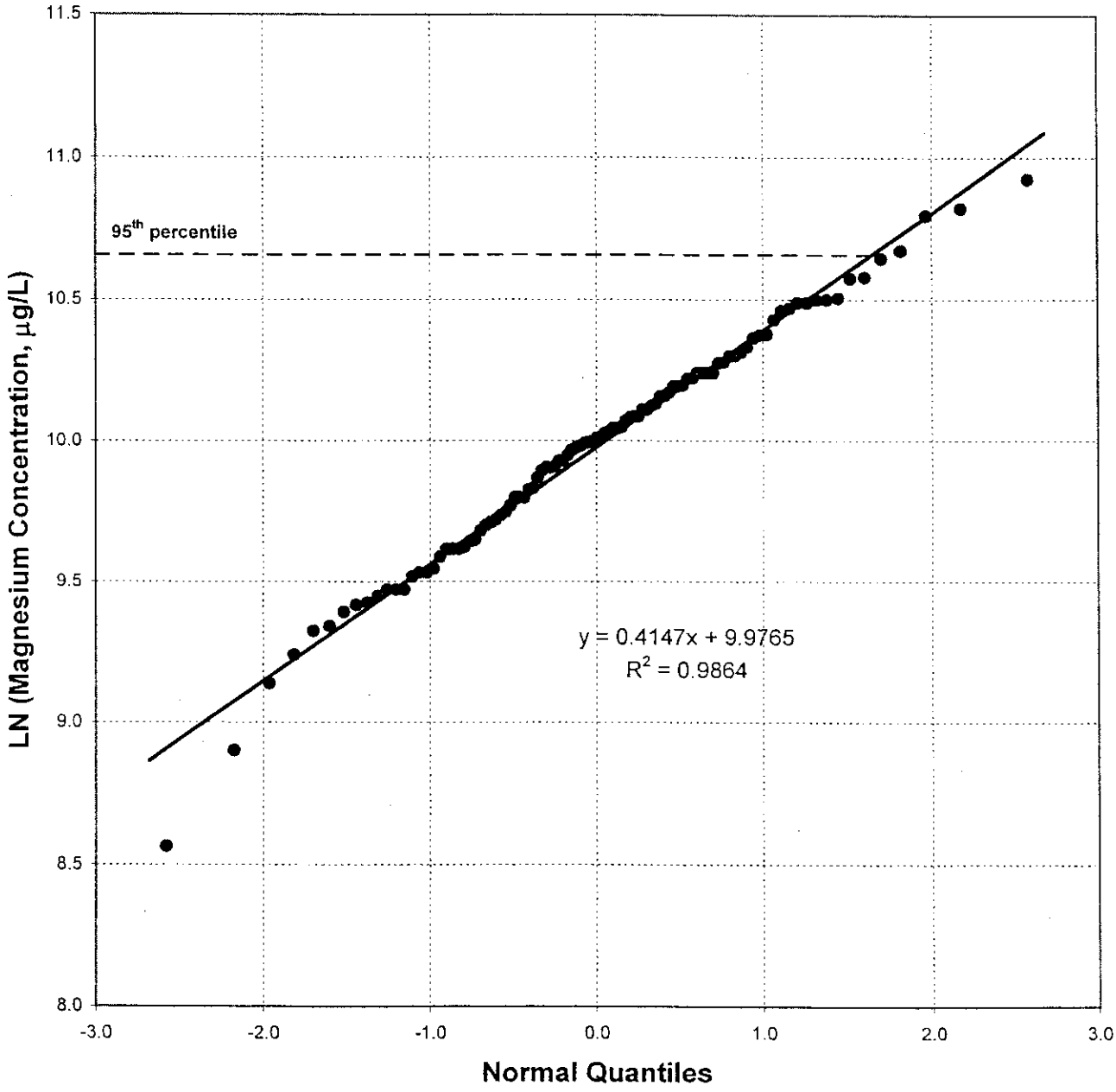
Notes: Distribution of detected iron concentrations is lognormal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 23. Probability Plot of Iron Concentrations DS.0284.16541



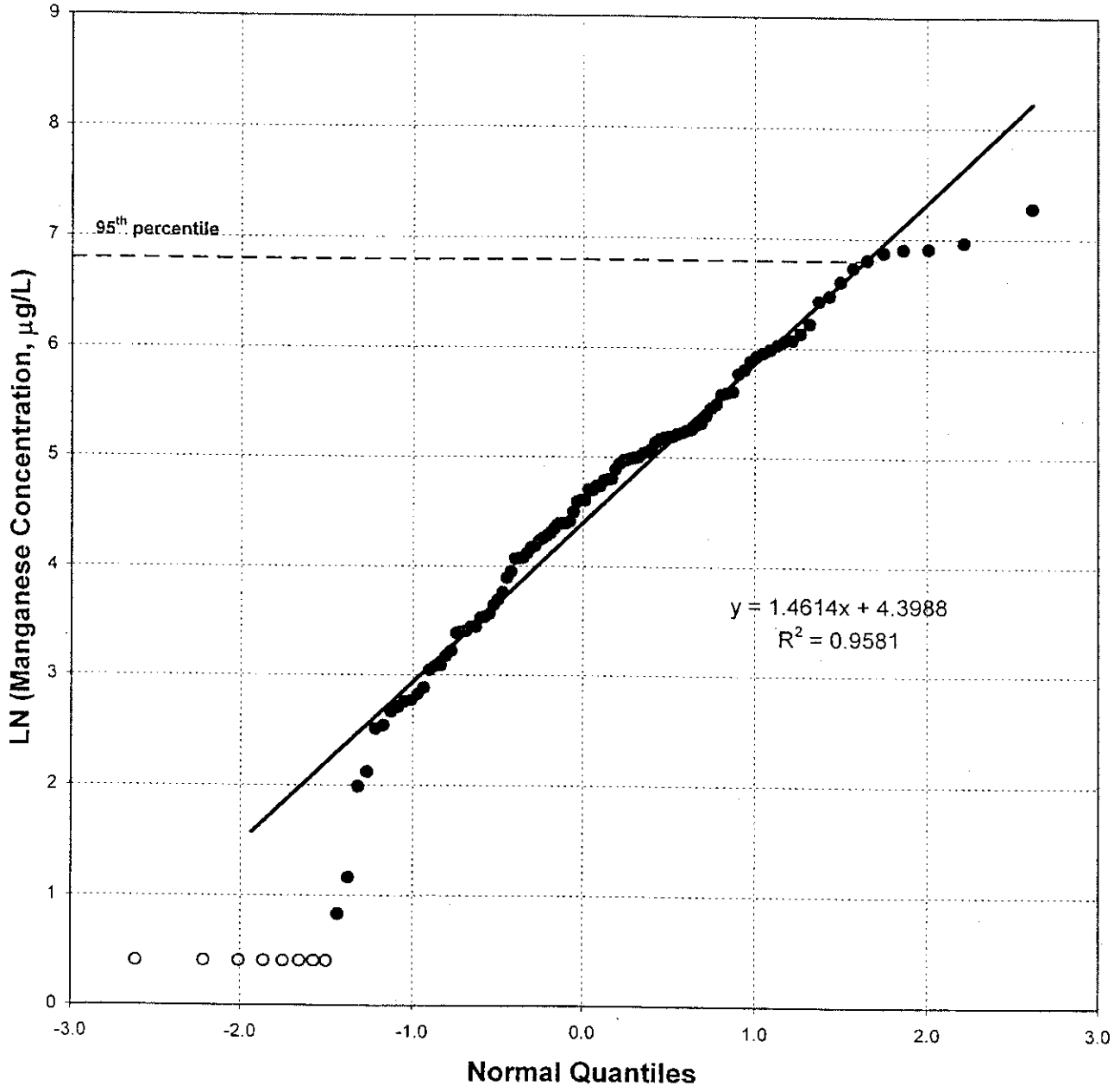
Notes: Distribution of detected lead concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 24. Probability Plot of Lead Concentrations DS.0284.16541



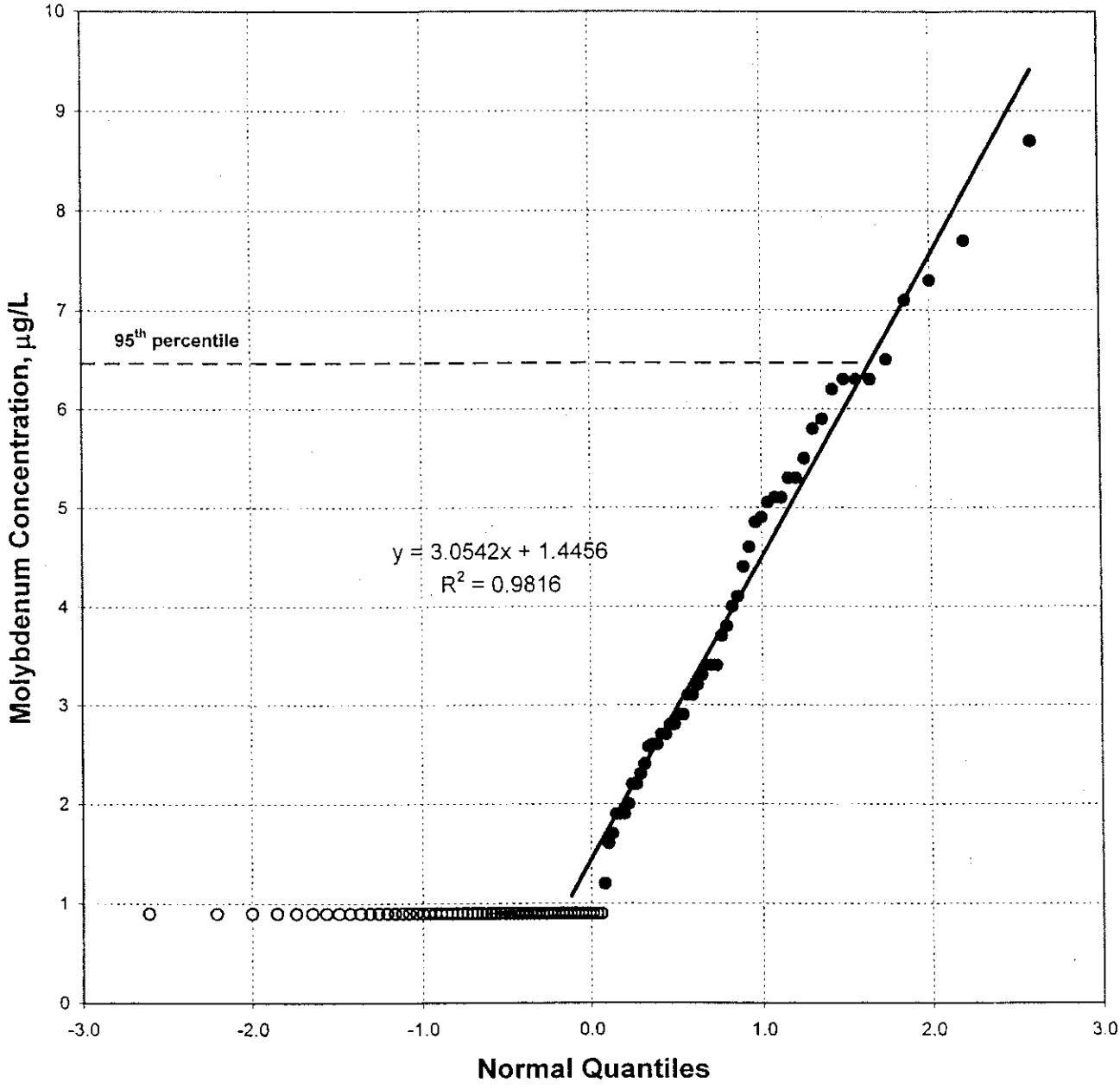
Notes: Distribution of magnesium concentrations is lognormal.

Figure 25. Probability Plot of Magnesium Concentrations DS.0284.16541



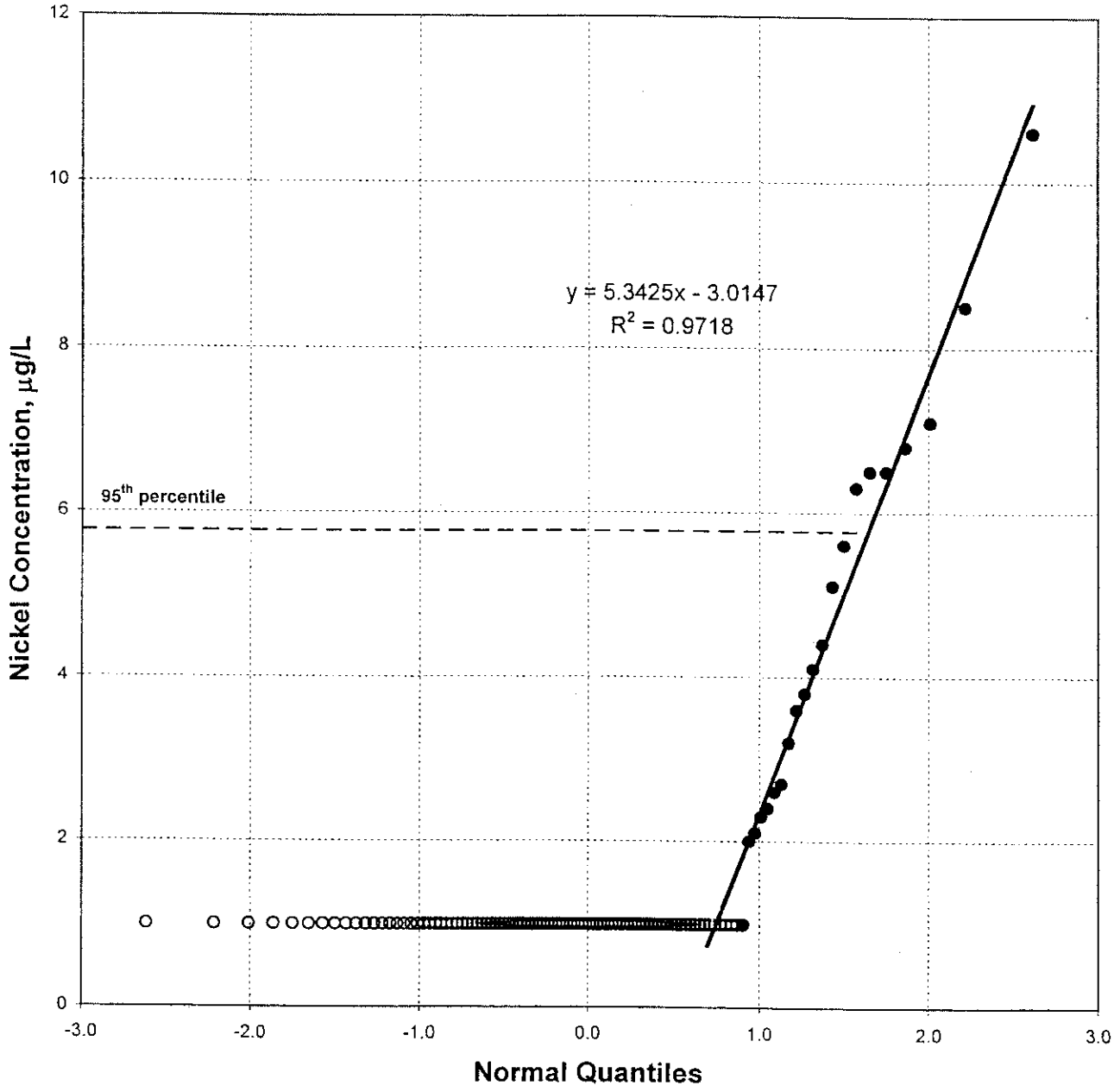
Notes: Distribution of detected manganese concentrations is lognormal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 26. Probability Plot of Manganese Concentrations DS.0284.16541



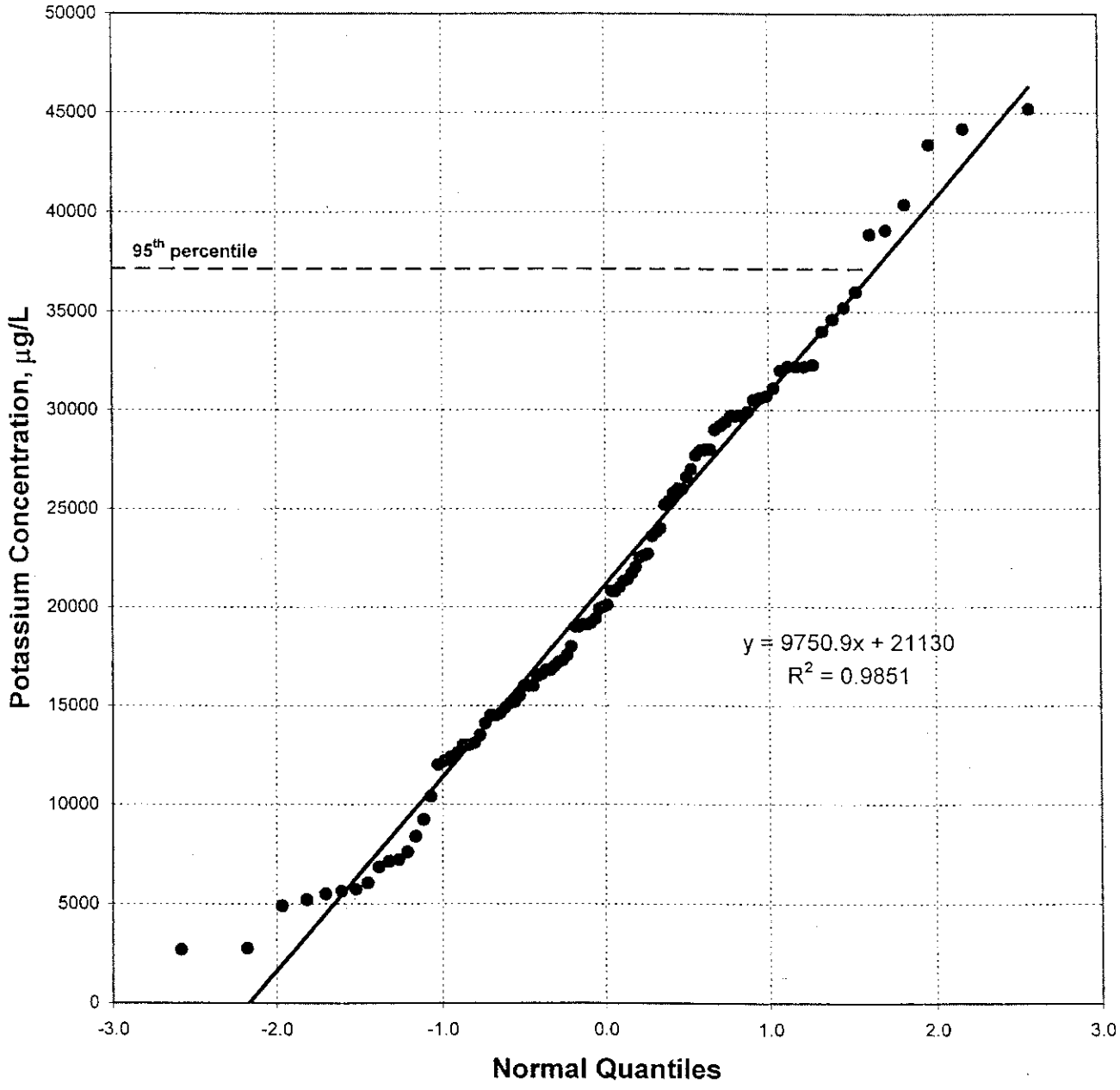
Notes: Distribution of detected molybdenum concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 27. Probability Plot of Molybdenum Concentrations DS.0284.16541



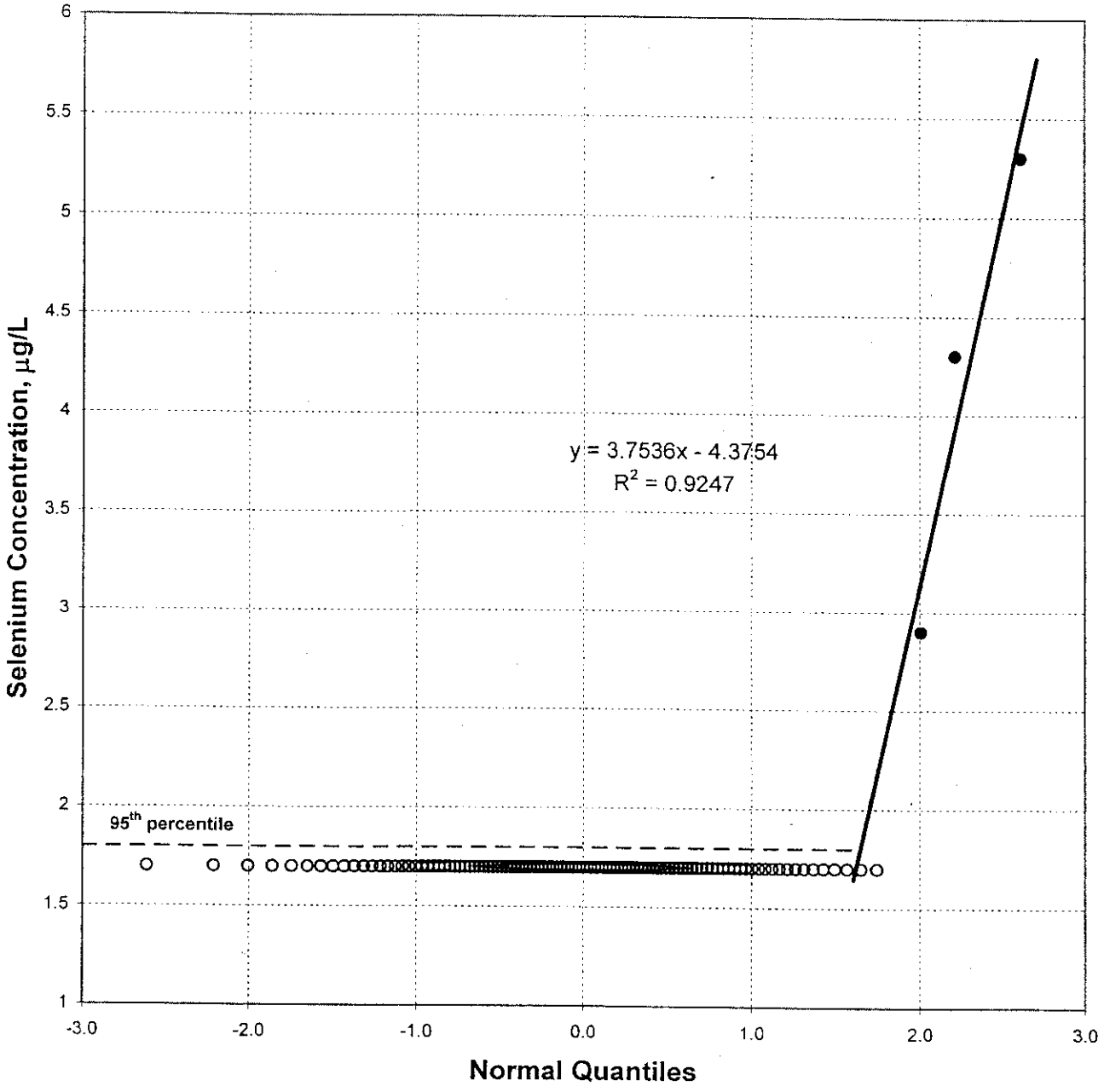
Notes: Distribution of detected nickel concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 28. Probability Plot of Nickel Concentrations DS.0284.16541



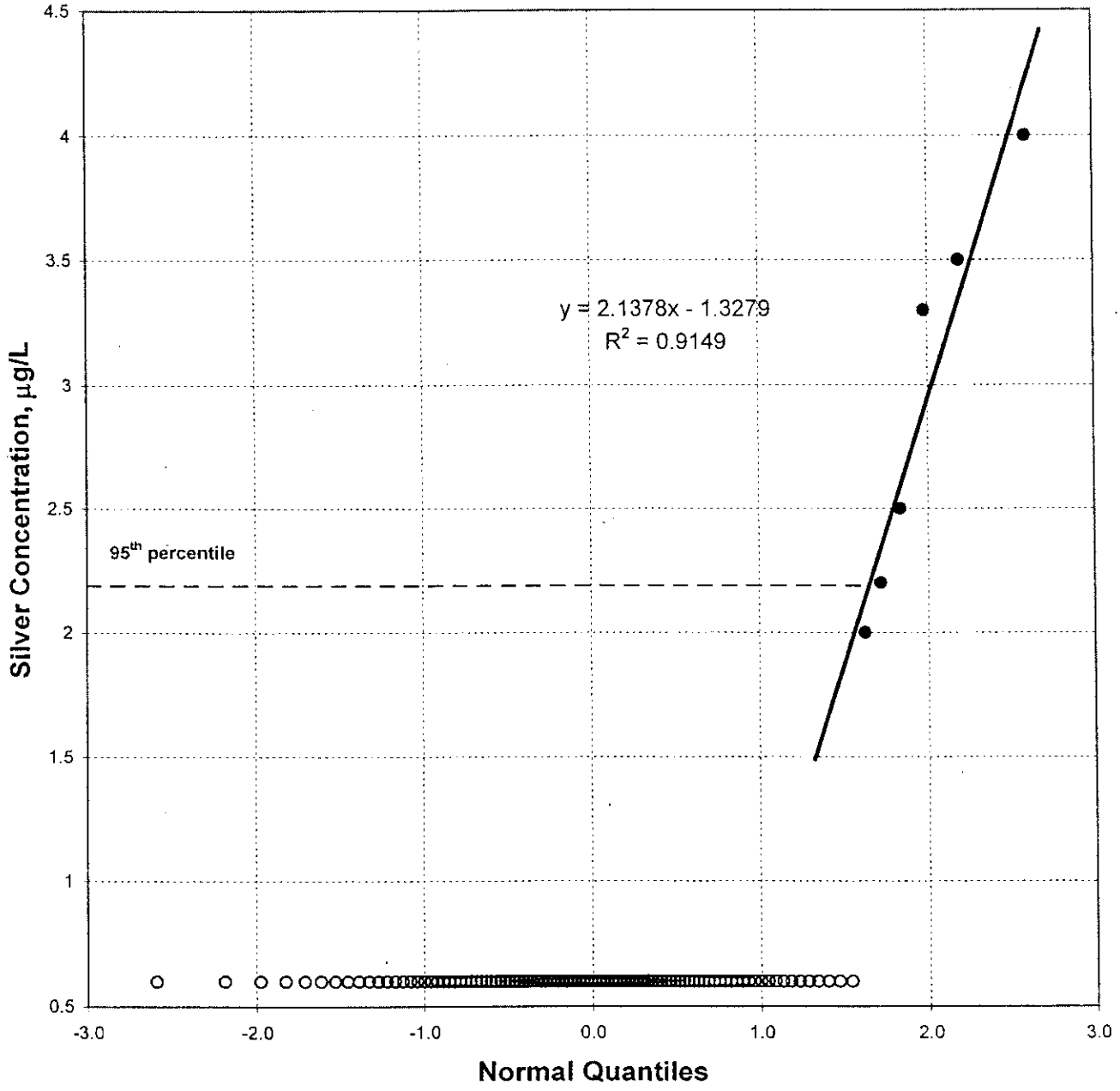
Notes: Distribution of potassium concentrations is normal.

Figure 29. Probability Plot of Potassium Concentrations DS.0284.16541



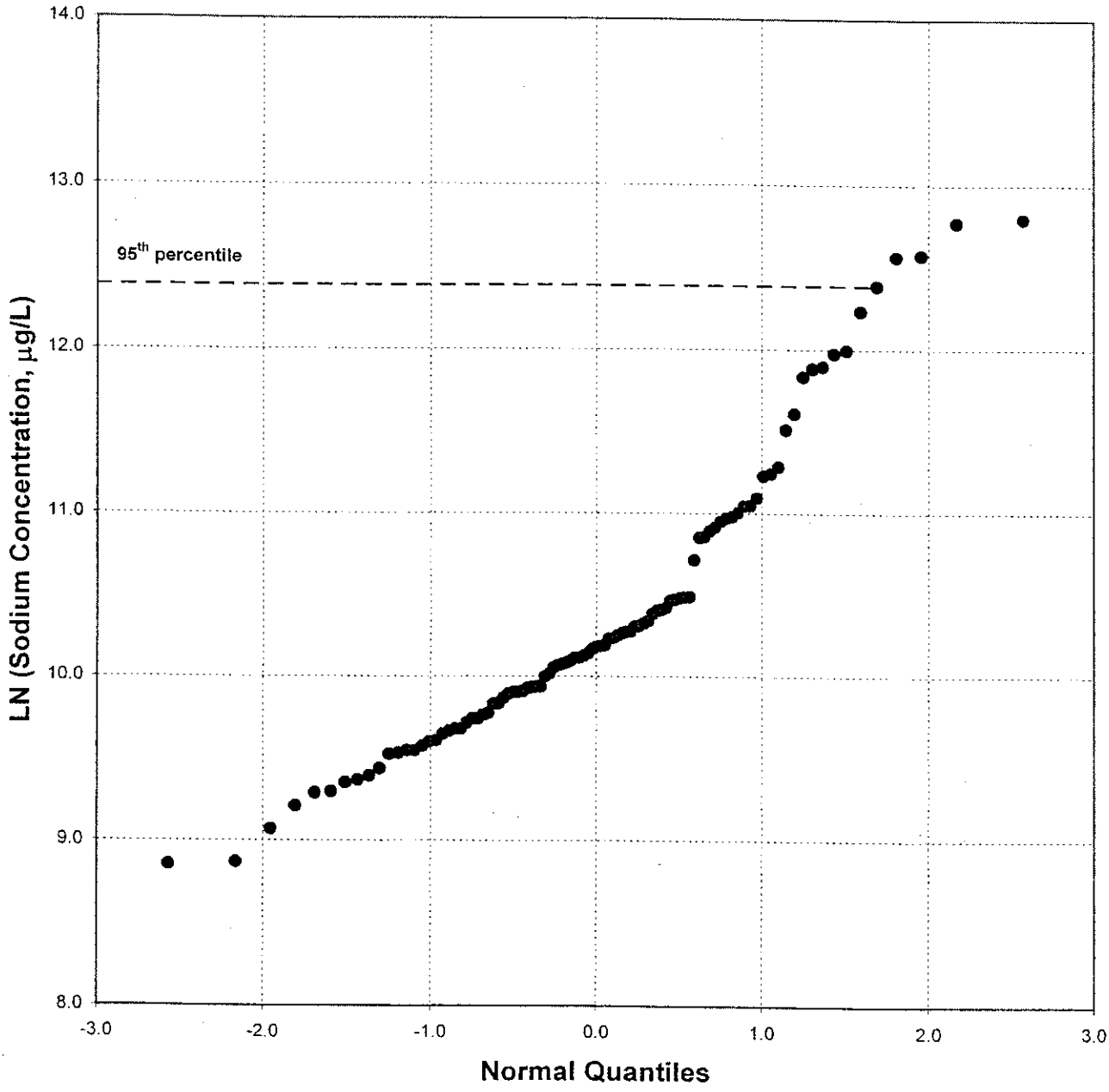
Notes: Distribution of detected selenium concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 30. Probability Plot of Selenium Concentrations DS.0284.16541



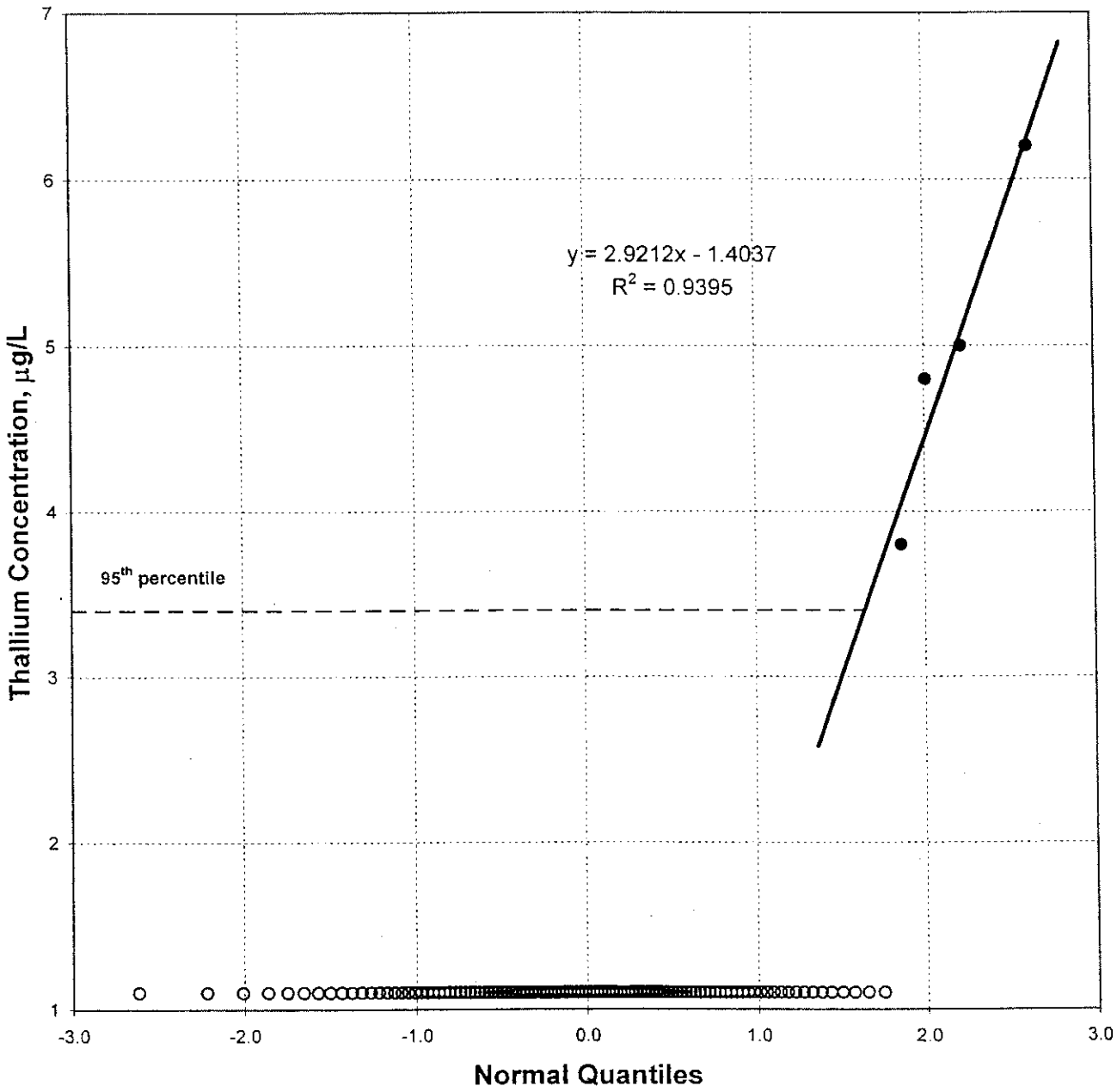
Notes: Distribution of detected silver concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 31. Probability Plot of Silver Concentrations DS.0284.16541



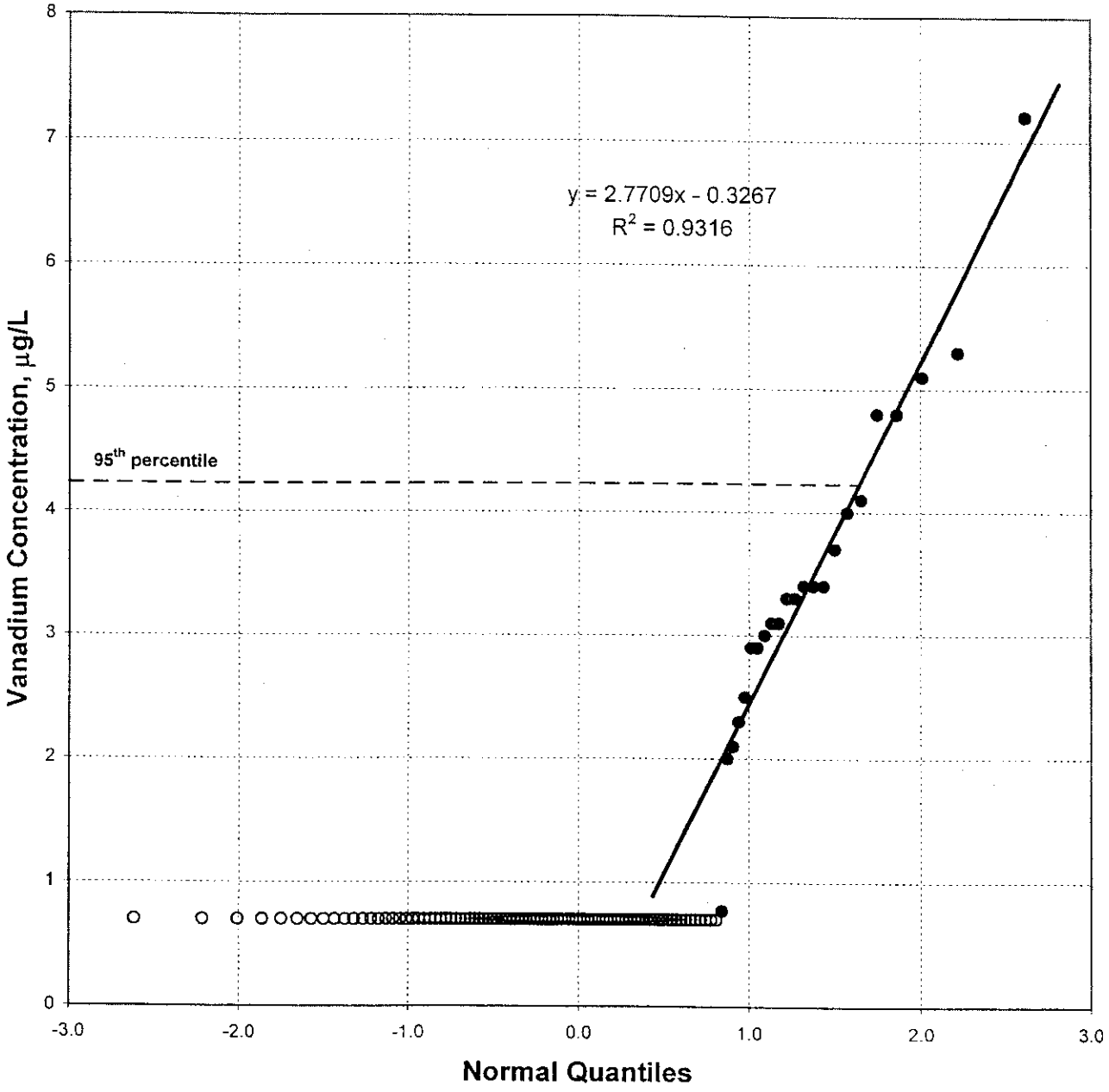
Notes: Distribution of sodium concentrations is nonparametric.

Figure 32. Probability Plot of Sodium Concentrations DS.0284.16541



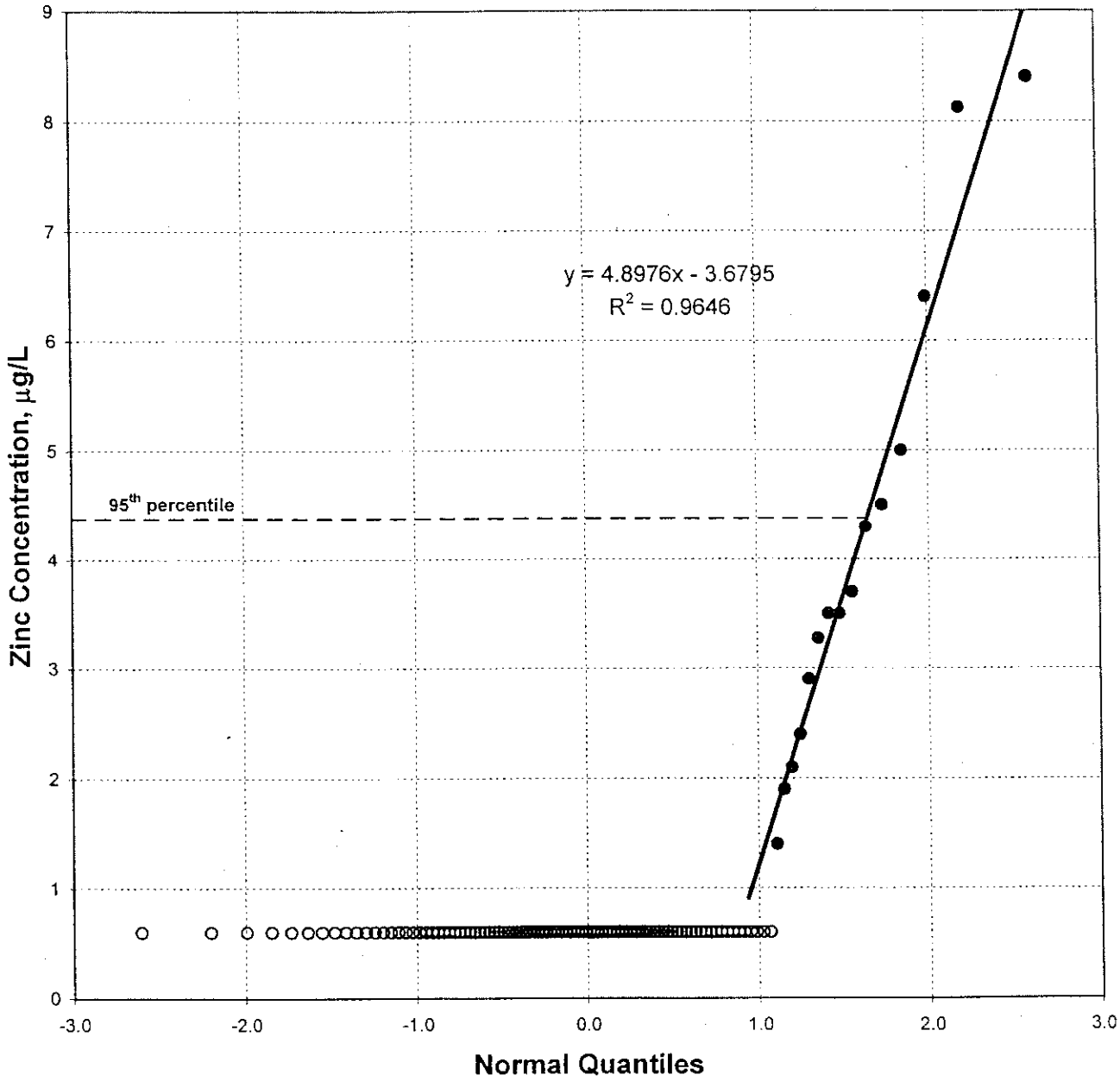
Notes: Distribution of detected thallium concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 33. Probability Plot of Thallium Concentrations DS.0284.16541



Notes: Distribution of detected vanadium concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 34. Probability Plot of Vanadium Concentrations DS.0284.16541



Notes: Distribution of detected zinc concentrations is normal. Nondetected results are replaced by a small value below the minimum detected concentration.

Figure 35. Probability Plot of Zinc Concentrations DS.0284.16541

TABLES

TABLE 1

COMPARISON OF METAL CONCENTRATIONS FROM UNFILTERED "LOW-FLOW" SAMPLES AND FILTERED SAMPLES

Metal	"Low-Flow" Samples		Filtered Samples		WRS Test Results		
	Number of Samples	Average (Standard Deviation)	Number of Samples	Average (Standard Deviation)	Z_{rs} (Z_{tab})	Two-sided *p*-value[a]	Test Conclusion[b]
Arsenic	30	9.5 (3.9)	8	8.6 (3.4)	0.412 (1.645)	0.680	No Significant Difference
Barium	8	12.5 (4.9)	12	4.5 (2.6)	3.125 (1.645)	0.002	Significant Difference
Magnesium	40	27,905 (10,257)	12	25,653 (8,953)	0.315 (1.645)	0.753	No Significant Difference
Manganese	37	274 (375)	11	183 (268)	0.809 (1.645)	0.418	No Significant Difference
Molybdenum	17	3.9 (1.2)	10	2.2 (0.7)	3.417 (1.645)	0.0006	Significant Difference

Notes: Only detected metal concentrations were used in calculations. The significance level for tests has been set at alpha = 0.05. The null hypothesis being tested is H_o: concentrations in one data set are equal to concentrations in the other data set.

Z_{rs} the normal approximation for the WRS test statistic (Gilbert 1987)

Z_{tab} quantile for the Z (standard normal) distribution that is equal to 1– alpha

[a] A two-sided probability value is used since the test looks for a difference between the data sets in both directions (whether the concentrations in one data set tend to be larger or smaller than those from other data set).

[b] Test conclusion: reject H_o if $Z_{rs} > Z_{tab}$ (two-sided *p*-value is less than 0.05). Fail to reject H_o = no significant difference; Reject H_o = significant difference.

TABLE 2

COMPARISON OF METAL CONCENTRATIONS IN SAMPLES COLLECTED DURING WET AND DRY PERIODS

Metal	Wet Period Samples		Dry Period Samples		WRS Test Results		
	Number of Samples	Average (Standard Deviation)	Number of Samples	Average (Standard Deviation)	Z_{rs} (Z_{tab})	Two-sided *p*-value[a]	Test Conclusion[b]
Arsenic	29	7.9 (3.6)	40	9.5 (3.7)	1.617 (1.645)	0.106	No Significant Difference
Barium	29	54.4 (41.5)	33	57.2 (42.5)	0.282 (1.645)	0.778	No Significant Difference
Magnesium	46	22,178 (8,785)	43	23,967 (10,287)	0.743 (1.645)	0.457	No Significant Difference
Manganese	44	203 (288)	49	217 (259)	0.650 (1.645)	0.516	No Significant Difference
Molybdenum	16	3.8 (1.8)	26	4.9 (1.5)	2.125 (1.645)	0.033	Significant Difference

Notes: Only detected metal concentrations were used in calculations. The significance level for all tests has been set at alpha = 0.05. The null hypothesis being tested is H_o: concentrations in one data set are equal to concentrations in the other data set.

Z_{rs} the normal approximation for the WRS test statistic (Gilbert 1987)

Z_{tab} quantile for the Z (standard normal) distribution that is equal to 1– alpha

[a] A two-sided probability value is used since the test looks for a difference between the data sets in both directions (whether the concentrations in one data set tend to be larger or smaller than those from other data set).

[b] Test conclusion: reject H_o if $Z_{rs} > Z_{tab}$ (two-sided *p*-value is less than 0.05). Fail to reject H_o = no significant difference; Reject H_o = significant difference.

TABLE 3

AMBIENT CONCENTRATIONS OF METALS IN GROUNDWATER AT TREASURE ISLAND

Metal	Number of Samples		Outlier Values Excluded	Detection Frequency, %	Size of Ambient Data Set[a]	Distribution of Ambient Data Set	Summary Statistics for Ambient Data Set (µg/L)					Screening Level[d] (µg/L)
	Detected	Analyzed					Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration[b]	**95th Percentile[c] (Ambient Level)**	
Aluminum	4	112	0	4	112	Lognormal	12.4	304	31.3	300	**27**	N/A
Antimony	0	112	0	0	112	NE	1.7	60	N/A	N/A	**1.7 (DL[e])**	4,300[1]
Arsenic	77	112	0	69	112	Normal	2.5	13.9	2.5	18.5	**15**	0.14[1]
Barium	74	112	0	66	112	Normal	4.1	12.8	2	160	**120**	N/A
Beryllium	5	112	0	4	112	Normal	0.1	2	0.11	0.55	**0.04 (DL[e])**	N/A
Cadmium	3	112	0	3	112	Normal	0.3	5	0.69	1.4	**0.27 (DL[e])**	9.3[1]
Calcium	112	112	0	100	112	Lognormal	N/A	N/A	11,800	162,000	**120,000**	N/A
Chromium	5	112	0	4	112	Normal	0.7	10	1.1	5.4	**0.13 (DL[e])**	50[1]
Cobalt	7	112	0	6	112	Normal	0.54	20	1	4	**1.4**	N/A
Copper	22	112	1	19	111	Lognormal	1.1	10	1.5	32.7	**6.6**	3.1[1]
Iron	23	112	0	21	112	Lognormal	12.5	186	32.6	510	**200**	N/A
Lead	3	112	0	3	112	Normal	0.6	3	3	5	**2.0**	5.6[2]

TABLE 3 (Continued)

AMBIENT CONCENTRATIONS OF METALS IN GROUNDWATER AT TREASURE ISLAND

Metal	Number of Samples		Outlier Values Excluded	Detection Frequency, %	Size of Ambient Data Set[a]	Distribution of Ambient Data Set	Summary Statistics for Ambient Data Set (µg/L)					Screening Level[d] (µg/L)
	Detected	Analyzed					Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Concentration	Maximum Detected Concentration[b]	**95th Percentile[c] (Ambient Level)**	
Magnesium	112	112	11	100	101	Lognormal	N/A	N/A	5,240	55,500	**43,000**	N/A
Manganese	104	112	0	93	112	Lognormal	1.5	21.7	2.3	1,450	**900**	100[1]
Mercury	2	112	1	2	112	NE	0.1	0.2	0.1	0.13	**0.1 (DL[e])**	0.025[2]
Molybdenum	54	112	2	48	110	Normal	0.9	20	1.2	8.7	**6.5**	N/A
Nickel	21	112	0	19	112	Normal	1	20	1	10.6	**5.8**	8.2[1]
Potassium	112	112	10	100	102	Normal	N/A	N/A	2,700	45,200	**37,000**	N/A
Selenium	3	111	0	3	111	Normal	1.7	5	2.9	5.3	**1.8 (DL[e])**	71[1]
Silver	6	104	0	6	104	Normal	0.6	5.0	2.0	4.0	**2.2**	0.38[3]
Sodium	112	112	13	100	99	Nonparam.	N/A	N/A	7,000	361,000	**240,000**	N/A
Thallium	4	112	0	4	112	Normal	1.1	7.9	3.8	6.2	**3.4**	6.3[1]
Vanadium	23	112	0	20	112	Normal	0.7	10	0.77	7.2	**4.2**	N/A
Zinc	18	112	3	16	112	Normal	0.6	20	1.4	8.4	**4.4**	81[1]

Notes:

a The ambient data set consists of both detected and nondetected results from the original and duplicate sample data based on four quarters of sampling from 26 wells in 2000 and one or two quarters of sampling from 10 wells in 1998. Anomalously high values of detected results (and a corresponding number of nondetected results) were excluded.

b The maximum concentration value in the ambient data set after exclusion of anomalously high values.

c The 95th percentile of the distribution was calculated using distribution dependent formulae. For normal and lognormal distributions, the 95th percentile calculation used the parameters of the best-fitted regression line drawn through the detected values on the probability plot. For nonparametric distribution, the analytical formula (Gilbert 1987) was used (see Appendix A for details). The results are rounded to two significant digits.

d The selected groundwater screening criteria for NAVSTA TI are described in detail in the Interim Groundwater Status Report (TTEMI 2000b). Sources: [1] RWQCB. 2000. "A Compilation of Water Quality Goals;" [2] RWQCB. 1995. "San Francisco Bay Basin Plan 'Water Quality Control Plan.'" June; [3] 20% of the Acute Criterion (RWQCB 2000).

e The ambient level was set at or below the minimum reported detection limit.

DL Detection limit

NE Not evaluated

N/A Not available

µg/L Micrograms per liter

TABLE 4

COMPARISON OF AMBIENT METALS CONCENTRATIONS IN SHALLOW GROUNDWATER AT TREASURE ISLAND, MARE ISLAND, AND HUNTERS POINT

Metal	TREASURE ISLAND 95th percentile	MARE ISLAND 95th percentile	HUNTERS POINT 95 Upper Confidence Limit on 95th percentile
Aluminum	27	480	N/A
Antimony	1.7 (DL)	5.6	43
Arsenic	15	78	27
Barium	120	1,200	500
Beryllium	0.04 (DL)	1.6	1.4
Cadmium	0.27 (DL)	16	5.1
Calcium	120,000	680,000	N/A
Chromium	0.13 (DL)	22	16
Cobalt	1.4	100	21
Copper	6.6	33	28
Iron	200	140,000	2,400
Lead	2.0	10	14
Magnesium	43,000	1,500,000	1,400,000
Manganese	900	5,400	8,100
Mercury	0.1 (DL)	0.22	0.6
Molybdenum	6.5	8.8	62
Nickel	5.8	7.5	97
Potassium	37,000	210,000	450,000
Selenium	1.8 (DL)	12	15
Silver	2.2	15	7.4
Sodium	240,000	7,400,000	9,200,000
Thallium	3.4	DL	13
Vanadium	4.2	140	27
Zinc	4.4	260	76

Notes:

All units are micrograms per liter.

N/A Not analyzed

DL Detection limit

APPENDIX A

OVERVIEW OF STATISTICAL METHODS

This appendix provides an overview of the statistical methods used to estimate ambient concentrations of metals in shallow groundwater at Treasure Island. Section 1.0 describes how the distributions of the data sets were tested for normality. Section 2.0 describes procedures for finding estimators of the 95th percentiles using distribution-dependent formulae. Section 3.0 discusses the site-to-ambient comparisons. The methods discussed in this attachment are based on published sources and guidance documents (Gilbert 1987; EPA 1998; Navy 1999).

1.0 NORMALITY TESTS

In conjunction with histograms and probability plots that allow qualitative analysis, the assumption of normality is tested using the Shapiro-Wilk W-test for data sets with 50 or fewer values and with D'Agostino's D-test for data sets with more than 50 values (Gilbert 1987).

For data sets with n less than or equal to 50, the W-test is used to test a null hypothesis that a sample population has a normal distribution as follows:

(1) Compute the denominator d of the W- test statistic for n values:

$$d = \sum_{i=1}^{n} (x_i - \bar{x})^2$$

(2) Rank the data from minimum to maximum to obtain the sample order statistics:

$$x_1 \leq x_2 \leq \ldots \leq x_k \ldots \leq x_n$$

(3) Compute k, where:

$k = n/2$ if n is even

$k = (n-1)/2$ if n is odd

(4) Find coefficients $a_1, a_2, \ldots a_k$ for n observations from Table A6 published by Gilbert (1987).

(5) Compute the W statistic:

$$W = \frac{1}{d} [\sum_{i=1}^{k} a_i (x_{[n-i+1]} - x_{[i]})]^2$$

(6) If W is less than the quantile in Table A7 (Gilbert 1987) for a given significance level, the null hypothesis that the population is normally distributed can be rejected.

If normality is not confirmed through the *W*-test, the test is conducted on the logarithms of the data. If both normal and lognormal assumptions are rejected, the nonparametric techniques must be used in estimating ambient limits.

For data sets with n greater than or equal to 50, the *D*-test is used to test a null hypothesis that a sample population has a normal distribution as follows:

(1) Rank the data from minimum to maximum to obtain the sample order statistics:

$$x_1 \leq x_2 \leq \ldots \leq x_k \ldots \leq x_n$$

2) Compute the statistic:

$$D = \frac{\sum_{i=1}^{n} [i - \frac{1}{2}(n+1)]\, x_{[i]}}{n^2 s}$$

where:

$$s = \left[\frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^2 \right]^{1/2}$$

(3) Transform D to the statistic Y by computing

$$Y = \frac{D - 0.28209479}{0.02998598/\sqrt{n}}$$

If n is large and the data are drawn from a normal distribution, the expected value of Y is zero. For distributions that are not normal, Y will tend to be either less than or greater than zero, depending on the particular distribution. This fact necessitates a two-tailed test (step 4).

(4) Reject at the α significance level the null hypothesis that the n data were drawn from a normal distribution if Y is less than the $\alpha/2$ quantile or greater than the $1 - \alpha/2$ quantile of the distribuiton Y. These quantiles are given in Table A8 published by Gilbert (1987) for selected values of n between 50 and 1,000.

If normality is not confirmed through the *D*-test, the test is conducted on the logarithms of the data. If both normal and lognormal assumptions are rejected, nonparametric techniques must be used in estimating ambient limits.

2.0 CALCULATION OF AMBIENT THRESHOLD VALUES

Ambient limits are estimated as the 95th percentiles using distribution-dependent formulae (Gilbert 1987). The procedures for calculating the ambient limits for data sets with normal, lognormal, and nonparametric distributions are presented in sections 2.1 through 2.3.

2.1 AMBIENT LIMITS FOR NORMAL DISTRIBUTIONS

For normally distributed data, the mean, $\bar{x}$, and standard deviation, s, are the parameters of the regression line drawn through the detected data points on the probability plots (the intercept and the slope, respectively). In general, the pth percentile (quantile), x_p, can be estimated by computing

$$\hat{x}_p = \bar{x} + Z_p s$$

where Z_p is the pth quantile of the standard normal distribution (obtained from Table A-1 published by Gilbert [1987]).

Since $Z_{0.95} = 1.645$, then the 95th percentile concentration is calculated as follows:

$$\hat{x}_p = \bar{x} + 1.645\, s$$

2.2 AMBIENT LIMITS FOR LOGNORMAL DISTRIBUTIONS

Evaluation of lognormally distributed data includes an additional step of "transforming" the data set to the logarithms:

$$y_i = \ln x_i$$

The lognormal mean and standard deviation, $\bar{y}$ and s_y, are the parameters of the regression line drawn through the detected data points on the probability plots (the intercept and the slope, respectively).

The 95th percentile concentration is calculated as follows:

$$\hat{x}_{0.95} = \exp(\bar{y} + 1.645\, s_y)$$

2.3 AMBIENT LIMITS FOR NONPARAMETRIC DISTRIBUTIONS

Ambient limits are estimated as the 95th percentile using nonparametric formula (Gilbert 1987) as follows:

(1) Rank the data from minimum to maximum to obtain the sample order statistics:

$$x_1 \leq x_2 \leq \ldots \leq x_k \ldots \leq x_n$$

(2) Calculate the kth value that corresponds to the 95th percentile as:

$$k = p\,(n + 1) = 0.95\,(n+1)$$

If k is an integer, the estimated pth percentile, x_p, is the kth largest datum (concentration) in the data set. If k is not an integer, x_p is obtained by linear interpolation between the two closest concentrations corresponding to k.

3.0 SITE-TO-AMBIENT COMPARISONS

The established ambient metals data set will be used for site-to-ambient comparisons to identify chemicals of potential concern (COPC) at NAVSTA TI sites. In conducting site-to-ambient comparisons, the null (H_o) and alternative (H_a) hypotheses are defined as:

H_o = Site concentrations do not tend to be larger in value than ambient concentrations, that is a chemical of interest is not a COPC

H_a = Site concentrations tend to be larger in value than ambient concentrations, that is a chemical of interest is a COPC

In hypothesis testing, two types of decision errors may occur by incorrectly accepting or rejecting the null hypothesis. A Type I decision error occurs when the null hypothesis is rejected when, in fact, it is true. With a Type I error, the project team will incorrectly conclude that a chemical release has occurred. A Type I error can lead to unnecessary remediation. In contrast, a Type II decision error occurs when the null hypothesis is accepted when, in fact, it is false. A Type II error can lead to a decision that no remediation is necessary when remediation may be required (Navy 1998).

The probability that a Type I error will occur is typically denoted as alpha (α), while the probability of a Type II error is designated by beta (β). The power of a statistical test to detect that a release has occurred is equal to 1-β, and is defined as probability that the test procedure correctly rejects the null hypothesis. The α is referred to as the level of significance of a statistical test (Navy 1998). When conducting site-to-

ambient comparisons, the level of statistical confidence will be set at 95 percent ($\alpha = 0.05$). Because the ambient data set size is large, it is expected that the tests will achieve a power of 90 percent ($\beta = 0.10$).

The following sections discuss two methods for identifying metals as COPCs at NAVSTA TI sites: 1) simple comparison method, and 2) two-sample statistical tests. To illustrate the application of both methods, the concentrations of arsenic and molybdenum in groundwater at Site 06 are compared to ambient concentrations. There are no known sources of arsenic or molybdenum contamination at Site 6 (TtEMI 1999), which is a typical scenario for most metals in groundwater at NAVSTA TI sites. The examples with these two metals show the expected outcomes of the COPC selection process at sites.

3.1 SIMPLE COMPARISON METHOD

The simplest method for identifying metals as COPC involves comparison of highest concentrations detected at the site (C_{max}) with a concentration representing the upper range of ambient conditions (DTSC 1996; Navy 1999). If C_{max} does not exceed this value, then the metal is excluded as a COPC. If it does, the metal is carried forward as a COPC.

This comparison method has the advantage of simplicity, but it suffers from increasing a Type I error (false positive) as the number of samples taken from the site increases. If the 95th percentile is used to represent the upper range of ambient concentrations, then 5% of any group of samples from a truly ambient population will exceed this threshold. Since a Type I error will be made if one sample exceeds the 95th percentile, and since the probability of encountering at least one sample greater than the 95th percentile increases with the number of samples collected from the site, it follows that the probability of Type I error must increase with the number of samples from the site (DTSC 1996; Navy 1999).

3.1.1 Example of Using Simple Comparison Method

Maximum concentrations of arsenic and molybdenum at Site 06 are 128 and 6.6 micrograms per liter [µg/L], respectively. Both metals exceed the estimated 95th percentile of ambient concentrations of 15 and 6.4 µg/L, respectively. As the result of this simple comparison method, both arsenic and molybdenum should be identified as the COPCs at Site 06.

It is likely, however, that simple comparison method incorrectly declared that site concentrations of molybdenum are greater than ambient concentrations. A more reliable determination should be made by

statistically comparing two distributions (site data versus ambient data) using two-sample tests such as the Wilcoxon Rank Sum (WRS) test and Quantile test (Gilbert 1987; EPA 1998; Navy 1999). These tests are discussed in the following sections.

3.2 TWO-SAMPLE TESTS

In most cases at NAVSTA TI, both site and ambient data sets of metals concentrations in groundwater are not expected to follow normal distribution, to have a frequency of detection of 100 percent, and have equal variances. Therefore, the use of the parametric tests such as Student t-test (Gilbert 1987; EPA 1998; Navy 1999) will be limited. The nonparametric tests, such as the WRS and Quantile tests primarily will be used because they are better able to handle nondetects and are expected to provide greater statistical power.

3.2.1 Wilcoxon Rank Sum Test

The WRS test is conducted to test whether measurements from one population tend to be consistently larger (smaller) than those from other population. This test is a nonparametric version of the two-sample Student's t-test. It compares the two data sets on the basis of the order (or rank) of the data values, rather than on their magnitudes. If both data sets are normally distributed, the WRS test is 95.5 percent as powerful as the traditional Student's t-test. That is, it is 95.5 percent as likely to detect a difference between the data sets when that difference really exists. If one or both data sets are not normally distributed, the Student's t-test becomes much less powerful, while the WRS test retains its power because it does not assume normality. The procedure and examples of conducting the WRS test are described in detail in the published sources (Gilbert 1987; Navy 1999).

The WRS test results include the calculated Z_{rs} statistic and probability value (p-value). If Z_{rs} value greater than a critical value for a given level of significance, then the median concentration at the site is statistically greater than the median ambient concentration and the metal is identified as a COPC. The p-value is the probability value that is used to evaluate whether or not both datasets came from the same distribution. It is a one-sided probability value, that is, the test looks for a difference between the data sets in one direction (whether the concentrations in site data set tend to be larger than ambient concentrations). By convention, a probability greater than 0.05 is considered to indicate that the two datasets probably came from the same distribution (the medians of both data sets are equal at a 5 percent level of significance).

3.2.2 Example of Using Wilcoxon Rank Sum Test

The WRS test was conducted for arsenic and molybdenum using a public domain statistical software Number Cruncher Statistical System (NCSS). The results of the WRS tests for both metals are summarized in Table A-1. In addition, Figure A-1 presents the box and whisker plots for site and ambient data sets.

TABLE A-1

STATISTICAL COMPARISON OF SITE VERSUS AMBIENT CONCENTRATIONS

Metal	Site 06 Concentrations		Ambient Concentrations		WRS Test Results		
	Detected/ Analyzed	Average (Standard Deviation)	Detected/ Analyzed	Average (Standard Deviation)	Z_{rs} (Z_{tab})	One-sided *p*-value	Test Conclusion[a]
Arsenic	30/31	44.2 (36.6)	77/112	6.8 (4.2)	7.096 (1.645)	0.0	Significant Difference
Molybdenum	17/31	2.6 (1.9)	52/110	2.4 (1.9)	0.772 (1.645)	0.220	No Significant Difference

Notes: Non-detected metal concentrations in both data sets were replaced by a small value equal to a one-tenth of the minimum detected concentration in the ambient data set. The significance level for all tests has been set at alpha = 0.05. The null hypothesis being tested is H_o: concentrations in site data set are less or equal to ambient concentrations.

Z_{rs} the normal approximation for the WRS test statistic (Gilbert 1987)

Z_{tab} quantile for the Z (standard normal) distribution that is equal to 1– alpha

[a] Test conclusion: reject H_o if $Z_{rs} > Z_{tab}$ (one-sided *p*-value is less than 0.05). Fail to reject H_o = no significant difference; Reject H_o = significant difference.

A box and whisker plot is made up of a box (a rectangle) with various lines and points added to it. The width of the box is arbitrary; the top and bottom of the box are the 25th and 75th percentiles of the distribution. The length of the box is thus the interquartile range (IQR). That is, the box represents the middle 50 percent of the data. A line is drawn through the middle of the box at the median (the 50th percentile).

The adjacent values are displayed as T-shaped lines (whiskers) that extend from each end of the box. The upper adjacent value is the largest observation that is less than or equal to the 75th percentile plus 1.5 times IQR. The lower adjacent value is the smallest observation that is greater than or equal to the 25th

percentile minus 1.5 times IQR. Values outside the upper and lower adjacent values are called outside values. Values that are under three IQRs from the 25th and 75th percentiles are called mild outliers. Those outside three IQRs are called severe outliers. There is only one mild outlier shown on Figure A-1, which is a non-detected value in the site data set.

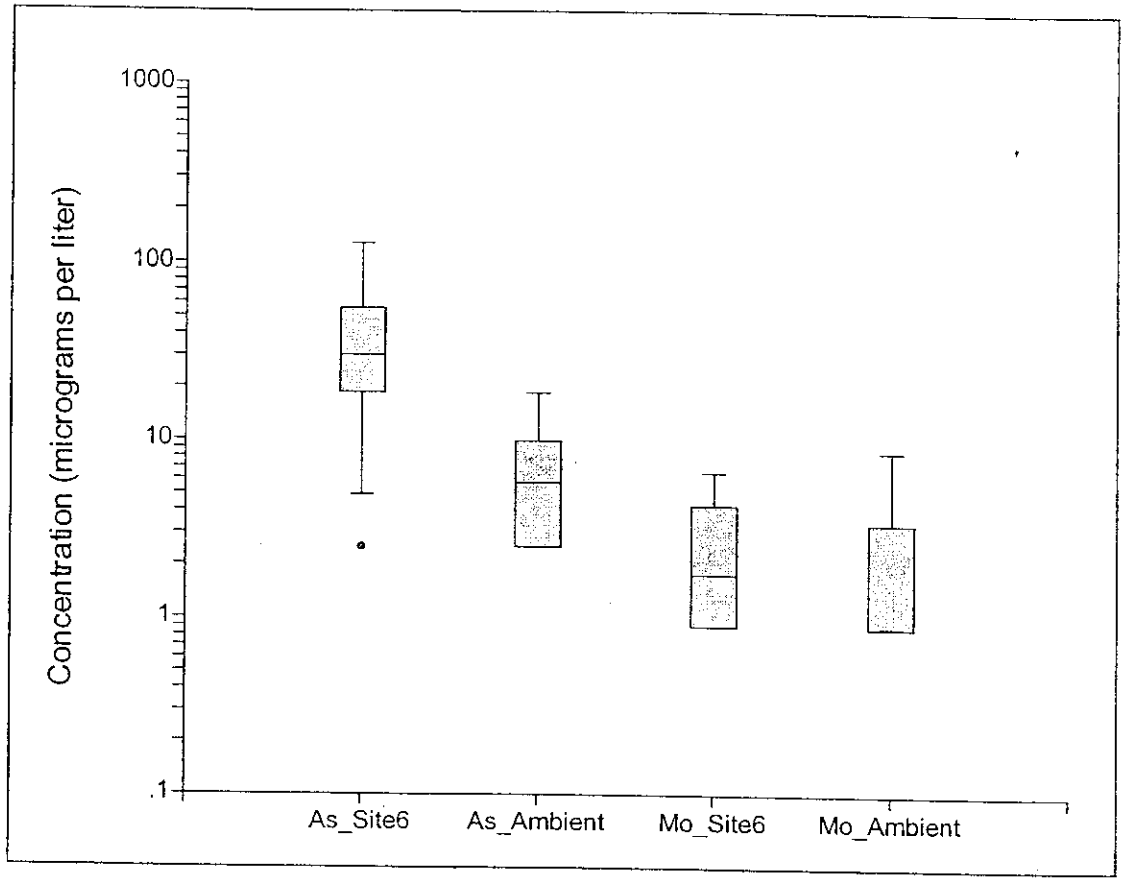


Figure A-1. Box and Whisker Plots of Arsenic and Molybdenum Concentrations in Site and Ambient Data Sets.

Based on the WRS test results, only arsenic is identified as the COPC at Site 06. However, it is not recommended to use the WRS test when more than 40 percent of both site and ambient data are nondetects (Navy 1999). Because molybdenum data sets contain more than 40 percent nondetects, the WRS test becomes less powerful and other tests, such as the Quantile test should be used.

3.2.4 Quantile Test

The Quantile test is not as powerful as the WRS test when the site concentration distribution is shifted in its entirety to the right of the ambient distribution. However, the Quantile test is more powerful when a

small group of data at high concentrations is present in the site data set. The Quantile test consists of looking at the largest *r* measurements in the pooled (and ordered) site and ambient data sets and counting the number of those *r* measurements that are from the site. If *k* or more of the *r* measurements are site measurements, the Quantile test declares the chemical is a COPC. The Quantile test focuses on comparing the right tails of the site and ambient distributions rather than comparing the median or mean of the two distributions. For this reason, the Quantile test should be used together with the WRS test because the WRS test focuses on looking for differences in means and medians. When applied together, these tests are most powerful for detecting true differences between two population distributions (EPA 1998, Navy 1999).

3.2.4 Example of Using Quantile Test

For arsenic and molybdenum data sets, Table A13 (Navy 1999) specifies that *r* largest measurements in the pooled and ordered site and ambient data should be 4 (at $\alpha = 0.05$) and $k = 3$ measurements should come from site data. Because the three largest measurements in the pooled site and ambient data sets of arsenic concentrations are site data, the Quantile test declares that arsenic is a COPC at Site 06. In the case of molybdenum, the three largest values are ambient concentrations. These three values exceed both the estimated 95th percentile of ambient concentrations (6.5 µg/L) and maximum value detected at Site 06 (6.6 µg/L). Therefore, the test does not indicate that molybdenum is a COPC at Site 06.

In conclusion, the simple comparison method identified both arsenic and molybdenum as COPCs in groundwater at Site 06. However, the results of more rigorous statistical tests indicate that only arsenic should be considered a COPC at this site.

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APPENDIX B

ANALYTICAL RESULTS FOR SELECTED WELL

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 01

WELL ID: 01-MW01

Sampling Events	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.95	4.12	2.81	UA
Sample Depth Below Ground Surface (feet)	7.00	7.00	7.00	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	ND	6.8J	ND
BARIUM	93.0	90.8J	92.0J	102J
CALCIUM	45,000	45,600	41,900	46,600
COPPER	ND	ND	ND	2.7J
MAGNESIUM	13,000	12,300	13,000	13,600
MANGANESE	190	179	184	203
MOLYBDENUM	ND	3.7J	6.3	3.6J
POTASSIUM	13,000	12,600	14,100	17,600
SILVER	ND	2.0	ND	ND
SODIUM	29,000	26,400	27,900	28,400
VANADIUM	ND	3.7J	ND	ND
ZINC	ND	ND	ND	13.3J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	ND	ND	650

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 01

WELL ID: 01-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	4.12	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	7.00	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	276,000	--	287,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 01

WELL ID: 01-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	ND	7,330	1,630	459	1,680	NC
BARIUM	76.7J	199J	175J	163J	175J	NC
CALCIUM	113,000	155,000	127,000	127,000	136,000J	NC
CHROMIUM	ND	35.2	6.5J	ND	7.5	50.4
COBALT	ND	8.3	ND	ND	ND	NC
IRON	46.7J	9,800	2,010	664	2,580	NC
LEAD	ND	ND	ND	ND	1.2J	5.6
MAGNESIUM	8,300	17,500	18,700	13,600	17,700	NC
MANGANESE	**377***	**621***	**586***	**477***	**932***	100
MERCURY	ND	ND	**0.160J***	ND	ND	0.025
NICKEL	ND	**50.6***	**22.9J***	ND	**16.0J***	8.3
POTASSIUM	6,330	11,100J	11,900J	8,850J	10,800	NC
SELENIUM	ND	ND	3.2J	ND	ND	71.0
SODIUM	28,800	35,400	42,400J	39,700	42,000	NC
THALLIUM	ND	ND	ND	ND	3.0J	6.3
VANADIUM	ND	27.2	6.6J	ND	7.5J	NC
ZINC	ND	**90.6J***	20.8	16.2J	ND	85.0
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	550,000	575,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 06 | **WELL ID: 06-MW09**

Sampling Events[F]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.57	3.52	3.33	UA
Sample Depth Below Ground Surface (feet)	9.75	9.75	9.75	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	8.3	11.2	14.6	10.0J
CALCIUM	27,000J	30,600	39,200	43,000
MAGNESIUM	18,000	22,200	31,700	36,500
MANGANESE	90.0	331	218	268
MOLYBDENUM	ND	3.8J	4.9J	4.0J
NICKEL	ND	5.6J	ND	ND
POTASSIUM	17,000	19,200	25,800	32,200
SODIUM	20,000	23,300	32,400	35,700
VANADIUM	ND	3.3J	ND	2.0J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	1,200	600	800

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 06

WELL ID: 06-MW09

Screened interval: 4.5 to 14.5 feet bgs

Sampling Events[F]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	3.52	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	9.75	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	271,000	--	407,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 06

WELL ID: 06-MW09

Screened interval: 4.5 to 14.5 feet bgs

Sampling Events[E] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Filtered					
ARSENIC	--	--	--	**8.9 J***	0.140
BARIUM	--	--	--	3.2 J	NC
CALCIUM	--	--	--	36,100	NC
COPPER	--	--	--	1.8 J	3.7
MAGNESIUM	--	--	--	27,500	NC
MANGANESE	--	--	--	**144***	100
MOLYBDENUM	--	--	--	2.0 J	NC
POTASSIUM	--	--	--	23,600 J	NC
SODIUM	--	--	--	24,300	NC
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	--	--	ND	
Total Petroleum Hydrocarbons[B]	--	--	--	ND	
Volatile Organic Compounds					
None Detected	--	ND	--	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 06

WELL ID: 06-MW09

Screened interval: 4.5 to 14.5 feet bgs

Sampling Events[E] / Sampling Method	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Unfiltered					
ALUMINUM	11,900J	4,470	7,400	ND	NC
ARSENIC	ND	**12.3***	ND	**9.9J***	0.140
BARIUM	ND	19.2J	28.3J	6.1J	NC
CALCIUM	107,000	39,500	40,500	45,600	NC
CHROMIUM	38.9J	17.6	30.0	ND	50.4
COBALT	13.8J	6.0J	7.2J	ND	NC
COPPER	ND	**9.4J***	ND	ND	3.7
IRON	17,300J	7,110	9,990	81.5J	NC
LEAD	**10.2J***	ND	ND	ND	5.6
MAGNESIUM	95,200	30,200	29,800	45,000	NC
MANGANESE	**1,200***	**533***	**793***	**316***	100
NICKEL	**47.4J***	**18.7J***	ND	ND	8.3
POTASSIUM	60,200J	24,000J	26,600	35,800	NC
SODIUM	46,500J	24,800J	24,600	34,300	NC
VANADIUM	40.7J	17.5J	23.9J	1.6J	NC
ZINC	50.9J	26.3	36.6	ND	85.0
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables)					
MOTOR OIL RANGE ORGANICS	ND	ND	ND	62J	1,400
Gasoline Range (purgeables)					
None Detected	ND	ND	ND	ND	
Total Petroleum Hydrocarbons[S]	ND	ND	ND	62	1,400
Semivolatile Organic Compounds					
None Detected	ND	ND	ND	ND	
Volatile Organic Compounds					
1,2-DICHLOROETHENE (TOTAL)	ND	ND	ND	0.2J	N
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Total Dissolved Solids					
TOTAL DISSOLVED SOLIDS	--	--	330,000	502,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 06

WELL ID: 06-MW20

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	2.82	2.82	2.59	UA
Sample Depth Below Ground Surface (feet)	9.17	9.17	9.17	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	4.6J	7.5J	7.3J
CALCIUM	34,000J	32,000	29,500	31,200
MAGNESIUM	22,000	20,500	18,500	23,600
MANGANESE	30.0	16.9	21.1	61.9
MOLYBDENUM	ND	3.3J	2.6J	ND
POTASSIUM	18,000	19,100	20,100	26,000
SELENIUM	ND	ND	ND	4.3J
SODIUM	31,000	33,200	35,800	35,100
THALLIUM	ND	ND	ND	5.0J
VANADIUM	ND	3.0J	ND	3.1J
ZINC	ND	ND	ND	8.4J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	600	ND	1,000

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 06

WELL ID: 06-MW20

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	2.82	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	9.17	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	297,000	--	284,000	N(

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 06

WELL ID: 06-MW20

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Filtered					
ARSENIC	--	--	--	**5.8J***	0.140
BARIUM	--	--	--	3.0J	NC
CALCIUM	--	--	--	23,800	NC
COPPER	--	--	--	2.3J	3.7
MAGNESIUM	--	--	--	22,600	NC
MANGANESE	--	--	--	17.9	100
MOLYBDENUM	--	--	--	2.3J	NC
POTASSIUM	--	--	--	22,500J	NC
SODIUM	--	--	--	27,800	NC
VANADIUM	--	--	--	2.1J	NC
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	--	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	--	ND	1,400[T]
Volatile Organic Compounds					
None Detected	--	ND	--	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 06

WELL ID: 06-MW20

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	5th (02/96)	6th (06/96)	7th (09/96)	Screening
Sampling Method	Bailer	Bailer	Bailer	Criteria[S]
ANALYTES OF CONCERN DATA				
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.				
Metals				
Unfiltered				
ALUMINUM	3,760	4,860	6,510J	NC
ARSENIC	**9.2***	**9.3J***	**13.6***	0.140
BARIUM	21.0J	25.2J	28.0J	NC
CALCIUM	83,000	86,400	85,600	NC
CHROMIUM	21.8	19.9	28.4	50.4
COBALT	10.6J	10.9J	12.0J	NC
COPPER	**9.0J***	**9.0J***	**11.2J***	3.7
IRON	11,100	11,300	15,300	NC
LEAD	**8.4***	ND	**7.9***	5.6
MAGNESIUM	36,400	38,700	44,300	NC
MANGANESE	**835***	**1,490***	**1,520***	100
MOLYBDENUM	ND	ND	1.7J	NC
NICKEL	**23.7J***	**25.4J***	**34.7J***	8.3
POTASSIUM	24,300	26,000	32,600	NC
SODIUM	41,700	34,600	34,600	NC
VANADIUM	21.1J	22.1J	28.9J	NC
ZINC	47.7	ND	53.1	85.0
Petroleum Hydrocarbons				
Diesel/Motor Oil Range (extractables)				
MOTOR OIL RANGE ORGANICS	ND	71J	91J	1,400
Gasoline Range (purgeables)				
None Detected	ND	ND	ND	
Total Petroleum Hydrocarbons[S]	ND	71	91	1,400
Semivolatile Organic Compounds				
None Detected	ND	ND	ND	
Volatile Organic Compounds				
None Detected	ND	ND	ND	
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS				
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.				
Total Dissolved Solids				
TOTAL DISSOLVED SOLIDS	398,000	393,000	406,000J	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 06

WELL ID: 06-MW20

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F] / Sampling Method		1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM		--	--	--	21,500	NC
ARSENIC		--	--	--	**23.2***	0.140
BARIUM		--	--	--	69.9J	NC
CALCIUM		--	--	--	206,000J	NC
CHROMIUM		--	--	--	**95.3***	50.4
COBALT		--	--	--	28.6J	NC
COPPER		--	--	--	**32.6***	3.7
IRON		--	--	--	46,900	NC
LEAD		--	--	--	**23.9***	5.6
MAGNESIUM		--	--	--	51,200	NC
MANGANESE		--	--	--	**1,270***	100
MERCURY		--	--	--	**0.180J***	0.025
MOLYBDENUM		--	--	--	2.0J	NC
NICKEL		--	--	--	**97.0***	8.3
POTASSIUM		--	--	--	32,900	[illegible]
SODIUM		--	--	--	37,000	NC
THALLIUM		--	--	--	2.4J	6.3
VANADIUM		--	--	--	88.4	NC
ZINC		--	--	--	**114***	85.0
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
MOTOR OIL RANGE ORGANICS		--	--	--	190Y	1,400
Gasoline Range (purgeables)						
None Detected		--	--	--	ND	
Total Petroleum Hydrocarbons[S]		--	--	--	190	1,400
Semivolatile Organic Compounds						
None Detected		--	--	--	ND	
Volatile Organic Compounds						
None Detected		--	--	--	ND	
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS		--	--	--	450,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12 | **WELL ID: 12-MW03**

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	2.76	2.83	2.66	UA
Sample Depth Below Ground Surface (feet)	6.92	6.92	6.92	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	ND	8.4J	ND
BARIUM	ND	ND	ND	10.2J
CALCIUM	93,000J	101,000	80,200	110,000
MAGNESIUM	23,000	24,900	21,800	23,900
MANGANESE	81.0	34.4	154	69.2
MOLYBDENUM	ND	2.7J	4.6J	ND
POTASSIUM	12,000	13,100	15,200	13,500
SODIUM	22,000	24,700	20,700	26,100
VANADIUM	ND	3.4J	ND	ND
ZINC	ND	1.9J	ND	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	700	500	700

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	2.76	2.83	2.66	UA	
Sample Depth Below Ground Surface (feet)	--	6.92	6.92	6.92	UA	

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals						
Unfiltered						
ARSENIC	--	ND	ND	**8.4J***	ND	0.14
BARIUM	--	ND	ND	ND	10.2J	N
CALCIUM	--	93,000J	101,000	80,200	110,000	N
MAGNESIUM	--	23,000	24,900	21,800	23,900	N
MANGANESE	--	81.0	34.4	**154***	69.2	10
MOLYBDENUM	--	ND	2.7J	4.6J	ND	N
POTASSIUM	--	12,000	13,100	15,200	13,500	N
SODIUM	--	22,000	24,700	20,700	26,100	N
VANADIUM	--	ND	3.4J	ND	ND	N
ZINC	--	ND	1.9J	ND	ND	85.
PCBs/Pesticides						
PCBs						
None Detected	--	--	ND	--	ND	
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	ND	--	ND	
Gasoline Range (purgeables)						
None Detected	--	--	ND	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	ND	--	ND	1,40
Semivolatile Organic Compounds						
None Detected	--	--	ND	--	ND	
Volatile Organic Compounds						
None Detected	--	--	ND	--	ND	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	465,000	--	480,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Unfiltered					
ALUMINUM	--	--	82.8J	--	NC
ARSENIC	--	--	**3.2J***	--	0.140
BARIUM	--	--	7.2J	--	NC
CALCIUM	--	--	75,700	--	NC
COPPER	--	--	2.2J	--	3.7
MAGNESIUM	--	--	21,400	--	NC
MANGANESE	--	--	**965***	--	100
POTASSIUM	--	--	15,500J	--	NC
SODIUM	--	--	21,500	--	NC
Filtered					
ARSENIC	--	--	**4.3J***	ND	0.140
BARIUM	--	--	4.2J	6.2J	NC
CADMIUM	--	--	ND	0.690J	9.3
CALCIUM	--	--	71,200	87,600	NC
COBALT	--	--	ND	1.2J	NC
COPPER	--	--	1.5J	ND	3.7
LEAD	--	--	ND	5.0	5.6
MAGNESIUM	--	--	20,100	20,900	NC
MANGANESE	--	--	**386***	ND	100
MOLYBDENUM	--	--	2.7J	1.2J	NC
POTASSIUM	--	--	14,600J	12,400J	NC
SODIUM	--	--	20,500	20,100J	NC
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	ND	--	ND	
Gasoline Range (purgeables)					
None Detected	--	ND	--	--	
Total Petroleum Hydrocarbons[B]	--	ND	--	ND	1,400
Volatile Organic Compounds					
CHLOROFORM	--	ND	--	3	470

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	09/92	1st (11/94)	2nd (02/95)	3rd (05/95)	4th (11/95)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Bailer	Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Explosives						
3-NITROTOLUENE	0.06J	ND	ND	ND	ND	NC
Metals						
Unfiltered						
ALUMINUM	417	920J	653	1,570	721	NC
ARSENIC	**7.8J***	ND	ND	ND	**5.5J***	0.140
BARIUM	8.9J	ND	19.4J	22.6J	16.6J	NC
CALCIUM	74,200	86,800	88,100	90,300	63,900	NC
CHROMIUM	ND	2.3	3.8J	ND	1.7J	50.4
COBALT	ND	ND	ND	3.3J	2.8J	NC
COPPER	ND	**7.4***	ND	ND	ND	3.7
IRON	583	1,470	1,050	2,940	1,340	NC
MAGNESIUM	27,300	28,600	28,300	27,800	18,600	NC
MANGANESE	**341***	81.0	**650***	**2,710***	**3,340***	100
MERCURY	ND	ND	ND	ND	**0.130J***	[illegible]25
MOLYBDENUM	ND	--	--	--	4.5J	
NICKEL	ND	6.2	5.1J	5.8J	**9.9J***	[illegible].5
POTASSIUM	23,100	17,400J	16,300	16,300J	14,500	NC
SODIUM	32,100	25,800J	28,900	29,900	19,800	NC
THALLIUM	ND	ND	ND	ND	**8.4J***	6.3
VANADIUM	ND	4.4	ND	ND	5.6J	NC
ZINC	ND	20.6	14.5J	15.5J	ND	85.0
PCBs/Pesticides						
Pesticides						
None Detected	ND	ND	ND	ND	ND	
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
MOTOR OIL RANGE ORGANICS	--	ND	ND	ND	120Y	1,400[T]
Gasoline Range (purgeables)						
None Detected	--	ND	ND	ND	ND	
Total Petroleum Hydrocarbons[S]	ND	ND	ND	ND	120	1,400[T]
Semivolatile Organic Compounds						
None Detected	ND	ND	ND	ND	ND	
Volatile Organic Compounds						
None Detected	ND	ND	ND	ND	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW03 (Con't)

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	470,000	318,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW04

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.03	3.17	2.98	UA
Sample Depth Below Ground Surface (feet)	6.33	6.33	6.33	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	9.3	14.5	18.5	13.2
BARIUM	ND	ND	ND	5.3J
CADMIUM	ND	ND	1.4J	ND
CALCIUM	35,000J	31,900	38,900	39,400
COPPER	ND	32.7	ND	ND
MAGNESIUM	28,000	39,300	35,200	35,900
MANGANESE	110	175	156	186
MOLYBDENUM	ND	2.2J	2.4J	ND
POTASSIUM	22,000	29,700	29,400	31,100
SILVER	ND	ND	3.5J	ND
SODIUM	17,000	23,600	22,400	26,700
VANADIUM	ND	ND	4.0J	ND
Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	600	ND	ND

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

ITE 12

WELL ID: 12-MW04

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	3.03	3.17	2.98	UA	
Sample Depth Below Ground Surface (feet)	--	6.33	6.33	6.33	UA	

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals						
Unfiltered						
ARSENIC	--	**9.3***	**14.5***	**18.5***	**13.2***	0.14
BARIUM	--	ND	ND	ND	5.3J	N(
CADMIUM	--	ND	ND	1.4J	ND	9.
CALCIUM	--	35,000J	31,900	38,900	39,400	N(
COPPER	--	ND	**32.7***	ND	ND	3.
MAGNESIUM	--	28,000	39,300	35,200	35,900	N(
MANGANESE	--	**110***	**175***	**156***	**186***	10
MOLYBDENUM	--	ND	2.2J	2.4J	ND	N(
POTASSIUM	--	22,000	29,700	29,400	31,100	N(
SILVER	--	ND	ND	**3.5J***	ND	0.92
SODIUM	--	17,000	23,600	22,400	26,700	N(
VANADIUM	--	ND	ND	4.0J	ND	N(
PCBs/Pesticides						
PCBs						
None Detected	--	--	ND	--	ND	
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	ND	--	ND	
Gasoline Range (purgeables)						
None Detected	--	--	ND	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	ND	--	ND	1,40
Semivolatile Organic Compounds						
None Detected	--	--	ND	--	ND	
Volatile Organic Compounds						
None Detected	--	--	ND	--	ND	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	375,000	--	388,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW04

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Unfiltered					
ARSENIC	--	**10.8***	--	--	0.140
BARIUM	--	6.5J	--	--	NC
CALCIUM	--	27,200	--	--	NC
CHROMIUM	--	1.6J	--	--	50.4
IRON	--	33.6J	--	--	NC
MAGNESIUM	--	30,000	--	--	NC
MANGANESE	--	**346***	--	--	100
NICKEL	--	2.3J	--	--	8.3
POTASSIUM	--	29,700	--	--	NC
SODIUM	--	27,600	--	--	NC
ZINC	--	5.3J	--	--	85.0
Filtered					
ARSENIC	--	**8.8J***	--	**15.1***	0.140
BARIUM	--	4.0J	--	3.5J	NC
CALCIUM	--	27,400	--	32,200	NC
MAGNESIUM	--	29,100	--	28,000	NC
MANGANESE	--	80.8	--	59.3	100
MOLYBDENUM	--	ND	--	1.9J	NC
NICKEL	--	1.0J	--	ND	8.3
POTASSIUM	--	28,000	--	29,200J	NC
SODIUM	--	26,600	--	29,900J	NC
ZINC	--	6.4J	--	ND	85.0
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	ND	--	ND	
Gasoline Range (purgeables)					
GASOLINE RANGE ORGANICS	--	29J	--	ND	1,400
Total Petroleum Hydrocarbons[S]	--	29	--	ND	1,400
Semivolatile Organic Compounds					
None Detected	--	ND	--	ND	
Volatile Organic Compounds					
None Detected	--	ND	--	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW04

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	09/92	1st (11/94)	2nd (02/95)	3rd (05/95)	4th (11/95)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Bailer	Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Explosives						
None Detected	ND	ND	ND	ND	ND	
Metals						
Unfiltered						
ALUMINUM	102J	ND	ND	361	218	NC
ARSENIC	**17.4***	ND	ND	ND	**12.5***	0.140
BARIUM	12.2J	ND	6.2J	8.6J	10.2J	NC
CALCIUM	33,000	44,600	44,000	32,300	38,500	NC
CHROMIUM	ND	ND	ND	ND	0.760J	50.4
IRON	118	380	500	663	582	NC
LEAD	ND	ND	ND	ND	1.2J	5.6
MAGNESIUM	31,900	27,500	29,800	30,700	38,300	NC
MANGANESE	**118***	**274***	**373***	**477***	**568***	100
MERCURY	ND	ND	ND	ND	**0.130J***	0.025
NICKEL	ND	ND	ND	ND	3.1J	8.3
POTASSIUM	36,400	21,800J	23,000	28,000J	31,600	NC
SODIUM	32,700	16,600J	19,200	19,500	60,000	NC
VANADIUM	ND	2.4	ND	ND	2.3J	NC
ZINC	ND	9.7	ND	8.0J	ND	85.0
PCBs/Pesticides						
Pesticides						
None Detected	ND	ND	ND	ND	ND	
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
MOTOR OIL RANGE ORGANICS	--	ND	ND	ND	72J	1,400
Gasoline Range (purgeables)						
None Detected	--	ND	ND	ND	ND	
Total Petroleum Hydrocarbons[S]	ND	ND	ND	ND	72	1,400
Semivolatile Organic Compounds						
FLUORANTHENE	ND	1J	ND	ND	ND	16
PYRENE	ND	0.5J	ND	ND	ND	11,000
Volatile Organic Compounds						
None Detected	ND	ND	ND	ND	--	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW04 (Co.

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	310,000	348,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW09

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	2.82	2.96	2.72	UA
Sample Depth Below Ground Surface (feet)	7.17	7.17	7.17	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	5.7	ND	10.7	5.2J
BARIUM	ND	ND	ND	12.8J
CALCIUM	55,500J	74,900	73,800	84,500
CHROMIUM	ND	ND	ND	1.1J
COPPER	ND	ND	ND	11.0
MAGNESIUM	41,500	50,100	48,900	55,500
MANGANESE	625	505	740	997
MOLYBDENUM	ND	5.1	2.9J	5.8
NICKEL	ND	ND	4.1J	3.8J
POTASSIUM	24,000	25,400	26,600	32,300
SILVER	ND	ND	2.2J	4.0J
SODIUM	62,500	51,600	56,900	75,200

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	700	800	800

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW09

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	2.82	2.96	2.72	UA	
Sample Depth Below Ground Surface (feet)	--	7.17	7.17	7.17	UA	

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals						
Unfiltered						
ARSENIC	--	**5.7***	ND	**10.7***	**5.2J***	0.14(
BARIUM	--	ND	ND	ND	12.8J	NC
CALCIUM	--	55,500J	74,900	73,800	84,500	NC
CHROMIUM	--	ND	ND	ND	1.1J	50.4
COPPER	--	ND	ND	ND	**11.0***	3.1
MAGNESIUM	--	41,500	50,100	48,900	55,500	NC
MANGANESE	--	**625***	**505***	**740***	**997***	10(
MOLYBDENUM	--	ND	5.1	2.9J	5.8	NC
NICKEL	--	ND	ND	4.1J	3.8J	8.3
POTASSIUM	--	24,000	25,400	26,600	32,300	NC
SILVER	--	ND	ND	**2.2J***	**4.0J***	0.92(
SODIUM	--	62,500	51,600	56,900	75,200	NC
						--
PCBs/Pesticides						
PCBs						
None Detected	--	--	ND	--	ND	
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	ND	--	ND	
Gasoline Range (purgeables)						
None Detected	--	--	ND	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	ND	--	ND	1,40(
Semivolatile Organic Compounds						
DIETHYLPHTHALATE	--	--	0.08J	--	ND	2,90(
Volatile Organic Compounds						
TOLUENE	--	--	ND	--	0.5J	5,00(

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	540,000	--	611,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW09

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Filtered					
BARIUM	--	--	--	5.0J	NC
CALCIUM	--	--	--	76,900	NC
COBALT	--	--	--	1.0J	NC
IRON	--	--	--	309J	NC
MAGNESIUM	--	--	--	43,200	NC
MANGANESE	--	--	--	**271***	100
MOLYBDENUM	--	--	--	1.7J	NC
NICKEL	--	--	--	2.0J	8.3
POTASSIUM	--	--	--	25,200J	NC
SODIUM	--	--	--	289,000	NC
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	ND	--	ND	
Gasoline Range (purgeables)					
None Detected	--	ND	--	ND	
Total Petroleum Hydrocarbons[S]	--	ND	--	ND	1,400
Volatile Organic Compounds					
None Detected	--	--	--	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW09

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	5th (02/96)	6th (06/96)	7th (09/96)	Screening
Sampling Method	Bailer	Bailer	Bailer	Criteria[S]

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Explosives				
None Detected	ND	ND	ND	
Metals				
Unfiltered				
ALUMINUM	15,200	6,230	26,300	NC
ARSENIC	**10.6***	ND	**17.0***	0.140
BARIUM	43.7J	20.5J	59.0J	NC
CALCIUM	106,000	83,000	102,000J	NC
CHROMIUM	49.3	19.4	**78.6***	50.4
COBALT	16.8J	6.1J	25.3J	NC
COPPER	**24.9J***	**11.3J***	**46.7***	3.7
IRON	23,900	9,260	37,000	NC
LEAD	**9.3***	ND	**14.4***	5.6
MAGNESIUM	51,700	59,200	70,400	NC
MANGANESE	**548***	**292***	**799***	100
MOLYBDENUM	ND	ND	1.6J	
NICKEL	**53.4***	**22.7J***	**90.1***	8.3
POTASSIUM	23,300	31,700	36,900	NC
SODIUM	80,200	97,600	91,800	NC
VANADIUM	49.0J	22.7J	89.2	NC
ZINC	**103***	42.4J	**125***	85.0
PCBs/Pesticides				
Pesticides				
None Detected	ND	ND	ND	
Petroleum Hydrocarbons				
Diesel/Motor Oil Range (extractables)				
DIESEL RANGE ORGANICS	130Y	85J	ND	1,400
MOTOR OIL RANGE ORGANICS	150Y	65J	94J	1,400
Gasoline Range (purgeables)				
None Detected	ND	ND	ND	
Total Petroleum Hydrocarbons[S]	280	150	94	1,400
Semivolatile Organic Compounds				
None Detected	ND	ND	ND	
Volatile Organic Compounds				
None Detected	ND	ND	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW09 (Con't)

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	5th (02/96)	6th (06/96)	7th (09/96)	Screening
Sampling Method	Bailer	Bailer	Bailer	Criteria[S]

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids				
TOTAL DISSOLVED SOLIDS	664,000	708,000	703,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW09

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	09/92	1st (11/94)	2nd (02/95)	3rd (05/95)	4th (11/95)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Bailer	Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Explosives						
None Detected	--	--	--	--	ND	
Metals						
Unfiltered						
ALUMINUM	--	--	--	--	17,400J	NC
ARSENIC	--	--	--	--	**12.7***	0.140
BARIUM	--	--	--	--	48.3J	NC
CALCIUM	--	--	--	--	79,600	NC
CHROMIUM	--	--	--	--	**60.7***	50.4
COBALT	--	--	--	--	21.1J	NC
COPPER	--	--	--	--	**28.3***	3.7
IRON	--	--	--	--	28,800	NC
LEAD	--	--	--	--	**13.8***	5.6
MAGNESIUM	--	--	--	--	57,000	NC
MANGANESE	--	--	--	--	**882***	100
MOLYBDENUM	--	--	--	--	1.7J	
NICKEL	--	--	--	--	**63.9***	8.3
POTASSIUM	--	--	--	--	28,500	NC
SODIUM	--	--	--	--	70,900	NC
VANADIUM	--	--	--	--	59.6	NC
ZINC	--	--	--	--	**103***	85.0
PCBs/Pesticides						
Pesticides						
None Detected	--	--	--	--	ND	
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
DIESEL RANGE ORGANICS	--	--	--	--	71J	1,400[T]
MOTOR OIL RANGE ORGANICS	--	--	--	--	70J	1,400[T]
Gasoline Range (purgeables)						
GASOLINE RANGE ORGANICS	--	--	--	--	25J	1,400[T]
Total Petroleum Hydrocarbons	--	--	--	--	170	1,400[T]
Semivolatile Organic Compounds						
None Detected	--	--	--	--	ND	
Volatile Organic Compounds						
BENZENE	--	--	--	--	2	71

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 12

WELL ID: 12-MW09 (Con't)

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	09/92	1st (11/94)	2nd (02/95)	3rd (05/95)	4th (11/95)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Bailer	Criteria[S]

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	--	685,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 14-MW04

Sampling Event[F]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	2.75	2.85	2.69	UA
Sample Depth Below Ground Surface (feet)	9.17	9.17	9.17	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	4.0J	11.4	8.9J
BERYLLIUM	ND	ND	ND	0.160J
CALCIUM	45,000J	51,600	49,600	51,600
CHROMIUM	ND	ND	ND	1.2J
MAGNESIUM	32,000	35,900	34,900	36,300
MANGANESE	ND	3.2J	ND	2.3J
MOLYBDENUM	ND	3.4J	5.3	ND
POTASSIUM	27,000	30,700	32,200	34,600
SODIUM	16,000	17,400	17,600	18,600J
VANADIUM	ND	3.4J	ND	3.3J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	500	ND	600

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 14-MW04

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	2.75	2.85	2.69	UA	
Sample Depth Below Ground Surface (feet)	--	9.17	9.17	9.17	UA	

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals						
Unfiltered						
ARSENIC	--	ND	**4.0J***	**11.4***	**8.9J***	0.14
BERYLLIUM	--	ND	ND	ND	**0.160J***	0.01
CALCIUM	--	45,000J	51,600	49,600	51,600	N
CHROMIUM	--	ND	ND	ND	1.2J	50.
MAGNESIUM	--	32,000	35,900	34,900	36,300	N
MANGANESE	--	ND	3.2J	ND	2.3J	10
MOLYBDENUM	--	ND	3.4J	5.3	ND	N
POTASSIUM	--	27,000	30,700	32,200	34,600	N
SODIUM	--	16,000	17,400	17,600	18,600J	N
VANADIUM	--	ND	3.4J	ND	3.3J	N
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	--	--	ND	
Gasoline Range (purgeables)						
None Detected	--	--	--	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	--	--	ND	1,40
Semivolatile Organic Compounds						
None Detected	--	--	--	--	ND	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	382,000	--	416,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 14-MW04

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Filtered					
BARIUM	--	--	--	2.8J	NC
CALCIUM	--	--	--	43,800	NC
MAGNESIUM	--	--	--	32,100	NC
MANGANESE	--	--	--	7.3J	100
MOLYBDENUM	--	--	--	3.4J	NC
POTASSIUM	--	--	--	28,000J	NC
SODIUM	--	--	--	18,700	NC
VANADIUM	--	--	--	0.770J	NC
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	--	--	ND	
Gasoline Range (purgeables)					
None Detected	--	--	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	--	ND	1,400[T]
Volatile Organic Compounds					
CHLOROFORM	--	ND	--	1	470

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 14-MW04

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	5th (02/96)	6th (06/96)	7th (09/96)	Screening
Sampling Method	Bailer	Bailer	Bailer	Criteria[S]
ANALYTES OF CONCERN DATA				
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.				
Metals				
Unfiltered				
ALUMINUM	73,200	4,700	15,000	NC
ARSENIC	**46.0***	**8.6J***	**12.6***	0.140
BARIUM	175J	32.0J	42.6J	NC
CALCIUM	282,000	121,000	118,000J	NC
CHROMIUM	**269***	13.3	**55.8***	50.4
COBALT	75.0	13.6J	18.0J	NC
COPPER	**110***	**24.4J***	**25.3***	3.7
IRON	124,000	8,620	26,300	NC
LEAD	**71.4***	**19.7***	**15.9***	5.6
MAGNESIUM	82,300	39,900	59,600	NC
MANGANESE	**3,530***	**1,540***	**1,320***	100
MERCURY	**0.610***	ND	**0.140J***	0.025
MOLYBDENUM	ND	2.1J	3.4J	NC
NICKEL	**266***	**23.2J***	**60.2***	8.3
POTASSIUM	44,900	33,400	45,000	NC
SODIUM	26,400	22,200	28,100	NC
VANADIUM	226	21.0J	49.3J	NC
ZINC	**326***	ND	**96.7***	85.0
Petroleum Hydrocarbons				
Diesel/Motor Oil Range (extractables)				
MOTOR OIL RANGE ORGANICS	260Y	ND	94J	1,400[T]
Gasoline Range (purgeables)				
GASOLINE RANGE ORGANICS	ND	30J	ND	1,400[T]
Total Petroleum Hydrocarbons[B]	260	30	94	1,400[T]
Semivolatile Organic Compounds				
None Detected	ND	ND	ND	
Volatile Organic Compounds				
CARBON DISULFIDE	0.4J	ND	ND	NC
CHLOROFORM	ND	ND	0.6	470

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids				
TOTAL DISSOLVED SOLIDS	393,000J	418,000	542,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 14-MW04

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	--	--	--	--	26,500	NC
ARSENIC	--	--	--	--	**17.2***	0.140
BARIUM	--	--	--	--	65.5J	NC
CALCIUM	--	--	--	--	123,000	NC
CHROMIUM	--	--	--	--	**103***	50.4
COBALT	--	--	--	--	25.3J	NC
COPPER	--	--	--	--	**40.5***	3.7
IRON	--	--	--	--	51,300	NC
LEAD	--	--	--	--	**28.2***	5.6
MAGNESIUM	--	--	--	--	53,700	NC
MANGANESE	--	--	--	--	**1,010***	100
MERCURY	--	--	--	--	**0.210J***	0.025
NICKEL	--	--	--	--	**100***	8.3
POTASSIUM	--	--	--	--	38,600	'C
SODIUM	--	--	--	--	19,200	.C
VANADIUM	--	--	--	--	85.6	NC
ZINC	--	--	--	--	**151***	85.0
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
MOTOR OIL RANGE ORGANICS	--	--	--	--	180Y	1,400
Gasoline Range (purgeables)						
None Detected	--	--	--	--	ND	
Total Petroleum Hydrocarbons[B]	--	--	--	--	180	1,400
Semivolatile Organic Compounds						
None Detected	--	--	--	--	ND	
Volatile Organic Compounds						
BENZENE	--	--	--	--	0.3J	71
ETHYLBENZENE	--	--	--	--	0.2J	29,000
TOLUENE	--	--	--	--	1	5,000
XYLENE (TOTAL)	--	--	--	--	2	NC
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	--	463,000	.C

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 15 | **WELL ID: 15-MW03**

Sampling Event[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	2.86	2.89	2.87	UA
Sample Depth Below Ground Surface (feet)	8.17	8.17	8.17	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	8.0	12.4	15.2	ND
CALCIUM	42,000	45,800	42,300	44,700
MAGNESIUM	14,000	16,900	15,100	16,700
MANGANESE	15.0	81.1	12.7 J	8.4 J
MOLYBDENUM	ND	7.1	5.5	5.1 J
POTASSIUM	16,000	19,400	19,100	20,800
SODIUM	12,000	13,700	11,500	12,600
ZINC	ND	3.5 J	ND	4.8 J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	1,800	ND	500

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 15

WELL ID: 15-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	2.89	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	8.17	--	UA	

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	ND	--	--	
Gasoline Range (purgeables)						
None Detected	--	--	ND	--	--	
Total Petroleum Hydrocarbons[S]	--	--	ND	--	--	1,40
Volatile Organic Compounds						
None Detected	--	--	ND	--	--	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	270,000	--	290,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 15

WELL ID: 15-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	--	--	ND	
Gasoline Range (purgeables)					
None Detected	--	--	--	ND	
Total Petroleum Hydrocarbons[B]	--	--	--	ND	1,400[T]
Volatile Organic Compounds					
None Detected	--	ND	--	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 15

WELL ID: 15-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	5th (02/96) Bailer	6th (06/96) Bailer	7th (09/96) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA				
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.				
Metals				
Unfiltered				
ALUMINUM	70,100	19,200	11,100	NC
ANTIMONY	ND	1.7J	ND	500
ARSENIC	**40.5***	**17.9***	**19.6***	0.140
BARIUM	141J	52.5J	34.4J	NC
CALCIUM	180,000	87,800	66,800J	NC
CHROMIUM	**283***	**76.3***	47.8	50.4
COBALT	66.4	20.8J	13.9J	NC
COPPER	**83.8***	**25.2***	**16.0J***	3.7
IRON	122,000	34,400	21,400	NC
LEAD	**36.0***	**9.9***	**8.5***	5.6
MAGNESIUM	61,600	32,500	28,100	NC
MANGANESE	**1,570***	**674***	**833***	100
MOLYBDENUM	4.9J	4.7J	5.1	NC
NICKEL	**240***	**71.1***	**47.2***	3
POTASSIUM	37,200	25,600	29,100	;
SILVER	ND	ND	0.710J	0.920
SODIUM	43,500	49,200	49,300	NC
THALLIUM	4.8J	ND	ND	6.3
VANADIUM	224	61.2	38.3J	NC
ZINC	**270***	**89.5***	68.9	85.0
Petroleum Hydrocarbons				
Diesel/Motor Oil Range (extractables)				
DIESEL RANGE ORGANICS	65J	170Y	130Y	1,400[T]
MOTOR OIL RANGE ORGANICS	180Y	140Y	150Y	1,400[T]
Gasoline Range (purgeables)				
GASOLINE RANGE ORGANICS	ND	ND	32J	1,400[T]
Total Petroleum Hydrocarbons[S]	250	310	310	1,400[T]
Semivolatile Organic Compounds				
None Detected	ND	ND	ND	
Volatile Organic Compounds				
None Detected	ND	ND	ND	
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS				
All detections and critena concentrations in micrograms per liter (ug/L). Notes detailed at end of site section				
Total Dissolved Solids				
TOTAL DISSOLVED SOLIDS	424,000J	441,000	426,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 15

WELL ID: 15-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	--	--	--	--	59,700	NC
ANTIMONY	--	--	--	--	4.1J	500
ARSENIC	--	--	--	--	**40.9***	0.140
BARIUM	--	--	--	--	152J	NC
BERYLLIUM	--	--	--	--	**0.470J***	0.012
CALCIUM	--	--	--	--	285,000	NC
CHROMIUM	--	--	--	--	**267***	50.4
COBALT	--	--	--	--	83.8	NC
COPPER	--	--	--	--	**90.3***	3.7
IRON	--	--	--	--	130,000	NC
LEAD	--	--	--	--	**45.2***	5.6
MAGNESIUM	--	--	--	--	65,700	NC
MANGANESE	--	--	--	--	**1,960***	100
MERCURY	--	--	--	--	**0.290***	0.025
MOLYBDENUM	--	--	--	--	3.1J	NC
NICKEL	--	--	--	--	**257***	8.3
POTASSIUM	--	--	--	--	40,300	NC
SODIUM	--	--	--	--	60,800	NC
THALLIUM	--	--	--	--	4.1J	6.3
VANADIUM	--	--	--	--	248	NC
ZINC	--	--	--	--	**333***	85.0
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
DIESEL RANGE ORGANICS	--	--	--	--	71J	1,400
MOTOR OIL RANGE ORGANICS	--	--	--	--	210Y	1,400
Gasoline Range (purgeables)						
None Detected	--	--	--	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	--	--	280	1,400
Semivolatile Organic Compounds						
None Detected	--	--	--	--	ND	
Volatile Organic Compounds						
CARBON DISULFIDE	--	--	--	--	1J	NC
XYLENE (TOTAL)	--	--	--	--	1J	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 15

WELL ID: 15-MW03 (C...

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	09/92	1st (11/94)	2nd (02/95)	3rd (05/95)	4th (11/95)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Bailer	Criteria[S]

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	--	536,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 17 | **WELL ID: 17-MW01**

Sampling Event[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	4.07	4.01	2.77	UA
Sample Depth Below Ground Surface (feet)	9.42	9.42	9.42	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	2.5J	8.0J	4.3J
BARIUM	91.0	84.2J	77.4J	65.9J
CALCIUM	83,000	83,600	106,000	93,800
CHROMIUM	ND	ND	5.4J	ND
COPPER	ND	ND	ND	2.8J
MAGNESIUM	15,000	15,500	14,600	12,700
MANGANESE	ND	25.1	374	650
MOLYBDENUM	ND	2.2J	6.2	6.3
NICKEL	ND	ND	2.4J	3.2J
POTASSIUM	2,700	2,760J	8,380	10,400
SODIUM	20,000	15,800	28,700	24,700
VANADIUM	ND	3.4J	4.8J	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	ND	ND	700

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 17

WELL ID: 17-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	4.01	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	9.42	--	UA	

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	ND	--	--	
Gasoline Range (purgeables)						
None Detected	--	--	ND	--	--	
Total Petroleum Hydrocarbons[B]	--	--	ND	--	--	1,40(
Volatile Organic Compounds						
None Detected	--	--	ND	--	--	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	365,000	--	445,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 17

WELL ID: 17-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
MOTOR OIL RANGE ORGANICS	--	300 J	ND	ND	1,400
Diesel/Motor Oil Range (extractables)					
None Detected	ND	--	--	--	
Total Petroleum Hydrocarbons[S]	ND	300	ND	ND	1,400
Volatile Organic Compounds					
None Detected	ND	ND	ND	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 17

WELL ID: 17-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	09/92	1st (11/94)	2nd (02/95)	3rd (05/95)	4th (11/95)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Bailer	Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	84.4J	1,260	2,210	221	1,140	NC
ARSENIC	**11.3J***	ND	ND	ND	ND	0.140
BARIUM	28.3J	95.3J	159J	110J	116J	NC
CALCIUM	68,200	122,000	139,000	107,000	126,000J	NC
CHROMIUM	ND	4.3	10.3	ND	4.5	50.4
COBALT	ND	ND	2.7J	ND	ND	NC
IRON	94.1J	1,700	3,000	328	1,860	NC
LEAD	ND	ND	ND	ND	3.4	5.6
MAGNESIUM	23,000	18,000	26,500	19,700	17,100	NC
MANGANESE	**198***	**442***	**174***	64.9	**464***	100
MERCURY	ND	ND	ND	ND	**0.110J***	0.025
NICKEL	ND	**9.7***	**13.8J***	ND	**10.7J***	8.3
POTASSIUM	21,100	8,520J	4,510J	ND	7,710	NC
SODIUM	56,100	58,300	31,100J	21,700	32,700	NC
THALLIUM	ND	ND	ND	ND	2.3J	3
VANADIUM	ND	7.7	9.3J	ND	6.6J	NC
ZINC	ND	ND	26.6	16.0J	79.0J	85.0
PCBs/Pesticides						
Pesticides						
None Detected	ND	ND	ND	ND	ND	
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
DIESEL RANGE ORGANICS	--	ND	ND	ND	390Y	1,400
MOTOR OIL RANGE ORGANICS	--	ND	ND	ND	230Y	1,400
Gasoline Range (purgeables)						
None Detected	ND	--	--	--	--	
Total Petroleum Hydrocarbons[S]	ND	ND	ND	ND	620	1,400
Semivolatile Organic Compounds						
None Detected	ND	ND	ND	ND	ND	
Volatile Organic Compounds						
None Detected	ND	ND	ND	ND	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 17

WELL ID: 17-MW01 (Con't)

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	09/92	1st (11/94)	2nd (02/95)	3rd (05/95)	4th (11/95)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Bailer	Criteria[S]

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	--	509,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 20 | **WELL ID: 20-MW01**

Sampling Events	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.53	3.45	2.99	UA
Sample Depth Below Ground Surface (feet)	7.08	7.08	7.08	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	14.0	13.3	11.7	12.3
BARIUM	46.0	62.8J	52.9J	51.9J
CALCIUM	42,000	53,100	42,600	45,800J
COPPER	ND	69.1	ND	2.8J
IRON	ND	60.3J	ND	ND
MAGNESIUM	20,000	25,800	25,100	26,700
MANGANESE	100	121	114	200
MOLYBDENUM	ND	ND	2.6J	6.3
NICKEL	ND	ND	3.6J	2.7J
POTASSIUM	19,000	22,700	29,900	36,000
SODIUM	240,000	206,000	353,000	361,000J
VANADIUM	ND	5.3J	ND	5.1J
ZINC	ND	39.1	ND	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	800	1,000	900

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 20

WELL ID: 20-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	3.45	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	7.08	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	843,000	--	1,180,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 20

WELL ID: 20-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	86.7J	ND	220	ND	2,230	NC
ARSENIC	**22.4***	ND	ND	ND	**22.2***	0.140
BARIUM	33.3J	47.8	50.5J	50.2J	55.3J	NC
CALCIUM	50,600	63,800	53,000	50,600	43,500J	NC
CHROMIUM	ND	ND	ND	ND	10.0	50.4
IRON	182	422	457J	572	4,090	NC
LEAD	ND	ND	ND	ND	1.2J	5.6
MAGNESIUM	29,200	30,200	33,100	32,500	36,600	NC
MANGANESE	**301***	**102***	**170***	**274***	**420***	100
MERCURY	ND	ND	ND	ND	**0.100J***	0.025
NICKEL	ND	ND	ND	ND	**12.1J***	8.3
POTASSIUM	25,800	29,200J	34,300J	24,500J	33,000	NC
SELENIUM	ND	ND	ND	ND	4.6J	71.0
SODIUM	190,000	248,000J	371,000	308,000	484,000	NC
THALLIUM	ND	ND	ND	ND	2.5J	3
VANADIUM	ND	4.7	3.5J	ND	9.7J	C
ZINC	ND	14.0	ND	8.3J	ND	85.0
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
OTHER COMPONENTS	--	120Y	270Y	ND	--	1,400
Gasoline Range (purgeables)						
None Detected	--	--	--	--	ND	
Total Petroleum Hydrocarbons[S]	ND	120	270	ND	ND	1,400
Semivolatile Organic Compounds						
None Detected	ND	ND	ND	ND	ND	
Volatile Organic Compounds						
BENZENE	ND	ND	ND	0.2J	ND	71
TOLUENE	ND	ND	ND	0.2J	ND	5,000
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	1,100,000	2,120,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 20

WELL ID: 20-MW05

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.56	3.58	3.19	UA
Sample Depth Below Ground Surface (feet)	7.00	7.00	7.00	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	8.7	13.4	16.6	12.8
BARIUM	ND	ND	ND	6.1 J
BERYLLIUM	ND	0.550 J	ND	0.360 J
CADMIUM	ND	ND	0.940 J	ND
CALCIUM	58,000 J	61,400	53,500	55,900 J
COPPER	ND	ND	ND	2.4 J
IRON	140	ND	ND	116
MAGNESIUM	28,000	33,800	26,800	26,100
MANGANESE	1,000	1,450	1,060	967
MOLYBDENUM	ND	ND	2.8 J	5.3
NICKEL	ND	ND	2.3 J	2.6 J
POTASSIUM	20,000	21,400	23,800	29,000
SODIUM	110,000	99,800	138,000	159,000 J
THALLIUM	ND	6.2	ND	ND
VANADIUM	ND	ND	ND	2.5 J
ZINC	ND	61.4	ND	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	2,100	1,000	1,100

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 20

WELL ID: 20-MW05

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	3.58	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	7.00	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	614,000	--	672,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 20

WELL ID: 20-MW05

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	1st (01/98)	2nd (05/98)	3rd (08/98)	4th (11/98)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Criteria[S]

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals					
Filtered					
ARSENIC	--	--	--	**9.9J***	0.140
BARIUM	--	--	--	6.7J	NC
CALCIUM	--	--	--	54,600	NC
LEAD	--	--	--	4.1	5.6
MAGNESIUM	--	--	--	30,100	NC
MANGANESE	--	--	--	**905***	100
MERCURY	--	--	--	**0.130J***	0.025
MOLYBDENUM	--	--	--	2.8J	NC
POTASSIUM	--	--	--	29,700J	NC
SODIUM	--	--	--	147,000J	NC
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	--	--	ND	
Gasoline Range (purgeables)					
None Detected	--	--	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	--	ND	1,400[T]
Volatile Organic Compounds					
None Detected	--	ND	--	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 20

WELL ID: 20-MW05

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	5th (02/96)	6th (06/96)	7th (09/96)	Screening
Sampling Method	Bailer	Bailer	Bailer	Criteria[S]
ANALYTES OF CONCERN DATA				
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.				
Metals				
Unfiltered				
ALUMINUM	55,600	17,300	8,030	NC
ARSENIC	**46.4***	**21.5***	**15.6***	0.140
BARIUM	153	58.3J	28.0J	NC
CALCIUM	144,000	70,500	48,500J	NC
CHROMIUM	**216***	**63.5***	29.8	50.4
COBALT	67.9	23.0J	10.2J	NC
COPPER	**88.1***	**31.4***	**14.0J***	3.7
IRON	119,000	32,000	14,500	NC
LEAD	**52.0***	**19.7***	**8.1***	5.6
MAGNESIUM	80,700	43,300	37,900	NC
MANGANESE	**3,190J***	**1,540***	**934***	100
MERCURY	**0.570***	**0.150J***	ND	0.025
MOLYBDENUM	6.6	2.1J	4.6J	NC
NICKEL	**236***	**83.4***	**34.9J***	8.3
POTASSIUM	39,100	33,500	34,000	[C]
SILVER	ND	ND	0.430J	
SODIUM	185,000	172,000	226,000	NC
VANADIUM	206	63.8J	28.7J	NC
ZINC	**351***	**360***	73.1	85.0
Petroleum Hydrocarbons				
Diesel/Motor Oil Range (extractables)				
DIESEL RANGE ORGANICS	ND	75J	78J	1,400[T]
MOTOR OIL RANGE ORGANICS	120Y	110J	120Y	1,400[T]
Gasoline Range (purgeables)				
GASOLINE RANGE ORGANICS	37J	ND	ND	1,400[T]
Total Petroleum Hydrocarbons[S]	160	180	200	1,400[T]
Semivolatile Organic Compounds				
None Detected	ND	ND	ND	
Volatile Organic Compounds				
None Detected	ND	ND	ND	
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS				
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.				
Total Dissolved Solids				
TOTAL DISSOLVED SOLIDS	982,000J	775,000	949,000	[C]

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 20

WELL ID: 20-MW05

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	--	--	--	--	151,000	NC
ANTIMONY	--	--	--	--	5.4J	500
ARSENIC	--	--	--	--	**110***	0.140
BARIUM	--	--	--	--	355	NC
CALCIUM	--	--	--	--	322,000	NC
CHROMIUM	--	--	--	--	**616***	50.4
COBALT	--	--	--	--	169	NC
COPPER	--	--	--	--	**232***	3.7
IRON	--	--	--	--	323,000	NC
LEAD	--	--	--	--	**132***	5.6
MAGNESIUM	--	--	--	--	146,000	NC
MANGANESE	--	--	--	--	**6,270***	100
NICKEL	--	--	--	--	**636***	8.3
POTASSIUM	--	--	--	--	53,200	C
SODIUM	--	--	--	--	157,000	C
THALLIUM	--	--	--	--	**10.5J***	6.3
VANADIUM	--	--	--	--	573	NC
ZINC	--	--	--	--	**732***	85.0
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
DIESEL RANGE ORGANICS	--	--	--	--	72J	1,400
MOTOR OIL RANGE ORGANICS	--	--	--	--	210Y	1,400
Gasoline Range (purgeables)						
GASOLINE RANGE ORGANICS	--	--	--	--	41J	1,400
Total Petroleum Hydrocarbons[S]	--	--	--	--	320	1,400
Semivolatile Organic Compounds						
None Detected	--	--	--	--	ND	
Volatile Organic Compounds						
None Detected	--	--	--	--	ND	
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	--	822,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 21

WELL ID: 21-MW01

Sampling Event[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	6.00	3.05	3.00	UA
Sample Depth Below Ground Surface (feet)	9.75	9.75	9.75	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	10.0	11.0	8.5J	ND
CALCIUM	22,000	23,400	30,800	33,700
COPPER	ND	12.9	ND	ND
MAGNESIUM	9,300	11,400	15,000	17,100
MANGANESE	16.0	ND	31.4	38.4
POTASSIUM	19,000	21,300	27,700	29,700
SODIUM	60,000	62,800	76,400	79,600
ZINC	ND	2.4J	ND	3.5J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	700	ND	1,100

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 21

WELL ID: 21-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	3.05	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	9.75	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	344,000	--	446,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 21

WELL ID: 21-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Filtered					
ARSENIC	--	--	--	**10.0***	0.140
BARIUM	--	--	--	2.0J	NC
CALCIUM	--	--	--	11,800	NC
MAGNESIUM	--	--	--	5,240	NC
MANGANESE	--	--	--	12.3J	100
MOLYBDENUM	--	--	--	1.9J	NC
POTASSIUM	--	--	--	16,800J	NC
SODIUM	--	--	--	35,400	NC
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	--	--	ND	
Total Petroleum Hydrocarbons[B]	--	--	--	ND	400
Volatile Organic Compounds					
None Detected	--	ND	--	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 21

WELL ID: 21-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	5th (02/96) Bailer	6th (06/96) Bailer	7th (09/96) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA				
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.				
Metals				
Unfiltered				
ALUMINUM	38,500	20,600	13,500	NC
ARSENIC	**34.0***	**21.3***	**18.3***	0.140
BARIUM	93.0	52.6J	34.1J	NC
CALCIUM	79,600	48,800	34,600J	NC
CHROMIUM	**160***	**80.6***	**59.6***	50.4
COBALT	44.5	22.2J	17.4J	NC
COPPER	**81.0***	**43.9***	**28.7***	3.7
IRON	74,800	32,700	24,600	NC
LEAD	**37.1***	**21.6***	**13.0***	5.6
MAGNESIUM	37,300	22,900	18,300	NC
MANGANESE	**741J***	**437***	**284***	100
MERCURY	ND	**0.120J***	ND	0.025
MOLYBDENUM	6.6	ND	4.9J	NC
NICKEL	**159***	**79.9***	**63.4***	8.3
POTASSIUM	29,700	26,500	26,800	NC
SODIUM	25,300	30,600	31,900	NC
VANADIUM	160	82.6	54.0	NC
ZINC	**284***	**154J***	**95.7***	85.0
Petroleum Hydrocarbons				
Diesel/Motor Oil Range (extractables)				
DIESEL RANGE ORGANICS	ND	91J	55J	1,400
MOTOR OIL RANGE ORGANICS	ND	130Y	ND	1,400
Total Petroleum Hydrocarbons[S]	ND	220	55	1,400
Semivolatile Organic Compounds				
None Detected	ND	ND	ND	
Volatile Organic Compounds				
None Detected	ND	ND	ND	
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS				
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.				
Total Dissolved Solids				
TOTAL DISSOLVED SOLIDS	273,000	227,000	266,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 21

WELL ID: 21-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	--	--	--	--	35,700	NC
ARSENIC	--	--	--	--	**33.6***	0.140
BARIUM	--	--	--	--	80.8J	NC
CALCIUM	--	--	--	--	62,900	NC
CHROMIUM	--	--	--	--	**146***	50.4
COBALT	--	--	--	--	34.8J	NC
COPPER	--	--	--	--	**60.5***	3.7
IRON	--	--	--	--	64,200	NC
LEAD	--	--	--	--	**28.0***	5.6
MAGNESIUM	--	--	--	--	32,800	NC
MANGANESE	--	--	--	--	**588***	100
NICKEL	--	--	--	--	**138***	8.3
POTASSIUM	--	--	--	--	28,300	NC
SODIUM	--	--	--	--	30,000	NC
THALLIUM	--	--	--	--	2.7J	3
VANADIUM	--	--	--	--	133	3
ZINC	--	--	--	--	**227***	85.0
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
DIESEL RANGE ORGANICS	--	--	--	--	82J	1,400
MOTOR OIL RANGE ORGANICS	--	--	--	--	120Y	1,400
Total Petroleum Hydrocarbons[S]	--	--	--	--	200	1,400
Semivolatile Organic Compounds						
None Detected	--	--	--	--	ND	
Volatile Organic Compounds						
TOLUENE	--	--	--	--	0.3J	5,000
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	--	259,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 22-MW05

Sampling Event[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.04	3.17	3.00	UA
Sample Depth Below Ground Surface (feet)	10.33	10.33	10.33	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	4.3J	ND	4.3J
CALCIUM	35,000J	38,400	43,000	48,600
MAGNESIUM	23,000	24,600	27,400	29,800
MANGANESE	43.0	30.2	21.8	14.4J
MOLYBDENUM	ND	ND	5.1	ND
POTASSIUM	16,000	17,200	19,900	21,700
SODIUM	7,000	7,110	8,680	10,000
VANADIUM	ND	2.9J	ND	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	ND	ND	800

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 22-MW05

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	3.04	3.17	3.00	UA	
Sample Depth Below Ground Surface (feet)	--	10.33	10.33	10.33	UA	
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ARSENIC	--	ND	**4.3J***	ND	**4.3J***	0.14(
CALCIUM	--	35,000J	38,400	43,000	48,600	NC
MAGNESIUM	--	23,000	24,600	27,400	29,800	NC
MANGANESE	--	43.0	30.2	21.8	14.4J	10(
MOLYBDENUM	--	ND	ND	5.1	ND	NC
POTASSIUM	--	16,000	17,200	19,900	21,700	NC
SODIUM	--	7,000	7,110	8,680	10,000	NC
VANADIUM	--	ND	2.9J	ND	ND	NC
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	--	--	ND	
Gasoline Range (purgeables)						
None Detected	--	--	--	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	--	--	ND	1,40(
Semivolatile Organic Compounds						
None Detected	--	--	--	--	ND	
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	266,000	--	334,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 22-MW05

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Filtered					
BARIUM	--	--	--	2.6J	NC
CALCIUM	--	--	--	34,800	NC
MAGNESIUM	--	--	--	22,300	NC
MANGANESE	--	--	--	15.8	100
MOLYBDENUM	--	--	--	1.6J	NC
POTASSIUM	--	--	--	16,600J	NC
SODIUM	--	--	--	10,800	NC
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	--	--	ND	
Total Petroleum Hydrocarbons[S]	--	--	--	ND	1,400
Volatile Organic Compounds					
CHLOROFORM	--	0.5	--	ND	470

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 22-MW05

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	5th (02/96)	6th (06/96)	7th (09/96)	Screening
Sampling Method	Bailer	Bailer	Bailer	Criteria[S]

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ALUMINUM	32,000	22,900	17,600	NC
ARSENIC	**25.0***	**17.0***	**16.2***	0.140
BARIUM	83.7J	68.2J	46.4J	NC
CALCIUM	63,300	77,200	58,400J	NC
CHROMIUM	**109***	**73.6***	**63.0***	50.4
COBALT	38.5J	32.0J	22.3J	NC
COPPER	**40.6***	**48.0***	**26.0***	3.7
IRON	51,100	36,800	30,800	NC
LEAD	**33.8***	**28.6***	**19.0***	5.6
MAGNESIUM	54,100	38,100	37,000	NC
MANGANESE	**1,780***	**1,570***	**948***	100
MERCURY	ND	**0.200***	**0.150J***	0.025
MOLYBDENUM	4.2	ND	2.1J	NC
NICKEL	**110***	**82.5***	**67.4***	8.3
POTASSIUM	37,700	26,200	29,100	[illegible]
SODIUM	180,000	12,600	10,800	[illegible]
THALLIUM	4.4J	ND	ND	6.3
VANADIUM	103	77.8	60.7	NC
ZINC	**145***	**115***	**114***	85.0
Petroleum Hydrocarbons				
Diesel/Motor Oil Range (extractables)				
MOTOR OIL RANGE ORGANICS	100Y	92J	51J	1,400[T]
Gasoline Range (purgeables)				
None Detected	ND	ND	ND	
Total Petroleum Hydrocarbons[S]	100	92	51	1,400[T]
Semivolatile Organic Compounds				
None Detected	ND	ND	ND	
Volatile Organic Compounds				
CHLOROFORM	ND	0.6	3	470

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids				
TOTAL DISSOLVED SOLIDS	757,000J	270,000	282,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 14/22

WELL ID: 22-MW05

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	--	--	--	--	189,000	NC
ANTIMONY	--	--	--	--	7.3	50
ARSENIC	--	--	--	--	**129***	0.14
BARIUM	--	--	--	--	457	NC
BERYLLIUM	--	--	--	--	**0.830J***	0.01
CALCIUM	--	--	--	--	401,000	NC
CHROMIUM	--	--	--	--	**745***	50.
COBALT	--	--	--	--	225	NC
COPPER	--	--	--	--	**339***	3.
IRON	--	--	--	--	382,000	NC
LEAD	--	--	--	--	**187***	5.
MAGNESIUM	--	--	--	--	159,000	NC
MANGANESE	--	--	--	--	**7,460***	10
MERCURY	--	--	--	--	**1.8J***	0.02
NICKEL	--	--	--	--	**755***	8.
POTASSIUM	--	--	--	--	60,200	NC
SODIUM	--	--	--	--	21,700	NC
VANADIUM	--	--	--	--	697	NC
ZINC	--	--	--	--	**897***	85.
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
MOTOR OIL RANGE ORGANICS	--	--	--	--	130Y	1,40
Gasoline Range (purgeables)						
None Detected	--	--	--	--	ND	
Total Petroleum Hydrocarbons[B]	--	--	--	--	130	1,40
Semivolatile Organic Compounds						
None Detected	--	--	--	--	ND	
Volatile Organic Compounds						
CARBON DISULFIDE	--	--	--	--	0.6	N
CHLOROFORM	--	--	--	--	0.5	47
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	--	340,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 24 | **WELL ID: 24-MW01**

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	2.27	2.61	2.66	UA
Sample Depth Below Ground Surface (feet)	11.25	11.25	11.25	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	7.1	8.1J	18.2	10.2
BARIUM	14.0	12.0J	ND	11.9J
CALCIUM	140,000	152,000	125,000	162,000J
COPPER	ND	ND	ND	2.2J
MAGNESIUM	20,000	22,700	19,300	21,600
MANGANESE	110	52.1	40.3	22.0
MOLYBDENUM	ND	3.1J	4.4J	4.9J
POTASSIUM	13,000	14,500	15,100	21,000
SODIUM	17,000	14,800	13,800	14,400J
ZINC	ND	ND	ND	5.0J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	600	900	800

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 24

WELL ID: 24-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	2.61	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	11.25	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	638,000	--	517,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 24

WELL ID: 24-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	ND	ND	ND	ND	79.5	NC
ARSENIC	**10.8J***	**19.8***	ND	ND	**17.3***	0.140
BARIUM	ND	ND	10.5J	48.6J	9.2J	NC
CALCIUM	85,400	102,000	136,000	116,000	130,000J	NC
IRON	91.1J	ND	ND	149	118	NC
MAGNESIUM	12,300	18,000	22,100	19,400	20,000	NC
MANGANESE	**213***	**107***	**204***	**181***	**375***	100
NICKEL	ND	2.7J	ND	ND	1.8J	8.3
POTASSIUM	12,900	14,900J	16,300J	14,800J	16,900	NC
SODIUM	24,300	17,500	33,400J	18,700	12,200	NC
VANADIUM	ND	1.5	ND	ND	0.830J	NC
ZINC	ND	ND	ND	13.2J	ND	85.0
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
OTHER COMPONENTS	--	270Y	ND	ND	--	J0
Total Petroleum Hydrocarbons	ND	270	ND	ND	ND	1,400
Semivolatile Organic Compounds						
None Detected	ND	ND	ND	ND	ND	
Volatile Organic Compounds						
BENZENE	ND	ND	ND	0.2J	ND	71
TOLUENE	ND	ND	ND	0.3J	ND	5,000
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	240,000	497,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 24 | **WELL ID: 24-MW03**

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	4.70	4.85	1.89	UA
Sample Depth Below Ground Surface (feet)	8.25	8.25	8.25	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	3.0J	ND	ND
BARIUM	23.0	28.6J	31.2J	33.5J
BERYLLIUM	ND	0.590J	ND	0.760J
CALCIUM	590,000J	554,000	646,000	438,000J
COPPER	ND	49.5	8.7	ND
IRON	18,000J	25,200	24,500	2,590
LEAD	5.9	ND	7.8	ND
MAGNESIUM	27,000	32,200	47,400	53,600
MANGANESE	1,300	1,720	2,060	2,560
MERCURY	1.5	ND	ND	ND
POTASSIUM	3,000	3,560J	4,950J	6,120
SILVER	ND	ND	2.3J	ND
SODIUM	20,000	20,900	42,100	40,700J
THALLIUM	ND	6.3J	ND	ND
ZINC	ND	27.5J	21.5	10.7J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	13,000	35,300	32,400	33,300

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 24

WELL ID: 24-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	4.85	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	8.25	--	UA	
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	ND	--	--	
Gasoline Range (purgeables)						
GASOLINE RANGE ORGANICS	--	--	80G	--	--	1,400
Total Petroleum Hydrocarbons[S]	--	--	80	--	--	1,400
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	2,140,000	--	2,870,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 24

WELL ID: 24-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Petroleum Hydrocarbons					
Diesel/Motor Oil Range (extractables) - Silica					
None Detected	--	--	--	ND	
Total Petroleum Hydrocarbons	--	--	--	ND	1,400[T]

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 24

WELL ID: 24-MW03

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E] / Sampling Method	09/92 Bailer	1st (11/94) Bailer	2nd (02/95) Bailer	3rd (05/95) Bailer	4th (11/95) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	ND	ND	374	ND	2,010	NC
ARSENIC	ND	ND	ND	ND	**3.0J***	0.140
BARIUM	16.7J	ND	32.5J	33.2J	47.8J	NC
CALCIUM	676,000	647,000	403,000	304,000	440,000J	NC
CHROMIUM	ND	ND	ND	ND	5.2J	50.4
IRON	123	17,600	6,990	5,400	21,300	NC
LEAD	ND	ND	**8.0***	ND	**51.3***	5.6
MAGNESIUM	60,200	35,900	11,600	8,730	24,300	NC
MANGANESE	**1,600***	**1,790***	**615***	**438***	**1,210***	100
MERCURY	ND	ND	ND	ND	**0.100J***	0.025
NICKEL	ND	ND	ND	ND	4.4J	8.3
POTASSIUM	10,700	4,640J	2,270J	ND	3,090J	NC
SELENIUM	ND	ND	ND	ND	4.7J	71.0
SODIUM	65,200	29,700J	14,200J	9,450	20,600	NC
THALLIUM	ND	ND	ND	ND	2.8J	3
VANADIUM	ND	ND	ND	ND	4.6J	3
ZINC	ND	52.4J	40.6	17.1J	**268J***	85.0
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
DIESEL RANGE ORGANICS	ND	ND	ND	ND	100Y	1,400
MOTOR OIL RANGE ORGANICS	--	ND	ND	ND	110Y	1,400
Total Petroleum Hydrocarbons	ND	ND	ND	ND	210	1,400
Semivolatile Organic Compounds						
None Detected	ND	ND	ND	ND	ND	
Volatile Organic Compounds						
None Detected	ND	ND	ND	ND	ND	
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	1,100,000	2,360,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 25

WELL ID: 25-MW01

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.33	3.13	2.86	UA
Sample Depth Below Ground Surface (feet)	10.17	10.17	10.17	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	5.3J	12.0	5.6J
BARIUM	14.0	15.8J	19.0J	17.1J
BERYLLIUM	ND	ND	ND	0.180J
CALCIUM	92,000	103,000	91,400	97,900
COPPER	ND	2.8J	ND	ND
IRON	120	197	ND	56.1J
MAGNESIUM	15,000	18,000	25,700	24,600
MANGANESE	120	319	98.5	74.4
POTASSIUM	4,900	6,050	14,900	17,300
SODIUM	24,000	19,800	19,300	20,600J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	3,600	1,200	1,100

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 25

WELL ID: 25-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	3.33	3.13	2.86	UA	
Sample Depth Below Ground Surface (feet)	--	10.17	10.17	10.17	UA	

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals						
Unfiltered						
ARSENIC	--	ND	**5.3J***	**12.0***	**5.6J***	0.140
BARIUM	--	14.0	15.8J	19.0J	17.1J	NC
BERYLLIUM	--	ND	ND	ND	**0.180J***	0.012
CALCIUM	--	92,000	103,000	91,400	97,900	NC
COPPER	--	ND	2.8J	ND	ND	3.7
IRON	--	120	197	ND	56.1J	NC
MAGNESIUM	--	15,000	18,000	25,700	24,600	NC
MANGANESE	--	**120***	**319***	98.5	74.4	100
POTASSIUM	--	4,900	6,050	14,900	17,300	NC
SODIUM	--	24,000	19,800	19,300	20,600J	NC

Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	--	--	ND	
Gasoline Range (purgeables)						
None Detected	--	--	--	--	ND	
Total Petroleum Hydrocarbons[B]	--	--	--	--	ND	1,400

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	430,000	--	266,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 25

WELL ID: 25-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[F] / Sampling Method	1st (01/98) Bailer	2nd (05/98) Bailer	3rd (08/98) Bailer	4th (11/98) Bailer	Screening Criteria[S]
ANALYTES OF CONCERN DATA					
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.					
Metals					
Filtered					
ALUMINUM	--	--	--	300	NC
ARSENIC	--	--	--	**5.6J***	0.140
BARIUM	--	--	--	11.3J	NC
CALCIUM	--	--	--	78,100	NC
CHROMIUM	--	--	--	1.4J	50.4
COBALT	--	--	--	1.3J	NC
COPPER	--	--	--	1.5J	3.
IRON	--	--	--	46.7J	NC
MAGNESIUM	--	--	--	26,700	NC
MANGANESE	--	--	--	**114***	100
NICKEL	--	--	--	2.1J	8.3
POTASSIUM	--	--	--	20,800J	NC
SODIUM	--	--	--	691,000	NC
ZINC	--	--	--	**2,900J***	85.(
Petroleum Hydrocarbons					
Gasoline Range (purgeables)					
GASOLINE RANGE ORGANICS	--	--	--	28J	1,40
Total Petroleum Hydrocarbons[B]	--	--	--	28	1,40
Volatile Organic Compounds					
None Detected	--	ND	--	ND	

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 25

WELL ID: 25-MW01

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	09/92	1st (11/94)	2nd (02/95)	3rd (05/95)	4th (11/95)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Bailer	Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	ND	1,770	198J	462	294	NC
ARSENIC	**6.6J***	ND	ND	ND	**9.9J***	0.140
BARIUM	ND	ND	11.6J	16.1J	13.9J	NC
CALCIUM	45,300	65,300	125,000	129,000	104,000J	NC
CHROMIUM	ND	9.6	ND	ND	1.9J	50.4
COBALT	ND	ND	ND	ND	0.860J	NC
COPPER	ND	ND	ND	ND	**5.1J***	3.7
IRON	106J	2,410	596	1,130	588	NC
MAGNESIUM	11,100	14,800	19,200	21,700	27,600	NC
MANGANESE	31.1	81.7	**156***	**302***	**176***	100
MOLYBDENUM	ND	--	--	--	1.8J	NC
NICKEL	ND	**10.9***	3.4J	ND	2.6J	8.3
POTASSIUM	10,100	9,190J	5,140	7,650J	15,600	NC
SODIUM	9,310	11,000	24,800	20,400	21,900	NC
THALLIUM	ND	ND	ND	ND	2.1J	3
VANADIUM	ND	7.7	ND	ND	3.3J	NC
ZINC	ND	ND	10.8J	6.8J	63.0	85.0
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
None Detected	ND	ND	ND	ND	ND	
Gasoline Range (purgeables)						
GASOLINE RANGE ORGANICS	--	ND	ND	ND	25J	1,400
Total Petroleum Hydrocarbons[S]	ND	ND	ND	ND	25	1,400
Semivolatile Organic Compounds						
None Detected	ND	ND	ND	ND	ND	
Volatile Organic Compounds						
BENZENE	ND	ND	ND	0.5J	ND	71
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	490,000	477,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 25 | **WELL ID: 143-MW2**

Sampling Events	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	2.99	3.15	2.87	UA
Sample Depth Below Ground Surface (feet)	10.50	10.50	10.50	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	ND	ND	5.5J
BARIUM	15.0	18.5J	23.5J	20.9J
BERYLLIUM	ND	ND	ND	0.110J
CALCIUM	53,000	67,400	84,500	82,800
COBALT	ND	ND	2.5J	ND
COPPER	ND	25.8	ND	5.1
IRON	100	168	ND	ND
MAGNESIUM	110,000	152,000	206,000	207,000
MANGANESE	ND	160	192	178
MOLYBDENUM	ND	ND	7.3	6.5
NICKEL	ND	7.1J	8.5	6.3J
POTASSIUM	70,000	95,100	110,000	92,400
SODIUM	1,500,000	145,000	1,930,000	1,940,000J
VANADIUM	ND	ND	ND	2.3J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	6,000	3,200	3,800	2,900

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 25

WELL ID: 143-MW2

Screened interval: Unknown

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening Criteria[S]
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	
Sample Depth Below Water Table (feet)	--	2.99	3.15	2.87	UA	
Sample Depth Below Ground Surface (feet)	--	10.50	10.50	10.50	UA	

ANALYTES OF CONCERN DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals						
Unfiltered						
ARSENIC	--	ND	ND	ND	**5.5J***	0.140
BARIUM	--	15.0	18.5J	23.5J	20.9J	NC
BERYLLIUM	--	ND	ND	ND	**0.110J***	0.012
CALCIUM	--	53,000	67,400	84,500	82,800	NC
COBALT	--	ND	ND	2.5J	ND	NC
COPPER	--	ND	**25.8***	ND	**5.1***	3.7
IRON	--	100	168	ND	ND	NC
MAGNESIUM	--	110,000	152,000	206,000	207,000	NC
MANGANESE	--	ND	**160***	**192***	**178***	100
MOLYBDENUM	--	ND	ND	7.3	6.5	NC
NICKEL	--	ND	7.1J	**8.5***	6.3J	8.3
POTASSIUM	--	70,000	95,100	110,000	92,400	NC
SODIUM	--	1,500,000	145,000	1,930,000	1,940,000J	NC
VANADIUM	--	ND	ND	ND	2.3J	.C

Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables) - Silica Gel						
None Detected	--	--	--	--	ND	
Gasoline Range (purgeables)						
None Detected	--	--	--	--	ND	
Total Petroleum Hydrocarbons[B]	--	--	--	--	ND	1,400

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	4,940,000	--	7,790,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 180C | **WELL ID: 180C-MW2**

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.99	4.02	3.75	UA
Sample Depth Below Ground Surface (feet)	10.33	10.33	10.33	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ALUMINUM	100	ND	ND	ND
ARSENIC	ND	ND	9.2 J	8.4 J
BARIUM	55.0	64.0 J	59.1 J	65.4 J
CALCIUM	77,000 J	90,900	84,400	94,500
COBALT	ND	3.1 J	3.3 J	4.0 J
COPPER	ND	ND	6.2	3.2 J
IRON	ND	297	ND	140
MAGNESIUM	250,000	240,000	218,000	199,000
MANGANESE	170	431	264	358
MERCURY	ND	ND	0.100 J	ND
MOLYBDENUM	ND	ND	11.6	11.7
NICKEL	ND	10.6	6.5 J	6.8 J
POTASSIUM	75,000	101,000	104,000	98,500
SODIUM	2,300,000	2,400,000	2,280,000	2,230,000
THALLIUM	ND	ND	3.8	ND
VANADIUM	ND	ND	7.2 J	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	7,000	4,600	6,500	3,400

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 180C

WELL ID: 180C-MW2

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	4.02	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	10.33	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	6,950,000	--	8,060,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 180C

WELL ID: 180C-MW2

Screened interval: 3.5 to 13.5 feet bgs

Sampling Events[E]	09/92	1st (11/94)	2nd (02/95)	3rd (05/95)	4th (11/95)	Screening
Sampling Method	Bailer	Bailer	Bailer	Bailer	Bailer	Criteria[S]
ANALYTES OF CONCERN DATA						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Metals						
Unfiltered						
ALUMINUM	--	--	--	--	4,390	NC
ARSENIC	--	--	--	--	**8.3J***	0.140
BARIUM	--	--	--	--	95.4J	NC
CALCIUM	--	--	--	--	176,000J	NC
CHROMIUM	--	--	--	--	16.4	50.4
COBALT	--	--	--	--	8.4J	NC
COPPER	--	--	--	--	**12.3J***	3.7
IRON	--	--	--	--	6,500	NC
LEAD	--	--	--	--	2.7J	5.6
MAGNESIUM	--	--	--	--	370,000	NC
MANGANESE	--	--	--	--	**259***	100
MOLYBDENUM	--	--	--	--	17.8	NC
NICKEL	--	--	--	--	**21.9J***	8.3
POTASSIUM	--	--	--	--	161,000	NC
SODIUM	--	--	--	--	3,840,000	NC
VANADIUM	--	--	--	--	18.1J	NC
Petroleum Hydrocarbons						
Diesel/Motor Oil Range (extractables)						
None Detected	--	--	--	--	ND	
Gasoline Range (purgeables)						
None Detected	--	--	--	--	ND	
Total Petroleum Hydrocarbons	--	--	--	--	ND	1,400
Semivolatile Organic Compounds						
None Detected	--	--	--	--	ND	
Volatile Organic Compounds						
None Detected	--	--	--	--	ND	
FATE AND TRANSPORT DATA - DISSOLVED SOLIDS						
All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.						
Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	--	--	13,700.00	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 201 | **WELL ID: 201-MW3**

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.39	3.41	2.87	UA
Sample Depth Below Ground Surface (feet)	9.00	9.00	9.00	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ALUMINUM	ND	ND	31.3J	ND
ARSENIC	5.3	ND	8.0J	6.9J
BARIUM	39.5	46.2J	76.6J	89.8J
CALCIUM	32,500	36,300	34,700	35,200
IRON	190	ND	ND	ND
LEAD	4.5	ND	ND	ND
MAGNESIUM	29,000	30,700	36,300	39,100
MANGANESE	180	241	414	461
MOLYBDENUM	ND	8.7	7.7	5.9
NICKEL	ND	6.5J	5.1	4.4J
POTASSIUM	28,000	30,500J	45,200	43,400
SODIUM	660,000	665,000	740,000	846,000
VANADIUM	ND	4.8J	2.9J	ND
ZINC	ND	ND	4.5J	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	1,100	1,700	1,900

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 201

WELL ID: 201-MW3

Screened interval: Unknown

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	3.41	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	9.00	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	1,750,000	--	2,440,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 227

WELL ID: 227-MW1

Sampling Event[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.05	3.16	3.32	UA
Sample Depth Below Ground Surface (feet)	11.33	11.33	11.33	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ALUMINUM	165	ND	ND	ND
ARSENIC	ND	8.3J	11.2	5.9J
BARIUM	11.0	ND	62.0J	12.8J
CALCIUM	26,000	21,800	74,300	17,000
CHROMIUM	ND	3.6J	ND	ND
COPPER	ND	3.2J	ND	ND
IRON	130	313	ND	ND
MAGNESIUM	20,500	18,600	72,300	13,800
MANGANESE	77.5	82.2	149	29.6
POTASSIUM	6,850	7,140	15,500	9,230
SELENIUM	ND	ND	2.9J	ND
SODIUM	55,000	51,900	162,000	65,800
ZINC	ND	2.1J	ND	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	2,000	1,700	500

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 227

WELL ID: 227-MW1

Screened interval: Unknown

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	3.16	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	11.33	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	420,000	--	287,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 227

WELL ID: 227-MW2

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.34	3.36	3.32	UA
Sample Depth Below Ground Surface (feet)	11.67	11.67	11.67	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	5.3	9.6J	13.2	9.8J
BARIUM	12.0	14.3J	80.8J	47.9J
CALCIUM	37,000	42,600	148,000	125,000
IRON	130	ND	ND	ND
MAGNESIUM	24,000	29,700	96,600	83,500
MANGANESE	24.0	34.1	233	122
MOLYBDENUM	ND	ND	3.4J	ND
POTASSIUM	34,000	39,100	82,100	73,500
SODIUM	45,000	53,700	587,000	286,000

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	1,200	2,450	2,400

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 227

WELL ID: 227-MW2

Screened interval: Unknown

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening Criteria[S]
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	
Sample Depth Below Water Table (feet)	--	--	3.36	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	11.67	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	456,000	--	1,590,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 227 | **WELL ID: 227-MW3**

Sampling Event[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	3.57	3.55	3.56	UA
Sample Depth Below Ground Surface (feet)	12.08	12.08	12.08	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	5.1	5.2J	6.7J	6.3J
BARIUM	14.0	12.3J	14.1J	12.8J
CALCIUM	44,000	41,100	51,700	43,100
COPPER	ND	ND	4.9	ND
IRON	ND	82.8J	ND	ND
MAGNESIUM	16,000	15,400	17,500	16,300
MANGANESE	59.0	58.5	66.0	70.7
MOLYBDENUM	ND	2.9J	ND	ND
POTASSIUM	16,000	16,800	16,500	22,600
SILVER	ND	ND	2.5J	ND
SODIUM	14,000	14,900	16,600	16,000

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	1,100	1,000	1,100

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 227

WELL ID: 227-MW3

Screened interval: Unknown

Sampling Events[F]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	3.55	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	12.08	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	250,000	--	268,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 368A | **WELL ID: 368A-MW2**

Sampling Event[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	4.36	4.54	3.85	UA
Sample Depth Below Ground Surface (feet)	9.50	9.50	9.50	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	5.6	10.6	6.7J	9.0J
BARIUM	120	152J	160J	158J
CALCIUM	57,000	61,500	51,500	55,700
MAGNESIUM	24,000	28,000	21,300	23,100
MANGANESE	100	148	147	145
MOLYBDENUM	ND	3.1J	ND	ND
POTASSIUM	26,000	30,600	35,200	40,400
SODIUM	25,000	29,100	33,600	35,900
ZINC	ND	ND	2.9J	ND

Total Suspended Solids[R]				
None Detected	ND	ND	ND	ND

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 368A

WELL ID: 368A-MW2

Screened interval: Unknown

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	4.54	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	9.50	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	434,000	--	400,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 368A | **WELL ID: 368A-MW3**

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	4.33	4.47	3.75	UA
Sample Depth Below Ground Surface (feet)	9.42	9.42	9.42	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	ND	7.4J	4.3J
BARIUM	120	132J	99.3J	137J
CALCIUM	56,000	62,400	44,600	53,500
IRON	510	395	190	201
MAGNESIUM	18,000	21,500	13,800	16,500
MANGANESE	840	398	140	133
MOLYBDENUM	ND	1.9J	ND	ND
POTASSIUM	32,000	32,200	38,900	44,200
SODIUM	33,000	30,500	58,500	58,100
ZINC	ND	4.3J	3.7J	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	4,900	2,100	2,300

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 368A | **WELL ID: 368A-MW3**

Screened interval: Unknown

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	4.47	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	9.42	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	416,000	--	458,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 368B | **WELL ID: 368B-MW1**

Sampling Events[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	2.82	2.99	2.25	UA
Sample Depth Below Ground Surface (feet)	8.00	8.00	8.00	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
ARSENIC	ND	2.8J	ND	ND
BARIUM	49.0	43.1J	60.8J	67.8J
CALCIUM	48,000	38,100	60,300	66,000
COPPER	ND	ND	ND	5.2
IRON	ND	47.6J	ND	32.6J
MAGNESIUM	13,000	11,200	19,800	21,900
MANGANESE	ND	ND	31.4	35.4
MOLYBDENUM	ND	3.2J	ND	ND
POTASSIUM	7,600	7,200	12,200	14,500
SELENIUM	5.3	ND	ND	ND
SILVER	ND	ND	ND	3.3J
SODIUM	30,000	23,800	25,400	20,700
VANADIUM	ND	ND	3.1J	4.1J

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	ND	ND	600

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

ITE 368B

WELL ID: 368B-MW1

Screened interval: Unknown

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	Criteria[S]
Sample Depth Below Water Table (feet)	--	--	2.99	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	8.00	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	225,000	--	353,000	NC

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 368B | **WELL ID: 368B-MW3**

Sampling Event[E]	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow
Sample Depth Below Water Table (feet)	4.33	4.47	3.77	UA
Sample Depth Below Ground Surface (feet)	9.58	9.58	9.58	UA

AMBIENT METALS DATA

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Metals				
Unfiltered				
BARIUM	67.0	67.7J	63.9J	50.7J
CALCIUM	84,000	90,200	84,000	58,700
COPPER	ND	ND	8.9	ND
MAGNESIUM	12,000	12,400	10,300	7,340
MANGANESE	65.0	49.2	72.3	433
MOLYBDENUM	ND	4.1J	ND	ND
POTASSIUM	5,200	5,630J	5,490	5,730
SODIUM	14,000	15,500	11,700	10,900
THALLIUM	ND	ND	4.8	ND
ZINC	220	ND	1.4J	ND

Total Suspended Solids[R]				
TOTAL SUSPENDED SOLIDS	ND	600	ND	900

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

SITE 368B

WELL ID: 368B-MW3

Screened interval: Unknown

Sampling Events[E]	1st (04/00)	2nd (05/00)	3rd (05/00)	4th (08/00)	5th (10/00)	Screening Criteria[S]
Sampling Method	Low-flow	Low-flow	Low-flow	Low-flow	Low-flow	
Sample Depth Below Water Table (feet)	--	--	4.47	--	UA	
Sample Depth Below Ground Surface (feet)	--	--	9.58	--	UA	

FATE AND TRANSPORT DATA - DISSOLVED SOLIDS

All detections and criteria concentrations in micrograms per liter (ug/L). Notes detailed at end of site section.

Total Dissolved Solids						
TOTAL DISSOLVED SOLIDS	--	--	367,000	--	245,000	N

APPENDIX B
GROUNDWATER SAMPLING ANALYTICAL RESULTS
NAVAL STATION TREASURE ISLAND

REMARKS AND NOTES

REMARKS:

1. Categories of analyses are shown, but only detected compounds are presented. A complete list of compounds analyzed by each method and the associated detection limits are presented in Appendix F (TtEMI 2000b).
2. Results in boldface type exceed or equal corresponding screening criteria.
3. Where a set of duplicate samples was collected, the reported concentration is the average of the two detected results. If an analyte was detected in only one of the duplicate samples, the detected value is presented.
4. As noted below, only selected data qualifiers are presented in this data summary.

NOTES:

Σ = PCB screening criterion applies to the sum of detected Aroclors (see Appendix A) (TtEMI 2000b).
† = Samples analyzed for BTEX only by EPA Method 8020.
* = Detected value exceeds screening criterion.
-- = Not analyzed.
D = Chromatographic pattern resembles diesel.
E = In 2000, as detailed in the project field sampling plan, analyte of concern data is collected in the 1st (April), 3rd (late May), 4th (August), and 5th (October) sampling events; fate and transport data in the 3rd and 5th events; and ambient metals data in the 2nd (early May), 3rd, 4th, and 5th events.
G = Chromatographic pattern resembles gasoline.
H = Chromatographic pattern is in the heavier hydrocarbon end of the analyte's range in the standard.
J = Estimated value.
L = Chromatographic pattern is in the lighter hydrocarbon end of the analyte's range in the standard.
M = Chromatographic pattern resembles motor oil.
NC = No screening criterion established.
ND = None detected.
P = Data qualifiers not transferred to summed value. See note "T" below.
R = Reporting limits for total suspended solids analyses in the 2nd and 3rd sampling events for 2000 were 5,000 ug/L and 500 ug/L, respectively.
S = Detailed information on screening criteria provided in Appendix A.
T = Petroleum screening criterion should be applied to the sum of purgeable and extractable detections. Where available, extractable samples subjected to silica gel cleanup were used in this analysis.
UA = Water level data not available (typically due to interference of bladder pump when top of bladder protrudes above water table, eliminating access to water table).
Y = Chromatographic pattern resembles hydrocarbon fuel pattern and was quantitated using the standard it resembled most.
Z = Chromatographic pattern does not resemble TPH fuel pattern (individual peaks).

APPENDIX C

RESPONSE TO COMMENTS

RESPONSE TO AGENCY COMMENTS ON DRAFT TECHNICAL MEMORANDUM, ESTIMATION OF AMBIENT CONCENTRATIONS OF METALS IN GROUNDWATER NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA

This document presents the Department of Navy's responses to comments on the Draft Technical Memorandum, Estimation of Ambient Concentrations of Metals in Groundwater, Naval Station Treasure Island, San Francisco, California, dated January 25, 2001. The comments addressed below were received from the California Regional Water Quality Control Board (RWQCB) on February 21, 2001. Comments dated February 23, 2001, were received from the Department of Toxic Substances Control (DTSC). Comments dated February 28, 2001, were received from the City and County of San Francisco (City), and presented by Dr. Jim McClure, a subcontractor of Geomatrix Inc.

RESPONSES TO RWQCB

1. **Comment:** **Section 1.0 Introduction – As stated in the 2nd paragraph, the approach for estimating the upper limits of ambient metals concentrations in groundwater follow an approach similar to the one developed for Mare Island. Please clarify whether RWQCB staff approved this approach or not.**

   Response: The methodology for estimating the upper limits of ambient metals concentrations in groundwater was described in the technical memorandum "*Estimation of Ambient Metal Concentrations in Shallow Groundwater. Mare Island, Vallejo, California.*" prepared by Tetra Tech EM Inc. (TtEMI), formerly called PRC Environmental Management, Inc. TtEMI submitted the technical memorandum to the agencies on November 22, 1996. Prior to this submittal, the Navy and TtEMI held working meetings with regulatory agency representatives including the RWQCB staff on July 22, 1996, and August 2, 1996. The agencies representatives accepted the proposed methodology (as documented in the meetings minutes). The Navy received written comments on the technical memorandum from the U.S. Environmental Protection Agency, Region IX (EPA) on January 27, 1997; California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) on November 17, 1997; and the RWQCB on November 17, 1997. On February 2, 1998, the Navy submitted responses to agency comments. No further comments were received from the RWQCB.

2. **Comment:** **Section 3.1 Well Selection – Please clarify that the source of groundwater contamination at each site has not been attributed to historical operations involving metals. Also, it is unclear why groundwater samples collected from well 24-MW03 are being used in the study given the high levels of total suspended solids (TSS). I recommend they be removed from the study unless you can demonstrate why they are essential to the data analysis.**

   Response: The requested clarifications have been added to Section 3.1. Groundwater samples collected from well 24-MW03 initially were used in the estimation because concentrations of most metals were similar to concentrations in other

wells selected for the study. The few observed metal concentrations from this well were eliminated as the result of tests for outliers. The estimates of ambient concentrations derived with or without the data from well 24-MW03 remain largely the same. However, to avoid any potential bias introduced by the well 24-MW03 data, the revised estimates of ambient concentrations are derived excluding the data from well 24-MW03.

3. **Comment:** **Section 3.2 Comparison of Metals Data from Different Sampling Procedures – Please clarify that groundwater samples collected using the "low flow" technique are not filtered. Results of the statistical analyses indicate there is no significant difference in metals concentrations coming from filtered and "low flow" samples, with the exception of barium and molybdenum. Please explain why these two metals are anomalous and if these results are of concern.**

Response: The requested clarifications have been added to Section 3.2. Unfiltered "low flow" samples may be expected to have slightly higher concentrations for some metals than filtered samples. The results of the statistical comparisons showed a statistically significant difference in metals concentrations coming from filtered and "low flow" samples for barium and molybdenum using available small data sets. However, the magnitude of the difference was found to be small. Judging by the relatively small magnitude of the difference between the means and noting that only detected concentrations were used in comparisons, it can be concluded that barium and molybdenum concentrations from filtered samples are similar to those from "low flow" samples. The somewhat higher concentrations of barium and molybdenum in "low flow" unfiltered samples are probably due to colloidal matter, which is filtered out in case of filtered samples. Unfiltered "low flow" samples provide more representative concentrations of metals in groundwater and should be considered valid. Adding filtered samples (the metals concentrations of which were found to be similar to "low flow" samples) helps to increase the statistical power of the ambient data set.

4. **Comment:** **Section 3.3 Comparison of Metals Data from Wet and Dry Periods – Please expand this discussion to describe how the year 1999/2000 wet season compares with the "average" wet seasons in the Bay Area. Also, please describe the groundwater conditions that occur during the wet and dry seasons at Treasure Island, such as, seasonal variation in water levels.**

Response: The 1999/2000 wet season compares well with the "average" wet seasons in the Bay Area (National Climatic Data Center). Groundwater levels are typically higher during the wet seasons and decrease during the dry seasons. Section 3.3 has been modified to include these clarifications.

5. **Comment:** **Section 3.4 Evaluation of Spatial and Temporal Trends – Please describe the conditions at Treasure Island that support how evapotransporation contributes to increases in metals concentrations.**

Response: The groundwater at Treasure Island is under unconfined conditions at an average depth of approximately 5 feet below grade. Groundwater flows radially from the

center of the island toward the shoreline. Groundwater recharge occurs primarily from infiltration of precipitation, with some contribution from landscape irrigation. A fresh-water lens that exists in the uppermost portion of the sandy aquifer is thickest during the winter months and gradually shrinks thereafter. Evapotranspiration contributes to the shrinking of the fresh-water lens and tends to increase the concentrations of metals during the dry season.

6. **Comment:** **Section 4.4 Calculation of the Upper Limits – Estimated ambient concentrations of metals in groundwater at Treasure Island, Mare Island and Hunters Point are listed in Table 4. The hydrogeologic conditions at Hunters Point are not comparable to the conditions at Treasure Island and Mare Island. However, the data from Hunters Point can be used to show more extreme ambient conditions in the Bay Area. Please revise the text accordingly.**

Response: The text of Section 4.4 has been revised as requested.

7. **Comment:** **Section 5.0 Summary of Findings – A statistical comparison of site data versus ambient data will not be appropriate for sites with an inadequate number of samples. Please revise the text accordingly.**

Response: The text of Section 5.0 has been revised as requested. The statistical comparison tests can be conducted when at least three samples from a site are available. However, the power of the tests will be limited and the results of the tests will be evaluated based on professional judgement.

RESPONSES TO DTSC

General Comments

1. **Comment:** **We have some disagreements with the selection of outliers, both on the upper and lower concentration range. Additional graphic presentations should be made for the between and among group comparisons of groundwater concentration.**

Response: This comment is addressed in the response to specific comments. Additional graphic presentations for the between and among group comparisons of groundwater concentrations have been added to the revised technical memorandum.

2. **Comment:** **HERD defers to the DTSC agency geology unit or the San Francisco Regional Water Quality Control Board regarding the issue of seasonally related or tidally influenced groundwater concentrations and the applicability of the 'low flow' groundwater sampling method as compared to filtered groundwater samples. HERD's comments are directed solely at the rationale and statistical methodology used to derive the proposed groundwater concentrations.**

Response: Comment noted.

Specific Comments

1. **Comment:** **HERD defers to the DTSC project manager, the DTSC geology unit and the San Francisco Regional Water Quality Control Board (SFRWQCB) staff to determine whether the wells chosen as unaffected by NAVSTATI activities (Section 2.0, page 4) are appropriate given the current knowledge of groundwater flow and tidal influence.**

   Response: Comment noted. As described in Section 3.0 of the technical memorandum, the wells chosen for the ambient metals study underwent a thorough selection process.

2. **Comment:** **If <u>some</u> groundwater concentrations from Well 24-MW03 are excluded because of high levels of Total Suspended Solids (TSS) (Section 3.1, page 6) there would seem no basis for not excluding all groundwater concentrations developed from this well. Please provide some rationale for excluding only some inorganic elements from this well. Otherwise, all inorganic concentrations from Well 24-MW03 should be excluded from the data set.**

   Response: The rationale for excluding only some concentration values for some inorganic elements from well 24-MW03 was based on the statistical outlier tests. Some metal concentrations, especially concentrations of highly soluble metals, are less likely to be affected by the presence of suspended solids (unlike the metals that tend to be sorbed to a particulate matter). The estimates of ambient concentrations derived with or without the data from well 24-MW03 remain largely the same. However, to avoid any potential bias introduced by the data from well 24-MW03, the revised estimates of ambient concentrations are derived excluding the data from well 24-MW03.

3. **Comment:** **A significant number of plots and graphs are provided for groundwater concentrations proposed to be ambient at NAVSTATI. However, what is lacking are 'box and whisker' plots of the groundwater concentrations so that independent evaluation of the variance and absolute difference within and among groups is possible (Section 3.2, page 8). Please provide box and whisker plots for all between and among group comparisons.**

   Response: The 'box and whisker' plots for all between and among group comparisons have been provided in the revised version of the technical memorandum.

4. **Comment:** **Having spent some time in the area of San Francisco Bay and at NAVSTATI, we doubt that May is representative of the 'wet season' (Section 3.3, page 9). Please provide some additional justification for selecting the samples collected in May as representative of 'wet season' conditions.**

   Response: The samples considered as representative of 'wet season' conditions were collected in the first days and middle of May. The highest groundwater

elevations occur in January and February in the central portion of the island. The precipitation diminishes in the following months but still occurs even in May. In addition, there is a lag time for water accumulated during winter months to reach wells that are closer to the margins of the island.

5. **Comment:** **Please provide box and whisker plots for the comparison of dry season to wet season groundwater concentrations (Section 3.3, page 9).**

   Response: The box and whisker plots have been added to the revised report.

6. **Comment:** **The argument is made that 'long-term variability of metals concentrations is relatively small'; while at the same time the processes of evapotranspiration and annual variations in geochemical conditions are responsible for short-term variability in metals concentrations (Section 3.4, page 11). Given this argument, please explain why it is not necessary that 'ambient' groundwater concentrations be developed for each climatological regime (i.e., wet and dry periods).**

   Response: The difference in metal concentrations of wet and dry periods was found to be either insignificant or small. The data set consists of concentrations from wet and dry periods of the year and provides a good representation of inherent variability of ambient metal concentrations. Use of separate data sets for wet and dry periods would add an unnecessary layer of complexity to the ambient metals study and would result in smaller data sets available from sites, thus decreasing the power of statistical tests used to evaluate the data.

7. **Comment:** **Use of field duplicate samples from the same well as discrete measurements of groundwater concentrations (Section 3.4, page 11) violates the assumption of independence for most statistical tests. Please provide some convincing rationale for this decision.**

   Response: Field duplicate samples were used as discrete measurements of groundwater concentrations to keep the ambient data set as large as possible. The ambient data set has been revised so that the primary and duplicate samples from the same well were averaged to satisfy the assumption of independence. The estimates of ambient concentrations were modified accordingly and are provided in the revised version of the technical memorandum.

8. **Comment:** **HERD recommends that any proxy value entered into the presentation of a probability plot be the maximum non-detected value. Use of 1% of the minimum detected value (Section 4.1, page 12) presents a graphical separation which does not represent the most likely separation of the detected concentrations from those which fall below the detection limit.**

   Response: Since the reported non-detected values often exceeded the minimum detected concentrations, the small value just below the minimum detected concentration of a metal was used as a proxy on a probability plot (please see the updated probability plots in the revised technical memorandum). Such replacement of nondetects resulted in a graphical separation, which represents the most likely

separation of the detected concentrations from those which fall below the detection limit.

9. **Comment:** **Antimony had no detected groundwater concentrations and mercury had only three detected groundwater concentrations (Section 4.2, page 13). Any detected groundwater value for antimony, given sufficient detection limits, must then be considered a release.**

Response: The Navy strongly disagrees with the statement that any detection "must then be considered a release." It is incorrect to assume that just because a specific metal (for example, antimony or mercury) is not detected or detected at a very low rate in the sample population used to represent background groundwater, that *any detection* in site samples represents "a release." The chemistry of geologic materials and the groundwater contained within them is inherently heterogeneous. Granted, if a detection rate for mercury is 2 percent in background samples and much larger percent in site samples collected from the same groundwater unit, then site data should be further evaluated for a potential release of mercury at a site. However, if one or two site samples contain detectable concentration of a metal not detected in background groundwater, that may indicate limitations of the available ambient data (that describes the background geochemistry just partially) but not "a release."

Any detected groundwater value for antimony, given sufficient detection limits, must be considered as exceeding the estimated ambient level. Whether or not the detected antimony concentration at a site is a release should be determined based on the knowledge of historic operations at a site and the origin of a fill material underlying the site.

10. **Comment:** **The process for evaluation of outliers (Section 4.2, page 13) is flawed. Removal of an equal amount of low detects to 'partially compensate' for removal of groundwater concentrations thought to be high-concentration outliers is not permissible. Removal of outliers with elevated concentrations from an 'ambient' data set is an admission that the site may not be fully characterized spatially, seasonally or geochemically. Removal of validated detected low concentrations is not appropriate (Table 3). Restore the low concentration values removed and recalculate the proposed 'ambient' values. This is particularly critical for those groundwater elements with low frequency of detection, which proceed to the statistical testing of populations (Section 5.0, page 15).**

Response: Removal of high-concentration outliers from an 'ambient' data set addressed the anomalies in metal concentrations that might not be representative of true ambient conditions and that are not necessarily related to site contamination. Removal of high-value outliers is a conservative treatment for the ambient data set because it lowers the estimate of the mean. The practice of simultaneously removing values in the lower tail of the distribution to better estimate a mean is described in EPA DQA guidance (EPA 1998), Section 4.7.2.2 and is known as a "trimmed mean." It is also important to remember that no outlier should ever be discarded solely on the basis of a statistical test (EPA 1998, Navy 1999).

However, to maintain the estimated ambient levels of metals conservatively low, the low concentration values have been restored in the revised data set as requested. The recalculated ambient levels are presented in the revised technical memorandum.

11. **Comment:** **The plots of seasonal variance in groundwater concentration (Figure 2 through Figure 6) are difficult to evaluate as the time sequence is different for each well (i.e., the start date of sampling differs). Please provide a series of plots with identical time frames along the horizontal axis for easier review.**

Response: The requested corrections have been made to the revised plots.

12. **Comment:** **We agree that the proposed groundwater values presented for 'ambient' concentrations of arsenic, barium, calcium, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, sodium, vanadium, and zinc have a sufficient number of detected values to present an adequate basis. However, the elements aluminum (n=5), beryllium (n=5), cadmium (n=3), and thallium (n=4) appear to have insufficient sample size to set an 'ambient' concentration. Any detected value for these latter elements should therefore not be considered 'ambient' unless it can be demonstrated that other Navy bases in San Francisco Bay have similar 'ambient' groundwater concentrations.**

Response: Aluminum, beryllium, cadmium, and thallium have sufficient sample size (n = 112); however, the number of detected concentrations is small. Based on observed distribution of detected values, the 95th percentiles (ambient levels) for aluminum and thallium were estimated in the range of detected concentrations. However, for beryllium and cadmium, the 95th percentile was estimated to be below the detection limit. Because the estimates of ambient levels for these metals are well below the estimates for other Navy bases in the San Francisco Bay Area (Mare Island, Hunters Point), the proposed ambient levels for Treasure Island should be considered very conservative.

13. **Comment:** **Some geographical presentation should be provided for the location of these elements with a low number of detects to determine if they are co-located. If the sample locations with detected groundwater concentrations are co-located HERD would not agree that they are representative of 'ambient'.**

Response: For elements with low detection frequencies, the detected concentrations generally were recorded once out of four quarterly sampling events in different wells located in various portions of Treasure Island. For example, the detected concentrations of aluminum are from wells 180-MW2, 201-MW3, 227-MW1, and 25-MW01. The detected concentrations of beryllium are from wells 14-MW04, 143-MW2, 20-MW05, and 25-MW01. The detected concentrations of cadmium are from wells 12-MW03, 12-MW04, and 20-MW05. The detected concentrations of thallium are from wells 06-MW20, 20-MW05, 180-MW2, and

368B-MW3. Although the detections of various metals could come from the same well (for example, 20-MW05), these detections were generally recorded in separate sampling events. The distribution of the detected concentrations for these and other metals with low detection frequencies (see Appendix B with analytical data for individual wells) does not suggest a consistent pattern of their occurrence or collocation. Therefore, the proposed estimates of ambient concentrations are considered representative.

14. **Comment:** **The footnote (d) indicates multiple sources for these 'Screening Levels'. Regardless of source, any 'Screening Level' should be the most conservative (i.e., the lowest concentration). Several of the 'Screening Levels' listed do not appear to be the lowest available. For example, the copper 'Screening Level' is 3.7 µg/l while the U.S. EPA Ambient Water Quality Control concentration is 2.9 µg/l for unfiltered and 2.4 µg/l for filtered water. Please provide the individual basis for each of the 'Screening Levels' (Table 3).**

Response: The toxicity based screening levels were identified for Treasure Island using a thorough ranking process to select the lowest value available for an inorganic element. The process of establishing the screening criteria is described in detail in the Interim Groundwater Status Report (TtEMI 2000). With a few exceptions, the criteria are presented in "A Compilation of Water Quality Goals" by the RWQCB (2000). The criteria for lead and mercury were selected based on the "San Francisco Bay Basin Plan 'Water Quality Control Plan.'" (RWQCB 1995, June), since this publication provided the lowest values for these metals than the former. The RWQCB publication "A Compilation of Water Quality Goals" used the following sources:

U.S. Environmental Protection Agency (EPA) 2000. "Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California." May.

EPA. 1999. "National Recommended Water Quality Criteria -- Correction." April.

EPA. 1998. "National Recommended Water Quality Criteria; Notice; Republication." December.

RWQCB. 1998. "A Compilation of Water Quality Goals." Prepared by Jon B. Marshack, D. Env. Senior Environmental Specialist. March.

RWQCB. 1985. "San Francisco Bay Basin Plan." June.

For copper, the lowest criterion listed was 3.1 micrograms per liter (µg/l), which is currently used as a groundwater screening criterion at Treasure Island. The provided values of 2.9 µg/l for unfiltered water and 2.4 µg/l for filtered water could not be confirmed from available published sources.

15. **Comment:** **The discussion of the statistical approach to developing these groundwater concentrations (Appendix A, Section 3.2, page A-6) states that**

groundwater concentrations are not expected to follow a normal distribution. Some mention should be made that 6 of 12 elements evaluated at NAVSTATI have a normal distribution (Table 3). The empirical evidence at NAVSTATI would seem to contradict this general statement.

Response: The statement applies to full data sets that include both detected and non-detected data. The results of normality testing for metals with low detection frequencies show nonparametric distribution. When the normality testing for such metals was conducted on detected concentrations only, the lognormal or normal distribution were obtained. Although many metals in nature display a lognormal distribution, some metals may show a normal distribution. There might be exceptions, however, with some metals exhibiting nonparametric distributions. This clarification has been added to the revised technical memorandum.

Conclusions

1. **Comment:** **Please provide some box and whisker plots for the between and among group comparisons presented in this document so that the range of variance can be visually evaluated.**

   Response: The box and whisker plots have been added to the revised technical memorandum.

2. **Comment:** **Removal of the lower detected concentrations based on the number of upper concentration outliers is unacceptable. These lower concentrations more likely represent some measure of the 'true' groundwater concentration and must be retained.**

   Response: The previously excluded lower detected concentrations have been restored in the ambient data set, and the ambient levels have been recalculated. See response to Comment 10.

3. **Comment:** **Any detected groundwater value for antimony, given sufficient detection limits, must be considered a release. Any detected value for the elements with a low number of detected values discussed above should therefore not be considered 'ambient' unless it can be demonstrated that other Navy bases in San Francisco Bay with similar fill material have similar 'ambient' groundwater concentrations.**

   Response: Comment noted. See responses to Comments 9 and 12.

4. **Comment:** **Independent identification of the source of the groundwater 'Screening Values' presented in the table must be supplied.**

   Response: The source of the groundwater 'Screening Values' presented in the Table 3 has been clarified.

RESPONSES TO CITY

General Comments

1. Comment: **Please provide more detail on the limitations and intended application of the ambient metal concentration characterizations, including both the screening levels and the overall concentration distributions. The ambient metals concentration characterizations presented in the report represent low-sediment ("low-flow" and filtered), "fresh," (as opposed to brackish) water. Would these ambient metal characterizations ever be used to assess data from potentially "high-sediment" (high flowrate and/or bailed, unfiltered) samples? Are there enough filtered and/or "low-flow" data from "non-ambient" wells to assess the possibility of metal contamination at all sites? If not, when and how will the additional necessary data be collected. Will the ambient metal characterizations be used to assess data collected from wells in the tidally influenced zone (less than 100 feet from shore) or brackish groundwater encountered elsewhere on the base and if so, would this be a useful comparison of comparable data sets? If the "fresh-water" ambient data in the report are not appropriate for assessing possible metal contamination of brackish or near-shore groundwater, then how will such water be assessed, especially with respect to the possible discharge of elevated concentrations of metals into the Bay?**

Response: This review comment actually addresses two issues: total dissolved solids (TDS) and total suspended solids (TSS).

As for the TSS factor, the study of ambient groundwater at TI has contributed to a better understanding of how sampling techniques can radically affect the outcome of sample analysis. The benefit of using "real world" data to demonstrate the comparability of data for groundwater samples collected using low-flow methods and field-filtered samples collected using traditional methods (for example, bailing) is substantial. Statistical tests used to compare metals data for field-filtered and low-flow samples showed statistically significant (but not practically significant) differences for only two metals. For most of metals, data for unfiltered samples collected using traditional methods will not be comparable to the data set compiled for this investigation of ambient groundwater at Treasure Island.

The problem with data for unfiltered samples collected using traditional sampling methods is that the data are likely not comparable with any other data in a meaningful way if TSS data have not simultaneously been collected. Gibbons and Sara (EPA. 1994. *Ground Water Sampling A Workshop Summary, Dallas, Texas, November 30-December 2, 1993*. EPA/600/R-94/205) present a convincing argument of why data for unfiltered samples collected by methods other than low-flow methods should never be used in statistical comparisons. It may be possible to normalize metals concentrations to TSS (if such data have been collected), and such normalization may help the validity of such statistical

comparisons; but the uncertainty will remain large.

The estimated ambient metal concentrations primarily are based on low-sediment, unfiltered samples, representative of "fresh" groundwater conditions. A small portion of the ambient data set consists of field-filtered samples collected with bailers. Therefore, the ambient data sets can be applied to compare the data from both low-flow unfiltered samples and "high-sediment" field-filtered samples. Future groundwater monitoring will be conducted using low-flow sampling methodology.

The ambient data set included the data from two wells that were partially screened in the transition from fresh to brackish water and had relatively high concentrations of total dissolved solids. The metal concentrations from these wells were found to be similar to other ambient wells. Because the ambient data set represents the variability of metal concentrations in groundwater at Treasure Island, it can be used to assess data from site wells located in the tidally influenced zone outside significant physical mixing with the Bay water. The ambient data set may not be appropriate to compare wells with physical mixing but significant mixing is limited to wells with much closer than 50 feet from the shoreline.

Currently, all metal data collected from sites at Treasure Island are obtained using "low-flow" unfiltered samples. In shoreline wells, the sampling is conducted at low tide when predominant conditions are of fresh groundwater discharging to the Bay. Therefore, the "fresh-water" ambient data are appropriate for assessing possible metal contamination in shoreline wells that are outside significant physical mixing with the Bay water. The groundwater monitoring is ongoing at the sites; the required data are being collected to ensure that an adequate number of samples from sites is available to assess whether site concentrations exceed ambient.

The currently derived ambient metal concentrations will not be used to assess data from potentially "high-sediment" (high flowrate and/or bailed, unfiltered) samples. Before 1998, samples were collected with bailers and not filtered prior to analysis; however, the TSS data were not collected simultaneously. Therefore, metals data from unfiltered samples collected with bailers cannot be used in any statistical comparisons.

APPENDIX H
CONTAMINANT FATE AND TRANSPORT MODELING

CONTENTS

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Attachment

H1 BIOSCREEN MODEL INPUT AND OUTPUT SCREENS

FIGURES

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
COPEC	Chemical of potential ecological concern
DAF	Dilution attenuation factor
EPA	U.S. Environmental Protection Agency
ft/d	Feet per day
ft/ft	Foot per foot
mg/L	Milligram per liter
NAVSTA TI	Naval Station Treasure Island
PCB	Polychlorinated biphenyls
POE	Point of exposure
PRC	PRC Environmental Management, Inc.
RI	Remedial investigation

1.0 INTRODUCTION

The fate and transport of groundwater contaminants at Installation Restoration Sites 09 and 10, Naval Station Treasure Island (NAVSTA TI) (see Figures H-1 and H-2), was evaluated using an analytical groundwater model code. Based on screening of analytical data from monitoring wells at Sites 09 and 10, nickel and two pesticides (alpha-chlordane and endosulfan II) were identified as chemicals of potential ecological concern (COPEC) at Site 09. No COPECs were found at Site 10. These analytes exceeded the criteria in the most recent sampling events of 2002. In addition, several pesticides, polychlorinated biphenyls (PCB), and mercury at both sites were reported as below the method detection limit; however, the detection limits for these analytes exceed the ecological aquatic criteria. The fate and transport modeling was conducted for both sites (1) to predict the concentrations of the identified COPECs at the point of exposure (POE) and (2) to address the uncertainty associated with the nondetected analytes with reported laboratory analytical detection limits above the criteria.

Section 1.0 of this report summarizes relevant site background information and identifies the objectives of modeling. Section 2.0 discusses the approach to modeling. Results of the modeling are provided in Section 3.0. Model limitations are presented in Section 4.0. Conclusions are provided in Section 5.0. References are provided in Section 6.0. All tables and figures follow Section 6.0. Model input and output screens are provided in an attachment at the end of this report.

1.1 SITE BACKGROUND

This section provides a brief description of Sites 09 and 10. A more detailed background description and history for these sites is presented in Section 2.0 of this report.

Site 09, a former foundry located near the southeastern portion of Treasure Island (Figure H-1), was used between the early 1940s and 1981 for various operations including forge and foundry, painting, welding, and vehicle maintenance. Accordingly, metals were identified as an analyte of concern at Site 09. Before October 2002, only one monitoring well (09-MW01) was present at Site 09. Six monitoring wells (09-MW02 through 09-MW07) were installed in October 2002 as part of the ongoing environmental investigation at Site 09. During the latest quartlerly sampling event of October and November 2002, nickel and alpha-chlordane were identified in monitoring well 09-MW05, and endosulfan II was detected in monitoring well 09-MW07. All three chemicals were identified at concentrations above the ambient water quality criteria for salt water life (see Table J-1 of Appendix J). In addition, several pesticides and PCBs were identified in monitoring wells 09-MW01 through 09-MW07, and mercury was identified in well 09-MW01 as a nondetected analyte with a reported detection limit above the criteria.

Site 10, a former bus painting shop, is located in the northeastern portion of Treasure Island (Figure H-2). Site 10, which contains buildings formerly used for paint storage, is covered with pavement in some areas and with bare ground, including some grass and shrubs, in other areas. Information on the storage of hazardous and nonhazardous materials at this location is detailed in

Section 2.0 of this main report. Monitoring well 07/10-MW01, previously installed at the site, was abandoned in December 2000 after it was damaged beyond repair (Tetra Tech EM Inc. [Tetra Tech] 2002). Two monitoring wells (10-MW02 and 10-MW03) were installed at Site 10 in October 2002. Monitoring well 14-MW03, which is located in the southern portion of Site 10, was installed as a cross-gradient groundwater monitoring well for the environmental investigation at Site 14. No COPECs were identified in groundwater at Site 10; however, several pesticides and PCBs were identified for monitoring wells 10-MW02 and 10-MW03 where nondetected analytes have reported laboratory analytical detection limits above the screening criteria.

The maximum concentrations of each COPEC measured in the monitoring wells at Site 09 and analytes with laboratory analytical detection limits exceeding the screening criteria at both Sites 09 and 10 are summarized in Table H-1; these maximum concentrations have been incorporated into the fate and transport modeling scenarios described in this appendix.

1.2 OBJECTIVES OF MODELING

The objectives of modeling were as follows:

1. Simulate the migration of COPECs from source area monitoring wells to the downgradient POEs identified for the purposes of this evaluation as the inland margin of the tidal mixing zone adjacent to San Francisco Bay

2. Simulate the reasonable worst-case concentration of COPECs in groundwater that might be expected at the POE

3. Compare simulated concentrations of COPECs at the POE to the screening criteria summarized in Table J-1 of Appendix J

The COPECs for this modeling evaluation at Site 09 include nickel and two pesticides (alpha-chlordane, endosulfan II) listed in Table H-1. In addition, the analytes that were not detected, but having laboratory analytical detection limits above the screening criteria, were also evaluated using modeling.

Most importantly, the modeling approach used and the model input parameters selected would result in the most conservative model results possible. For this assessment, conservative model results are defined as results that yield reasonable worst-case concentrations of COPECs at the POE. BIOSCREEN version 1.3 (U.S. Environmental Protection Agency [EPA] 1996) was used to model the fate and transport of COPECs in groundwater. The rationale for selecting this model is discussed in greater detail in Section 1.4.

1.3 SITE HYDROGEOLOGY

Both Sites 09 and 10 are underlain by dredged fill deposits composed predominantly of poorly sorted, fine- to coarse-grained sands, with occasional thin silt lenses. The fill sands form an

aquifer with an average thickness of approximately 30 feet. Detailed descriptions of lithology and hydraulic characteristics can be found in Section 4.0 of this main report. The groundwater monitoring data for these sites are summarized in groundwater status reports (Tetra Tech 2002). The water levels at both sites are generally higher during the wet season (December through April) and lower during the dry season (May through November). Average depth to groundwater at these sites is up to 6.5 feet. Groundwater in the area of Sites 09 and 10 typically flows toward the shoreline.

1.4 RATIONALE FOR SELECTION OF MODEL CODES

The screening-level model BIOSCREEN version 1.3 (EPA 1996) was selected to simulate the migration of COPECs at both sites. BIOSCREEN was developed for EPA by the Air Force Center for Environmental Excellence, Technology Transfer Division, at Brooks Air Force Base by Groundwater Services, Inc., Houston, Texas. The BIOSCREEN model code is based on the Domenico analytical solution for solute transport (Domenico 1987) and has the ability to simulate advection, dispersion, and retardation of chemicals because of sorption and in situ biodegradation. BIOSCREEN allows for solute transport without retardation or decay; therefore, the application of the model in this mode at Sites 09 and 10 results in maximization of the simulated concentrations of COPECs in groundwater.

2.0 MODELING APPROACH

The approach to modeling contaminant fate and transport at Sites 09 and 10 was simplified to the greatest degree possible without compromising the objectives of modeling. As a result, one analytical model (BIOSCREEN) rather than a more complex numerical model was used to simulate the migration of COPECs in groundwater. Use of an analytical model resulted in cost savings and rapid development of modeling scenarios but may only be applied to meet the specific modeling objectives outlined in Section 1.2 (EPA 1992). The limitations of using a simplified analytical modeling approach are more fully discussed in Section 4.0.

Most importantly, the approach to groundwater modeling included selection of model input parameters that would result in the most conservative model results possible. For this assessment, "conservative model results" are defined as those results that would yield reasonable worst-case concentrations of COPECs at the POE. To this end, models were constructed incorporating a steady-state continuing source equal in concentration to the maximum detected concentration in source area monitoring wells at Sites 09 and 10. This approach resulted in model simulations that likely significantly overestimate concentrations of COPECs at the POE.

For all the chemicals, the modeling was conducted as follows. First, a unitary concentration (an arbitrary initial concentration of 1 milligram per liter) at the source well was assigned to the source zone as explained in Section 2.2. Second, the BIOSCREEN model was run for each of the source well to predict steady-state concentrations at the POE; the POE associated with each well is located downgradient from the source well at a unique distance.

For each monitoring well, the (1) initial unitary concentration, and (2) the predicted concentration at the POE are used to calculate a dilution attenuation factor (DAF). A unique DAF is calculated for each source area monitoring well by dividing the standard unitary concentration at a source well by the simulated concentration at the POE (using the unitary source concentration). The DAF therefore accounts for the relative reduction in concentration resulting from advection and dilution processes. The simulated concentration of a chemical at the POE is then calculated by dividing the maximum detected concentration of a chemical at a source well by the appropriate DAF. The resulting concentration value for each chemical is then used in the ecological risk assessment.

2.1 SITE CONCEPTUAL MODEL

A conceptual model of the hydrogeology at Sites 09 and 10 was formulated before computer code was selected to simulate the migration of COPECs. A conceptual model describes the components of the groundwater flow system and is developed from site-specific data. Flow system components include parameters such as groundwater flow direction and gradient, aquifer thickness, and water transmitting properties. Development of a conceptual model is always necessary before constructing a computerized groundwater flow or contaminant transport model (EPA 1992).

The conceptual model for Sites 09 and 10 was formulated to organize existing field data and literature-derived parameter values so that the groundwater flow system could be analyzed more readily. The conceptual model was simplified as much as possible; however, enough complexity was retained to simulate groundwater system behavior adequately for the intended purposes of modeling (Anderson and Woessner 1992).

2.2 MODEL ASSUMPTIONS

Model assumptions that were applied during the model construction phase are listed as follows.

Assumptions Required for Use in Analytical Models

- The aquifer is homogeneous, isotropic, and infinite in areal extent.
- Groundwater flow is horizontal, unidirectional, and at steady state.
- Groundwater flows in the direction of shortest travel from the source area to the POE.

Assumptions Based on Available Field Data

- The hydraulic conductivity is equal to 10.12 feet per day (ft/d) for Site 09 and 12.47 ft/d for Site 10. The hydraulic conductivity for Site 09 was estimated based on average for NAVSTA TI. The hydraulic conductivity for Site 10 was estimated as an average of two slug test results available for adjacent Site 14/22 (Tetra Tech 2002).

- The hydraulic gradient is equal to 0.0048 foot per foot (ft/ft) for Site 09 and 0.0036 ft/ft for Site 10. The hydraulic gradient selected for each site is equal to the maximum measured gradient.

- The principal direction of the hydraulic gradient is to the southeast at Site 09 and to the northeast at Site 10. All groundwater flows to the shoreline.

- The aquifer effective porosity is equal to 0.28 (unitless), an estimate based on medium-grained sands (Todd 1980).

- For Site 09, the groundwater seepage velocity is about 63.3 feet per year. For Site 10, the groundwater seepage velocity is about 58.5 feet per year. These estimates are calculated using Darcy's Law (Fetter 1980) and site-specific values of the hydraulic conductivity, hydraulic gradient, and an effective porosity listed above as follows:

  $v = (k \times i) / n_e$

  where

  v = seepage velocity, or pore water velocity (ft/d)
  k = hydraulic conductivity (ft/d)
  i = hydraulic gradient (ft/ft)
  n_e = effective porosity (unitless)

- The longitudinal dispersivity (α_x), transverse dispersivity (α_y), and vertical dispersivity (α_z) are determined based on the distance from a monitoring well to the POE:

  α_x = 0.1L, where L is a distance to the POE (feet)
  α_y = $\alpha_x/3$
  α_z = $0.05\alpha_x$

The approach to estimate dispersivities is consistent with American Society for Testing and Materials (ASTM) guidances (ASTM 1996).

Chemical-Specific Assumptions

- The source of contamination and source release is continuous and at steady state. This assumption was made to ensure conservative model results that yielded reasonable worst-case concentrations of COPECs at the POE (Anderson and Woessner 1992).

- The maximum concentrations of COPECs detected during the 2002 sampling event provide reasonable worst-case initial conditions, including values for the model source strength.

- The simulated source release is through a vertical plane defined by the width of the area of concern (source width) and the source zone thickness, where the vertical plane is perpendicular to the groundwater flow direction (EPA 1996).

- The source width for each well at Site 09 was estimated using soil data for COPECs and was conservatively set equal to the width of Site 09 perpendicular to direction of groundwater flow (Figure H-1). The source width for each well at Site 10 was estimated using data for metals, pesticides, and PCBs from soil borings in the vicinity of a well (Figure H-2).

- At both sites, fewer analytes and at lower concentrations were detected at depth (near the water table) than in the upper vadose zone soils. For both sites, therefore, the maximum potential thickness of the source in the saturated zone was assumed to be 5 feet.

- Even though the migration of evaluated chemicals may be retarded in groundwater at Sites 09 and 10, the retardation factor for all model runs was set equal to 1.0. A retardation factor of 1.0 is conservative because it maximizes the rate of contaminant migration to the POE.

- Biodegradation is assumed not to occur. This assumption is also conservative, and would have the impact of maximizing the concentration at the POE.

The conceptual model described previously formed the basis for selection of model input parameters during model construction. Model parameters describing source release are summarized in Table H-2. Table H-3 summarizes additional transport model parameter values that were used. Table H-4 provides a summary of the range of likely values for various transport model parameters as well as the values selected for the model simulations presented in this appendix.

To the extent practical, development of a conceptual model, model setup, and selection of input parameters incorporated field data and conservative assumptions that likely overestimate the

simulated concentrations of constituents at the POE, and are therefore acceptable for the purpose of screening (Anderson and Woessner 1992). Model results are discussed in Section 3.0.

3.0 MODEL RUNS AND RESULTS

The BIOSCREEN model was run to predict the concentrations of nickel, alpha-chlordane, and endosulfan II at the POE. Table H-5 summarizes simulated concentrations of nickel, alpha-chlordane, and endosulfan II at the POE.

Although only three COPECs were identified in two Site 09 monitoring wells, many chemicals analyzed for in several other wells at Sites 09 and 10 also required modeling evaluation because the reported laboratory analytical detection limits for these chemicals exceed the screening criteria. Therefore, modeling was conducted for wells with no identified COPECs, such as 09-MW01 through 09-MW07, 10-MW02, and 10-MW03.

Using the methodology described in Section 2.2, DAFs were developed using the BIOSCREEN model for each monitoring well. The DAF describes the reduction in the concentration of a chemical as it is transported in the groundwater from a source well to a downgradient receptor point (that is, the POE). For an individual well, the DAF is equal to the unitary concentration of a chemical divided by the simulated concentration at the POE. Model input and output screens for all model runs used to predict concentrations of COPECs at the POE and generate DAFs are provided in Attachment H-1. The resulting DAFs are summarized as follows:

Monitoring well	Distance from Monitoring Well to POE (feet)	Unitary Concentration at Monitoring well (mg/L)	BIOSCREEN-Simulated Concentration at the POE (mg/L)	Calculated DAF for Respective Monitoring Well
09-MW01	195	1.0	0.11601	8.62
09-MW02	230	1.0	0.08598	11.63
09-MW03	209	1.0	0.10204	9.80
09-MW04	204	1.0	0.10695	9.35
09-MW05	260	1.0	0.06798	14.71
09-MW06	284	1.0	0.05800	17.24
09-MW07	185	1.0	0.12706	7.87
10-MW02	90	1.0	0.30303	3.30
10-MW03	91	1.0	0.29674	3.37

Consistent with the treatment of the nondetects in the human health risk assessment, the reported nondetected results for individual analytes in this evaluation were replaced by one-half of the detection limit (Table H-6). Using the DAFs generated for monitoring wells at Sites 09 and 10, the reasonable worst case concentration at the POE for each nondetected analyte was predicted by dividing one-half of the detection limit by the applicable DAF. Table H-6 summarizes

simulated concentrations for nondetected analytes such as mercury, pesticides, and PCBs at the POE and compares the predicted concentrations to screening criteria.

Model results presented in Table H-5 indicate that the maximum worst-case concentrations of COPECs at the POE were less than the screening criteria for each COPEC. Model results presented in Table H-6 show that nondetectable concentrations of toxaphene at the POEs for Sites 09 and 10 could theoretically be above the screening criteria.

The simulated concentrations of toxaphene would not be detectable at the POE with currently available laboratory analytical methods. Moreover, because the pesticide toxaphene tends to strongly sorb to aquifer materials, toxaphene mobility in groundwater is actually very low; the actual retardation factor for toxaphene is significantly greater than the model-assumed value of 1.0 used in BIOSCREEN modeling. Therefore, the simulated undetected concentrations of toxaphene at the POE are not considered further in this evaluation.

4.0 MODEL LIMITATIONS

For this investigation, model parameters were selected based on field data where possible or were based on published values for similar site conditions. No attempt was made to perform a groundwater flow or contaminant transport calibration or to simulate historical source releases; therefore, the type of modeling application described in this report is consistent with the characteristics of a "generic model" (Anderson and Woessner 1992). According to Anderson and Woessner (1992), generic models are used to analyze flow in simplified hydrogeological systems and may be useful for the purpose of screening. Generic models do not necessarily require formal calibration (Anderson and Woessner 1992).

Development of analytical transport models for Sites 09 and 10 involved incorporating numerous assumptions and simplifications that likely overestimate concentrations of COPECs at the POE. The model results provide a reasonable worst-case analysis and are considered to be conservative from the standpoint of protecting the environment. Important assumptions and simplifications are listed in Section 2.0 of this report.

Even though no model calibration was completed, the results of current modeling activities are adequate to satisfy the primary objectives of this report. Specifically, modeling results provide a conservative estimate of the reasonable worst-case concentration of COPECs that might be expected at the POE. The model results can be used for screening but should not be used to accurately predict the concentration distribution of COPECs in groundwater.

5.0 CONCLUSIONS

Modeling of the fate and transport of groundwater contaminants at Site 09 and 10 of NAVSTA TI was conducted using BIOSCREEN. The objectives of modeling were to (1) simulate the migration of COPECs from source areas to the downgradient POE, (2) simulate the reasonable worst-case concentration of COPECs in groundwater that might be expected at the POE, and (3)

compare simulated concentrations of COPECs at the POE to screening criteria. In addition, analytes that were not actually detected, but that have laboratory analytical detection limits above the screening criteria were also evaluated.

The analytical fate and transport model BIOSCREEN was used to simulate the reduction in concentration of COPECs in groundwater from monitoring wells in the source area to the shoreline. Based on BIOSCREEN modeling, DAFs were calculated and the reasonable worst-case concentrations of COPECS at the POE were estimated. The approach to modeling included selection of input parameters that would result in the most conservative model results possible. For this assessment, conservative results yielded reasonable worst-case concentrations of COPECs at the POE. Model simulation results suggest that the maximum estimated concentrations at the POE for each COPEC were less than the screening criteria.

Similarly, model simulation results for nondetected analytes with detection limits above the criteria suggest that the expected concentrations for all analytes, except toxaphene, would be below the screening criteria. Because non-detectable concentrations of toxaphene also exhibit very low mobility in groundwater, the nondetected concentrations of toxaphene at the POE that were above the screening criteria are not considered important for this analysis.

6.0 REFERENCES

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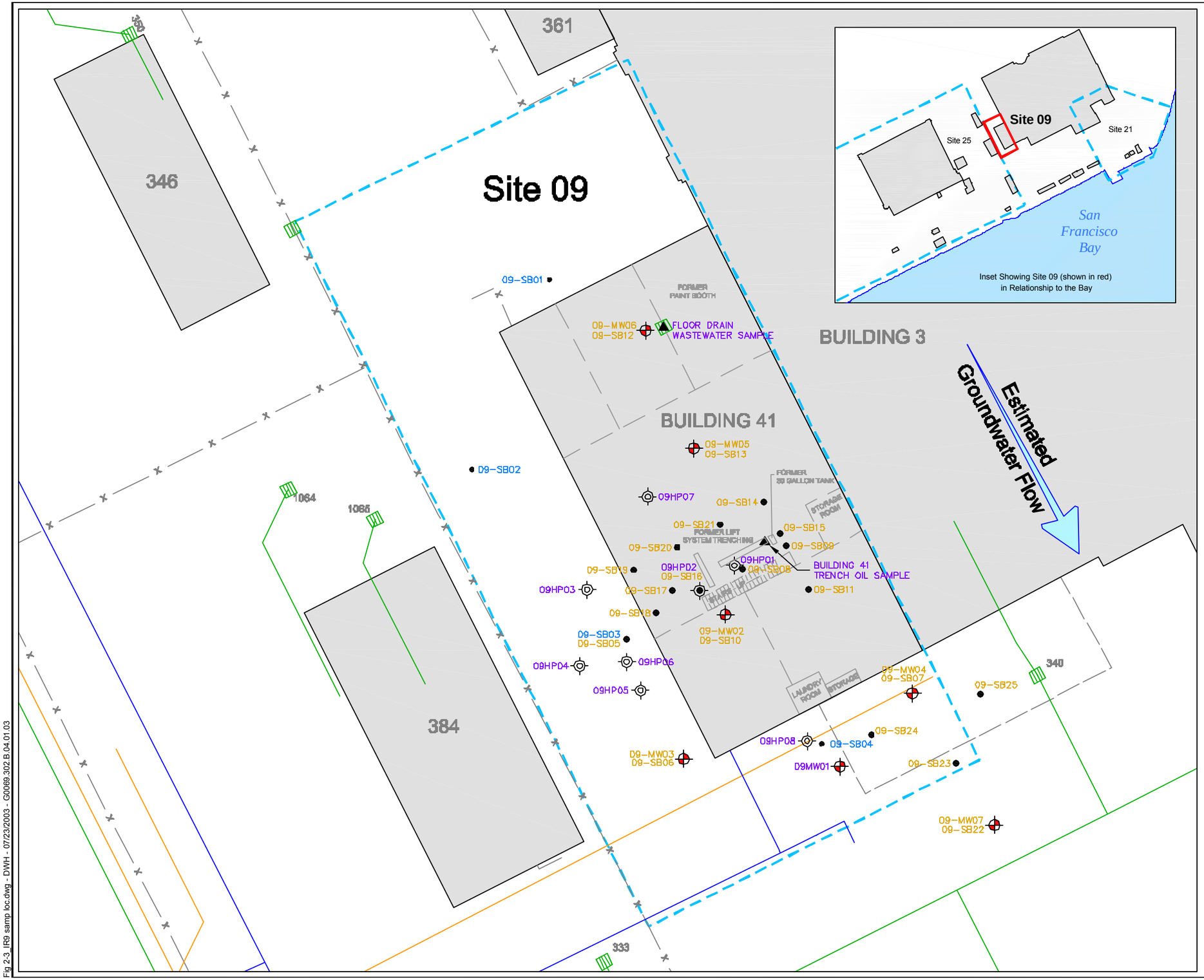
FIGURES



AREA OF INTEREST

LEGEND

- MONITORING WELL LOCATION
- GEOPROBE SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- GRAB SAMPLE
- FRESHWATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- STORM DRAIN CATCH BASIN
- FENCE
- 384 BUILDING
- SITE BOUNDARY
- 09-SB01 PHASE I REMEDIAL INVESTIGATION - 1992
- 09-HP01 PHASE IIB REMEDIAL INVESTIGATION - 1995
- 09-SB05 ADDITIONAL INVESTIGATION - 2002

N

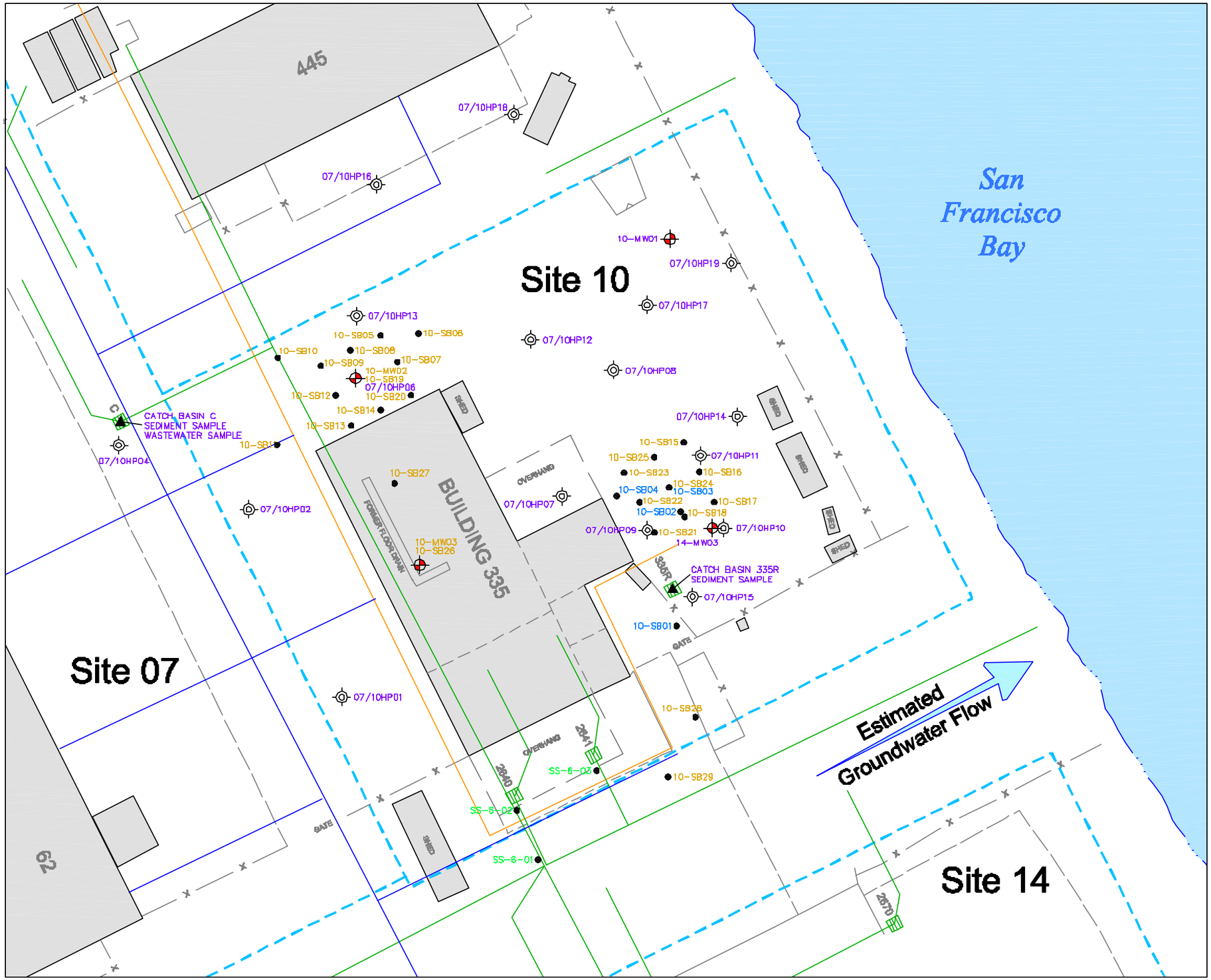
10 0 10 20
SCALE IN FEET

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE H-1
Site 09 - Foundry
Sample Location History

Fig 2-3_IR9 samp loc.dwg - DWH - 07/23/2003 - G0069.302.B.04.01.03



AREA OF INTEREST

LEGEND

- MONITORING WELL LOCATION
- GEOPROBE SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- GRAB SAMPLE
- FRESHWATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- STORM DRAIN CATCH BASIN
- FENCE
- 384 — BUILDING
- SITE BOUNDARY
- 10-SB01 — PHASE I REMEDIAL INVESTIGATION - 1992
- 07/10HP01 — PHASE IIB REMEDIAL INVESTIGATION - 1995
- SS-6-01 — ENVIRONMENTAL BASELINE SURVEY - 1997
- 10-SB05 — ADDITIONAL INVESTIGATION - 2002

N

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SCALE IN FEET

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE H-2
Site 10 - Bus Painting Shop
Sample Location History

Fig 2-4_IR10 samp loc.dwg - DWH - 07/24/2003 - G0069.302.B.04.01.03

TABLES

TABLE H-1: GROUNDWATER RESULTS EXCEEDING SCREENING CRITERIA
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Sample Date	Analyte Group	Analyte	Result	Reporting Detection Limit	Qualifier	Screening Criteria[a]
Site 09 Detected Analytes at Concentrations Above Screening Criteria							
09-MW05	31-Oct-02	Pesticides	Alpha-Chlordane	0.0067	0.0061	J	0.004
09-MW07	4-Nov-02	Pesticides	Endosulfan II	0.014	0.1		0.0087
09-MW05	31-Oct-02	Metals	Nickel	11.9	0.1		8.2
Site 09 Nondetected Analytes with Reporting Detection Limits Above the Screening Criteria							
09-MW01	31-Oct-02	Pesticides	Toxaphene	0.05	0.05	U	0.0002
09-MW01	31-Oct-02	Pesticides	4,4'-DDT	0.0051	0.0051	U	0.001
09-MW01	31-Oct-02	Pesticides	Endrin	0.0047	0.0047	U	0.0023
09-MW01	31-Oct-02	Pesticides	Methoxychlor	0.0069	0.0069	U	0.003
09-MW01	31-Oct-02	Pesticides	Heptachlor	0.0049	0.0049	U	0.0036
09-MW01	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	0.0084	U	0.0036
09-MW01	31-Oct-02	Pesticides	Alpha-Chlordane	0.0061	0.0061	U	0.004
09-MW01	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	0.0075	U	0.004
09-MW01	31-Oct-02	PCB	Aroclor 1221	0.041	0.041	U	0.03
09-MW01	31-Oct-02	PCB	Aroclor 1232	0.06	0.06	U	0.03
09-MW01	31-Oct-02	PCB	Aroclor 1242	0.036	0.036	U	0.03
09-MW01	31-Oct-02	Metals	Mercury	0.1	0.1	U	0.025
09-MW02	31-Oct-02	Pesticides	Toxaphene	0.05	0.05	U	0.0002
09-MW02	31-Oct-02	Pesticides	4,4'-DDT	0.0051	0.0051	U	0.001
09-MW02	31-Oct-02	Pesticides	Endrin	0.0047	0.0047	U	0.0023
09-MW02	31-Oct-02	Pesticides	Methoxychlor	0.0069	0.0069	U	0.003
09-MW02	31-Oct-02	Pesticides	Heptachlor	0.0049	0.0049	U	0.0036
09-MW02	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	0.0084	U	0.0036
09-MW02	31-Oct-02	Pesticides	Alpha-Chlordane	0.0061	0.0061	U	0.004
09-MW02	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	0.0075	U	0.004
09-MW02	31-Oct-02	PCB	Aroclor 1221	0.041	0.041	U	0.03
09-MW02	31-Oct-02	PCB	Aroclor 1232	0.06	0.06	U	0.03
09-MW02	31-Oct-02	PCB	Aroclor 1242	0.036	0.036	U	0.03
09-MW03	31-Oct-02	Pesticides	Toxaphene	0.05	0.05	U	0.0002
09-MW03	31-Oct-02	Pesticides	4,4'-DDT	0.0051	0.0051	U	0.001
09-MW03	31-Oct-02	Pesticides	Endrin	0.0047	0.0047	U	0.0023
09-MW03	31-Oct-02	Pesticides	Methoxychlor	0.0069	0.0069	U	0.003
09-MW03	31-Oct-02	Pesticides	Heptachlor	0.0049	0.0049	U	0.0036
09-MW03	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	0.0084	U	0.0036
09-MW03	31-Oct-02	Pesticides	Alpha-Chlordane	0.0061	0.0061	U	0.004
09-MW03	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	0.0075	U	0.004
09-MW03	31-Oct-02	PCB	Aroclor 1221	0.041	0.041	U	0.03
09-MW03	31-Oct-02	PCB	Aroclor 1232	0.06	0.06	U	0.03
09-MW03	31-Oct-02	PCB	Aroclor 1242	0.036	0.036	U	0.03
09-MW04	30-Oct-02	Pesticides	Toxaphene	0.05	0.05	U	0.0002
09-MW04	30-Oct-02	Pesticides	4,4'-DDT	0.0051	0.0051	U	0.001
09-MW04	30-Oct-02	Pesticides	Endrin	0.0047	0.0047	U	0.0023
09-MW04	30-Oct-02	Pesticides	Methoxychlor	0.0069	0.0069	U	0.003
09-MW04	30-Oct-02	Pesticides	Heptachlor	0.0049	0.0049	U	0.0036
09-MW04	30-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	0.0084	U	0.0036
09-MW04	30-Oct-02	Pesticides	Alpha-Chlordane	0.0061	0.0061	U	0.004

TABLE H-2: SOURCE RELEASE PARAMETER

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Analyte/ Detection Limits Exceeding Screening Criteria	Maximum Concentration Detected or Detection Limit (µg/L)	Width of Area of Concern[a] (feet)	Width of Source Zone with Maximum Concentration Detected[b] (feet)	Assumed Source Thickness[c] (feet)
Chemicals of Potential Ecological Concern					
09-MW05	Nickel	11.9	<80	80	5
	Alpha-Chlordane	0.0067	<80	80	5
09-MW07	Endosulfan II	0.014	<80	80	5
Non Detected Analytes with Reported Detection Limits Above the Screening Criteria					
09-MW01	Pesticides, PCBs, Mercury	Analyte-specific Detection Limit[d]	<80	80	5
09-MW02	Pesticides, PCBs	Analyte-specific Detection Limit[d]	<80	80	5
09-MW03	Pesticides, PCBs	Analyte-specific Detection Limit[d]	<80	80	5
09-MW04	Pesticides, PCBs	Analyte-specific Detection Limit[d]	<80	80	5
09-MW06	Pesticides, PCBs	Analyte-specific Detection Limit[d]	<80	80	5
10-MW02	Pesticides, PCBs	Analyte-specific Detection Limit[d]	<50	50	5
10-MW03	Pesticides, PCBs	Analyte-specific Detection Limit[d]	<50	50	5

Notes:

a Width (perpendicular to direction of transport) of area of concern.

b Width of source zone for wells at Site 09 is approximately equal to the site width perpendicular to direction of transport.
Width of source zone for wells at Site 10 is estimated based on the soil data for pesticides, polychlorinated biphenyls (PCB), and metals from adjacent borings.
The contaminant concentration in the source zone is set equal to the unitary concentration of 1 milligram per liter.

c The maximum potential thickness of the source zone is assumed.

d See Table H-1

µg/L Microgram per liter

TABLE H-3: TRANSPORT PARAMETERS

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Distance to Exposure Point (Inland Edge of the Tidal Mixing Zone)	Hydraulic Gradient (feet/feet)	Hydraulic Conductivity in Vicinity of Well		Groundwater Seepage Velocity[a] (feet/year)	Longitudinal Dispersivity (feet)	Transverse Dispersivity (feet)	Vertical Dispersivity (feet)
			(feet/day)	(cm/sec)				
09-MW01	195	0.0048	10.12	3.57E-03	63.3	19.5	6.5	1.0
09-MW02	230	0.0048	10.12	3.57E-03	63.3	23.0	7.7	1.2
09-MW03	209	0.0048	10.12	3.57E-03	63.3	20.9	7.0	1.0
09-MW04	204	0.0048	10.12	3.57E-03	63.3	20.4	6.8	1.0
09-MW05	260	0.0048	10.12	3.57E-03	63.3	26.0	8.7	1.3
09-MW06	284	0.0048	10.12	3.57E-03	63.3	28.4	9.5	1.4
09-MW07	185	0.0048	10.12	3.57E-03	63.3	18.5	6.2	0.9
10-MW02	90	0.0036	12.47	4.40E-03	58.5	9.0	3.00	0.45
10-MW03	91	0.0036	12.47	4.40E-03	58.5	9.1	3.03	0.46

Notes:

a Assumes an estimated effective porosity for sand of 28 percent (Todd 1980).

cm Centimeter

sec Second

TABLE H-4: RANGE OF POSSIBLE MODEL PARAMETER VALUES AND ACTUAL VALUES USED

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Parameter	Minimum Possible Value			Maximum Possible Value			Model Parameter Value Used	
	Site 09	Site 10	Basis	Site 09	Site 10	Basis	Site 09	Site 10
Source zone width (feet)	50	30	Minimum width (conservatively estimated from soil data)	80	50	Maximum width (conservatively estimated from soil data)	80	50
Source thickness in saturated zone (feet)	1	1	Estimated from soil data	5	5	Estimated from soil data	5	5
Hydraulic conductivity (feet/day)	5.1 Lowest measured at Treasure Island	12.30 Lowest measured at adjacent Site 14/22	Slug tests	15.6 Highest measured at Treasure Island	12.75 Highest measured at adjacent Site 14/22	Slug tests	10.12	12.47
Hydraulic gradient (feet/feet)	0.0013 Lowest measured at the site	0.001 Lowest measured at the site	Measured groundwater elevations	0.0036 Highest measured at the site	0.0048 Highest measured at the site	Measured groundwater elevations	0.0036	0.0048
Effective porosity	0.20	Lower value for site soil types	Typical reported values (Todd 1980)	0.30	Higher value for site soil types	Typical reported values (Todd 1980)	0.28	0.28
Dispersivity (feet) (longitudinal [α_x], transverse[α_y], and vertical [α_z])	α_x = 18.5 α_y = 6.2 α_z = 0.9 Lowest for the site (see Table H-3)	α_x = 9.0 α_y = 3.00 α_z = 0.45 Lowest for the site (see Table H-3)	Estimated using published relationships (EPA 1986, 1996; ASTM 1995)	α_x = 28.4 α_y = 9.5 α_z = 1.4 Lowest for the site (see Table H-3)	α_x = 9.1 α_y = 3.03 α_z = 0.46 Highest for the site (see Table H-3)	Estimated using published relationships (EPA 1986, 1996; ASTM 1995)	Unique values for each well (see Table H-3)	Unique values for each well (see Table H-3)

TABLE H-5: MODELING RESULTS FOR CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN, SITE 09

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Analyte Detected at Concentration Above Screening Criteria	Distance to Exposure Point (Inland Edge of the Tidal Mixing Zone)	Maximum Concentration Detected (µg/L)	Maximum Predicted Concentration at Exposure Point[a] (µg/L)	Screening Criteria (µg/L)		Applicable Screening Criteria Exceeded at Exposure Point?
					AWQC[b]	Ambient[c]	
09-MW05	Nickel	260	11.9	0.93	8.2	5.8	No
	Alpha-Chlordane	260	0.0067	0.0005	0.004	NA	No
09-MW07	Endosulfan II	185	0.01	0.002	0.0087	NA	No

Notes:

[a] Contaminant concentrations are predicted using BIOSCREEN (U.S. Environmental Protection Agency 1996) model for solute transport with no decay. The only attenuation mechanism is dispersion in the longitudinal, transverse, and vertical directions. No adsorption of contaminants to the soil matrix is assumed.

[b] See Table J-1 for details

[c] See Tetra Tech 2001

µg/L Micrograms per liter

NA Not applicable

AWQC Ambient Water Quality Criteria

TABLE H-6: MODELING RESULTS FOR NONDETECTED ANALYTES WITH DETECTION LIMITS ABOVE SCREENING CRITERIA
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Sample Date	Analyte Group	Analyte	Reported Detection Limit	Qualifier	1/2 of Reported Detection Limit	Screening Criteria[a]	DAF	Maximum Predicted Concentration at Exposure Point (µg/L)	Exceeds the Criteria?
Site 09 Nondetected Analytes with Reporting Detection Limits Above the Screening Criteria										
09-MW01	31-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	8.62	2.9E-03	Yes
09-MW01	31-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	8.62	3.0E-04	No
09-MW01	31-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	8.62	2.7E-04	No
09-MW01	31-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	8.62	4.0E-04	No
09-MW01	31-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	8.62	2.8E-04	No
09-MW01	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	8.62	4.9E-04	No
09-MW01	31-Oct-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	8.62	3.5E-04	No
09-MW01	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	8.62	4.4E-04	No
09-MW01	31-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	8.62	2.4E-03	No
09-MW01	31-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	8.62	3.5E-03	No
09-MW01	31-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	8.62	2.1E-03	No
09-MW01	31-Oct-02	Metals	Mercury	0.1	U	0.05	0.025	8.62	5.8E-03	No
09-MW02	31-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	11.63	2.1E-03	Yes
09-MW02	31-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	11.63	2.2E-04	No
09-MW02	31-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	11.63	2.0E-04	No
09-MW02	31-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	11.63	3.0E-04	No
09-MW02	31-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	11.63	2.1E-04	No
09-MW02	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	11.63	3.6E-04	No
09-MW02	31-Oct-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	11.63	2.6E-04	No
09-MW02	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	11.63	3.2E-04	No
09-MW02	31-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	11.63	1.8E-03	No
09-MW02	31-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	11.63	2.6E-03	No
09-MW02	31-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	11.63	1.5E-03	No
09-MW03	31-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	9.80	2.6E-03	Yes
09-MW03	31-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	9.80	2.6E-04	No
09-MW03	31-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	9.80	2.4E-04	No
09-MW03	31-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	9.80	3.5E-04	No
09-MW03	31-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	9.80	2.5E-04	No
09-MW03	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	9.80	4.3E-04	No

ATTACHMENT H1
BIOSCREEN MODEL INPUT AND OUTPUT SCREENS

This attachment presents input and output screens of BIOSCREEN model for each well where chemicals of potential ecological concern (COPEC) or analytes with reported detection limits above the criteria were identified. The following table lists the input and output screens present on the following pages.

For all the chemicals, the modeling was conducted as follows. First, a unitary concentration (a standard initial concentration of 1 mg/L) at the source well was assigned to the whole source zone width as shown on each input screen. Second, the BIOSCREEN model was run for each the source well to predict a steady-state concentration at the point of exposure (POE), which is located downgradient from the source well at a unique distance. The predicted concentrations at the POE for each well are shown on the output screens listed in the table.

For each well, the (1) initial unitary concentration, and (2) the predicted concentration at the POE are used to calculate a dilution attenuation factor (DAF). A unique DAF is calculated for each source area monitoring well by dividing the assumed unitary concentration at a source well by the simulated concentration at the POE (using the unitary source concentration). The DAF therefore accounts for the relative reduction in concentration resulting from advection and dilution processes. The simulated concentration of a chemical at the POE is then calculated by dividing the maximum detected concentration of a chemical at a source well by the appropriate DAF. The resulting concentration value for each chemical is then used in the ecological risk assessment.

Monitoring Well	Analyte(s) detected?	Concentrations/Detection Limits Exceeding Screening Criteria	Input Screen Page	Output Screen Page
09-MW01	No[a]	Pesticides, PCBs, Mercury	H1-2	H1-3
09-MW02	No[a]	Pesticides, PCBs	H1-4	H1-5
09-MW03	No[a]	Pesticides, PCBs	H1-6	H1-7
09-MW04	No[a]	Pesticides, PCBs	H1-8	H1-9
09-MW05	Yes - COPECs	Nickel, Alpha-Chlordane	H1-10	H1-11
09-MW06	No[a]	Pesticides, PCBs	H1-12	H1-13
09-MW07	Yes - COPEC	Endosulfan II	H1-14	H1-15
10-MW02	No[a]	Pesticides, PCBs	H1-16	H1-17
10-MW03	No[a]	Pesticides, PCBs	H1-18	H1-19

Notes:

[a] One half of the reported detection limit was used in modeling as an initial concentration of a chemical
PCB Polychlorinated biphenyls

BIOSCREEN Model Input for Well 09-MW01
Site 09, Treasure Island

Contaminant Fate and Transport in Groundwater
(advection and dispersion only; no retardation due to sorption; no degradation

Site 09, Well 09-MW01 — *Run Name*

Data Input Instructions:

115 → *1. Enter value directly....or*
↑ or
0.02 → *2. Calculate by filling in grey cells below. (To restore formulas, hit button below).*

Variable* → *Data used directly in model.*
20 → *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	63.3	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	3.57E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.0048	*(ft/ft)*
Porosity	*n*	0.28	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	19.5	*(ft)*
Transverse Dispersivity*	*alpha y*	6.5	*(ft)*
Vertical Dispersivity*	*alpha z*	1.0	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	195	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	1.0	*(-)*
or		↑ or	
Soil Bulk Density	*rho*	1.6	*(kg/l)*
Partition Coefficient	*Koc*	0	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	0.0E+0	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*	1000.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	195	*(ft)*	L
Modeled Area Width*	80	*(ft)*	W
Simulation Time*	100	*(yr)*	

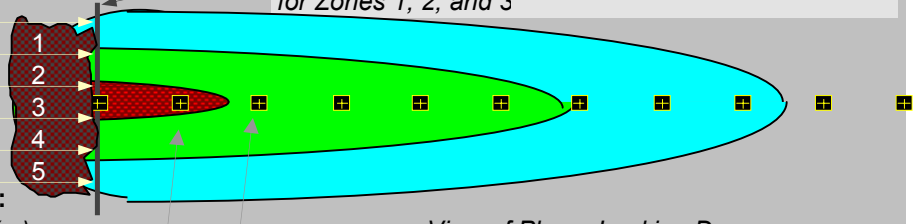
6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*	
0	0	1
0	0	2
80	1	3
0	0	4
0	0	5

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React. ↑	↑ 1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.0										
Dist. from Source (ft)	*0*	*20*	*39*	*59*	*78*	*98*	*117*	*137*	*156*	*176*	*195*

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

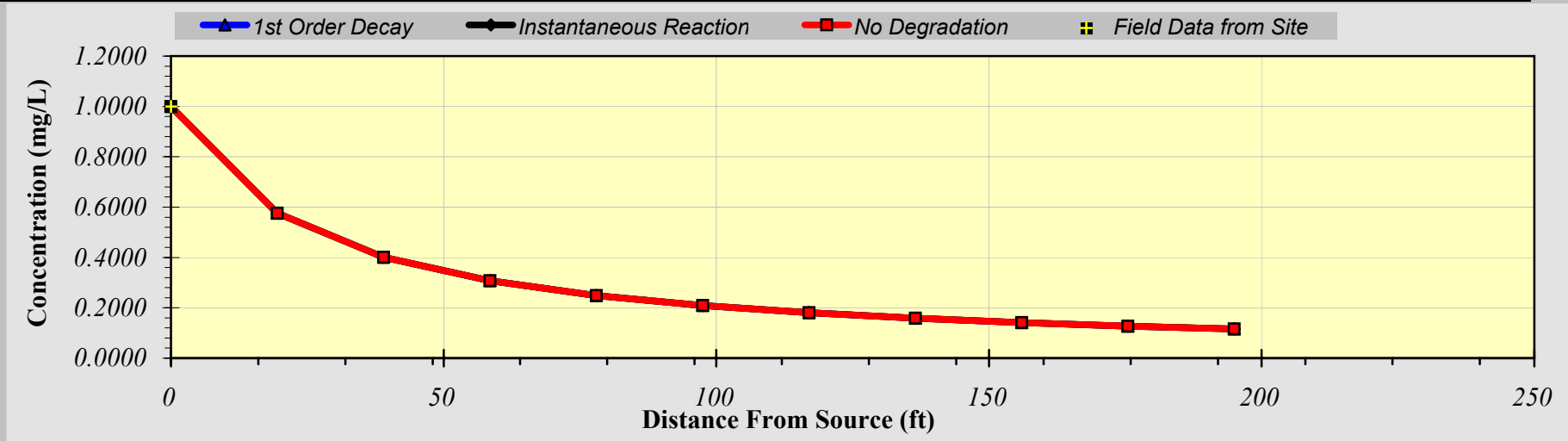
Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Model Output for Well 09-MW01
Site 09, Treasure Island

CONTAMINANT CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	20	39	59	78	98	117	137	156	176	195
No Degradation	1.000	0.576	0.401	0.307	0.249	0.209	0.180	0.158	0.141	0.127	0.116
1st Order Decay	1.000	0.576	0.401	0.307	0.249	0.209	0.180	0.158	0.141	0.127	0.116
Inst. Reaction	1.000	0.576	0.401	0.307	0.249	0.209	0.180	0.158	0.141	0.127	0.116
Field Data from Site	1.000										



Calculate Animation

Time: 100 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Model Input for Well 09-MW02
Site 09, Treasure Island

Contaminant Fate and Transport in Groundwater
(advection and dispersion only; no retardation due to sorption; no degradation

Site 09, Well 09-MW02 — *Run Name*

Data Input Instructions:
115 — *1. Enter value directly....or*
or — *2. Calculate by filling in grey cells below. (To restore formulas, hit button below).*
0.02
Variable* — *Data used directly in model.*
20 — *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	63.3	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	3.57E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.0048	*(ft/ft)*
Porosity	*n*	0.28	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	23.0	*(ft)*
Transverse Dispersivity*	*alpha y*	7.7	*(ft)*
Vertical Dispersivity*	*alpha z*	1.2	*(ft)*
or		or	
Estimated Plume Length	*Lp*	230	*(ft)*

3. ADSORPTION

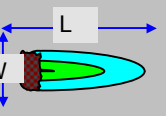
Retardation Factor*	*R*	1.0	*(-)*
or		or	
Soil Bulk Density	*rho*	1.6	*(kg/l)*
Partition Coefficient	*Koc*	0	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	0.0E+0	*(per yr)*
or		or	
Solute Half-Life	*t-half*	1000.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	230	*(ft)*
Modeled Area Width*	80	*(ft)*
Simulation Time*	100	*(yr)*



6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

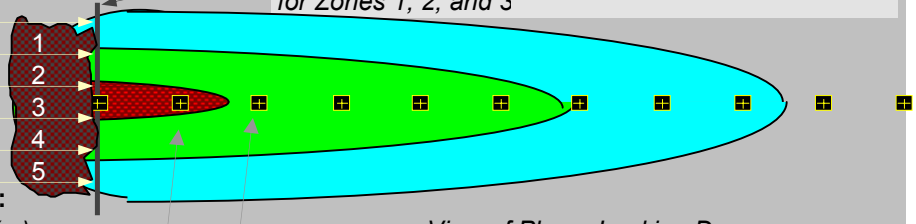
Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
80	1
0	0
0	0

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.0										
Dist. from Source (ft)	0	23	46	69	92	115	138	161	184	207	230

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

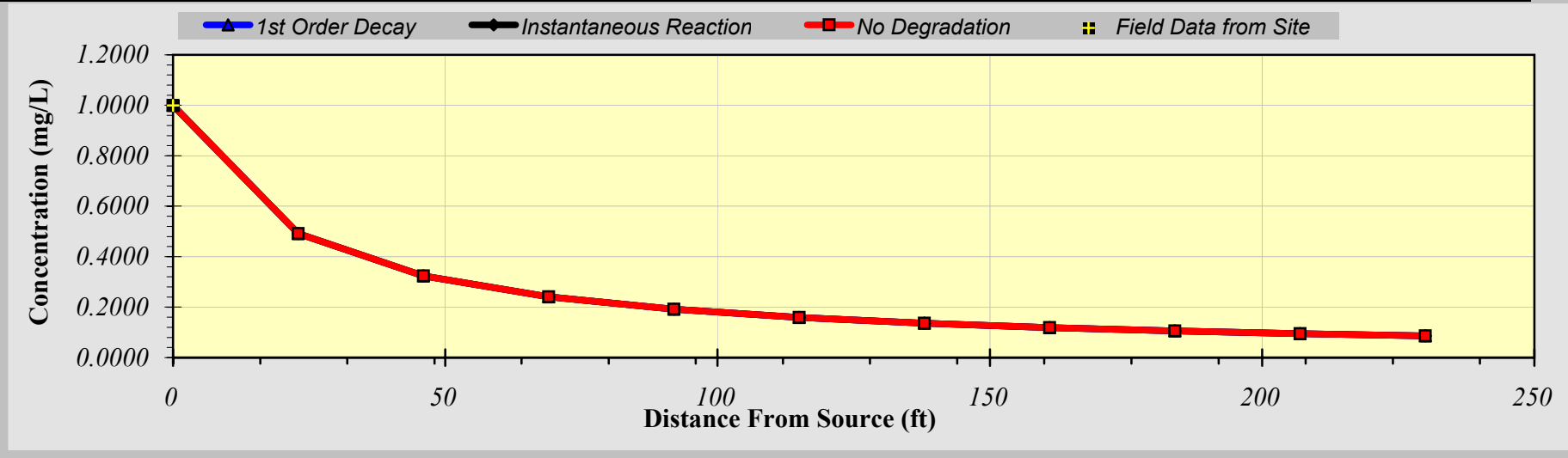
Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Model Output for Well 09-MW02
Site 09, Treasure Island

CONTAMINANT CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	23	46	69	92	115	138	161	184	207	230
No Degradation	1.000	0.491	0.324	0.241	0.192	0.159	0.136	0.119	0.105	0.095	0.086
1st Order Decay	1.000	0.491	0.324	0.241	0.192	0.159	0.136	0.119	0.105	0.095	0.086
Inst. Reaction	1.000	0.491	0.324	0.241	0.192	0.159	0.136	0.119	0.105	0.095	0.086
Field Data from Site	1.000										



Calculate Animation

Time:
100 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Model Input for Well 09-MW03
Site 09, Treasure Island

Contaminant Fate and Transport in Groundwater
(advection and dispersion only; no retardation due to sorption; no degradation

Site 09, Well 09-MW03 — *Run Name*

Data Input Instructions:

115 — *1. Enter value directly....or*
↑ or — *2. Calculate by filling in grey*
0.02 — *cells below. (To restore formulas, hit button below).*

Variable* — *Data used directly in model.*
20 — *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	63.3	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	3.57E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.0048	*(ft/ft)*
Porosity	*n*	0.28	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	20.9	*(ft)*
Transverse Dispersivity*	*alpha y*	7.0	*(ft)*
Vertical Dispersivity*	*alpha z*	1.0	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	209	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	1.0	*(-)*
or		↑ or	
Soil Bulk Density	*rho*	1.6	*(kg/l)*
Partition Coefficient	*Koc*	0	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	0.0E+0	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*	1000.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	209	*(ft)*	L
Modeled Area Width*	80	*(ft)*	W
Simulation Time*	100	*(yr)*	

6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

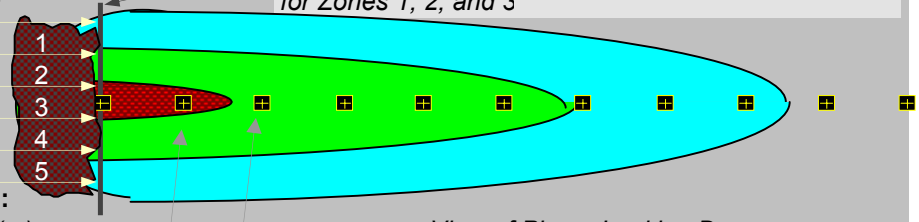
Source Zones:

Width* (ft)	Conc. (mg/L)*	
0	0	1
0	0	2
80	1	3
0	0	4
0	0	5

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	↑ 1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.0										
Dist. from Source (ft)	0	21	42	63	84	105	125	146	167	188	209

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

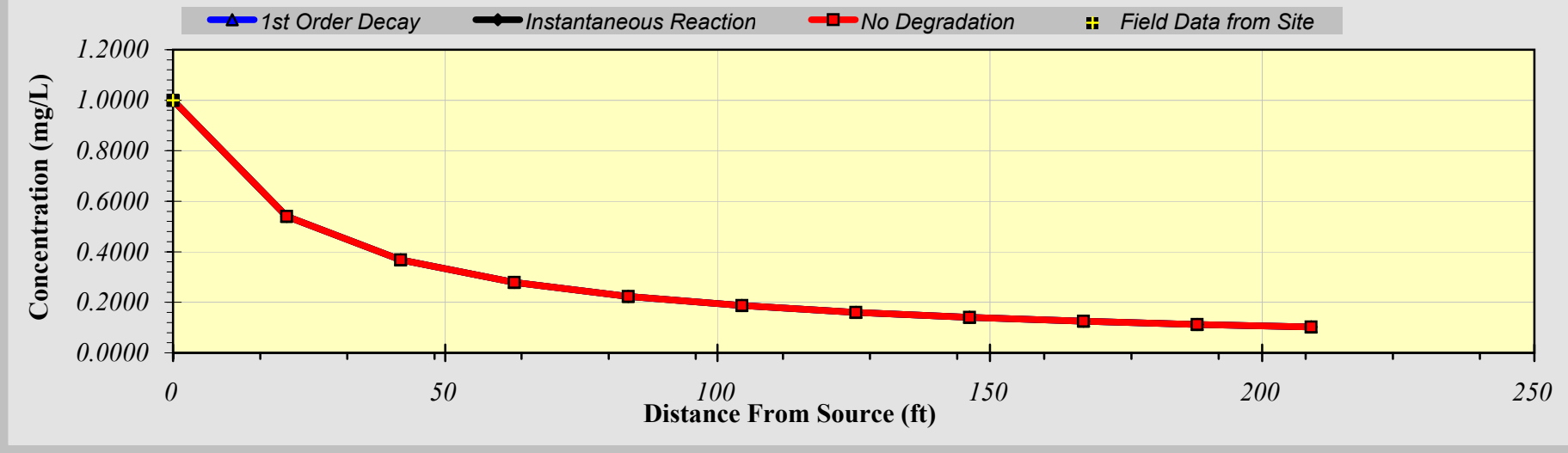
Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Model Output for Well 09-MW03
Site 09, Treasure Island

CONTAMINANT CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	21	42	63	84	105	125	146	167	188	209
No Degradation	1.000	0.540	0.368	0.278	0.224	0.187	0.160	0.141	0.125	0.113	0.102
1st Order Decay	1.000	0.540	0.368	0.278	0.224	0.187	0.160	0.141	0.125	0.113	0.102
Inst. Reaction	1.000	0.540	0.368	0.278	0.224	0.187	0.160	0.141	0.125	0.113	0.102
Field Data from Site	1.000										



Calculate Animation

Time: 100 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Model Input for Well 09-MW04
Site 09, Treasure Island

Contaminant Fate and Transport in Groundwater
(advection and dispersion only; no retardation due to sorption; no degradation

Site 09, Well 09-MW04 — *Run Name*

Data Input Instructions:
1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

115 / or / 0.02

Variable* → *Data used directly in model.*
20 → *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	63.3	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	3.57E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.0048	*(ft/ft)*
Porosity	*n*	0.28	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	20.4	*(ft)*
Transverse Dispersivity*	*alpha y*	6.8	*(ft)*
Vertical Dispersivity*	*alpha z*	1.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	204	*(ft)*

3. ADSORPTION

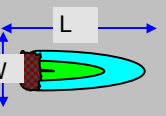
Retardation Factor*	*R*	1.0	*(-)*
or		or	
Soil Bulk Density	*rho*	1.6	*(kg/l)*
Partition Coefficient	*Koc*	0	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	0.0E+0	*(per yr)*
or		or	
Solute Half-Life	*t-half*	1000.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	204	*(ft)*
Modeled Area Width*	80	*(ft)*
Simulation Time*	100	*(yr)*



6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

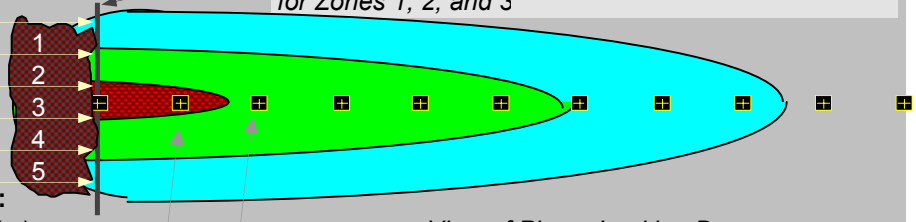
Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
80	1
0	0
0	0

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass In Source NAPL, Soil	infinite	*(Kg)*

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.0										
Dist. from Source (ft)	0	20	41	61	82	102	122	143	163	184	204

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help | Recalculate This Sheet

Paste Example Dataset

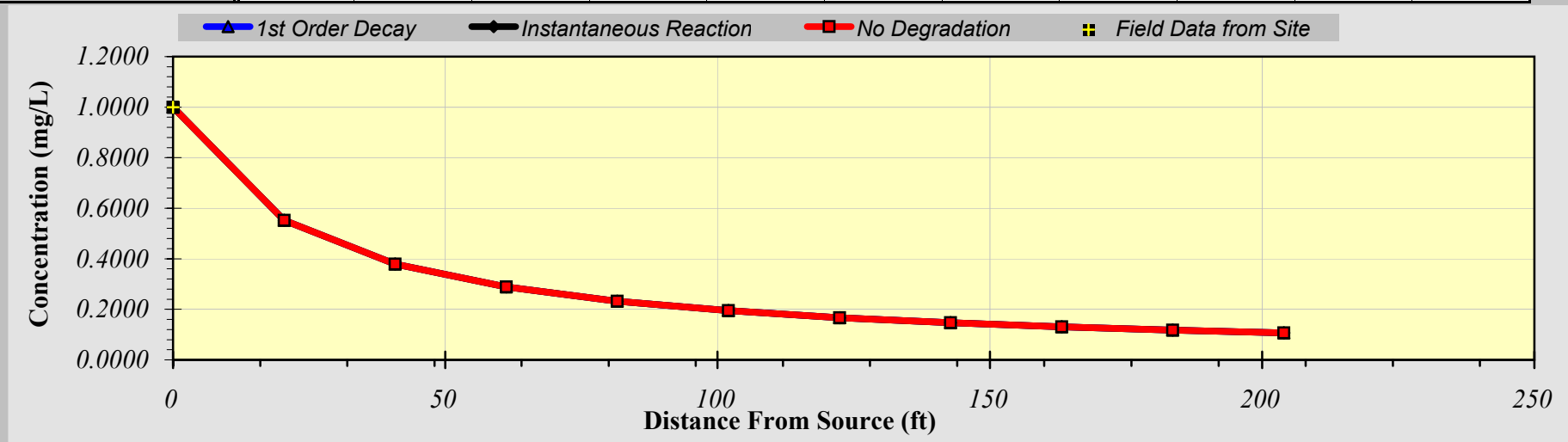
Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Model Output for Well 09-MW04
Site 09, Treasure Island

CONTAMINANT CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	20	41	61	82	102	122	143	163	184	204
No Degradation	1.000	0.553	0.379	0.288	0.232	0.194	0.167	0.147	0.130	0.118	0.107
1st Order Decay	1.000	0.553	0.379	0.288	0.232	0.194	0.167	0.147	0.130	0.118	0.107
Inst. Reaction	1.000	0.553	0.379	0.288	0.232	0.194	0.167	0.147	0.130	0.118	0.107
Field Data from Site	1.000										



Calculate Animation

Time: 100 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Model Input for Well 09-MW05
Site 09, Treasure Island

Contaminant Fate and Transport in Groundwater
(advection and dispersion only; no retardation due to sorption; no degradation

Site 09, Well 09-MW05 — *Run Name*

Data Input Instructions:
1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

*Variable** → *Data used directly in model.*
Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	63.3	*(ft/yr)*
or		*or*	
Hydraulic Conductivity	*K*	3.57E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.0048	*(ft/ft)*
Porosity	*n*	0.28	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	26.0	*(ft)*
Transverse Dispersivity*	*alpha y*	8.7	*(ft)*
Vertical Dispersivity*	*alpha z*	1.3	*(ft)*
or		*or*	
Estimated Plume Length	*Lp*	260	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	1.0	*(-)*
or		*or*	
Soil Bulk Density	*rho*	1.6	*(kg/l)*
Partition Coefficient	*Koc*	0	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	0.0E+0	*(per yr)*
or		*or*	
Solute Half-Life	*t-half*	1000.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	260	*(ft)*	L
Modeled Area Width*	80	*(ft)*	W
Simulation Time*	100	*(yr)*	

115 → *1. Enter value directly....or*
or → *2. Calculate by filling in grey*
0.02 → *cells below. (To restore formulas, hit button below).*

20 → *Value calculated by model. (Don't enter any data).*

6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

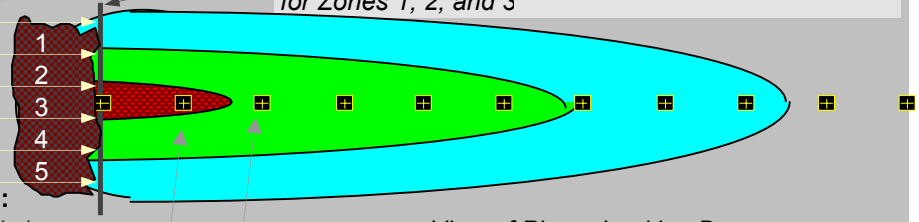
Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
80	1
0	0
0	0

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.0										
Dist. from Source (ft)	0	26	52	78	104	130	156	182	208	234	260

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

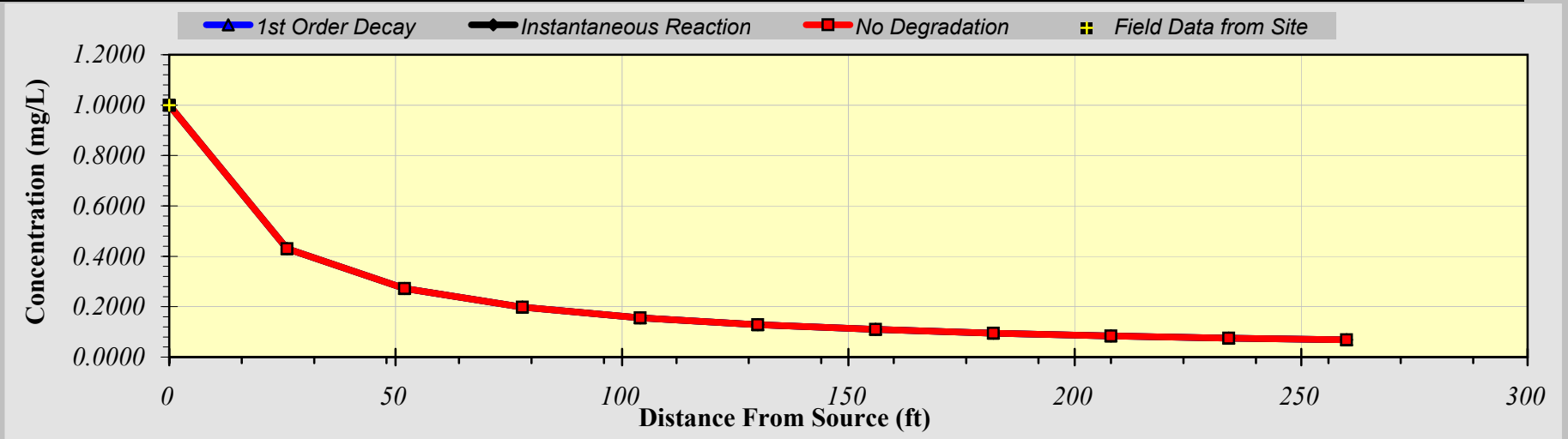
Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Model Output for Well 09-MW05
Site 09, Treasure Island

CONTAMINANT CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	26	52	78	104	130	156	182	208	234	260
No Degradation	1.000	0.430	0.272	0.199	0.156	0.129	0.109	0.095	0.084	0.076	0.068
1st Order Decay	1.000	0.430	0.272	0.199	0.156	0.129	0.109	0.095	0.084	0.076	0.068
Inst. Reaction	1.000	0.430	0.272	0.199	0.156	0.129	0.109	0.095	0.084	0.076	0.068
Field Data from Site	1.000										



Calculate Animation

Time:
100 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Model Input for Well 09-MW06
Site 09, Treasure Island

Contaminant Fate and Transport in Groundwater
(advection and dispersion only; no retardation due to sorption; no degradation

Site 09, Well 09-MW06 — *Run Name*

Data Input Instructions:
1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

*Variable** → *Data used directly in model.*
Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	63.3	*(ft/yr)*
or		*or*	
Hydraulic Conductivity	*K*	3.57E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.0048	*(ft/ft)*
Porosity	*n*	0.28	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	28.4	*(ft)*
Transverse Dispersivity*	*alpha y*	9.5	*(ft)*
Vertical Dispersivity*	*alpha z*	1.4	*(ft)*
or		*or*	
Estimated Plume Length	*Lp*	284	*(ft)*

3. ADSORPTION

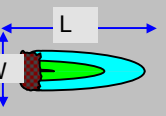
Retardation Factor*	*R*	1.0	*(-)*
or		*or*	
Soil Bulk Density	*rho*	1.6	*(kg/l)*
Partition Coefficient	*Koc*	0	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	0.0E+0	*(per yr)*
or		*or*	
Solute Half-Life	*t-half*	1000.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	284	*(ft)*
Modeled Area Width*	80	*(ft)*
Simulation Time*	100	*(yr)*



115 or 0.02 → *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

20 → *Value calculated by model. (Don't enter any data).*

6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

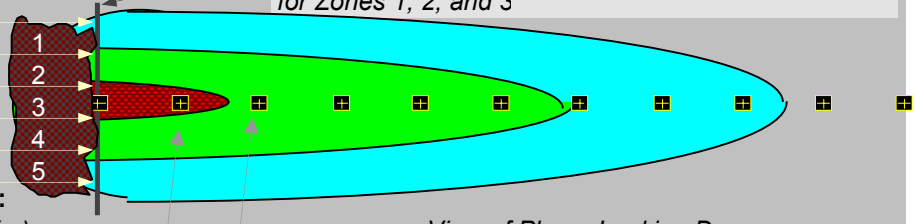
Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
80	1
0	0
0	0

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.0										
Dist. from Source (ft)	0	28	57	85	114	142	170	199	227	256	284

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help | Recalculate This Sheet

Paste Example Dataset

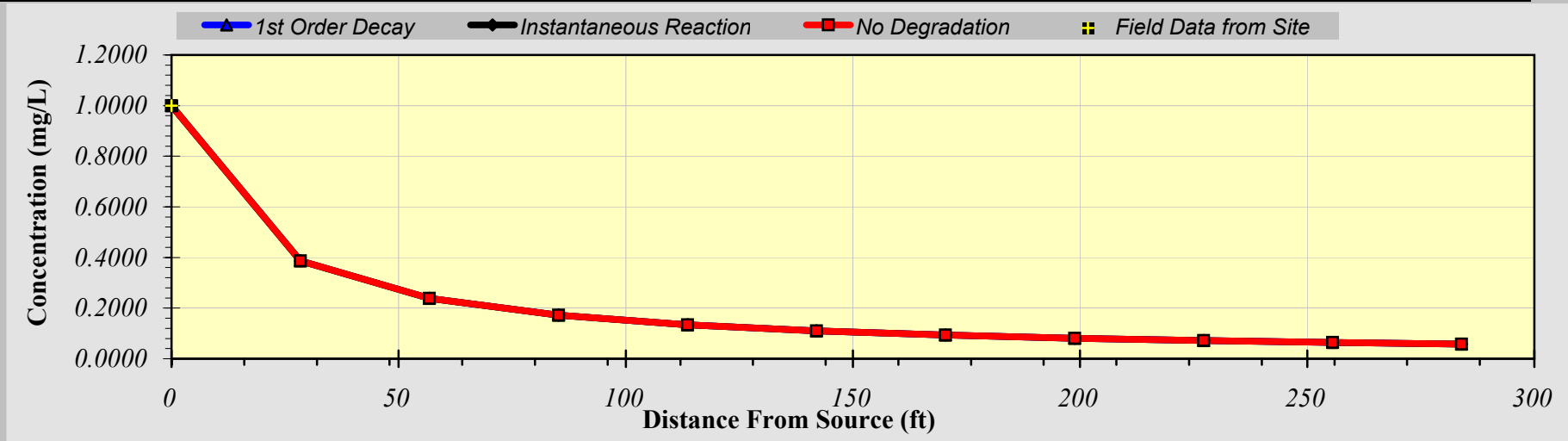
Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Model Output for Well 09-MW06
Site 09, Treasure Island

CONTAMINANT CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	28	57	85	114	142	170	199	227	256	284
No Degradation	1.000	0.387	0.238	0.172	0.134	0.110	0.093	0.081	0.071	0.064	0.058
1st Order Decay	1.000	0.387	0.238	0.172	0.134	0.110	0.093	0.081	0.071	0.064	0.058
Inst. Reaction	1.000	0.387	0.238	0.172	0.134	0.110	0.093	0.081	0.071	0.064	0.058
Field Data from Site	1.000										



Calculate Animation

Time:
100 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Model Input for Well 09-MW07
Site 09, Treasure Island

Contaminant Fate and Transport in Groundwater
(advection and dispersion only; no retardation due to sorption; no degradation

Site 09, Well 09-MW07 — *Run Name*

Data Input Instructions:
115 — *1. Enter value directly....or*
or — *2. Calculate by filling in grey*
0.02 — *cells below. (To restore formulas, hit button below).*
Variable* — *Data used directly in model.*
20 — *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	63.3	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	3.57E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.0048	*(ft/ft)*
Porosity	*n*	0.28	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	18.5	*(ft)*
Transverse Dispersivity*	*alpha y*	6.2	*(ft)*
Vertical Dispersivity*	*alpha z*	0.9	*(ft)*
or		or	
Estimated Plume Length	*Lp*	185	*(ft)*

3. ADSORPTION

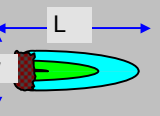
Retardation Factor*	*R*	1.0	*(-)*
or		or	
Soil Bulk Density	*rho*	1.6	*(kg/l)*
Partition Coefficient	*Koc*	0	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	0.0E+0	*(per yr)*
or		or	
Solute Half-Life	*t-half*	1000.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	185	*(ft)*
Modeled Area Width*	80	*(ft)*
Simulation Time*	100	*(yr)*



6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

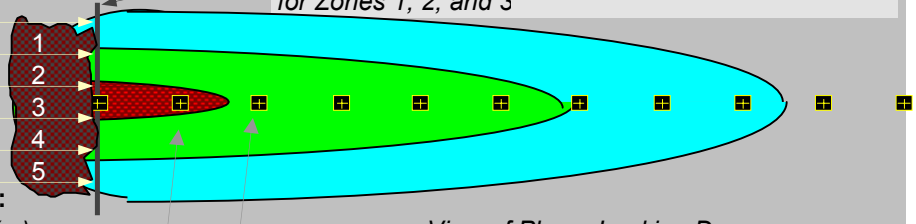
Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
80	1
0	0
0	0

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.0										
Dist. from Source (ft)	0	19	37	56	74	93	111	130	148	167	185

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

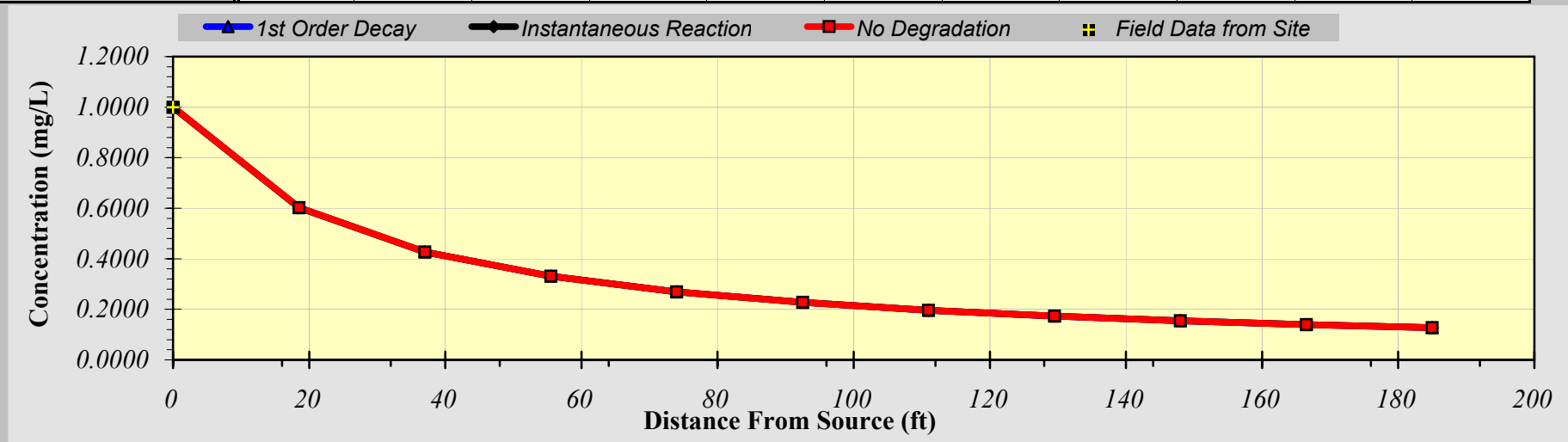
Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Model Output for Well 09-MW07
Site 09, Treasure Island

CONTAMINANT CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	19	37	56	74	93	111	130	148	167	185
No Degradation	1.000	0.602	0.427	0.331	0.269	0.227	0.197	0.173	0.155	0.140	0.127
1st Order Decay	1.000	0.602	0.427	0.331	0.269	0.227	0.197	0.173	0.155	0.140	0.127
Inst. Reaction	1.000	0.602	0.427	0.331	0.269	0.227	0.197	0.173	0.155	0.140	0.127
Field Data from Site	1.000										



Calculate Animation

Time:
100 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Model Input for Well 10-MW02
Site 10, Treasure Island

Contaminant Fate and Transport in Groundwater

(advection and dispersion only; no retardation due to sorption; no degradation

Site 10 Well 10-MW02
Run Name

Data Input Instructions:

115 → *1. Enter value directly....or*
or
0.02 → *2. Calculate by filling in grey cells below. (To restore formulas, hit button below).*

Variable* → *Data used directly in model.*
20 → *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	58.5	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	4.40E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.0036	*(ft/ft)*
Porosity	*n*	0.28	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	9.0	*(ft)*
Transverse Dispersivity*	*alpha y*	3.0	*(ft)*
Vertical Dispersivity*	*alpha z*	0.5	*(ft)*
or		or	
Estimated Plume Length	*Lp*	90	*(ft)*

3. ADSORPTION

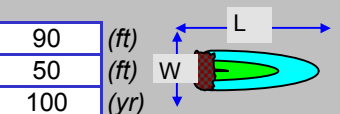
Retardation Factor*	*R*	1.0	*(-)*
or		or	
Soil Bulk Density	*rho*	1.57	*(kg/l)*
Partition Coefficient	*Koc*	0	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	0.0E+0	*(per yr)*
or		or	
Solute Half-Life	*t-half*	1000.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	90	*(ft)*
Modeled Area Width*	50	*(ft)*
Simulation Time*	100	*(yr)*



6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

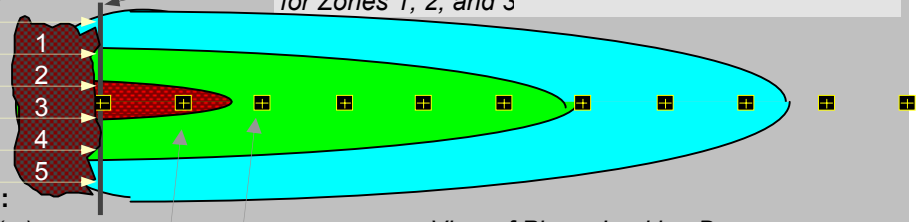
Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
50	1
0	0
0	0

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.0										
Dist. from Source (ft)	0	9	18	27	36	45	54	63	72	81	90

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

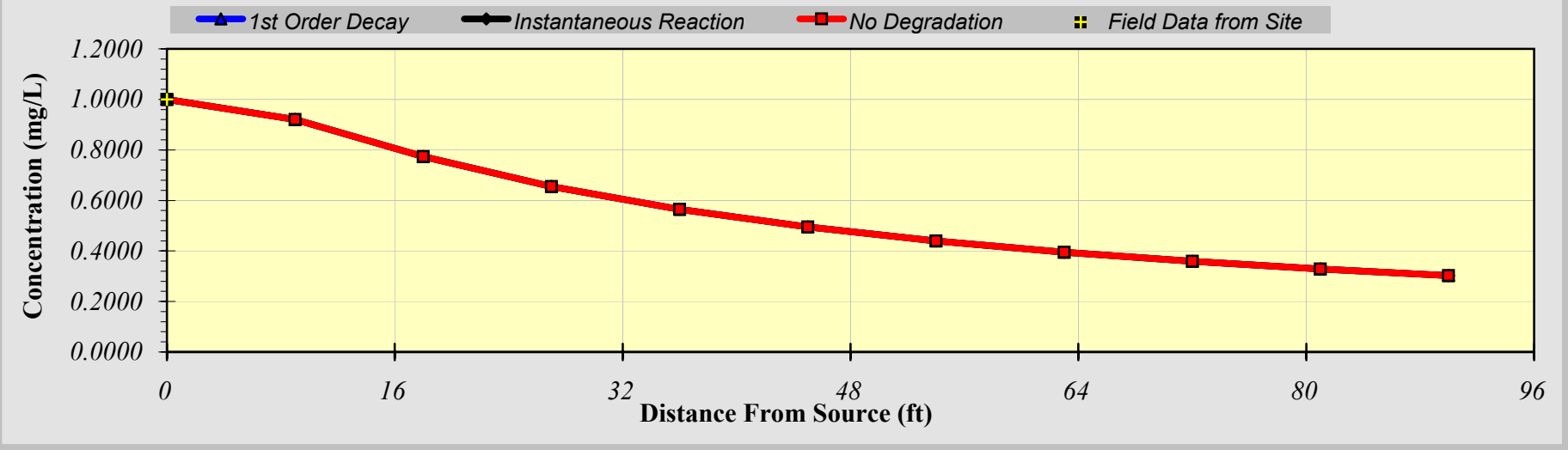
Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Model Output for Well 10-MW02
Site 10, Treasure Island

MOLYBDENUM CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	9	18	27	36	45	54	63	72	81	90
No Degradation	1.000	0.920	0.773	0.655	0.565	0.495	0.440	0.395	0.359	0.328	0.303
1st Order Decay	1.000	0.920	0.773	0.655	0.565	0.495	0.440	0.395	0.359	0.328	0.303
Inst. Reaction	1.000	0.920	0.773	0.655	0.565	0.495	0.440	0.395	0.359	0.328	0.303
Field Data from Site	1.000										



Calculate Animation

Time: 100 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Model Input for Well 10-MW03
Site 10, Treasure Island

Contaminant Fate and Transport in Groundwater
(advection and dispersion only; no retardation due to sorption; no degradation

Site 10 Well 10-MW03 — *Run Name*

Data Input Instructions:
1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

*Variable** — *Data used directly in model.*
Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	58.5	*(ft/yr)*
or		*or*	
Hydraulic Conductivity	*K*	4.40E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.0036	*(ft/ft)*
Porosity	*n*	0.28	*(-)*

2. DISPERSION

Longitudinal Dispersivity	*alpha x*	9.1	*(ft)*
Transverse Dispersivity*	*alpha y*	3.0	*(ft)*
Vertical Dispersivity*	*alpha z*	0.5	*(ft)*
or		*or*	
Estimated Plume Length	*Lp*	91	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	1.0	*(-)*
or		*or*	
Soil Bulk Density	*rho*	1.57	*(kg/l)*
Partition Coefficient	*Koc*	0	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E+0	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	0.0E+0	*(per yr)*
or		*or*	
Solute Half-Life	*t-half*	1000.00	*(year)*
or Instantaneous Reaction Mode			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	91	*(ft)*	L
Modeled Area Width*	50	*(ft)*	W
Simulation Time*	100	*(yr)*	

115 — *or* — 0.02

20 — *Value calculated by model. (Don't enter any data).*

6. SOURCE DATA

Source Thickness in Sat.Zone* 5 *(ft)*

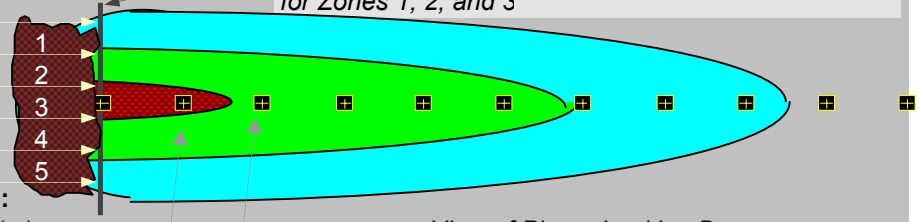
Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
50	1
0	0
0	0

Source Halflife (see Help):

Infinite	Infinite	*(yr)*
Inst. React.	1st Order	
Soluble Mass	infinite	*(Kg)*
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.0										
Dist. from Source (ft)	0	9	18	27	36	46	55	64	73	82	91

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

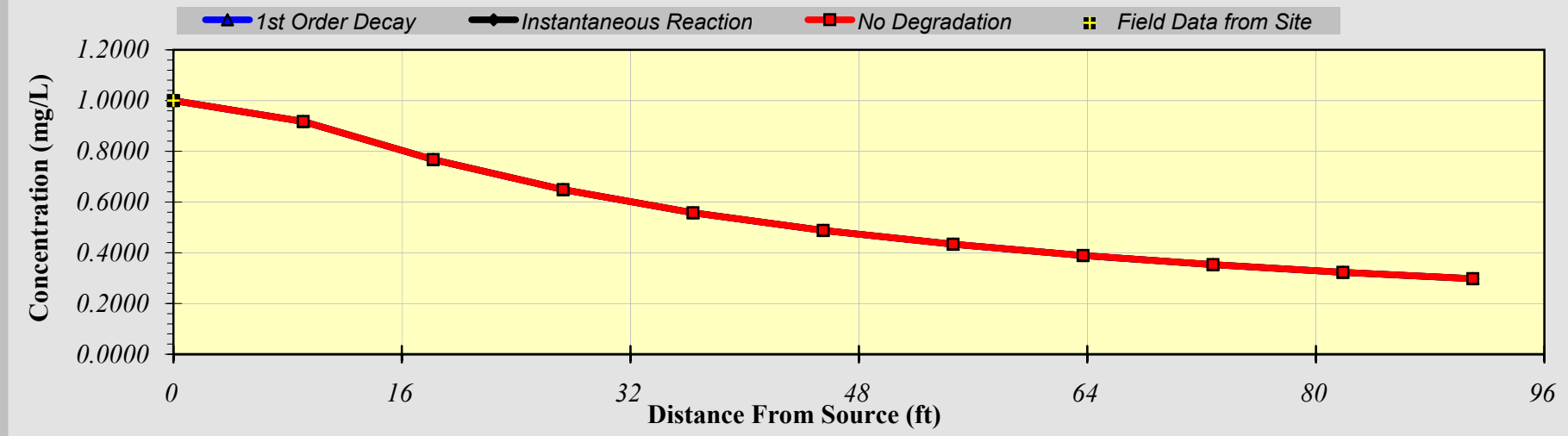
Restore Formulas for Vs, Dispersivities, R, lambda, other

BIOSCREEN Model Output for Well 10-MW03
Site 10, Treasure Island

MOLYBDENUM CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	9	18	27	36	46	55	64	73	82	91
No Degradation	1.000	0.917	0.767	0.649	0.558	0.488	0.433	0.389	0.353	0.323	0.297
1st Order Decay	1.000	0.917	0.767	0.649	0.558	0.488	0.433	0.389	0.353	0.323	0.297
Inst. Reaction	1.000	0.917	0.767	0.649	0.558	0.488	0.433	0.389	0.353	0.323	0.297
Field Data from Site	1.000										



Calculate Animation

Time: 100 Years

Return to Input

Recalculate This Sheet

APPENDIX I
HUMAN HEALTH RISK ASSESSMENT FOR INSTALLATION RESTORATION SITES 09 AND 10

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ACRONYMS AND ABBREVIATIONS

ABS	Dermal absorption factor
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
Cal/EPA	California Environmental Protection Agency
cm^2	Square centimeter
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CCSF	City and County of San Francisco
COPC	Chemical of potential concern
CRWQCB	California Regional Water Quality Control Board
CSM	Conceptual site model
CTE	Central tendency exposure
DDD	Dichlorodiphenyldichloroethane
DDT	Dichlorodiphenyltrichloroethane
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERA	Ecological Risk Assessment
HEAST	Health Effects Assessment Summary Tables
HHRA	Human health risk assessment
HI	Hazard index
HQ	Hazard quotient
ID	Identification
IR	Installation Restoration
IRIS	Integrated Risk Information System
J	Estimated (data qualifier)
LOAEL	Lowest observed adverse effect level
m^3/hr	Cubic meter per hour
mg/cm^2	Milligrams per square centimeter
mg/kg-day	Milligrams of chemical per kilogram body weight per day
mg/kg	Milligrams per kilogram
mg/m^3	Milligrams per cubic meter

ACRONYMS AND ABBREVIATIONS (Continued)

µg/L	Micrograms per liter
MVUE	Minimum variance unbiased estimator
NAVSTA TI	Naval Station Treasure Island
Navy	U.S. Department of the Navy
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	No observed adverse effect level
NDW	Nondrinking water
OEHHA	California Environmental Protection Agency Office of Environmental Health Hazard Assessment
PAH	Polycyclic aromatic hydrocarbon
PARCC	Precision, accuracy, representativeness, comparability, and completeness
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PEF	Particulate emission factor
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
QAPP	Quality assurance project plan
QA/QC	Quality assurance and quality control
QCSR	Quality control summary report
R	Rejected (data qualifier)
RAGS	Risk Assessment Guidance for Superfund
RBSL	Risk-based screening level
RfC	Reference concentration
RfD	Reference dose
RI	Remedial investigation
REL	Reference Exposure Level
RME	Reasonable maximum exposure
SF	Slope factor
SFWD	San Francisco Water Department
SVOC	Semivolatile organic compound
Tetra Tech	Tetra Tech EM Inc.
TI	Treasure Island
TPH	Total petroleum hydrocarbons

U	Undetected (data qualifier)
UCL_{95}	95th percentile upper confidence limit on the arithmetic mean
VF	Volatilization factor
VOC	Volatile organic compound
YBI	Yerba Buena Island

1.0 INTRODUCTION AND OBJECTIVES

This appendix presents the methods and the results of the baseline human health risk assessment (HHRA) conducted as part of the remedial investigation (RI) for Sites 09 and 10 at Naval Station Treasure Island (NAVSTA TI). The HHRA has been prepared in partial fulfillment of the objectives of the RI and incorporates guidance issued by the U.S. Department of Navy (Navy), U.S. Environmental Protection Agency (EPA), and California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC). Section 1.2 of the main RI text contains background information on the history of the shipyard and other operations conducted at NAVSTA TI, the physical characteristics of Treasure Island, the nature and results of large-scale environmental investigations, and the conceptual framework used to implement and document the RI. This information was used to conduct this HHRA.

HHRAs are prepared to evaluate potential health risks associated with a site under current and future land use conditions. The specific objectives of this HHRA for Sites 09 and 10 are as follows:

- Estimate the magnitude of potential human health risks associated with current and hypothetical future conditions at each site
- Identify the environmental media and contaminants that pose the primary health concerns
- Identify the environmental media and contaminants that pose little or no threat to human health
- Provide the basis to support risk management decisions about the need for further action at Sites 09 and 10

2.0 SITE DESCRIPTION AND BACKGROUND

Since the main RI report text is an integral part of this HHRA, the extensive site history documented in Section 2.1 of the main text is not repeated here; however, a brief introduction to the two IR sites discussed in this HHRA is presented in the following text.

2.1 SITE BACKGROUND SUMMARY FOR SITE 09

Site 09 comprises Building 41 (the former foundry) and the paved area immediately adjacent to the northwest, west, and south sides of the building. Site 09 is approximately 11,000 square feet in size. Building 41 has been in use since the early 1940s, including the following known operations:

- From 1943 to 1947, Building 41 was listed as a forge and foundry.

- From 1952 to 1981, Building 41 was listed as a paint shop.

- From 1981 to 1987, Building 41 was used as a welding training school by the Navy Technical Training Center.

- More recently, in 1994, Building 41 was used for small boat maintenance, mainly body work.

The Navy and its contractors believe that the outdoor areas of Site 09 have been paved for most of the building's existence. Various investigations have been completed at Site 09, as detailed in the main RI text (see Section 2.0 of the main RI report) and summarized in Section 2.3 of this HHRA appendix.

2.2 SITE BACKGROUND SUMMARY FOR SITE 10

Site 10 comprises Building 335 (the former bus painting shop) and the area immediately adjacent to the northwest, west, and south sides of the building. Site 10 is approximately 32,000 square feet in size. The surrounding area is covered primarily by pavement and bare ground, with small amounts of grass and shrubbery. Building 335 has been used for multiple operations over time, including the following:

- Mid-1940s through 1950s: Site 10 supported operations as a bus painting shop, including possible paint mixing, as well as related waste paint, thinner, and solvent handling.

- Building 335 was also reportedly used for storing, mixing, and handling pesticides, although the time period of this operation is unknown. Solution residues may have been washed from containers and application equipment in this area.

- Building 335 housed a self-service steam rack used to clean vehicles, drums, garbage cans, and related equipment. A floor drain in the building was reportedly used and connected to the storm sewer.

Various investigations have been completed at Site 10, as detailed in the main RI text (Section 2.0) and summarized in the following section of this HHRA.

2.3 SUMMARY OF PREVIOUS INVESTIGATIONS

The main RI text (see Section 2.1) details the historic investigations completed at Sites 09 and 10. The previous investigations include the following:

- Preliminary assessment (completed by the Dames and Moore Group in 1988)

- RI (completed by Tetra Tech EM Inc. [Tetra Tech] from 1993 to present)
- Environmental baseline study (conducted by the Navy in 1997)
- Additional investigation of onshore IR sites (conducted by the Navy in 2002)

Data from each of these investigations were considered, as discussed in Section 5.0 and the following sections.

3.0 RISK ASSESSMENT GUIDELINES

The following discussion summarizes the federal, state, and Navy risk assessment guidance that was incorporated into the HHRA for Sites 09 and 10. Guidance provided by EPA and DTSC are summarized in Section 3.1. Section 3.2 summarizes the Navy risk assessment guidance.

3.1 U.S. ENVIRONMENTAL PROTECTION AGENCY AND CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY DEPARTMENT OF TOXIC SUBSTANCES AND CONTROL

The methods used to conduct the HHRA for Sites 09 and 10 are based on the risk assessment framework developed by EPA and DTSC. The framework is documented in "Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)" (EPA 1989) and "Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities" (DTSC 1992). The EPA and DTSC framework consists of the following four basic steps:

- **Data Evaluation and Selection of Chemicals of Potential Concern (COPC):** This step consists of evaluating the analytical data for usability in the HHRA, grouping analytical data by site and by medium, and selecting COPCs in site media. Guiding principles were derived from various EPA documents (EPA 1992a, 2001c)
- **Exposure Assessment:** This step involves evaluating potential exposure pathways to the COPCs and human populations that might be exposed to them under current or future site conditions. Exposure point concentrations (EPC) are estimated from measured or modeled concentrations, and pathway-specific intakes (doses) are estimated using hypothetical receptors for evaluation in the subsequent risk calculations.
- **Toxicity Assessment:** This step consists of compiling toxicity values that characterize potential adverse health effects of exposure to COPCs.
- **Risk Characterization:** This step combines the results of the previous steps to quantitatively characterize potential human health risks associated with exposure to COPCs at the area under evaluation. Both potential cancer risks and hazard indices

(HI), a measure of the potential for adverse health effects other than cancer, are evaluated.

3.2 U.S. DEPARTMENT OF THE NAVY RISK ASSESSMENT GUIDANCE

This section summarizes the Navy's three-tiered risk assessment guidance and the requirement to conduct dual tracking.

3.2.1 Three-Tiered Risk Assessment Guidance

This HHRA is consistent with the Navy policy for conducting HHRAs related to the IR Program (Navy 2001). This policy presents a three-tiered approach to conducting HHRAs as follows:

- **Tier 1 – Screening Assessment.** This step involves a screening risk assessment to identify COPCs by comparing the maximum detected concentration of each chemical in each medium to an appropriate "risk-based criteria." Based on this screening, sites may be eliminated from further evaluation if concentrations of all detected chemicals are less than the risk-based criteria. Chemicals with detected concentrations exceeding risk-based criteria are retained as COPCs and evaluated in tier 2.

- **Tier 2 – Baseline HHRA.** This step is more rigorous than tier 1 and involves the quantification of adverse health effects to hypothetical human receptors.

- **Tier 3 – Evaluation of Remedial Alternatives.** This step involves the evaluation of remedial alternatives and is based on the determination of unacceptable risks. Dependent upon the results of the evaluation in tier 2, an evaluation of remedial alternatives may be initiated as part of tier 3, which may be conducted during the feasibility study.

Tiers 1 and 2 of the Navy policy are applied in this HHRA. Specifically, the HHRA for Sites 09 and 10 incorporates the tier 1 assessment into the COPC selection step, which is presented in Section 6.0. Chemicals retained as COPCs were then evaluated quantitatively in the remaining three steps of the HHRA (exposure assessment, toxicity assessment, and risk characterization), which are equivalent to the Navy tier 2 assessment.

3.2.2 Dual-Tracking Human Health Risk Assessment

To provide for a conservative estimate of potential toxic responses measured by using DTSC toxicity values, DTSC advocates use of state of California toxicity values. These California toxicity values are used in developing the "Cal-modified" preliminary remediation goals (PRG) used by Region IX. In its background document regarding the development of the Cal-modified PRGs, EPA (2002c) noted the following:

> When EPA Region IX first came out with a Draft of the PRGs table in 1992, there was concern expressed by California EPA's Department of Toxic Substances and Control (DTSC) that for some chemicals the risk-based concentrations calculated using Cal-EPA toxicity values were "significantly" more protective than the risk-based PRGs calculated by Region IX. At an interagency meeting comprised of mostly toxicologists, it was agreed that PRG values are at best order-of-magnitude estimates, so that if we assume a logarithmic scale, then a difference greater than 3.3 (½ log above or below) would be considered a significant difference. Therefore, for individual chemicals where California PRG values are significantly more protective than Region IX EPA PRGs, Cal-modified PRGs are included in the Region IX PRGs table.

The Navy subsequently adopted similar guidance, wherein consideration of DTSC toxicity values is included where significant differences exist between the DTSC and EPA Region IX toxicity value. In response to additional Navy risk assessment guidance (Navy 2002), this HHRA considered DTSC toxicity values where a Cal-modified PRG has been developed, indicating that the underlying toxicity factor was determined by EPA Region IX to be significantly more protective than the federal EPA-recommended toxicity value.

4.0 SITE REUSE PLANS FOR SITES EVALUATED IN THE HUMAN HEALTH RISK ASSESSMENT

This HHRA for Sites 09 and 10 was based on the potential for exposure of human receptors under current and expected future uses, the types of contaminants detected, and the spatial distribution of contaminants across the sites. The rationale for assessing each IR site in the HHRA is discussed in the following text:

Site 09. Site 09 (Figure I-1) is a relatively small site of approximately 11,000 square feet, or approximately 0.25 acre. Its small size allowed for reasonable evaluation of exposures across the IR site without further subdividing the IR site into smaller exposure areas. The most likely future land use for Site 09 is commercial/industrial, as detailed in Section 7.1.

Site 10. Site 10 (Figure I-2) is a relatively small site of approximately 32,000 square feet, or 0.73 acre. Its small size allowed for reasonable evaluation of exposures across the IR site without further subdividing the IR site into smaller exposure areas. The most likely future land use for Site 10 is commercial/industrial, as detailed in Section 7.1.

5.0 DATA EVALUATION

This section provides a brief summary of the methods used to collect, evaluate, and validate the data used to conduct the HHRA at Sites 09 and 10. A more detailed discussion is provided in Section 5.3.5 of the main RI report text.

5.1 DATA QUALITY

As part of the data evaluation process, all analytical data were reviewed to verify that the data met EPA data quality criteria for use in risk assessments (EPA 1992a). Samples collected during the RI were validated in accordance with EPA data validation guidelines (EPA 1994a, 1994b), described in the quality assurance project plan (QAPP) (Tetra Tech 2002). To summarize the data validation process, all analytical data were subject to a cursory review, and 10 percent of the data were fully validated. The cursory review evaluated key quality assurance and quality control (QA/QC) information such as holding times, calibration requirements, and spiking accuracy. The full validation evaluated additional QA/QC criteria and used the raw data to check calculations and analyte identifications. The overall objective of data validation was to verify that the analytical data met EPA guidelines for adequacy based on precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters. At each stage of the validation, qualifiers were assigned to the results according to EPA guidelines (1994a, 1994b), the QAPP (Tetra Tech 2002), and associated analytical methods.

The results of the data validation process are documented in a quality control summary report (QCSR) presented in Appendix E. The QCSR includes a discussion of PARCC parameters, an evaluation of how well data met PARCC parameter goals established in the QAPP, and a summary of how meeting these PARCC goals helps achieve data quality objectives for the RI. All data without qualifiers and all data qualified as estimated (J) were used in the HHRA. Data qualified as not detected (U) were incorporated into the HHRA by using a proxy concentration of one-half of the sample quantitation limit (EPA 1989). Consistent with EPA guidance, only data qualified as rejected (R) were considered unusable for risk assessment purposes (EPA 1989, 1992a).

Relative to the HHRA for Sites 09 and 10, very little data were rejected (R-qualified), except as summarized in the following sections.

5.1.1 Data Quality Issues for Site 09

At Site 09, the following soil results were rejected:

- Sample location 09-HP002 sampled at 6.5 to 7 feet below ground surface (bgs) (sample identification number [ID] 199HH004) in August 1995 had rejected results for six carcinogenic polycyclic aromatic hydrocarbons (PAH) in the semivolatile organic compound (SVOC) analytical suite. To address this, an October 2002 soil boring (09-SB16) was advanced in this location to a depth including the interval from 5 to 7.5 feet bgs. Soil boring 09-SB16 was found to be nondetect (at appropriately conservative detection limits below residential PRGs) for the following three of the previously R-qualified analytes: benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene. For the other three contaminants where results had been rejected in 1995 (benzo[ghi]perylene, dibenz[ah]anthracene, and indeno[123-cd]pyrene), estimated J-qualified concentrations were reported near the detection limit but were found to be usable for risk assessment purposes. The data reported for

09-SB16 represent the concentration at this depth where HP002 data had previously been rejected.

- Volatile results for the SW-846 Method 8260 suite in 09-SB25 sampled at 5 to 7.5 feet bgs (sample ID 30209SB25003) in November 2002 were rejected. This sampling location falls just outside of the eastern boundary of Site 09; although it is useful for nature and extent determinations discussions, it does not constitute a data gap for risks caused by exposure at Site 09 itself. Volatile organic compound (VOC) results for 09-SB23 (the nearest boring to 09-SB25 inside the Site 09 boundary) at this same depth were nondetect at appropriately conservative (that is, below residential PRG) detection limits.

None of the rejected soil data at Site 09 poses a data gap for the HHRA. In addition to the rejected soil data, two samples (for lead and selenium) in groundwater at 07/10-MW01 (sample ID 284Q1010 collected in April 2000) were rejected. As noted in Section 5.3, however, the more recent data from 2002 were the basis for the HHRA. These two rejected groundwater results had no impact on the conclusions of the HHRA for Site 09.

5.1.2 Data Quality Issues for Site 10

At Site 10, no data from soil samples were rejected. At Site 10, however, data from two groundwater sample points were rejected. Specifics follow:

- Monitoring well 07/10-MW01 (sample ID 196Q4001 collected in November 1998) results for 2-butanone and acetone were rejected. As noted in Section 5.3, however, more recent results from Site 10 (for the other wells remaining on Site 10 sampled in 2002) were used to characterize concentrations in Site 10 groundwater for the HHRA.

- Four sample IDs for 14-MW03 (which physically lies within the Site 10 boundary but was installed to be a control or upgradient well for Site 14) were rejected for various volatile parameters. All of these results were from 1995, 1998, or 2001 investigations. As noted in Section 5.3, however, more recent results from Site 10 (for the other wells remaining on Site 10 sampled in 2002) were used to characterize concentrations in Site 10 groundwater for the HHRA.

These rejected data are not believed to have any impact on the results and conclusions of the HHRA for Site 10 because groundwater is adequately represented by 10-MW02 and 10-MW03 results from 2002, as described in Section 5.3.

Tables listing the sampling location, identification numbers, and the corresponding depth intervals for each site are presented in Attachment I-1, and the soil and groundwater sampling locations are shown on Figures I-1 and I-2. Tables I-2.1 through I-2.8 provides a list of detected analytes at Sites 09 and 10, along with the following information:

- Sample size (number of analyses)

- Frequency of detection
- The minimum and maximum reported detection limits (for values below detection limits)
- The minimum and maximum detected concentrations

These statistics are presented for soil and groundwater results in tables formatted to comply with Risk Assessment Guidance for Superfund (RAGS) Part D (EPA 2001c). Analytes for which all results were reported as nondetect (U-qualified) are not listed in the tables.

5.2 SOIL DATA REDUCTION

In some cases, soil samples were collected outside of the physical IR site boundaries to ensure that nature and extent was characterized. When a sampling location fell outside of the site boundaries, however, professional judgment was used to determine whether the soil sample should be included in the present HHRA or be reserved for evaluation in a separate HHRA for the specific IR site associated with the sample.

Specifically, for Site 10, three hydropunches (one on Site 07 and two on Site 10) were installed to the west and northwest of Site 10. These sampling locations (07/10-HP004, 07/10-HP016, and 07/10HP018) were not included in the Site 10 HHRA because they will be evaluated under their own HHRAs. In contrast, samples from the hatched (discolored) area along the southeast fence line (SS-6-01, SS-6-02, SS-6-03) were included in the Site 10 HHRA because their release history is believed to be related to former Site 10 operations (see the main RI text, Section 5.2, for further details).

In addition to the data quality ensured by the validation process discussed in Section 5.3, some additional practical data reduction processes were required. Specifically, three soil sample locations were removed from the HHRA database for the reasons described in the following sections.

5.2.1 Replacement Data for Site 09

At Site 09, sample boring 09-SB03 results were averaged before the soil statistics were calculated for the HHRA because sample boring 09-SB05 was later drilled in the exact same location to verify results. The 09-SB03 results from a 1992 investigation included an estimated measurement of 947 J milligrams per kilogram (mg/kg) lead (at 1 to 1.5 feet bgs, which is just below the asphalt and gravel that covers Site 09). These results were, however, anomalous in comparison to other results from the Site 09 yard. All results from this 1992 boring were "estimated" J-qualified detections. For this data quality reason, the location was resampled in 1995.

The resampling of this location in 2002 indicated that results in the 1- to 2-foot bgs interval were 2.41 mg/kg; the maximum concentration of lead in 09-SB05 was 76.2 mg/kg in the 0.5- to 1-foot

bgs interval. The working hypothesis of the Navy and its contractors has been that either the data quality for the original result was poor or the 1992 lead result represented a flake of lead-based paint from the nearby structure on Site 09, and the high concentration measured in 1992 cannot be duplicated.

The collection of two samples from the same spatial location is problematic for subsequent spatially based statistics, such as the determination of an EPC relevant to human health risk assessment. Multiple measurements of the same spatial location gives more weight to the data characterizing that single location. To offset this, the simple mean (average) of the two borings' results was employed to represent that location in the HHRA EPC calculations for lead. The net effect of averaging the original 1992 09-SB03 lead measurement and the 2002 confirmation 09-SB05 lead measurement in the relevant interval yields an average result of 488 mg/kg. Although the use of a simple mean in this manner is in technical violation of statistical principles because averaged data should not be subsequently subjected to further statistical treatment (such as use of the Student's t-statistic or Land's method to determine a 95th percentile upper confidence limit on the arithmetic mean [UCL_{95}] for use as an EPC), this was agreed among Navy, EPA, DTSC and the RWQCB to be the most reasonable approach given the data at Site 09. The uncertainty associated with this decision is discussed further in Section 11.1.

See Section 5.1.1.5 of the main RI text for further details regarding the intended use of the 09-SB05 data and this data anomaly.

5.2.2 Replacement Data for Site 10

At Site 10, sample results from boring 10-SB03 and 07/10-HP006 were deleted before the soil statistics were calculated for the HHRA because sample boring 10-SB24 was drilled in the same location as 10-SB03, and sample boring 10-SB19 was drilled in the same location as 07/10-HP006. These new borings were installed as part of follow-up sampling to determine the extent of previously detected PAH and pesticide contamination, respectively, at those locations. See Section 5.2 of the main RI text for further details. Replacement data includes:

- Sample boring 10-SB03 reportedly contained 1 mg/kg each of fluoranthene, phenanthrene, and pyrene at a depth of 6 to 6.5 feet bgs, as well as five estimated (J-qualified) values of less than 1 mg/kg for five other PAHs. The detection limit during the 1992 investigation, when this result was recorded, was 0.8 mg/kg, which exceeds the EPA Region IX PRG. 10-SB24 was installed to attempt to get better quality (not estimated) data with better detection limits and included collection of soil from 6 to 7.5 feet bgs. These data also included low-level detection of four J-qualified PAHs but no positive detections. Because 10-SB24 attained lower detection limits (as low as 0.022 mg/kg using selected ion monitoring technology) and represents state-of-the-art (October 2002) laboratory analysis, this result is more representative than that attained in August 1992. In addition, as discussed with the BCT in March 2004, the 2002 results are more representative of present-day, baseline conditions (which may have included 10 years of biodegradation). The uncertainty

associated with the use of the 2002 result rather than the original 1992 estimated result is presented in the Uncertainty Analysis (Section 11.1.1.2).

- Sample location 07/10-HP006 was a chlordane "hot spot" in 1995 where 21 and 1.9 mg/kg alpha and gamma chlordane were detected at 3 to 4 feet bgs. While the vertical extent was believed to be delineated, trace chlordane (estimated J-qualified concentrations of 0.0009 and 0.0011 mg/kg for the alpha and gamma isomers, respectively) was detected in the deeper interval (6 to 7 feet bgs). The October 2002 installation of 10-SB19 resulted in resampling for chlordane, which indicated estimated concentrations of 0.0018 J mg/kg and 0.0026 J mg/kg for the two isomers, respectively, at a depth of 3.5 to 5 feet bgs. Dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyltrichloroethane (DDT) were also detected at estimated concentrations in this interval. All sample results (vertically above and below) this interval were nondetect at a detection limit of 0.0012 mg/kg for alpha chlordane, 0.00016 mg/kg for gamma chlordane and DDD, and 0.00018 mg/kg for DDT. In addition, 7 years of natural biodegradation may have been observed in the 2002 measurement, as compared to the 1995 result. Because the 2002 data attained much lower detection limits and are more representative of present-day baseline conditions, the 2002 results are more representative than those attained in 1995. Additional uncertainty regarding these data and pesticide risk is presented in Section 11.1.1.3.

5.2.3 Soil Data Grouping

The validated analytical data were then grouped according to IR site location and (for soil) further divided into the following two subsets, corresponding to the following depth intervals:

1. Surface soils, represented by soil samples collected from 0 to 2 feet bgs, where 2 feet represents the bottom of the sample depth interval. This data set was used to evaluate potential exposures associated with the current site configuration and future use assuming no redevelopment disturbance of subsurface soils. While a true "current" exposure does not exist to samples collected from below the pavement, all samples from 0 to 2 feet bgs were included in case future reuse results in minimal disturbance of the pavement (that is, removal of asphalt or concrete only to 2 feet bgs).

2. Surface and subsurface soils that could become surface soils in the future, represented by soil samples collected from 0 to 8 feet bgs, where 8 feet represents the bottom of the sample depth interval. This data set was used to evaluate potential exposures associated with a future intrusive redevelopment plans, including scenarios where future intrusive regrading or excavation activities could result in the redistribution of subsurface soils to the surface.

No subdivision of the relatively small IR sites was necessary because samples were adequately spaced and good coverage was achieved to characterize risks across these small areas. The rationale for these depth groupings (based on the exposure assessment) is further discussed in Section 7.3.

5.3 GROUNDWATER DATA REDUCTION

All available historic data (up to nine sampling events since 1995) from Sites 09 and 10 groundwater monitoring wells were included in the HHRA database and are reflected in the historical data range. Tables I-2.3, I-2.4, I-2.7, and I-2.8 provide the data range for groundwater at Sites 09 and 10. No hydropunch (groundwater grab sample) data were used in the HHRA because concentrations measured in samples collected with this sampling approach are not generally considered representative of aquifer conditions, particularly with regard to estimating human health risks associated with exposure to groundwater.

Although historic data provide a good summary of overall conditions, important changes to the groundwater sampling methodology were implemented during 2002. In particular, low-flow sampling was implemented to better estimate actual aquifer concentrations of both VOCs (where bailer sampling may disturb VOC concentrations and result in lower measured concentrations) and inorganic compounds (where bailer sampling may result in entrained sediments not reflective of dissolved inorganic compounds in a more natural state). In addition, the base-wide ambient study to document background concentrations of inorganic compounds was conducted with low-flow sampling techniques. To have representative and comparable data sets, therefore, the more recent (2002) groundwater data were considered most representative for the HHRA. Additional site-specific details are presented in Sections 5.3.1 and 5.3.2.

In the standard "Concentration Used for Screening" column of Tables I-2.3, I-2.4, I-2.7, and I-2.8, the highest concentration (maximum) of all site wells is shown for the October/November 2002 sampling events. The site-specific descriptions demonstrating the protectiveness and representative nature of the groundwater data reduction approach are provided in the following sections.

5.3.1 Groundwater Data Reduction for Site 09

All seven wells (09-MW01 through 0-9MW07) on Site 09 remain functional and were sampled in 2002, so the Site 09 data set is robust for fall 2002. However, 09-MW02 through 09-MW07 were newly installed wells, so the decision criteria for selecting the fall 2002 data were based solely on the trends observed in 09-MW01, as follows.

The primary class of contaminants relative to human health concerns at Site 09 (given the nondrinking water (NDW) status of the underlying shallow groundwater) is the volatile organic compounds. Volatile compounds in 09-MW01 have consistently been absent from Site 09 groundwater during the VOC analyses in 1997, 2000, and 2002. With one exception, SVOCs have also been historically absent; naphthalene appeared in October 2002 at a concentration of 0.028 J micrograms per liter (µg/L). Pesticides and polychlorinated biphenyls (PCB) have been absent from 09-MW01. Based on the new detection of naphthalene in fall 2002, this data set is the most conservative (that is, has the highest concentration) of the historic data. The only data upon which to base a trend to guide the Site 09 data selection process would be inorganic (metals) data. Inorganic data, however, are not relevant to the complete HHRA pathways at Site 09 because shallow groundwater is not a current or future potential source of drinking water; the

only potentially complete pathway would be passive volatilization through the vadose zone upward into breathing space air at the land surface.

Groundwater has been determined to have no beneficial future use at Treasure Island. Based on the San Francisco and Northern San Mateo County Pilot Beneficial Use Designation Project, groundwater at Treasure Island and Yerba Buena Island (YBI) was recommended for de-designation as a municipal and domestic supply. As a result of this recommendation, groundwater from Site 10 would not be used as a drinking water source (California Regional Water Quality Control Board [CRWQCB] 1996). Two water supply lines currently serve NAVSTA TI and YBI. The primary supply is provided by the San Francisco Water Department (SFWD), and the secondary or emergency supply is provided by the East Bay Municipal Utilities District. Historically, groundwater at Treasure Island has not been used for any purpose, and it is anticipated that the existing water supply service to Treasure Island and YBI will continue and that groundwater will not be used in the future (City and County of San Francisco [CCSF] 1996).

Because low-flow micropurge techniques were implemented in 2002, the most representative inorganic data were collected with this method. Thus, the most recent fall 2002 data set for Site 09 was found to be most representative and appropriate.

5.3.2 Groundwater Data Reduction for Site 10

By October 2002, only 10-MW02 and 10-MW03 remained on Site 10. The upgradient, control well for Site 14 that was placed on Site 10 (well 14-MW03) was destroyed some time between 1998 and 2002. Similarly, although 07/10-MW01 previously existed on Site 10, it was also destroyed or buried some time between 1998 and 2002; therefore, no results are available for these two historic wells, and current conditions were represented by wells 10-MW02 and 10-MW03.

The 2002 data from the two newer wells (10-MW02 and 10-MW03) provide a "snapshot" of likely conditions in the aquifer underlying Site 10. Unfortunately, although 10-MW03 was sampled for VOCs, SVOCs, metals, total petroleum hydrocarbons (TPH), and pesticides/PCBs, 10-MW02 was only sampled for the pesticide/PCB analytical suite in 2002; both 10-MW02 and 10-MW03 have only been sampled once, in 2002. Despite this, data from two wells are considered sufficient to characterize Site 10 groundwater conditions for three reasons. First, Site 10 is a small site; second, sampling locations are biased, near a suspected release; and third, groundwater underlying Site 10 is not a drinking water source.

Because of the latter, the only complete human health exposure pathway would be passive volatilization of groundwater contamination upward from the aquifer into breathing space air. Given the focus on the NDW volatilization pathway, the only volatiles detected in the historic wells previously located at 14-MW03 or 07/10-MW01 at Site 10 have been the following:

- At former 14-MW03, methyl-tertiary butyl ether (MTBE) was detected at concentrations of 2 µg/L in May 1998 and 4 J µg/L in November 1998. Results were

nondetect at 1 U µg/L in 2000 and 1 J µg/L in October 2001. An estimated carbon disulfide concentration (0.3 J µg/L in February 1996) was not confirmed in the subsequent seven samples collected from this well during the next six sampling events.

- At former 07/10-MW01 in the northernmost corner of Site 10, 1996 sampling showed estimated concentrations of 0.09 J µg/L tetrachloroethene (PCE) and 0.4 J µg/L carbon disulfide. Neither PCE nor carbon disulfide had been detected previously in 1995 or other 1996 sampling events (at a detection limit of 0.5 µg/L). In addition, neither PCE nor carbon disulfide was detected during subsequent 1998 sampling of 07/10-MW01.

This information, in combination with the fact that a biased sampling approach was used (that is, 10-MW03 was installed immediately adjacent to the former floor drain within Building 335 at Site 10), indicates that had a release of volatiles to groundwater occurred in the former bus painting shop, results from 10-MW03 would reflect such contamination. Thus, 2002 results from the two remaining wells provide representative characterization of volatiles in the shallow underlying groundwater.

5.4 OTHER MEDIA

Sediment samples were not collected as part of the Sites 09 and 10 RI, and all discharge to surface water issues were evaluated as part of the ecological risk assessment (ERA) (see Section 8 of the RI report). While wastewater, oil/waste, and immunoassay sampling was conducted to aid in nature and extent and waste characterization activities during the RI, none of the data is relevant to the HHRA.

Air samples were not collected as part of the site characterization of Sites 09 and 10. As discussed in Section 7.2, however, outdoor air concentrations of VOCs and particulates were modeled on the basis of soil concentrations.

A secondary medium (vadose zone soil) would usually be an intermediate source of contamination for VOCs migrating upward from the water table; however, no VOCs were identified as COPCs in groundwater (see Section 6.2) and no VOC soil COPCs were identified (see Section 6.1). Based on their absence above risk-based screening concentrations set to be protective of a one-in-a-million risk of cancer and a hazard quotient (HQ) of 1, the VOC inhalation pathways for these media were insignificant and thus did not require quantification.

6.0 IDENTIFYING CHEMICALS OF POTENTIAL CONCERN

COPCs are chemicals that are carried through the quantitative exposure and risk analysis portions of the HHRA. Soil and groundwater data from samples collected within and near the site throughout several sampling efforts were used for COPC selection. The following sections describe the COPC selection process for soil (Section 6.1) and groundwater (Section 6.2).

6.1 SOIL

COPCs represent those site-related chemicals assumed to account for the majority of any estimated health effects at a site. Consistent with EPA (1989, 2001c) and Navy (2000, 2001) guidance, the following criteria were used to identify COPCs for both IR sites for chemicals detected in soil:

- If the maximum detected chemical concentration in soil exceeded the EPA soil residential PRG (EPA 2002b), it was retained as a COPC. Residential soil PRGs account for chemical exposures associated with incidental ingestion, dermal contact, and inhalation of soil particulates and vapors. The net effect of using a risk-based screen to select COPCs (relative to "total risk" calculated for all chemicals without application of a risk-based screening level) is explored in Section 10.3.

- If an inorganic chemical is considered an essential nutrient (that is, calcium, magnesium, potassium, or sodium), it was excluded as a COPC provided maximum detected concentrations were lower than concentrations associated with adverse health effects. Section 6.1.2 explores this in more detail. Although iron may fall in the trace nutrient category, it was conservatively retained to evaluate potential risk to sensitive subpopulations with a specific iron-related metabolic disorder.

- For inorganic chemicals potentially present in ambient fill upon which Treasure Island was constructed, a further step in COPC selection (and uncertainty contributing to the risk characterization) included a statistical analysis of whether the analyte is present below the ambient levels documented at Treasure Island (PRC Environmental Management, Inc. [PRC] 1996). In the case of Sites 09 and 10, all inorganic compounds with ambient data sets from NAVSTA TI media (with the single exception of silver at Site 09) were present below their ambient levels (see Attachment I3). Although iron may be present at ambient levels, no ambient fill data set was available for iron to conduct such a statistical analysis. Arsenic was not considered significantly greater than background at either Site 09 or 10. Three samples at Site 09 were considered potential outliers, but were within the range of naturally occurring arsenic in the United States and are likely a manifestation of two different soil types from different geologic deposits (i.e., native soils and fill/dredged material). A full discussion of arsenic at Site 09 is provided in Attachment I3.

COPCs in soil and groundwater for both IR sites evaluated are summarized in RAGS Part D standard format (EPA 2001c) as Tables I-2.1 through I-2.8. A more detailed discussion of the PRGs and the methods used to conduct the ambient analysis is provided in the following text.

6.1.1 Preliminary Remediation Goals

PRGs are risk-based concentrations that correspond to a cancer risk of 1×10^{-6} or a HQ of 1, based on standardized equations that combine standard exposure assumptions and EPA toxicity values. Exposure pathways incorporated into the PRGs for soil are incidental ingestion and

inhalation of airborne particles and VOCs released from soil to ambient (outdoor) air. PRGs are currently available for a resident and an industrial/commercial worker. The residential PRG is more conservative (that is, lower) than the industrial PRG because it accounts for childhood exposures. Children are considered more sensitive to chemicals than adults. The risk estimates developed using PRGs represent the risk for all exposure pathways evaluated within the PRG framework.

Consistent with EPA (EPA 1989, 2001c) and Navy guidance (Navy 2001), compounds with maximum detected concentrations less than Region IX residential PRGs (or Cal-modified PRGs, if presented in EPA 2002b) were eliminated as COPCs for the quantitative evaluation of incremental risk. The effect of the COPC screen relative to "total risk" (including risk from all detected chemicals, regardless of whether measured concentrations are above or below PRGs) is explored in Section 10.3. A compound was considered present below screening levels and eliminated as a COPC if the maximum detected concentration was below the Region IX PRG (Tables I-2.1 through I-2.8). If the maximum detected concentration exceeded its Region IX PRG, the compound was selected as a COPC for that IR site. For those compounds where no Region IX PRG was available, a surrogate compound that had a Region IX PRG was chosen for screening purposes (see Section 8.4 for surrogate selection). The COPC selection process produced separate sets of COPCs for surface soils (0- to 2-foot bgs soil depth interval) and mixed zone soils (0- to 8-foot bgs soil depth interval) for Sites 09 and 10 to allow for risk managers to evaluate two future reuse scenarios. In the first scenario, which includes exposure to the 0- to 2-foot bgs soil depth interval, only the "surface" cover is removed and redistributed during redevelopment. In the second scenario, which includes exposure to the 0- to 8-foot bgs soil depth interval, the possibility of intrusive (including subsurface) construction activities to the water table may occur during redevelopment.

Tables I-2.1 through I-2.8 identify the compounds eliminated for each soil interval for each COPC evaluation. Iron was eliminated as a COPC for both the 0- to 2-foot bgs soil depth interval at Site 09 and the 0- to 2-foot bgs soil depth interval at Site 10 because its maxima in those surface soil data sets were below the Region IX residential PRG. Iron's maximum concentration, however, was above the Region IX PRG for Sites 09 and 10 in the deeper (2 to 8 feet bgs) soils, as shown in Table I-2.2 and I-2.6. All remaining contaminants detected in one or more samples were eliminated as COPCs because they were all below Region IX PRG screening levels; however, risk associated with analytes detected below Region IX PRGs is also presented in Section 10.3.

PAHs were detected in soil at both sites. The concentrations detected, however, were below Region IX PRGs for all PAHs with the exception of benzo(a)pyrene and dibenz(a,h)anthracene. These PAHs were retained as COPCs for both Sites 09 and 10 in the soil intervals where their maxima exceeded residential Region IX PRGs (see Tables I-2.1 through I-2.8).

TPH fractions were also detected in the soil at all depth intervals at both Sites 09 and 10. The petroleum hydrocarbons were screened against their risk-based screening levels (Table B of CRWQCB 2001) as a conservative measure. For more detail on TPH risk characterization, see Section 10.5.

6.1.2 Essential Nutrient Analysis

Guidance from EPA (1989) and the DTSC (1992) indicates that elements considered to be essential human nutrients (calcium, magnesium, potassium, and sodium) may be eliminated as COPCs if they are present at concentrations that are not associated with adverse health effects. A toxicity review indicated that the detected concentrations of calcium, magnesium, potassium, and sodium represent concentrations not associated with adverse health effects, as described in the following paragraph.

Dietary recommendations from the U.S. Food and Drug Administration for these four nutrients are identified as follows. The recommendations for calcium, magnesium, and potassium are quantities recommended to maintain a balanced diet. The daily value for sodium represents an upper limit on the intake considered desirable based on a 2,000-calorie-per-day energy intake. Ingestion of site soil at a rate of 100 mg/day would not exceed ordinary dietary intakes (see Table I-1) because the recommended daily values are substantially greater than the total amount of soil presumed to be ingested for the reasonable maximum exposure (RME) case. In addition, concentrations of these chemicals at the site are largely within the ranges of typical background concentration in U.S. soil (see Table I-1). Accordingly, these four nutrients were eliminated as COPCs in the HHRA.

EPA and DTSC also classify iron as an essential nutrient, but it was not eliminated as a COPC at this step. Iron was carried to the next step in the COPC selection process based on its presence (in the 0- to 8-foot bgs interval) at a maximum concentration above the PRG (see Section 6.1.1) developed by EPA Region IX (EPA 2002b).

6.1.3 Ambient Analysis

Site soil concentrations were considered for comparison with NAVSTA TI (PRC 1996) ambient concentrations of inorganic chemicals following Navy guidance (Navy 1998, 1999, 2000). If an inorganic chemical data set was not statistically distinguishable from ambient fill concentration based on a two-population statistical test, that chemical was excluded as a COPC, consistent with DTSC and Navy (2004) guidance. For Sites 09 and 10, all inorganic compounds with ambient data sets (with the single exception of silver at Site 09) were present below their ambient levels (see Attachment I3). Although iron may be present at ambient levels, no ambient data set was available to conduct such an analysis for iron. Details of the two-population tests and ambient comparison findings (including graphical box plots and summary statistics) are found in Attachment I3.

Arsenic was not considered significantly greater than background at either Site 09 or 10, as demonstrated in Tables I3-1 and I3-2. Three samples (09-SB10, 09-SB12, and 09-SB18) collected from the surface soil (0.5 to 2 feet below ground surface [bgs]) at Site 09 were, however, considered outliers because their concentrations were greater than the 80 percent lower confidence limit on the 95th percentile (10 milligrams per kilogram [mg/kg]) for fill material dredged from the San Francisco Bay. See Figure I3-3 for graphical representation of the Site 09

arsenic data set as compared to the ambient fill concentrations of arsenic. The three outlier concentrations of arsenic (15.4, 16.9, and 17.7 mg/kg) are considered potential outliers.

The arsenic concentrations between 15.4 to 17.7 mg/kg are well within the range of naturally occurring arsenic in the United States (1 to 100 mg/kg; Shacklette and Boerngen 1984). These higher concentrations (i.e., outliers) and lower concentrations are likely a manifestation of two different soil types from different geologic deposits (i.e., native soils and fill/dredged material). There are general correlations between arsenic, chromium, molybdenum, selenium, and vanadium, which are oxyanion-forming metals that tend to behave similarly under certain environmental conditions. This correlation further supports that the arsenic concentrations are naturally occurring, although the concentrations are still considered potential outliers for Site 09 soils.

Information relevant to the potential for release sources or preferential exposure to these three outliers was also evaluated as relevant to the human health risk assessment. These three locations with elevated arsenic are not in the same vicinity (see Figure 2-3 in the RI report); soil sample 09-SB12 is located remotely from the other two samples. A future resident or commercial/industrial worker would likely not, therefore, be exposed to these three highest concentrations of arsenic over time. This is especially true for residents who have small residential properties and are not regularly exposed to surface soil on another residential property. In addition, the spatial distribution of the three arsenic outliers at Site 09 does not indicate a source of release because a release would be expected to result in a tightly grouped area of concentrations that are more elevated and similar to one another. These three arsenic locations are not considered to be significant outliers that warrant a hot spot evaluation but were considered potential outliers of the data set. Thus, based on this weight-of-evidence evaluation, it was confirmed that the Site 09 arsenic data set was statistically below ambient fill concentrations.

6.2 GROUNDWATER

As discussed in Section 4.3.1.4 of the main RI report text, groundwater at NAVSTA TI is no longer designated as a potential municipal or domestic water supply. The RWQCB completed a Pilot Beneficial Use Designation Project for several groundwater basins in San Francisco and northern San Mateo Counties, including Treasure Island and YBI (RWQCB 1996). The report indicated that the use of groundwater for municipal and domestic supply at NAVSTA TI would be limited by (1) the small volume of fresh groundwater available, (2) the likelihood of saltwater intrusion, and (3) potential future ground improvements for stability (stone columns and dynamic compaction). Further information regarding this decision is found in Section 4.0 of the RI report.

6.2.1 Preliminary Remediation Goals and Vapor Screening Values

Since NAVSTA TI Sites 09 and 10 groundwater is not potable, the only potentially complete HHRA pathway from groundwater contamination would be the inhalation of VOCs released (via vadose zone soil transport) to outdoor and indoor air. For completeness and transparency in the HHRA process, a set of tables showing all (volatile and nonvolatile) contaminants detected in

groundwater is provided. Tables I-2.3 and I-2.7 show the detected chemicals in relation to their respective Region IX PRGs for tap water. However, as described previously, these tap water PRGs are not applicable, due to the nonpotable nature of the shallow groundwater. Even so, the only contaminant detected above a residential tap water PRG was arsenic. The subset of volatile chemicals in groundwater was subsequently screened separately in Tables I-2.4 and I-2.8 against applicable indoor air screening values, as described in the following text. For the purposes of the Sites 09 and 10 HHRA, the EPA definition of volatility (Henry's law constant greater than 1×10^{-5} atmosphere-cubic meter per mole and molecular weight less than 200 grams per mole) was adopted from EPA (1991c, 2002c).

Although outdoor air vapors also hypothetically exist over groundwater plumes, indoor air exposures are considered the most significant because vapors become more concentrated indoors. Although risk-based screening levels (RBSL) developed by the CRWQCB are available to account for the inhalation of chemical vapors while indoors (CRWQCB 2004), these values presently lack building default values recommended by federal EPA guidance (EPA 2002c). The most recent compilation of risk-based screening values for the groundwater-to-indoor air pathway was presented by EPA in November 2002 (EPA 2002c). Because they account for indoor air exposures, these vapor intrusion screening guidance values were used as COPC selection criteria when evaluating VOCs detected in groundwater at Sites 09 and 10. The values selected for screening were EPA's Table 2c (EPA 2002c) concentrations in groundwater. These values are based on a target cancer risk of 10^{-6} and a HQ of 1 for each chemical.

Thus, nonvolatile compounds with maximum detected concentrations less than tap water PRGs and volatiles with detected concentrations less than subsurface vapor intrusion guidance levels were eliminated as COPCs. A COPC was considered present below screening levels and eliminated as a COPC if the maximum detected concentration was below the Region IX tap water PRG (Tables I-2.3 and I-2.7). If the maximum detected concentration exceeded its Region IX tap water PRG, the compound was selected as a COPC. For those compounds that did not have a Region IX tap water PRG available, a surrogate compound that had a tap water PRG was chosen for screening purposes (see also Section 8.4 for surrogates used and Section 11.3.4 for uncertainty associated with this practice). For volatile compounds, if the maximum detected concentration was greater than EPA's subsurface vapor intrusion guidance risk-based level for that compound, the compound was selected as a COPC. Otherwise, it was eliminated as a COPC. The COPC selection process produced separate sets of COPCs for household use of shallow groundwater and water vapor from shallow groundwater for Sites 09 and 10 (Tables I-2.4 and I-2.8).

Arsenic was the only detected contaminant with a maximum concentration (in Site 09 or 10 shallow groundwater) present above the Region IX tap water PRG. Because no human health exposure pathway was complete for arsenic, this was not evaluated further. Ambient groundwater data are available for Treasure Island and were compared to these values as part of the ERA (see Section 8 of the RI report). All remaining contaminants detected in one or more samples were eliminated as COPCs as they were all below Region IX PRG screening levels. In addition, although a few volatile compounds were detected in both Sites 09 and 10, the

concentrations detected were below both Region IX tap water PRGs and EPA's Subsurface Vapor Intrusion Guidance (EPA 2002c) risk-based screening levels.

Petroleum hydrocarbons were also detected in the groundwater at both Sites 09 and 10. Although DTSC (1993) does not require petroleum hydrocarbon data to be evaluated in cases where data for specific chemicals, which comprise the TPH fraction, have been evaluated, petroleum hydrocarbons were screened against residential RBSLs (CRWQCB 2001) as a conservative measure. All petroleum hydrocarbons detected in the groundwater were below NDW RBSLs (see Tables I-2.3 and I-2.7).

6.3 CHEMICALS OF POTENTIAL CONCERN SUMMARY

On the basis of the above PRG and nutrient screens (and on the basis of the arsenic background discussion in Section 6.1.3.1), the following COPCs were identified for each site.

6.3.1 Chemicals of Potential Concern for Site 09

In surface soils (0 to 2 feet bgs), only benzo(a)pyrene was a COPC. For all depths combined (0 to 8 feet bgs), iron, benzo(a)pyrene, and dibenz(a,h)anthracene were COPCs. No COPCs were identified in Site 09 groundwater.

6.3.2 Chemicals of Potential Concern for Site 10

In surface soils (0 to 2 feet bgs), only dibenz(a,h)anthracene was a COPC. For all depths combined (0 to 8 feet bgs), iron, benzo(a)pyrene, and dibenz(a,h)anthracene were COPCs. No COPCs were identified in Site 10 groundwater.

7.0 EXPOSURE ASSESSMENT

The exposure assessment evaluates the nature and magnitude of potential exposures associated with the site. The assessment includes a description of the exposure setting and land use, identification of potential receptors and exposure pathways, identification of exposure points, and estimation of EPCs and chemical intakes.

The exposure assessment is anchored in the HHRA conceptual site model (CSM) (Figure I-3), with accompanying text and a RAGS Part D Standard Table 1, which is presented as Table I-1.1. Each of the components of the exposure assessment is explained in the following subsections.

7.1 EXPOSURE SETTING, LAND USE, AND POTENTIAL RECEPTORS

The RI report contains background information on the exposure setting and land use at Sites 09 and 10, including site history, geology, hydrogeology, and climate. Information from the RI was

used to develop a CSM for the HHRA, which details potential human health exposure scenarios. The HHRA CSM is presented in Figure I-3.

7.1.1 Site 09 Current and Future Exposure Setting and Potential Receptors

The following sections describe current conditions at Site 09 and potential human exposure scenarios under various potential reuse configurations.

7.1.1.1 Current Exposure Setting and Potential Receptors

Site 09, the former foundry, is covered nearly entirely with a building foundation and asphalt. The site is developed with one building (Building 41) that has concrete foundations and flooring. The thickness of the asphalt at Site 09 ranges from approximately 3 to 6 inches and was generally underlain by a layer of aggregate base gravel that ranges from 4 to 12 inches thick. The base gravel layer is underlain by sandy fill. The sandy fill consists of tan to grayish-brown, fine-to medium-grained, angular sand with some pea-size gravel. Previous subsurface investigations have shown that a clayey silt lens that ranges from approximately 0.75 to 4 feet bgs is present in the south/central region of the site, in front of Building 41.

In summary, the current land use for Site 09 is primarily inactive and vacant land. Site 09 is not currently used for any purposes that would result in exposures by human receptors to COPCs. As a result, no potential receptors are identified for the current exposure scenario. Navy subcontractors visit Site 09 infrequently to perform remedial, construction, and removal activities associated with preparing Site 09 for closure, transition, and property transfer. The site is entirely fenced in, and access to the site must be arranged through the Navy.

7.1.1.2 Future Exposure Setting and Potential Receptors

The draft NAVSTA TI reuse plan states that the proposed reuse for Site 09 is a film production area (CCSF 1996). As a result, the most likely potential future receptor is the commercial/industrial worker for the land use scenario outlined in the reuse plan. To ensure compliance with EPA guidance and in case of modifications to the reuse plan, however, hypothetical future residential redevelopment was also considered. Construction workers involved in construction and digging activities as part of the implementation of the reuse plan could be exposed to COPCs on the site. EPA guidance (EPA 1989) mandates the evaluation of a residential exposure scenario to support risk management decisions and where land uses could include residential development, including changes to the NAVSTA TI redevelopment plan. To account for potential future variances in land use from the reuse plan, the following receptors are evaluated for exposure in the HHRA: commercial/industrial workers, construction workers, and hypothetical child/adult residents.

Environmental media to which humans could feasibly be exposed at Site 09 under the various future site reuses include soil and air; no groundwater COPCs were identified in Section 6. Potential exposure pathways associated with soil and air at Site 09 are presented in Section 7.3.

7.1.2 Site 10 Current and Future Exposure Setting and Potential Receptors

The following sections describe current conditions at Site 10 and potential human exposure scenarios under various potential reuse configurations.

7.1.2.1 Current Exposure Setting and Potential Receptors

Site 10, the former bus painting shop, is currently used as a staging area for a landscaping company, including the storage of miscellaneous equipment. Structures on site consist of a building (Building 335) and several storage sheds. The building and sheds are primarily used by workers for storage. The remainder of the site is covered with gravel, grass, and small shrubbery. Access to the site is restricted by a fence and a gate that is locked at night. Potential current receptors at Site 10 are commercial/industrial workers that utilize the staging area for outdoor landscaping support functions, such as chipping wood into mulch for use on Treasure Island.

Environmental media to which humans could feasibly be exposed at Site 10 under the various future site reuses include soil and air; no groundwater COPCs were identified in Section 6. Potential exposure pathways associated with soil and air at Site 10 are presented in Section 7.3.

7.1.2.2 Future Exposure Setting and Potential Receptors

The draft NAVSTA TI reuse plan states that the proposed reuse for Site 10 is retail, restaurant, and community facilities (CCSF 1996). As a result, the most likely potential future receptor is the commercial/industrial worker, based on the future use scenarios outlined in the reuse plan. To ensure compliance with EPA guidance and in case of modifications to the reuse plan, however, hypothetical future child/adult residential redevelopment was also considered. Construction workers involved in construction and digging activities as part of the implementation of the reuse plan could be exposed to COPCs on the site. EPA guidance (EPA 1989) mandates the evaluation of a residential exposure scenario to support risk management decisions and where land uses could include residential development including changes to the NAVSTA TI redevelopment plan. Because of potential variance in land uses from the reuse plan, the following receptors are evaluated for exposure in the HHRA: commercial/industrial workers, construction workers, and hypothetical child/adult residents.

Environmental media to which humans could feasibly be exposed at Site 10 under the various future site reuses include soil and air; no groundwater COPCs were identified in Section 6. Potential exposure pathways associated with soil and air at Site 10 are presented in Section 7.3.

7.2 IDENTIFYING CURRENT AND FUTURE EXPOSURE PATHWAYS

Receptors and exposure pathways at Sites 09 and 10 were identified in Section 7.1 on the basis of several factors, including site configuration, land use, and activity patterns. The CSM depicting the exposure pathways identified for Sites 09 and 10 is presented on Figure I-3. The

routes of exposure quantitatively evaluated in this HHRA for the construction worker receptor included incidental ingestion of soil, dermal contact with soil, and inhalation of particulates from soil. Although inhalation of vapors from soil was a complete exposure pathway, no soil COPCs met the criteria for volatility (see EPA 1989, 2002c); therefore, inhalation of vapors in ambient air from soil was not assessed. Exposure pathways evaluated for the commercial/industrial worker and hypothetical resident were identical to those of the construction worker. Because no groundwater COPCs were identified in Section 6.2, no complete groundwater exposure pathways were carried through the evaluation. The following exposure pathways were quantified for all three receptors:

- Incidental ingestion of soil
- Dermal contact with soil
- Inhalation of chemicals adsorbed to windblown soils

Other potentially complete pathways were found to be insignificant, based on the COPC screen discussed in Section 6. No groundwater ingestion was evaluated for either current or future receptors based on the lack of potability of shallow saline groundwater at Sites 09 and 10 documented in Section 7.1.

Volatilization from groundwater to indoor air is considered a potentially complete pathway, but volatilization from soil to indoor air was found to be an incomplete pathway. At the RAGS Part D Table 2 stage (selection of COPCs) where it is determined whether the pathway is actually (not just conceptually) complete, the presence of a VOC in soil would be required. No VOCs were, however, present in soil at great enough concentrations to result in indoor air impacts. Specifically, the minor concentrations of infrequently detected VOCs in soil did not require quantification. For example, toluene was detected in 2 of 69 soil samples collected from the 0- to 8-foot depth interval at Site 09; the maximum concentration was estimated (J-qualified) at 0.003 mg/kg. Also, no VOCs were present in soil collected from the 0- to 8-foot depth interval at Site 10. Even if the pathway were complete, the evaluation of subsurface soil volatilization to indoor air is not recommended by the EPA "Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils" (Subsurface Vapor Intrusion Guidance) because of the "large uncertainties associated with measuring concentrations of volatile contaminants introduced during soil sampling, preservation, and chemical analysis, as well as the uncertainties associated with soil partitioning calculations" (EPA 2002c).

To initiate the RAGS Part D standardized reporting process (EPA 2001c), the "Selection of Exposure Pathways" standard Table 1 was completed for Sites 09 and 10. This table mirrors the graphical CSM (Figure I-3) and is presented as Table I-1.1.

7.3 SOIL EXPOSURE POINTS AND EXPOSURE POINT CONCENTRATIONS

Potential exposure points are identified on the basis of present and anticipated future population activity patterns and the relationship of those activities to the presence of contaminated media. A

location is identified as an exposure point if a human might ingest or have dermal contact with contaminated soil or inhale contaminated air in the present or in the future. The spatial distribution of COPC concentrations at Sites 09 and 10 was evaluated to identify possible areas of localized contamination. Because evaluation of the data indicated no particular "hot spots" requiring separate evaluation, the media-based data sets were grouped by IR site.

EPCs were calculated following EPA guidance (EPA 2002d) for a surface soil (0 to 2 feet bgs) data set and a combined surface/subsurface soils (0 to 8 feet bgs) data set. The underlying assumption in the assessment of the combined surface/subsurface soils data set is that subsurface soil may be brought to the surface during intrusive redevelopment activities (for example, removal of current structures, excavation of soil for construction of new facilities, and regrading). For all complete current exposure scenarios (Site 10 only), potential direct exposure to COPCs was evaluated using the 0 to 2 feet bgs data set because present-day land use does not entail contact with soils at depths greater than 2 feet bgs. In addition, future use entailing only limited surface disturbance (0 to 2 feet bgs) was evaluated for commercial/industrial workers at both sites.

The RAGS Part D standard Table 3 series was completed (see Tables I-3.1 through I-3.8) for the NAVSTA TI Sites 09 and 10 COPCs. Each table illustrates the distribution found to be relevant, following EPA guidance (2002d). Following the most recent guidance, UCL_{95} concentrations were calculated using distribution-dependent formulae, following Gilbert (1987) and EPA (1992b, 2002d) as described in Attachment I3.

In addition, all of the Sites 09 and 10 summary statistics (maximum/minimum values, ranges of detection limits, frequencies of detection, etc.) are presented in standard RAGS Part D format in Tables I-2.1 through I-2.8.

Arsenic was not considered significantly greater than background at either Site 09 or 10, as demonstrated in Attachment I3 in the revised draft HHRA. There were, however, three samples (09-SB10, 09-SB12, and 09-SB18) collected from the surface soil (0.5 to 2 feet bgs) at Site 09 that were considered potential outliers, as their concentrations were greater than the 80 percent lower confidence limit on the 95th percentile (10 milligrams per kilogram [mg/kg]) for fill material dredged from the Bay. The three outlier concentrations of arsenic (15.4, 16.9, and 17.7 mg/kg) are not in the same vicinity (see Figure 2-3 in the RI report); soil sample 09-SB12 would be located (even in a residential yard) remotely from the other two samples in a different exposure area. A future resident or commercial/industrial worker would likely not be exposed to these three highest concentrations of arsenic over time. This is especially true for residents who have small residential properties and are not regularly exposed to surface soil on another residential property. These three arsenic locations are not considered to be significant enough outliers to warrant a hot spot evaluation (in part because of their failure to exceed the noncancer EPA Region IX PRG). Further, the entire data set was statistically below ambient fill concentrations in a two-population test (see Attachment I3).

7.3.1 Surface Soil (0 to 2 feet below ground surface)

Site 10 may be used for commercial/industrial purposes without construction or other activities that would disturb soils, as with its present use. As a result, exposures by corresponding receptors (commercial/industrial workers) to surface soil may occur. In addition, potential future exposure to surface soil may occur for residential receptors at Sites 09 and 10. For both Sites 09 and 10, surface soil is assumed to be within 2 feet of the ground surface. Typically, surface soil is defined as the 0- to 0.5-foot bgs depth interval for risk assessment purposes; however, few surface samples were collected at Site 10 since site cover mostly consists of buildings and paved surfaces, rendering it difficult to collect a true "surface" sample. Because of the limited number of 0- to 0.5-foot bgs samples, surface samples were defined as the 0- to 2-foot bgs depth interval for this HHRA. Exposure to soils from 0 to 2 feet bgs was evaluated under the commercial/industrial and future residential land-use scenarios, and exposure point concentration terms for Sites 09 and 10 were calculated using chemical concentration data from soil samples collected between 0 and 2 feet bgs.

7.3.2 Surface and Subsurface Soil (0 to 8 feet below ground surface)

Some potential future land uses at Sites 09 and 10, including commercial/industrial or potential future residential exposure could require intrusive digging or construction of the parcel in which site soils would be excavated, disturbed, and/or redistributed. If soils below 2 feet bgs are disturbed or excavated during intrusive construction activities, exposures to soil currently deeper than 2 feet bgs could also occur. As a result of this possibility, exposures to soil between 0 feet to the maximum depth sampled (8 feet bgs) were evaluated under the future residential and commercial/industrial land-use scenarios. On the basis of Cal/EPA guidance (DTSC 1992), all soil (that is, surface and subsurface) is typically defined as the 0- to 10-foot bgs interval for risk assessments. Because samples were not collected at a depth greater than 7.75 feet bgs at these sites, however, the depth interval evaluated for Site 10 was from the bottom of the existing surface cover (concrete or asphalt or other surface) to the maximum depth sampled of 7.75 feet bgs. This is considered the 0- to 8-foot bgs interval and represents potential future surface soil, assuming intrusive redevelopment results in subsurface soil disturbance.

For all land-use scenarios at Sites 09 and 10, it was assumed that all surface cover (asphalt, existing buildings, etc.) at the site would be removed and that site soil would be exposed. Based on this assumption, several potential pathways are possible by which human receptors could be directly exposed to COPCs present in surface or subsurface soil. These potential exposure pathways for surface and subsurface soil include incidental ingestion and dermal contact as well as possible particulate inhalation (see Section 7.3.3).

The soil EPCs were calculated for each detected analyte for both an RME case and a central tendency exposure (CTE) case. The UCL_{95} was used as the soil concentration term for the RME case, and the arithmetic mean was used as the soil concentration term for the CTE case. Calculation of the UCL_{95} was based on the data-set distribution type (normal or lognormal), as described in detail in Tables I-3.1 through I-3.4 and following the protocol established in Attachment I3.

All of the Sites 09 and 10 summary statistics are presented in standard RAGS Part D format in Tables I-2.1 through I-2.8. EPCs and the basis for their calculation are presented in the standard RAGS Part D format in Tables I-3.1 through I-3.4 for the RME case (and Tables I-3.5 through I-3.8 for the CTE case).

7.3.3 Airborne Particulate

Conceptually, chemicals can be transferred to air by three mechanisms: (1) wind erosion and release of airborne particulates from soil, (2) volatilization from soil, and (3) volatilization from groundwater (Section 7.3.2). Given the physical characteristics of the Sites 09 and 10 COPCs, however, only soil particles released via wind erosion were relevant. In the absence of direct measurements of chemical concentrations in air, models were used to estimate EPCs in outdoor air as a result of these soil transfer mechanisms.

EPCs of particulates released from soil to outdoor air were estimated using the soil EPCs as the source term and methodology provided by EPA Region IX in its memorandum about the derivation of PRGs (EPA 2002b). To derive the EPCs in outdoor air, the soil EPC was multiplied by the reciprocal of the particulate emission factor (PEF), which is a nonchemical-specific value that relates chemical concentrations in soil to airborne concentrations that may be inhaled. A conservative PEF was used, assuming future unvegetated (highly erodable) soils at Sites 09 and 10, although this assumption is not reflective of current (mainly paved or otherwise covered) conditions at Sites 09 and 10.

7.4 Chemical Intake Estimates

Estimates of exposure are based on the EPCs (as described in Section 7.3) and scenario-specific assumptions and intake parameters. Consistent with EPA guidance (1995), exposure estimates (intakes) were calculated for both a CTE and an RME case for each receptor and exposure pathway at Sites 09 and 10 and are expressed in terms of milligrams of chemical per kilogram body weight per day (mg/kg-day). The RME case represents the highest exposure reasonably expected to occur at the site and is calculated using the UCL_{95} and the RME exposure parameters. The average exposure (CTE) is the most likely exposure expected to occur at the site and is calculated using the mean concentration and CTE exposure parameters. For the purposes of this HHRA, only health effects associated with the (EPA-based) RME scenario are presented in the main text. CTE health effects are presented in Attachment I-2.

EPA-derived exposure algorithms were used to estimate the chemical intakes for each route of exposure. Equation 7-1 is a generic equation for calculating chemical intake as follows (EPA 1989):

$$I = \frac{C \times CR \times EF \times ED}{BW \times AT} \qquad (7\text{-}1)$$

where

I	=	Intake: the amount of chemical at the exchange boundary (mg/kg-day)
C	=	Chemical concentration: the EPC (for example, mg/kg for soil)
CR	=	Contact rate: the amount of contaminated medium contacted per unit of time or event; may be the ingestion rate, inhalation rate, or dermal contact rate (for example, mg/day for the ingestion rate of soil)
EF	=	Exposure frequency: how often the exposure occurs (days/year)
ED	=	Exposure duration: the number of years in which a receptor comes in contact with the contaminated medium (years)
BW	=	Body weight: the average body weight of the receptor over the exposure period (kilograms)
AT	=	Averaging time: the period over which exposure is averaged (days); for carcinogens, the averaging time is 25,550 days on the basis of a lifetime exposure of 70 years (average life expectancy), and for noncarcinogens, the averaging time is equal to the exposure duration multiplied by the number of days in a year (365 days)

Pathway-specific variations of Equation 7-1 were used to calculate intakes of COPCs. The exposure parameters common to all equations are discussed in Section 7.4.1, and pathway-specific equations and exposure parameters are discussed in Section 7.4.2.

7.4.1 General Exposure Assumptions

The exposure parameter values used in the intake equations are based on a series of reported and assumed factors related to current and potential land use patterns at Sites 09 and 10. Exposure parameters also account for a number of physiological factors, such as daily breathing rate and surface area of exposed skin. Exposure parameters common to all intake equations are the exposure time, exposure frequency, exposure duration, body weight, and averaging time. Each of these parameters is discussed in detail in the following text.

7.4.1.1 Exposure Time, Frequency, and Duration

The three parameters (exposure time, exposure frequency, and exposure duration) together define the total extent of exposure of a receptor. The exposure time is the number of hours per day (or hours per event) during which a receptor is present at a specific exposure point; it is used only to describe the inhalation pathway. The exposure times for the RME and the CTE cases were 8 hours per day for the commercial/industrial worker (EPA 1991a; DTSC 1992) and the construction worker (EPA 1991a). The exposure times for the RME and CTE cases for the child and adult resident were assumed to be 24 hours per day (EPA 1991a; DTSC 1992).

The exposure frequency is the number of days per year (or events per year) during which exposure occurs. The exposure frequencies for both the RME and CTE cases were 350 days per year for both the child and adult resident (EPA 1991a; DTSC 1992). The exposure frequency of 250 days per year for the commercial/industrial worker (EPA 1991a; DTSC 1992) was assumed to correspond to the number of workdays in a year. The CTE case incorporated 219 days per year as a more "average" estimate of days spent at a work site, including 31 days per year allowed for sick leave, holidays, extended vacation or family leave, and off-site work duties such as training or other off-site work-related activities. For the construction worker, an exposure frequency of 250 days per year was used for the RME case (EPA 1991a), and a period of 90 days per year was used for the CTE case. The value of 90 days per year is based on professional judgment, considering typical construction practices. That is, most construction work is completed by several subcontractors performing specific tasks (for example, the foundation and excavation contractor, the concrete crew, and the framing contractor). Even within those tasks, different individuals would perform specialized subtasks (for example, the concrete forming crew and the finishing crew). Workers would generally be present at a site for limited time periods while performing specific tasks. The one notable exception is the general contractor. The general contractor would not typically be involved in the high soil contact activities evaluated for the "construction worker," however, and the potential exposures of a general contractor are expected to be more similar to those of the commercial/industrial worker.

The exposure duration is the total number of years over which exposure occurs. For the RME case, the exposure durations were 30 years for the resident (EPA 1991a; DTSC 1992), 25 years for the commercial/industrial worker (EPA 1991a; DTSC 1992), and 1 year for the construction worker (DTSC 2000). For the CTE case, the exposure durations were 9 years for the resident (EPA 1989), 4.5 years for the commercial/industrial worker (U.S. Department of Commerce 1994), and 1 year for the construction worker (DTSC 2000).

7.4.1.2 Body Weight

Consistent with EPA and DTSC guidance (EPA 1991a; DTSC 1992), a default body weight of 70 kilograms was used for all adult receptors, and 15 kilograms was used for the child receptor.

7.4.1.3 Averaging Time

The averaging time for addressing adverse noncancer health effects is equal to the exposure duration (in years) times 365 days per year, as recommended by EPA (1989). The averaging time for cancer risk estimation is the number of days in a 70-year lifetime or 25,550 days, as recommended by EPA (1989). That cancer risk averaging time is used to be consistent with the basis for slope factors (SF). SFs are discussed in Section 8.0.

7.4.2 Pathway-Specific Exposure Factors

This section summarizes the exposure factors unique to each of the exposure pathways quantified in this HHRA and are summarized in RAGS Part D standard "Values Used for Daily Intake" tables (Tables I-4.1 and I-4.2).

7.4.2.1 Exposure Parameters and Equation for Inhalation of Particulate

Individuals may be exposed to COPCs in air by inhaling chemicals in vapor phase or sorbed to particulates. At NAVSTA TI Sites 09 and 10, no volatile COPCs were identified and thus, the inhalation pathway was potentially complete and significant only for particulate inhalation. The only exposure parameter specific to the assessment of the inhalation pathway is the inhalation rate.

The inhalation rate used to estimate an inhaled dose or intake for a given chemical is dependent on the activity level of the potential receptor. An RME inhalation rate of 0.42 and 0.83 cubic meters per hour (m^3/hr) was used to evaluate the child and adult resident, respectively (EPA 1991a). The default value of 2.5 m^3/hr (assuming heavy activity, where 20 m^3 is inhaled during the workday) was used for the RME inhalation rates of the commercial/industrial and construction workers (EPA 1991a; DTSC 1992).

The CTE inhalation rate was 0.35 and 0.55 m^3/hr for the child and adult resident, respectively (from Table 5-23 of EPA 1997b). For the commercial/industrial worker, 1.3 m^3/hr or 10.4 m^3/workday is the value recommended by EPA for outdoor workers engaged in medium or moderate activities (from Table 5-23 of EPA 1997b). The inhalation rate for the commercial/industrial worker was also used for the CTE construction worker. The exposure parameters for inhalation of airborne particulates released from soil are summarized in Table I-4.1 (RME) and Table I-4.2 (CTE). The intake equations for this pathway are presented in the last column of each table; the tables follow this appendix text.

7.4.2.2 Exposure Parameters and Equation for Incidental Ingestion of Soil

Individuals may be exposed to COPCs in soil by inadvertently ingesting contaminated soil. The intake (applied dose) is estimated as the amount of chemical at the exchange boundary (gastrointestinal tract). The exposure parameters specific to the ingestion of soil pathway are the soil ingestion rate and the fraction of the ingested soil assumed to be contaminated.

An estimated soil ingestion rate for the RME case for the child and adult resident is 200 and 100 mg/day, respectively, given children's mouthing habits, which are assumed to result in greater incidental soil intakes during the preschool years (EPA 1991a). For the workers, default soil ingestion rates were used for the RME case: 100 mg/day for the commercial/industrial worker and 330 mg/day for the construction worker (EPA 1991a; EPA 2001a). All RME factors are presented in Table I-4.1.

For the CTE case, ingestion rates of 100 and 50 mg/day were used to evaluate the child and adult residents, respectively, based on professional judgment in consultation with the *Exposure Factors Handbook* (EPA 1997b). In the absence of information that supports derivation of a CTE value for the commercial/industrial worker, the RME value of 50 mg/day was used for the CTE case (EPA 1991a). A value of 100 mg/day was used for the construction worker (EPA 1997b). All CTE factors are presented in Table I-4.2.

The term "fraction ingested" is used to account for the fraction of soil contacted that is assumed contaminated. For this HHRA, all soil contacted is conservatively assumed to be contaminated (that is, the fraction ingested was set equal to 1).

7.4.2.3 Exposure Parameters and Equation for Dermal Contact with Soil

Individuals may be exposed to COPCs in soil by direct contact with the skin. For the dermal pathway, the intake is estimated as an absorbed dose, which is the amount of chemical that crosses the skin, enters the body, and passes into the bloodstream. (The absorbed dose is in contrast to an applied dose, which is used to estimate intake for all other exposure routes.) The exposure parameters specific to the assessment of the dermal pathway are the skin surface area (the amount of skin in contact with soil), the amount of soil adhering to the skin (adherence factor), and the chemical-specific dermal absorption fraction (ABS) (that is, the fraction of chemical in contact with the skin that actually crosses the skin barrier). ABS values are given in Table I-2.

Receptor-specific values for the dermal adherence factor for the RME case were provided by EPA (2001b): 0.2 and 0.07 milligrams per square centimeter (mg/cm^2) for the child and adult residents, respectively; 0.2 mg/cm^2 for the commercial/industrial worker; and 0.3 mg/cm^2 for the construction worker. The RME values were also used for the CTE case in the absence of information that supports the derivation of separate values for the CTE case. Where RAGS Part E made a recommendation (such as using 0.02 mg/cm^2 for the CTE case for the commercial/industrial worker), those values were adopted. Please see Table I-4.1 (RME) and Table I-4.2 (CTE) for soil dermal parameter values.

Values for body surface area for the RME case were taken from the most recent EPA supplemental guidance to RAGS for dermal assessment (RAGS Part E, EPA 2001b): 2,800 and 5,700 square centimeter (cm^2) for child and adult residents, respectively, and 3,300 cm^2 for commercial/industrial and construction workers. The value for these adult receptors assumes an exposed head (1,200 cm^2), forearms (1,200 cm^2), and hands (900 cm^2). A body surface area of 3,300 cm^2 for the commercial/industrial and construction workers (EPA 2001b) was also used for the CTE case.

Chemical-specific dermal absorption factors are presented in Table I-2, and the exposure parameters for the dermal contact with soil pathway are presented in Tables I-4.1 (RME) and I-4.2 (CTE). The intake equation for this pathway is presented in each of the standard RAGS Part D Tables (Tables I-4.1 and I-4.2) in accordance with EPA guidance (EPA 2001c).

8.0 TOXICITY ASSESSMENT

The toxicity assessment identifies the reference doses (RfD) and SFs used to evaluate adverse noncancer health effects and cancer risks. The major toxicological effects associated with the COPCs are also presented. The RfDs and SFs are discussed in Sections 8.1 and 8.2, and special considerations regarding route-to-route extrapolations, surrogate selection, and lead are

discussed in Sections 8.3 through 8.5, respectively. The following were the sources of toxicity values used for the EPA-based HHRA:

- EPA's Integrated Risk Information System (IRIS). IRIS is an on-line database that contains EPA-approved RfDs and SFs (EPA 2002b). The RfDs and SFs have undergone extensive review and are recognized as high-quality, agency-wide consensus information. Values current as of May 2003 were verified in IRIS (EPA 2003).

- National Center for Environmental Assessment (NCEA) provisional values, which continue to be used as of October 2002 in Region IX (as cited by EPA [2002b]).

- EPA's Health Effects Assessment Summary Tables (HEAST) (EPA 1997a)

Consistent with Navy (2002) guidance on dual tracking, DTSC (Cal/EPA) toxicity values were used only if a value 4 times more conservative (that is, either at least four 4 times less [for noncancer effects] or 4 times greater [for cancer effects]) than the corresponding EPA toxicity value (Navy 2002) was available[1]. Possible sources of toxicity values used to conduct the DTSC-based HHRA were as follows:

- Cal/EPA Office of Environmental Health Hazard Assessment on-line database, "California Cancer Potency Factors: Update" (OEHHA 2002). This memorandum provides a compilation of SFs developed or approved by offices and departments within Cal/EPA. Among the COPCs at Sites 09 and 10 was dibenz(a,h)anthracene, which has an "expedited" cancer potency value (OEHHA 1992).

- Reference exposure levels (REL) available from OEHHA (1997). The Air Toxicology and Epidemiology Section within Cal/EPA develops and publishes RELs. RELs are health-based exposure levels for characterization of risk from air emissions.

No California-specific cancer or noncancer toxicity values were available for iron. No California-specific noncancer toxicity values were available for the two PAH COPCs, benzo(a)pyrene or dibenz(a,h)anthracene (OEHHA 1997); however, OEHHA cancer toxicity values were available, as discussed in the following text.

OEHHA uses an oral SF of 12 per mg/kg-day for benzo(a)pyrene and an inhalation SF of 3.9 per mg/kg-day. OEHHA uses an oral and inhalation SF of 4.1 per mg/kg-day for dibenz(a,h)-anthracene, which is an "expedited" cancer potency value (OEHHA 1992). In contrast, the federal EPA recommends oral SFs of 7.3 per mg/kg-day for both benzo(a)pyrene and dibenz(a,h)anthracene; during this risk assessment, these federal EPA oral SFs were route-to-route extrapolated (see Section 8.3) for use as inhalation toxicity SFs as well. Because these OEHHA SFs were not significantly (at least 4 times) different (as defined by Navy [2002]), no

[1] Navy guidance on the dual tracking of both federal and state toxicity values has since changed, but Navy (2002) guidance was in effect at the time this HHRA was first drafted.

COPCs at Sites 09 and 10 required a separate DTSC-based assessment[1]. The toxicity values from the previously identified EPA sources are presented in standard RAGS Part D format "Toxicity Data" tables (Tables I-5.1 through I-6.2) and are discussed in the following sections.

8.1 REFERENCE DOSES

The potential for adverse noncancer health effects to result from exposure to chemicals was characterized by comparing an exposure estimate (intake) with an RfD. EPA (1989, 2003) defines an RfD as an estimate (with uncertainty that spans perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects. The RfDs are expressed as mg/kg-day and are specific to the chemical, exposure route (for example, ingestion or inhalation), and exposure duration (chronic or subchronic). The sources of RfDs used in the HHRA for Sites 09 and 10 (in order of preference) were IRIS, NCEA, and HEAST (EPA 2003, 1997a), as described and cited in Section 8.0. This approach is adopted by EPA Region IX as their hierarchy for developing PRGs.

EPA derives RfDs to assess oral exposures and reference concentrations (RfC) to assess exposure via inhalation and publishes these values and supporting information in IRIS (EPA 2002b) and HEAST (EPA 1997a). The RfCs are concentrations in air expressed as milligrams per cubic meter (mg/m^3) and were converted to RfDs using the following equation:

$$RfD = \frac{RfC \times IR}{BW} \qquad (8\text{-}1)$$

where

RfD	=	Reference dose (mg/kg-day)
RfC	=	Reference concentration (mg/m^3)
IR	=	Inhalation rate assumption (20 m^3/day)
BW	=	Body weight assumption (70 kilograms)

Consistent with DTSC guidance (1992), oral RfDs were used to assess dermal exposure in the absence of route-specific dermal RfDs. Chronic RfDs are developed for evaluating exposures that occur over periods of more than 7 years, and subchronic RfDs are for exposures of less than 7 years. Although the potential exposures considered in this risk assessment are for periods of from 1 to 30 years, chronic RfDs were used to evaluate both chronic and subchronic exposures. Few subchronic RfDs were available, and the use of only one set of RfDs simplified the analysis. Using chronic RfDs results in more conservative estimates of potential hazard, but because the site and incremental HIs at Sites 09 and 10 were well below levels of concern for all receptors evaluated, the use of chronic RfDs did not affect the interpretation or conclusions of the assessment.

RfDs and RfCs are derived by EPA work groups. The EPA work groups review all relevant human and animal studies for each chemical and select the study (or studies) pertinent to the derivation of the specific RfD. RfDs are often derived from a measured or estimated no observed adverse effect level (NOAEL). The NOAEL corresponds to the dose, in mg/kg-day, that can be administered without inducing observable adverse effects. If a NOAEL cannot be determined, the lowest observed adverse effect level (LOAEL) is used. The LOAEL corresponds to the lowest daily dose administered that induces an observable adverse effect. The toxic effect characterized by the LOAEL is referred to as the "critical effect."

NOAELs are most often based on data from experimental studies in animals. Both the experimental parameters and the extrapolation of animal data to humans are potential sources of uncertainty; therefore, in deriving an RfD, the NOAEL or LOAEL is divided by uncertainty factors to ensure that the RfD will be protective of human health. The uncertainty factors usually occur in multiples of 10, and each factor represents a specific area of uncertainty inherent in the extrapolation from available data. Uncertainty factors account for the following:

- Extrapolation of data from animals to humans (interspecies extrapolation)
- Variation in human sensitivity to the toxic effects of a compound (intraspecies' differences)
- Derivation of a chronic RfD based on a subchronic rather than a chronic study
- Derivation of an RfD based on a LOAEL rather than a NOAEL

Modifying factors between 0 and 10 may also be applied to accommodate other factors or additional uncertainty associated with the data. For most compounds, the modifying factor is 1. The chronic RfDs used for Sites 09 and 10 are presented in Table I-5.1 and I-5.2.

8.2 SLOPE FACTORS

The toxicity information considered in the assessment of potential cancer risks includes a weight-of-evidence classification and a SF. The weight-of-evidence classification qualitatively describes the likelihood that a chemical is a human carcinogen and is based on an evaluation of the available data from human and animal studies. Chemicals evaluated by EPA since the publication of the 1996 cancer guidelines, "Proposed Guidelines for Carcinogen Risk Assessment" (EPA 1996), are evaluated using a weight-of-evidence narrative and one of the following descriptors for classifying potential carcinogenicity to humans: "known/likely," "cannot be determined," and "not likely." Chemicals evaluated by EPA before the publication of the 1996 guidelines were evaluated in accordance with the 1986 guidelines (EPA 1986). These chemicals were classified using an alphanumeric system in which the chemical was assigned to one of five groups: Group A, a known human carcinogen; Groups B1 and B2, a probable human carcinogen; and Group C, a possible human carcinogen. Chemicals that could not be classified as human carcinogens because of lack of data were categorized in Group D, and chemicals for which there was evidence of noncarcinogenicity in humans were categorized in Group E.

An SF is an upperbound estimate, approximating a 95 percent upper confidence limit on the increased cancer risk from lifetime exposure to a chemical (EPA 1989). The SFs used to assess cancer risk were obtained from IRIS (EPA 2003) and OEHHA (2002).

Similar to RfDs, SFs are specific to the chemical and route of exposure and are available for oral and inhalation exposures. EPA typically publishes inhalation unit risks instead of inhalation SFs. The unit risks were converted to inhalation SFs using the following equation:

$$SF = \frac{UR \times BW \times UCF}{IR} \quad (8\text{-}3)$$

where

SF	=	Slope factor $(mg/kg\text{-}d)^{-1}$
UR	=	Unit risk (micrograms per cubic meter)
BW	=	Body weight assumption (70 kilograms)
UCF	=	Unit conversion factor (1,000 micrograms per milligram)
IR	=	Inhalation rate assumption (20 m^3/day)

As with RfDs, oral SFs were used to estimate cancer risks for exposures via the dermal route if no dermal SF was available; however, surrogate chemicals were not used to characterize cancer potency. The SFs used in this assessment are presented in Table I-6.1 and I-6.2.

8.3 ROUTE-TO-ROUTE EXTRAPOLATION

Toxicity values are available for only one route of exposure (that is, for only the inhalation or the oral exposure route) for some chemicals. In some of these cases, route-to-route extrapolations were conducted so that toxicity values developed for one route of exposure (for example, the oral route) were applied to another (for example, the inhalation route). This approach assumes that toxicity is identical regardless of the route of exposure. Route-to-route extrapolations are recommended for organic analytes by the State of California (DTSC 1992) and are used by EPA Region IX to develop PRGs (EPA 2002b).

As previously mentioned, oral RfDs and SFs were used to quantify effects associated with dermal exposures for all COPCs because dermal toxicity values have not been developed. Route-to-route extrapolations were also used for organic COPCs in the following cases:

- If an organic oral toxicity value (RfD or SF) but no inhalation toxicity value was available, the oral toxicity value was also used as the inhalation toxicity value.
- If an organic inhalation toxicity value but no oral toxicity value was available, the inhalation toxicity value was also used as the oral toxicity value.

Such route-to-route extrapolations were not used for metals because their toxicological endpoints are heavily dependent on the exposure route (EPA 2002b). Route-to-route extrapolations for organic compounds and other exceptions to the RfDs and SFs used in the HHRA are denoted with an "R" (for route extrapolated) in Tables I-5.1 through I-6.2.

In addition, the dermal pathway was evaluated using oral toxicity values adjusted for oral absorption efficiencies where appropriate (EPA 2001b; Navy 2001). For iron, the oral absorption efficiency was 100 percent, and no conversion was applied to the oral RfD to adjust for dermal exposure. For the PAH COPCs, the oral SF values were divided by chemical-specific absorption factor (0.89) to transform administered doses into absorbed doses for dermal contact (see Tables I-5.1 and I-6.1).

8.4 SURROGATES

Because of a lack of EPA Region IX PRGs for screening chemicals to identify COPCs, surrogate chemicals were chosen for the following chemicals based upon structural similarity to avoid data gaps:

- Pyrene was used as a surrogate to represent phenanthrene and benzo(g,h,i)perylene, which have no EPA Region IX PRG or chemical-specific toxicity factors. Pyrene was chosen as a surrogate chemical for phenanthrene because of the similar structure; phenanthrene is a three-ringed PAH, and pyrene is a four-ringed PAH. The three-ringed PAH pyrene was chosen as the surrogate chemical for the six-ringed PAH benzo(g,h,i)perylene because it was the closest surrogate with a noncarcinogenic endpoint. Other PAHs that were more structurally similar to benzo(g,h,i)perylene (for example, indeno(1,2,3-cd)pyrene) were not considered because they had carcinogenic endpoints and because EPA toxicity information on benzo(g,h,i)perylene was insufficient to classify the chemical as a carcinogen.

- Total chromium toxicity values and PRGs were chosen to represent all chromium detected at Sites 09 and 10. Because hexavalent chromium was analyzed in soils but found to be nondetect in all samples (see Section 11.3.1 as well as discussion below), this surrogate is considered appropriately conservative.

- Many pesticide analogs did not have their own PRGs, but the following detected pesticides were structurally similar to other pesticides in their class. Endosulfan's PRG was used to screen detected endosulfan sulfate; endrin was used to screen endrin aldehyde and endrin ketone; technical chlordane was used to screen both gamma- and alpha-chlordane; and DDT was used to screen DDE.

Although the selection and use of surrogates for PRG screening is not ideal, the surrogates selected for use in the COPC screening process were all very closely structurally related to the contaminants they were chosen to represent. A lack of a PRG would otherwise remain a data gap. The degree of uncertainty contributed by the use of surrogates in this manner is addressed in the uncertainty section (see Section 11.3.3).

Hexavalent chromium was evaluated at Sites 09 and 10 because historical operations (for example, painting and metal work) are associated with the use of hexavalent chromium. Six soil samples were collected from Sites 09 and 10 (three at each site) and analyzed for trivalent and hexavalent chromium. Although trivalent chromium was detected in all six samples, hexavalent chromium was not detected in any of the samples (see Table I-3). The reporting limits for the nondetect hexavalent chromium samples (0.05 mg/kg) were significantly less than the EPA Region IX PRG for residential exposure (30 mg/kg), so reporting limits were determined to be adequate for this evaluation. Although hexavalent chromium was not detected at either Site 09 or 10, chromium was evaluated as "total chromium" in the HHRA. Total chromium is assumed to comprise a one-to-six ratio of hexavalent chromium, the most toxic form of chromium, to trivalent chromium, a less toxic form of chromium. The effect of using total chromium in the HHRA was conservative (that is, overly protective) but had no net effect on the results of the risk assessment as chromium concentrations were determined to be significantly less than background. Chromium was not included in the forward risk characterization.

8.5 LEAD

No consensus-based toxicity values are available for lead, which is a contaminant of particular toxicological concern wherever child receptors and other sensitive subpopulations may come into contact with lead-contaminated media. The potential for human health effects caused by lead is typically estimated on the basis of blood-lead concentrations. Mathematical models have been developed to estimate blood-lead levels on the basis of total lead uptake from exposures by diet, drinking water, air, and soil. Based on these models, the maximum detected concentrations for lead in soils were compared against the EPA Region IX residential PRG of 400 mg/kg (EPA 2002b). These comparisons are shown (for soil) in the RAGS Part D standard COPC selection tables (Tables I-2.1, I-2.2, I-2.5, and I-2.6). The standard RAGS Part D EPC tables (Tables I-3.1 through I.3-4) show that the lead EPCs for Sites 09 and 10 would all be below both the 400 mg/kg residential PRG as well as below the Cal-modified residential PRG of 150 mg/kg.

In addition, Attachment I3 found that lead concentrations at both Sites 09 and 10 are below the ambient fill concentrations upon which Treasure Island was based. The findings related to lead are thus presented in Section 11.4, which also discusses the Cal-modified residential PRG of 150 mg/kg.

9.0 RISK CHARACTERIZATION

The final step in the HHRA is the characterization of the potential risks associated with exposure to chemicals detected at a site. Noncancer health hazards and cancer risks are characterized separately. The general methodology for estimating HIs and cancer risks is presented in Section 7 of the main RI report text as well as in Sections 9.1 and 9.2. As indicated previously in Section 8.5, lead is evaluated separately, as described in Section 10.3. The risk characterization results are then presented in Section 10.0.

9.1 CHARACTERIZATION OF NONCANCER HAZARDS

For chemicals that are not classified as carcinogens and for those carcinogens known to cause adverse health effects other than cancer, the potential for exposure to result in adverse health effects other than cancer is evaluated by comparing the intake with an RfD. When calculated for a single chemical, the comparison yields a ratio termed the HQ:

$$Hazard\ Quotient = \frac{Intake\ (mg/kg\text{-}day)}{RfD\ (mg/kg\text{-}day)} \quad (9\text{-}1)$$

To evaluate the potential for adverse health effects other than cancer from simultaneous exposure to multiple chemicals, the HQs for all chemicals are summed, yielding an HI as follows:

$$Hazard\ Index = \sum HQ \quad (9\text{-}2)$$

Pathway-specific HIs are then summed to estimate a total HI for each receptor identified at a site. If the total HI exceeded 1.0, further evaluation in the form of a segregation of HI analysis may be performed to determine whether the noncancer HIs are a concern at a site (EPA 1989). In the case of the Sites 09 and 10 HHRA, the only noncancer hazards were associated with exposure to a single COPC (iron), so no target organ segregation was needed.

9.2 CHARACTERIZATION OF CANCER RISKS

Risks associated with exposure to chemicals classified as carcinogens are estimated as the incremental probability that an individual will develop cancer over a lifetime as a direct result of an exposure (EPA 1989). The estimated risk is expressed as a unitless probability.

To aid in the interpretation of the results of the risk assessment, EPA guidance on exposure levels considered protective of human health is presented. In the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), EPA defined general remedial action goals for sites on the National Priorities List (Title 40 of the *Code of Federal Regulations* Part 300.430). The goals include a range for residual carcinogenic risk, which is "an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}," or 1 in 10,000 to 1 in 1,000,000. The goals set out in the NCP are applied once a decision to remediate a site has been made. A more recent EPA directive (EPA 1991b) provides additional guidance on the role of the HHRA in supporting risk management decisions, and in particular, determining whether remedial action is necessary at a site. Specifically, the guidance states, “Where cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the noncancer HQ is less than 1, action generally is not warranted unless there are adverse environmental impacts.” EPA Region IX has stated, however, that action may be taken to address risks between 10^{-4} and 10^{-6}. For that reason, the range between 10^{-4} and 10^{-6} is referred to as the "risk management range" in this HHRA. Risks and health hazards discussed in the text and main tables of the RI report and the HHRA appendix are limited to one significant

figure, as recommended by RAGS Part A (EPA 1989). To enable checks for mathematical accuracy to additional decimals, however, the tables of Appendix I include results beyond the single significant figure.

For chemicals classified as carcinogens, three steps are used in estimating cancer risks. First, to derive a cancer risk estimate for a single chemical and pathway, the chemical intake is multiplied by the chemical-specific SF. The calculation is based on the following relationship:

$$\textit{Chemical-Specific Cancer Risk} = \textit{Intake (mg/kg-day)} \times \textit{SF (mg/kg-day)}^{-1} \quad (9\text{-}3)$$

Second, to estimate the cancer risk associated with exposure to multiple carcinogens for a single exposure pathway, the individual chemical cancer risks are assumed to be additive, as follows:

$$\textit{Pathway-Specific Cancer Risk} = \sum \textit{Chemical-Specific Cancer Risk} \quad (9\text{-}4)$$

Third, pathway-specific risks are summed to estimate the total cancer risk.

10.0 RESULTS OF THE HUMAN HEALTH RISK ASSESSMENT

This section summarizes the results of the HHRA conducted for Sites 09 and 10 at NAVSTA TI. The HHRA included statistical analysis of soil data sets, selection of COPCs, exposure assessment, and risk characterization. Based on expected uses of Sites 09 and 10, a hypothetical resident, commercial/industrial worker, and a construction worker were all evaluated. Although residences are not expected on Sites 09 or 10 (Section 7.0), potential effects were quantified for both child and adult resident receptors in the case of a planned future reuse revision.

As indicated previously in Section 8.0, both RME and CTE cases were estimated using EPA toxicity values. Only the results associated with the RME HHRA are presented and discussed in this section (see Tables I-7.1.1.RME through I-10.2.5.RME). The results of the CTE case are presented in Attachment I2. As indicated in Section 7.0 (Exposure Assessment), the following receptors were evaluated for both sites:

- Future on-site commercial/industrial worker
- Future on-site construction worker
- Future on-site resident

A current commercial/industrial worker was evaluated at Site 10, based on its current use. Cancer risks and noncancer adverse health effects are summarized for each site in the following text and are summarized in formal RAGS Part D-required tables.

As noted in Section 9, risks and health hazards discussed in the text and main tables of the RI report and the HHRA appendix are limited to one significant figure, as recommended by RAGS

Part A (EPA 1989). To enable checks for mathematical accuracy to additional decimals, however, the tables of Appendix I include results beyond the single significant figure.

10.1 SITE 09

Consistent with the exposure assessment (Section 7.0), both current and future exposures were evaluated for plausible receptors in Site 09.

10.1.1 Future Site Conditions Assuming Minimal Disturbance (Exposure to 0 to 2 Feet of Soil)

No current cancer or noncancer risks were projected for Site 09, as no current use of the property exists. Risks were calculated for a future on-site commercial/industrial worker and adult/child resident based on the assumption that future site configurations and redevelopment would disturb soils only to a depth of 2 feet bgs, such as with only simple removal of all existing asphalt and other ground cover.

Benzo(a)pyrene was the only constituent evaluated quantitatively as a COPC because all other constituents fell below EPA Region IX PRGs (see Section 6.1.1). Risks were assessed for the inhalation, dermal, and ingestion pathways.

The total cancer risk probability for all combined surface soil (0 to 2 feet bgs) exposures for an on-site industrial worker would be 5×10^{-7}, which is below the agency target cancer risk level "brightline" of 10^{-6}. Consistent with the method EPA Region IX uses to develop soil PRGs for benzo(a)pyrene, no noncancer hazards were estimated because no noncancer toxicity values are available for this chemical (EPA 2003).

The total cancer risk probability for all combined surface soil (0 to 2 feet bgs) exposures for an on-site adult/child resident would be 2×10^{-6}, which is slightly greater than the agency target cancer risk level "brightline" of 10^{-6}. Consistent with the method EPA Region IX uses to develop soil PRGs for benzo(a)pyrene, no noncancer hazards were estimated because no noncancer toxicity values are available for this chemical (EPA 2003).

10.1.2 Future Site Conditions Assuming Intrusive Redevelopment (Exposure to 0 to 8 Feet of Soil)

For the more likely future redevelopment conditions, both cancer and noncancer risks were calculated for a construction worker, commercial/industrial worker, and adult/child residents based on the assumption that any significant redevelopment will include disturbance of soils at depths of 0 to 8 feet bgs. This intrusive scenario would also involve the removal of all existing asphalt and ground cover.

Under the more intrusive future redevelopment scenario, benzo(a)pyrene and dibenz(a,h)-anthracene were the COPCs evaluated quantitatively for cancer effects for exposure via the

dermal, ingestion, and inhalation pathways. Iron was also evaluated for noncancer effects through the ingestion pathway; iron has no recommended provisional inhalation toxicity reference criterion (NCEA 1999) and is not evaluated for dermal uptake from soil (EPA 2001b, 2002b). Risks were calculated as follows if future redevelopment were to occur at Site 09:

- Construction worker cancer risk of 1×10^{-7} is predicted, and a noncancer hazard of 0.1 is predicted. Both of these risks are acceptable because they are below the EPA risk target risk level of 10^{-6} and the acceptable HI of 1.

- A future commercial/industrial worker cancer risk of 1×10^{-6} is predicted, and a noncancer hazard of 0.04 is predicted. This predicted hazard falls below the acceptable HI of 1, and the calculated risk falls within the EPA risk management range of 10^{-6} to 10^{-4}.

Although unlikely, if future intrusive redevelopment as a residential area were to occur and involve redistribution of presently subsurface soil media to 8 feet bgs at Site 09, a future resident HI of 0.5 was predicted, which is below the acceptable HI of 1. The estimated cancer risk probability for a future resident (combination adult and child) is 4×10^{-6}, which falls within the EPA risk management range (between 10^{-6} and 10^{-4}). Only the incidental ingestion of soil exposure pathway for a hypothetical future child resident exceeded a cancer risk probability of 10^{-6} with a risk of 2×10^{-6}.

10.2 SITE 10

Consistent with the exposure assessment (Section 7.0), both current and future exposures were evaluated for plausible receptors at Site 10.

10.2.1 Current and Future Site Conditions Assuming Minimal Disturbance (Exposure to 0 to 2 Feet of Soil)

Some current use of Site 10 exists, so present-day exposures may be expected to result from surface soils (0 to 2 feet bgs). In addition, a future on-site commercial/industrial workers and adult/child residents may be exposed to soils up to 2 feet bgs if future site redevelopment disturbs soils only to a depth of 2 feet, such as with only simple removal of all existing asphalt and other ground cover. The construction worker was evaluated in Section 10.2.2 because the future Site 10 reuse resulting in exposure to this receptor is more likely to involve more intrusive redevelopment, including soils at 2 to 8 feet bgs.

Dibenz(a,h)anthracene was the only COPC identified in this depth interval (see Section 6.1.1). Risks were assessed for the inhalation, dermal, and ingestion pathways. The estimated cancer risk for the current on-site commercial/industrial worker is 3×10^{-7}, which is acceptable because it is below the EPA target risk level of 10^{-6}. Consistent with the method EPA Region IX uses to develop soil PRGs for dibenz(a,h)anthracene, no noncancer hazards were estimated because no noncancer toxicity values are available for this chemical (EPA 2003).

Dibenz(a,h)anthracene was the only COPC identified in this depth interval (see Section 6.1.1). Risks were assessed for the inhalation, dermal, and ingestion pathways. The estimated cancer risk for the future on-site adult/child resident is 2×10^{-6}, which is slightly greater than the EPA target risk level of 10^{-6}. Consistent with the method EPA Region IX uses to develop soil PRGs for dibenz(a,h)anthracene, no noncancer hazards were estimated because no noncancer toxicity values are available for this chemical (EPA 2003).

10.2.2 Future Site Conditions Assuming Intrusive Redevelopment (Exposure to 0 to 8 Feet of Soil)

For future conditions, both cancer and noncancer risks were calculated for a construction worker, commercial/industrial worker, and resident. The same assumption presented in Section 10.1.2 for Site 09 also applies to Site 10: any redevelopment will include disturbance of soils at depths of 0 to 8 feet bgs. Under this more intrusive future redevelopment scenario, benzo(a)pyrene and dibenz(a,h)anthracene were evaluated quantitatively through exposure via the dermal, ingestion, and inhalation pathways. Iron was also evaluated for noncancer effects through the ingestion pathway; iron has no recommended provisional inhalation toxicity reference criterion (NCEA 1999) and is not evaluated for dermal uptake from soil (EPA 2001b, 2002b). Risks were calculated as follows, if future redevelopment were to occur at Site 10:

- A construction worker cancer risk of 1×10^{-7} is predicted, and a noncancer hazard of 0.2 is predicted. Both of these risks are acceptable because they are below the acceptable cancer risk "brightline" of 10^{-6} as well as the hazard index of unity.

- A future commercial/industrial worker cancer risk of 1×10^{-6} is predicted, and a noncancer hazard of 0.05 is predicted. No individual constituents or exposure pathways yielded a cancer risk probability in excess of 10^{-6}; risks fell within the risk management range of 10^{-6} to 10^{-4}.

Although unlikely, if future intrusive redevelopment as a residential area were to occur and involve redistribution of presently subsurface soil media to 8 feet bgs at Site 10, a future resident HI of 0.6 was predicted, which is below unity. The estimated cancer risk probability for a future resident (combination adult and child) is 5×10^{-6}, which is in excess of the target risk level "brightline" of 10^{-6}. The calculated risk falls within the EPA risk management range of 10^{-6} to 10^{-4}. Only the incidental ingestion of soil exposure pathway for both hypothetical future adult and child resident exceeded a cancer risk probability of 10^{-6} with values of 1×10^{-6} and 2×10^{-6}, respectively.

10.3 "TOTAL RISK" VERSUS "INCREMENTAL RISK"

DTSC has voiced an interest in insuring that "total risk" (with no risk-based screen, such that all detected analytes above ambient concentrations were included in the risk assessment) be communicated in addition to the incremental risk. To effectively communicate these differences and continue to follow Navy (2001) guidance that implements a risk-based screening step, the

following "total risk" screening was conducted. Because no COPCs were identified in groundwater based on the methodology presented in Section 6.2, the analysis focused on soil.

In this process, all detected contaminants in soils were evaluated, and the EPC was screened relative to its residential and industrial PRGs. Effectively, this screening is a "shortcut" (suggested in the Navy tiered guidance [Navy 2001]) that still presents enough information to ensure that human health risks are not being underpredicted by use of a risk-based PRG screen to identify COPCs. Findings of this approach are presented as follows.

10.3.1 "Total Risk" Based on Site 09 Soil

The "Total Risk" evaluation assumed that a resident lived on Site 09 and was exposed to the EPC of every chemical detected in Site 09 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 3×10^{-5} and noncancer hazard of 2 would result (see Table I-4). Note that the ambient fill contribution (cancer risk of 2×10^{-5} and noncancer hazard of 0.9) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that a resident lived on Site 09 and was exposed to the EPC of every chemical detected in all Site 09 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 2×10^{-5} and noncancer hazard of 1 would result (see Table I-5). Note that the ambient fill contribution (cancer risk of 1×10^{-5} and noncancer hazard of 0.6) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

The "Total Risk" evaluation assumed that a commercial/industrial worker at Site 09 was exposed to the EPC of every chemical detected in Site 09 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 7×10^{-6} and noncancer hazard of 0.1 would result (see Table I-4). Note that the ambient fill contribution (cancer risk of 6×10^{-6} and noncancer hazard of 0.08) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1 Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that a commercial/industrial worker at Site 09 was exposed to all Site 09 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 5×10^{-6} and noncancer hazard of 0.1 would result (see Table I-5). Note that the ambient fill contribution (cancer risk of 3×10^{-6} and noncancer hazard of 0.05) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

Arsenic was not considered significantly greater than background at Site 09. Three samples (15.4, 16.9, and 17.7 mg/kg) at Site 09 were considered potential outliers, but were within the range of naturally occurring arsenic in the United States and are likely a manifestation of two different soil types from different geologic deposits (i.e., native soils and fill/dredged material). A full discussion of arsenic at Site 09 is provided in Attachment I3.

The results associated with the "Total Risk" evaluation would not change the conclusions of the HHRA presented in Section 10.1.

10.3.2 "Total Risk" Based on Site 10 Soil

The "Total Risk" evaluation assumed that a resident lived on Site 10 and was exposed to the EPC of every chemical detected in Site 10 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 2×10^{-5} and noncancer hazard of 2 would result (see Table I-6). Note that the ambient fill contribution (cancer risk of 2×10^{-5} and noncancer hazard of 0.8) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that same resident lived on Site 10 and was exposed to the EPC of every chemical detected in all Site 10 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 2×10^{-5} and noncancer hazard of 2 would result (see Table I-7). Note that the ambient fill contribution (cancer risk of 2×10^{-5} and noncancer hazard of 0.9) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

The "Total Risk" evaluation assumed that a commercial/industrial worker at Site 10 was exposed to the EPC of every chemical detected in Site 10 surface soils (0 to 2 feet bgs) by all the same pathways inherent in the PRG calculation. If this scenario occurred, a cancer risk of 5×10^{-6} and noncancer hazard of 0.1 would result (see Table I-6). Note that the ambient fill contribution (cancer risk of 4×10^{-6} and noncancer hazard of 0.07) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1. Similarly, the "Total Risk" evaluation for residential exposure to subsurface soils assumed that same commercial/industrial worker at Site 10 was exposed to all Site 10 soils (0 to 8 feet bgs). If this scenario occurred, a cancer risk of 6×10^{-6} and noncancer hazard of 0.1 would result (see Table I-7). Note that the ambient fill contribution (cancer risk of 4×10^{-6} and noncancer hazard of 0.08) is a significant portion of the "Total Risk". Also, based upon a target organ speciation of the largest HQs, no target organ HI exceeds 1.

The results associated with the "Total Risk" evaluation would not change the conclusions of the HHRA presented in Section 10.1.

10.4 TOTAL PETROLEUM HYDROCARBONS AND HUMAN HEALTH RISK

Evaluation of TPH is not required for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) assessments in California where the chemical-specific indicator compounds are already assessed (DTSC 1993); however, TPH data were screened against available NDW risk-based screening levels. No concentrations in surface soils (0 to 2 feet bgs) at Site 09 exceeded conservative CRWQCB RBSLs for nondiscrete TPH in soils overlying a NDW aquifer. In the 2- to 8-foot bgs range at Site 09, however, samples exceeded the residential soil RBSL (Table B of CRWQCB 2001). The TPH result maxima (both obtained from the same location, 09-HP002) were qualified as "JY," indicating these were estimated concentrations that

do not resemble the quantitated fuel; therefore, the identification of the subsurface fuel concentration maxima was uncertain.

When NDW is concerned, these screening levels are based on factors both based on human health (assuming that all nondiscrete TPH is pyrene) as well as potential for migration to surface water (including impact to ecological receptors) and nuisance criteria. In CERCLA and other contaminated site assessments in California (DTSC 1993), however, nondiscrete TPH risks are calculated by analyzing for the most toxic TPH components. For lighter-end gasoline range petroleum fractions, these constituents include benzene, toluene, ethylbenzene, and xylene (BTEX). For heavier-end range petroleum fractions (diesel-range and motor oil-range TPH), these constituents are PAHs. Because these more toxic TPH constituents were analyzed and already assessed in the risk assessment, no cumulative risk assessment addressing the less toxic, nondiscrete TPH is presented.

11.0 UNCERTAINTY EVALUATION

Some uncertainties are inherent in the estimates of potential cancer risk and noncancer health hazard presented in this document. The uncertainties fall into two categories, including uncertainties associated with the general risk assessment methodologies and uncertainties uniquely associated with this HHRA. The following subsections present information related to these uncertainties.

11.1 DATA EVALUATION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

To identify COPCs for the HHRA, the adequacy of site characterization data was reviewed, and a structured selection process was employed. The uncertainties associated with these two components of COPC selection are discussed in the following sections.

11.1.1 Site Characterization Data

The risk assessment is based on analytical data presented in the RI. Each of the strengths and weaknesses associated with the data is then carried through to the risk assessment. Fortunately, the very small (0.25-acre and 0.73-acre, respectively) sizes of Sites 09 and 10 and the appropriate if somewhat limited (for example, groundwater data collected for Site 10) number of samples collected from site media indicate that sufficient data are available to detect human health risks. As with any small data set, uncertainty is associated with the data and subsequently characterized risks. Since groundwater is not a source of drinking water and VOCs were not detected for intrusion to overlying indoor air, the impact of the small data set on protection of human health is negligible, as no complete human health exposure pathways exist.

11.1.1.1 Lead at Site 09

As discussed in Section 5.2.1, a 2002 boring was installed to verify or refute anomalous lead results. This assessment evaluated use of an average of the two results (as suggested by

regulators) rather than only adopting the 2002 data over the other (see Section 10.4). Use of an average concentration (rather than choosing between the old data or relying on the new data) does not change the conclusion that site-wide concentrations fall below the EPA Region IX residential PRG of 400 mg/kg, as well as the Cal-modified PRG of 150 mg/kg.

11.1.1.2 Polycyclic Aromatic Hydrocarbons at Site 10

As discussed in Section 5.2.2, a 2002 boring was installed to improve the data quality objectives (that is, detection limit capabilities) to assess PAH concentrations. Replacement 2002 data was thus used in the calculation of the Site 10 PAH EPCs for benzo(a)pyrene and dibenz(a,h)anthracene, as better detection limits resulted. This is an improvement in data quality as well as a measure to avoid double-counting results from the same location. Since better quality data were used, the use of replacement data improved the uncertainty associated with the assessment, rather than using J-qualified (estimated) values or proxy values (such as half the detection limit) for nondetected PAHs.

In addition, 10 years of natural degradation have occurred, and although there were detections of the smaller (lower molecular weight), noncarcinogenic PAHs in 1992, these have largely attenuated. The carcinogenic analytes benzo(a)anthracene, benzo(a)pyrene, benzo(b)-fluoranthene, and benzo(k)fluoranthene were not detected in the sample collected in 2002. Further, benzo(g,h,i)perylene was detected in 2002, whereas it was not in 1992. The use of the 1992 data set over the 2002 data set would, therefore, have a negligible impact on the final risk characterization, and the PAH EPC calculation did not include 1992 results from this boring.

11.1.1.3 Pesticides at Site 10

As discussed in Section 5.2.2, a 2002 boring was installed to improve the data quality objectives (that is, detection limit capabilities) to assess pesticide concentrations. Replacement 2002 data were thus used in the COPC screen for Site 10. This is an improvement in data quality as well as a measure to avoid double-counting results from the same location. Since better quality data were used, the use of replacement data improved the uncertainty associated with the assessment.

Historic data would not be reflective of present-day, baseline conditions as it disregards 7 years of biodegradation. Use of historic data would not change the risk characterization significantly (see results comparison in Table I-9) relative to the residential PRG for chlordane (1.6 mg/kg). Also, the half-life of chlordane in soil is 350 days (OSU 1994). The reduced concentrations measured in 2002 reflect 7 years of biodegradation. The use of the 1995 data set over the 2002 would have a negligible impact on the final risk characterization and would likely overestimate risks associated with exposure to baseline (present-day) concentrations of chlordane in soil.

11.1.2 Methods Used to Identify Chemicals of Potential Concern

The primary uncertainty associated with the COPC selection process is the possibility that a chemical may be inappropriately identified as a COPC for evaluation in the risk assessment (that

is, a detected chemical may be inappropriately excluded or included as a COPC). For the HHRA, chemicals were excluded as COPCs using the following criteria:

- Essential nutrients detected at concentrations typical of U.S. background levels
- Chemicals in soils with a maximum detected concentration below the residential PRG for soil
- VOCs in groundwater detected below appropriate EPA screening levels (EPA 2002c)
- Presence of an inorganic chemical statistically below ambient levels in NAVSTA TI ambient fill (following the protocol in Attachment I3)

None of these criteria is likely to significantly underestimate risks. A semiquantitative assessment of the impact of a "no screen" HHRA is presented for soil in Section 10.3. This discussion concluded that no risk drivers were excluded from the HHRA and that the conclusions of the HHRA (presented in Sections 10.1 and 10.2) would not change had the COPC screen not been followed in accordance with Navy (2001) guidance. The impact of the ambient (background) screen is explored in Section 11.4 below, per Navy (2004) guidance.

11.2 EXPOSURE ASSESSMENT

Uncertainties were identified in association with four areas of the exposure assessment process: (1) the selection of exposure scenarios, (2) the selection of exposure pathways, (3) the estimation of EPCs, and (4) the selection of exposure variables used to estimate chemical intake. Uncertainties in each of these areas are discussed in Section 11.2.1 through 11.2.4.

11.2.1 Exposure Scenarios

Exposure scenarios were identified based on observed and assumed land use and activity that may occur there. To the degree that actual land use and activity patterns are not represented by those assumed, uncertainties are introduced. Exposure estimates developed under the future redeveloped land use scenarios (commercial/industrial) may conservatively overestimate risks if the properties are not reused for such purposes as presently planned. In addition, even under current conditions, actual exposures are not likely to approach those assumed in the current commercial/industrial worker scenario, given that only less-than-continuous use of Site 10 presently exists.

11.2.2 Selecting Exposure Pathways

The exposure pathways quantified in this risk assessment were identified on the basis of the area conceptual model, relevant site characterization data, and contaminant fate and transport considerations. To the extent that these factors may not accurately predict the migration of contaminants within and from the area, uncertainty is introduced into the exposure assessment.

Volatilization from groundwater to indoor air was considered a potentially complete pathway, but volatilization from soil to indoor air was not considered a complete pathway. The likelihood that potential risks are underestimated is negligible because VOC concentrations in soil and groundwater were very low (that is, below respective screening criteria).

Ingestion of homegrown produce was considered an incomplete pathway. The likelihood that potential risks are underestimated are negligible because (1) the 1996 planned reuse indicates receptors are unlikely to spend significant time at the site; (2) all inorganics (except silver) are below ambient fill concentrations (see Attachment I3); and (3) the only surface soil COPCs were large molecular weight PAHs that are fairly insoluble in water, which inhibits uptake and thus makes these COPCs likely to accumulate in hypothetical produce.

11.2.3 Estimating Exposure Point Concentrations

The sample collection strategy was designed as a purposive investigation, whereby samples were collected in areas of suspected or known contamination. The primary objective of this sampling effort was to define the nature and extent of contamination. The EPCs based on these nonrandom soil samples are likely to overestimate the concentrations at the exposure point as well as the actual dose to the receptor.

11.2.4 Selecting Exposure Variables

The exposure variables used to estimate chemical intake are standard upperbound estimates. In reality, however, there may be considerable variation in the activity patterns and physiological response of individuals. It is possible that the exposure variables used in this evaluation do not represent actual future exposure conditions.

At the same time, the exposure parameters used in the HHRA for Sites 09 and 10 were standard "default" exposure parameters for workers and residents; the only pathway requiring "professional judgment" was the construction worker. Because the defaults were generally used, this HHRA is expected to be comparable to others conducted within Region IX and California. All defaults are expected to err on the conservative side, rather than underpredicting unforeseen human health risks.

11.3 TOXICITY ASSESSMENT

The primary uncertainties associated with the toxicity assessment are related to derivation of toxicity values for COPCs. Standard RfDs and SFs developed by EPA were used to estimate potential cancer and noncancer health effects from exposure to COPCs at the site. These values are derived by applying conservative (health-protective) assumptions and are intended to protect the most sensitive potentially exposed individuals.

To derive the toxicity values, EPA makes several assumptions that tend to overestimate the actual hazard or risk to human health. Because data from human studies are generally

unavailable, the RfDs are typically derived from animal studies. Uncertainty factors and modifying factors are then applied to the data from animal studies to ensure that the RfDs are adequately protective of human health. For many compounds, this approach is anticipated to result in an overestimated potential for noncancer adverse health effects.

Derivation of SFs used to estimate cancer risk is also typically based on data from animal studies. These data are taken from studies in which high doses of a test chemical were administered to laboratory animals, and the reported response is extrapolated to the much lower doses to which humans are likely to be subjected. Very little experimental data are available on the nature of the dose-response relationship at low doses (for example, a threshold may exist or the dose-response curve may pass through the origin). Because of this uncertainty, EPA has selected a conservative model to estimate the low-dose relationship, and EPA uses an upperbound estimate (typically a 95 percent upper confidence limit of the slope predicted by the extrapolation model) as the SF. With this SF, an upperbound estimate of potential cancer risks is obtained.

A second uncertainty associated with toxicity values is the unavailability of RfDs or SFs for all COPCs at a site. The cancer risks and noncancer health hazards can be assessed only for those COPCs for which the relevant toxicity values are available. For organic COPCs for which a SF or an RfD was available for only one route of exposure, route-to-route extrapolations were made. These extrapolations will introduce some uncertainty into the risk and hazard estimates. Further, the use of oral toxicity values to assess the dermal pathway introduces additional uncertainty into the results; risks may be overestimated or underestimated using this approach. Risks may be underestimated for exposure to the PAH COPCs, for which no RfD was available.

In addition to the uncertainties associated with derivation and availability of toxicity values, the toxicity assessment is affected by chemical-specific factors, as described in the following subsections.

11.3.1 Chromium Speciation

Selection of the appropriate toxicity value for chromium depends on the chemical species of chromium encountered; hexavalent chromium is a potent carcinogen (by the inhalation route only), whereas trivalent chromium is not. Chromium occurs in nature primarily in the trivalent form, which is its most stable oxidation state. Hexavalent chromium is easily transformed to trivalent chromium in reducing environments such as those found in acidic soil or soil that contains iron or dissolved sulfides. At Sites 09 and 10, hexavalent chromium was analyzed in three samples from each site and detected in none (at a detection limit of 0.05 mg/kg). As a result, all detected chromium at Sites 09 and 10 were evaluated as total chromium, an appropriately conservative approach. The Region IX PRG for total chromium, which assumes that one sixth of the total chromium result comprises hexavalent chromium instead of all trivalent chromium, was applied to screen maximum site concentrations in the COPC selection. As a result, chromium risks may have been slightly overestimated.

11.3.2 Surrogates for Total Petroleum Hydrocarbons

BTEX and PAHs were all independently quantified as surrogates for the assessment of potential risk and hazards associated with TPH. The assessment of TPH was thus dependent upon the adequacy of the BTEX and PAH analytical data. Most samples were analyzed for BTEX, and the analytical results are expected to give an adequate representation of the health risks associated with potential exposure to TPH as gasoline. Greater uncertainty is associated with use of the PAH data because the number of analyses was limited. The magnitude of the uncertainties in the TPH assessment was assumed to be a function of the spatial distribution of TPH as diesel and motor oil contamination, relative to the distribution of the samples analyzed for PAHs.

In general, however, it is generally accepted (DTSC 1993) that assessment of the target compounds (BTEX and PAHs) adequately describes human health risks at Superfund sites. This approach is not likely to significantly underestimate human health risks.

11.3.3 Surrogates for Preliminary Remediation Goals Screening

While the selection and use of surrogates for PRG screening is not ideal, the surrogates selected for use in the COPC screening process were all very closely structurally related to the contaminants they were chosen to represent. A lack of a PRG would otherwise remain a data gap. The degree of uncertainty contributed by the use of surrogates in this manner is unknown but is not expected to result in underestimates of risk.

11.4 RISK CHARACTERIZATION

Standard EPA methodologies were used for the risk characterization step. Using these methods, the risks from exposure to multiple carcinogens were added to estimate the total cancer risk associated with exposures at a site. The underlying assumption with this approach is that the risks from carcinogens with different target organs are additive. This assumption contributes to the uncertainty in the risk assessment and may result in underestimated or overestimated risks, depending on whether there are synergistic or antagonistic interactions between the site COPCs. Because information on such interactions, however, is generally not available, most possible interactions were not evaluated in this HHRA. The target organ-specific analyses may be conducted if additive effects contributed to HIs greater than unity; however, for Sites 09 and 10, no unacceptable HIs were found, so no target organ breakdown was necessary.

11.4.1 Health Effects Associated with Analytes Below Background

In accordance with DTSC guidance, inorganic chemicals below ambient concentrations need not be selected as COPCs. In response to Navy (2004) guidance, risk associated with the inorganic chemicals detected at Sites 09 and 10 is presented separately for risk management information only. Risks predicted for exposure to the ambient fill that Treasure Island was built upon are not incremental risks related to Navy operations at NAVSTA TI.

As risks for inorganic compounds below background are presented in the "total risk" tables (Tables I-4 through I-7), no separate tables were prepared. Because of its high carcinogenic potency, arsenic was the main background risk driver for both Sites 09 and 10. Tables I-4 through I-7 list estimates of the contribution of inorganic compounds in ambient fill at Treasure Island.

Arsenic was not considered significantly greater than background at Site 09. Three samples (15.4, 16.9, and 17.7 mg/kg) at Site 09 were considered potential outliers, but were within the range of naturally occurring arsenic in the United States and are likely a manifestation of two different soil types from different geologic deposits (i.e., native soils and fill/dredged material). A full discussion of arsenic at Site 09 is provided in Attachment I3.

There is some uncertainty associated with conducting background evaluations as the Wilcoxon Rank Sum and Gehan-Wilcoxon tests are insensitive to the magnitude of values in the tails of the distribution. The arsenic evaluation for Site 09 provides an example of the insensitivity. The three potential outliers with concentrations of 15.4, 16.9, and 17.7 mg/kg are ranked 1, 2, and 3 in the pooled ambient and site population. This ranking and the outcome of the statistical test would be the same if the concentrations were 154 mg/kg, 169 mg/kg, and 177 mg/kg or even if the concentrations were 154,000 mg/kg, 169,000 mg/kg, and 177,000 mg/kg. Although there is some uncertainty associated with these nonparametric tests, potential outliers were identified to facilitate risk management decisions.

11.4.2 Health Effects Associated with Exposure to Lead

As noted in Section 8.5, the health effects associated with exposure to lead are unique in nature, and thus, the potential risk from lead exposure is not included in the traditional characterization of health effects associated with inorganic analytes. Lead was confirmed to be below ambient fill concentrations, however, and the site-wide EPCs calculated for lead (as described in Section 7.3) were all below both the EPA Region IX residential PRG (400 mg/kg) and the Cal-modified residential PRG of 150 mg/kg. Tables I-3.1 through I-3.4 illustrate these EPCs. No blood-lead modeling was necessary for either Site 09 or 10, therefore, by virtue of the fact that the soil EPCs were orders of magnitude below a concentration that could trigger unacceptable blood lead concentrations given that shallow groundwater at NAVSTA TI is NDW. The single lead-contaminated medium (soil) could thus not trigger a blood lead risk because it is below the concentration (150 mg/kg) that Cal-EPA calculated as protective of residents, including children.

11.4.3 Total Risk and Incremental Risk Characterization

Total risk and incremental risk were presented in the risk characterization (see Section 10). The incremental risk evaluation used a COPC screen and background evaluation to identify a select list of analytes for the incremental risk evaluation. The incremental risk evaluation was conducted using exposure parameters and equations from EPA guidance (EPA 1989, 2001b, 2001c). The total risk evaluation included all detected analytes and was conducted via a comparison to EPA Region 9 PRGs (EPA 2002b). Effectively, this screening is a "shortcut" (suggested in the Navy tiered guidance [Navy 2001]) that still presents enough information to

ensure that human health risks are not being underpredicted by use of a risk-based PRG screen to identify COPCs. The EPA Region 9 PRGs are based upon standard default exposure parameters, which may differ from those used in the incremental risk evaluation. Because the exposure parameters from the two risk evaluations differ, the incremental and total risk estimates are similar, but not exactly the same. This leads to uncertainty because the total and incremental risks estimates are not directly comparable. Nevertheless, both the total and incremental risk evaluations can be used to evaluate potential risks to receptors at the site.

11.5 UNCERTAINTY SUMMARY

The overall magnitude of each uncertainty discussed previously is summarized in Table I-10.

This HHRA was developed based upon a series of assumptions, almost all conservative, that are expected to yield an overestimate of risks. Even considering a few uncertainties contributing to a small underestimate of risk, the compounding conservatism in the HHRA process is expected to negate the assumptions that may lead to underestimating risks.

12.0 REFERENCES

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TABLES

TABLE I-1: RANGES OF ANALYTES CONSIDERED ESSENTIAL NUTRIENTS

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Analyte	Concentration Ranges			Dietary Reference Value (mg/day)	Type of Value	Source
	Site 09 (mg/kg)	Site 10 (mg/kg)	California [a] (mg/kg)			
Calcium	1,260 to 17,700	2,470 J to 23,100 J	2,451 to 45,577	1,000	RDI	FDA
Magnesium	1,830 to 8,130	2,660 to 9,360	1,456 to 32,378	400	RDI	FDA
Potassium	463 J to 2,130	421 J to 1,420	2,100 to 30,000	3,500	DV	CFR
Sodium	49.9 to 684	99.3 J to 730	5,580 to 73,400	2,400	DV	FDA

Notes:

a	Bradford and others 1996
b	Assuming an adult daily intake of 100 mg soil daily, daily intakes based on the maxima reported for these nutrients may be calculated. Using the maxima for Sites 09 and 10, intake of up to 2.31 mg calcium, 9.36 mg magnesium, 2.1 mg potassium, and 0.7 mg sodium would be contributed to the diet from site-related essential nutrient consumption during incidental soil ingestion.
CFR	Title 21 of the *Code of Federal Regulations*, Volume 2, Part 104
DV	Daily Value
FDA	U.S. Food and Drug Administration, 2003. http://www.fda.gov/fdac/special/foodlabel/dvs.html
J	Laboratory qualifier indicating reported result is an estimated concentration
mg/day	Milligram per day
mg/kg	Milligram per kilogram
RDI	Recommended daily intake

TABLE I-2: CHEMICAL-SPECIFIC FACTORS USED IN THE HUMAN HEALTH RISK ASSESSMENT

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical of Potential Concern	ABS (unitless)[a]	VF (m^3/kg)[b]
Benzo(a)pyrene	0.130	--
Dibenz(a,h)anthracene	0.130	--

Notes:

a Chemical specific ABS are taken from RAGS Part E (EPA 2001b).

b Neither of these contaminants of potential concern was volatile.

-- Not applicable, or chemical is not volatile

ABS Dermal absorption factor

EPA U.S. Environmental Protection Agency

m^3/kg Cubic meters per kilogram

RAGS Risk Assessment Guidance for Superfund

VF Volatilization factor

TABLE I-3: TOTAL CHROMIUM AND HEXAVALENT CHROMIUM SAMPLING RESULTS

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Sample Location	Cr^{+6} Result (mg/kg)	Total Cr Result (mg/kg)	Depth Interval (ft bgs)	Date Sampled
Site 09				
09-HP001	0.05 UJ	38.6	1.25-1.75	8/3/95
09-HP002	0.05 UJ	25.1	6.5-7	8/3/95
09-HP003	0.05 UJ	23.2	5.5-6	8/3/95
Site 10				
07/10-HP012	0.05 U	52.4	7.25-7.75	8/10/95
07/10-HP013	0.05 U	36.1	3.25-3.75	8/10/95
07/10-HP013	0.05 U	33.8	7.25-7.75	8/10/95

Notes:

Cr	Chromium
ft bgs	feet below ground surface
J	Estimated value
mg/kg	Milligram per kilogram
U	Analyte not detected above the reporting limit

TABLE I-4: SITE 09 EVALUATION OF RESIDENTIAL AND INDUSTRIAL TOTAL RISK FOR SURFACE SOIL (0 TO 2 FEET BGS), REASONABLE MAXIMUM EXPOSURE
Site 09 and 10 Remedial Investigation, NAVSTA Treasure Islanc

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration (1) Value	Units	Statistic	Residential Screening Toxicity Value (Carcinogenic-based PRG) (2)	Residential Risk [EPC/Cancer PRG * 1E-06]	Industrial Screening Toxicity Value (Carcinogenic-based PRG) (2)	Industrial Risk [EPC/Cancer PRG * 1E-06]	Residential Screening Toxicity Value (Nonarcinogenic-based PRG) (2)	Residential Hazard Quotient [EPC/Noncancer PRG]	Residential Hazard Quotient Target Organ	Industrial Screening Toxicity Value (Nonarcinogenic-based PRG) (2)	Industrial Hazard Quotient [EPC/Noncancer PRG]	Industrial Hazard Quotient Target Organ
ALL DETECTED CHEMICALS THAT MAY CONTRIBUTE TO INCREMENTAL RISK																			
4,4'-DDD	mg/kg	9.18E-04	2.82E-03	NT	6.30E-03	J	2.82E-03	mg/kg	95% UCL- NP	2.4E+00	1.16E-09	1.0E+01	2.84E-10	--	--	--	--	--	--
4,4'-DDE	mg/kg	9.05E-04	2.60E-03	NT	3.40E-03	J	2.60E-03	mg/kg	95% UCL- NP	1.7E+00	1.51E-09	7.0E+00	3.70E-10	--	--	--	--	--	--
4,4'-DDT	mg/kg	2.26E-03	8.94E-03	NT	3.70E-02		8.94E-03	mg/kg	95% UCL- NP	1.7E+00	5.20E-09	7.0E+00	1.27E-09	3.6E+01	2.48E-04	--	4.3E+02	2.10E-05	--
4-Methyl-2-pentanone	mg/kg	7.71E-03	1.58E-02	NT	4.00E-03	J	4.00E-03	mg/kg	MAX	--	--	--	--	7.9E+02	5.09E-06	--	2.8E+03	1.41E-06	--
Acetone	mg/kg	2.96E-02	8.99E-02	NT	3.00E-01		8.99E-02	mg/kg	95% UCL- NP	--	--	--	--	1.6E+03	5.73E-05	--	6.0E+03	1.49E-05	--
alpha-Chlordane [a]	mg/kg	4.37E-04	1.29E-03	NT	1.80E-03	J	1.29E-03	mg/kg	95% UCL- NP	1.6E+00	7.93E-10	6.5E+00	1.99E-10	3.5E+01	3.66E-05	--	4.0E+02	3.19E-06	--
Aroclor-1260	mg/kg	8.65E-03	2.79E-02	NT	5.80E-02		2.79E-02	mg/kg	95% UCL- NP	2.2E-01	1.26E-07	7.4E-01	3.75E-08	2.2E+04	1.27E-06	--	2.4E+05	1.17E-07	--
Benzo(a)anthracene	mg/kg	7.59E-02	3.34E-01	NT	2.70E-02	J	2.70E-02	mg/kg	MAX	6.2E-01	4.34E-08	2.1E+00	1.28E-08	--	--	--	--	--	--
Benzo(a)pyrene	mg/kg	8.70E-02	3.35E-01	NT	1.00E-01		1.00E-01	mg/kg	MAX	6.2E-02	1.61E-06	2.1E-01	4.74E-07	--	--	--	--	--	--
Benzo(b)fluoranthene	mg/kg	8.44E-02	3.37E-01	NT	6.50E-02		6.50E-02	mg/kg	MAX	6.2E-01	1.05E-07	2.1E+00	3.08E-08	--	--	--	--	--	--
Benzo(g,h,i)perylene [b]	mg/kg	1.15E-01	5.37E-01	O(T)	3.20E-01		3.20E-01	mg/kg	MAX	--	--	--	--	2.3E+03	1.38E-04	--	2.9E+04	3.09E-06	--
Benzo(k)fluoranthene	mg/kg	8.11E-02	3.34E-01	NT	7.60E-02		7.60E-02	mg/kg	MAX	3.8E-01	2.01E-07	1.3E+00	5.92E-08	--	--	--	--	--	--
Carbon disulfide	mg/kg	3.80E-03	8.24E-03	NT	1.20E-03	J	1.20E-03	mg/kg	MAX	2.1E+02	5.70E-12	4.5E+02	2.68E-12	3.6E+02	3.38E-06	--	1.2E+03	9.99E-07	--
Chrysene	mg/kg	8.13E-02	3.34E-01	NT	6.60E-02		6.60E-02	mg/kg	MAX	3.8E+00	1.75E-08	1.3E+01	5.14E-09	--	--	--	--	--	--
Dibenzo(a,h)anthracene	mg/kg	7.66E-02	3.31E-01	NT	3.80E-02	J	3.80E-02	mg/kg	MAX	6.2E-02	6.11E-07	2.1E-01	1.80E-07	--	--	--	--	--	--
Endosulfan Sulfate [c]	mg/kg	9.14E-04	2.80E-03	NT	5.80E-03	J	2.80E-03	mg/kg	95% UCL- NP	--	--	--	--	3.7E+02	7.64E-06	--	3.7E+03	7.58E-07	--
Fluoranthene	mg/kg	8.57E-02	3.43E-01	NT	5.20E-02	J	5.20E-02	mg/kg	MAX	--	--	--	--	2.3E+03	2.27E-05	--	2.2E+04	2.36E-06	--
Indeno(1,2,3-cd)pyrene	mg/kg	9.68E-02	3.50E-01	NT	1.90E-01		1.90E-01	mg/kg	MAX	6.2E-01	3.06E-07	2.1E+00	9.01E-08	--	--	--	--	--	--
Iron	mg/kg	1.38E+04	1.51E+04	T	2.19E+04		1.51E+04	mg/kg	95% UCL- T	--	--	--	--	2.3E+04	6.45E-01	Blood	3.1E+05	4.94E-02	--
Naphthalene	mg/kg	4.05E-02	1.87E-01	NT	3.80E-02	J	3.80E-02	mg/kg	MAX	--	--	--	--	5.6E+01	6.80E-04	--	1.9E+02	2.02E-04	--
Phenanthrene [b]	mg/kg	7.46E-02	3.29E-01	NT	2.90E-02	J	2.90E-02	mg/kg	MAX	--	--	--	--	2.3E+03	1.25E-05	--	2.9E+04	9.96E-07	--
Phenol	mg/kg	1.10E-01	4.27E-01	NT	1.10E+00		4.27E-01	mg/kg	95% UCL- NP	--	--	--	--	3.7E+04	1.16E-05	--	3.7E+05	1.15E-06	--
Pyrene	mg/kg	9.17E-02	3.39E-01	NT	6.70E-02		6.70E-02	mg/kg	MAX	--	--	--	--	2.3E+03	2.89E-05	--	2.9E+04	2.30E-06	--
Silver	mg/kg	1.72E-01	5.68E-01	O(T)	2.90E+00	J	5.68E-01	mg/kg	95% UCL- O(T)	--	--	--	--	3.9E+02	1.45E-03	--	5.1E+03	1.11E-04	--
Toluene [d]	mg/kg	4.14E-03	8.75E-03	NT	3.00E-03	J	3.00E-03	mg/kg	MAX	--	--	--	--	5.2E+02	5.77E-06	--	5.2E+02	5.77E-06	--
ALL DETECTED CHEMICALS THAT ARE STATISTICALLY BELOW AMBIENT FILL AND DO NOT CONTRIBUTE TO INCREMENTAL RISK																			
Aluminum	mg/kg	5.71E+03	6.56E+03	T	1.38E+04		6.56E+03	mg/kg	95% UCL- T	--	--	--	--	7.6E+04	8.61E-02	--	9.2E+05	7.12E-03	--
Antimony	mg/kg	8.97E-01	4.44E+00	O(T)	4.15E+00	J	4.15E+00	mg/kg	MAX	--	--	--	--	3.1E+01	1.33E-01	Blood	4.1E+02	1.02E-02	--
Arsenic	mg/kg	7.02E+00	9.03E+00	T	1.77E+01		9.03E+00	mg/kg	95% UCL- T	3.9E-01	2.32E-05	1.6E+00	5.67E-06	2.2E+01	4.17E-01	Skin	2.6E+02	3.53E-02	--
Barium	mg/kg	3.58E+01	5.52E+01	T	1.81E+02	J	5.52E+01	mg/kg	95% UCL- T	--	--	--	--	5.4E+03	1.03E-02	--	6.7E+04	8.29E-04	--
Beryllium	mg/kg	1.67E-01	1.99E-01	T	3.60E-01	J	1.99E-01	mg/kg	95% UCL- T	1.1E+03	1.89E-10	2.2E+03	8.88E-11	1.5E+02	1.29E-03	--	1.9E+03	1.03E-04	--
Cadmium	mg/kg	2.24E-01	3.86E-01	T	8.90E-01	J	3.86E-01	mg/kg	95% UCL- T	1.4E+03	2.75E-10	3.0E+03	1.29E-10	3.7E+01	1.04E-02	--	4.5E+02	8.56E-04	--
Chromium [e]	mg/kg	3.46E+01	3.86E+01	T	5.92E+01		3.86E+01	mg/kg	95% UCL- T	2.1E+02	1.83E-07	4.5E+02	8.61E-08	1.2E+05	3.29E-04	--	1.5E+06	2.52E-05	--
Cobalt	mg/kg	6.80E+00	7.35E+00	O(T)	1.39E+01	J	7.35E+00	mg/kg	95% UCL- O(T)	9.0E+02	8.14E-09	1.9E+03	3.83E-09	1.4E+03	5.33E-03	--	1.3E+04	5.51E-04	--
Copper	mg/kg	1.03E+01	1.36E+01	T	3.21E+01		1.36E+01	mg/kg	95% UCL- T	--	--	--	--	3.1E+03	4.34E-03	--	4.1E+04	3.32E-04	--
Lead	mg/kg	1.38E+01	2.20E+01	T	7.62E+01		2.20E+01	mg/kg	95% UCL- T	--	--	--	--	--	--	--	--	--	--
Manganese	mg/kg	2.22E+02	2.53E+02	N	4.28E+02		2.53E+02	mg/kg	95% UCL- N	--	--	--	--	1.8E+03	1.44E-01	CNS	1.9E+04	1.30E-02	--
Mercury	mg/kg	4.57E-02	1.12E-01	T	1.40E-01		1.12E-01	mg/kg	95% UCL- NP	--	--	--	--	2.3E+01	4.79E-03	--	3.1E+02	3.67E-04	--
Molybdenum	mg/kg	1.09E+00	5.70E+00	T	4.31E+00	J	4.31E+00	mg/kg	MAX	--	--	--	--	3.9E+02	1.10E-02	--	5.1E+03	8.43E-04	--
Nickel	mg/kg	3.10E+01	3.41E+01	T	5.31E+01		3.41E+01	mg/kg	95% UCL- T	--	--	--	--	1.6E+03	2.18E-02	--	2.0E+04	1.67E-03	--
Selenium	mg/kg	1.75E-01	4.16E-01	NT	6.00E-01	J	4.16E-01	mg/kg	95% UCL- NP	--	--	--	--	3.9E+02	1.06E-03	--	5.1E+03	8.13E-05	--
Thallium	mg/kg	8.30E-02	1.28E-01	O(T)	1.46E-01		1.28E-01	mg/kg	95% UCL- O(T)	--	--	--	--	5.2E+00	2.48E-02	--	6.7E+01	1.90E-03	--
Vanadium	mg/kg	2.47E+01	2.75E+01	T	4.88E+01		2.75E+01	mg/kg	95% UCL- T	--	--	--	--	5.5E+02	5.03E-02	--	7.2E+03	3.85E-03	--
Zinc	mg/kg	4.60E+01	7.14E+01	O(T)	6.42E+02		7.14E+01	mg/kg	95% UCL- O(T)	--	--	--	--	2.3E+04	3.04E-03	--	3.1E+05	2.33E-04	--

TABLE I-5: SITE 09 EVALUATION OF RESIDENTIAL AND INDUSTRIAL TOTAL RISK FOR SOIL (0 TO 8 FEET BGS), REASONABLE MAXIMUM EXPOSURE
Site 09 and 10 Remedial Investigation, NAVSTA Treasure Islanc

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration (1) Value	Units	Statistic	Residential Screening Toxicity Value (Carcinogenic-based PRG) (2)	Residential Risk [EPC/Cancer PRG * 1E-06]	Industrial Screening Toxicity Value (Carcinogenic-based PRG) (2)	Industrial Risk [EPC/Cancer PRG * 1E-06]	Residential Screening Toxicity Value (Nonarcinogenic-based PRG) (2)	Residential Hazard Quotient [EPC/Noncancer PRG]	Residential Hazard Quotient Target Organ	Industrial Screening Toxicity Value (Nonarcinogenic-based PRG) (2)	Industrial Hazard Quotient [EPC/Noncancer PRG]	Industrial Hazard Quotient Target Organ
ALL DETECTED CHEMICALS THAT MAY CONTRIBUTE TO INCREMENTAL RISK																			
1,4-Dichlorobenzene	mg/kg	8.19E-02	5.08E-01	NT	2.50E-02	J	2.50E-02	mg/kg	MAX	3.4E+00	7.25E-09	7.9E+00	3.18E-09	4.8E+02	5.18E-05	--	1.9E+03	1.34E-05	--
4,4'-DDD	mg/kg	1.23E-03	6.24E-03	NT	7.00E-03	J	6.24E-03	mg/kg	95% UCL- NP	2.4E+00	2.56E-09	1.0E+01	6.27E-10	--	--	--	--	--	--
4,4'-DDE	mg/kg	1.14E-03	6.12E-03	NT	3.40E-03	J	3.40E-03	mg/kg	MAX	1.7E+00	1.98E-09	7.0E+00	4.84E-10	--	--	--	--	--	--
4,4'-DDT	mg/kg	1.82E-03	7.29E-03	NT	3.70E-02		7.29E-03	mg/kg	95% UCL- NP	1.7E+00	4.24E-09	7.0E+00	1.04E-09	3.6E+01	2.02E-04	--	4.3E+02	1.71E-05	--
2-Methylnaphthalene [a]	mg/kg	1.72E-01	9.46E-01	NT	1.80E+00		9.46E-01	mg/kg	95% UCL- NP	--	--	--	--	5.6E+01	1.69E-02	--	1.9E+02	5.04E-03	--
4-Methyl-2-pentanone	mg/kg	6.47E-03	1.00E-02	NT	4.00E-03	J	4.00E-03	mg/kg	MAX	--	--	--	--	7.9E+02	5.09E-06	--	2.8E+03	1.41E-06	--
Acenaphthene	mg/kg	1.65E-01	9.24E-01	NT	8.60E-01		8.60E-01	mg/kg	MAX	--	--	--	--	3.7E+03	2.34E-04	--	2.9E+04	2.94E-05	--
Acetone	mg/kg	1.74E-02	3.84E-02	NT	3.00E-01		3.84E-02	mg/kg	95% UCL- NP	--	--	--	--	1.6E+03	2.44E-05	--	6.0E+03	6.36E-06	--
alpha-Chlordane [b]	mg/kg	5.59E-04	3.09E-03	NT	1.80E-03	J	1.80E-03	mg/kg	MAX	1.6E+00	1.11E-09	6.5E+00	2.78E-10	3.5E+01	5.12E-05	--	4.0E+02	4.45E-06	--
Aroclor-1260	mg/kg	1.06E-02	6.01E-02	NT	5.80E-02		5.80E-02	mg/kg	MAX	2.2E-01	2.61E-07	7.4E-01	7.80E-08	2.2E+04	2.65E-06	--	2.4E+05	2.43E-07	--
Benzo(a)anthracene	mg/kg	1.52E-01	9.22E-01	NT	3.70E-01	J	3.70E-01	mg/kg	MAX	6.2E-01	5.95E-07	2.1E+00	1.75E-07	--	--	--	--	--	--
Benzo(a)pyrene	mg/kg	7.88E-02	1.96E-01	NT	3.70E-01	J	1.96E-01	mg/kg	95% UCL- NP	6.2E-02	3.15E-06	2.1E-01	9.29E-07	--	--	--	--	--	--
Benzo(b)fluoranthene	mg/kg	7.37E-02	1.92E-01	NT	2.20E-01	J	1.92E-01	mg/kg	95% UCL- NP	6.2E-01	3.08E-07	2.1E+00	9.08E-08	--	--	--	--	--	--
Benzo(g,h,i)perylene [c]	mg/kg	8.75E-02	2.04E-01	NT	3.30E-01	J	2.04E-01	mg/kg	95% UCL- NP	--	--	--	--	2.3E+03	8.82E-05	--	2.9E+04	7.01E-06	--
Benzo(k)fluoranthene	mg/kg	7.49E-02	1.93E-01	NT	3.10E-01	J	1.93E-01	mg/kg	95% UCL- NP	3.8E-01	5.10E-07	1.3E+00	1.50E-07	--	--	--	--	--	--
Carbon disulfide	mg/kg	3.33E-03	5.33E-03	NT	1.20E-03	J	1.20E-03	mg/kg	MAX	2.1E+02	5.70E-12	4.5E+02	2.68E-12	3.6E+02	3.38E-06	--	1.2E+03	9.99E-07	--
Chrysene	mg/kg	1.54E-01	9.24E-01	NT	4.70E-01	J	4.70E-01	mg/kg	MAX	3.8E+00	1.24E-07	1.3E+01	3.66E-08	--	--	--	--	--	--
Dibenzo(a,h)anthracene	mg/kg	7.31E-02	1.89E-01	NT	7.00E-02		7.00E-02	mg/kg	MAX	6.2E-02	1.13E-06	2.1E-01	3.32E-07	--	--	--	--	--	--
Dibenzofuran	mg/kg	1.84E-01	9.54E-01	NT	1.70E+00	J	9.54E-01	mg/kg	95% UCL- NP	--	--	--	--	2.9E+02	3.28E-03	--	3.1E+03	3.05E-04	--
Endosulfan I [d]	mg/kg	5.80E-04	3.06E-03	NT	1.30E-03		1.30E-03	mg/kg	MAX	--	--	--	--	3.7E+02	3.55E-06	--	3.7E+03	3.52E-07	--
Endosulfan Sulfate [d]	mg/kg	1.13E-03	6.09E-03	NT	5.80E-03	J	5.80E-03	mg/kg	MAX	--	--	--	--	3.7E+02	1.58E-05	--	3.7E+03	1.57E-06	--
Endrin aldehyde [e]	mg/kg	1.23E-03	6.22E-03	NT	4.10E-03	J	4.10E-03	mg/kg	MAX	--	--	--	--	1.8E+01	2.24E-04	--	1.8E+02	2.22E-05	--
Fluoranthene	mg/kg	1.58E-01	9.18E-01	NT	6.20E-01		6.20E-01	mg/kg	MAX	--	--	--	--	2.3E+03	2.70E-04	--	2.2E+04	2.82E-05	--
Fluorene	mg/kg	2.52E-01	1.10E+00	NT	5.70E+00		1.10E+00	mg/kg	95% UCL- NP	--	--	--	--	2.7E+03	4.02E-04	--	2.6E+04	4.20E-05	--
Indeno(1,2,3-cd)pyrene	mg/kg	8.53E-02	2.01E-01	NT	1.90E-01		1.90E-01	mg/kg	MAX	6.2E-01	3.06E-07	2.1E+00	9.01E-08	--	--	--	--	--	--
Iron	mg/kg	1.16E+04	1.21E+04	O(T)	2.63E+04		1.21E+04	mg/kg	95% UCL- O(T)	--	--	--	--	2.3E+04	5.17E-01	Blood	3.1E+05	3.96E-02	--
Isopropylbenzene	mg/kg	3.39E-03	5.31E-03	NT	6.70E-03		5.31E-03	mg/kg	95% UCL- NP	--	--	--	--	5.7E+02	9.28E-06	--	2.0E+03	2.69E-06	--
Methoxychlor	mg/kg	4.67E-03	2.98E-02	NT	1.40E-03	J	1.40E-03	mg/kg	MAX	--	--	--	--	3.1E+02	4.58E-06	--	3.1E+03	4.55E-07	--
Methyl-Tert-Butyl Ether	mg/kg	3.33E-03	5.29E-03	NT	2.10E-03	J	2.10E-03	mg/kg	MAX	1.7E+01	1.26E-10	3.6E+01	5.76E-11	5.7E+03	3.65E-07	--	2.0E+04	1.05E-07	--
Methylene chloride	mg/kg	1.56E-02	2.85E-02	NT	1.60E-01		2.85E-02	mg/kg	95% UCL- NP	9.1E+00	3.13E-09	2.1E+01	1.39E-09	2.0E+03	1.46E-05	--	9.3E+03	3.08E-06	--
n-Butylbenzene [f]	mg/kg	3.90E-03	7.19E-03	NT	3.70E-02		7.19E-03	mg/kg	95% UCL- NP	--	--	--	--	2.4E+02	3.00E-05	--	2.4E+02	3.00E-05	--
n-Propylbenzene [f]	mg/kg	3.47E-03	5.52E-03	NT	1.30E-02		5.52E-03	mg/kg	95% UCL- NP	--	--	--	--	2.4E+02	2.30E-05	--	2.4E+02	2.30E-05	--
Naphthalene	mg/kg	8.81E-02	5.13E-01	NT	4.60E-01		4.60E-01	mg/kg	MAX	--	--	--	--	5.6E+01	8.23E-03	--	1.9E+02	2.45E-03	--
Phenanthrene [c]	mg/kg	2.44E-01	1.07E+00	NT	4.60E+00		1.07E+00	mg/kg	95% UCL- NP	--	--	--	--	2.3E+03	4.62E-04	--	2.9E+04	3.67E-05	--
Phenol	mg/kg	3.00E-01	1.29E+00	NT	1.60E+01		1.29E+00	mg/kg	95% UCL- NP	--	--	--	--	3.7E+04	3.51E-05	--	3.7E+05	3.48E-06	--
Pyrene	mg/kg	1.71E-01	9.37E-01	NT	8.90E-01		8.90E-01	mg/kg	MAX	--	--	--	--	2.3E+03	3.84E-04	--	2.9E+04	3.06E-05	--
sec-Butylbenzene [f]	mg/kg	3.72E-03	6.45E-03	NT	2.70E-02		6.45E-03	mg/kg	95% UCL- NP	3.5E+01	1.86E-10	1.2E+02	5.24E-11	2.2E+02	2.93E-05	--	2.2E+02	2.93E-05	--
Silver	mg/kg	9.89E-02	1.58E-01	O(T)	2.90E+00	J	1.58E-01	mg/kg	95% UCL- O(T)	--	--	--	--	3.9E+02	4.05E-04	--	5.1E+03	3.10E-05	--
Toluene [f]	mg/kg	3.60E-03	5.59E-03	NT	3.00E-03	J	3.00E-03	mg/kg	MAX	--	--	--	--	5.2E+02	5.77E-06	--	5.2E+02	5.77E-06	--

TABLE I-6: SITE 10 EVALUATION OF RESIDENTIAL AND INDUSTRIAL TOTAL RISK FOR SURFACE SOIL (0 TO 2 FEET BGS), REASONABLE MAXIMUM EXPOSURE
Site 09 and 10 Remedial Investigation, NAVSTA Treasure Islanc

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration (1) Value	Units	Statistic	Residential Screening Toxicity Value (Carcinogenic-based PRG) (2)	Residential Risk [EPC/Cancer PRG * 1E-06]	Industrial Screening Toxicity Value (Carcinogenic-based PRG) (2)	Industrial Risk [EPC/Cancer PRG * 1E-06]	Residential Screening Toxicity Value (Nonarcinogenic-based PRG) (2)	Residential Hazard Quotient [EPC/Noncancer PRG]	Residential Hazard Quotient Target Organ	Industrial Screening Toxicity Value (Nonarcinogenic-based PRG) (2)	Industrial Hazard Quotient [EPC/Noncancer PRG]	Industrial Hazard Quotient Target Organ
ALL DETECTED CHEMICALS THAT MAY CONTRIBUTE TO INCREMENTAL RISK																			
4,4'-DDD	mg/kg	5.41E-02	2.43E-01	NT	1.00E+00		2.43E-01	mg/kg	95% UCL- NP	2.4E+00	9.97E-08	1.0E+01	2.44E-08	--	--	--	--	--	--
4,4'-DDE	mg/kg	1.08E-02	3.43E-02	NT	1.10E-01	J	3.43E-02	mg/kg	95% UCL- NP	1.7E+00	2.00E-08	7.0E+00	4.89E-09	--	--	--	--	--	--
4,4'-DDT	mg/kg	5.96E-02	2.11E-01	NT	7.50E-01		2.11E-01	mg/kg	95% UCL- NP	1.7E+00	1.23E-07	7.0E+00	3.01E-08	3.6E+01	5.85E-03	--	4.3E+02	4.95E-04	--
4-Chloroaniline	mg/kg	9.85E-02	3.13E-01	NT	7.30E-02	J	7.30E-02	mg/kg	MAX	--	--	--	--	2.4E+02	2.99E-04	--	2.5E+03	2.96E-05	--
alpha-Chlordane [a]	mg/kg	2.96E-02	9.81E-02	NT	3.00E-01		9.81E-02	mg/kg	95% UCL- NP	1.6E+00	6.04E-08	6.5E+00	1.52E-08	3.5E+01	2.79E-03	--	4.0E+02	2.43E-04	--
Benzo(a)anthracene	mg/kg	9.58E-02	3.14E-01	NT	3.20E-02	J	3.20E-02	mg/kg	MAX	6.2E-01	5.15E-08	2.1E+00	1.52E-08	--	--	--	--	--	--
Benzo(a)pyrene	mg/kg	1.01E-01	3.17E-01	NT	5.50E-02		5.50E-02	mg/kg	MAX	6.2E-02	8.85E-07	2.1E-01	2.61E-07	--	--	--	--	--	--
Benzo(b)fluoranthene	mg/kg	1.03E-01	3.17E-01	NT	7.20E-02		7.20E-02	mg/kg	MAX	6.2E-01	1.16E-07	2.1E+00	3.41E-08	--	--	--	--	--	--
Benzo(g,h,i)perylene [b]	mg/kg	1.14E-01	3.22E-01	NT	1.20E-01		1.20E-01	mg/kg	MAX	--	--	--	--	2.3E+03	5.18E-05	--	2.9E+04	4.12E-06	--
Benzo(k)fluoranthene	mg/kg	1.02E-01	3.21E-01	NT	5.30E-02		5.30E-02	mg/kg	MAX	3.8E-01	1.40E-07	1.3E+00	4.13E-08	--	--	--	--	--	--
Dalapon	mg/kg	4.58E-02	1.42E-01	NT	1.05E-01		1.05E-01	mg/kg	MAX	--	--	--	--	1.8E+03	5.73E-05	--	1.8E+04	5.69E-06	--
Dibenzo(a,h)anthracene	mg/kg	1.02E-01	3.14E-01	NT	6.30E-02		6.30E-02	mg/kg	MAX	6.2E-02	1.01E-06	2.1E-01	2.99E-07	--	--	--	--	--	--
Endosulfan Sulfate [c]	mg/kg	1.92E-02	9.30E-02	NT	3.90E-01		9.30E-02	mg/kg	95% UCL- NP	--	--	--	--	3.7E+02	2.54E-04	--	3.7E+03	2.52E-05	--
Endrin aldehyde [d]	mg/kg	2.17E-03	6.02E-03	NT	1.50E-02		6.02E-03	mg/kg	95% UCL- NP	--	--	--	--	1.8E+01	3.29E-04	--	1.8E+02	3.26E-05	--
Fluoranthene	mg/kg	9.44E-02	3.09E-01	NT	1.60E-02	J	1.60E-02	mg/kg	MAX	--	--	--	--	2.3E+03	6.98E-06	--	2.2E+04	7.27E-07	--
gamma-Chlordane [a]	mg/kg	3.89E-02	1.26E-01	NT	3.60E-01		1.26E-01	mg/kg	95% UCL- NP	1.6E+00	7.77E-08	6.5E+00	1.95E-08	3.5E+01	3.59E-03	--	4.0E+02	3.12E-04	--
Heptachlor	mg/kg	4.34E-03	1.41E-02	NT	4.10E-02		1.41E-02	mg/kg	95% UCL- NP	1.1E-01	1.31E-07	3.8E-01	3.69E-08	3.1E+01	4.62E-04	--	3.1E+02	4.59E-05	--
Heptachlor Epoxide	mg/kg	2.00E-03	5.91E-03	NT	1.60E-02		5.91E-03	mg/kg	95% UCL- NP	5.3E-02	1.11E-07	1.9E-01	3.12E-08	7.9E-01	7.44E-03	--	8.0E+00	7.38E-04	--
Indeno(1,2,3-cd)pyrene	mg/kg	1.08E-01	3.18E-01	NT	8.80E-02		8.80E-02	mg/kg	MAX	6.2E-01	1.42E-07	2.1E+00	4.17E-08	--	--	--	--	--	--
Iron	mg/kg	1.30E+04	1.46E+04	T	1.70E+04		1.46E+04	mg/kg	95% UCL- T	--	--	--	--	2.3E+04	6.22E-01	Blood	3.1E+05	4.76E-02	--
Phenanthrene [b]	mg/kg	9.36E-02	3.08E-01	NT	1.40E-02	J	1.40E-02	mg/kg	MAX	--	--	--	--	2.3E+03	6.05E-06	--	2.9E+04	4.81E-07	--
Phenol	mg/kg	1.45E-01	4.04E-01	NT	7.50E-01		4.04E-01	mg/kg	95% UCL- NP	--	--	--	--	3.7E+04	1.10E-05	--	3.7E+05	1.09E-06	--
Pyrene	mg/kg	9.69E-02	3.12E-01	NT	3.50E-02	J	3.50E-02	mg/kg	MAX	--	--	--	--	2.3E+03	1.51E-05	--	2.9E+04	1.20E-06	--
Toluene [e]	mg/kg	4.04E-03	9.32E-03	NT	6.80E-04	J	6.80E-04	mg/kg	MAX	--	--	--	--	5.2E+02	1.31E-06	--	5.2E+02	1.31E-06	--
ALL DETECTED CHEMICALS THAT ARE STATISTICALLY BELOW AMBIENT FILL AND DO NOT CONTRIBUTE TO INCREMENTAL RISK																			
Aluminum	mg/kg	4.13E+03	5.28E+03	T	7.40E+03		5.28E+03	mg/kg	95% UCL- T	--	--	--	--	7.6E+04	6.93E-02	--	9.2E+05	5.73E-03	--
Arsenic	mg/kg	5.44E+00	5.86E+00	T	6.40E+00		5.86E+00	mg/kg	95% UCL- T	3.9E-01	1.50E-05	1.6E+00	3.69E-06	2.2E+01	2.71E-01	Skin	2.6E+02	2.29E-02	--
Antimony	mg/kg	2.36E+00	8.35E+00	NT	6.10E+00	J	6.10E+00	mg/kg	MAX	--	--	--	--	3.1E+01	1.95E-01	Blood	4.1E+02	1.49E-02	--
Barium	mg/kg	1.83E+01	4.20E+01	O(T)	6.11E+01		4.20E+01	mg/kg	95% UCL- O(T)	--	--	--	--	5.4E+03	7.82E-03	--	6.7E+04	6.32E-04	--
Beryllium	mg/kg	1.03E-01	1.61E-01	N	2.10E-01	J	1.61E-01	mg/kg	95% UCL- NP	1.1E+03	1.53E-10	2.2E+03	7.17E-11	1.5E+02	1.04E-03	--	1.9E+03	8.29E-05	--
Cadmium	mg/kg	1.96E-01	1.11E+00	O(T)	5.90E-01	J	5.90E-01	mg/kg	MAX	1.4E+03	4.20E-10	3.0E+03	1.97E-10	3.7E+01	1.59E-02	--	4.5E+02	1.31E-03	--
Chromium [f]	mg/kg	3.29E+01	3.83E+01	T	4.83E+01		3.83E+01	mg/kg	95% UCL- T	2.1E+02	1.82E-07	4.5E+02	8.54E-08	1.2E+05	3.26E-04	--	1.5E+06	2.50E-05	--
Cobalt	mg/kg	6.69E+00	7.72E+00	T	9.30E+00	J	7.72E+00	mg/kg	95% UCL- T	9.0E+02	8.56E-09	1.9E+03	4.02E-09	1.4E+03	5.60E-03	--	1.3E+04	5.79E-04	--
Copper	mg/kg	1.14E+01	3.23E+01	O(T)	6.00E+01		3.23E+01	mg/kg	95% UCL- O(T)	--	--	--	--	3.1E+03	1.03E-02	--	4.1E+04	7.89E-04	--
Lead	mg/kg	1.27E+01	6.12E+01	O(T)	1.12E+02		6.12E+01	mg/kg	95% UCL- O(T)	--	--	--	--	--	--	--	--	--	--
Manganese	mg/kg	2.41E+02	2.77E+02	T	3.27E+02	J	2.77E+02	mg/kg	95% UCL- T	--	--	--	--	1.8E+03	1.57E-01	CNS	1.9E+04	1.42E-02	--
Mercury	mg/kg	3.44E-02	6.29E-02	N	8.00E-02	J	6.29E-02	mg/kg	95% UCL- NP	--	--	--	--	2.3E+01	2.68E-03	--	3.1E+02	2.05E-04	--
Molybdenum	mg/kg	4.04E-01	1.62E+00	NT	1.90E-01		1.90E-01	mg/kg	MAX	--	--	--	--	3.9E+02	4.86E-04	--	5.1E+03	3.72E-05	--
Nickel	mg/kg	3.57E+01	4.12E+01	N	4.80E+01		4.12E+01	mg/kg	95% UCL- N	--	--	--	--	1.6E+03	2.63E-02	--	2.0E+04	2.01E-03	--
Silver	mg/kg	2.05E-01	7.96E-01	NT	4.60E-02		4.60E-02	mg/kg	MAX	--	--	--	--	3.9E+02	1.18E-04	--	5.1E+03	9.00E-06	--
Thallium	mg/kg	1.69E-01	5.29E-01	NT	5.70E-02		5.70E-02	mg/kg	MAX	--	--	--	--	5.2E+00	1.10E-02	--	6.7E+01	8.45E-04	--
Vanadium	mg/kg	2.02E+01	2.37E+01	T	2.88E+01		2.37E+01	mg/kg	95% UCL- T	--	--	--	--	5.5E+02	4.32E-02	--	7.2E+03	3.31E-03	--
Zinc	mg/kg	5.35E+01	1.74E+02	O(T)	3.31E+02		1.74E+02	mg/kg	95% UCL- O(T)	--	--	--	--	2.3E+04	7.40E-03	--	3.1E+05	5.67E-04	--

TABLE I-7: SITE 10 EVALUATION OF RESIDENTIAL AND INDUSTRIAL TOTAL RISK FOR SOIL (0 TO 8 FEET BGS), REASONABLE MAXIMUM EXPOSURE
Site 09 and 10 Remedial Investigation, NAVSTA Treasure Islanc

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration (1) Value	Units	Statistic	Residential Screening Toxicity Value (Carcinogenic-based PRG) (2)	Residential Risk [EPC/Cancer PRG * 1E-06]	Industrial Screening Toxicity Value (Carcinogenic-based PRG) (2)	Industrial Risk [EPC/Cancer PRG * 1E-06]	Residential Screening Toxicity Value (Nonarcinogenic-based PRG) (2)	Residential Hazard Quotient [EPC/Noncancer PRG]	Residential Hazard Quotient Target Organ	Industrial Screening Toxicity Value (Nonarcinogenic-based PRG) (2)	Industrial Hazard Quotient [EPC/Noncancer PRG]	Industrial Hazard Quotient Target Organ
ALL DETECTED CHEMICALS THAT MAY CONTRIBUTE TO INCREMENTAL RISK																	
4,4'-DDD	mg/kg	1.85E-02	8.20E-02 NT	1.00E+00	8.20E-02	mg/kg	95% UCL- NP	2.4E+00	3.37E-08	1.0E+01	8.24E-09	--	--	--	--	--	--
4,4'-DDE	mg/kg	4.03E-03	1.22E-02 NT	1.10E-01 J	1.22E-02	mg/kg	95% UCL- NP	1.7E+00	7.12E-09	7.0E+00	1.74E-09	--	--	--	--	--	--
4,4'-DDT	mg/kg	2.03E-02	7.23E-02 NT	7.50E-01	7.23E-02	mg/kg	95% UCL- NP	1.7E+00	4.20E-08	7.0E+00	1.03E-08	3.6E+01	2.00E-03	--	4.3E+02	1.70E-04	--
4-Chloroaniline	mg/kg	1.01E-01	2.26E-01 NT	7.30E-02 J	7.30E-02	mg/kg	MAX	--	--	--	--	2.4E+02	2.99E-04	--	2.5E+03	2.96E-05	--
Acenaphthylene [a]	mg/kg	1.00E-01	2.27E-01 NT	3.00E-02 J	3.00E-02	mg/kg	MAX	--	--	--	--	3.7E+03	8.15E-06	--	2.9E+04	1.03E-06	--
alpha-Chlordane [b]	mg/kg	1.01E-02	3.38E-02 NT	3.00E-01	3.38E-02	mg/kg	95% UCL- NP	1.6E+00	2.08E-08	6.5E+00	5.23E-09	3.5E+01	9.61E-04	--	4.0E+02	8.36E-05	--
Anthracene	mg/kg	1.04E-01	2.28E-01 NT	1.70E-01	1.70E-01	mg/kg	MAX	--	--	--	--	2.2E+04	7.76E-06	--	2.4E+05	7.13E-07	--
Benzo(a)anthracene	mg/kg	1.06E-01	2.31E-01 NT	2.90E-01	2.31E-01	mg/kg	95% UCL- NP	6.2E-01	3.72E-07	2.1E+00	1.10E-07	--	--	--	--	--	--
Benzo(a)pyrene	mg/kg	1.10E-01	2.34E-01 NT	3.00E-01	2.34E-01	mg/kg	95% UCL- NP	6.2E-02	3.77E-06	2.1E-01	1.11E-06	--	--	--	--	--	--
Benzo(b)fluoranthene	mg/kg	1.08E-01	2.33E-01 NT	1.60E-01	1.60E-01	mg/kg	MAX	6.2E-01	2.57E-07	2.1E+00	7.58E-08	--	--	--	--	--	--
Benzo(g,h,i)perylene [c]	mg/kg	1.13E-01	2.37E-01 NT	2.50E-01	2.37E-01	mg/kg	95% UCL- NP	--	--	--	--	2.3E+03	1.02E-04	--	2.9E+04	8.15E-06	--
Benzo(k)fluoranthene	mg/kg	1.09E-01	2.32E-01 NT	2.50E-01	2.32E-01	mg/kg	95% UCL- NP	3.8E-01	6.14E-07	1.3E+00	1.81E-07	--	--	--	--	--	--
bis(2-ethylhexyl)phthalate	mg/kg	2.97E-01	1.16E+00 NT	1.20E+01	1.16E+00	mg/kg	95% UCL- NP	3.5E+01	3.34E-08	1.2E+02	9.42E-09	1.2E+03	9.49E-04	--	1.2E+04	9.42E-05	--
Chrysene	mg/kg	1.08E-01	2.35E-01 NT	3.10E-01	2.35E-01	mg/kg	95% UCL- NP	3.8E+00	6.22E-08	1.3E+01	1.83E-08	--	--	--	--	--	--
Dalapon	mg/kg	3.47E-02	7.96E-02 NT	1.05E-01	7.96E-02	mg/kg	95% UCL- NP	--	--	--	--	1.8E+03	4.34E-05	--	1.8E+04	4.31E-06	--
Dibenzo(a,h)anthracene	mg/kg	1.06E-01	2.30E-01 NT	6.30E-02	6.30E-02	mg/kg	MAX	6.2E-02	1.01E-06	2.1E-01	2.99E-07	--	--	--	--	--	--
Dicamba	mg/kg	1.81E-02	5.25E-02 NT	1.20E-02 J	1.20E-02	mg/kg	MAX	--	--	--	--	1.8E+03	6.55E-06	--	1.8E+04	6.50E-07	--
Endosulfan Sulfate [d]	mg/kg	6.79E-03	3.15E-02 NT	3.90E-01	3.15E-02	mg/kg	95% UCL- NP	--	--	--	--	3.7E+02	8.60E-05	--	3.7E+03	8.54E-06	--
Endrin aldehyde [e]	mg/kg	1.34E-03	2.98E-03 NT	1.50E-02	2.98E-03	mg/kg	95% UCL- NP	--	--	--	--	1.8E+01	1.63E-04	--	1.8E+02	1.62E-05	--
Endrin Ketone [e]	mg/kg	8.29E-04	1.95E-03 NT	1.40E-02 J	1.95E-03	mg/kg	95% UCL- NP	--	--	--	--	1.8E+01	1.06E-04	--	1.8E+02	1.06E-05	--
Fluoranthene	mg/kg	1.15E-01	2.43E-01 NT	5.40E-01	2.43E-01	mg/kg	95% UCL- NP	--	--	--	--	2.3E+03	1.06E-04	--	2.2E+04	1.11E-05	--
Fluorene	mg/kg	1.01E-01	2.27E-01 NT	5.50E-02 J	5.50E-02	mg/kg	MAX	--	--	--	--	2.7E+03	2.00E-05	--	2.6E+04	2.09E-06	--
gamma-Chlordane [b]	mg/kg	1.32E-02	4.35E-02 NT	3.60E-01	4.35E-02	mg/kg	95% UCL- NP	1.6E+00	2.68E-08	6.5E+00	6.72E-09	3.5E+01	1.24E-03	--	4.0E+02	1.08E-04	--
Heptachlor	mg/kg	1.67E-03	5.08E-03 NT	4.10E-02	5.08E-03	mg/kg	95% UCL- NP	1.1E-01	4.70E-08	3.8E-01	1.33E-08	3.1E+01	1.66E-04	--	3.1E+02	1.65E-05	--
Heptachlor Epoxide	mg/kg	9.20E-04	2.31E-03 NT	1.60E-02	2.31E-03	mg/kg	95% UCL- NP	5.3E-02	4.33E-08	1.9E-01	1.22E-08	7.9E-01	2.91E-03	--	8.0E+00	2.89E-04	--
Indeno(1,2,3-cd)pyrene	mg/kg	1.14E-01	2.36E-01 NT	2.50E-01	2.36E-01	mg/kg	95% UCL- NP	6.2E-01	3.79E-07	2.1E+00	1.12E-07	--	--	--	--	--	--
Iron	mg/kg	1.33E+04	1.44E+04 T	2.49E+04	1.44E+04	mg/kg	95% UCL- T	--	--	--	--	2.3E+04	6.14E-01	Blood	3.1E+05	4.70E-02	--
Phenanthrene [c]	mg/kg	1.13E-01	2.43E-01 NT	6.10E-01	2.43E-01	mg/kg	95% UCL- NP	--	--	--	--	2.3E+03	1.05E-04	--	2.9E+04	8.33E-06	--
Phenol	mg/kg	1.58E-01	3.38E-01 NT	1.60E+00	3.38E-01	mg/kg	95% UCL- NP	--	--	--	--	3.7E+04	9.21E-06	--	3.7E+05	9.15E-07	--
Pyrene	mg/kg	1.18E-01	2.47E-01 NT	6.80E-01	2.47E-01	mg/kg	95% UCL- NP	--	--	--	--	2.3E+03	1.07E-04	--	2.9E+04	8.48E-06	--
Toluene [f]	mg/kg	4.04E-03	7.29E-03 NT	2.00E-03 J	2.00E-03	mg/kg	MAX	--	--	--	--	5.2E+02	3.85E-06	--	5.2E+02	3.85E-06	--

TABLE I-8: PAH REPLACEMENT DATA UNCERTAINTY

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical	1992 Concentration (mg/kg) 6 to 6.5 feet bgs 10-SB03	2002 Concentration (mg/kg) 6 to 7.5 feet bgs 10-SB24	Notes
Benzo(a)anthracene	0.38 J	ND (0.014 U)	Reduction reflects 10 years of biodegradation and improved analytical techniques. Samples were collected from the exact same location. These three detects from 1992 are for noncarcinogens; hence, there is no effect on the cancer risk estimate and the kidney target organ HI is much less than 1, so the potential effect is negligible.
Benzo(a)pyrene	0.3 J	ND (0.022 U)	
Benzo(b)fluoranthene	0.27 J	ND (0.02 U)	
Benzo(k)fluoranthene	0.27 J	ND (0.022 U)	
Chrysene	0.52 J	0.015 J	
Fluoranthene	1	ND (0.043 UJ)	
Phenanthrene	1	ND (0.012 U)	
Pyrene	1	0.05 J	
Benzo(ghi)perylene	ND (0.8 U)	0.024 J	

Notes:

bgs	Below ground surface
HI	Hazard Index
J	Estimated value
mg/kg	Milligram per kilogram
ND	Non Detect Concentration
U	Analyte not detected above the reporting limit

TABLE I-9: PESTICIDE REPLACEMENT DATA UNCERTAINTY

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

1995 Concentration (mg/kg) 3 to 4 ft bgs 07/10-HP06	2002 Concentration (mg/kg) 2.5 to 5 ft bgs 10-SB19
2.1	0.0018J
1.9	0.0026J

Notes:

ft bgs Feet below ground surface
J Estimated value
mg/kg Milligram per kilogram

TABLE I-10: SUMMARY OF UNCERTAINTIES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Item	Effect on Human Health Risk Assessment	Potential Magnitude of Effect on Risk
Use of PRGs to identify COPCs (Note: See Section 10.3 for the quantitative analysis of this uncertainty)	May underestimate risk by failing to account for the cumulative effects of chemicals detected just below the PRG	Low Underestimate
Potential outlier arsenic concentrations at Site 09 that were not considered significantly greater than background	May underestimate risk if a receptor were to be exposed to the maximum detected concentration (i.e., potential outliers) over time	Low Underestimate
Evaluation of hypothetical residential receptor population exposures	Will represent overestimate of potential exposures; future reuse is most likely to be commercial/industrial without residences	High Overestimate
Use of replacement data for lead, PAHs, and pesticides in soil	Unlikely to have an appreciable effect on the human health risk assessment because the few number of samples affected by replacement data.	Unknown
Use of BTEX and PAH risks as surrogate for total petroleum hydrocarbons risks (no nondiscrete TPH risk characterized)	May underestimate risks in the unlikely event that toxic components were not already accounted for in BTEX and PAH analyses are present. This is unlikely at Sites 09 and 10 because VOC and SVOC suites were analyzed in the same locations.	Unknown
Use of default exposure parameters	May overestimate risks because exposures are likely to be less than those chosen for the RME exposure scenario.	Low Overestimate
Toxicity values	Toxicity values incorporate uncertainty factors that reduce the acceptable dose for a receptor. Uncertainty factors often lead to a conservative evaluation.	Low Overestimate
Use of single representative concentration for chemicals for entire investigation area (single exposure point)	Overestimate of potential exposures for chemicals sporadically detected	Low Overestimate

Notes:

BTEX	Benzene, toluene, ethylbenzene, and xylenes
COPC	Chemical of potential concern
PAH	Polycyclic aromatic hydrocarbon
PRG	Preliminary remediation goal
HHRA	Human health risk assessment
SVOC	Semivolatile organic compound
VOC	Volatile organic compound

TABLE I-1.1: EPA RAGS PART D TABLE 1, SELECTION OF EXPOSURE PATHWAYS

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current (Site 10 only)	Soil (0-2 feet bgs)	Soil	Surface Soil (0-2 feet bgs)	Commercial/ Industrial Worker	Adult	Incidental Ingestion	Quant.	Industrial workers currently utilize Site 10. Site 09 is not currently used for any purposes.
						Dermal Contact	Quant.	Industrial workers currently utilize Site 10. Site 09 is not currently used for any purposes.
		Particulates	Respirable Particulates Suspended from Surface Soil (0-2 feet bgs)	Commercial/Industrial Worker	Adult	Inhalation	Quant.	Industrial workers currently utilize Site 10. Site 09 is not currently used for any purposes.
		Vapors	Vapors from Surface Soil (0-2 feet bgs) (Outdoor Air)	Commercial/Industrial Worker	Adult	Inhalation	Quant.	Industrial workers currently utilize Site 10. Site 09 is not currently used for any purposes.
	Soil (0-8 feet bgs)	Soil	Subsurface Soil (0-8 feet bgs)	Commercial/Industrial Worker	Adult	Incidental Ingestion	None	Site activities involving disturbance of subsoils are not expected for the current scenario.
						Dermal Contact	None	Site activities involving disturbance of subsoils are not expected for the current scenario.
		Particulates	Respirable Particulates Suspended from Subsurface Soil (0-8 feet bgs)	Commercial/Industrial Worker	Adult	Inhalation	None	Site activities involving disturbance of subsoils are not expected for the current scenario.
		Vapors	Vapors from Subsurface Soil (0-8 feet bgs) (Outdoor Air)	Commercial/Industrial Worker	Adult	Inhalation	None	Exposure to vapors from soil at the 0- to 2-foot bgs depth is evaluated; in the current scenario, soils deeper than 2 feet bgs are not expected to contribute significantly to this pathway. This pathway was, however, quantitatively evaluated for future redeveloped land use (see below).
	Groundwater	Groundwater	Tap Water from Shallow Groundwater	Commercial/Industrial Worker	Adult	Incidental Ingestion	None	Groundwater is not considered potable; therefore, ingestion of groundwater is not considered a complete exposure pathway for any receptor. Drinking water is currently supplied by an off-site source.
					Adult	Dermal Contact	None	Dermal contact with groundwater is not considered a complete exposure pathway for any receptor.
		Vapors	Vapors from Groundwater (Indoor Air Vapor Intrusion)	Commercial/Industrial Worker	Adult	Inhalation	Quant.	Industrial workers currently utilize buildings on Site 10. Site 09 is not currently used for any purposes.
Future (Sites 09 and 10)	Soil (0-2 feet bgs)	Soil	Surface Soil (0-2 feet bgs)	Commercial/Industrial Worker	Adult	Incidental Ingestion	Quant.	Sites 09 and 10 are intended to be redeveloped for commercial purposes; under a redevelopment scenario with minimal surface regrading, this exposure will be the same as today's current exposures.
						Dermal Contact	Quant.	Sites 09 and 10 are intended to be redeveloped for commercial purposes; under a redevelopment scenario with minimal surface regrading, this exposure will be the same as today's current exposures.
		Particulates	Respirable Particulates Suspended from Surface Soil (0-2 feet bgs)	Commercial/Industrial Worker	Adult	Inhalation	Quant.	Sites 09 and 10 are intended to be redeveloped for commercial purposes; under a redevelopment scenario with minimal surface regrading, this exposure will be the same as today's current exposures.
		Vapors	Vapors from Surface Soil (0-2 feet bgs) (Outdoor Air)	Commercial/Industrial Worker	Adult	Inhalation	Quant.	Sites 09 and 10 are intended to be redeveloped for commercial purposes; under a redevelopment scenario with minimal surface regrading, this exposure will be the same as today's current exposures.

TABLE I-2.1: EPA RAGS PART D TABLE 2, OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN, SURFACE SOIL, SITE 09

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe: Current
Medium: Surface Soil (0 to 2 feet bgs)
Exposure Medium: Soil

Exposure Point	CAS Number	Chemical[1]	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening[2]	Background Value (mg/kg)[e]	Screening Toxicity Value[1]	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[3]
Soil at Site 09	**Metals**														
	7442995	Aluminum	3.41E+03	1.38E+04	mg/kg	09-SB12	23/23	-- --	1.38E+04	1190 - 18600	7.6E+04 N	--	--	NO	BSL, BAL
	7440360	Antimony	3.80E-02 J	4.15E+00 J	mg/kg	09-SB07	18/23	5.00E-02 - 1.71E+01	4.15E+00	0.38 - 18.2	3.1E+01 N	--	--	NO	BSL, BAL
	7440382	Arsenic	2.50E+00	1.77E+01	mg/kg	09-SB18	23/23	-- --	1.77E+01	1.1 - 14	2.2E+01 N	--	--	NO	BSL, BAL f
	7440393	Barium	8.90E+00	1.81E+02 J	mg/kg	09-SB12	23/23	-- --	1.81E+02	3.6 - 1090	5.4E+03 N	--	--	NO	BSL, BAL
	7440417	Beryllium	7.00E-02 J	3.60E-01 J	mg/kg	09-SB12	23/23	-- --	3.60E-01	0.02 - 0.77	1.5E+02 N	--	--	NO	BSL, BAL
	7440439	Cadmium	3.00E-02 J	8.90E-01 J	mg/kg	09-SB01	21/23	6.20E-01 - 1.10E+00	8.90E-01	0.02 - 9.2	3.7E+01 N	--	--	NO	BSL, BAL
	7440702	Calcium	2.28E+03	1.49E+04	mg/kg	09-SB16	23/23	-- --	1.49E+04	--	--	--	--	NO	NUT
	7440473	Chromium a	2.10E+01	5.92E+01	mg/kg	09-SB18	23/23	-- --	5.92E+01	10.7 - 191	2.1E+02 C	--	--	NO	BSL, BAL
	7440484	Cobalt	5.40E+00	1.39E+01 J	mg/kg	09-SB04	23/23	-- --	1.39E+01	4 - 26.7	9.0E+02 C	--	--	NO	BSL, BAL
	7440508	Copper	3.54E+00	3.21E+01	mg/kg	09-SB11	20/23	1.68E+01 - 3.36E+01	3.21E+01	1.9 - 1260	3.1E+03 N	--	--	NO	BSL, BAL
	7439896	Iron	8.58E+03	2.19E+04	mg/kg	09-SB04	23/23	-- --	2.19E+04	--	2.3E+04 N	--	--	NO	BSL
	7439921	Lead b	2.30E+00	4.88E+02	mg/kg	09-SB03/09-SB05	30/30	-- --	4.88E+02	0.73 - 51.4	1.5E+02 N	--	--	NO	BAL
	7439954	Magnesium	2.20E+03	6.09E+03	mg/kg	09-SB16	23/23	-- --	6.09E+03	--	--	--	--	NO	NUT
	7439965	Manganese	8.55E+01	4.28E+02	mg/kg	09-SB16	23/23	-- --	4.28E+02	58.9 - 1070	1.8E+03 N	--	--	NO	BSL, BAL
	7487947	Mercury	1.00E-02 J	1.40E-01	mg/kg	09-SB04	19/23	2.00E-02 - 1.80E-01	1.40E-01	0.03 - 2.4	2.3E+01 N	--	--	NO	BSL, BAL
	7439987	Molybdenum	8.00E-02	4.31E+00 J	mg/kg	09-SB12	12/23	8.00E-02 - 3.60E+00	4.31E+00	0.16 - 37.4	3.9E+02 N	--	--	NO	BSL, BAL
	7440020	Nickel c	1.98E+01 J	5.31E+01	mg/kg	09-SB04	23/23	-- --	5.31E+01	18 - 275	1.6E+03 N	--	--	NO	BSL, BAL
	7440097	Potassium	4.84E+02 J	1.08E+03 J	mg/kg	09-SB16	23/23	-- --	1.08E+03	--	--	--	--	NO	NUT
	7782492	Selenium	2.00E-01 J	6.00E-01 J	mg/kg	09-SB10	3/23	2.00E-01 - 1.10E+00	6.00E-01	0.67 - 1.4	3.9E+02 N	--	--	NO	BSL, BAL
	7440224	Silver	1.50E-02 J	2.90E+00 J	mg/kg	09-SB04	23/23	-- --	2.90E+00	0.1 - 2.4	3.9E+02 N	--	--	NO	BSL g
	7440235	Sodium	7.78E+01	6.84E+02	mg/kg	09-SB10	20/23	1.29E+02 - 1.92E+02	6.84E+02	--	--	--	--	NO	NUT
	7440280	Thallium	2.80E-02	1.46E-01	mg/kg	09-SB12	20/23	6.20E-01 - 1.10E+00	1.46E-01	0.3 - 1.2	5.2E+00 N	--	--	NO	BSL, BAL
	7440622	Vanadium	1.50E+01	4.88E+01	mg/kg	09-SB12	23/23	-- --	4.88E+01	11.4 - 47.3	5.5E+02 N	--	--	NO	BSL, BAL
	7440666	Zinc	1.55E+01	6.42E+02	mg/kg	09-SB07	23/23	-- --	6.42E+02	11.2 - 147	2.3E+04 N	--	--	NO	BSL, BAL
	Volatile Organic Chemicals														
	108101	4-Methyl-2-Pentanone	4.00E-03 J	4.00E-03 J	mg/kg	09-SB20	1/24	1.00E-02 - 3.20E-02	4.00E-03	--	7.9E+02 N	--	--	NO	BSL
	67641	Acetone	3.00E-01	3.00E-01	mg/kg	09-SB02	1/23	1.10E-02 - 1.20E-01	3.00E-01	--	1.6E+03 N	--	--	NO	BSL h
	75150	Carbon disulfide	4.00E-04 J	1.20E-03 J	mg/kg	09-SB17	3/23	5.10E-03 - 1.80E-02	1.20E-03	--	3.6E+02 N	--	--	NO	BSL
	108883	Toluene	1.20E-03 J	3.00E-03 J	mg/kg	09-SB02	2/23	5.10E-03 - 1.80E-02	3.00E-03	--	5.2E+02 sat	--	--	NO	BSL h
	Semivolatile Organic Chemicals														
	56553	Benzo(a)anthracene	1.80E-02 J	2.70E-02 J	mg/kg	09-SB21	8/24	1.30E-02 - 1.20E+00	2.70E-02	--	6.2E-01 C	--	--	NO	BSL
	50328	Benzo(a)pyrene	2.40E-02 J	1.00E-01	mg/kg	09-SB16	9/23	2.10E-02 - 1.20E+00	1.00E-01	--	6.2E-02 C	--	--	YES	ASL
	205992	Benzo(b)flouranthene	1.90E-02 J	6.50E-02	mg/kg	09-SB16	10/24	1.80E-02 - 1.20E+00	6.50E-02	--	6.2E-01 C	--	--	NO	BSL
	191242	Benzo(g,h,i)perlyene	2.70E-02 J	3.20E-01	mg/kg	09-SB07	13/24	2.10E-02 - 1.20E+00	3.20E-01	--	2.3E+03 N	--	--	NO	BSL
	207089	Benzo(k)flouranthene	3.00E-02 J	7.60E-02	mg/kg	09-SB16	7/24	2.10E-02 - 1.20E+00	7.60E-02	--	6.2E+00 C	--	--	NO	BSL
	218019	Chrysene	1.90E-02 J	6.60E-02	mg/kg	09-SB21	8/24	1.30E-02 - 1.20E+00	6.60E-02	--	6.2E+01 C	--	--	NO	BSL
	53703	Dibenz(a,h)anthracene	3.50E-02 J	3.80E-02 J	mg/kg	09-SB22	2/24	2.90E-02 - 1.20E+00	3.80E-02	--	6.2E-02 C	--	--	NO	BSL
	206440	Fluoranthene	2.30E-02 J	5.20E-02 J	mg/kg	09-SB06	8/24	1.20E-02 - 1.20E+00	5.20E-02	--	2.3E+03 N	--	--	NO	BSL
	193395	Indeno(1,2,3-cd)pyrene	4.40E-02 J	1.90E-01	mg/kg	09-SB07	5/24	4.10E-02 - 1.20E+00	1.90E-01	--	6.2E-01 C	--	--	NO	BSL
	91203	Naphthalene	3.80E-02 J	3.80E-02 J	mg/kg	09-SB12	1/44	5.10E-03 - 1.20E+00	3.80E-02	--	5.6E+01 N	--	--	NO	BSL
	85018	Phenanthrene d	1.40E-02 J	2.90E-02 J	mg/kg	09-SB22	4/24	1.10E-02 - 1.20E+00	2.90E-02	--	2.3E+03 N	--	--	NO	BSL
	108952	Phenol	1.10E+00	1.10E+00	mg/kg	09-HP001	1/24	2.10E-02 - 1.20E+00	1.10E+00	--	3.7E+04 N	--	--	NO	BSL
	129000	Pyrene	2.80E-02 J	6.70E-02	mg/kg	09-SB21	8/24	1.50E-02 - 1.20E+00	6.70E-02	--	2.3E+03 N	--	--	NO	BSL
	Pesticides													--	NO BSL
	72548	4,4-DDD	6.30E-03 J	6.30E-03 J	mg/kg	09-SB12	1/25	1.60E-04 - 7.60E-03	6.30E-03	--	2.4E+00 C	--	--	NO	BSL

TABLE I-2.2: EPA RAGS PART D TABLE 2, OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN, SURFACE AND SUBSURFACE SOIL, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe: Current/Future
Medium: Surface and Subsurface Soil (0 to 8 feet bgs)
Exposure Medium: Soil

Exposure Point	CAS Number	Chemical[1]	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening[2]	Background Value (mg/kg)[j]	Screening Toxicity Value[1]	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[3]
Soil at Site 09	**Metals**														
	742995	Aluminum	3.01E+03	1.56E+04 J	mg/kg	09-SB04	70/70	-- --	1.56E+04	1190 - 18600	7.6E+04 N	--	--	NO	BSL, BAL
	7440360	Antimony	3.10E-02 J	4.15E+00 J	mg/kg	09-SB07	39/70	2.70E-02 - 1.71E+01	4.15E+00	0.38 - 18.2	3.1E+01 N	--	--	NO	BSL, BAL
	7440382	Arsenic	2.10E+00 J	1.77E+01	mg/kg	09-SB18	70/70	-- --	1.77E+01	1.1 - 14	2.2E+01 N	--	--	NO	BSL, BAL i
	7440393	Barium	5.30E+00	1.81E+02 J	mg/kg	09-SB12	70/70	-- --	1.81E+02	3.6 - 1090	5.4E+03 N	--	--	NO	BSL, BAL
	7440417	Berylium	7.00E-02 J	4.20E-01 J	mg/kg	09-SB04	70/70	-- --	4.20E-01	0.02 - 0.77	1.5E+02 N	--	--	NO	BSL, BAL
	7440439	Cadmium	3.00E-02 J	8.90E-01 J	mg/kg	09-SB01	61/70	6.20E-01 - 1.10E-01	8.90E-01	0.02 - 9.2	3.7E+01 N	--	--	NO	BSL, BAL
	7440702	Calcium	1.26E+03	1.77E+04	mg/kg	09-SB14	70/70	-- --	1.77E+04	--	--	--	--	NO	NUT
	7440473	Chromium a	2.06E+01	5.96E+01	mg/kg	09-SB04	73/73	-- --	5.96E+01	10.7 - 191	2.1E+02 C	--	--	NO	BSL, BAL
	7440484	Cobalt	5.00E+00	1.47E+01	mg/kg	09-SB04	70/70	-- --	1.47E+01	4 - 26.7	9.0E+02 C	--	--	NO	BSL, BAL
	7440508	Copper	3.09E+00	2.37E+03	mg/kg	09-SB15	60/70	4.70E+00 - 3.36E+01	2.37E+03	1.9 - 1260	3.1E+03 N	--	--	NO	BSL, BAL
	7439896	Iron	7.68E+03	2.63E+04	mg/kg	09-SB04	70/70	-- --	2.63E+04	--	2.3E+04 N	--	--	YES	ASL
	7439921	Lead b	1.71E+00	4.88E+02	mg/kg	09-SB03/09-SB05	85/85	-- --	4.88E+02	0.73 - 51.4	1.5E+02 N	--	--	NO	BAL
	7439954	Magnesium	1.83E+03	8.13E+03	mg/kg	09-SB04	70/70	-- --	8.13E+03	--	--	--	--	NO	NUT
	7439965	Manganese	6.18E+01	4.28E+02	mg/kg	09-SB16	70/70	-- --	4.28E+02	58.9 - 1070	1.8E+03 N	--	--	NO	BSL, BAL
	7487947	Mercury	1.00E-02	1.40E-01	mg/kg	09-SB08	45/70	1.00E-02 - 1.80E-01	1.40E-01	0.03 - 2.4	2.3E+01 N	--	--	NO	BSL, BAL
	7439987	Molybdenum	6.00E-02	4.31E+00	mg/kg	09-SB12	28/70	6.00E-02 - 3.60E+00	4.31E+00	0.16 - 37.4	3.9E+02 N	--	--	NO	BSL, BAL
	7440020	Nickel c	1.86E+01 J	6.91E+01	mg/kg	09-SB04	70/70	-- --	6.91E+01	18 - 275	1.6E+03 N	--	--	NO	BSL, BAL
	7440097	Potassium	4.63E+02 J	2.13E+03	mg/kg	09-SB04	70/70	-- --	2.13E+03	--	--	--	--	NO	NUT
	7782492	Selenium	2.00E-01 J	6.00E-01 J	mg/kg	09-SB10	3/70	2.00E-01 - 1.10E+00	6.00E-01	0.67 - 1.4	3.9E+02 N	--	--	NO	BSL, BAL
	7440224	Silver	1.20E-02 J	2.90E+00 J	mg/kg	09-SB04	64/70	1.00E+00 - 1.10E+00	2.90E+00	0.1 - 2.4	3.9E+02 N	--	--	NO	BSL k
	7440235	Sodium	4.99E+01	6.84E+02	mg/kg	09-SB10	60/70	4.56E+01 - 2.17E+02	6.84E+02	--	--	--	--	NO	NUT
	7440280	Thallium	2.80E-02	1.46E-01	mg/kg	09-SB12	60/70	6.20E-01 - 1.10E+00	1.46E-01	0.3 - 1.2	5.2E+00 N	--	--	NO	BSL, BAL
	7440622	Vanadium	1.32E+01	4.88E+01	mg/kg	09-SB12	70/70	-- --	4.88E+01	11.4 - 47.3	5.5E+02 N	--	--	NO	BSL, BAL
	7440666	Zinc	1.37E+01	6.42E+02	mg/kg	09-SB07	63/70	1.84E+01 - 3.54E+01	6.42E+02	11.2 - 147	2.3E+04 N	--	--	NO	BSL, BAL
	Volatile Organic Chemicals														
	108101	4-Methyl-2-pentanone	4.00E-03 J	4.00E-03 J	mg/kg	09-SB20	1/69	1.00E-02 - 3.20E-02	4.00E-03	--	7.9E+02 N	--	--	NO	BSL
	67641	Acetone	3.00E-01	3.00E-01	mg/kg	09-SB02	1/70	4.00E-03 - 1.20E-01	3.00E-01	--	1.6E+03 N	--	--	NO	BSL l
	75150	Carbon disulfide	4.00E-04 J	1.20E-03 J	mg/kg	09-SB17	8/69	5.10E-03 - 1.80E-02	1.20E-03	--	3.6E+02 N	--	--	NO	BSL
	98828	Isopropylbenzene	6.70E-03	6.70E-03	mg/kg	09-SB23	1/59	5.10E-03 - 1.60E-02	6.70E-03	--	5.7E+02 N	--	--	NO	BSL
		Methylene Chloride	1.60E-01	1.60E-01	mg/kg	09-SB05	1/70	1.00E-02 - 9.30E-02	1.60E-01	--	9.1E+00 C	--	--	NO	BSL l
	1634044	MTBE	2.10E-03 J	2.10E-03 J	mg/kg	09-SB16	1/59	5.10E-03 - 1.60E-02	2.10E-03	--	6.2E+01 C	--	--	NO	BSL
	104518	n-Butylbenzene	2.70E-03 J	3.70E-02	mg/kg	09-SB23	2/59	5.10E-03 - 1.60E-02	3.70E-02	--	2.4E+02 sat	--	--	NO	BSL
	103651	n-Propylbenzene	7.80E-04 J	1.30E-02	mg/kg	09-SB23	2/59	5.10E-03 - 1.60E-02	1.30E-02	--	2.4E+02 sat	--	--	NO	BSL
	135988	S-Butylbenzene	1.50E-03 J	2.70E-02	mg/kg	09-SB23	2/59	5.10E-03 - 1.60E-02	2.70E-02	--	2.2E+02 sat	--	--	NO	BSL
	108883	Toluene	1.20E-03 J	3.00E-03 J	mg/kg	09-SB02	2/69	5.10E-03 - 1.80E-02	3.00E-03	--	5.2E+02 sat	--	--	NO	BSL l
	Semivolatile Organic Chemicals														
	106467	1,4-Dichlorobenzene	2.50E-02 J	2.50E-02 J	mg/kg	09-SB23	1/72	1.90E-02 - 1.20E+01	2.50E-02	--	3.4E+00 C	--	--	NO	BSL
	91576	2-Methylnaphthalene d	5.00E-01	1.80E+00	mg/kg	09-SB07	2/72	1.20E-02 - 1.20E+01	1.80E+00	--	5.6E+01 N	--	--	NO	BSL
	83329	Acenapthene e	5.50E-01	8.60E-01	mg/kg	09-SB07	2/72	1.40E-02 - 1.20E+01	8.60E-01	--	3.7E+03 N	--	--	NO	BSL
	56553	Benzo(a)anthracene	1.80E-02 J	3.70E-01 J	mg/kg	09-SB07	11/73	1.30E-02 - 1.20E+01	3.70E-01	--	6.2E-01 C	--	--	NO	BSL
	50328	Benzo(a)pyrene	2.40E-02 J	3.70E-01 J	mg/kg	09-SB07	16/72	2.10E-02 - 1.20E+00	3.70E-01	--	6.2E-02 C	--	--	YES	ASL
	205992	Benzo(b)fluoranthene	1.90E-02 J	2.20E-01 J	mg/kg	09-SB07	18/71	1.80E-02 - 1.20E+00	2.20E-01	--	6.2E-01 C	--	--	NO	BSL
	191242	Benzo(g,h,i)perylene f	2.60E-02 J	3.30E-01 J	mg/kg	09-SB07	21/71	2.10E-02 - 1.20E+00	3.30E-01	--	2.3E+03 N	--	--	NO	BSL
	207089	Benzo(k)fluoranthene	2.20E-02 J	3.10E-01 J	mg/kg	09-SB07	14/71	2.10E-02 - 1.20E+00	3.10E-01	--	6.2E+00 C	--	--	NO	BSL
	218019	Chrysene	1.90E-02 J	4.70E-01 J	mg/kg	09-SB07	11/72	1.30E-02 - 1.20E+01	4.70E-01	--	6.2E+01 C	--	--	NO	BSL
	53703	Dibenz(a,h)anthracene	3.40E-02 J	7.00E-02	mg/kg	09-SB11	4/71	2.90E-02 - 1.20E+00	7.00E-02	--	6.2E-02 C	--	--	YES	ASL
	132649	Dibenzofuran	1.10E+00	1.70E+00 J	mg/kg	09-SB07	2/72	1.30E-02 - 1.20E+01	1.70E+00	--	2.9E+02 N	--	--	NO	BSL
	206440	Fluoranthene	1.50E-02 J	6.20E-01	mg/kg	09-SB07	12/72	1.20E-02 - 1.20E+01	6.20E-01	--	2.3E+03 N	--	--	NO	BSL
	86737	Fluorene	1.90E+00	5.70E+00	mg/kg	09-SB07	2/72	1.40E-02 - 1.20E+01	5.70E+00	--	2.7E+03 N	--	--	NO	BSL
	193395	Indeno(1,2,3-cd)pyrene	4.40E-02 J	1.90E-01	mg/kg	09-SB07	8/71	4.10E-02 - 1.20E+00	1.90E-01	--	6.2E-01 C	--	--	NO	BSL
	91203	Naphthalene	2.40E-02	4.60E-01	mg/kg	09-SB23	3/132	5.10E-03 - 1.20E+01	4.60E-01	--	5.6E+01 N	--	--	NO	BSL
	85018	Phenanthrene f	1.40E-02 J	4.60E+00	mg/kg	09-SB07	7/72	1.10E-02 - 1.20E+01	4.60E+00	--	2.3E+03 N	--	--	NO	BSL
	108952	Phenol	1.10E+00	1.60E+01	mg/kg	09-HP002	2/72	2.10E-02 - 1.20E+00	1.60E+01	--	3.7E+04 N	--	--	NO	BSL
	129000	Pyrene	2.30E-02 J	8.90E-01	mg/kg	09-SB07	13/72	1.50E-02 - 1.20E+01	8.90E-01	--	2.3E+03 N	--	--	NO	BSL

TABLE I-2.3: EPA RAGS PART D TABLE 2, OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN, GROUNDWATER, SITE 09

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe: Future
Medium: Water
Exposure Medium: Water

Exposure Point	CAS Number	Chemical[1,7]		Minimum Concentration (Qualifier)		Maximum Concentration (Qualifier)		Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening[2]		Background Value	Screening Toxicity Value[1]		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[3]
Whole House Use of Shallow Groundwater at Site 09	**Metals**																			
	7429905	Aluminum		2.66E+01	J	1.14E+05		ug/L	09MW01199Q4024	9/16	2.68E+01 - 1.17E+02	2.04E+03		--	3.6E+04	N	1.00E+00	CalMCL	NO	BSL
	7440360	Antimony		5.20E-01	J	4.90E+00	J	ug/L	09MW01199Q4024	7/16	4.00E-01 - 7.90E+00	2.46E+00		--	1.5E+01	N	6.00E-02	CalMCL	NO	BSL
	7440382	Arsenic		3.80E+00	J	6.75E+01		ug/L	09MW01199Q4024	11/16	1.90E+00 - 5.30E+00	1.30E+01		--	4.5E-02	C	5.00E-02	CalMCL	YES	ASL
	7440393	Barium		3.20E+00	J	2.10E+02		ug/L	09MW01199Q4024	13/16	5.30E+00 - 7.80E+00	1.23E+02		--	2.6E+03	N	1.00E+00	CalMCL	NO	BSL
	7440702	Calcium		2.12E+04		3.07E+05		ug/L	09MW0730209GW07001	16/16		3.07E+05		--	--		--	--	NO	NUT
	7440473	Chromium	a	9.80E+00		5.16E+02		ug/L	09MW01199Q4024	6/16	2.80E-01 - 3.00E+00	9.80E+00		--	1.1E+02	N	5.00E-02	CalMCL	NO	BSL
	7440484	Cobalt		2.40E+00	J	1.26E+02		ug/L	09MW01199Q4024	6/16	5.60E-01 - 2.70E+00	2.40E+00		--	7.3E+02	N	--	--	NO	BSL
	7440508	Copper		1.80E+00		1.50E+02		ug/L	09MW01199Q4024	6/16	9.00E-01 - 9.90E+00	1.80E+00		--	1.5E+03	N	--	--	NO	BSL
	7439896	Iron		6.40E+00	J	2.31E+05		ug/L	09MW01199Q4024	13/16	1.99E+01 - 4.42E+01	3.93E+03		--	1.1E+04	N	--	--	NO	BSL
	7439921	Lead	b	1.22E-01	J	8.83E+01		ug/L	09MW01199Q4024	13/16	1.80E+00 - 1.90E+00	4.03E+00		--	1.5E+01	N	1.50E+01	Action Level	NO	BSL
	7439954	Magnesium		1.15E+04		6.15E+05		ug/L	09MW0730209GW07001	16/16		6.15E+05		--	--		--	--	NO	NUT
	7439965	Manganese		5.00E-01	J	1.80E+03		ug/L	09MW01199Q4024	13/16	4.00E-01 - 7.40E+00	7.10E+02		--	8.8E+02	N	--	--	NO	BSL
	7439976	Mercury		1.20E-01	J	1.20E+00		ug/L	09MW01199Q4024	2/16	1.00E-01 - 1.60E-01	1.00E-01	U	--	1.1E+01	N	2.00E-03	CalMCL	NO	BSL
	7439987	Molybdenum		1.00E+00	J	1.14E+01		ug/L	09MW0230209GW02001	12/16	9.20E-01 - 3.10E+00	1.14E+01		--	1.8E+02	N	--	--	NO	BSL
	7440020	Nickel		9.00E-01	J	4.45E+02		ug/L	09MW01199Q4024	12/16	9.00E-01 - 4.00E+00	1.19E+01		--	7.3E+02	N	1.00E-01	CalMCL	NO	BSL
	7440097	Potassium		1.59E+04		1.68E+05		ug/L	09MW0730209GW07001	16/16		1.68E+05		--	--		--	--	NO	NUT
	7782492	Selenium		4.80E+00	J	4.80E+00	J	ug/L	09MW01199Q4024	1/16	1.00E+00 - 5.00E+00	5.00E+00	UJ	--	1.8E+02	N	5.00E-02	CalMCL	NO	BSL
	7440224	Silver		1.60E-01	J	3.70E-01	J	ug/L	09MW0330209GW03001	8/16	4.00E-01 - 2.60E+00	3.70E-01		--	1.8E+02	N	--	--	NO	BSL
	7440235	Sodium		1.49E+04		4.48E+06		ug/L	09MW0730209GW07001	16/16		4.48E+06		--	--		--	--	NO	NUT
	7440280	Thallium		5.50E+00		5.50E+00		ug/L	09MW01199Q4024	1/16	8.00E-02 - 4.50E+00	8.00E-02	U	--	2.4E+00	N	2.00E-03	CalMCL	NO	BSL
	7440622	Vanadium		6.80E+00	J	4.11E+02		ug/L	09MW01199Q4024	6/16	5.20E-01 - 6.00E+00	6.80E+00		--	2.6E+02	N	--	--	NO	BSL
	7440666	Zinc		2.10E+00	J	4.98E+02	J	ug/L	09MW01199Q4024	9/16	2.00E+00 - 7.03E+01	2.60E+01		--	1.1E+04	N	--	--	NO	BSL
	Semivolatile Organic Chemicals																			
	91576	2-Methylnaphthalene		1.90E-02	J	2.50E-02	J	ug/L	09MW0230209GW02001	3/13	1.20E-02 - 1.00E+01	2.50E-02		--	6.2E+00	N	--	--	NO	BSL
	88755	2-Nitrophenol	c	1.10E-01	J	2.00E-01	J	ug/L	09MW0230209GW02001	2/13	1.40E-02 - 1.00E+01	2.00E-01		--	7.3E+01	N	--	--	NO	BSL
	83329	Acenaphthene		4.10E-02	J	1.10E+00		ug/L	09MW0530209GW05001	2/13	8.80E-03 - 1.00E+01	1.10E+00		--	3.7E+02	N	--	--	NO	BSL
	132649	Dibenzofuran		4.30E-02	J	2.50E+00		ug/L	09MW01199Q7009	2/13	1.40E-02 - 1.00E+01	2.50E+00		--	2.4E+01	N	--	--	NO	BSL
	86737	Fluorene		6.60E-02	J	6.60E-02	J	ug/L	09MW0430209GW04001	1/13	1.20E-02 - 1.00E+01	6.60E-02		--	2.4E+02	N	--	--	NO	BSL
	91203	Naphthlalene		2.50E-02	J	3.80E-02	J	ug/L	09MW0530209GW05001	4/21	1.20E-02 - 1.00E+01	3.80E-02		--	6.2E+00	N	--	--	NO	BSL
	87865	Pentachlorophenol		8.90E-02	J	8.90E-02	J	ug/L	09MW0730209GW07001	1/13	2.90E-02 - 2.50E+01	8.90E-02		--	5.6E-01	C	--	--	NO	BSL
	85018	Phenanthrene	d	3.00E-02	J	3.00E-02	J	ug/L	09MW01199Q7009	1/13	1.10E-02 - 1.00E+01	3.00E-02		--	1.8E+02	N	--	--	NO	BSL
	108952	Phenol		3.70E-02		8.80E+00		ug/L	09MW0230209GW02001	6/13	2.00E-02 - 1.00E+01	8.80E+00		--	2.2E+04	N	--	--	NO	BSL
	129000	Pyrene		2.30E-02	J	3.10E-02	J	ug/L	09MW0430209GW04001	3/13	1.50E-02 1.00E+01	3.10E-02		--	1.8E+02	N	--	--	NO	BSL
	Pesticides																			
	127890306	alpha-Chlordane	e	6.70E-03	J	6.70E-03	J	ug/L	09MW0530209GW05001	1/8	6.10E-03 - 6.10E-03	6.70E-03		--	1.9E-01	C	1.00E-04	CalMCL	NO	BSL
	33213659	Endosulfan II	f	1.40E-02		1.40E-02		ug/L	09MW0730209GW07001	1/8	5.90E-03 - 5.90E-03	1.40E-02		--	2.2E+02	N	--	--	NO	BSL
	58899	Gamma-BHC (Lindane)		7.10E-03	J	7.10E-03	J	ug/L	09MW0730209GW07001	1/8	4.20E-03 - 4.20E-03	7.10E-03		--	5.2E-02	C	2.00E-04	CalMCL	NO	BSL
	Volatile Organic Chemicals																			
	1634044	Methyl-Tert-Butyl Ether	g	3.00E-01	J	3.00E-01	J	ug/L	09MW0530209GW05001	4/11	1.00E+00 - 5.00E+00	3.00E-01		--	6.2E+00	N	1.30E-02	CalMCL	NO	BSL
	108383, 106423	m,p-Xylene	h	3.00E-01	J	3.00E-01	J	ug/L	09MW0530209GW05001	1/8	1.00E+00 - 1.00E+00	3.00E-01		--	2.3E+04	N	1.75E+00	CalMCL	NO	BSL

Notes:

(1) Screening toxicity values are EPA Region IX PRGs for tap water (assuming potential future whole-house use).
a = The U.S. EPA Preliminary Remediation Goal (PRG) for tap water for hexavalent chromium (EPA 2002b) was used as the screening value
b = The action level was used as the screening value for lead
c = The PRG for 2,4-dinitrophenol was used as the screening value
d = The PRG for pyrene was used as the screening value
e = The PRG for chlordane was used as the screening value
f = The PRG for endosulfan was used as the screening value
g = The Cal-Modified tap water PRG for MTBE is shown.
h = The PRG for xylenes was used as a surrogate

(2) Maximum detected concentration for the October 2002 sampling event was used as screening value. If compound had no detected results at during that sampling event, the detection limit was used as the screening value.

(3) Rationale Codes
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Below Screening Level (BSL)

Definitions:

ARAR/TBC = Applicable or relevant and appropriate requirement/to be considered
C = Carcinogenic
CalMCL = California Maximum Contaminant Level (DHS 2002)
COPC = Contaminant of potential concern
EPA = U.S. Environmental Protection Agency
J = Estimated value
MCL = Maximum contaminant level
mg/L = Milligrams per liter
N = Noncancer
NA = Not applicable
U = Nondetect at detection level stated. Historical data range shown at left.
ug/L = Microgram per liter
UJ = Nondetect at estimated detection level stated. Historical data shown at left.

TABLE I-2.4: EPA RAGS PART D TABLE 2, OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN, INDOOR AIR, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Indoor Air (Vapor)

Exposure Point	CAS Number	Chemical[1]	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening[2]	Background Value	Screening Toxicity Value[1]	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[3]
Water Vapor from Shallow Groundwater at Site 09	**Volatile Organic Chemicals**														
	1634044	Methyl-Tert-Butyl Ether	3.00E-01 J	3.00E-01 J	ug/L	09MW0530209GW05001	4/11	1.00E+00 - 5.00E+00	3.00E-01	--	1.2E+05 N	--	--	NO	BSL
	108383, 106423	m,p-Xylene	3.00E-01 J	3.00E-01 J	ug/L	09MW0530209GW05001	1/8	1.00E+00 - 1.00E+00	3.00E-01	--	2.3E+04 N	--	--	NO	BSL

Notes:

(1) Groundwater screening values are risk-based screening levels from Table 2c of EPA (2002c) draft vapor intrusion screening guidance.
(2) Maximum detected concentration for the October 2002 sampling event was used as screening value. If compound had no detected results at during that sampling event, the detection limit was used as the screening value.
(3) Vapor intrusion from volatile chemicals in groundwater to indoor is the only complete or potentially complete pathway evaluated; therefore, only volatile chemicals present at concentrations above their respective screening toxicity values were considered COPCs. A volatile chemical was defined as having a molecular weight less than 200 grams per mole and a Henry's Law constant greater than 10-5 atmospheres per cubic meter per mole.

Rationale Codes
Deletion Reason: Below Screening Level (BSL)

Definitions:
ARAR/TBC = Applicable or relevant and appropriate requirement/to be considered
COPC = Contaminant of potential concern
EPA = U.S. Environmental Protection Agency
J = Estimated value
N = Noncancer
-- = Not available

Reference:
EPA 2002c. Draft Vapor Intrusion Guidance. November. Available on-line at http://www.epa.gov/correctiveaction/eis/vapor.htm

TABLE I-2.5: EPA RAGS PART D TABLE 2, OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN, SURFACE SOIL, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe: Current/Future
Medium: Surface Soil (0 to 2 feet bgs)
Exposure Medium: Soil

Exposure Point	CAS Number	Chemical[1]	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening[2]	Background Value (mg/kg)[i]	Screening Toxicity Value[1]	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[3]
Soil at Site 10	**Metals**														
	742995	Aluminum	2.60E+03	7.40E+03	mg/kg	10-SB27	10/10	-- --	7.40E+03	1190 - 18600	7.6E+04 N	--	--	NO	BSL, BAL
	7440360	Antimony	1.10E-01 J	6.10E+00 J	mg/kg	07/10-HP010	4/10	8.00E-02 - 1.00E+01	6.10E+00	0.38 - 18.2	3.1E+01 N	--	--	NO	BSL, BAL
	7440382	Arsenic	4.60E+00 J	6.40E+00	mg/kg	10-SB26	10/10	-- --	6.40E+00	1.1 - 14	2.2E+01 N	--	--	NO	BSL, BAL j
	7440393	Barium	5.70E+00 J	6.11E+01	mg/kg	07/10-HP011	10/10	-- --	6.11E+01	3.6 - 1090	5.4E+03 N	--	--	NO	BSL, BAL
	7440417	Beryllium	9.00E-02 J	2.10E-01 J	mg/kg	10-SB02	6/10	2.00E-02 - 2.10E-01	2.10E-01	0.02 - 0.77	1.5E+02 N	--	--	NO	BSL, BAL
	7440439	Cadmium	3.00E-02 J	5.90E-01 J	mg/kg	07/10-HP011	5/10	4.00E-02 - 6.20E-01	5.90E-01	0.02 - 9.2	3.7E+01 N	--	--	NO	BSL, BAL
	7440702	Calcium	4.97E+03 J	1.76E+04 J	mg/kg	07/10-HP011	10/10	-- --	1.76E+04	--	--	--	--	NO	NUT
	7440473	Chromium a	2.15E+01	4.83E+01	mg/kg	07/10-HP010	10/10	-- --	4.83E+01	10.7 - 191	2.1E+02 C	--	--	NO	BSL, BAL
	7440484	Cobalt	4.60E+00	9.30E+00 J	mg/kg	07/10-HP010	10/10	-- --	9.30E+00	4 - 26.7	9.0E+02 C	--	--	NO	BSL, BAL
	7440508	Copper	3.20E+00 J	6.00E+01	mg/kg	07/10-HP011	10/10	-- --	6.00E+01	1.9 - 1260	3.1E+03 N	--	--	NO	BSL, BAL
	7439896	Iron	9.40E+03	1.70E+04	mg/kg	10-SB27	10/10	-- --	1.70E+04	--	2.3E+04 N	--	--	NO	BSL
	7439921	Lead b	2.45E+00 J	1.12E+02	mg/kg	07/10-HP010	12/12	-- --	1.12E+02	0.73 - 51.4	1.5E+02 N	--	--	NO	BSL, BAL
	7439954	Magnesium	3.15E+03	6.03E+03	mg/kg	07/10-HP010	10/10	-- --	6.03E+03	--	--	--	--	NO	NUT
	7439965	Manganese	1.78E+02 J	3.27E+02 J	mg/kg	10-SB29	10/10	-- --	3.27E+02	58.9 - 1070	1.8E+03 N	--	--	NO	BSL, BAL
	7487947	Mercury	1.00E-02 J	8.00E-02 J	mg/kg	07/10-HP011	5/10	5.00E-02 - 1.00E-01	8.00E-02	0.03 - 2.4	2.3E+01 N	--	--	NO	BSL, BAL
	7439987	Molybdenum	7.00E-02	1.90E-01	mg/kg	10-SB27	4/10	1.80E-01 - 2.10E+00	1.90E-01	0.16 - 37.4	3.9E+02 N	--	--	NO	BSL, BAL
	7440020	Nickel c	2.20E+01	4.80E+01	mg/kg	10-SB29	10/10	-- --	4.80E+01	18 - 275	1.6E+03 N	--	--	NO	BSL, BAL
	7440097	Potassium	4.21E+02 J	1.42E+03	mg/kg	10-SB27	10/10	-- --	1.42E+03	--	--	--	--	NO	NUT
	7440224	Silver	1.10E-02 J	4.60E-02	mg/kg	10-SB27	4/10	1.20E-01 - 1.00E+00	4.60E-02	0.1 - 2.4	3.9E+02 N	--	--	NO	BSL, BAL
	7440235	Sodium	1.08E+02 J	7.30E+02	mg/kg	10-SB27	9/10	1.03E+02 - 1.03E+02	7.30E+02	--	--	--	--	NO	NUT
	7440280	Thallium	1.40E-02 J	5.70E-02	mg/kg	10-SB27	4/10	4.10E-01 - 6.20E-01	5.70E-02	0.3 - 1.2	5.2E+00 N	--	--	NO	BSL, BAL
	7440622	Vanadium	1.41E+01	2.88E+01	mg/kg	10-SB27	10/10	-- --	2.88E+01	11.4 - 47.3	5.5E+02 N	--	--	NO	BSL, BAL
	7440666	Zinc	1.37E+01	3.31E+02	mg/kg	07/10-HP010	10/10	-- --	3.31E+02	11.2 - 147	2.3E+04 N	--	--	NO	BSL, BAL
	Semivolatile Organic Chemicals														
	56553	Benzo(a)anthracene	1.60E-02 J	3.20E-02 J	mg/kg	10-SB15	2/21	1.30E-02 - 6.80E-01	3.20E-02	--	6.2E-01 C	--	--	NO	BSL
	50328	Benzo(a)pyrene	4.10E-02 J	5.50E-02	mg/kg	10-SB15	3/21	2.10E-02 - 6.80E-01	5.50E-02	--	6.2E-02 C	--	--	NO	BSL
	205992	Benzo(b)fluoranthene	1.80E-02 J	7.20E-02	mg/kg	10-SB16	6/21	1.80E-02 - 6.80E-01	7.20E-02	--	6.2E-01 C	--	--	NO	BSL
	191242	Benzo(g,h,i)perylene d	5.10E-02 J	1.20E-01	mg/kg	10-SB17	5/21	2.10E-02 - 6.80E-01	1.20E-01	--	2.3E+03 N	--	--	NO	BSL
	207089	Benzo(k)fluoranthene	3.10E-02 J	5.30E-02	mg/kg	10-SB15	3/21	2.00E-02 - 6.80E-01	5.30E-02	--	6.2E+00 C	--	--	NO	BSL
	53703	Dibenz(a,h)anthracene	3.20E-02 J	6.30E-02	mg/kg	10-SB17	3/21	2.80E-02 - 6.80E-01	6.30E-02	--	6.2E-02 C	--	--	YES	ASL
	206440	Fluoranthene	1.60E-02 J	1.60E-02 J	mg/kg	10-SB28	1/21	1.20E-02 - 6.80E-01	1.60E-02	--	2.3E+03 N	--	--	NO	BSL
	193395	Indeno(1,2,3-cd)pyrene	5.00E-02 J	8.80E-02	mg/kg	10-SB17	3/21	4.00E-02 - 6.80E-01	8.80E-02	--	6.2E-01 C	--	--	NO	BSL
	85018	Phenanthrene d	1.30E-02 J	1.40E-02 J	mg/kg	10-SB23	2/21	1.10E-02 - 6.80E-01	1.40E-02	--	2.3E+03 N	--	--	NO	BSL
	108952	Phenol	2.10E-01 J	7.50E-01	mg/kg	07/10-HP011	4/21	2.00E-02 - 6.80E-01	7.50E-01	--	3.7E+04 N	--	--	NO	BSL
	129000	Pyrene	2.10E-02 J	3.50E-02 J	mg/kg	10-SB24	2/21	1.50E-02 - 6.80E-01	3.50E-02		2.3E+03 N	--	--	NO	BSL
	Pesticides									--					
	72548	4,4'-DDD	3.70E-03 J	1.00E+00	mg/kg	10-SB12	8/23	1.60E-04 - 3.50E-03	1.00E+00	--	2.4E+00 C	--	--	NO	BSL
	72559	4,4'-DDE e	2.10E-03 J	1.10E-01 J	mg/kg	10-SB12	6/23	2.50E-04 - 3.70E-02	1.10E-01	--	1.7E+00 C	--	--	NO	BSL
	50293	4,4'-DDT	4.10E-03	7.50E-01	mg/kg	10-SB12	10/23	1.80E-04 - 3.50E-03	7.50E-01	--	1.7E+00 C	--	--	NO	BSL
	1031078	Endosulfan Sulfate f	8.40E-04 J	3.90E-01	mg/kg	10-SB12	5/23	1.70E-04 - 1.10E-02	3.90E-01	--	3.7E+02 N	--	--	NO	BSL
	7421934	Endrin Aldehyde g	1.40E-02	1.50E-02	mg/kg	10-SB12	2/23	3.60E-04 - 3.70E-03	1.50E-02	--	1.8E+01 N	--	--	NO	BSL
	127890306	Gamma-Chlordane h	1.80E-03	3.60E-01	mg/kg	10-SB07	11/23	1.50E-04 - 1.80E-03	3.60E-01	--	1.6E+00 C	--	--	NO	BSL
	76448	Heptachlor	5.70E-04 J	4.10E-02	mg/kg	10-SB07	6/23	1.40E-04 - 1.90E-03	4.10E-02	--	1.1E-01 C	--	--	NO	BSL
	1024573	Heptachlor Expoxide	1.90E-03	1.60E-02	mg/kg	10-SB07	4/23	1.40E-04 - 6.10E-03	1.60E-02	--	5.3E-02 C	--	--	NO	BSL
	127890306	Alpha-Chlordane h	1.40E-03	3.00E-01	mg/kg	10-SB07	11/23	1.10E-04 - 1.80E-03	3.00E-01	--	1.6E+00 C	--	--	NO	BSL
	75990	Dalapon	1.05E-01	1.05E-01	mg/kg	10-SB04	1/4	4.94E-02 - 5.40E-02	1.05E-01	--	1.8E+03 N	--	--	NO	BSL
	Petroleum Hydrocarbons									--					
	NA	Diesel Range Organics	3.40E+01 H	3.60E+01 Y	mg/kg	07/10-HP012	2/12	4.30E+00 - 2.60E+02	3.60E+01	--	5.0E+02 N	--	--	NO	BSL
	NA	Motor Oil Range Organics	8.30E+01 Y	1.40E+03 Y	mg/kg	07/10-HP011	5/9	4.30E+00 - 1.00E+01	8.30E+01	--	5.0E+02 N	--	--	NO	See Section 10.4

Notes:

(1) Screening values are risk-based screening levels from the Region IX Preliminary Remediation Goals (PRG) (EPA 2002b) for the residential soil scenario.
a = The PRG for total chromium was used as a surrogate
b = The maximum concentration was screened against the Cal-modified PRG for lead.

Definitions:

ARAR/TBC = Applicable or relevant and appropriate requirement/to be considered
bgs = Below ground surface
C = Carcinogenic

TABLE I-2.6: EPA RAGS PART D TABLE 2, OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN, SURFACE AND SUBSURFACE SOIL, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe: Current/Future
Medium: Surface and Subsurface Soil (0 to 8 feet bgs)
Exposure Medium: Soil

Exposure Point	CAS Number	Chemical[1]	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening[2]	Background Value (mg/kg)[i]	Screening Toxicity Value[1]	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[3]
Soil at Site 10	**Metals**														
	742995	Aluminum	2.60E+03	9.84E+03	mg/kg	10-SB02	28/28	-- - --	9.84E+03	1190 - 18600	7.6E+04 N	--	--	NO	BSL, BAL
	7440360	Antimony	1.10E-01 J	6.10E+00 J	mg/kg	07/10-HP010	5/28	6.00E-02 - 1.26E+01	6.10E+00	0.38 - 18.2	3.1E+01 N	--	--	NO	BSL, BAL
	7440382	Arsenic	4.50E+00 J	1.27E+01	mg/kg	10-SB27	28/28	-- --	1.27E+01	1.1 - 14	2.2E+01 N	--	--	NO	BSL, BAL j
	7440393	Barium	5.00E+00 J	6.11E+01	mg/kg	07/10-HP011	28/28	-- --	6.11E+01	3.6 - 1090	5.4E+03 N	--	--	NO	BSL, BAL
	7440417	Beryllium	7.00E-02 J	2.50E-01 J	mg/kg	10-SB02	18/28	2.00E-02 - 2.30E-01	2.50E-01	0.02 - 0.77	1.5E+02 N	--	--	NO	BSL, BAL
	7440439	Cadmium	3.00E-02 J	5.90E-01 J	mg/kg	07/10-HP011	14/28	4.00E-02 - 7.60E-01	5.90E-01	0.02 - 9.2	3.7E+01 N	--	--	NO	BSL, BAL
	7440702	Calcium	2.47E+03 J	2.31E+04 J	mg/kg	10-SB04	28/28	-- --	2.31E+04	--	--	--	--	NO	NUT
	7440473	Chromium a	1.60E+01 J	8.95E+01	mg/kg	10-SB02	31/31	-- --	8.95E+01	10.7 - 191	2.1E+02 C	--	--	NO	BSL, BAL
	7440484	Cobalt	4.30E+00	1.36E+01	mg/kg	10-SB02	27/28	5.90E+00 - 5.90E+00	1.36E+01	4 - 26.7	9.0E+02 C	--	--	NO	BSL, BAL
	7440508	Copper	2.90E+00 J	6.00E+01	mg/kg	07/10-HP011	27/28	3.60E+00 - 3.60E+00	6.00E+01	1.9 - 1260	3.1E+03 N	--	--	NO	BSL, BAL
	7439896	Iron	9.40E+03	2.49E+04	mg/kg	10-SB02	28/28	-- --	2.49E+04	--	2.3E+04 N	--	--	YES	ASL
	7439921	Lead b	2.32E+00	1.12E+02	mg/kg	07/10-HP010	32/32	-- --	1.12E+02	0.73 - 51.4	1.5E+02 N	--	--	NO	BSL, BAL k
	7439954	Magnesium	2.66E+03	9.36E+03	mg/kg	10-SB02	28/28	-- --	9.36E+03	--	--	--	--	NO	NUT
	7439965	Manganese	1.62E+02	6.61E+02 J	mg/kg	10-SB04	28/28	-- --	6.61E+02	58.9 - 1070	1.8E+03 N	--	--	NO	BSL, BAL
	7487947	Mercury	1.00E-02 J	8.00E-02 J	mg/kg	07/10-HP011	11/28	1.00E-02 - 1.30E-01	8.00E-02	0.03 - 2.4	2.3E+01 N	--	--	NO	BSL, BAL
	7439987	Molybdenum	7.00E-02	1.16E+01	mg/kg	SS-6-01	13/28	1.80E-01 - 2.50E+00	1.16E+01	0.16 - 37.4	3.9E+02 N	--	--	NO	BSL, BAL
	7440020	Nickel c	1.72E+01	9.32E+01	mg/kg	10-SB02	28/28	-- --	9.32E+01	18 - 275	1.6E+03 N	--	--	NO	BSL, BAL
	7440097	Potassium	4.21E+02 J	1.42E+03	mg/kg	10-SB27	28/28	-- --	1.42E+03	--	--	--	--	NO	BSL
	7782492	Selenium	4.40E-01	4.40E-01	mg/kg	SS-6-01	1/28	2.00E-01 - 7.60E-01	4.40E-01	0.67 - 1.4	3.9E+02 N	--	--	NO	BSL, BAL
	7440224	Silver	1.00E-02 J	1.80E+00 J	mg/kg	10-SB02	14/28	1.20E-01 - 1.20E+00	1.80E+00	0.1 - 2.4	3.9E+02 N	--	--	NO	BSL, BAL
	7440235	Sodium	9.93E+01 J	7.30E+02	mg/kg	10-SB27	25/28	9.53E+01 - 1.03E+02	7.30E+02	--	--	--	--	NO	NUT
	7440280	Thallium	1.20E-02 J	3.90E-01	mg/kg	SS-6-01	13/28	4.10E-01 - 7.60E-01	3.90E-01	0.3 - 1.2	5.2E+00 N	--	--	NO	BSL, BAL
	7440622	Vanadium	1.41E+01	3.91E+01	mg/kg	10-SB02	28/28	-- --	3.91E+01	11.4 - 47.3	5.5E+02 N	--	--	NO	BSL, BAL
	7440666	Zinc	1.37E+01	3.31E+02	mg/kg	07/10-HP010	28/28	-- --	3.31E+02	11.2 - 147	2.3E+04 N	--	--	NO	BSL, BAL
	Semivolatile Organic Chemicals														
	120127	Anthracene	4.10E-02 J	1.70E-01	mg/kg	10-SB17	3/62	1.50E-02 - 8.30E-01	1.70E-01	--	2.2E+04 N	--	--	NO	BSL
	56553	Benzo(a)anthracene	1.60E-02 J	2.90E-01	mg/kg	10-SB17	8/62	1.30E-02 - 8.30E-01	2.90E-01	--	6.2E-01 C	--	--	NO	BSL
	50328	Benzo(a)pyrene	2.20E-02 J	3.00E-01 J	mg/kg	10-SB17	8/62	2.10E-02 - 8.30E-01	3.00E-01	--	6.2E-02 C	--	--	YES	ASL
	205992	Benzo(b)fluoranthene	1.80E-02 J	1.60E-01	mg/kg	10-SB17	12/62	1.80E-02 - 8.30E-01	1.60E-01	--	6.2E-01 C	--	--	NO	BSL
	191242	Benzo(g,h,i)perylene d	2.30E-02 J	2.50E-01	mg/kg	10-SB17	11/62	2.10E-02 - 8.30E-01	2.50E-01	--	2.3E+03 N	--	--	NO	BSL
	207089	Benzo(k)fluoranthene	2.70E-02 J	2.50E-01	mg/kg	10-SB17	8/62	2.00E-02 - 8.30E-01	2.50E-01	--	6.2E+00 C	--	--	NO	BSL
	218019	Chrysene	1.50E-02 J	3.10E-01	mg/kg	10-SB17	7/62	1.20E-02 - 8.30E-01	3.10E-01	--	6.2E+01 C	--	--	NO	BSL
	53703	Dibenzo(a,h)anthracene	3.10E-02 J	6.30E-02	mg/kg	10-SB17	4/62	2.80E-02 - 8.30E-01	6.30E-02	--	6.2E-02 C	--	--	YES	ASL
	206440	Fluoranthene	1.60E-02 J	5.40E-01	mg/kg	10-SB17	9/62	1.20E-02 - 8.30E-01	5.40E-01	--	2.3E+03 N	--	--	NO	BSL
	193395	Indeno(1,2,3-cd)pyrene	5.00E-02 J	2.50E-01	mg/kg	10-SB17	5/62	4.00E-02 - 8.30E-01	2.50E-01	--	6.2E-01 C	--	--	NO	BSL
	85018	Phenanthrene d	1.30E-02 J	6.10E-01	mg/kg	10-SB17	7/62	1.10E-02 - 8.30E-01	6.10E-01	--	2.3E+03 N	--	--	NO	BSL
	108952	Phenol	2.10E-01 J	1.60E+00	mg/kg	07/10-HP013	9/62	2.00E-02 - 8.30E-01	1.60E+00	--	3.7E+04 N	--	--	NO	BSL
	129000	Pyrene	1.90E-02 J	6.80E-01	mg/kg	10-SB17	11/62	1.50E-02 - 8.30E-01	6.80E-01	--	2.3E+03 N	--	--	NO	BSL
	Pesticides									--					
	72548	4,4'-DDD	5.50E-04 J	1.00E+00	mg/kg	10-SB12	12/69	1.60E-04 - 4.10E-03	1.00E+00	--	2.4E+00 C	--	--	NO	BSL
	72559	4,4'-DDE e	2.10E-03 J	1.10E-01 J	mg/kg	10-SB12	7/69	2.50E-04 - 4.10E-03	1.10E-01	--	1.7E+00 C	--	--	NO	BSL
	50293	4,4'-DDT	2.80E-04 J	7.50E-01	mg/kg	10-SB12	14/69	1.80E-04 - 4.10E-03	7.50E-01	--	1.7E+00 C	--	--	NO	BSL
	1031078	Endosulfan Sulfate f	8.40E-04 J	3.90E-01	mg/kg	10-SB12	5/69	1.70E-04 - 1.10E-03	3.90E-01	--	3.7E+02 N	--	--	NO	BSL
	7421934	Endrin Aldehyde g	1.28E-02 J	1.50E-02	mg/kg	10-SB12	3/69	3.60E-04 - 4.10E-03	1.50E-02	--	1.8E+01 N	--	--	NO	BSL

TABLE I-2.7: EPA RAGS PART D TABLE 2, OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN, GROUNDWATER, SITE 10

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater (Whole House Use)

Exposure Point	CAS Number	Chemical[1]	Minimum Concentration (Qualifier)		Maximum Concentration (Qualifier)		Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening[2]		Background Value	Screening Toxicity Value[1]		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[3]
	Metals																		
Whole House Use of Shallow Groundwater at Site 10	7429905	Aluminum	3.11E+01	J	8.42E+04		ug/L	14MW03199Q4055	11/14	1.63E+01 - 7.34E+01	3.49E+02		--	3.6E+04	N	1.00E+00	CalMCL	NO	BSL
	7440360	Antimony	4.80E-01	J	4.30E+00	J	ug/L	14MW03199Q4055	2/14	1.20E+00 - 6.10E+00	4.80E-01		--	1.5E+01	N	6.00E-02	CalMCL	NO	BSL
	7440382	Arsenic	9.00E+00	J	8.00E+01		ug/L	14MW03199Q4055	14/14		1.48E+01		--	4.5E-02	C	5.00E-02	CalMCL	YES	ASL
	7440393	Barium	2.10E+00	J	2.04E+02		ug/L	14MW03199Q4055	12/14	3.40E+00 - 1.07E+01	1.63E+01		--	2.6E+03	N	1.00E+00	CalMCL	NO	BSL
	7440417	Beryllium	3.60E-01	J	3.60E-01	J	ug/L	14MW03199Q4055	1/14	1.00E-01 - 4.70E-01	4.00E-01	U	--	7.3E+01	N	4.00E-03	CalMCL	NO	BSL
	7440702	Calcium	3.49E+04		1.85E+05		ug/L	0710MW01199Q5008	14/14		8.12E+04		--	--		--	--	NO	NUT
	7440473	Chromium	3.60E+00	J	3.38E+02		ug/L	14MW03199Q4055	10/14	5.70E-01 - 2.20E+00	3.60E+00		--	1.1E+02	N	5.00E-02	CalMCL	NO	BSL
	7440484	Cobalt	1.00E+00	J	8.32E+01		ug/L	14MW03199Q4055	10/14	4.10E-01 - 3.00E+00	2.00E+00	U	--	7.3E+02	N	--	--	NO	BSL
	7440508	Copper	9.30E+00	J	1.67E+02		ug/L	14MW03199Q4055	6/14	9.00E-01 - 1.00E+01	9.00E-01	U	--	1.5E+03	N	--	--	NO	BSL
	7439896	Iron	4.15E+01		1.76E+05		ug/L	14MW03199Q4055	11/14	1.99E+01 - 2.49E+01	1.03E+03		--	1.1E+04	N	--	--	NO	BSL
	7439921	Lead	4.27E-01		1.38E+02		ug/L	14MW03199Q4055	10/14	7.80E-01 - 2.60E+00	4.27E-01		--	1.5E+01	N	1.50E+01	Action Level	NO	BSL
	7439954	Magnesium	1.15E+04		9.22E+04		ug/L	0710MW01199Q5008	14/14		8.23E+04		--	--		--	--	NO	NUT
	7439965	Manganese	2.40E+00	J	3.35E+03		ug/L	0710MW01199Q5008	12/14	4.10E+00 - 9.20E+00	6.28E+02		--	8.8E+02	N	--	--	NO	BSL
	7439976	Mercury	1.10E-01	J	1.30E+00	J	ug/L	14MW03199Q4055	5/14	1.00E-01 - 3.20E-01	1.00E-01	U	--	1.1E+01	N	2.00E-03	CalMCL	NO	BSL
	7439987	Molybdenum	1.00E+00	J	5.43E+00		ug/L	10MW0330210GW03001	8/14	1.10E+00 - 5.50E+00	5.43E+00		--	1.8E+02	N	--	--	NO	BSL
	7440020	Nickel	1.10E+00	J	2.98E+02		ug/L	14MW03199Q4055	12/14	2.10E+00 - 2.90E+00	1.10E+00		--	7.3E+02	N	1.00E-01	CalMCL	NO	BSL
	7440097	Potassium	1.54E+04		4.59E+04		ug/L	10MW0330210GW03001	14/14		4.59E+04		--	--		--	--	NO	NUT
	7782492	Selenium	2.20E+00	J	2.20E+00	J	ug/L	14MW03284Q8134	1/14	1.00E+00 - 4.00E+00	1.00E+00	U	--	1.8E+02	N	5.00E-02	CalMCL	NO	BSL
	7440224	Silver	3.50E-01	J	3.50E-01	J	ug/L	10MW0330210GW03001	1/14	2.80E-01 - 1.90E+00	3.50E-01		--	1.8E+02	N	--	--	NO	BSL
	7440235	Sodium	1.30E+04		7.76E+05		ug/L	0710MW01199Q5008	14/14		6.19E+05		--	--		--	--	NO	NUT
	7440280	Thallium	3.80E+00	J	3.80E+00	J	ug/L	0710MW01199Q5008	1/14	8.00E-02 - 3.90E+00	8.00E-02	U	--	2.4E+00	N	2.00E-03	CalMCL	NO	BSL
	7440622	Vanadium	4.70E+00	J	2.91E+02		ug/L	14MW03199Q4055	11/14	3.80E+00 - 6.00E+00	6.00E+00	U	--	2.6E+02	N	--	--	NO	BSL
	7440666	Zinc	2.20E+00	J	4.79E+02	J	ug/L	14MW03199Q4055	10/14	4.30E+00 - 6.65E+01	5.10E+00		--	1.1E+04	N	--	--	NO	BSL
	Semivolatile Organic Chemicals																		
	206440	Fluoranthene	3.10E-02	J	3.10E-02	J	ug/L	10MW0330210GW03001	1/12	1.00E+00 - 1.00E+01	3.10E-02		--	1.5E+03	N	--	--	NO	BSL
	108952	Phenol	1.10E-01	J	1.10E-01	J	ug/L	10MW0330210GW03001	1/12	1.00E+00 - 1.00E+01	1.10E-01		--	2.2E+04	N	--	--	NO	BSL
	129000	Pyrene	3.40E-02	J	3.40E-02	J	ug/L	10MW0330210GW03001	1/12	1.00E+00 - 1.00E+01	3.40E-02		--	1.8E+02	N	--	--	NO	BSL
	Volatile Organic Chemicals																		
	75150	Carbon disulfide	3.00E-01		4.00E-01		ug/L	0710MW01199Q7008	2/14	5.00E-01 - 2.00E+00	1.00E+00	U	--	1.0E+03	N	--	--	NO	BSL
	1634044	Methyl-Tert-Butyl Ether	1.00E+00	J	4.00E+00	J	ug/L	14MW03196Q4086	3/6	5.00E-01 - 1.00E+00	1.00E+00	U	--	6.2E+00	N	1.30E-02	CalMCL	NO	BSL
	127184	Tetrachloroethene	9.00E-02	J	9.00E-02	J	ug/L	0710MW01199Q6008	1/15	5.00E-01 - 2.00E+00	1.00E+00	U	--	6.6E-01	C	5.00E-03	CalMCL	NO	BSL

Notes:

(1) Screening toxicity values are EPA Region IX PRGs for tap water (assuming potential future whole-house use).

(2) Maximum detected concentration for the October 2002 sampling event was used as screening value. If compound had no detected results at during that sampling event, the detection limit is shown. Half the detection limit may be considered as the concentration used for screening.

(3) Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Below Screening Level (BSL)
Trace Nutrient (NUT)

Definitions:

ARAR/TBC = Applicable or relevant and appropriate requirement/to be considered
C = Carcinogenic
CalMCL = California Maximum Contaminant Level (DHS 2002)
COPC = Contaminant of potential concern
EPA = U.S. Environmental Protection Agency
J = Estimated value
MCL = Maximum contaminant level
mg/L = Milligrams per liter
N = Noncancer
NA = Not applicable
U = Nondetect at detection level stated. Historical data range shown at left.
ug/L = Microgram per liter
UJ = Nondetect at estimated detection level stated. Historical data shown at left.
-- = Not available

References:

CRWQCB 2001Primary Standards - Inorganic Chemicals." February 22. Available on-line at http://www.dhs.cahwnet.gov/ps/ddwem/chemicals/MCL/mclindex.htm
DHS 2002. "Title 22 California Code of Regulations; Division 4 Environmental Health; Chapter 15 Domestic Water Quality and Monitoring; Article 4
EPA 2002b. "Region IX Preliminary Remediation Goals." October. Available on-line at http://www.epa.gov/region09/waste/sfund/prg/.

TABLE I-2.8: EPA RAGS PART D TABLE 2, OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN, INDOOR AIR, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Indoor Air (Vapor)

Exposure Point	CAS Number	Chemical[1]	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening[2]	Background Value	Screening Toxicity Value[1]	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[3]
Water Vapor from Shallow Groundwater at Site 10	**Volatile Organic Chemicals**														
	75150	Carbon disulfide	3.00E-01	4.00E-01	ug/L	0710MW01199Q7008	2/14	5.00E-01 - 2.00E+00	1.00E+00 U	--	5.6E+02 N	--	--	NO	BSL
	1634044	Methyl-Tert-Butyl Ether	1.00E+00 J	4.00E+00 J	ug/L	14MW03196Q4086	3/6	5.00E-01 - 1.00E+00	1.00E+00 U	--	1.2E+05 N	--	--	NO	BSL
	127184	Tetrachloroethene	9.00E-02 J	9.00E-02 J	ug/L	0710MW01199Q6008	1/15	5.00E-01 - 2.00E+00	1.00E+00 U	--	5.0E+00 M	--	--	NO	BSL

Notes:

(1) Groundwater screening values are risk-based screening levels from Table 2c of EPA (2002c) draft vapor intrusion screening guidance.

(2) Maximum detected concentration for the October 2002 sampling event was used as screening value. If compound had no detected results at during that sampling event, the detection limit was used as the screening value.

(3) Vapor intrusion from volatile chemicals in groundwater to indoor is the only complete or potentially complete pathway evaluated; therefore, only volatile chemicals present at concentrations above their respective screening toxicity values were considered COPCs. A volatile chemical was defined as having a molecular weight less than 200 grams per mole and a Henry's Law constant greater than 10-5 atmospheres per cubic meter per mole.

Rationale Codes
Deletion Reason: Below Screening Level (BSL)

Definitions:
ARAR/TBC = Applicable or relevant and appropriate requirement/to be considered
COPC = Contaminant of potential concern
EPA = U.S. Environmental Protection Agency
J = Estimated value
M = Screening Level Equals Maximum Contaminant Level
N = Noncancer
ug/L = Microgram per liter
-- = Not available

Reference:

EPA 2002c. Draft Vapor Intrusion Guidance. November. Available on-line at http://www.epa.gov/correctiveaction/eis/vapor.htm

TABLE I-3.1: EXPOSURE POINT CONCENTRATION SUMMARY REASONABLE MAXIMUM EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Medium:	Soil (0-2 feet bgs)
Exposure Medium:	Site 9 Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	UCL_{95} (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale[a]
Site 9	Benzo(a)pyrene	mg/kg	8.70E-02	3.35E-01 NT	1.00E-01	1.00E-01	mg/kg	MAX	(1)
	Lead[b]	mg/kg	2.01E+01	3.81E+01 T	4.88E+02	3.81E+01	mg/kg	UCL_{95}-T	(2)

Notes:

See Attachment I3 for a description of the statistical methods used.

a The lesser of the UCL_{95} and maximum detected concentration was used as the exposure point concentration (EPC).

b The maximum concentration for lead was based on an average of two soil borings (09-SB03 and 09-SB05) because 09-SB03 was considered to be an outlier when compared to other samples; therefore, the sample location was resampled and the results of the two sample events were averaged. Although the two-population test confirmed lead to be not significantly greater than ambient fill concentrations (see Attachment I3), an EPC was calculated to facilitate comparison to the Cal-modied Preliminary Remediation Goal of 150 mg/kg.

For chemicals detected in at least 85% of the samples censored data were replaced with one-half of the reported concentration. For detection frequencies less than 85% censored measurements were treated as random variables that could assume any value between zero and the reported concentration (see note under NP).

UCL_{95}	One-sided 95 percent upper confidence limit of the mean
ft bgs	Feet below ground surface
MAX	Maximum detected concentration
mg/kg	Milligrams per kilogram
MVUE	Minimum variance unbiased estimator
NP	Non-parametric method*. Calculations based on stochastic modeling following the "bounding" approach in EPA (2002). 2,000 iterations of a Monte Carlo model performed for each estimate. For confirmed or assumed lognormal distributions the UCL_{95} was determined using the MVUE Chebyshev inequality. For normal distributions the UCL_{95} was calculated using the t statistic. For distributions listed as NT, the UCL_{95} was calculated using the nonparametric Chebyshev inequality. For all distributions, the 95th percentile value from the distribution of 2,000 calculations was used as the final estimate for the UCL_{95}. Censored (non-detected) data were treated as random variables that could assume any value between zero and the reported concentration. *This is not a nonparametric approach in cases where the UCL is calculated using the t statistic or the MVUE Chebyshev inequality, but NP is used for consistency with the RAGS guidelines for preparing summary tables for exposure point concentrations.
NT	Distribution was not tested if the sample size was less than five or the frequency of detection was less than 50 percent. Distribution defaults to nonparametric.
RAGS	Risk assessment guidance for Superfund
T	Transformed (lognormal) distribution confirmed using the Shapiro-Wilk W test (alpha= 0.05).
(1)	Detection frequency less than 50%, distribution not tested. UCL_{95} estimated using the bounding approach from EPA (2002).
(2)	Detection frequency greater than or equal to 85%, distribution confirmed or assumed lognormal. UCL_{95} calculated using Land's method

Reference

U.S. Environmental Protection Agency (EPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Washington, D.C. December.

TABLE I-3.2: EXPOSURE POINT CONCENTRATION SUMMARY REASONABLE MAXIMUM EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Medium:	Soil (0-8 feet bgs)
Exposure Medium:	Site 9 Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	UCL_{95} (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale[a]
Site 9	Benzo(a)pyrene	mg/kg	7.88E-02	1.96E-01 NT	3.70E-01 J	1.96E-01	mg/kg	UCL_{95}- NP	(1)
	Dibenzo(a,h)anthracene	mg/kg	7.31E-02	1.89E-01 NT	7.00E-02	7.00E-02	mg/kg	MAX	(1)
	Iron	mg/kg	1.16E+04	1.21E+04 O(T)	2.63E+04	1.21E+04	mg/kg	UCL_{95}- O(T)	(2)
	Lead[b]	mg/kg	7.27E+00	9.42E+00 T	4.88E+02	9.42E+00	mg/kg	UCL_{95}-T	(2)

Notes:

See Attachment I3 for a description of the statistical methods used.

a The lesser of the UCL_{95} and maximum detected concentration was used as the exposure point concentration (EPC).

b The maximum concentration for lead was based on an average of two soil borings (09-SB03 and 09-SB05) because 09-SB03 was considered to be an outlier when compared to other samples; therefore, the sample location was resampled and the results of the two sample events were averaged. Although the two-population test confirmed lead to be not significantly greater than ambient fill concentrations (see Attachment I3), an EPC was calculated to facilitate comparison to the Cal-modied Preliminary Remediation Goal of 150 mg/kg.

For chemicals detected in at least 85% of the samples censored data were replaced with one-half of the reported concentration. For detection frequencies less than 85% censored measurements were treated as random variables that could assume any value between zero and the reported concentration (see note under NP).

UCL_{95}	One-sided 95 percent upper confidence limit of the mean
ft bgs	Feet below ground surface
J	Estimated value
MAX	Maximum detected concentration
mg/kg	Milligrams per kilogram
MVUE	Minimum variance unbiased estimator
NP	Non-parametric method*. Calculations based on stochastic modeling following the "bounding" approach in EPA (2002). 2,000 iterations of a Monte Carlo model performed for each estimate. For confirmed or assumed lognormal distributions the UCL_{95} was determined using the MVUE Chebyshev inequality. For normal distributions the UCL_{95} was calculated using the t statistic. For distributions listed as NT, the UCL_{95} was calculated using the nonparametric Chebyshev inequality. For all distributions, the 95th percentile value from the distribution of 2,000 calculations was used as the final estimate for the UCL_{95}. Censored (non-detected) data were treated as random variables that could assume any value between zero and the reported concentration. *This is not a nonparametric approach in cases where the UCL is calculated using the t statistic or the MVUE Chebyshev inequality, but NP is used for consistency with the RAGS guidelines for preparing summary tables for exposure point concentrations.
NT	Distribution was not tested if the sample size was less than five or the frequency of detection was less than 50 percent. Distribution defaults to nonparametric.
O(T)	Other distribution (unknown); assumed to be lognormal based on examination of probability plots, box plots, and frequency histograms.
RAGS	Risk assessment guidance for Superfund
T	Transformed (lognormal) distribution confirmed using the Shapiro-Wilk W test (alpha= 0.05).
(1)	Detection frequency less than 50%, distribution not tested. UCL_{95} estimated using the bounding approach from EPA (2002).
(2)	Detection frequency greater than or equal to 85%, distribution confirmed or assumed lognormal. UCL_{95} calculated using Land's method

Reference

U.S. Environmental Protection Agency (EPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Washington, D.C. December.

TABLE I-3.3: EXPOSURE POINT CONCENTRATION SUMMARY REASONABLE MAXIMUM EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Medium:	Soil (0-2 feet bgs)
Exposure Medium:	Site 10 Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	UCL_{95} (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale[a]
Site 10	Dibenzo(a,h)anthracene	mg/kg	1.02E-01	3.14E-01 NT	6.30E-02	6.30E-02	mg/kg	MAX	(1)

Notes:

See Attachment I3 for a description of the statistical methods used.

a The lesser of the UCL_{95} and maximum detected concentration was used as the exposure point concentration (EPC).

For chemicals detected in at least 85% of the samples censored data were replaced with one-half of the reported concentration. For detection frequencies less than 85% censored measurements were treated as random variables that could assume any value between zero and the reported concentration (see note under NP).

UCL_{95}	One-sided 95 percent upper confidence limit of the mean
ft bgs	Feet below ground surface
MAX	Maximum detected concentration
mg/kg	Milligrams per kilogram
MVUE	Minimum variance unbiased estimator
NP	Non-parametric method*. Calculations based on stochastic modeling following the "bounding" approach in EPA (2002). 2,000 iterations of a Monte Carlo model performed for each estimate. For confirmed or assumed lognormal distributions the UCL_{95} was determined using the MVUE Chebyshev inequality. For normal distributions the UCL_{95} was calculated using the t statistic. For distributions listed as NT, the UCL_{95} was calculated using the nonparametric Chebyshev inequality. For all distributions, the 95th percentile value from the distribution of 2,000 calculations was used as the final estimate for the UCL_{95}. Censored (non-detected) data were treated as random variables that could assume any value between zero and the reported concentration. *This is not a nonparametric approach in cases where the UCL is calculated using the t statistic or the MVUE Chebyshev inequality, but NP is used for consistency with the RAGS guidelines for preparing summary tables for exposure point concentrations.
NT	Distribution was not tested if the sample size was less than five or the frequency of detection was less than 50 percent. Distribution defaults to nonparametric.
RAGS	Risk assessment guidance for Superfund
(1)	Detection frequency less than 50%, distribution not tested. UCL_{95} estimated using the bounding approach from EPA (2002).

Reference

U.S. Environmental Protection Agency (EPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Washington, D.C. December.

TABLE I-3.4: EXPOSURE POINT CONCENTRATION SUMMARY REASONABLE MAXIMUM EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Medium:	Soil (0-8 feet bgs)
Exposure Medium:	Site 10 Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	UCL_{95} (Distribution)		Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale[a]
Site 10	Benzo(a)pyrene	mg/kg	1.10E-01	2.34E-01	NT	3.00E-01	2.34E-01	mg/kg	UCL_{95}- NP	(1)
	Dibenzo(a,h)anthracene	mg/kg	1.06E-01	2.30E-01	NT	6.30E-02	6.30E-02	mg/kg	MAX	(1)
	Iron	mg/kg	1.33E+04	1.44E+04	T	2.49E+04	1.44E+04	mg/kg	UCL_{95}- T	(2)

Notes:

See Attachment I3 for a description of the statistical methods used.

a The lesser of the UCL_{95} and maximum detected concentration was used as the exposure point concentration (EPC).

For chemicals detected in at least 85% of the samples censored data were replaced with one-half of the reported concentration. For detection frequencies less than 85% censored measurements were treated as random variables that could assume any value between zero and the reported concentration (see note under NP).

UCL_{95}	One-sided 95 percent upper confidence limit of the mean
ft bgs	Feet below ground surface
MAX	Maximum detected concentration
mg/kg	Milligrams per kilogram
MVUE	Minimum variance unbiased estimator
NP	Non-parametric method*. Calculations based on stochastic modeling following the "bounding" approach in EPA (2002). 2,000 iterations of a Monte Carlo model performed for each estimate. For confirmed or assumed lognormal distributions the UCL_{95} was determined using the MVUE Chebyshev inequality. For normal distributions the UCL_{95} was calculated using the t statistic. For distributions listed as NT, the UCL_{95} was calculated using the nonparametric Chebyshev inequality. For all distributions, the 95th percentile value from the distribution of 2,000 calculations was used as the final estimate for the UCL_{95}. Censored (non-detected) data were treated as random variables that could assume any value between zero and the reported concentration. *This is not a nonparametric approach in cases where the UCL is calculated using the t statistic or the MVUE Chebyshev inequality, but NP is used for consistency with the RAGS guidelines for preparing summary tables for exposure point concentrations.
NT	Distribution was not tested if the sample size was less than five or the frequency of detection was less than 50 percent. Distribution defaults to nonparametric.
RAGS	Risk assessment guidance for Superfund
T	Transformed (lognormal) distribution confirmed using the Shapiro-Wilk W test (alpha= 0.05).
(1)	Detection frequency less than 50%, distribution not tested. UCL_{95} estimated using the bounding approach from EPA (2002).
(2)	Detection frequency greater than or equal to 85%, distribution confirmed or assumed lognormal. UCL_{95} calculated using Land's method

Reference

U.S. Environmental Protection Agency (EPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Washington, D.C. December.

TABLE I-3.5: EXPOSURE POINT CONCENTRATION SUMMARY CENTRAL TENDENCY EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Medium:	Soil (0-2 feet bgs)
Exposure Medium:	Site 9 Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	UCL_{95} (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale[a]
Site 9	Benzo(a)pyrene	mg/kg	8.70E-02	3.35E-01 NT	1.00E-01	8.70E-02	mg/kg	Mean- NP	(1)
	Lead[b]	mg/kg	2.01E+01	3.81E+01 T	4.88E+02	2.01E+01	mg/kg	Mean- T	(2)

Notes:

See Attachment I3 for a description of the statistical methods used.

a The lesser of the mean and maximum detected concentration was used as the exposure point concentration (EPC).

b The maximum concentration for lead was based on an average of two soil borings (09-SB03 and 09-SB05) because 09-SB03 was considered to be an outlier when compared to other samples; therefore, the sample location was resampled and the results of the two sample events were averaged. Although the two-population test confirmed lead to be not significantly greater than ambient fill concentrations (see Attachment I3), an EPC was calculated to facilitate comparison to the Cal-modied Preliminary Remediation Goal of 150 mg/kg.

For chemicals detected in at least 85% of the samples censored data were replaced with one-half of the reported concentration. For detection frequencies less than 85% censored measurements were treated as random variables that could assume any value between zero and the reported concentration (see note under NP).

ft bgs	Feet below ground surface
UCL_{95}	One-sided 95 percent upper confidence limit of the mean
MAX	Maximum detected concentration
MG/KG	Milligram per kilogram
MVUE	Minimum variance unbiased estimator
NP	Non-parametric method*. Calculations based on stochastic modeling following the "bounding" approach in EPA (2002). 2,000 iterations of a Monte Carlo model performed for each estimate. For confirmed or assumed lognormal distributions the mean is the MVUE following equation 13.3 in Gilbert (1987). For normal and distributions listed as NT the arithmetic mean is used. For all distributions, the median value from the distribution of 2,000 calculations was used as the final estimate for the mean. Censored (non-detected) data were treated as random variables that could assume any value between zero and the reported concentration. *This is not a non-parametric approach in cases where the distribution is normal or lognormal, but NP is used for consistency with the RAGS guidelines for preparing summary tables for exposure point concentrations.
NT	Distribution was not tested if the sample size was less than five or the frequency of detection was less than 50 percent. Distribution defaults to nonparametric.
RAGS	Risk assessment guidance for Superfund
T	Transformed (lognormal) distribution confirmed using the Shapiro-Wilk W test (alpha= 0.05).
(1)	Detection frequency less than 50%, distribution not tested. A nonparametric assumption was used to calculate the mean using stochastic modeling as described under the note for N
(2)	Detection frequency greater than or equal to 85%, distribution confirmed or assumed lognormal. UCL_{95} calculated using Land's method

Reference

Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring* . John Wiley & Sons, Inc., New York, NY.

U.S. Environmental Protection Agency (EPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Washington, D.C. December.

TABLE I-3.6: EXPOSURE POINT CONCENTRATION SUMMARY CENTRAL TENDENCY EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Medium:	Soil (0-8 feet bgs)
Exposure Medium:	Site 9 Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	UCL_{95} (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale[a]
Site 9	Benzo(a)pyrene	mg/kg	7.88E-02	1.96E-01	NT	3.70E-01	J	7.88E-02	mg/kg	Mean- NP	(1)
	Dibenzo(a,h)anthracene	mg/kg	7.31E-02	1.89E-01	NT	7.00E-02		7.00E-02	mg/kg	MAX	(1)
	Iron	mg/kg	1.16E+04	1.21E+04	O(T)	2.63E+04		1.16E+04	mg/kg	Mean- O(T)	(2)
	Lead[b]	mg/kg	7.27E+00	9.42E+00	T	4.88E+02		7.27E+00	mg/kg	Mean- T	(2)

Notes:

See Attachment I3 for a description of the statistical methods used.

a The lesser of the mean and maximum detected concentration was used as the exposure point concentration (EPC).

b The maximum concentration for lead was based on an average of two soil borings (09-SB03 and 09-SB05) because 09-SB03 was considered to be an outlier when compared to other samples; therefore, the sample location was resampled and the results of the two sample events were averaged. Although the two-population test confirmed lead to be not significantly greater than ambient fill concentrations (see Attachment I3), an EPC was calculated to facilitate comparison to the Cal-modied Preliminary Remediation Goal of 150 mg/kg.

For chemicals detected in at least 85% of the samples censored data were replaced with one-half of the reported concentration. For detection frequencies less than 85% censored measurements were treated as random variables that could assume any value between zero and the reported concentration (see note under NP).

ft bgs	Feet below ground surface
UCL_{95}	One-sided 95 percent upper confidence limit of the mean
J	Estimated value
MAX	Maximum detected concentration
MG/KG	Milligram per kilogram
MVUE	Minimum variance unbiased estimator
NP	Non-parametric method*. Calculations based on stochastic modeling following the "bounding" approach in EPA (2002). 2,000 iterations of a Monte Carlo model performed for each estimate. For confirmed or assumed lognormal distributions the mean is the MVUE following equation 13.3 in Gilbert (1987). For normal and distributions listed as NT the arithmetic mean is used. For all distributions, the median value from the distribution of 2,000 calculations was used as the final estimate for the mean. Censored (non-detected) data were treated as random variables that could assume any value between zero and the reported concentration. *This is not a non-parametric approach in cases where the distribution is normal or lognormal, but NP is used for consistency with the RAGS guidelines for preparing summary tables for exposure point concentrations.
NT	Distribution was not tested if the sample size was less than five or the frequency of detection was less than 50 percent. Distribution defaults to nonparametric.
O(T)	Other distribution (unknown); assumed to be lognormal based on examination of probability plots, box plots, and frequency histograms.
RAGS	Risk assessment guidance for Superfund
T	Transformed (lognormal) distribution confirmed using the Shapiro-Wilk W test (alpha= 0.05).
(1)	Detection frequency less than 50%, distribution not tested. A nonparametric assumption was used to calculate the mean using stochastic modeling as described under the note for N
(2)	Detection frequency greater than or equal to 85%, distribution confirmed or assumed lognormal. The MVU estimate of the mean of a lognormal distribution was calculated.

Reference

Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring* . John Wiley & Sons, Inc., New York, NY.

U.S. Environmental Protection Agency (EPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Washington, D.C. December.

TABLE I-3.7: EXPOSURE POINT CONCENTRATION SUMMARY CENTRAL TENDENCY EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Medium:	Soil (0-2 feet bgs)
Exposure Medium:	Site 10 Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	UCL_{95} (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale[a]
Site 10	Dibenzo(a,h)anthracene	mg/kg	1.02E-01	3.14E-01 NT	6.30E-02	6.30E-02	mg/kg	MAX	(1)

Notes:

See Attachment I3 for a description of the statistical methods used.

a The lesser of the mean and maximum detected concentration was used as the exposure point concentration (EPC).

For chemicals detected in at least 85% of the samples censored data were replaced with one-half of the reported concentration. For detection frequencies less than 85% censored measurements were treated as random variables that could assume any value between zero and the reported concentration (see note under NP).

ft bgs	Feet below ground surface
UCL_{95}	One-sided 95 percent upper confidence limit of the mean
MAX	Maximum detected concentration
MG/KG	Milligram per kilogram
MVUE	Minimum variance unbiased estimator
NP	Non-parametric method*. Calculations based on stochastic modeling following the "bounding" approach in EPA (2002). 2,000 iterations of a Monte Carlo model performed for each estimate. For confirmed or assumed lognormal distributions the mean is the MVUE following equation 13.3 in Gilbert (1987). For normal and distributions listed as NT the arithmetic mean is used. For all distributions, the median value from the distribution of 2,000 calculations was used as the final estimate for the mean. Censored (non-detected) data were treated as random variables that could assume any value between zero and the reported concentration. *This is not a non-parametric approach in cases where the distribution is normal or lognormal, but NP is used for consistency with the RAGS guidelines for preparing summary tables for exposure point concentrations.
NT	Distribution was not tested if the sample size was less than five or the frequency of detection was less than 50 percent. Distribution defaults to nonparametric.
RAGS	Risk assessment guidance for Superfund
(1)	Detection frequency less than 50%, distribution not tested. A nonparametric assumption was used to calculate the mean using stochastic modeling as described under the note for NP.

Reference

Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring* . John Wiley & Sons, Inc., New York, NY.

U.S. Environmental Protection Agency (EPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Washington, D.C. December.

TABLE I-3.8: EXPOSURE POINT CONCENTRATION SUMMARY CENTRAL TENDENCY EXPOSURE

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Medium:	Soil (0-8 feet bgs)
Exposure Medium:	Site 10 Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	UCL_{95} (Distribution)		Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale[a]
Site 10	Benzo(a)pyrene	mg/kg	1.10E-01	2.34E-01	NT	3.00E-01	1.10E-01	mg/kg	Mean- NP	(1)
	Dibenzo(a,h)anthracene	mg/kg	1.06E-01	2.30E-01	NT	6.30E-02	6.30E-02	mg/kg	MAX	(1)
	Iron	mg/kg	1.33E+04	1.44E+04	T	2.49E+04	1.33E+04	mg/kg	Mean- T	(2)

Notes:

See Attachment I3 for a description of the statistical methods used.

a The lesser of the mean and maximum detected concentration was used as the exposure point concentration (EPC).

For chemicals detected in at least 85% of the samples censored data were replaced with one-half of the reported concentration. For detection frequencies less than 85% censored measurements were treated as random variables that could assume any value between zero and the reported concentration (see note under NP).

ft bgs	Feet below ground surface
UCL_{95}	One-sided 95 percent upper confidence limit of the mean
MAX	Maximum detected concentration
MG/KG	Milligram per kilogram
MVUE	Minimum variance unbiased estimator
NP	Non-parametric method*. Calculations based on stochastic modeling following the "bounding" approach in EPA (2002). 2,000 iterations of a Monte Carlo model performed for each estimate. For confirmed or assumed lognormal distributions the mean is the MVUE following equation 13.3 in Gilbert (1987). For normal and distributions listed as NT the arithmetic mean is used. For all distributions, the median value from the distribution of 2,000 calculations was used as the final estimate for the mean. Censored (non-detected) data were treated as random variables that could assume any value between zero and the reported concentration. *This is not a non-parametric approach in cases where the distribution is normal or lognormal, but NP is used for consistency with the RAGS guidelines for preparing summary tables for exposure point concentrations.
NT	Distribution was not tested if the sample size was less than five or the frequency of detection was less than 50 percent. Distribution defaults to nonparametric.
RAGS	Risk assessment guidance for Superfund
T	Transformed (lognormal) distribution confirmed using the Shapiro-Wilk W test (alpha= 0.05).
(1)	Detection frequency less than 50%, distribution not tested. A nonparametric assumption was used to calculate the mean using stochastic modeling as described under the note for NP.
(2)	Detection frequency greater than or equal to 85%, distribution confirmed or assumed lognormal. The MVU estimate of the mean of a lognormal distribution was calculated.

Reference

Gilbert, R. O. 1987. *Statistical Methods for Environmental Pollution Monitoring* . John Wiley & Sons, Inc., New York, NY.

U.S. Environmental Protection Agency (EPA). 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Washington, D.C. December.

TABLE I-4.1: EPA RAGS PART D TABLE 4, VALUES USED FOR DAILY INTAKE, RME SOIL EXPOSURES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current; Future[a]
Medium:	Soil
Exposure Medium:	Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name (1)
Ingestion	Industrial Worker	Adult	Sites 09 and 10	CS	Chemical Concentration in Soil	95UCL or MAX	mg/kg	Calculated	Intake (mg/kg-day) =
				IRS	Ingestion Rate - Soil	100	mg/day	EPA 2001a	(CS x FI x IRS x EF x ED x MCF) / (BW x AT)
				FI	Fraction Ingested	1	unitless	professional judgment	
				EF	Exposure Frequency	250	days/year	EPA 1991, DTSC 1992	
				ED	Exposure Duration	25	years	EPA 1991	
				MCF	Mass Conversion Factor	1E-06	kg/mg		
				BW	Body Weight	70	kg	EPA 1991	
				AT-C	Averaging Time - Cancer	25,550	days	EPA 1989	
				AT-NC	Averaging Time - Non-Cancer	9,125	days	EPA 1989	
	Construction Worker	Adult	Sites 09 and 10	CS	Chemical Concentration in Soil	95UCL or MAX	mg/kg	Calculated	Intake (mg/kg-day) =
				IRS	Ingestion Rate - Soil	330	mg/day	EPA 2001a	(CS x FI x IRS x EF x ED x MCF) / (BW x AT)
				FI	Fraction Ingested	1	unitless	professional judgment	
				EF	Exposure Frequency	250	days/year	EPA 1991	
				ED	Exposure Duration	1	years	DTSC 2000	
				MCF	Mass Conversion Factor	1E-06	kg/mg		
				BW	Body Weight	70	kg	EPA 1991	
				AT-C	Averaging Time - Cancer	25,550	days	EPA 1989	
				AT-NC	Averaging Time - Non-Cancer	365	days	EPA 1989	
	Resident	Adult	Sites 09 and 10	CS	Chemical Concentration in Soil	95UCL or MAX	mg/kg	Calculated	Intake (mg/kg-day) =
				IRS	Ingestion Rate - Soil	100	mg/day	EPA 1991	(CS x FI x IRS x EF x ED x MCF) / (BW x AT)
				FI	Fraction Ingested	1	unitless	professional judgment	
				EF	Exposure Frequency	350	days/year	EPA 1991	
				ED	Exposure Duration	24	years	EPA 1991, DTSC 1992	
				MCF	Mass Conversion Factor	1E-06	kg/mg		
				BW	Body Weight	70	kg	EPA 1991	
				AT-C	Averaging Time - Cancer	25,550	days	EPA 1989	
				AT-NC	Averaging Time - Non-Cancer	8,760	days	EPA 1989	
		Child	Sites 09 and 10	CS	Chemical Concentration in Soil	95UCL or MAX	mg/kg	Calculated	Intake (mg/kg-day) =
				IRS	Ingestion Rate - Soil	200	mg/day	EPA 1991	(CS x FI x IRS x EF x ED x MCF) / (BW x AT)
				FI	Fraction Ingested	1	unitless	professional judgment	
				EF	Exposure Frequency	350	days/year	EPA 1991	
				ED	Exposure Duration	6	years	EPA 1991, DTSC 1992	
				MCF	Mass Conversion Factor	1E-06	kg/mg		
				BW	Body Weight	15	kg	EPA 1991	
				AT-C	Averaging Time - Cancer	25,550	days	EPA 1989	
				AT-NC	Averaging Time - Non-Cancer	2,190	days	EPA 1989	

TABLE I-4.2: EPA RAGS PART D TABLE 4, VALUES USED FOR DAILY INTAKE, CTE SOIL EXPOSURES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current; Future[a]
Medium:	Soil
Exposure Medium:	Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name (1)
Ingestion	Industrial Worker	Adult	Sites 09 and 10	CS	Chemical Concentration in Soil	Mean or MAX	mg/kg	Calculated	Intake (mg/kg-day) =
				IRS	Ingestion Rate - Soil	50	mg/day	EPA 1991	(CS x FI x IRS x EF x ED x MCF) / (BW x AT)
				FI	Fraction Ingested	1	unitless	professional judgment	
				EF	Exposure Frequency	219	days/year	EPA 2001b	
				ED	Exposure Duration	4.5	years	USDC 1994	
				MCF	Mass Conversion Factor	1E-06	kg/mg		
				BW	Body Weight	70	kg	EPA 1991	
				AT-C	Averaging Time - Cancer	25,550	days	EPA 1989	
				AT-NC	Averaging Time - Non-Cancer	1,643	days	EPA 1989	
	Construction Worker	Adult	Sites 09 and 10	CS	Chemical Concentration in Soil	Mean or MAX	mg/kg	Calculated	Intake (mg/kg-day) =
				IRS	Ingestion Rate - Soil	100	mg/day	EPA 1997	(CS x FI x IRS x EF x ED x MCF) / (BW x AT)
				FI	Fraction Ingested	1	unitless	professional judgment	
				EF	Exposure Frequency	90	days/year	professional judgment	
				ED	Exposure Duration	1	years	EPA 1991	
				MCF	Mass Conversion Factor	1E-06	kg/mg		
				BW	Body Weight	70	kg	EPA 1991	
				AT-C	Averaging Time - Cancer	25,550	days	EPA 1989	
				AT-NC	Averaging Time - Non-Cancer	365	days	EPA 1989	
	Resident	Adult	Sites 09 and 10	CS	Chemical Concentration in Soil	Mean or MAX	mg/kg	Calculated	Intake (mg/kg-day) =
				IRS	Ingestion Rate - Soil	50	mg/day	EPA 1997	(CS x FI x IRS x EF x ED x MCF) / (BW x AT)
				FI	Fraction Ingested	1	unitless	professional judgment	
				EF	Exposure Frequency	350	days/year	EPA 1991	
				ED	Exposure Duration	7	years	EPA 1989	
				MCF	Mass Conversion Factor	1E-06	kg/mg		
				BW	Body Weight	70	kg	EPA 1991	
				AT-C	Averaging Time - Cancer	25,550	days	EPA 1989	
				AT-NC	Averaging Time - Non-Cancer	2,555	days	EPA 1989	
		Child	Sites 09 and 10	CS	Chemical Concentration in Soil	Mean or MAX	mg/kg	Calculated	Intake (mg/kg-day) =
				IRS	Ingestion Rate - Soil	100	mg/day	EPA 1997	(CS x FI x IRS x EF x ED x MCF) / (BW x AT)
				FI	Fraction Ingested	1	unitless	professional judgment	
				EF	Exposure Frequency	350	days/year	EPA 1991	
				ED	Exposure Duration	2	years	EPA 1989	
				MCF	Mass Conversion Factor	1E-06	kg/mg		
				BW	Body Weight	15	kg	EPA 1991	
				AT-C	Averaging Time - Cancer	25,550	days	EPA 1989	
				AT-NC	Averaging Time - Non-Cancer	730	days	EPA 1989	

TABLE I-5.1: EPEA RAGS PART D TABLE 5, EPA NON-CANCER TOXICITY DATA -- ORAL/DERMAL

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal		Primary Target Organ(s)	Combined Uncertainty/ Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Iron	Chronic	3.00E-01	mg/kg-day	100%	3.00E-01	mg/kg-day	--	--	IRIS	2002
Benzo(a)pyrene	Chronic	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	Chronic	--	--	--	--	--	--	--	--	--

Notes:

(1) Oral absorption efficiencies were applied as recommended in EPA (2001b). See Section 8.3 of the Appendix I text for additional information.

-- = Not available

IRIS = Integrated Risk Information System

mg/kg-day = Milligram per kilogram per day

RfD = Reference dose, oral

Reference:

EPA. 2001b. "Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Office of Emergency and Remedial Response. Washington, DC. September.

TABLE I-5.2: EPA RAGS PART D TABLE 5, EPA NON-CANCER TOXICITY DATA -- INHALATION

Sites 09 and 10 Remedial Investigaiton, NAVSTA Treasure Island

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD		Primary Target Organ(s)	Combined Uncertainty/ Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Iron	Chronic	--	--	--	--	--	--	--	--
Benzo(a)pyrene	Chronic	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	Chronic	--	--	--	--	--	--	--	--

Notes:
-- = Not available

RfC = Reference concentration

RfD = Reference dose, inhalation

TABLE I-6.1: EPA RAGS PART D TABLE 6, EPA CANCER TOXICITY DATA -- ORAL/DERMAL

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Iron	--	--	--	--	--	--	--	--
Benzo(a)pyrene	7.30E+00	$(mg/kg\text{-}day)^{-1}$	89%	8.20E+00	$(mg/kg\text{-}day)^{-1}$	B2 (IRIS 2003)	IRIS	2003
Dibenz(a,h)anthracene	7.30E+00	$(mg/kg\text{-}day)^{-1}$	89%	8.20E+00	$(mg/kg\text{-}day)^{-1}$	B2 (IRIS 2003)	R9-NCEA	2002

Notes:

(1) Oral absorption efficiencies were applied as recommended in EPA (2001b). See Section 8.3 of the Appendix I text for additional information.

-- = Not available

mg/kg-day = Milligram per kilogram per day

IRIS = Integrated Risk Information System

NCEA = National Center for Environmental Assessment

R9 = U.S. Environmental Protection Agency

EPA Weight-of-Evidence Classification:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as to human carcinogenicity

Reference:

EPA. 2001b. "Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)." Office of Emergency and Remedial Response. Washington, DC. September.

TABLE I-6.2: EPA RAGS PART D TABLE 6, EPA CANCER TOXICITY DATA -- INHALATION

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Iron	--	--	--	--	--	--	--
Benzo(a)pyrene	--	--	7.30E+00	$(mg/kg\text{-}day)^{-1}$	B2 (IRIS 2003)	R9-R	2002
Dibenz(a,h)anthracene	--	--	7.30E+00	$(mg/kg\text{-}day)^{-1}$	B2 (IRIS 2003)	R9-R	2002

Notes:

-- = Not available

mg/kg-day = Milligram per kilogram per day

IRIS = Integrated Risk Information System

R = Route-to-route extrapolation

R9 = U.S. Environmental Protection Agency, Region IX

EPA Weight-of-Evidence Classification:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available.

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans.

C - Possible human carcinogen

D - Not classifiable as to human carcinogenicity

TABLE I-7.1.1.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - CURRENT INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	1.00E-01	mg/kg	9.78E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Benzo(a)pyrene	1.00E-01	mg/kg	8.4E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	1.00E-01	mg/kg	1.5E-11	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-7.1.2.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.21E+04	mg/kg	1.19E-02	mg/kg-day	3.00E-01	mg/kg-day	3.96E-02
				Benzo(a)pyrene	1.96E-01	mg/kg	1.92E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	6.85E-08	mg/kg-day	--	--	--
			Exp. Route Total								**3.96E-02**
			Dermal	Iron	1.21E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	1.96E-01	mg/kg	1.64E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	5.88E-08	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**3.96E-02**
	Exposure Medium Total										**3.96E-02**
	Air	Outdoor Air	Inhalation	Iron	1.21E+04	mg/kg	1.80E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.96E-01	mg/kg	2.90E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.04E-11	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**3.96E-02**
										Total of Receptor Hazards Across All Media	**3.96E-02**

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.1.3.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.21E+04	mg/kg	3.92E-02	mg/kg-day	3.00E-01	mg/kg-day	1.31E-01
				Benzo(a)pyrene	1.96E-01	mg/kg	6.3E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	2.3E-07	mg/kg-day	--	--	--
			Exp. Route Total								**1.31E-01**
			Dermal	Iron	1.21E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	1.96E-01	mg/kg	2.5E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	8.8E-08	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**1.31E-01**
	Exposure Medium Total										**1.31E-01**
	Air	Outdoor Air	Inhalation	Iron	1.21E+04	mg/kg	1.8E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.96E-01	mg/kg	2.9E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.0E-11	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**1.31E-01**
										Total of Receptor Hazards Across All Media	**1.31E-01**

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.1.4.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED ADULT RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	1.00E-01	mg/kg	1.37E-07	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Benzo(a)pyrene	1.00E-01	mg/kg	7.1E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	1.00E-01	mg/kg	2.1E-11	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.1.5.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CHILD RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	1.00E-01	mg/kg	1.28E-06	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Benzo(a)pyrene	1.00E-01	mg/kg	4.7E-07	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	1.00E-01	mg/kg	4.8E-11	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.1.6.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.21E+04	mg/kg	1.66E-02	mg/kg-day	3.00E-01	mg/kg-day	5.54E-02
				Benzo(a)pyrene	1.96E-01	mg/kg	2.7E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	9.6E-08	mg/kg-day	--	--	--
			Exp. Route Total								**5.54E-02**
			Dermal	Iron	1.21E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	1.96E-01	mg/kg	1.4E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	5.0E-08	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**5.54E-02**
	Exposure Medium Total										**5.54E-02**
	Air	Outdoor Air	Inhalation	Iron	1.21E+04	mg/kg	2.5E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.96E-01	mg/kg	4.1E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.5E-11	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**5.54E-02**
										Total of Receptor Hazards Across All Media	**5.54E-02**

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.1.7.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.21E+04	mg/kg	1.55E-01	mg/kg-day	3.00E-01	mg/kg-day	5.17E-01
				Benzo(a)pyrene	1.96E-01	mg/kg	2.5E-06	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	8.9E-07	mg/kg-day	--	--	--
			Exp. Route Total								**5.17E-01**
			Dermal	Iron	1.21E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	1.96E-01	mg/kg	9.1E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	3.3E-07	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**5.17E-01**
	Exposure Medium Total										**5.17E-01**
	Air	Outdoor Air	Inhalation	Iron	1.21E+04	mg/kg	5.9E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.96E-01	mg/kg	9.5E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	3.4E-11	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**5.17E-01**
										Total of Receptor Hazards Across All Media	**5.17E-01**

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.2.1.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - CURRENT INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	6.16E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	5.3E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	9.3E-12	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-7.2.2.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.44E+04	mg/kg	1.41E-02	mg/kg-day	3.00E-01	mg/kg-day	4.70E-02
				Benzo(a)pyrene	2.34E-01	mg/kg	2.29E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	6.16E-08	mg/kg-day	--	--	--
			Exp. Route Total								**4.70E-02**
			Dermal	Iron	1.44E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	2.34E-01	mg/kg	1.97E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	5.29E-08	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**4.70E-02**
	Exposure Medium Total										**4.70E-02**
	Air	Outdoor Air	Inhalation	Iron	1.44E+04	mg/kg	2.14E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	2.34E-01	mg/kg	3.48E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	9.34E-12	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**4.70E-02**
										Total of Receptor Hazards Across All Media	**4.70E-02**

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.2.3.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.44E+04	mg/kg	4.65E-02	mg/kg-day	3.00E-01	mg/kg-day	1.55E-01
				Benzo(a)pyrene	2.34E-01	mg/kg	7.6E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.0E-07	mg/kg-day	--	--	--
			Exp. Route Total								**1.55E-01**
			Dermal	Iron	1.44E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	2.34E-01	mg/kg	3.0E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	7.9E-08	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**1.55E-01**
	Exposure Medium Total										**1.55E-01**
	Air	Outdoor Air	Inhalation	Iron	1.44E+04	mg/kg	2.1E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	2.34E-01	mg/kg	3.5E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	9.3E-12	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**1.55E-01**
										Total of Receptor Hazards Across All Media	**1.55E-01**

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.2.4.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED ADULT RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	8.63E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.5E-08	mg/kg-day	--	--	--
			Exp. Route Total								-
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.3E-11	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.2.5.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CHILD RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	8.05E-07	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.9E-07	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	3.1E-11	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.2.6.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.44E+04	mg/kg	1.97E-02	mg/kg-day	3.00E-01	mg/kg-day	6.58E-02
				Benzo(a)pyrene	2.34E-01	mg/kg	3.2E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	8.6E-08	mg/kg-day	--	--	--
			Exp. Route Total								**6.58E-02**
			Dermal	Iron	1.44E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	2.34E-01	mg/kg	1.7E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.5E-08	mg/kg-day	--	--	--
			Exp. Route Total								**-**
		Exposure Point Total									**6.58E-02**
	Exposure Medium Total										**6.58E-02**
	Air	Outdoor Air	Inhalation	Iron	1.44E+04	mg/kg	3.0E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	2.34E-01	mg/kg	4.9E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.3E-11	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**6.58E-02**
										Total of Receptor Hazards Across All Media	**6.58E-02**

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-7.2.7.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.44E+04	mg/kg	1.84E-01	mg/kg-day	3.00E-01	mg/kg-day	6.14E-01
				Benzo(a)pyrene	2.34E-01	mg/kg	3.0E-06	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	8.1E-07	mg/kg-day	--	--	--
			Exp. Route Total								**6.14E-01**
			Dermal	Iron	1.44E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	2.34E-01	mg/kg	1.1E-06	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.9E-07	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**6.14E-01**
	Exposure Medium Total										**6.14E-01**
	Air	Outdoor Air	Inhalation	Iron	1.44E+04	mg/kg	7.0E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	2.34E-01	mg/kg	1.1E-10	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	3.1E-11	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**6.14E-01**
										Total of Receptor Hazards Across All Media	**6.14E-01**

Notes:

EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
RME	Reasonable maximum expsoure
--	Not applicable or not available

TABLE I-8.1.1.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - CURRENT INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	1.00E-01	mg/kg	3.49E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.55E-07
			Exp. Route Total								**2.55E-07**
			Dermal	Benzo(a)pyrene	1.00E-01	mg/kg	3.00E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.46E-07
			Exp. Route Total								**2.46E-07**
		Exposure Point Total									**5.01E-07**
	Exposure Medium Total										**5.01E-07**
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	1.00E-01	mg/kg	5.29E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.87E-11
			Exp. Route Total								**3.87E-11**
		Exposure Point Total									**3.87E-11**
	Exposure Medium Total										**3.87E-11**
Medium Total											**5.01E-07**
										Total of Receptor Hazards Across All Media	**5.01E-07**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.1.2.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.21E+04	mg/kg	4.24E-03	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.96E-01	mg/kg	6.85E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.00E-07
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	2.45E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.79E-07
			Exp. Route Total								**6.78E-07**
			Dermal	Iron	1.21E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.96E-01	mg/kg	5.87E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	4.82E-07
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	2.10E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.72E-07
			Exp. Route Total								**6.54E-07**
		Exposure Point Total									**1.33E-06**
	Exposure Medium Total										**1.33E-06**
	Air	Outdoor Air	Inhalation	Iron	1.21E+04	mg/kg	6.43E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.96E-01	mg/kg	1.04E-11	mg/kg-day	7.30E+00	(mg/kg-day)-1	7.57E-11
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	3.71E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.71E-11
			Exp. Route Total								**1.03E-10**
		Exposure Point Total									**1.03E-10**
	Exposure Medium Total										**1.03E-10**
Medium Total											**1.33E-06**
										Total of Receptor Hazards Across All Media	**1.33E-06**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.1.3.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.21E+04	mg/kg	5.60E-04	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.96E-01	mg/kg	9.04E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	6.60E-08
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	3.23E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.36E-08
			Exp. Route Total								**8.95E-08**
			Dermal	Iron	1.21E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.96E-01	mg/kg	3.52E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.89E-08
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.26E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.03E-08
			Exp. Route Total								**3.92E-08**
		Exposure Point Total									**1.29E-07**
	Exposure Medium Total										**1.29E-07**
	Air	Outdoor Air	Inhalation	Iron	1.21E+04	mg/kg	2.57E-08	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.96E-01	mg/kg	4.15E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.03E-12
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.48E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.08E-12
			Exp. Route Total								**4.11E-12**
		Exposure Point Total									**4.11E-12**
	Exposure Medium Total										**4.11E-12**
Medium Total											**1.29E-07**
										Total of Receptor Hazards Across All Media	**1.29E-07**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.1.4.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED ADULT RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	1.00E-01	mg/kg	4.70E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.43E-07
			Exp. Route Total								**3.43E-07**
			Dermal	Benzo(a)pyrene	1.00E-01	mg/kg	2.44E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.00E-07
			Exp. Route Total								**2.00E-07**
		Exposure Point Total									**5.43E-07**
	Exposure Medium Total										**5.43E-07**
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	1.00E-01	mg/kg	7.12E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.19E-11
			Exp. Route Total								**5.19E-11**
		Exposure Point Total									**5.19E-11**
	Exposure Medium Total										**5.19E-11**
Medium Total											**5.43E-07**
										Total of Receptor Hazards Across All Media	**5.43E-07**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.1.5.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED CHILD RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	1.00E-01	mg/kg	1.10E-07	mg/kg-day	7.30E+00	(mg/kg-day)-1	8.00E-07
			Exp. Route Total								**8.00E-07**
			Dermal	Benzo(a)pyrene	1.00E-01	mg/kg	3.99E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	3.27E-07
			Exp. Route Total								**3.27E-07**
		Exposure Point Total									**1.13E-06**
	Exposure Medium Total										**1.13E-06**
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	1.00E-01	mg/kg	4.15E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.03E-11
			Exp. Route Total								**3.03E-11**
		Exposure Point Total									**3.03E-11**
	Exposure Medium Total										**3.03E-11**
Medium Total											**1.13E-06**
										Total of Receptor Hazards Across All Media	**1.13E-06**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.1.6.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.21E+04	mg/kg	5.70E-03	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.96E-01	mg/kg	9.20E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	6.72E-07
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	3.29E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.40E-07
			Exp. Route Total								**9.12E-07**
			Dermal	Iron	1.21E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.96E-01	mg/kg	4.77E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	3.91E-07
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.71E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.40E-07
			Exp. Route Total								**5.31E-07**
		Exposure Point Total									**1.44E-06**
	Exposure Medium Total										**1.44E-06**
	Air	Outdoor Air	Inhalation	Iron	1.21E+04	mg/kg	8.64E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.96E-01	mg/kg	1.39E-11	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.02E-10
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	4.98E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.64E-11
			Exp. Route Total								**1.38E-10**
		Exposure Point Total									**1.38E-10**
	Exposure Medium Total										**1.38E-10**
Medium Total											**1.44E-06**
										Total of Receptor Hazards Across All Media	**1.44E-06**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.1.7.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.21E+04	mg/kg	1.33E-02	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.96E-01	mg/kg	2.15E-07	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.57E-06
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	7.67E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.60E-07
			Exp. Route Total								**2.13E-06**
			Dermal	Iron	1.21E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.96E-01	mg/kg	7.81E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	6.41E-07
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	2.79E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.29E-07
			Exp. Route Total								**8.70E-07**
		Exposure Point Total									**3.00E-06**
	Exposure Medium Total										**3.00E-06**
	Air	Outdoor Air	Inhalation	Iron	1.21E+04	mg/kg	5.04E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.96E-01	mg/kg	8.13E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.94E-11
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	2.91E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.12E-11
			Exp. Route Total								**8.06E-11**
		Exposure Point Total									**8.06E-11**
	Exposure Medium Total										**8.06E-11**
Medium Total											**3.00E-06**
										Total of Receptor Hazards Across All Media	**3.00E-06**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.2.1.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - CURRENT INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.20E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.61E-07
			Exp. Route Total								**1.61E-07**
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.89E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.55E-07
			Exp. Route Total								**1.55E-07**
		Exposure Point Total									**3.16E-07**
	Exposure Medium Total										**3.16E-07**
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	3.34E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.44E-11
			Exp. Route Total								**2.44E-11**
		Exposure Point Total									**2.44E-11**
	Exposure Medium Total										**2.44E-11**
Medium Total											**3.16E-07**
										Total of Receptor Hazards Across All Media	**3.16E-07**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.2.2.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.44E+04	mg/kg	5.04E-03	mg/kg-day	--	--	--
				Benzo(a)pyrene	2.34E-01	mg/kg	8.19E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.98E-07
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.20E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.61E-07
			Exp. Route Total								**7.59E-07**
			Dermal	Iron	1.44E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	2.34E-01	mg/kg	7.03E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	5.77E-07
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.89E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.55E-07
			Exp. Route Total								**7.32E-07**
		Exposure Point Total									**1.49E-06**
	Exposure Medium Total										**1.49E-06**
	Air	Outdoor Air	Inhalation	Iron	1.44E+04	mg/kg	7.63E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	2.34E-01	mg/kg	1.24E-11	mg/kg-day	7.30E+00	(mg/kg-day)-1	9.06E-11
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	3.34E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.44E-11
			Exp. Route Total								**1.15E-10**
		Exposure Point Total									**1.15E-10**
	Exposure Medium Total										**1.15E-10**
Medium Total											**1.49E-06**
										Total of Receptor Hazards Across All Media	**1.49E-06**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.2.3.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.44E+04	mg/kg	6.65E-04	mg/kg-day	--	--	--
				Benzo(a)pyrene	2.34E-01	mg/kg	1.08E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	7.89E-08
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.91E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.12E-08
			Exp. Route Total								**1.00E-07**
			Dermal	Iron	1.44E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	2.34E-01	mg/kg	4.22E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	3.46E-08
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.13E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	9.30E-09
			Exp. Route Total								**4.39E-08**
		Exposure Point Total									**1.44E-07**
	Exposure Medium Total										**1.44E-07**
	Air	Outdoor Air	Inhalation	Iron	1.44E+04	mg/kg	3.05E-08	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	2.34E-01	mg/kg	4.97E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.62E-12
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.33E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	9.74E-13
			Exp. Route Total								**4.60E-12**
		Exposure Point Total									**4.60E-12**
	Exposure Medium Total										**4.60E-12**
Medium Total											**1.44E-07**
										Total of Receptor Hazards Across All Media	**1.44E-07**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.2.4.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED ADULT RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.96E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.16E-07
			Exp. Route Total								**2.16E-07**
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.53E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.26E-07
			Exp. Route Total								**1.26E-07**
		Exposure Point Total									**3.42E-07**
	Exposure Medium Total										**3.42E-07**
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.48E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.27E-11
			Exp. Route Total								**3.27E-11**
		Exposure Point Total									**3.27E-11**
	Exposure Medium Total										**3.27E-11**
Medium Total											**3.42E-07**
										Total of Receptor Hazards Across All Media	**3.42E-07**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.2.5.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED CHILD RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	6.90E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.04E-07
			Exp. Route Total								**5.04E-07**
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.51E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.06E-07
			Exp. Route Total								**2.06E-07**
		Exposure Point Total									**7.10E-07**
	Exposure Medium Total										**7.10E-07**
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.62E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.91E-11
			Exp. Route Total								**1.91E-11**
		Exposure Point Total									**1.91E-11**
	Exposure Medium Total										**1.91E-11**
Medium Total											**7.10E-07**
										Total of Receptor Hazards Across All Media	**7.10E-07**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.2.6.RME: EPA RAGS PART D TABLE 7a
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.44E+04	mg/kg	6.77E-03	mg/kg-day	--	--	--
				Benzo(a)pyrene	2.34E-01	mg/kg	1.10E-07	mg/kg-day	7.30E+00	(mg/kg-day)-1	8.04E-07
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.96E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.16E-07
			Exp. Route Total								**1.02E-06**
			Dermal	Iron	1.44E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	2.34E-01	mg/kg	5.71E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	4.68E-07
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.53E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.26E-07
			Exp. Route Total								**5.94E-07**
		Exposure Point Total									**1.61E-06**
	Exposure Medium Total										**1.61E-06**
	Air	Outdoor Air	Inhalation	Iron	1.44E+04	mg/kg	1.03E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	2.34E-01	mg/kg	1.67E-11	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.22E-10
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.48E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.27E-11
			Exp. Route Total								**1.55E-10**
		Exposure Point Total									**1.55E-10**
	Exposure Medium Total										**1.55E-10**
Medium Total											**1.61E-06**
										Total of Receptor Hazards Across All Media	**1.61E-06**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-8.2.7.RME: EPA RAGS PART D TABLE 7b
CALCULATION OF RME CHEMICAL CANCER RISKS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.44E+04	mg/kg	1.58E-02	mg/kg-day	--	--	--
				Benzo(a)pyrene	2.34E-01	mg/kg	2.57E-07	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.88E-06
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	6.90E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.04E-07
			Exp. Route Total								**2.38E-06**
			Dermal	Iron	1.44E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	2.34E-01	mg/kg	9.35E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	7.67E-07
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.51E-08	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.06E-07
			Exp. Route Total								**9.73E-07**
		Exposure Point Total									**3.35E-06**
	Exposure Medium Total										**3.35E-06**
	Air	Outdoor Air	Inhalation	Iron	1.44E+04	mg/kg	5.98E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	2.34E-01	mg/kg	9.73E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	7.10E-11
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.62E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.91E-11
			Exp. Route Total								**9.01E-11**
		Exposure Point Total									**9.01E-11**
	Exposure Medium Total										**9.01E-11**
Medium Total											**3.35E-06**
										Total of Receptor Hazards Across All Media	**3.35E-06**

Notes:

CSF	Cancer slope factor
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
RME	Reasonable maximum exposure
--	Not applicable or not available

TABLE I-9.1.1.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - CURRENT INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Benzo(a)pyrene	2.55E-07	--	2.46E-07	--	5.01E-07	--	--	--	--	--
			Chemical Total	2.55E-07	--	2.46E-07	--	5.01E-07		--	--	--	--
		Exposure Point Total						5.01E-07					--
	Exposure Medium Total							5.01E-07					--
	Air	Outdoor Air (Particulates and VOCs)	Benzo(a)pyrene	--	3.87E-11	--	--	3.87E-11	--	--	--	--	--
			Chemical Total	--	3.87E-11	--	--	3.87E-11		--	--	--	--
		Exposure Point Total						3.87E-11					--
	Exposure Medium Total							3.87E-11					--
Medium Total								5.01E-07					--
Receptor Total							Receptor Risk Total	5.01E-07				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.1.2.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	3.96E-02	--	--	3.96E-02
			Benzo(a)pyrene	5.00E-07	--	4.82E-07	--	9.82E-07	--	--	--	--	--
			Dibenz(a,h)anthracene	1.79E-07	--	1.72E-07	--	3.51E-07	--	--	--	--	--
			Chemical Total	6.78E-07	--	6.54E-07	--	1.33E-06		3.96E-02	--	--	3.96E-02
		Exposure Point Total						1.33E-06					3.96E-02
	Exposure Medium Total							1.33E-06					3.96E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	7.57E-11	--	--	7.57E-11	--	--	--	--	--
			Dibenz(a,h)anthracene	--	2.71E-11	--	--	2.71E-11	--	--	--	--	--
			Chemical Total	--	1.03E-10	--	--	1.03E-10		--	--	--	--
		Exposure Point Total						1.03E-10					--
	Exposure Medium Total							1.03E-10					--
Medium Total								1.33E-06					3.96E-02
Receptor Total							Receptor Risk Total	1.33E-06				Receptor HI Total	3.96E-02

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.1.3.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	1.31E-01	--	--	1.31E-01
			Benzo(a)pyrene	6.60E-08	--	2.89E-08	--	9.49E-08	--	--	--	--	--
			Dibenz(a,h)anthracene	2.36E-08	--	1.03E-08	--	3.39E-08	--	--	--	--	--
			Chemical Total	8.95E-08	--	3.92E-08	--	1.29E-07		1.31E-01	--	--	1.31E-01
		Exposure Point Total						1.29E-07					1.31E-01
	Exposure Medium Total							1.29E-07					1.31E-01
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	3.03E-12	--	--	3.03E-12	--	--	--	--	--
			Dibenz(a,h)anthracene	--	1.08E-12	--	--	1.08E-12	--	--	--	--	--
			Chemical Total	--	4.11E-12	--	--	4.11E-12		--	--	--	--
		Exposure Point Total						4.11E-12					--
	Exposure Medium Total							1.29E-07					--
Medium Total								1.29E-07					1.31E-01
Receptor Total							Receptor Risk Total	1.29E-07				Receptor HI Total	1.31E-01

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.1.4.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED ADULT RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Benzo(a)pyrene	3.43E-07	--	2.00E-07	--	5.43E-07	--	--	--	--	--
			Chemical Total	3.43E-07	--	2.00E-07	--	5.43E-07		--	--	--	--
		Exposure Point Total						5.43E-07					--
	Exposure Medium Total							5.43E-07					--
	Air	Outdoor Air (Particulates and VOCs)	Benzo(a)pyrene	--	5.19E-11	--	--	5.19E-11	--	--	--	--	--
			Chemical Total	--	5.19E-11	--	--	5.19E-11		--	--	--	--
		Exposure Point Total						5.19E-11					--
	Exposure Medium Total							5.43E-07					--
Medium Total								5.43E-07					--
Receptor Total							Receptor Risk Total	5.43E-07				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.1.5.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CHILD RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Benzo(a)pyrene	8.00E-07	--	3.27E-07	--	1.13E-06	--	--	--	--	--
			Chemical Total	8.00E-07	--	3.27E-07	--	1.13E-06		--	--	--	--
		Exposure Point Total						1.13E-06					--
	Exposure Medium Total							1.13E-06					--
	Air	Outdoor Air (Particulates and VOCs)	Benzo(a)pyrene	--	3.03E-11	--	--	3.03E-11	--	--	--	--	--
			Chemical Total	--	3.03E-11	--	--	3.03E-11		--	--	--	--
		Exposure Point Total						3.03E-11					--
	Exposure Medium Total							1.13E-06					--
Medium Total								1.13E-06					--
Receptor Total							Receptor Risk Total	1.13E-06				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.1.6.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	5.54E-02	--	--	5.54E-02
			Benzo(a)pyrene	6.72E-07	--	3.91E-07	--	1.06E-06	--	--	--	--	--
			Dibenz(a,h)anthracene	2.40E-07	--	1.40E-07	--	3.80E-07	--	--	--	--	--
			Chemical Total	9.12E-07	--	5.31E-07	--	1.44E-06		5.54E-02	--	--	5.54E-02
		Exposure Point Total						1.44E-06					5.54E-02
	Exposure Medium Total							1.44E-06					5.54E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	1.02E-10	--	--	1.02E-10	--	--	--	--	--
			Dibenz(a,h)anthracene	--	3.64E-11	--	--	3.64E-11	--	--	--	--	--
			Chemical Total	--	1.38E-10	--	--	1.38E-10		--	--	--	--
		Exposure Point Total						1.38E-10					--
	Exposure Medium Total							1.44E-06					--
Medium Total								1.44E-06					5.54E-02
Receptor Total							Receptor Risk Total	1.44E-06				Receptor HI Total	5.54E-02

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.1.7.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	5.17E-01	--	--	5.17E-01
			Benzo(a)pyrene	1.57E-06	--	6.41E-07	--	2.21E-06	--	--	--	--	--
			Dibenz(a,h)anthracene	5.60E-07	--	2.29E-07	--	7.89E-07	--	--	--	--	--
			Chemical Total	2.13E-06	--	8.70E-07	--	3.00E-06		5.17E-01	--	--	5.17E-01
		Exposure Point Total						3.00E-06					5.17E-01
	Exposure Medium Total							3.00E-06					5.17E-01
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	5.94E-11	--	--	5.94E-11	--	--	--	--	--
			Dibenz(a,h)anthracene	--	2.12E-11	--	--	2.12E-11	--	--	--	--	--
			Chemical Total	--	8.06E-11	--	--	8.06E-11		--	--	--	--
		Exposure Point Total						8.06E-11					--
	Exposure Medium Total							3.00E-06					--
Medium Total								3.00E-06					5.17E-01
Receptor Total							Receptor Risk Total	3.00E-06				Receptor HI Total	5.17E-01

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.2.1.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - CURRENT INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Dibenz(a,h)anthracene	1.61E-07	--	1.55E-07	--	3.16E-07	--	--	--	--	--
			Chemical Total	1.61E-07	--	1.55E-07	--	3.16E-07		--	--	--	--
		Exposure Point Total						3.16E-07					--
	Exposure Medium Total							3.16E-07					--
	Air	Outdoor Air (Particulates and VOCs)	Dibenz(a,h)anthracene	--	2.44E-11	--	--	2.44E-11	--	--	--	--	--
			Chemical Total	--	2.44E-11	--	--	2.44E-11		--	--	--	--
		Exposure Point Total						2.44E-11					--
	Exposure Medium Total							2.44E-11					--
Medium Total								3.16E-07					--
Receptor Total							Receptor Risk Total	3.16E-07				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.2.2.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	4.70E-02	--	--	4.70E-02
			Benzo(a)pyrene	5.98E-07	--	5.77E-07	--	1.17E-06	--	--	--	--	--
			Dibenz(a,h)anthracene	1.61E-07	--	1.55E-07	--	3.16E-07	--	--	--	--	--
			Chemical Total	7.59E-07	--	7.32E-07	--	1.49E-06		4.70E-02	--	--	4.70E-02
		Exposure Point Total						1.49E-06					4.70E-02
	Exposure Medium Total							1.49E-06					4.70E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	9.06E-11	--	--	9.06E-11	--	--	--	--	--
			Dibenz(a,h)anthracene	--	2.44E-11	--	--	2.44E-11	--	--	--	--	--
			Chemical Total	--	1.15E-10	--	--	1.15E-10		--	--	--	--
		Exposure Point Total						1.15E-10					--
	Exposure Medium Total							1.15E-10					--
Medium Total								1.49E-06					4.70E-02
Receptor Total							Receptor Risk Total	1.49E-06				Receptor HI Total	4.70E-02

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.2.3.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	1.55E-01	--	--	1.55E-01
			Benzo(a)pyrene	7.89E-08	--	3.46E-08	--	1.14E-07	--	--	--	--	--
			Dibenz(a,h)anthracene	2.12E-08	--	9.30E-09	--	3.05E-08	--	--	--	--	--
			Chemical Total	1.00E-07	--	4.39E-08	--	1.44E-07		1.55E-01	--	--	1.55E-01
		Exposure Point Total						1.44E-07					1.55E-01
	Exposure Medium Total							1.44E-07					1.55E-01
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	3.62E-12	--	--	3.62E-12	--	--	--	--	--
			Dibenz(a,h)anthracene	--	9.74E-13	--	--	9.74E-13	--	--	--	--	--
			Chemical Total	--	4.60E-12	--	--	4.60E-12		--	--	--	--
		Exposure Point Total						4.60E-12					--
	Exposure Medium Total							1.44E-07					--
Medium Total								1.44E-07					1.55E-01
Receptor Total							Receptor Risk Total	1.44E-07				Receptor HI Total	1.55E-01

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.2.4.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED ADULT RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Dibenz(a,h)anthracene	2.16E-07	--	1.26E-07	--	3.42E-07	--	--	--	--	--
			Chemical Total	2.16E-07	--	1.26E-07	--	3.42E-07		--	--	--	--
		Exposure Point Total						3.42E-07					--
	Exposure Medium Total							3.42E-07					--
	Air	Outdoor Air (Particulates and VOCs)	Dibenz(a,h)anthracene	--	3.27E-11	--	--	3.27E-11	--	--	--	--	--
			Chemical Total	--	3.27E-11	--	--	3.27E-11		--	--	--	--
		Exposure Point Total						3.27E-11					--
	Exposure Medium Total							3.42E-07					--
Medium Total								3.42E-07					--
Receptor Total							Receptor Risk Total	3.42E-07				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.2.5.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CHILD RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Dibenz(a,h)anthracene	5.04E-07	--	2.06E-07	--	7.10E-07	--	--	--	--	--
			Chemical Total	5.04E-07	--	2.06E-07	--	7.10E-07		--	--	--	--
		Exposure Point Total						7.10E-07					--
	Exposure Medium Total							7.10E-07					--
	Air	Outdoor Air (Particulates and VOCs)	Dibenz(a,h)anthracene	--	1.91E-11	--	--	1.91E-11	--	--	--	--	--
			Chemical Total	--	1.91E-11	--	--	1.91E-11		--	--	--	--
		Exposure Point Total						1.91E-11					--
	Exposure Medium Total							7.10E-07					--
Medium Total								7.10E-07					--
Receptor Total							Receptor Risk Total	7.10E-07				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.2.6.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	6.58E-02	--	--	6.58E-02
			Benzo(a)pyrene	8.04E-07	--	4.68E-07	--	1.27E-06	--	--	--	--	--
			Dibenz(a,h)anthracene	2.16E-07	--	1.26E-07	--	3.42E-07	--	--	--	--	--
			Chemical Total	1.02E-06	--	5.94E-07	--	1.61E-06		6.58E-02	--	--	6.58E-02
		Exposure Point Total						1.61E-06					6.58E-02
	Exposure Medium Total							1.61E-06					6.58E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	1.22E-10	--	--	1.22E-10	--	--	--	--	--
			Dibenz(a,h)anthracene	--	3.27E-11	--	--	3.27E-11	--	--	--	--	--
			Chemical Total	--	1.55E-10	--	--	1.55E-10		--	--	--	--
		Exposure Point Total						1.55E-10					--
	Exposure Medium Total							1.61E-06					--
Medium Total								1.61E-06					6.58E-02
Receptor Total							Receptor Risk Total	1.61E-06				Receptor HI Total	6.58E-02

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-9.2.7.RME: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	6.14E-01	--	--	6.14E-01
			Benzo(a)pyrene	1.88E-06	--	7.67E-07	--	2.64E-06	--	--	--	--	--
			Dibenz(a,h)anthracene	5.04E-07	--	2.06E-07	--	7.10E-07	--	--	--	--	--
			Chemical Total	2.38E-06	--	9.73E-07	--	3.35E-06		6.14E-01	--	--	6.14E-01
		Exposure Point Total						3.35E-06					6.14E-01
	Exposure Medium Total							3.35E-06					6.14E-01
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	7.10E-11	--	--	7.10E-11	--	--	--	--	--
			Dibenz(a,h)anthracene	--	1.91E-11	--	--	1.91E-11	--	--	--	--	--
			Chemical Total	--	9.01E-11	--	--	9.01E-11		--	--	--	--
		Exposure Point Total						9.01E-11					--
	Exposure Medium Total							3.35E-06					--
Medium Total								3.35E-06					6.14E-01
Receptor Total							Receptor Risk Total	3.35E-06				Receptor HI Total	6.14E-01

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-10.1.1.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - CURRENT INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I-10.1.2.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I-10.1.3.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I-10.1.4.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED ADULT RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I-10.1.5.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CHILD RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Benzo(a)pyrene	8.00E-07	--	3.27E-07	--	1.13E-06	--	--	--	--	--
			Chemical Total	8.00E-07	--	3.27E-07	--	1.13E-06		--	--	--	--
		Exposure Point Total						1.13E-06					--
	Exposure Medium Total							1.13E-06					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							1.13E-06					--
Medium Total								1.13E-06					--
Receptor Total							Receptor Risk Total	1.13E-06				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-10.1.6.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Benzo(a)pyrene	6.72E-07	--	3.91E-07	--	1.06E-06	--	--	--	--	--
			Chemical Total	6.72E-07	--	3.91E-07	--	1.06E-06		--	--	--	--
		Exposure Point Total						1.06E-06					--
	Exposure Medium Total							1.06E-06					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	1.06E-06				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-10.1.7.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Benzo(a)pyrene	1.57E-06	--	6.41E-07	--	2.21E-06	--	--	--	--	--
			Chemical Total	1.57E-06	--	6.41E-07	--	2.21E-06		--	--	--	--
		Exposure Point Total						2.21E-06					--
	Exposure Medium Total							2.21E-06					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	2.21E-06				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum expsoure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-10.2.1.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - CURRENT INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil									--		
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I-10.2.2.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Benzo(a)pyrene	5.98E-07	--	5.77E-07	--	1.17E-06	--	--	--	--	--
			Chemical Total	--	--	--	--	1.17E-06		--	--	--	--
		Exposure Point Total						1.17E-06					--
	Exposure Medium Total							1.17E-06					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	1.17E-06				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-10.2.3.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I-10.2.4.RME: EPA RAGS PART D TABLE 9
RISK SUMMARY - FUTURE DEVELOPED ADULT RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I-10.2.5.RME: EPA RAGS PART D TABLE 9
RISK SUMMARY - FUTURE DEVELOPED CHILD RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I-10.2.6.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Benzo(a)pyrene	8.04E-07	--	4.68E-07	--	1.27E-06	--	--	--	--	--
			Chemical Total	--	--	--	--	1.27E-06		--	--	--	--
		Exposure Point Total						1.27E-06					--
	Exposure Medium Total							1.27E-06					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	1.27E-06				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum exposure
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I-10.2.7.RME: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

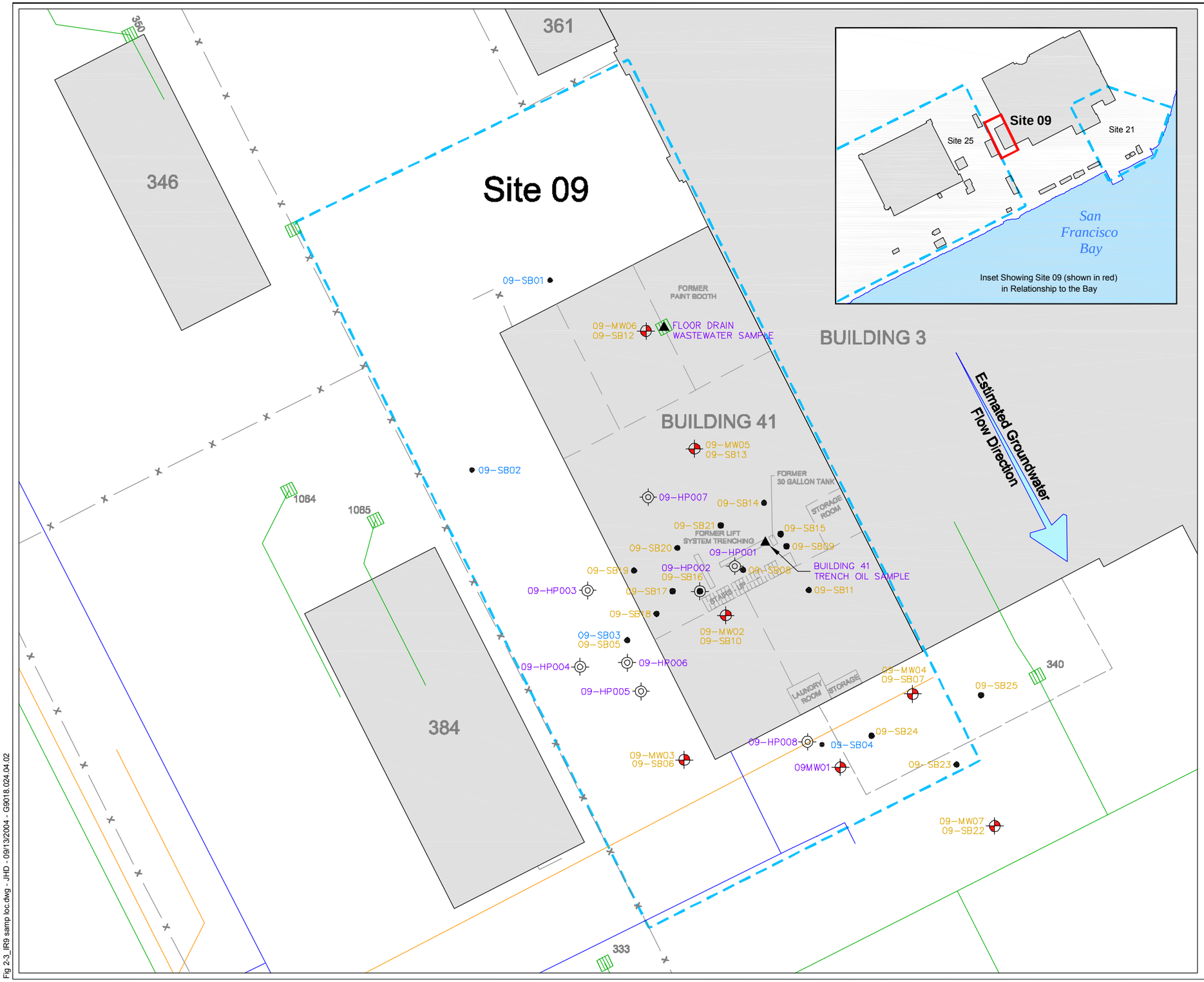
Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Benzo(a)pyrene	1.88E-06	--	7.67E-07	--	2.64E-06	--	--	--	--	--
			Chemical Total	--	--	--	--	2.64E-06		--	--	--	--
		Exposure Point Total						2.64E-06					--
	Exposure Medium Total							2.64E-06					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	2.64E-06				Receptor HI Total	--

Notes:

HI	Hazard index
RME	Reasonable maximum expsoure
VOC	Volatile organic compound
--	Not applicable or not available

FIGURES



AREA OF INTEREST

LEGEND

- MONITORING WELL LOCATION
- GEOPROBE SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- GRAB SAMPLE
- FRESHWATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- STORM DRAIN CATCH BASIN
- FENCE
- 384 — BUILDING
- SITE BOUNDARY
- 09-SB01 — PHASE I REMEDIAL INVESTIGATION - 1992
- 09-HP001 — PHASE IIB REMEDIAL INVESTIGATION - 1995
- 09-SB05 — ADDITIONAL INVESTIGATION - 2002

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SCALE IN FEET

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NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE I-1
Site 09 - Foundry
Sample Location History

Fig 2-3_IR9 samp loc.dwg - JHD - 09/13/2004 - G9018.024.04.02

Site 10

Site 07

Site 14

445

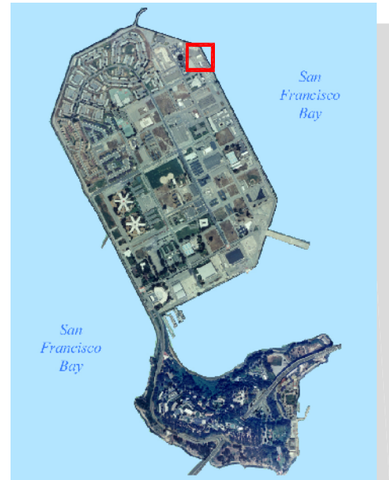
62

BUILDING 335

San Francisco Bay

07/10-HP018
07/10-HP016
07/10-MW01
07/10-HP019
07/10-HP017
07/10-HP012
07/10-HP008
07/10-HP013
10-SB05
10-SB06
10-SB10
10-SB08
10-SB09
10-SB07
10-MW02
10-SB19
07/10-HP006
10-SB12
10-SB20
10-SB14
10-SB13
CATCH BASIN C
SEDIMENT SAMPLE
WASTEWATER SAMPLE
07/10-HP004
10-SB11
07/10-HP014
10-SB15
10-SB25
07/10-HP011
10-SB23
10-SB16
10-SB24
10-SB04
10-SB03
10-SB22
10-SB17
10-SB02
10-SB18
07/10-HP007
07/10-HP009
10-SB21
07/10-HP010
14-MW03
10-SB27
07/10-HP002
10-MW03
10-SB26
FORMER FLOOR DRAIN
OVERHANG
SHED
335R
CATCH BASIN 335R
SEDIMENT SAMPLE
07/10-HP015
10-SB01
GATE
07/10-HP001
10-SB28
OVERHANG
2641
2640
SS-6-03
SS-6-02
SS-6-01
10-SB29
2670
Estimated Groundwater
Flow Direction

AREA OF INTEREST



LEGEND

- MONITORING WELL LOCATION
- GEOPROBE SOIL BORING LOCATION
- HYDROPUNCH LOCATION
- GRAB SAMPLE
- FRESHWATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- STORM DRAIN CATCH BASIN
- x — FENCE
- 384 — BUILDING
- SITE BOUNDARY
- 10-SB01 — PHASE I REMEDIAL INVESTIGATION - 1992
- 07/10-HP001 — PHASE IIB REMEDIAL INVESTIGATION - 1995
- SS-6-01 — ENVIRONMENTAL BASELINE SURVEY - 1997
- 10-SB05 — ADDITIONAL INVESTIGATION - 2002

N

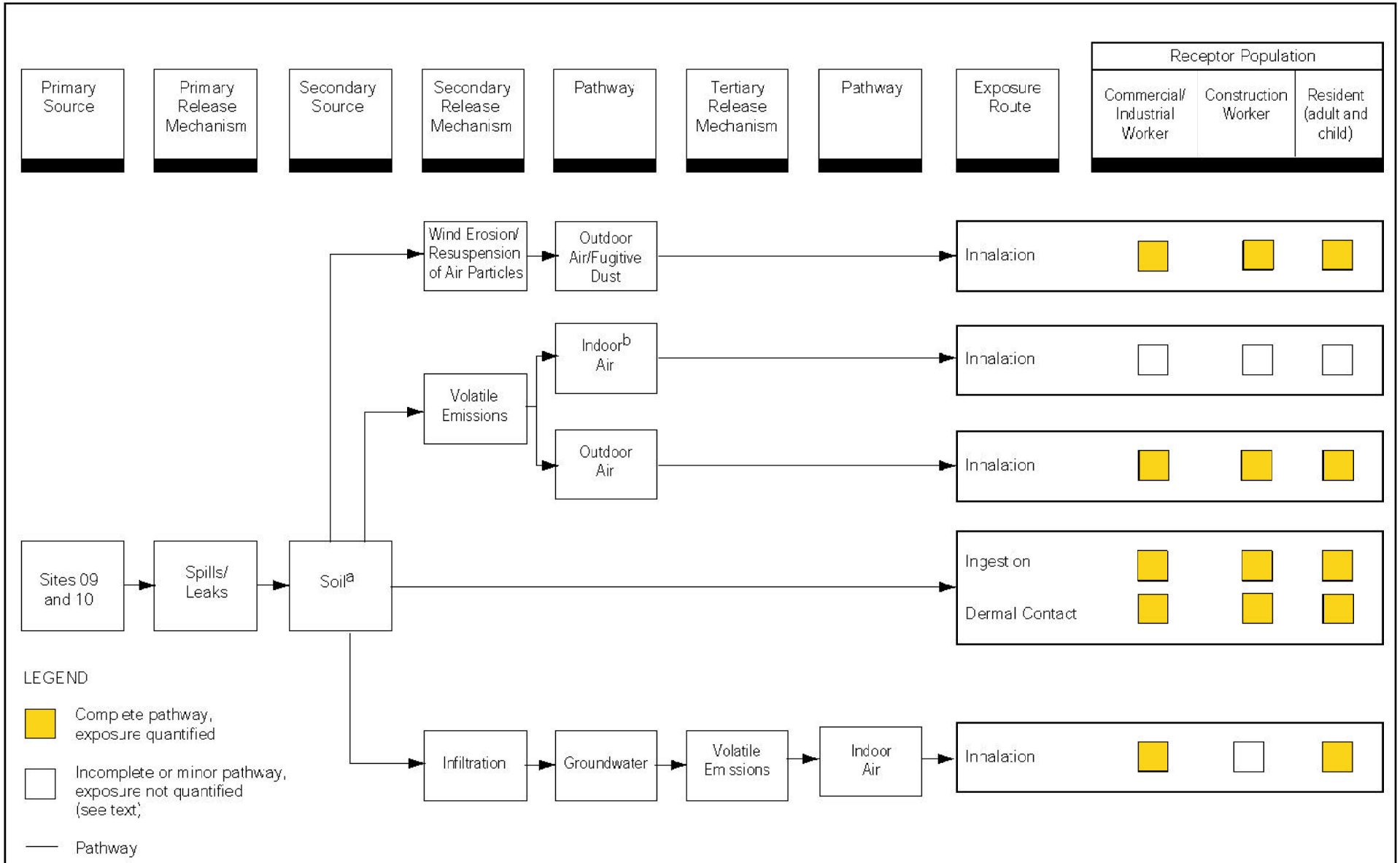
15 0 15 30
SCALE IN FEET

SulTech

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE I-2
Site 10 - Bus Painting Shop
Sample Location History

Fig 2-4_IR10 samp loc.dwg - JHD - 09/13/2004 - G9018.024.04.02



[a] For future exposures assuming intrusive redevelopment, soil includes samples between 0 and 8 feet below ground surface. For current exposures or redevelopment assuming little surface disturbance, soil includes samples between 0 and 2 feet below ground surface.

[b] While indoor air pathways are conceptually complete from impacted soil and groundwater, no soil gas data were collected since groundwater concentrations of volatiles were all below risk-based levels protective of inhalation in indoor air. No soil volatiles were detected above preliminary remediation goals and therefore, the soil-based portion of the conceptual indoor air pathway was also an insignificant one that was not quantified.

NAVAL STATION TREASURE ISLAND, CALIFORNIA
U.S. NAVY SOUTHWEST DIVISION NAVFAC, SAN DIEGO

FIGURE I-3
Conceptual Site Model
Sites 09 and 10

ATTACHMENT I1
SOIL AND GROUNDWATER DATA SETS

TABLES

Site 09 Soil and Groundwater Data Sets

I1-1 Site Location and Sample Identification Numbers, Soil, Site 09 – 0 to 2 feet bgs

I1-2 Site Location and Sample Identification Numbers, Soil, Site 09 – 0 to 8 feet bgs

I1-3 Site Location and Sample Identification Numbers, Groundwater, Site 09

Site 10 Soil and Groundwater Data Sets

I1-4 Site Location and Sample Identification Numbers, Soil, Site 10 – 0 to 2 feet bgs

I1-5 Site Location and Sample Identification Numbers, Soil, Site 10 – 0 to 8 feet bgs

I1-6 Site Location and Sample Identification Numbers, Groundwater, Site 10

TABLE I1-1: SITE LOCATION AND SAMPLE IDENTIFICATION NUMBERS, SOIL, SITE 09 - 0 to 2 feet bgs

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Medium	Depth	Location Number	Sample Number
		09-HP001	199HH001
Soil	0-2 feet	09-HP003	199HH006
		09-HP004	199HH009
		09-HP005	199HH012
		09-HP006	199HH015
		09-SB01	09SB01A
		09-SB02	09SB02A
		09-SB02	09SB02A
		09-SB04	09SB04A
		09-SB04	09SB04RSA
		09-SB05	30209SB05001
		09-SB05	30209SB05002
		09-SB05	30209SB05004
		09-SB06	30209SB06001
		09-SB07	30209SB07001
		09-SB08	30209SB08001
		09-SB10	30209SB10001
		09-SB11	30209SB11001
		09-SB12	30209SB12001
		09-SB13	30209SB13001
		09-SB14	30209SB14001
		09-SB15	30209SB15001
		09-SB16	30209SB16001
		09-SB17	30209SB17001
		09-SB18	30209SB18001
		09-SB19	30209SB19001
		09-SB20	30209SB20001
		09-SB21	30209SB21001
		09-SB22	30209SB22001
		09-SB23	30209SB23001
		09-SB24	30209SB24001
		09-SB25	30209SB25001

TABLE I1-2: SITE LOCATION AND SAMPLE IDENTIFICATION NUMBERS, SOIL, SITE 09 - 0 to 8 feet bgs

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Medium	Depth	Location Number	Sample Number
		09-HP001	199HH001
Soil	0-8 feet	09-HP002	199HH004
		09-HP003	199HH006
		09-HP003	199HH007
		09-HP003	199HH008
		09-HP004	199HH009
		09-HP004	199HH010
		09-HP004	199HH011
		09-HP005	199HH012
		09-HP005	199HH013
		09-HP005	199HH014
		09-HP006	199HH015
		09-SB01	09SB01A
		09-SB01	09SB01B
		09-SB01	09SB01C
		09-SB02	09SB02A
		09-SB02	09SB02B
		09-SB02	09SB02C
		09-SB02	09SB02RSB
		09-SB02	09SB02RSC
		09-SB04	09SB04A
		09-SB04	09SB04B
		09-SB04	09SB04C
		09-SB04	09SB04RSA
		09-SB04	09SB14C
		09-SB05	30209SB05001
		09-SB05	30209SB05002
		09-SB05	30209SB05003
		09-SB05	30209SB05004
		09-SB05	30209SB05005
		09-SB05	30209SB05006
		09-SB06	30209SB06001
		09-SB06	30209SB06002
		09-SB06	30209SB06003
		09-SB07	30209SB07001
		09-SB07	30209SB07002
		09-SB07	30209SB07003
		09-SB08	30209SB08001
		09-SB08	30209SB08002
		09-SB08	30209SB08003
		09-SB10	30209SB10001
		09-SB10	30209SB10002
		09-SB10	30209SB10003
		09-SB11	30209SB11001
		09-SB11	30209SB11002
		09-SB11	30209SB11003

TABLE I1-2: SITE LOCATION AND SAMPLE IDENTIFICATION NUMBERS, SOIL, SITE 09 - 0 to 8 feet bgs

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Medium	Depth	Location Number	Sample Number
		09-SB12	30209SB11003
		09-SB12	30209SB12001
		09-SB12	30209SB12002
		09-SB12	30209SB12003
		09-SB13	30209SB13001
		09-SB13	30209SB13002
		09-SB13	30209SB13003
		09-SB14	30209SB14001
		09-SB14	30209SB14002
		09-SB14	30209SB14003
		09-SB15	30209SB15001
		09-SB15	30209SB15002
		09-SB15	30209SB15003
		09-SB16	30209SB16001
		09-SB16	30209SB16002
		09-SB16	30209SB16003
		09-SB17	30209SB16003
		09-SB17	30209SB17001
		09-SB17	30209SB17002
		09-SB17	30209SB17003
		09-SB18	30209SB18001
		09-SB18	30209SB18002
		09-SB18	30209SB18003
		09-SB19	30209SB19001
		09-SB19	30209SB19002
		09-SB19	30209SB19003
		09-SB20	30209SB20001
		09-SB20	30209SB20002
		09-SB20	30209SB20003
		09-SB21	30209SB20003
		09-SB21	30209SB21002
		09-SB21	30209SB21003
		09-SB22	30209SB22001
		09-SB22	30209SB22002
		09-SB22	30209SB22003
		09-SB23	30209SB23001
		09-SB23	30209SB23002
		09-SB23	30209SB23003
		09-SB24	30209SB24001
		09-SB24	30209SB24002
		09-SB24	30209SB24003
		09-SB25	30209SB24003
		09-SB25	30209SB25002
		09-SB25	30209SB25003

TABLE I1-3: SITE LOCATION AND SAMPLE IDENTIFICATION NUMBERS, GROUNDWATER, SITE 09

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Medium	Location Number	Sample Number
	09-MW01	04109MW01
Groundwater	09-MW02	30209GW02001
	09-MW03	30209GW03001
	09-MW04	30209GW04001
	09-MW05	30209GW05001
	09-MW06	30209GW06001
	09-MW07	30209GW07001
	09-MW01	196Q4010
	09-MW01	199Q4024
	09-MW01	199Q5009
	09-MW01	199Q6009
	09-MW01	199Q6052
	09-MW01	199Q7009
	09-MW01	284Q1010
	09-MW01	284Q5079
	09-MW01	30209GW01001
	09-MW01	30209GW20001

Notes: The sample numbers shown were used in the quantitative human health risk assessment, including historical ranges reported in the summary statistics shown in the RAGS Part D Table 2 series. However, the most recent data from 2002 was used to select contaminants of potential concern, as described in the Appendix I text.

TABLE I1-4: SITE LOCATION AND SAMPLE IDENTIFICATION NUMBERS, SOIL, SITE 10 - 0 to 2 feet bgs

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Medium	Depth	Location Number	Sample Number
Soil	0-2 feet	07/10-HP001	199AA082
		07/10-HP002	199AA084
		07/10-HP007	199AA098
		07/10-HP010	199AA107
		07/10-HP011	199AA110
		07/10-HP012	199AA113B
		07/10-HP013	199AA116B
		10-SB01	10SB01A
		10-SB02	10SB02A
		10-SB04	10SB04A
		10-SB05	30210SB05001
		10-SB06	30210SB06001
		10-SB07	30210SB07001
		10-SB08	30210SB08001
		10-SB09	30210SB09001
		10-SB10	30210SB10001
		10-SB11	30210SB11001
		10-SB12	30210SB12001
		10-SB13	30210SB13001
		10-SB14	30210SB14001
		10-SB15	30210SB15001
		10-SB16	30210SB16001
		10-SB17	30210SB17001
		10-SB18	30210SB18001
		10-SB19	30210SB19001
		10-SB20	30210SB20001
		10-SB21	30210SB21001
		10-SB22	30210SB22001
		10-SB23	30210SB23001
		10-SB24	30210SB24001
		10-SB25	30210SB25001
		10-SB26	30210SB26001
		10-SB27	30210SB27001
		10-SB28	30210SB28001
		10-SB29	30210SB29001

TABLE I1-5: SITE LOCATION AND SAMPLE IDENTIFICATION NUMBERS, SOIL, SITE 10 - 0 to 8 feet bgs

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Medium	Depth	Location Number	Sample Number
		07/10-HP001	199AA082
Soil	0-8 feet	07/10-HP001	199AA083
		07/10-HP002	199AA084
		07/10-HP002	199AA085
		07/10-HP007	199AA098
		07/10-HP008	199AA103
		07/10-HP010	199AA107
		07/10-HP011	199AA110
		07/10-HP011	199AA111
		07/10-HP012	199AA113B
		07/10-HP012	199AA114B
		07/10-HP012	199AA115B
		07/10-HP013	199AA116B
		07/10-HP013	199AA117B
		07/10-HP013	199AA118B
		10-SB01	10SB01A
		10-SB01	10SB01B
		10-SB01	10SB01C
		10-SB01	10SB11A
		10-SB02	10SB02A
		10-SB02	10SB02B
		10-SB02	10SB02C
		10-SB04	10SB04A
		10-SB04	10SB04B
		10-SB04	10SB04C
		10-SB05	30210SB05001
		10-SB05	30210SB05002
		10-SB06	30210SB06001
		10-SB06	30210SB06002
		10-SB07	30210SB07001
		10-SB08	30210SB08001
		10-SB09	30210SB09001
		10-SB10	30210SB10001
		10-SB11	30210SB11001
		10-SB12	30210SB12001
		10-SB13	30210SB13001
		10-SB14	30210SB14001
		10-SB15	30210SB15001
		10-SB16	30210SB16001
		10-SB17	30210SB17001
		10-SB18	30210SB18001
		10-SB18	30210SB18002
		10-SB18	30210SB18003
		10-SB19	30210SB19001
		10-SB19	30210SB19002
		10-SB19	30210SB19003

TABLE I1-5: SITE LOCATION AND SAMPLE IDENTIFICATION NUMBERS, SOIL, SITE 10 - 0 to 8 feet bgs

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Medium	Depth	Location Number	Sample Number
		10-SB20	30210SB20001
		10-SB20	30210SB20002
		10-SB20	30210SB20003
		10-SB21	30210SB21001
		10-SB21	30210SB21002
		10-SB21	30210SB21003
		10-SB22	30210SB22001
		10-SB22	30210SB22002
		10-SB22	30210SB22003
		10-SB23	30210SB23001
		10-SB23	30210SB23002
		10-SB23	30210SB23003
		10-SB24	30210SB24001
		10-SB24	30210SB24002
		10-SB24	30210SB24003
		10-SB25	30210SB25001
		10-SB25	30210SB25002
		10-SB25	30210SB25003
		10-SB26	30210SB26001
		10-SB26	30210SB26002
		10-SB26	30210SB26003
		10-SB27	30210SB27001
		10-SB27	30210SB27002
		10-SB27	30210SB27003
		10-SB28	30210SB28001
		10-SB28	30210SB28002
		10-SB28	30210SB28003
		10-SB29	30210SB29001
		10-SB29	30210SB29002
		10-SB29	30210SB29003

TABLE I1-6: SITE LOCATION AND SAMPLE IDENTIFICATION NUMBERS, GROUNDWATER, SITE 10

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Subarea/Media	Location Number	Sample Number
	07/10-MW01	196Q4001
Groundwater	10-MW03	30210GW03001
	14-MW03	196Q2058
	07/10-MW01	199Q4023
	07/10-MW01	199Q5008
	07/10-MW01	199Q6008
	07/10-MW01	199Q7008
	14-MW03	196Q4086
	14-MW03	199Q4055
	14-MW03	199Q5025
	14-MW03	199Q6025
	14-MW03	199Q7025
	14-MW03	199Q7052
	14-MW03	284Q3119
	14-MW03	284Q8134

ATTACHMENT I2
CENTRAL TENDENCY EXPOSURE SCENARIO RESULTS

TABLES

Site 09 Chemical Noncancer Hazards

I2-7.1.1.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Current Industrial Worker, Site09

I2-7.1.2.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Industrial Worker, Site09

I2-7.1.3.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Construction Worker, Site09

I2-7.1.4.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Adult Resident, Site09

I2-7.1.5.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Child Resident, Site09

I2-7.1.6.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Adult Resident (Intrusive), Site09

I2-7.1.7.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Child Resident (Intrusive), Site09

Site 10 Chemical Noncancer Hazards

I2-7.2.1.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Current Industrial Worker, Site10,

I2-7.2.2.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Industrial Worker, Site10,

I2-7.2.3.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Construction Worker, Site10

I2-7.2.4.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Adult Resident, Site10

I2-7.2.5.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Child Resident, Site10

I2-7.2.6.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Adult Resident (Intrusive), Site10

I2-7.2.7.CTE EPA RAGS Part D Table 7b, Calculation of CTE Chemical Noncancer Hazards, Future Developed Child Resident (Intrusive), Site10

Site 09 Chemical Cancer Risks

I2-8.1.1.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Current Industrial Worker, Site09

I2-8.1.2.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Industrial Worker, Site09

I2-8.1.3.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Construction Worker, Site09

TABLES (Continued)

I2-8.1.4.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Adult Resident, Site09

I2-8.1.5.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Child Resident, Site09

I2-8.1.6.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Adult Resident (Intrusive), Site09

I2-8.1.7.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Child Resident (Intrusive), Site09

Site 10 Chemical Cancer Risks

I2-8.2.1.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Current Industrial Worker, Site10

I2-8.2.2.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Industrial Worker, Site10

I2-8.2.3.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Construction Worker, Site10

I2-8.2.4.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Adult Resident, Site10

I2-8.2.5.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Child Resident, Site10

I2-8.2.6.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Adult Resident (Intrusive), Site10

I2-8.2.7.CTE EPA RAGS Part D Table 7a, Calculation of CTE Chemical Cancer Risks, Future Developed Child Resident (Intrusive), Site10

Site 09 Summaries of Receptor Risks and Hazards for COPCs

I2-9.1.1.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Current Industrial Worker, Site09

I2-9.1.2.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Industrial Worker, Site09

I2-9.1.3.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Construction Worker, Site09

I2-9.1.4.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Adult Resident, Site09

I2-9.1.5.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Child Resident, Site09

I2-9.1.6.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Adult Resident (Intrusive), Site09

I2-9.1.7.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Child Resident (Intrusive), Site09

TABLES (Continued)

Site 10 Summaries of Receptor Risks and Hazards for COPCs

I2-9.2.1.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Current Industrial Worker, Site10

I2-9.2.2.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Industrial Worker, Site10

I2-9.2.3.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Construction Worker, Site10

I2-9.2.4.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Adult Resident, Site10

I2-9.2.5.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Child Resident, Site10

I2-9.2.6.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Adult Resident (Intrusive), Site10

I2-9.2.7.CTE EPA RAGS Part D Table 9, Summary of Receptor Risks and Hazards for COPCs, Future Developed Child Resident (Intrusive), Site10

Site 09 Risk Summaries

I2-10.1.1.CTE EPA RAGS Part D Table 10, Risk Summary, Current Industrial Worker, Site09

I2-10.1.2.CTE EPA RAGS Part D Table 10, Risk Summary, Future Developed Industrial Worker, Site09

I2-10.1.3.CTE EPA RAGS Part D Table 10, Risk Summary, Future Developed Construction Worker, Site09

I2-10.1.4.CTE EPA RAGS Part D Table 10, Risk Summary, Future Developed Adult Resident, Site09

I2-10.1.5.CTE EPA RAGS Part D Table 10, Risk Summary, Future Developed Child Resident, Site09

I2-10.1.6.CTE EPA RAGS Part D Table 10, Risk Summary, Future Developed Adult Resident (Intrusive), Site09

I2-10.1.7.CTE EPA RAGS Part D Table 10, Risk Summary, Future Developed Child Resident (Intrusive), Site09

Site 10 Risk Summaries

I2-10.2.1.CTE EPA RAGS Part D Table 10, Risk Summary, Current Industrial Worker, Site10

I2-10.2.2.CTE EPA RAGS Part D Table 10, Risk Summary, Future Developed Industrial Worker, Site10

I2-10.2.3.CTE EPA RAGS Part D Table 10, Risk Summary, Future Developed Construction Worker, Site10

I2-10.2.4.CTE EPA RAGS Part D Table 10, Risk Summary, Future Developed Adult Resident, Site10

TABLES (Continued)

I2-10.2.5.CTE	EPA RAGS Part D Table 10, Risk Summary, Future Developed Child Resident, Site10
I2-10.2.6.CTE	EPA RAGS Part D Table 10, Risk Summary, Future Developed Adult Resident (Intrusive), Site10
I2-10.2.7.CTE	EPA RAGS Part D Table 10, Risk Summary, Future Developed Child Resident (Intrusive), Site10

TABLE I2-7.1.1.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - CURRENT INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	8.70E-02	mg/kg	3.73E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Benzo(a)pyrene	8.70E-02	mg/kg	6.4E-09	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	8.70E-02	mg/kg	5.9E-12	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.1.2.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.16E+04	mg/kg	4.95E-03	mg/kg-day	3.00E-01	mg/kg-day	1.65E-02
				Benzo(a)pyrene	7.88E-02	mg/kg	3.38E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	3.00E-08	mg/kg-day	--	--	--
			Exp. Route Total								**1.65E-02**
			Dermal	Iron	1.16E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	7.88E-02	mg/kg	5.79E-09	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	5.15E-09	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**1.65E-02**
	Exposure Medium Total										**1.65E-02**
	Air	Outdoor Air	Inhalation	Iron	1.16E+04	mg/kg	7.80E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	7.88E-02	mg/kg	5.32E-12	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	4.73E-12	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**1.65E-02**
										Total of Receptor Hazards Across All Media	**1.65E-02**

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.1.3.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.16E+04	mg/kg	4.07E-03	mg/kg-day	3.00E-01	mg/kg-day	1.36E-02
				Benzo(a)pyrene	7.88E-02	mg/kg	2.8E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	2.5E-08	mg/kg-day	--	--	--
			Exp. Route Total								**1.36E-02**
			Dermal	Iron	1.16E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	7.88E-02	mg/kg	1.2E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.1E-08	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**1.36E-02**
	Exposure Medium Total										**1.36E-02**
	Air	Outdoor Air	Inhalation	Iron	1.16E+04	mg/kg	3.2E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	7.88E-02	mg/kg	2.2E-12	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.9E-12	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**1.36E-02**
										Total of Receptor Hazards Across All Media	**1.36E-02**

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.1.4.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - CURRENT ADULT RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	8.70E-02	mg/kg	5.96E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Benzo(a)pyrene	8.70E-02	mg/kg	8.8E-09	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	8.70E-02	mg/kg	1.2E-11	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.1.5.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - CURRENT CHILD RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	8.70E-02	mg/kg	5.56E-07	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Benzo(a)pyrene	8.70E-02	mg/kg	8.1E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	8.70E-02	mg/kg	3.5E-11	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.1.6.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.16E+04	mg/kg	7.91E-03	mg/kg-day	3.00E-01	mg/kg-day	2.64E-02
				Benzo(a)pyrene	7.88E-02	mg/kg	5.4E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	4.8E-08	mg/kg-day	--	--	--
			Exp. Route Total								**2.64E-02**
			Dermal	Iron	1.16E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	7.88E-02	mg/kg	8.0E-09	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	7.1E-09	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**2.64E-02**
	Exposure Medium Total										**2.64E-02**
	Air	Outdoor Air	Inhalation	Iron	1.16E+04	mg/kg	1.6E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	7.88E-02	mg/kg	1.1E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	9.6E-12	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**2.64E-02**
										Total of Receptor Hazards Across All Media	**2.64E-02**

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.1.7.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.16E+04	mg/kg	7.38E-02	mg/kg-day	3.00E-01	mg/kg-day	2.46E-01
				Benzo(a)pyrene	7.88E-02	mg/kg	5.0E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	4.5E-07	mg/kg-day	--	--	--
			Exp. Route Total								**2.46E-01**
			Dermal	Iron	1.16E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	7.88E-02	mg/kg	7.3E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	6.5E-08	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**2.46E-01**
	Exposure Medium Total										**2.46E-01**
	Air	Outdoor Air	Inhalation	Iron	1.16E+04	mg/kg	4.7E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	7.88E-02	mg/kg	3.2E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	2.8E-11	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**2.46E-01**
										Total of Receptor Hazards Across All Media	**2.46E-01**

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.2.1.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - CURRENT INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.70E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.6E-09	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.3E-12	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.2.2.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.33E+04	mg/kg	5.71E-03	mg/kg-day	3.00E-01	mg/kg-day	1.90E-02
				Benzo(a)pyrene	1.10E-01	mg/kg	4.71E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.70E-08	mg/kg-day	--	--	--
			Exp. Route Total								**1.90E-02**
			Dermal	Iron	1.33E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	1.10E-01	mg/kg	8.09E-09	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.63E-09	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**1.90E-02**
	Exposure Medium Total										**1.90E-02**
	Air	Outdoor Air	Inhalation	Iron	1.33E+04	mg/kg	9.00E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.10E-01	mg/kg	7.43E-12	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.25E-12	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**1.90E-02**
										Total of Receptor Hazards Across All Media	**1.90E-02**

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.2.3.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.33E+04	mg/kg	4.70E-03	mg/kg-day	3.00E-01	mg/kg-day	1.57E-02
				Benzo(a)pyrene	1.10E-01	mg/kg	3.9E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.2E-08	mg/kg-day	--	--	--
			Exp. Route Total								**1.57E-02**
			Dermal	Iron	1.33E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	1.10E-01	mg/kg	1.7E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	9.5E-09	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**1.57E-02**
	Exposure Medium Total										**1.57E-02**
	Air	Outdoor Air	Inhalation	Iron	1.33E+04	mg/kg	3.7E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.10E-01	mg/kg	3.1E-12	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.7E-12	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**1.57E-02**
										Total of Receptor Hazards Across All Media	**1.57E-02**

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.2.4.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED ADULT RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.32E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	6.4E-09	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	8.6E-12	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.2.5.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CHILD RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.03E-07	mg/kg-day	--	--	--
			Exp. Route Total								--
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	5.9E-08	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.6E-11	mg/kg-day	--	--	--
			Exp. Route Total								--
		Exposure Point Total									--
	Exposure Medium Total										--
Medium Total											--
										Total of Receptor Hazards Across All Media	--

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.2.6.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.33E+04	mg/kg	9.13E-03	mg/kg-day	3.00E-01	mg/kg-day	3.04E-02
				Benzo(a)pyrene	1.10E-01	mg/kg	7.5E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.3E-08	mg/kg-day	--	--	--
			Exp. Route Total								**3.04E-02**
			Dermal	Iron	1.33E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	1.10E-01	mg/kg	1.1E-08	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	6.4E-09	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**3.04E-02**
	Exposure Medium Total										**3.04E-02**
	Air	Outdoor Air	Inhalation	Iron	1.33E+04	mg/kg	1.8E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.10E-01	mg/kg	1.5E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	8.6E-12	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**3.04E-02**
										Total of Receptor Hazards Across All Media	**3.04E-02**

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-7.2.7.CTE: EPA RAGS PART D TABLE 7b
CALCULATION OF CTE CHEMICAL NONCANCER HAZARDS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.33E+04	mg/kg	8.52E-02	mg/kg-day	3.00E-01	mg/kg-day	2.84E-01
				Benzo(a)pyrene	1.10E-01	mg/kg	7.0E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.0E-07	mg/kg-day	--	--	--
			Exp. Route Total								**2.84E-01**
			Dermal	Iron	1.33E+04	mg/kg	--	mg/kg-day	3.00E-01	mg/kg-day	--
				Benzo(a)pyrene	1.10E-01	mg/kg	1.0E-07	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	5.9E-08	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**2.84E-01**
	Exposure Medium Total										**2.84E-01**
	Air	Outdoor Air	Inhalation	Iron	1.33E+04	mg/kg	5.4E-06	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.10E-01	mg/kg	4.5E-11	mg/kg-day	--	--	--
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.6E-11	mg/kg-day	--	--	--
			Exp. Route Total								**--**
		Exposure Point Total									**--**
	Exposure Medium Total										**--**
Medium Total											**2.84E-01**
										Total of Receptor Hazards Across All Media	**2.84E-01**

Notes:

CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
RfD	Reference dose
RfC	Reference concentration
--	Not applicable or not available

TABLE I2-8.1.1.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - CURRENT INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	8.70E-02	mg/kg	2.40E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.75E-08
			Exp. Route Total								**1.75E-08**
			Dermal	Benzo(a)pyrene	8.70E-02	mg/kg	4.11E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	3.37E-09
			Exp. Route Total								**3.37E-09**
		Exposure Point Total									**2.09E-08**
	Exposure Medium Total										**2.09E-08**
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	8.70E-02	mg/kg	3.77E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.76E-12
			Exp. Route Total								**2.76E-12**
		Exposure Point Total									**2.76E-12**
	Exposure Medium Total										**2.76E-12**
Medium Total											**2.09E-08**
										Total of Receptor Hazards Across All Media	**2.09E-08**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.1.2.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.16E+04	mg/kg	3.18E-04	mg/kg-day	--	--	--
				Benzo(a)pyrene	7.88E-02	mg/kg	2.17E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.58E-08
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.93E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.41E-08
			Exp. Route Total								**2.99E-08**
			Dermal	Iron	1.16E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	7.88E-02	mg/kg	3.73E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	3.06E-09
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	3.31E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.71E-09
			Exp. Route Total								**5.77E-09**
		Exposure Point Total									**3.57E-08**
	Exposure Medium Total										**3.57E-08**
	Air	Outdoor Air	Inhalation	Iron	1.16E+04	mg/kg	5.01E-08	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	7.88E-02	mg/kg	3.42E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.50E-12
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	3.04E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.22E-12
			Exp. Route Total								**4.72E-12**
		Exposure Point Total									**4.72E-12**
	Exposure Medium Total										**4.72E-12**
Medium Total											**3.57E-08**
									Total of Receptor Hazards Across All Media		**3.57E-08**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.1.3.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.16E+04	mg/kg	5.81E-05	mg/kg-day	--	--	--
				Benzo(a)pyrene	7.88E-02	mg/kg	3.97E-10	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.89E-09
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	3.52E-10	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.57E-09
			Exp. Route Total								**5.47E-09**
			Dermal	Iron	1.16E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	7.88E-02	mg/kg	1.70E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.40E-09
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.51E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.24E-09
			Exp. Route Total								**2.63E-09**
		Exposure Point Total									**8.10E-09**
	Exposure Medium Total										**8.10E-09**
	Air	Outdoor Air	Inhalation	Iron	1.16E+04	mg/kg	4.58E-09	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	7.88E-02	mg/kg	3.12E-14	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.28E-13
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	2.78E-14	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.03E-13
			Exp. Route Total								**4.31E-13**
		Exposure Point Total									**4.31E-13**
	Exposure Medium Total										**4.31E-13**
Medium Total											**8.10E-09**
										Total of Receptor Hazards Across All Media	**8.10E-09**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.1.4.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - CURRENT ADULT RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	8.70E-02	mg/kg	5.96E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	4.35E-08
			Exp. Route Total								**4.35E-08**
			Dermal	Benzo(a)pyrene	8.70E-02	mg/kg	8.83E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	7.24E-09
			Exp. Route Total								**7.24E-09**
		Exposure Point Total									**5.07E-08**
	Exposure Medium Total										**5.07E-08**
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	8.70E-02	mg/kg	1.19E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	8.70E-12
			Exp. Route Total								**8.70E-12**
		Exposure Point Total									**8.70E-12**
	Exposure Medium Total										**8.70E-12**
Medium Total											**5.07E-08**
										Total of Receptor Hazards Across All Media	**5.07E-08**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.1.5.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - CURRENT CHILD RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Benzo(a)pyrene	8.70E-02	mg/kg	1.59E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.16E-07
			Exp. Route Total								**1.16E-07**
			Dermal	Benzo(a)pyrene	8.70E-02	mg/kg	2.31E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.90E-08
			Exp. Route Total								**1.90E-08**
		Exposure Point Total									**1.35E-07**
	Exposure Medium Total										**1.35E-07**
	Air	Outdoor Air	Inhalation (particulates)	Benzo(a)pyrene	8.70E-02	mg/kg	1.01E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	7.38E-12
			Exp. Route Total								**7.38E-12**
		Exposure Point Total									**7.38E-12**
	Exposure Medium Total										**7.38E-12**
Medium Total											**1.35E-07**
										Total of Receptor Hazards Across All Media	**1.35E-07**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.1.6.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.16E+04	mg/kg	7.91E-04	mg/kg-day	--	--	--
				Benzo(a)pyrene	7.88E-02	mg/kg	5.40E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.94E-08
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	4.79E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.50E-08
			Exp. Route Total								**7.44E-08**
			Dermal	Iron	1.16E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	7.88E-02	mg/kg	8.00E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	6.56E-09
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	7.11E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	5.83E-09
			Exp. Route Total								**1.24E-08**
		Exposure Point Total									**8.68E-08**
	Exposure Medium Total										**8.68E-08**
	Air	Outdoor Air	Inhalation	Iron	1.16E+04	mg/kg	1.58E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	7.88E-02	mg/kg	1.08E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	7.88E-12
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	9.59E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	7.00E-12
			Exp. Route Total								**1.49E-11**
		Exposure Point Total									**1.49E-11**
	Exposure Medium Total										**1.49E-11**
Medium Total											**8.68E-08**
									Total of Receptor Hazards Across All Media		**8.68E-08**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.1.7.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.16E+04	mg/kg	2.11E-03	mg/kg-day	--	--	--
				Benzo(a)pyrene	7.88E-02	mg/kg	1.44E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.05E-07
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.28E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	9.33E-08
			Exp. Route Total								**1.98E-07**
			Dermal	Iron	1.16E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	7.88E-02	mg/kg	2.10E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.72E-08
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	1.86E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.53E-08
			Exp. Route Total								**3.25E-08**
		Exposure Point Total									**2.31E-07**
	Exposure Medium Total										**2.31E-07**
	Air	Outdoor Air	Inhalation	Iron	1.16E+04	mg/kg	1.34E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	7.88E-02	mg/kg	9.16E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	6.69E-12
				Dibenz(a,h)anthracene	7.00E-02	mg/kg	8.14E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.94E-12
			Exp. Route Total								**1.26E-11**
		Exposure Point Total									**1.26E-11**
	Exposure Medium Total										**1.26E-11**
Medium Total											**2.31E-07**
										Total of Receptor Hazards Across All Media	**2.31E-07**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.2.1.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - CURRENT INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.74E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.27E-08
			Exp. Route Total								**1.27E-08**
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.98E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.44E-09
			Exp. Route Total								**2.44E-09**
		Exposure Point Total									**1.51E-08**
	Exposure Medium Total										**1.51E-08**
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.74E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.00E-12
			Exp. Route Total								**2.00E-12**
		Exposure Point Total									**2.00E-12**
	Exposure Medium Total										**2.00E-12**
Medium Total											**1.51E-08**
										Total of Receptor Hazards Across All Media	**1.51E-08**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.2.2.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.33E+04	mg/kg	3.67E-04	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.10E-01	mg/kg	3.03E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.21E-08
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.74E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.27E-08
			Exp. Route Total								**3.48E-08**
			Dermal	Iron	1.33E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.10E-01	mg/kg	5.20E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	4.27E-09
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.98E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.44E-09
			Exp. Route Total								**6.71E-09**
		Exposure Point Total									**4.15E-08**
	Exposure Medium Total										**4.15E-08**
	Air	Outdoor Air	Inhalation	Iron	1.33E+04	mg/kg	5.79E-08	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.10E-01	mg/kg	4.78E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.49E-12
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.74E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.00E-12
			Exp. Route Total								**5.48E-12**
		Exposure Point Total									**5.48E-12**
	Exposure Medium Total										**5.48E-12**
Medium Total											**4.15E-08**
										Total of Receptor Hazards Across All Media	**4.15E-08**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.2.3.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.33E+04	mg/kg	6.71E-05	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.10E-01	mg/kg	5.54E-10	mg/kg-day	7.30E+00	(mg/kg-day)-1	4.04E-09
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	3.17E-10	mg/kg-day	7.30E+00	(mg/kg-day)-1	2.31E-09
			Exp. Route Total								**6.36E-09**
			Dermal	Iron	1.33E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.10E-01	mg/kg	2.38E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.95E-09
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.36E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.12E-09
			Exp. Route Total								**3.06E-09**
		Exposure Point Total									**9.42E-09**
	Exposure Medium Total										**9.42E-09**
	Air	Outdoor Air	Inhalation	Iron	1.33E+04	mg/kg	5.29E-09	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.10E-01	mg/kg	4.36E-14	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.18E-13
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	2.50E-14	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.82E-13
			Exp. Route Total								**5.01E-13**
		Exposure Point Total									**5.01E-13**
	Exposure Medium Total										**5.01E-13**
Medium Total											**9.42E-09**
										Total of Receptor Hazards Across All Media	**9.42E-09**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.2.4.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED ADULT RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.32E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.15E-08
			Exp. Route Total								**3.15E-08**
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	6.39E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	5.25E-09
			Exp. Route Total								**5.25E-09**
		Exposure Point Total									**3.67E-08**
	Exposure Medium Total										**3.67E-08**
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	8.63E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	6.30E-12
			Exp. Route Total								**6.30E-12**
		Exposure Point Total									**6.30E-12**
	Exposure Medium Total										**6.30E-12**
Medium Total											**3.68E-08**
										Total of Receptor Hazards Across All Media	**3.68E-08**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.2.5.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED CHILD RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-2)	Soil	Site Soil	Ingestion	Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.15E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	8.40E-08
			Exp. Route Total								**8.40E-08**
			Dermal	Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.68E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.37E-08
			Exp. Route Total								**1.37E-08**
		Exposure Point Total									**9.77E-08**
	Exposure Medium Total										**9.77E-08**
	Air	Outdoor Air	Inhalation (particulates)	Dibenz(a,h)anthracene	6.30E-02	mg/kg	7.32E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.35E-12
			Exp. Route Total								**5.35E-12**
		Exposure Point Total									**5.35E-12**
	Exposure Medium Total										**5.35E-12**
Medium Total											**9.77E-08**
										Total of Receptor Hazards Across All Media	**9.77E-08**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.2.6.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.33E+04	mg/kg	9.13E-04	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.10E-01	mg/kg	7.54E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.50E-08
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	4.32E-09	mg/kg-day	7.30E+00	(mg/kg-day)-1	3.15E-08
			Exp. Route Total								**8.65E-08**
			Dermal	Iron	1.33E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.10E-01	mg/kg	1.12E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	9.16E-09
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	6.39E-10	mg/kg-day	8.20E+00	(mg/kg-day)-1	5.25E-09
			Exp. Route Total								**1.44E-08**
		Exposure Point Total									**1.01E-07**
	Exposure Medium Total										**1.01E-07**
	Air	Outdoor Air	Inhalation	Iron	1.33E+04	mg/kg	1.83E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.10E-01	mg/kg	1.51E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.10E-11
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	8.63E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	6.30E-12
			Exp. Route Total								**1.73E-11**
		Exposure Point Total									**1.73E-11**
	Exposure Medium Total										**1.73E-11**
Medium Total											**1.01E-07**
										Total of Receptor Hazards Across All Media	**1.01E-07**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-8.2.7.CTE: EPA RAGS PART D TABLE 7a
CALCULATION OF CTE CHEMICAL CANCER RISKS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk
							Value	Units	Value	Units	
Soil (0-8)	Soil	Site Soil	Ingestion	Iron	1.33E+04	mg/kg	2.44E-03	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.10E-01	mg/kg	2.01E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	1.47E-07
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.15E-08	mg/kg-day	7.30E+00	(mg/kg-day)-1	8.40E-08
			Exp. Route Total								**2.31E-07**
			Dermal	Iron	1.33E+04	mg/kg	--	mg/kg-day	--	--	--
				Benzo(a)pyrene	1.10E-01	mg/kg	2.93E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	2.40E-08
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	1.68E-09	mg/kg-day	8.20E+00	(mg/kg-day)-1	1.37E-08
			Exp. Route Total								**3.77E-08**
		Exposure Point Total									**2.68E-07**
	Exposure Medium Total										**2.68E-07**
	Air	Outdoor Air	Inhalation	Iron	1.33E+04	mg/kg	1.55E-07	mg/kg-day	--	--	--
			(particulates)	Benzo(a)pyrene	1.10E-01	mg/kg	1.28E-12	mg/kg-day	7.30E+00	(mg/kg-day)-1	9.34E-12
				Dibenz(a,h)anthracene	6.30E-02	mg/kg	7.32E-13	mg/kg-day	7.30E+00	(mg/kg-day)-1	5.35E-12
			Exp. Route Total								**1.47E-11**
		Exposure Point Total									**1.47E-11**
	Exposure Medium Total										**1.47E-11**
Medium Total											**2.68E-07**
										Total of Receptor Hazards Across All Media	**2.68E-07**

Notes:

CSF	Cancer slope factor
CTE	Central tendency exposure
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
(mg/kg-day)-1	1/(Milligram per kilogram per day)
--	Not applicable or not available

TABLE I2-9.1.1.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - CURRENT INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Benzo(a)pyrene	1.75E-08	--	3.37E-09	--	2.09E-08	--	--	--	--	--
			Chemical Total	1.75E-08	--	3.37E-09	--	2.09E-08		--	--	--	--
		Exposure Point Total						2.09E-08					--
	Exposure Medium Total							2.09E-08					--
	Air	Outdoor Air (Particulates and VOCs)	Benzo(a)pyrene	--	2.76E-12	--	--	2.76E-12	--	--	--	--	--
			Chemical Total	--	2.76E-12	--	--	2.76E-12		--	--	--	--
		Exposure Point Total						2.76E-12					--
	Exposure Medium Total							2.76E-12					--
Medium Total								2.09E-08					--
Receptor Total							Receptor Risk Total	2.09E-08				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.1.2.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	1.65E-02	--	--	1.65E-02
			Benzo(a)pyrene	1.58E-08	--	3.06E-09	--	1.89E-08	--	--	--	--	--
			Dibenz(a,h)anthracene	1.41E-08	--	2.71E-09	--	1.68E-08	--	--	--	--	--
			Chemical Total	2.99E-08	--	5.77E-09	--	3.57E-08		1.65E-02	--	--	1.65E-02
		Exposure Point Total						3.57E-08					1.65E-02
	Exposure Medium Total							3.57E-08					1.65E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	2.50E-12	--	--	2.50E-12	--	--	--	--	--
			Dibenz(a,h)anthracene	--	2.22E-12	--	--	2.22E-12	--	--	--	--	--
			Chemical Total	--	4.72E-12	--	--	4.72E-12		--	--	--	--
		Exposure Point Total						4.72E-12					--
	Exposure Medium Total							4.72E-12					--
Medium Total								3.57E-08					1.65E-02
Receptor Total							Receptor Risk Total	3.57E-08				Receptor HI Total	1.65E-02

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.1.3.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	1.36E-02	--	--	1.36E-02
			Benzo(a)pyrene	2.89E-09	--	1.40E-09	--	4.29E-09	--	--	--	--	--
			Dibenz(a,h)anthracene	2.57E-09	--	1.24E-09	--	3.81E-09	--	--	--	--	--
			Chemical Total	5.47E-09	--	2.63E-09	--	8.10E-09		1.36E-02	--	--	1.36E-02
		Exposure Point Total						8.10E-09					1.36E-02
	Exposure Medium Total							8.10E-09					1.36E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	2.28E-13	--	--	2.28E-13	--	--	--	--	--
			Dibenz(a,h)anthracene	--	2.03E-13	--	--	2.03E-13	--	--	--	--	--
			Chemical Total	--	4.31E-13	--	--	4.31E-13		--	--	--	--
		Exposure Point Total						4.31E-13					--
	Exposure Medium Total							4.31E-13					--
Medium Total								8.10E-09					1.36E-02
Receptor Total							Receptor Risk Total	8.10E-09				Receptor HI Total	1.36E-02

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.1.4.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED ADULT RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Benzo(a)pyrene	4.35E-08	--	7.24E-09	--	5.07E-08	--	--	--	--	--
			Chemical Total	4.35E-08	--	7.24E-09	--	5.07E-08		--	--	--	--
		Exposure Point Total						5.07E-08					--
	Exposure Medium Total							5.07E-08					--
	Air	Outdoor Air (Particulates and VOCs)	Benzo(a)pyrene	--	8.70E-12	--	--	8.70E-12	--	--	--	--	--
			Chemical Total	--	8.70E-12	--	--	8.70E-12		--	--	--	--
		Exposure Point Total						8.70E-12					--
	Exposure Medium Total							5.07E-08					--
Medium Total								5.07E-08					--
Receptor Total							Receptor Risk Total	5.07E-08				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.1.5.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CHILD RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Benzo(a)pyrene	1.16E-07	--	1.90E-08	--	1.35E-07	--	--	--	--	--
			Chemical Total	1.16E-07	--	1.90E-08	--	1.35E-07		--	--	--	--
		Exposure Point Total						1.35E-07					--
	Exposure Medium Total							1.35E-07					--
	Air	Outdoor Air (Particulates and VOCs)	Benzo(a)pyrene	--	7.38E-12	--	--	7.38E-12	--	--	--	--	--
			Chemical Total	--	7.38E-12	--	--	7.38E-12		--	--	--	--
		Exposure Point Total						7.38E-12					--
	Exposure Medium Total							1.35E-07					--
Medium Total								1.35E-07					--
Receptor Total							Receptor Risk Total	1.35E-07				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.1.6.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	2.64E-02	--	--	2.64E-02
			Benzo(a)pyrene	3.94E-08	--	6.56E-09	--	4.60E-08	--	--	--	--	--
			Dibenz(a,h)anthracene	3.50E-08	--	5.83E-09	--	4.08E-08	--	--	--	--	--
			Chemical Total	7.44E-08	--	1.24E-08	--	8.68E-08		2.64E-02	--	--	2.64E-02
		Exposure Point Total						8.68E-08					2.64E-02
	Exposure Medium Total							8.68E-08					2.64E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	7.88E-12	--	--	7.88E-12	--	--	--	--	--
			Dibenz(a,h)anthracene	--	7.00E-12	--	--	7.00E-12	--	--	--	--	--
			Chemical Total	--	1.49E-11	--	--	1.49E-11		--	--	--	--
		Exposure Point Total						1.49E-11					--
	Exposure Medium Total							8.68E-08					--
Medium Total								8.68E-08					2.64E-02
Receptor Total							Receptor Risk Total	8.68E-08				Receptor HI Total	2.64E-02

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.1.7.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	2.46E-01	--	--	2.46E-01
			Benzo(a)pyrene	1.05E-07	--	1.72E-08	--	1.22E-07	--	--	--	--	--
			Dibenz(a,h)anthracene	9.33E-08	--	1.53E-08	--	1.09E-07	--	--	--	--	--
			Chemical Total	1.98E-07	--	3.25E-08	--	2.31E-07		2.46E-01	--	--	2.46E-01
		Exposure Point Total						2.31E-07					2.46E-01
	Exposure Medium Total							2.31E-07					2.46E-01
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	6.69E-12	--	--	6.69E-12	--	--	--	--	--
			Dibenz(a,h)anthracene	--	5.94E-12	--	--	5.94E-12	--	--	--	--	--
			Chemical Total	--	1.26E-11	--	--	1.26E-11		--	--	--	--
		Exposure Point Total						1.26E-11					--
	Exposure Medium Total							2.31E-07					--
Medium Total								2.31E-07					2.46E-01
Receptor Total							Receptor Risk Total	2.31E-07				Receptor HI Total	2.46E-01

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.2.1.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - CURRENT INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Dibenz(a,h)anthracene	1.27E-08	--	2.44E-09	--	1.51E-08	--	--	--	--	--
			Chemical Total	1.27E-08	--	2.44E-09	--	1.51E-08		--	--	--	--
		Exposure Point Total						1.51E-08					--
	Exposure Medium Total							1.51E-08					--
	Air	Outdoor Air (Particulates and VOCs)	Dibenz(a,h)anthracene	--	2.00E-12	--	--	2.00E-12	--	--	--	--	--
			Chemical Total	--	2.00E-12	--	--	2.00E-12		--	--	--	--
		Exposure Point Total						2.00E-12					--
	Exposure Medium Total							2.00E-12					--
Medium Total								1.51E-08					--
Receptor Total							Receptor Risk Total	1.51E-08				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.2.2.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	1.90E-02	--	--	1.90E-02
			Benzo(a)pyrene	2.21E-08	--	4.27E-09	--	2.64E-08	--	--	--	--	--
			Dibenz(a,h)anthracene	1.27E-08	--	2.44E-09	--	1.51E-08	--	--	--	--	--
			Chemical Total	3.48E-08	--	6.71E-09	--	4.15E-08		1.90E-02	--	--	1.90E-02
		Exposure Point Total						4.15E-08					1.90E-02
	Exposure Medium Total							4.15E-08					1.90E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	3.49E-12	--	--	3.49E-12	--	--	--	--	--
			Dibenz(a,h)anthracene	--	2.00E-12	--	--	2.00E-12	--	--	--	--	--
			Chemical Total	--	5.48E-12	--	--	5.48E-12		--	--	--	--
		Exposure Point Total						5.48E-12					--
	Exposure Medium Total							5.48E-12					--
Medium Total								4.15E-08					1.90E-02
Receptor Total							Receptor Risk Total	4.15E-08				Receptor HI Total	1.90E-02

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.2.3.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	1.57E-02	--	--	1.57E-02
			Benzo(a)pyrene	4.04E-09	--	1.95E-09	--	5.99E-09	--	--	--	--	--
			Dibenz(a,h)anthracene	2.31E-09	--	1.12E-09	--	3.43E-09	--	--	--	--	--
			Chemical Total	6.36E-09	--	3.06E-09	--	9.42E-09		1.57E-02	--	--	1.57E-02
		Exposure Point Total						9.42E-09					1.57E-02
	Exposure Medium Total							9.42E-09					1.57E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	3.18E-13	--	--	3.18E-13	--	--	--	--	--
			Dibenz(a,h)anthracene	--	1.82E-13	--	--	1.82E-13	--	--	--	--	--
			Chemical Total	--	5.01E-13	--	--	5.01E-13		--	--	--	--
		Exposure Point Total						5.01E-13					--
	Exposure Medium Total							5.01E-13					--
Medium Total								9.42E-09					1.57E-02
Receptor Total							Receptor Risk Total	9.42E-09				Receptor HI Total	1.57E-02

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.2.4.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED ADULT RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Dibenz(a,h)anthracene	3.15E-08	--	5.25E-09	--	3.67E-08	--	--	--	--	--
			Chemical Total	3.15E-08	--	5.25E-09	--	3.67E-08		--	--	--	--
		Exposure Point Total						3.67E-08					--
	Exposure Medium Total							3.67E-08					--
	Air	Outdoor Air (Particulates and VOCs)	Dibenz(a,h)anthracene	--	6.30E-12	--	--	6.30E-12	--	--	--	--	--
			Chemical Total	--	6.30E-12	--	--	6.30E-12		--	--	--	--
		Exposure Point Total						6.30E-12					--
	Exposure Medium Total							3.68E-08					--
Medium Total								3.68E-08					--
Receptor Total							Receptor Risk Total	3.68E-08				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.2.5.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CHILD RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil	Dibenz(a,h)anthracene	8.40E-08	--	1.37E-08	--	9.77E-08	--	--	--	--	--
			Chemical Total	8.40E-08	--	1.37E-08	--	9.77E-08		--	--	--	--
		Exposure Point Total						9.77E-08					--
	Exposure Medium Total							9.77E-08					--
	Air	Outdoor Air (Particulates and VOCs)	Dibenz(a,h)anthracene	--	5.35E-12	--	--	5.35E-12	--	--	--	--	--
			Chemical Total	--	5.35E-12	--	--	5.35E-12		--	--	--	--
		Exposure Point Total						5.35E-12					--
	Exposure Medium Total							9.77E-08					--
Medium Total								9.77E-08					--
Receptor Total							Receptor Risk Total	9.77E-08				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.2.6.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	3.04E-02	--	--	3.04E-02
			Benzo(a)pyrene	5.50E-08	--	9.16E-09	--	6.42E-08	--	--	--	--	--
			Dibenz(a,h)anthracene	3.15E-08	--	5.25E-09	--	3.67E-08	--	--	--	--	--
			Chemical Total	8.65E-08	--	1.44E-08	--	1.01E-07		3.04E-02	--	--	3.04E-02
		Exposure Point Total						1.01E-07					3.04E-02
	Exposure Medium Total							1.01E-07					3.04E-02
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	1.10E-11	--	--	1.10E-11	--	--	--	--	--
			Dibenz(a,h)anthracene	--	6.30E-12	--	--	6.30E-12	--	--	--	--	--
			Chemical Total	--	1.73E-11	--	--	1.73E-11		--	--	--	--
		Exposure Point Total						1.73E-11					--
	Exposure Medium Total							1.01E-07					--
Medium Total								1.01E-07					3.04E-02
Receptor Total							Receptor Risk Total	1.01E-07				Receptor HI Total	3.04E-02

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-9.2.7.CTE: EPA RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCS - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil	Iron	--	--	--	--	--	--	2.84E-01	--	--	2.84E-01
			Benzo(a)pyrene	1.47E-07	--	2.40E-08	--	1.71E-07	--	--	--	--	--
			Dibenz(a,h)anthracene	8.40E-08	--	1.37E-08	--	9.77E-08	--	--	--	--	--
			Chemical Total	2.31E-07	--	3.77E-08	--	2.68E-07		2.84E-01	--	--	2.84E-01
		Exposure Point Total						2.68E-07					2.84E-01
	Exposure Medium Total							2.68E-07					2.84E-01
	Air	Outdoor Air (Particulates and VOCs)	Iron	--	--	--	--	--	--	--	--	--	--
			Benzo(a)pyrene	--	9.34E-12	--	--	9.34E-12	--	--	--	--	--
			Dibenz(a,h)anthracene	--	5.35E-12	--	--	5.35E-12	--	--	--	--	--
			Chemical Total	--	1.47E-11	--	--	1.47E-11		--	--	--	--
		Exposure Point Total						1.47E-11					--
	Exposure Medium Total							2.68E-07					--
Medium Total								2.68E-07					2.84E-01
Receptor Total							Receptor Risk Total	2.68E-07				Receptor HI Total	2.84E-01

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

TABLE I2-10.1.1.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - CURRENT INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.1.2.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.1.3.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.1.4.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED ADULT RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.1.5.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CHILD RESIDENT, SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.1.6.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.1.7.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 09
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.2.1.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - CURRENT INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Current/Future
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.2.2.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED INDUSTRIAL WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Industrial Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.2.3.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CONSTRUCTION WORKER, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Construction Worker
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.2.4.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED ADULT RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.2.5.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CHILD RESIDENT, SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-2)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.2.6.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED ADULT RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

TABLE I2-10.2.7.CTE: EPA RAGS PART D TABLE 10
RISK SUMMARY - FUTURE DEVELOPED CHILD RESIDENT (INTRUSIVE), SITE 10
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Scenario Timeframe:	Future-Developed
Receptor Population:	Resident
Receptor Age:	Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0-8)	Soil	Site Soil											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
	Air	Outdoor Air (Particulates and VOCs)											
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					--
Medium Total								--					--
Receptor Total							Receptor Risk Total	--				Receptor HI Total	--

Notes:

CTE	Central tendency exposure
HI	Hazard index
VOC	Volatile organic compound
--	Not applicable or not available

No risk drivers were identified for this receptor.

ATTACHMENT I3
STATISTICAL EVALUATION

CONTENTS

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ATTACHMENT I3

STATISTICAL EVALUATION FOR TREASURE ISLAND SITES 9 AND 10

1.0 INTRODUCTION

Attachment I3 summarizes the statistical analysis of soil data conducted to support the human health risk assessment (HHRA) at Sites 09 and 10. This analysis had the following two objectives:

1. Calculate descriptive statistics, including exposure point concentrations (EPC), for all chemicals detected in at least one sample

2. Compare concentrations of inorganic compounds in site samples with ambient concentrations established for Treasure Island using two-population tests

The calculations described in this attachment follow U.S. Environmental Protection Agency (EPA) (2000, 2002) and U.S. Department of the Navy (Navy) (1998, 1999, 2002, 2004) guidance. The following sections summarize the methods used to accomplish each of these objectives.

2.0 CALCULATION OF DESCRIPTIVE STATISTICS AND EXPOSURE POINT CONCENTRATIONS

Descriptive statistics and EPCs were calculated for all chemicals that exceeded screening criteria and were considered chemicals of potential concern (COPC) in Appendix I. Summary tables (Table 3 series in Appendix I) were prepared in accordance with "Risk Assessment Guidance for Superfund" for reporting descriptive statistics and EPCs (EPA 2001).

The following methods were used to determine the underlying distribution for each chemical and to calculate population summary statistics and EPCs.

2.1 DISTRIBUTION TESTS

The Shapiro-Wilk W test was conducted for analytes with at least five measurements and detection frequencies greater than or equal to 50 percent (Figure I3-1). The W test is one of the most powerful tests for determining whether a set of measurements follows either a normal or a lognormal distribution. The W test relies on computing a correlation between the quantiles of the standard normal distribution and the ordered values of the observed data. When the W statistic is close to 1.0, the observed data will follow an essentially straight line when displayed using a normal probability plot. The following null (H_0) and alternative (H_A) hypotheses were tested using the W test:

- H_0: The data follow a normal distribution.
- H_A: The data do not follow a normal distribution.

Tests were conducted sequentially on data in original and natural log-transformed units. A Type I error rate (α) of 0.05 (equivalent to 5 percent) was used to interpret the significance of each test. A Type I error rate of 0.05 means that there is a 5 percent chance that the null hypothesis will be rejected when it is true (that is, the data are normally distributed), leading to the false conclusion that the underlying distribution is not normal. When the test is conducted using log-transformed data, failure to reject H_0 leads to the conclusion that the data follow a lognormal distribution (rejection of H_0 indicates that the data are not lognormally distributed).

Censored (nondetect) data were evaluated in the distribution tests using the reporting limit for each chemical. Chemical data confirmed as following a normal or lognormal distribution based on the outcome of the W test were identified as "normal" or "lognormal," respectively, in the summary tables (Table 3 series in Appendix I). Chemical data not confirmed as either normal or lognormal were further evaluated by examining normal and lognormal probability plots, outlier box plots, and frequency histograms (Figure I3-1). Professional judgment was used to select the distribution that most closely fits the data. Chemical data judged to best fit a normal or lognormal model were identified as "assumed normal" or "assumed lognormal," respectively, in the summary tables (Table 3 series in Appendix I). No distribution assessment was conducted for sample sizes less than five or detection frequencies less than 50 percent, and these chemicals are listed as "Not Tested" in the summary tables; in these cases, a nonparametric distribution was assumed.

2.2 POPULATION PARAMETERS

Calculation of the mean, standard deviation *s*, and 95th percentile upper confidence limit on the arithmetic mean (UCL_{95}) was conducted for all chemicals that exceeded screening criteria and were considered COPCs in Appendix I. Calculations were performed using distribution-dependent formulae. In cases where the sample size was less than five or the underlying distribution could not be determined with confidence, calculations were performed using nonparametric methods (Figure I3-1). For sample sizes less than three, calculations were not performed, and the maximum detected concentration was used as the EPC.

For samples with at least 85 percent detected data, one-half the reporting limit was substituted for censored data (Figure I3-1). For samples confirmed or assumed to follow a normal distribution, the arithmetic mean and *s* were calculated and the UCL_{95} was calculated using Student's *t* statistic, as shown in equation 1:

$$UCL_{1-\alpha} = \bar{x} + t_{1-\alpha,n-1}\frac{s}{\sqrt{n}} \quad (1)$$

where:

$\bar{x}$	=	Arithmetic mean of the sample
s	=	Sample standard deviation
t	=	Student's t statistic
n	=	Sample size

For samples confirmed or assumed to follow a lognormal distribution, minimum variance unbiased estimates (MVUE) of the mean and variance of the mean were calculated as shown in equations 2 and 3:

$$\hat{\mu} = [e(\bar{y})]\psi_n\left(\frac{s_y^2}{2}\right) \tag{2}$$

$$s^2(\hat{\mu}) = e(2\bar{y})\left\{\left[\psi_n\left(\frac{s_y^2}{2}\right)\right]^2 - \psi_n\left[\frac{s_y^2(n-2)}{n-1}\right]\right\} \tag{3}$$

where:

$\bar{y}$	=	Mean of the n transformed values y_i= ln x
s^2	=	Variance of y
n	=	Sample size
$\psi_n(t)$	=	Infinite series, calculated as

$$\psi_n(t) = 1 + \frac{(n-1)t}{n} + \frac{(n-1)^3 t^2}{2!\,n^2(n+1)} + \frac{(n-1)^5 t^3}{3!\,n^3(n+1)(n+3)} + \frac{(n-1)^7 t^4}{4!\,n^4(n+1)(n+3)(n+5)} + \cdots$$

and $t = \frac{s_y^2}{2}$

Equations 2 and 3 are equivalent to equations 13.3 and 13.5, respectively, published by Gilbert (1987). The UCL_{95} for lognormal distributions was calculated using Land's method (Land 1975), as shown in equation 4:

$$UCL_{1-\alpha} = e\left(\bar{y} + 0.5s_y^2 + \frac{s_y H_{1-\alpha}}{\sqrt{n-1}}\right) \tag{4}$$

where:

$H_{1-\alpha}$	=	Obtained from tables published in Land (1975) or from Gilbert (1987)
$\bar{y}$, s, and n	=	See definitions under equations 2 and 3

For cases where the detection frequency was at least 85 percent, but the sample size was less than five, the arithmetic mean and s were used to calculate the UCL_{95} using the nonparametric Chebyshev method, as shown in equation 5:

$$UCL_{1-\alpha} = \bar{x} + \sqrt{\frac{1}{\alpha} - 1}\left(\frac{s}{\sqrt{n}}\right) \quad (5)$$

where:

$\bar{x}$, s, and n	=	See definitions under equation 1.

For samples with greater than 15 percent censored data, population moments were calculated using stochastic modeling, following the "bounding" approach described in EPA (2002) and illustrated on Figure I3-2. This approach treats each censored datum as a random variable that can assume any value between zero and its respective reporting limit. The mean and s for samples with greater than 15 percent censored data were determined using Monte Carlo analysis by taking the median values for the mean and standard deviation generated using either arithmetic (for confirmed or assumed normal distributions and distributions listed as "Not Tested") or MVUE (for confirmed or assumed lognormal distributions). The Monte Carlo model calculated a minimum of 2,000 estimates for the mean, s, and UCL_{95}, substituting random values for each censored measurement. Each UCL_{95} was calculated using equations based on either the t statistic (for confirmed or assumed normal distributions), the MVUE Chebyshev method (for confirmed or assumed lognormal distributions), or the nonparametric Chebyshev method (for distributions listed as "Not Tested"). The MVUE Chebyshev method is shown as follows in equation 6.

$$UCL_{1-\alpha} = \hat{\mu}_{LN} + \sqrt{\left(\frac{1}{\alpha} - 1\right)\sigma_{\mu}^{2}} \quad (6)$$

where:

$\hat{\mu}_{LN}$	=	MVUE of the mean from equation 2
σ_{μ}^{2}	=	Variance for $\hat{\mu}_{LN}$ from equation 3

For calculations performed using the "bounding" method, a distribution of 2,000 estimates for the UCL_{95} was constructed using either equations 1, 5, or 6, and the minimum, median, 95th percentile, and maximum estimated values were recorded. If the range (difference between the

minimum and maximum) for the distribution was small, then this indicated that censored measurements contributed little to the uncertainty of the estimate. In practice, this was generally not the case, and it was necessary to select a concentration to be used as a "plausible upper bound" for the UCL_{95}. For Treasure Island, the 95th percentile of the distribution was used as the upper-bound concentration. The maximum concentration was not used because it represents the highest concentration that could theoretically be calculated (or nearly so, based on 2,000 calculations) from the sample data and does not represent a plausible upper bound value that a receptor will be exposed to over time.

2.3 EXPOSURE POINT CONCENTRATIONS

EPCs were the lesser of the UCL_{95} and maximum detected concentration for each chemical as indicated in the EPC summary tables (Table 3 series in Appendix I).

3.0 AMBIENT SCREENING OF INORGANICS

Two-population statistical tests were used to compare inorganic concentrations in site data to ambient concentrations determined for Treasure Island artificial fill soil and groundwater. The methodologies employed follow Navy guidance (Navy 1998, 1999, 2002, 2004). One or more of the following methods were used to conduct two-population tests, depending on the relative frequency of detection of the populations being compared. One-sided statistical tests were used in all cases and employed a Type I error rate of 0.05. Graphical depiction of the box plots and quantile comparisons are shown in Figure I3-3.

WILCOXON RANK SUM AND GEHAN-WILCOXON TESTS

For inorganic compounds with at least 60 percent detected data in both the site and ambient populations, testing was performed using either the nonparametric Wilcoxon rank sum (WRS) or Gehan-Wilcoxon (GT) tests (Navy 1998, 1999, 2002). The following H_0 and H_A hypotheses were tested:

- H_0: The median metal concentration for the site is less than or equal to the median concentration in the ambient population.

- H_A: The median metal concentration for the site is greater than the median concentration in the ambient population.

The WRS test was used in cases where only a single detection limit was present, and the GT test was used with multiple detection limits, as described by the Navy (1999). The reporting limit was substituted for all censored data analyzed using the WRS or GT test. There is some uncertainty associated with these tests because elevated reporting limits may indicate that an analyte is significantly greater than ambient based on nondetect results. This uncertainty augments the need for the weight-of-evidence approach adopted in this evaluation.

TEST OF PROPORTIONS

For chemicals with fewer than 60 percent detected data, the detection frequencies in the site and ambient populations were compared using the test of proportions. Tests of proportions used a contingency table approach, and the significance of the tests was determined using the Fisher exact test. The Navy [1999] also describes an approach for conducting the test of proportions using a normal approximation to the binomial distribution, which can also be used if software is not available for implementing the Fisher exact test. Details on the Fisher exact test can be found in standard textbooks on statistics (for example, Zar 1996).

The following H_0 and H_A hypotheses were tested using the test of proportions:

- H_0: The metal detection frequency at the site is less than or equal to the detection frequency in the ambient population.

- H_A: The metal detection frequency at the site is greater than the detection frequency in the ambient population.

QUANTILE TEST

The quantile test (Johnson and others 1987; EPA 1994; Navy 1998, 1999, 2002) was conducted for all analytes. The quantile test is a nonparametric two-population test developed for comparing the right-hand tails or upper quantiles of two distributions. The quantile test can be used when some proportion of high-value measurements (rather than the entire distribution) of one population has shifted relative to a second population. The quantile test is not as powerful as the WRS test when the distribution of site concentrations is shifted in its entirety to the right of the ambient distribution. The quantile test is more powerful than the WRS test, however, for detecting cases where only a small number of high-value measurements are present in the upper quantile of the site distribution. For this reason, EPA and Navy guidance recommends that the quantile test be used in conjunction with the WRS test (EPA 1994, 2000; Navy 1998, 1999, 2002).

The quantile test is easy to apply and consists of looking at the largest *r* measurements in the pooled (and ordered) site and ambient data sets and counting the number of *r* measurements that are from the site. If *k* or more of the *r* measurements are site measurements, the quantile test declares that the upper range of concentrations at the site is elevated relative to the ambient population. All of the *r*-largest concentrations must be detected values; otherwise, the quantile test cannot be performed. The H_o addressed by the quantile test is that $\varepsilon \leq 0$ and $\Delta/\sigma \leq 0$, where ε is the proportion of site measurements that have shifted to the right and Δ/σ is the magnitude (in units of standard deviation, σ) of the shift.

EPA and Navy guidance provide critical values for the quantile test (EPA 1994, 2000; Navy 1999). For cases where the sample sizes for the site or ambient populations exceed the range of values provided in these tables (that is, either the site or ambient sample size exceeds 100) or the

paired values for the site and ambient population do not exactly match the tabulated values, the critical probabilities were derived using Monte Carlo simulation. The stochastic model developed for calculating critical values of the quantile test was validated by successfully reproducing the published critical values for site and ambient population sizes in the range of 5 to 100.

The WRS, GT, and the test of proportions were used in conjunction with the quantile test to identify analytes significantly greater than background. For those analytes where there are conflicting statistical results (that is, both tests didn't confirm significantly greater or not significantly greater than background), a weight of evidence approach was used with quantile plots to evaluate for significance (see Figure I3-3). The results of the background statistical evaluation for Sites 09 and 10 are presented in Tables I3-1 and I3-2.

Arsenic

Arsenic was not considered significantly greater than background at either Site 09 or 10, as demonstrated in Tables I3-1 and I3-2. Three samples (09-SB10, 09-SB12, and 09-SB18) collected from the surface soil (0.5 to 2 feet below ground surface [bgs]) at Site 09 were, however, considered outliers because their concentrations were greater than the 80 percent lower confidence limit on the 95th percentile (10 milligrams per kilogram [mg/kg]) for fill material dredged from the San Francisco Bay. See Figure I3-3 for graphical representation of the Site 09 arsenic data set as compared to the ambient fill concentrations of arsenic. The three outlier concentrations of arsenic (15.4, 16.9, and 17.7 mg/kg) are considered potential outliers.

The arsenic concentrations between 15.4 to 17.7 milligrams per kilogram (mg/kg) are well within the range of naturally occurring arsenic in the United States (1 to 100 mg/kg; Shacklette and Boerngen 1984). These higher concentrations (i.e., outliers) and lower concentrations are likely a manifestation of two different soil types from different geologic deposits (i.e., native soils and fill/dredged material). There are general correlations between arsenic, chromium, molybdenum, selenium, and vanadium, which are oxyanion-forming metals that tend to behave similarly under certain environmental conditions. This correlation further supports that the arsenic concentrations are naturally occurring, although the concentrations are still considered potential outliers for Site 09 soils.

Information relevant to potential for release sources or preferential exposure to these three outliers was also evaluated as relevant to the human health risk assessment. These three locations with elevated arsenic are not in the same vicinity (see Figure 2-3 in the RI report); soil sample 09-SB12 is located remotely from the other two samples. A future resident or commercial/industrial worker would likely not, therefore, be exposed to these three highest concentrations of arsenic over time. This is especially true for residents who have small residential properties and are not regularly exposed to surface soil on another residential property. In addition, the spatial distribution of the three arsenic outliers at Site 09 do not indicate a source of release because a release would be expected to result in a tightly grouped area of concentrations that are more elevated and similar to one another. These three arsenic locations are not considered to be significant outliers that warrant a hot spot evaluation but were

considered potential outliers of the data set. Thus, based on this weight-of-evidence evaluation, it was confirmed that the Site 09 arsenic data set was statistically below ambient fill concentrations.

Lead

Lead was not considered significantly greater than background at either Site 09 or 10, as demonstrated in Tables I3-1 and I3-2. There was one historic sample with an estimated value of 974 J mg/kg in 09-SB03 at Site 09; however, this exact location was resampled to obtain an unqualified (not estimated) result. As discussed in Section 5.2.1 of Appendix I, the average concentration between this estimated result and its 1995 confirmation sample from 09-SB05 was 488 mg/kg (see Figure I3-3). An examination of the lead concentrations (see Figure I3-3) indicate that essentially only this single outlier is significantly greater than the maximum detected ambient concentration.

In addition to the statistical findings that lead at Sites 09 and 10 is similar to that of the ambient fill at Treasure Island, additional information relevant to potential for release sources or preferential exposure to this lead maximum was also reviewed. Lead concentrations above the ambient fill 95th percentile concentration (see Figure I3-3) are not in the same vicinity (see Figure 2-3 in the RI report). Soil sample 09-SB03 (the maximum 1992 detection of 974 J mg/kg lead) and 09-SB05 (the 1995 confirmation sample of 76.2 mg/kg lead) are both in the exact same location. The only other lead detection greater than the maximum ambient fill concentration of 51.4 mg/kg was 61.4 mg/kg, detected at location 09-SB15, which is separated by at least four other samples of lower concentrations. Thus, the spatial distribution of the lead results do not indicate a source of release because a release would be expected to result in a tightly grouped area of concentrations that are more elevated and similar to one another. Finally, for the one result that was the maximum (and was resampled), no adjoining concentrations are similarly elevated, and the resampled (confirmation) result did not confirm the elevated first sample estimated concentration. In effect, there is no remaining lead above the resample result in this area. Thus, based on this weight-of-evidence evaluation, it was confirmed that the Site 09 lead data set was not statistically different from ambient fill concentrations.

4.0 REFERENCES

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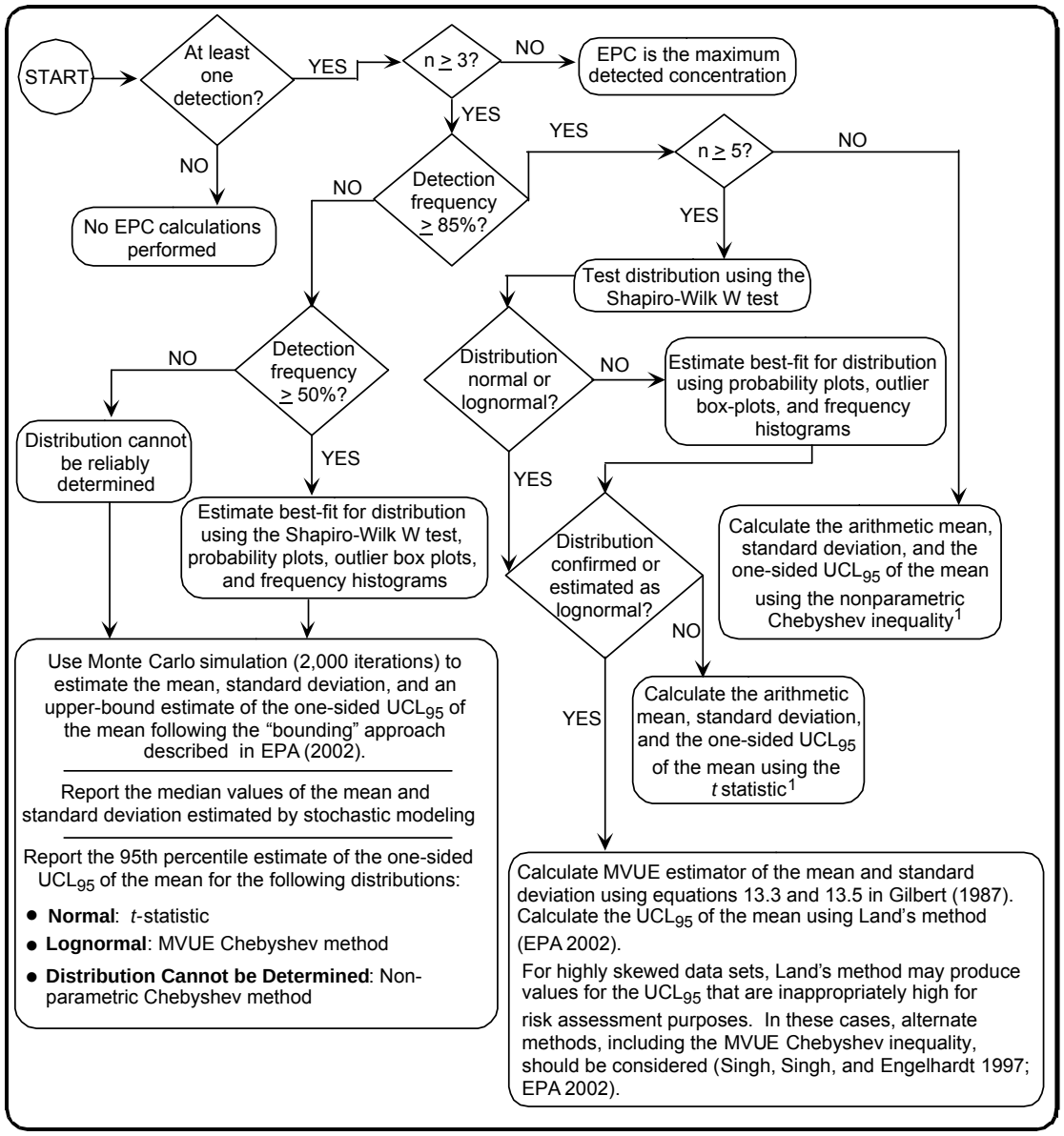
Zar, J.H. 1996. *Biostatistical Analysis*. Third Edition. Prentice Hall. Upper Saddle River, New Jersey.

FIGURE I3-1

SUMMARY OF THE STATISTICAL TREATMENT OF DATA FOR ESTIMATING EXPOSURE POINT CONCENTRATIONS



Notes:

Details of the Monte Carlo model for estimating the mean, standard deviation, and upper-bound estimate of the one-side UCL_{95} of the mean are provided on Figure I3-2.

1 One-half the reporting limit was substituted for censored measurements in these calculations

EPA U.S. Environmental Protection Agency

EPC Exposure point concentration. The EPC is equal to the lesser of the UCL_{95} and the maximum. detected concentration

MVUE Minimum variance unbiased

UCL_{95} The one-sided upper 95 percent confidence limit of the mean

Sources:

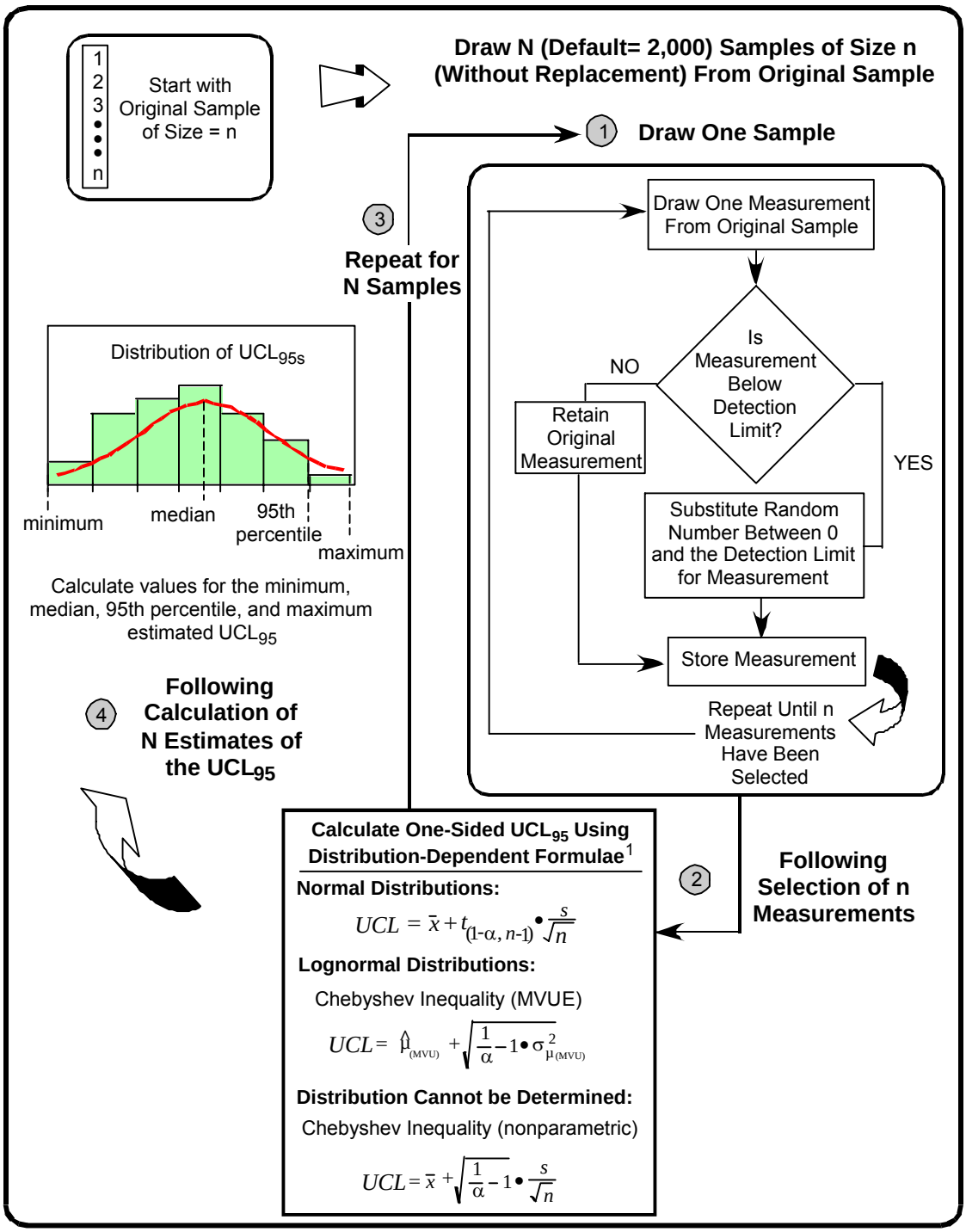
Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. John Wiley & Sons, Inc. New York, New York.

Singh, A.K., Singh, A., and M. Engelhardt. 1997. "The Lognormal Distribution in Environmental Applications." EPA/600/R-97/006. December.

EPA. 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Office of Emergency and Remedial Response. Washington, D.C. December.

FIGURE I3-2

CONCEPTUAL DIAGRAM OF MONTE CARLO APPROACH FOR ESTIMATING A PLAUSIBLE UPPER BOUND OF THE UCL_{95} OF THE MEAN FOR SAMPLES WITH CENSORED MEASUREMENTS



Notes:

MVUE Minimum variance unbiased

UCL_{95} One-sided 95 percent upper confidence limit of the mean

Source:

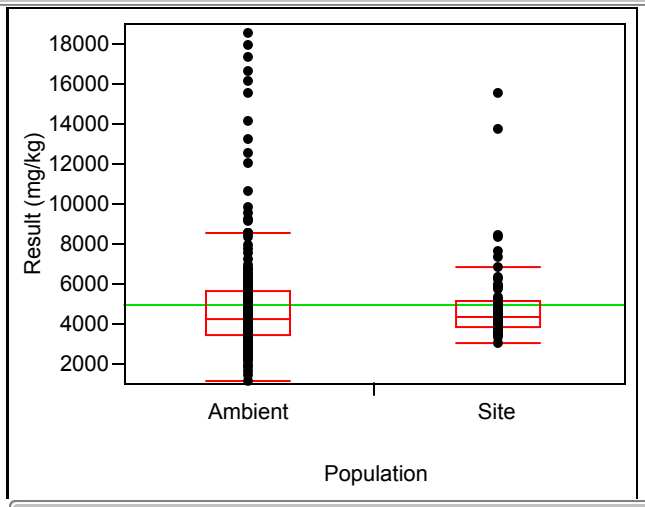
[1] U.S. Environmental Protection Agency. 2002. "Calculating Exposure Point Concentrations at Hazardous Waste Sites." OSWER 9285.6-10. Office of Emergency and Remedial Response. Washington, D.C. December.

FIGURE I3-3

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Aluminum

Oneway Analysis of Result (mg/kg) By Population

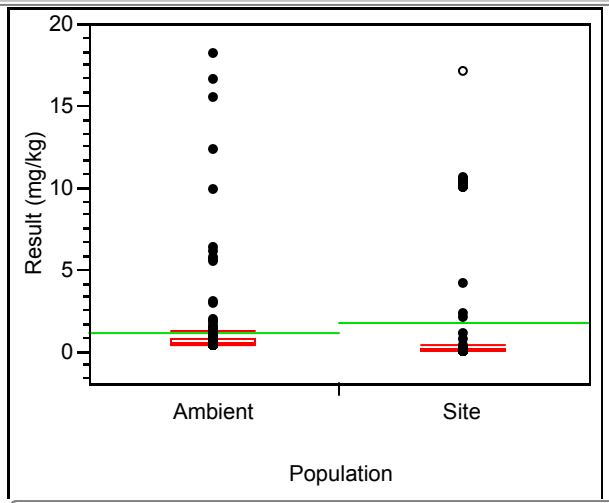


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	1190	2798	3455	4230	5615	6918	18600
Site	3010	3712	3900	4345	5115	6821	15600

Site=9, Depth=0-8, Metal=Antimony

Oneway Analysis of Result (mg/kg) By Population



Quantiles

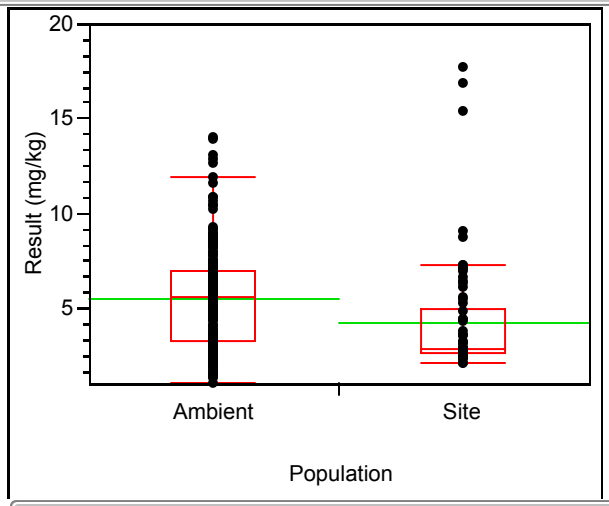
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.38	0.4	0.44	0.51	0.77	1.2	18.2
Site	0.027	0.0452	0.05075	0.08	0.195	10.1	17.1

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Arsenic

Oneway Analysis of Result (mg/kg) By Population

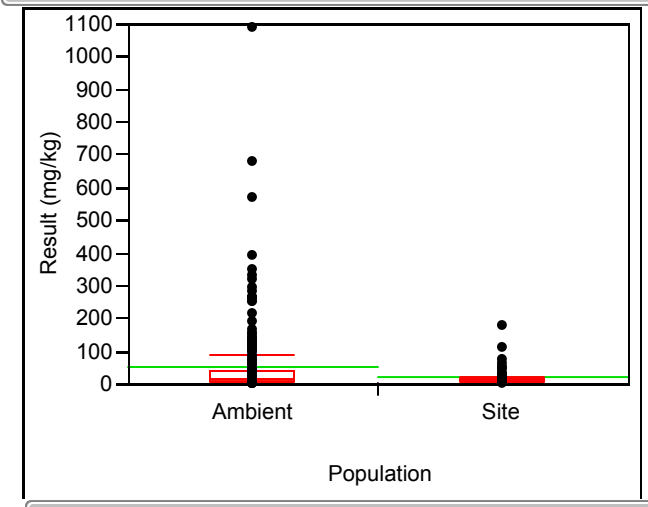


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	1.1	2.2	3.3	5.6	7	8.6	14
Site	2.1	2.4	2.6	2.9	5	7.29	17.7

Site=9, Depth=0-8, Metal=Barium

Oneway Analysis of Result (mg/kg) By Population



Quantiles

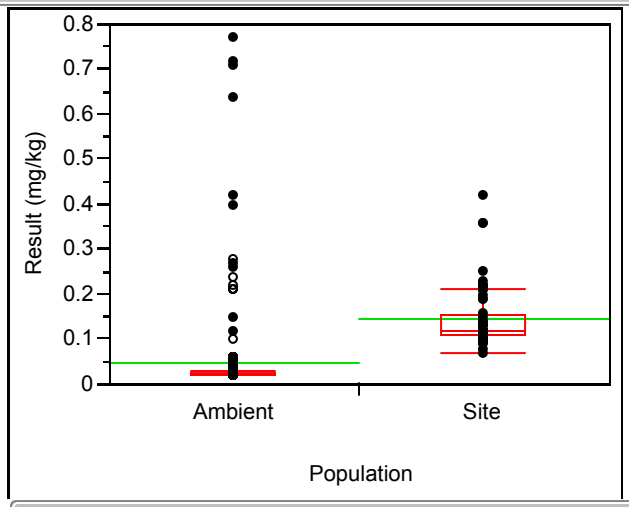
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	3.6	7.52	9.4	17.7	42.55	128	1090
Site	5.3	7.41	8.475	10.55	15.825	46.75	181

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Beryllium

Oneway Analysis of Result (mg/kg) By Population

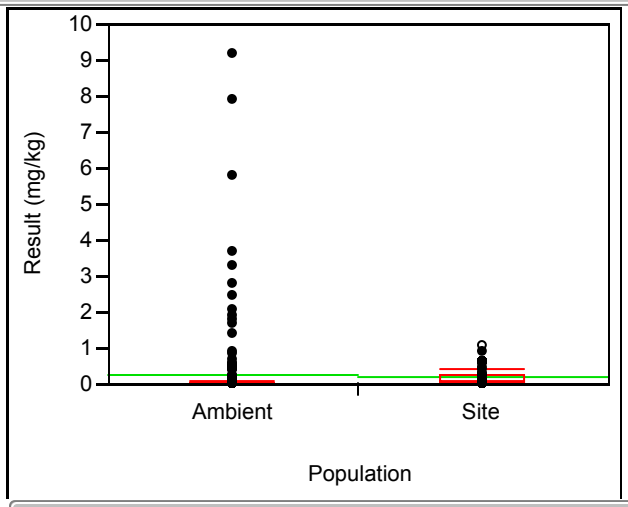


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.02	0.02	0.02	0.02	0.025	0.05	0.77
Site	0.07	0.1	0.11	0.12	0.1525	0.22	0.42

Site=9, Depth=0-8, Metal=Cadmium

Oneway Analysis of Result (mg/kg) By Population



Quantiles

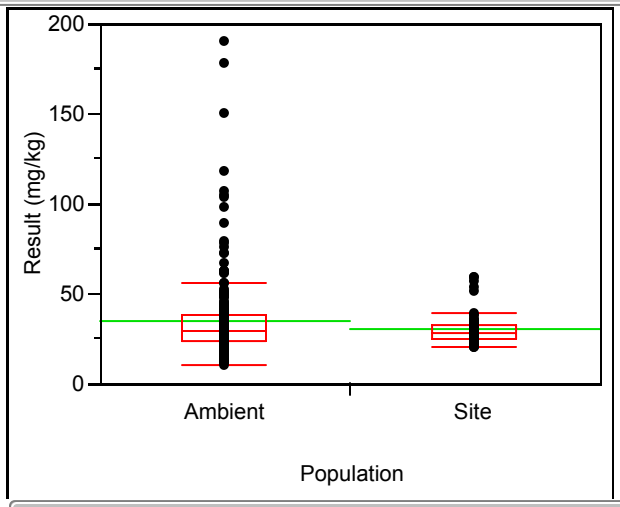
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.02	0.04	0.04	0.04	0.05	0.24	9.2
Site	0.03	0.04	0.05	0.06	0.225	0.63	1.1

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Chromium

Oneway Analysis of Result (mg/kg) By Population

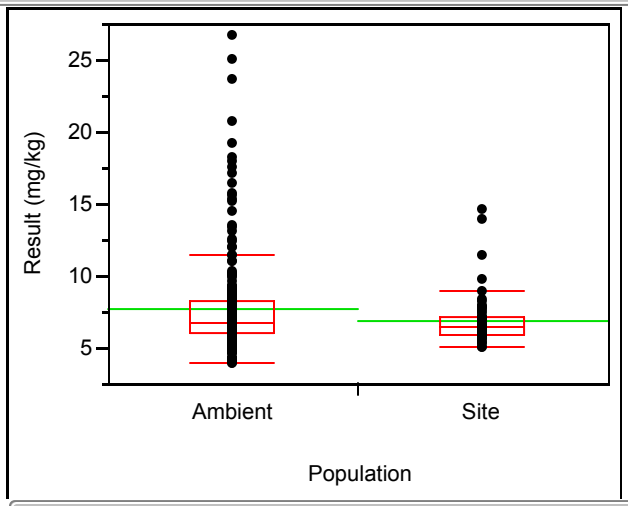


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	10.7	20.04	23.5	29.3	37.8	52	191
Site	20.6	22.6	25.25	28.2	32.85	38.4	59.6

Site=9, Depth=0-8, Metal=Cobalt

Oneway Analysis of Result (mg/kg) By Population



Quantiles

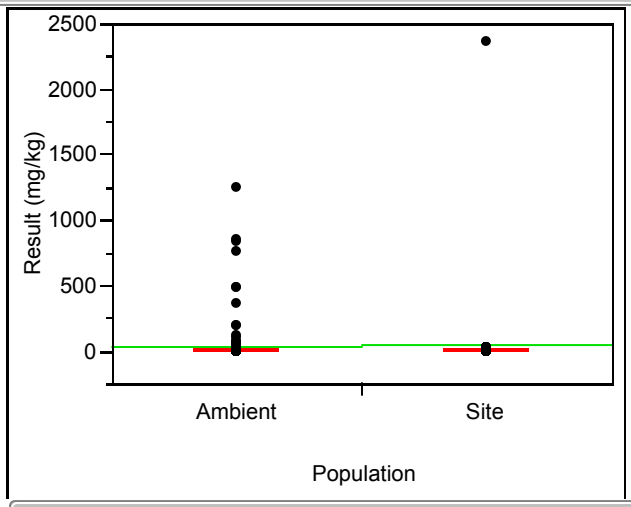
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	4	5.08	6	6.8	8.3	11.42	26.7
Site	5	5.7	5.9	6.5	7.125	8.18	14.7

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Copper

Oneway Analysis of Result (mg/kg) By Population

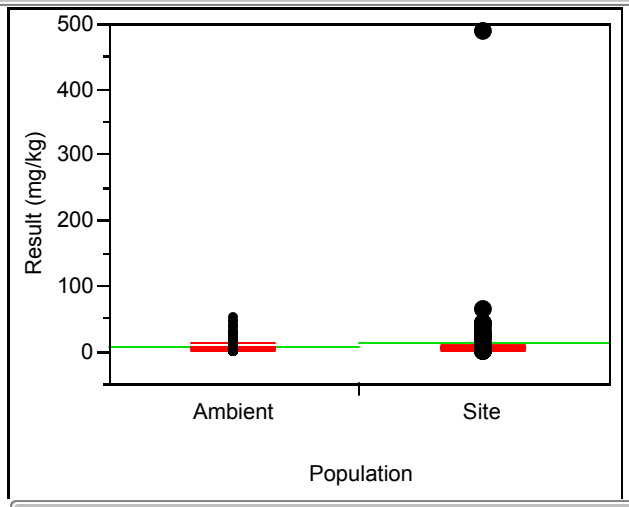


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	1.9	3	3.7	5.6	12.4	37.8	1260
Site	3.09	3.621	4.0375	4.75	10	21.39	2370

Site=9, Depth=0-8, Metal=Lead

Oneway Analysis of Result (mg/kg) By Population



Quantiles

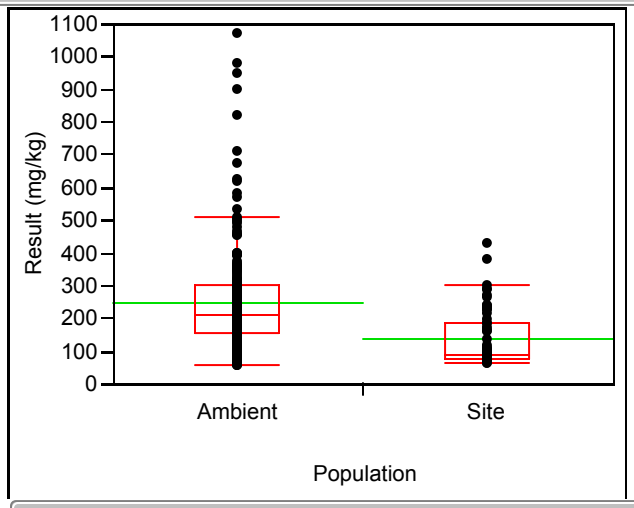
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.73	2.3	3	3.7	7.2	13.04	51.4
Site	1.71	2.065	2.3075	2.805	5.9275	25.4	488.205

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Manganese

Oneway Analysis of Result (mg/kg) By Population

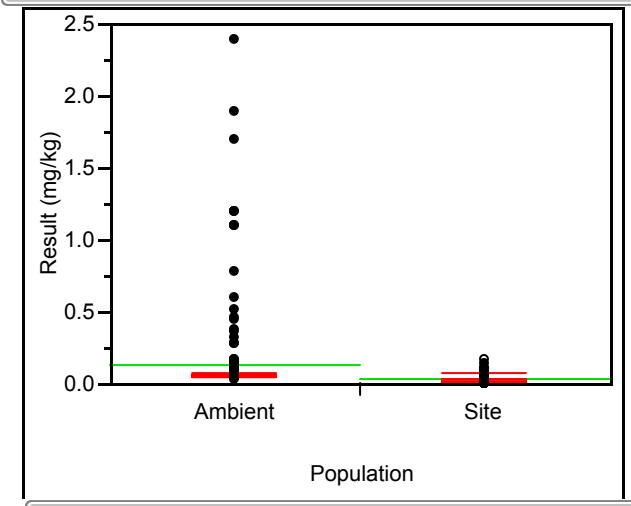


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	58.9	88.7	158	212	303	399	1070
Site	61.8	75.7	79.425	90.7	186.25	263.8	428

Site=9, Depth=0-8, Metal=Mercury

Oneway Analysis of Result (mg/kg) By Population



Quantiles

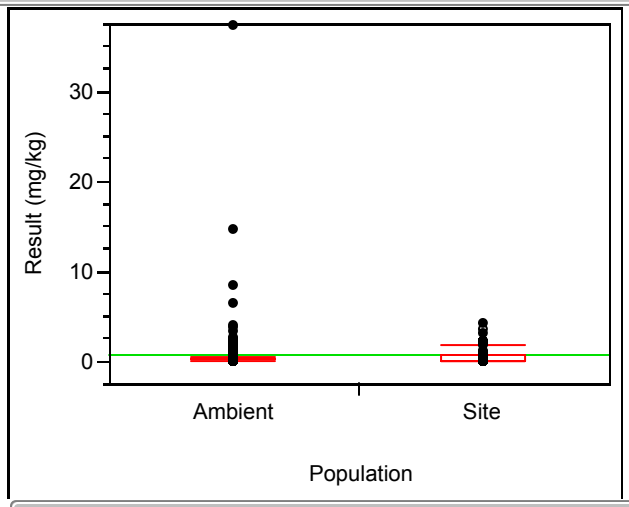
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.03	0.05	0.05	0.055	0.06	0.145	2.4
Site	0.01	0.01	0.01	0.02	0.04	0.11	0.18

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Molybdenum

Oneway Analysis of Result (mg/kg) By Population

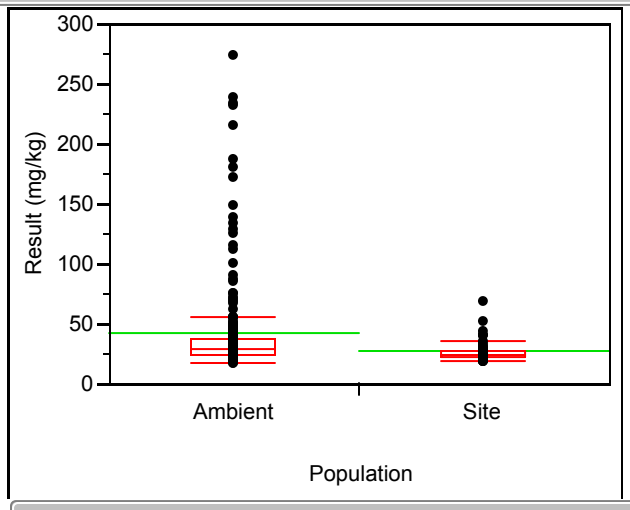


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.16	0.17	0.19	0.21	0.28	1.38	37.4
Site	0.06	0.07	0.08	0.145	0.8225	2.1	4.31

Site=9, Depth=0-8, Metal=Nickel

Oneway Analysis of Result (mg/kg) By Population



Quantiles

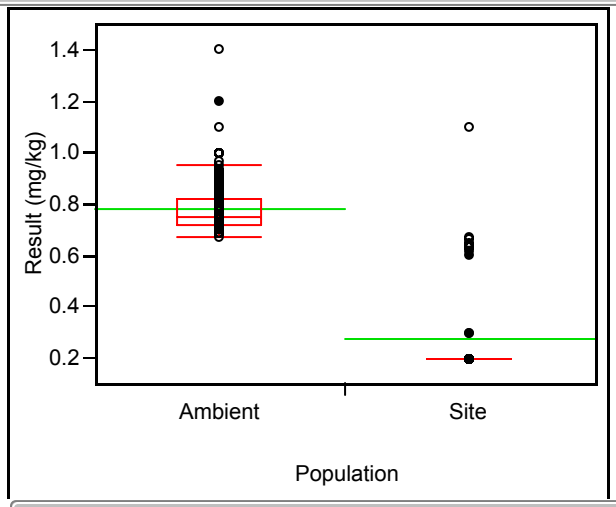
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	18	20.9	23.6	29.6	38.2	70.1	275
Site	18.6	21.2	22.3	24.85	28.225	35.84	69.1

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Selenium

Oneway Analysis of Result (mg/kg) By Population

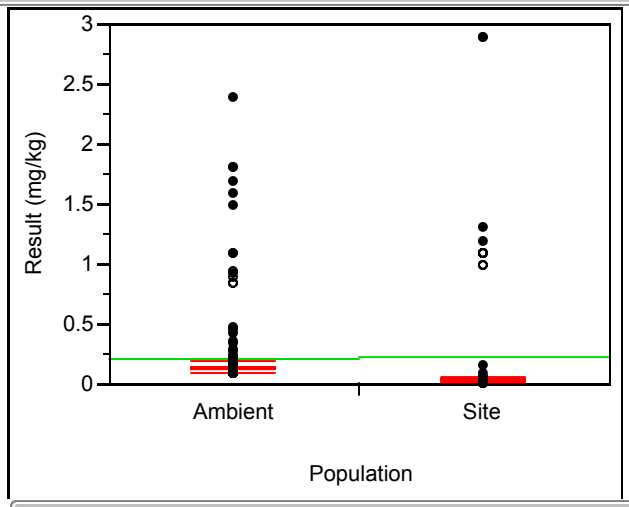


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.67	0.71	0.72	0.75	0.82	0.89	1.4
Site	0.2	0.2	0.2	0.2	0.2	0.63	1.1

Site=9, Depth=0-8, Metal=Silver

Oneway Analysis of Result (mg/kg) By Population



Quantiles

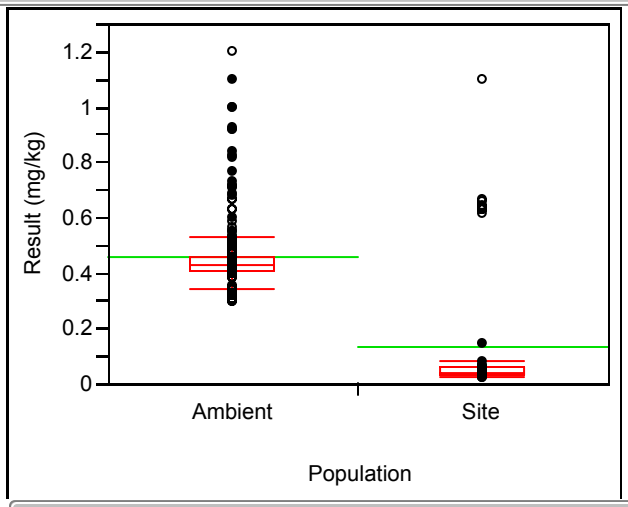
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.1	0.11	0.12	0.13	0.15	0.2	2.4
Site	0.012	0.016	0.018	0.021	0.043	1.1	2.9

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Thallium

Oneway Analysis of Result (mg/kg) By Population

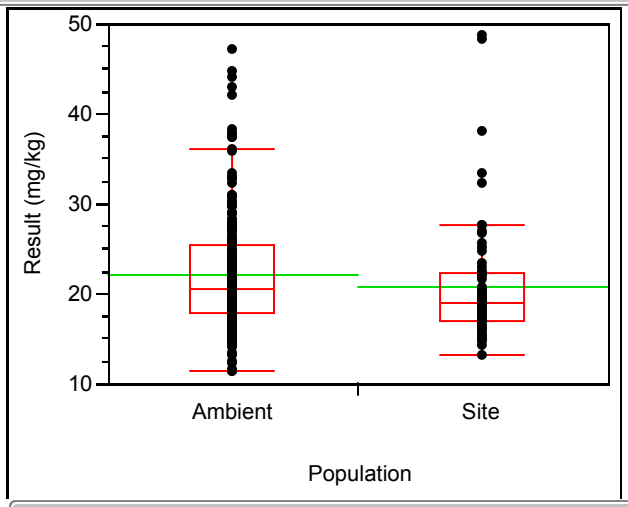


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.3	0.32	0.41	0.43	0.46	0.588	1.2
Site	0.028	0.031	0.03575	0.0415	0.05825	0.63	1.1

Site=9, Depth=0-8, Metal=Vanadium

Oneway Analysis of Result (mg/kg) By Population



Quantiles

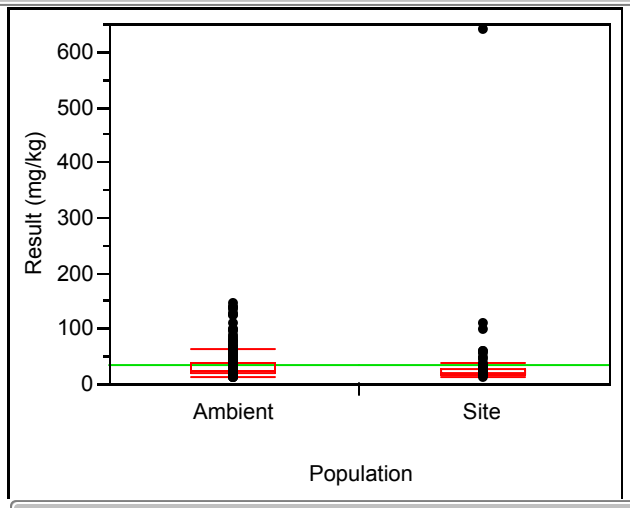
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	11.4	15.22	18	20.5	25.5	30.02	47.3
Site	13.2	15.4	17	19	22.325	27.55	48.8

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=9, Depth=0-8, Metal=Zinc

Oneway Analysis of Result (mg/kg) By Population



Quantiles

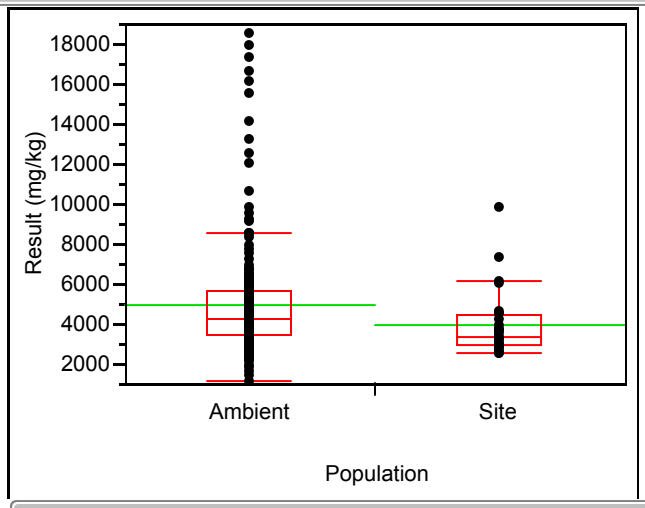
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	11.2	17.73	20.575	24.65	38.15	65.61	147
Site	13.7	16.1	17.25	19.85	26.825	47.58	642

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=10, Depth=0-8, Metal=Aluminum

Oneway Analysis of Result (mg/kg) By Population

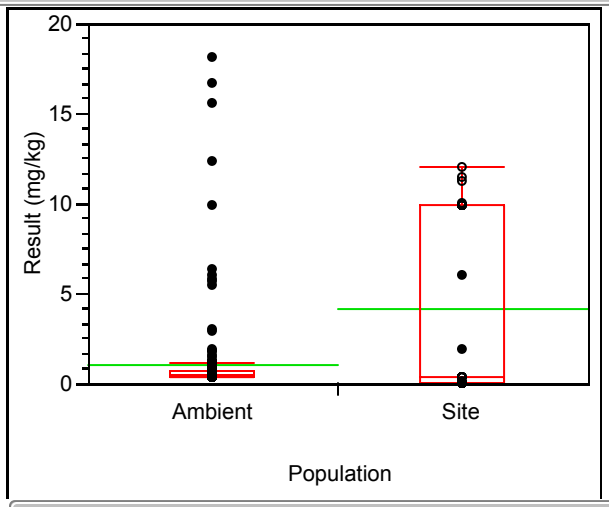


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	1190	2798	3455	4230	5615	6918	18600
Site	2600	2618	2920	3330	4475	6257	9840

Site=10, Depth=0-8, Metal=Antimony

Oneway Analysis of Result (mg/kg) By Population



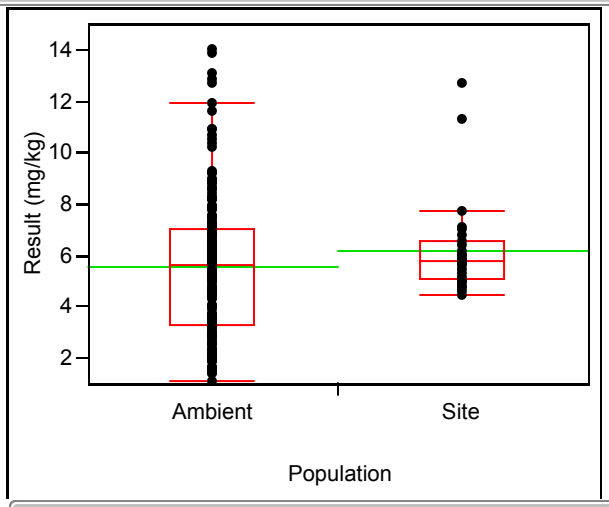
Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.38	0.4	0.44	0.51	0.77	1.2	18.2
Site	0.06	0.079	0.1	0.43	9.975	11.32	12.1

FIGURE I3-3 (CONTINUED)
AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=10, Depth=0-8, Metal=Arsenic

Oneway Analysis of Result (mg/kg) By Population

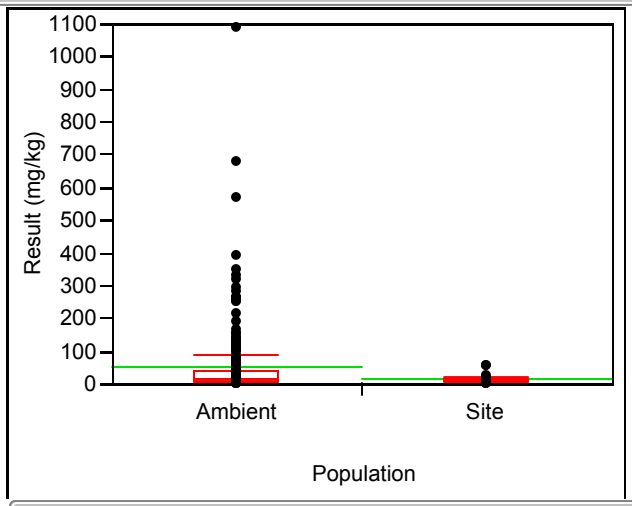


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	1.1	2.2	3.3	5.6	7	8.6	14
Site	4.5	4.78	5.05	5.75	6.55	8.06	12.7

Site=10, Depth=0-8, Metal=Barium

Oneway Analysis of Result (mg/kg) By Population



Quantiles

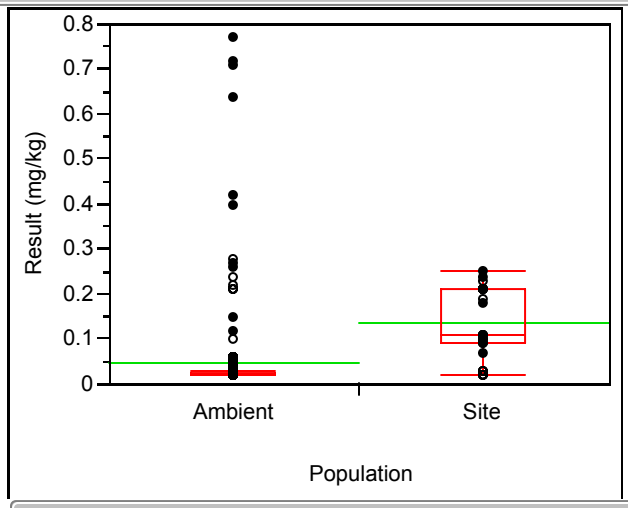
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	3.6	7.52	9.4	17.7	42.55	128	1090
Site	5	5.67	7.325	8.9	13.025	31.17	61.1

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=10, Depth=0-8, Metal=Beryllium

Oneway Analysis of Result (mg/kg) By Population

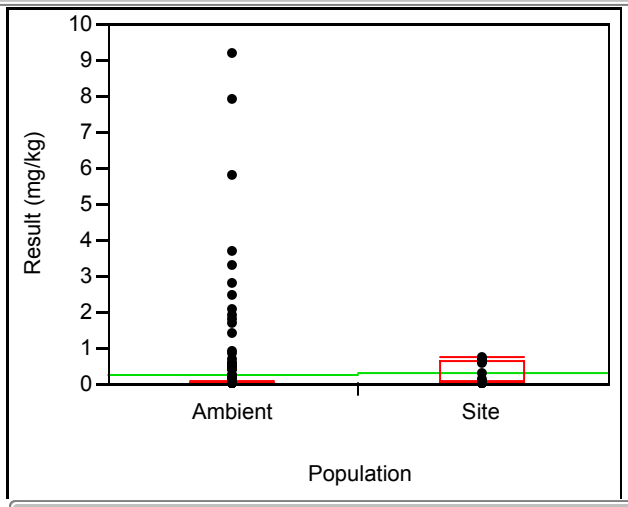


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.02	0.02	0.02	0.02	0.025	0.05	0.77
Site	0.02	0.02	0.09	0.11	0.21	0.231	0.25

Site=10, Depth=0-8, Metal=Cadmium

Oneway Analysis of Result (mg/kg) By Population



Quantiles

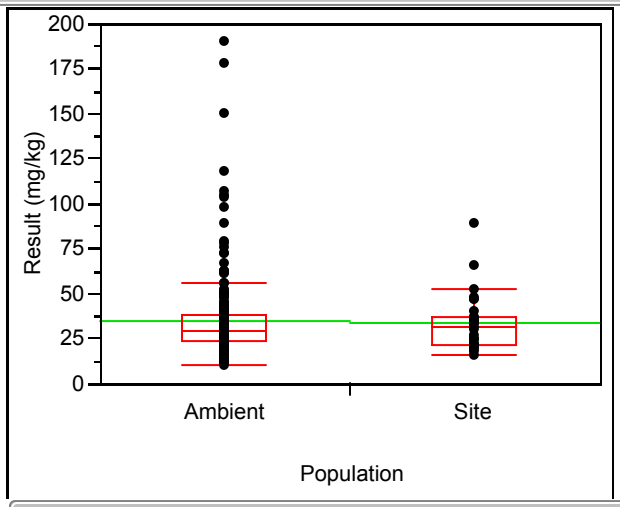
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.02	0.04	0.04	0.04	0.05	0.24	9.2
Site	0.03	0.03	0.04	0.09	0.62	0.702	0.76

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=10, Depth=0-8, Metal=Chromium

Oneway Analysis of Result (mg/kg) By Population

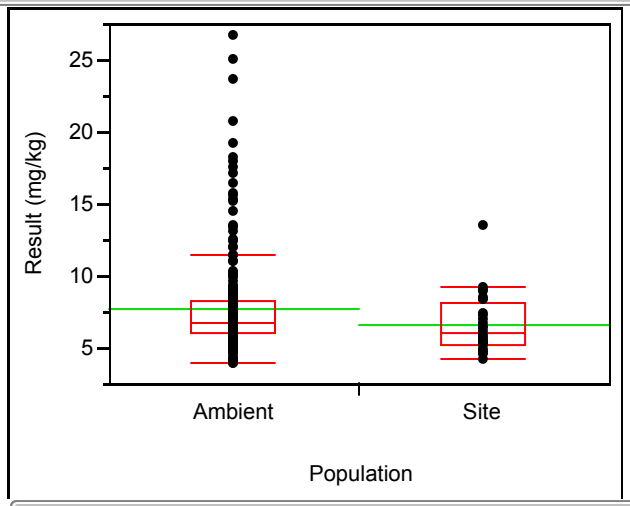


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	10.7	20.04	23.5	29.3	37.8	52	191
Site	16	19.54	22.1	31.6	37.1	51.58	89.5

Site=10, Depth=0-8, Metal=Cobalt

Oneway Analysis of Result (mg/kg) By Population



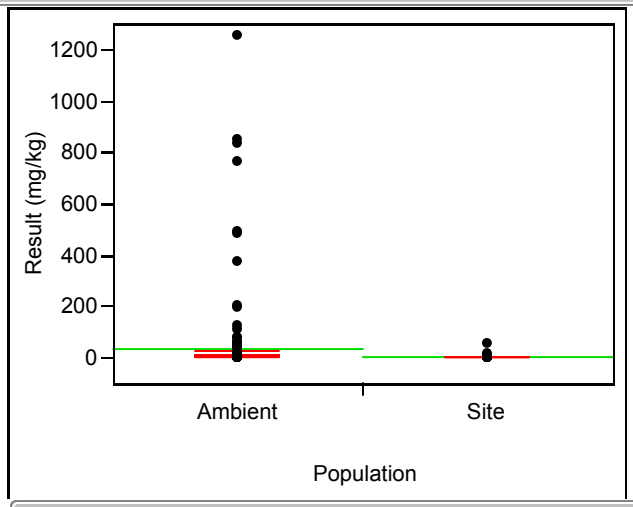
Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	4	5.08	6	6.8	8.3	11.42	26.7
Site	4.3	4.69	5.25	6.05	8.15	9.12	13.6

FIGURE I3-3 (CONTINUED)
AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=10, Depth=0-8, Metal=Copper

Oneway Analysis of Result (mg/kg) By Population

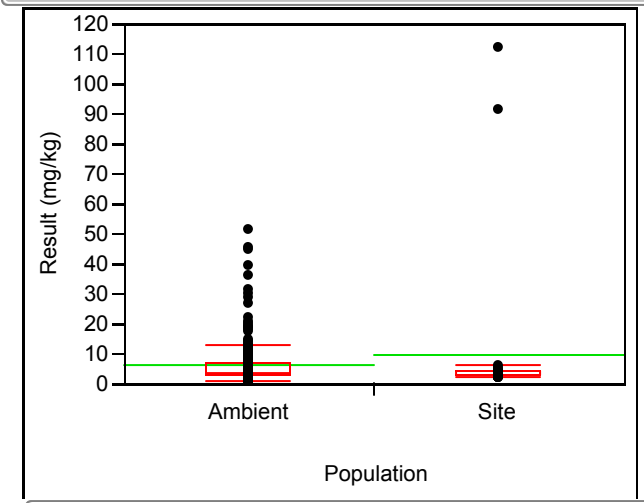


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	1.9	3	3.7	5.6	12.4	37.8	1260
Site	2.9	3.193	3.2725	4.635	7.15	15.57	60

Site=10, Depth=0-8, Metal=Lead

Oneway Analysis of Result (mg/kg) By Population



Quantiles

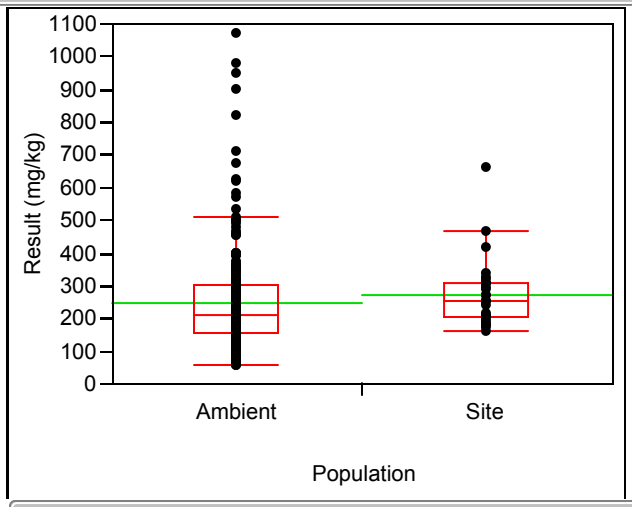
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.73	2.3	3	3.7	7.2	13.04	51.4
Site	2.32	2.42	2.785	3.26	4.335	6.13	112

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=10, Depth=0-8, Metal=Manganese

Oneway Analysis of Result (mg/kg) By Population

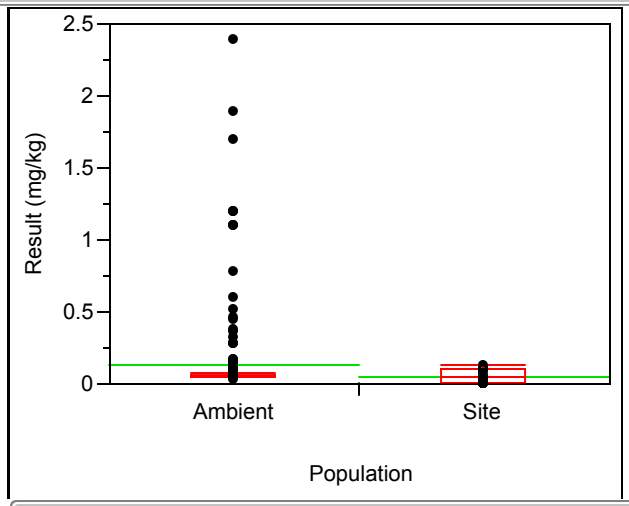


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	58.9	88.7	158	212	303	399	1070
Site	162	177.6	201.75	251	309.75	421.1	661

Site=10, Depth=0-8, Metal=Mercury

Oneway Analysis of Result (mg/kg) By Population



Quantiles

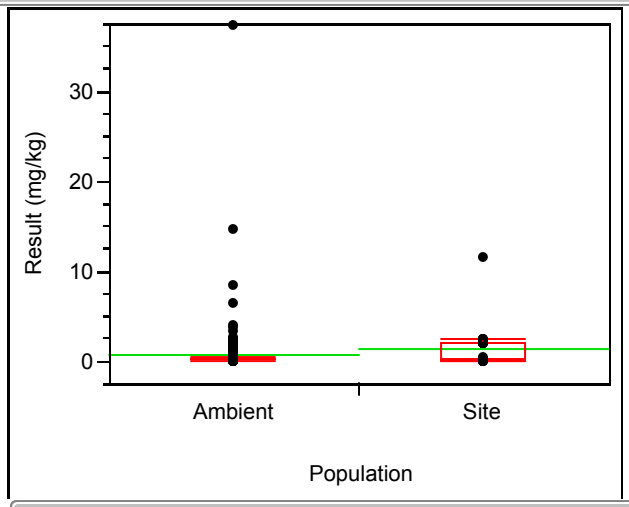
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.03	0.05	0.05	0.055	0.06	0.145	2.4
Site	0.01	0.01	0.01	0.05	0.1	0.12	0.13

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=10, Depth=0-8, Metal=Molybdenum

Oneway Analysis of Result (mg/kg) By Population

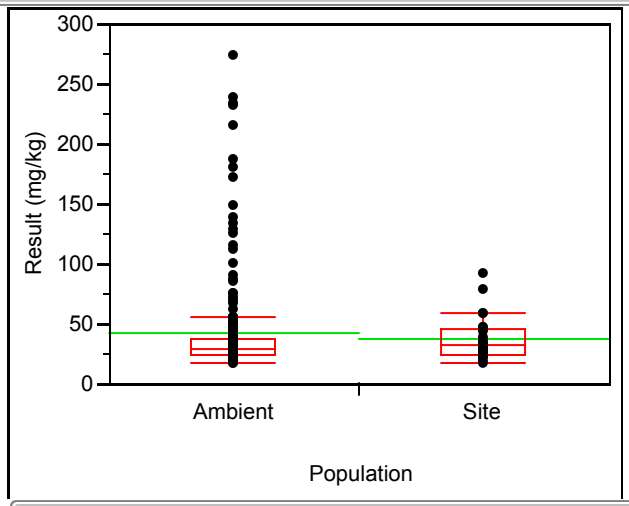


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.16	0.17	0.19	0.21	0.28	1.38	37.4
Site	0.07	0.107	0.155	0.19	2.1	2.41	11.6

Site=10, Depth=0-8, Metal=Nickel

Oneway Analysis of Result (mg/kg) By Population



Quantiles

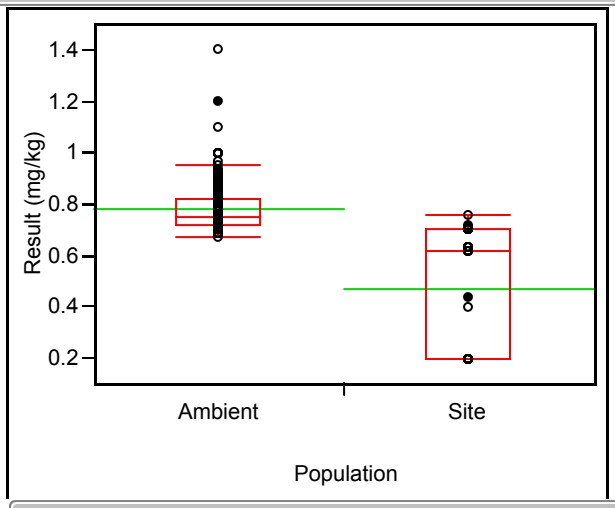
Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	18	20.9	23.6	29.6	38.2	70.1	275
Site	17.2	21.7	24.35	32.25	45.975	61.22	93.2

FIGURE I3-3 (CONTINUED)

AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=10, Depth=0-8, Metal=Selenium

Oneway Analysis of Result (mg/kg) By Population

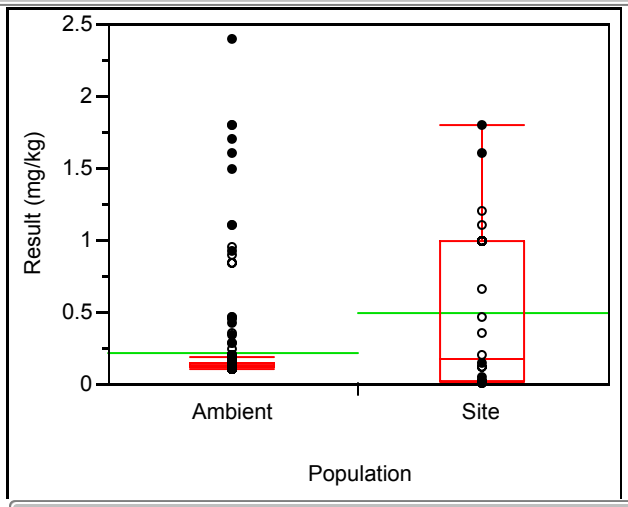


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.67	0.71	0.72	0.75	0.82	0.89	1.4
Site	0.2	0.2	0.2	0.62	0.7	0.711	0.76

Site=10, Depth=0-8, Metal=Silver

Oneway Analysis of Result (mg/kg) By Population



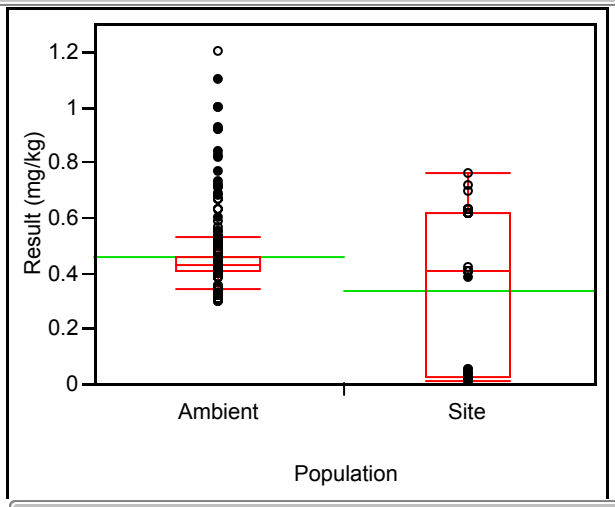
Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.1	0.11	0.12	0.13	0.15	0.2	2.4
Site	0.01	0.0119	0.015	0.175	1	1.24	1.8

FIGURE I3-3 (CONTINUED)
AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL

Site=10, Depth=0-8, Metal=Thallium

Oneway Analysis of Result (mg/kg) By Population

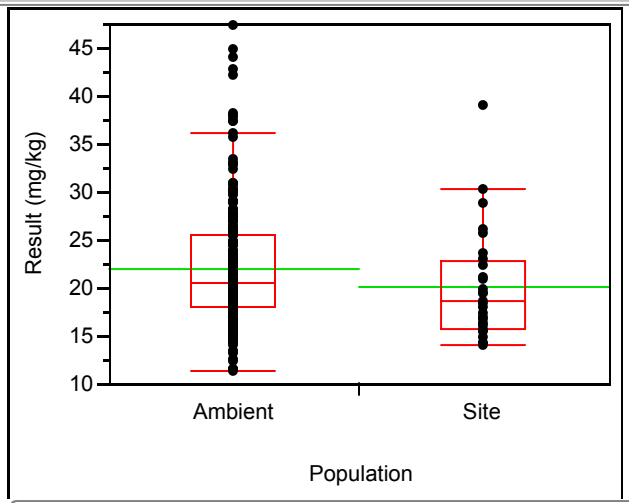


Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	0.3	0.32	0.41	0.43	0.46	0.588	1.2
Site	0.012	0.0149	0.0265	0.41	0.62	0.702	0.76

Site=10, Depth=0-8, Metal=Vanadium

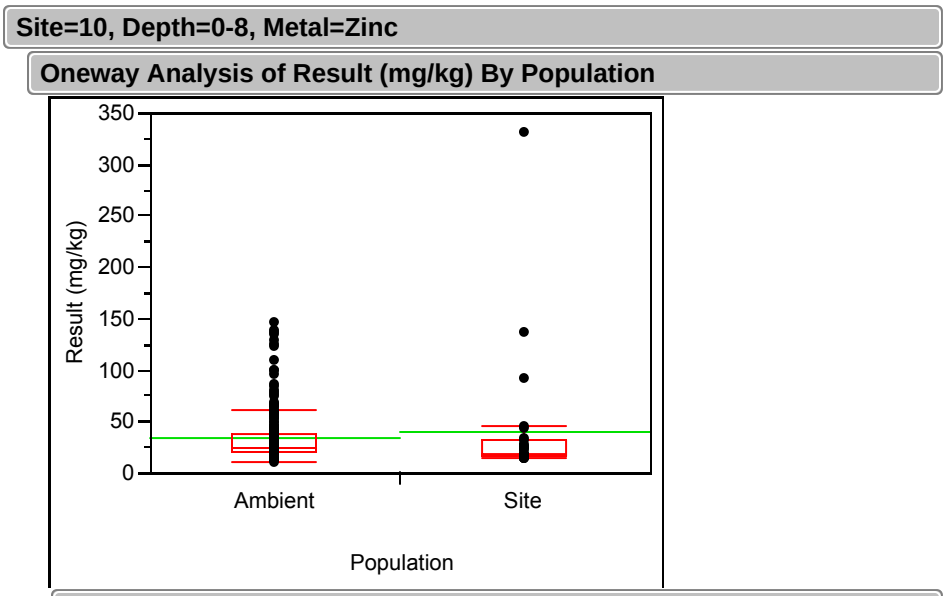
Oneway Analysis of Result (mg/kg) By Population



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	11.4	15.22	18	20.5	25.5	30.02	47.3
Site	14.1	14.2	15.825	18.6	22.85	28.95	39.1

FIGURE I3-3 (CONTINUED)
AMBIENT AND SITE QUANTILE PLOTS FOR INORGANICS IN SOIL



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Ambient	11.2	17.73	20.575	24.65	38.15	65.61	147
Site	13.7	14.85	16.025	18.65	31.775	96.69	331

Notes:

mg/kg milligram per kilogram

Open symbols indicate left-censored (non-detect) data
Solid symbols indicate detected data

TABLE I3-1: RESULTS OF AMBIENT SCREEN FOR SITE 9 SOIL (0-8 FEET BGS)
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical[a]	Site 9 (0-8 feet bgs)			Treasure Island Artificial Fill			Statistical Test[b]		Quantile Test Conclusion	Site > Ambient?	Notes
	Sample Size		Detection	Sample Size		Detection					
	Detected	Total	Frequency	Detected	Total	Frequency	(WRS, GT, or TP)	Probability[c]		(YES or NO)	(1)
Aluminum	70	70	100	241	241	100	WRS	0.074	Site ≤ Ambient	NO	
Antimony	39	70	56	48	232	21	TP	<0.001 (4)	(2)	NO	Box plots of the two data sets demonstrate that the detected antimony concentrations ap values; although there are a few non-detect values greater than the maximum detected Si statistics high (see box plots). The maximum detected Site 9 concentraion (4.15 mg/kg) i ambient concentration (18.2 mg/kg). Based upon this weight-of-evidence evaluation, an greater than ambient for Site 9.
Arsenic	70	70	100	202	231	87	GT	1.000	(3)	NO	The three outlier concentrations of arsenic (15.4, 16.9, and 17.7 mg/kg) are considere concentrations and lower concentrations are likely a manifestation of two different soil type native soils and fill/dredged material). There are general correlations between arsenic, cl vanadium, which are oxyanion-forming metals that tend to behave similarly under c The 25th, 50th (median), 75th, and 90th percentile site concentrations were all less tha maximum detected Site 9 concentration (17.7 mg/kg) was greater than the maximum dete An inspection of the box plot reveals that there are four Site 9 soil samples that have arser concentrations, but the overall distribution of Site 9 arsenic is within the range of ambient c of-evidence evaluation, arsenic is not considered significantly greater tha
Barium	70	70	100	238	241	99	GT	1.000	Site ≤ Ambient	NO	
Beryllium	70	70	100	12	241	5	TP	<0.001 (4)	Site ≤ Ambient	NO	The ambient beryllium dataset is highly non-detect, which tends to bias statitics low (e concentration, etc.). Nevertheless, the maximum detected Site 9 concentration (0.42 mg/ ambient concentration (0.77 mg/kg) and the overall distribution of beryllium is within the ra evaluation of the box plots). Based upon this weight-of-evidence evaluation, beryllium is n ambient for Site 9.
Cadmium	61	70	87	24	241	10	TP	<0.001 (4)	Site ≤ Ambient	NO	The ambient cadmium dataset is highly non-detect, which tends to bias statitics low (e concentration, etc.). Nevertheless, the maximum detected Site 9 concentration (1.1 mg detected ambient concentration (9.2 mg/kg) and the overall distribution of cadmium is with upon an evaluation of the box plots). Based upon this weight-of-evidence evaluation, ca greater than ambient for Site 9.
Chromium	73	73	100	243	243	100	WRS	0.760	Site ≤ Ambient	NO	

TABLE I3-1: RESULTS OF AMBIENT SCREEN FOR SITE 9 SOIL (0-8 FEET BGS)
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical[a]	Site 9 (0-8 feet bgs)			Treasure Island Artificial Fill			Statistical Test[b]		Quantile Test Conclusion	Site > Ambient?	Notes
	Sample Size		Detection	Sample Size		Detection					
	Detected	Total	Frequency	Detected	Total	Frequency	(WRS, GT, or TP)	Probability[c]		(YES or NO)	(1)
Cobalt	70	70	100	237	237	100	WRS	0.980	Site ≤ Ambient	NO	
Copper	60	70	86	213	239	89	GT	0.888	Site ≤ Ambient	NO	
Lead	84	84	100	214	227	94	GT	1.000	Site ≤ Ambient	NO	Although the statistical finding was that Site 9 lead concentrations were not significntly location was evaluated further to ensure it was not an exposure hot spot (se
Manganese	70	70	100	239	239	100	WRS	1.000	Site ≤ Ambient	NO	
Mercury	45	70	64	50	244	20	TP	<0.001 (4)	Site ≤ Ambient	NO	The ambient mercury dataset is highly non-detect, which tends to bias statitics low (e concentration, etc.). Nevertheless, the maximum detected Site 9 concentration (0.18 mg detected ambient concentration (2.4 mg/kg) and the overall distribution of mercury is with upon an evaluation of the box plots). Based upon this weight-of-evidence evaluation, m greater than ambient for Site 9.
Molybdenum	28	70	40	27	241	11	TP	<0.001 (4)	Site ≤ Ambient	NO	The ambient molybdenum dataset is highly non-detect, which tends to bias statitics low concentration, etc.). Nevertheless, the maximum detected Site 9 concentration (4.31 mg detected ambient concentration (37.4 mg/kg) and the overall distribution of molybdenum (based upon an evaluation of the box plots). Even if the maximum detected ambient conc which may be an outlier, overall distribution of molybdenum is within the range of ambier evidence evaluation, molybdenum is not considered significantly greater t
Nickel	70	70	100	229	229	100	WRS	1.000	Site ≤ Ambient	NO	

TABLE I3-1: RESULTS OF AMBIENT SCREEN FOR SITE 9 SOIL (0-8 FEET BGS)
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical[a]	Site 9 (0-8 feet bgs)			Treasure Island Artificial Fill			Statistical Test[b]		Quantile Test Conclusion	Site > Ambient?	Notes
	Sample Size		Detection	Sample Size		Detection					
	Detected	Total	Frequency	Detected	Total	Frequency	(WRS, GT, or TP)	Probability[c]		(YES or NO)	(1)
Selenium	3	70	4	5	241	2	TP	0.259	(2)	NO	The ambient selenium dataset is highly non-detect, which tends to bias statitics low (e concentration, etc.). Nevertheless, the maximum detected Site 9 concentration (1.1 mg/ detected ambient concentration (1.4 mg/kg) and the overall distribution of molybdenum (based upon an evaluation of the box plots). Based upon this weight-of-evidence evalua significantly greater than ambient for Site 9.
Silver	64	70	91	13	234	6	TP	<0.001	Site > Ambient	YES	
Thallium	60	70	86	23	240	10	TP	<0.001 (4)	(2)	NO	The ambient thallium dataset is highly non-detect, which tends to bias statitics low (e. concentration, etc.). The maximum detected Site 9 concentraion (0.15 mg/kg) is far less concentration (1.1 mg/kg). Also, box plots of the two data sets demonstrate that the dete be less than the range of ambient values; although there is a non-detect Site 9 value c concentration (see box plots). Based upon this weight-of-evidence evaluation, thallium i than ambient for Site 9.
Vanadium	70	70	100	233	233	100	WRS	0.986	(3)	NO	The 25th, 50th (median), 75th, and 90th percentile site concentrations were all less tha maximum detected Site 9 concentration (48.8 mg/kg) was only slightly greater than the ma (47.3 mg/kg). An inspection of the box plot reveals that there are two Site 9 soil sample greater than ambient concentrations, but the overall distribution of Site 9 vanadium is withi Because long-term exposre is represented by an average concentration over time and is r the extreme upper tail of a dataset, the overall distribution of the data should be given mo evidence evaluation, vanadium is not considered significantly greater tha
Zinc	63	70	90	190	222	86	GT	1.000	Site $\leq$ Ambient	NO	

Notes:

a Essential nutrients and chemicals with zero detections were not evaluated.

b GT= Gehan-Wilcoxon rank sum test
TP= test of proportions (implemented using the Fisher exact test)
WRS= Wilcoxon rank sum test
H_0 is that site $\leq$ ambient

c Calculated significance level for individual statistical tests. Reject H_0 if Probability $\leq$ 0.05.

\> Greater than

$\leq$ Less than or equal to

H_0 Null hypothesis

1 A weight-of-evidence approach was used to evaluate analytes that had conflicting statistical test results.

2 The quantile test could not be run because at least one of the largest r measurements was a censored value. See Attachment I3 text for description of the determination of variable r.

3 Although the quantile test provides a result relevant to the upper tail, see Notes column for weight of evidence regarding the complete Site 9 dataset.

4 This test result was based on reporting limits in the upper tail. Therefore. See Notes column for weight-of-evidence regarding actual detected values in the Site 9 dataset.

TABLE I3-2: RESULTS OF AMBIENT SCREEN FOR SITE 10 SOIL (0-8 FEET BGS)
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical[a]	Site 10 (0-8 feet bgs)			Treasure Island Artificial Fill			Statistical Test[b]		Quantile Test Conclusion	Site > Ambient?	Notes
	Sample Size		Detection	Sample Size		Detection					
	Detected	Total	Frequency	Detected	Total	Frequency	(WRS, GT, or TP)	Probability[c]		(YES or NO)	(1)
Aluminum	28	28	100	241	241	100	WRS	0.997	Site ≤ Ambient	NO	
Antimony	5	28	18	48	232	21	TP	0.716	Site ≤ Ambient	NO	
Arsenic	28	28	100	202	231	87	GT	0.147	Site ≤ Ambient	NO	
Barium	28	28	100	238	241	99	GT	1.000	Site ≤ Ambient	NO	
Beryllium	18	28	64	12	241	5	TP	<0.001 (3)	Site ≤ Ambient	NO	The ambient beryllium dataset is highly non-detect, which tends to bias st concentration, etc.). Nevertheless, the maximum detected Site 10 concentrati ambient concentration (0.77 mg/kg) and the overall distribution of beryllium is evaluation of the box plots). Based upon this wieght-of-evidence evaluation, t ambient for Site 10.
Cadmium	14	28	50	24	241	10	TP	<0.001 (3)	Site ≤ Ambient	NO	The ambient cadmium dataset is highly non-detect, which tends to bias st concentration, etc.). Nevertheless, the maximum detected Site 10 concentra detected ambient concentration (9.2 mg/kg) and the overall distribution of values (based upon an evaluation of the box plots). Based upon this wieght- significantly greater than ambient fo
Chromium	31	31	100	243	243	100	WRS	0.518	Site ≤ Ambient	NO	
Cobalt	27	28	96	237	237	100	WRS	0.978	Site ≤ Ambient	NO	
Copper	27	28	96	213	239	89	GT	0.919	Site ≤ Ambient	NO	
Lead	32	32	100	214	227	94	GT	0.959	Site ≤ Ambient	NO	Although the statistical finding was that Site 9 lead concentrations w maximum location was evaluated further to ensure it was not an ex
Manganese	28	28	100	239	239	100	WRS	0.018	(2)	NO	The 25th, 50th (median), 75th, and 90th percentile site concentrations we However, the maximum detected Site 10 concentration (661 mg/kg) was less (1070 mg/kg). An inspection of the box plot reveals that the Site 10 data is data. Also, the median Site 10 concentration (251 mg/kg) is only slightly gre mg/kg), which can be interpreted as only a slight increase in the center of the robustness of the two datasets. Nevertheless, the overall distribution of Site concentrations. Based upon this wieght-of-evidence evaluation, manganese for Site 10.
Mercury	11	28	39	50	244	20	TP	0.026 (3)	Site ≤ Ambient	NO	The ambient mercury dataset is highly non-detect, which tends to bias st concentration, etc.). Nevertheless, the maximum detected Site 10 concentra detected ambient concentration (2.4 mg/kg) and the overall distribution of me upon an evaluation of the box plots). Based upon this wieght-of-evidence e greater than ambient for Site

TABLE I3-2: RESULTS OF AMBIENT SCREEN FOR SITE 10 SOIL (0-8 FEET BGS)
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical[a]	Site 10 (0-8 feet bgs)			Treasure Island Artificial Fill			Statistical Test[b]		Quantile Test Conclusion	Site > Ambient?	Notes
	Sample Size		Detection	Sample Size		Detection					
	Detected	Total	Frequency	Detected	Total	Frequency	(WRS, GT, or TP)	Probability[c]		(YES or NO)	(1)
Molybdenum	13	28	46	27	241	11	TP	<0.001 (3)	Site ≤ Ambient	NO	The ambient molybdenum dataset is highly non-detect, which tends to bias concentration, etc.). Nevertheless, the maximum detected Site 10 concentra detected ambient concentration (37.4 mg/kg) and the overall distribution of r (based upon an evaluation of the box plots). Even if the maximum detected a which may be an outlier, overall distribution of molybdenum is within the ran evidence evaluation, molybdenum is not considered significan
Nickel	28	28	100	229	229	100	WRS	0.239	Site ≤ Ambient	NO	
Selenium	1	28	4	5	241	2	TP	0.486	(2)	NO	
Silver	14	28	50	13	234	6	TP	<0.001 (3)	Site ≤ Ambient	NO	The ambient silver dataset is highly non-detect, which tends to bias stat concentration, etc.). Nevertheless, the maximum detected Site 10 concentr detected ambient concentration (2.4 mg/kg) and the overall distribution of s upon an evaluation of the box plots). Even the two highest detected Sit concentrations that the next lowest detected concentration, are within the r Based upon this wieght-of-evidence evaluation, silver is not considered
Thallium	13	28	46	23	240	10	TP	<0.001 (3)	(2)	NO	The ambient thallium dataset is highly non-detect, which tends to bias sta concentration, etc.). The maximum detected Site 10 concentraion (0.39 mg/l concentration (1.1 mg/kg). Also, box plots of the two data sets demonstrate t be lower than the range of ambient values. Based upon this wieght-of-e significantly greater than ambient fo
Vanadium	28	28	100	233	233	100	WRS	0.976	Site ≤ Ambient	NO	
Zinc	28	28	100	190	222	86	GT	0.973	Site ≤ Ambient	NO	

Notes:

a Essential nutrients and chemicals with zero detections were not evaluated.

b GT= Gehan-Wilcoxon rank sum test
TP= test of proportions (implemented using the Fisher exact test)
WRS= Wilcoxon rank sum test
H_0 is that site ≤ ambient

c Calculated significance level for individual statistical tests. Reject H_0 if Probability ≤ 0.05.

> Greater than

≤ Less than or equal to

H_0 Null hypothesis

1 A weight-of-evidence approach was used to evaluate analytes that had conflicting statistical test results.

2 The quantile test could not be run because at least one of the largest r measurements was a censored value. See Attachment I3 text for description of the determination of variable r.

3 This test result was based on reporting limits in the upper tail. Therefore. See Notes column for weight-of-evidence regarding actual detected values in the Site 9 dataset.

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ABBREVIATIONS AND ACRONYMS

µg/L	micrograms per liter
AWQC	Ambient water quality criterion
COEC	Chemical of ecological concern
COPEC	Chemical of potential ecological concern
CSC	California Species of Special Concern
CSM	Conceptual site model
DAF	Dilution attenuation factor
DL	Dilution factor
EPA	U.S. Environmental Protection Agency
ERA	Ecological risk assessment
FWS	California Fish and Wildlife Service
IR	Installation Restoration
MTBE	Methyl Tertiary-Butyl Ether
NA	Not applicable
NAVSTA TI	Naval Station Treasure Island
Navy	U.S. Department of the Navy
PCB	Polychlorinated biphenyl
RI	Remedial investigation
RWQCB	Regional Water Quality Control Board
SMDP	Scientific Management Decision Point SLERA - Screening-level ecological risk assessment
Tetra Tech	Tetra Tech EM Inc.
TI	Treasure Island
VOC	Volatile organic compound
WESTDIV	Naval Facilities Engineering Command, Western Division
YBI	Yerba Buena Island

1.0 INTRODUCTION

This appendix presents the methods and the results of the screening-level ecological risk assessment (SLERA) conducted as part of the remedial investigation (RI) for the Installation Restoration (IR) Sites 09 and 10 at Naval Station Treasure Island (NAVSTA TI). The SLERA has been prepared in partial fulfillment of the objectives of the RI and incorporates guidance issued by the U.S. Department of Navy (Navy) (Navy 1999) and the U.S. Environmental Protection Agency (EPA) (EPA 1997). As part of the RI, a SLERA must be conducted to characterize current and potential threats to the environment that may be posed by chemicals of concern at the sites being investigated.

This screening-level approach uses conservative assumptions and available scientific literature to evaluate ecological risk in an approach consistent with steps 1 and 2 of the eight-step process described in the EPA guidance (EPA 1997) and Tier I (which includes steps 1 and 2) of the Navy guidance (Navy 1999). The SLERA has four primary phases: (1) problem formulation, (2) ecological effects, (3) exposure estimates, and (4) risk characterization. Step 1 of the eight-step process corresponds to problem formulation and ecological effects; exposure estimates and risk characterization are completed as part of step 2. During the problem formulation phase in step 1, an ecological conceptual site model (CSM) is developed for evaluation of exposure at the site and selection of assessment and measurement endpoints. During the ecological effects evaluation, chemical exposure levels that represent conservative thresholds for adverse ecological effects are identified. During the exposure estimate phase, exposure parameters are determined for representative receptors identified in the problem formulation phase. Finally, during the risk characterization phase, the potential risks to selected assessment endpoints associated with the site are conservatively estimated.

In accordance with EPA guidance (EPA 1997), following the completion of this assessment, a scientific management decision point (SMDP) is reached. Through the SMDP, the risk managers should determine whether one or more of the following descriptions apply to the information gathered regarding preliminary risks associated with exposure to chemical concentrations at Sites 09 and 10 NAVSTA TI:

- Adequate to conclude that ecological risks are negligible; therefore, no remediation is necessary
- Inadequate to make a decision; therefore, a site-specific baseline ecological risk assessment (ERA) is requested to refine the risk estimate and reduce the uncertainty associated with the SLERA
- Adequate to indicate a potential for adverse ecological effects; therefore, a site-specific baseline ERA is requested to refine the risk estimate and reduce the uncertainty associated with the SLERA

2.0 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT APPROACH

The following sections describe the approach used in this SLERA, in accordance with steps 1 and 2 of EPA guidance for ERAs at Superfund sites (EPA 1997). Specifically, this SLERA addresses detected chemicals in groundwater at Sites 09 and 10, NAVSTA TI, and the potential risk to aquatic receptors associated with chemical groundwater migration to the offshore surface waters of San Francisco Bay.

2.1 STEP 1: PROBLEM FORMULATION AND ECOLOGICAL EFFECTS

The following sections describe the problem formulation for Sites 09 and 10, including site location and history, environmental setting, and CSM, which provides descriptions of known and potential stressors, evaluation of potential exposure pathways, discussion of chemical fate and transport, and identification of assessment and measurement endpoints. Problem formulation and ecological effects correspond to step 1 of the SLERA process, as described in EPA guidance (EPA 1997).

2.1.1 Site Location and History

The main RI report text is an integral part of this SLERA; therefore, the extensive site history documented in Section 1.2 of the main text is not repeated here. A brief introduction to the two NAVSTA TI IR sites discussed in this SLERA is, however, presented in the following paragraphs.

Site 09 comprises Building 41 (the foundry) and the paved area immediately adjacent to the northwest, west, and south sides of the building. Site 09 is approximately 11,000 square feet in size. Building 41 has been in use since the early 1940s, including the following known operations:

- From 1943 to 1947, Building 41 was listed as a forge and foundry.
- From 1952 to 1981, Building 41 was listed as a paint shop.
- From 1981 to 1987, Building 41 was used as a welding training school by the Navy Technical Training Center.
- More recently, in 1994, Building 41 was used for small boat maintenance, comprising mainly bodywork.

The Navy and its contractors believe that the outdoor areas of Site 09 have been paved for most of the building's existence.

Site 10 comprises Building 335 (the bus painting shop) and the area immediately adjacent to the northwest, west, and south sides of the building. Site 10 is approximately 32,000 square feet in size. The surrounding area is covered primarily by pavement and bare ground, with small amounts of grass and shrubbery. Building 335 has been used for the following multiple operations over time:

- Mid-1940s through 1950s: Site 10 supported operations as a bus painting shop, including possible paint mixing, as well as related waste paint, thinner, and solvent handling.
- Building 335 was also reportedly used for storing, mixing, and handling pesticides, although the time period of this operation is unknown. Solution residues may have been washed from containers and application equipment in this area.
- Building 335 housed a self-service steam rack used to clean vehicles, drums, garbage cans, and related equipment. A floor drain in the building was reportedly used and was reportedly connected to the storm sewer.

2.1.2 Previous Investigations

Various onshore investigations have been completed at both Sites 09 and 10, as detailed in the main RI text (Section 2.2).

The final RI for the Offshore Sediments Operable Unit at NAVSTA TI was completed in 2001 (Tetra Tech EM Inc. [TtEMI] 2001a). This comprehensive ERA covered the offshore areas of both Treasure Island (TI) and Yerba Buena Island (YBI), including the Clipper Cove Skeet Range (Site 27). The RI concluded, based on the information and data evaluated as part of the offshore investigation at NAVSTA TI, that current chemical levels offshore of TI and YBI did not pose a level of risk to aquatic and avian receptors that would require action. No further investigation or action was recommended for any of the offshore areas of NAVSTA TI with the exception that possible future sediment dredging at the Clipper Cove Skeet Range might warrant institutional controls to protect diving ducks.

2.1.3 Environmental Setting and Ecological Characterization

The following sections characterize the environmental setting and ecology of both the onshore and offshore areas at NAVSTA TI. The ecology specific to the offshore area is based on natural history literature and surveys of the San Francisco Bay area, conducted by both the Navy and Audubon Society.

2.1.3.1 Terrestrial Habitat

Generally, the terrestrial habitat of TI is of poor quality for wildlife species because TI is predominantly covered with urbanized areas. To increase the understanding of the habitat and conditions found at each of the IR sites on both TI and YBI, a group of Navy and federal, state, and regional agency representatives drove and walked through the IR sites on both TI and YBI. During the site tour, conducted on June 3, 1994, the group characterized the habitat on TI as poor quality, with large areas of pavement, gravel, or buildings restricting use of the sites by ecological receptors of concern. With higher quality habitat nearby at YBI, the group concluded that receptor species' use of TI was infrequent, the terrestrial receptor risk was minimal, and further assessment of the TI onshore sites for the phase II ERA of the offshore sediments RI was not necessary (TtEMI 1997). These recommendations helped focus the selection of assessment and measurement endpoints and the risk analysis portions of future ERAs to the offshore waters directly adjacent to TI.

The vegetated parts of TI are made up of lawns and landscaped areas; lawns, in general, provide poor habitat, and the landscaped areas are planted with largely nonnative species. Additional disturbance from vehicular traffic and widespread human presence also reduce the quality of the habitat for wildlife species onshore at TI. Although Sites 09 and 10 are onshore sites at NAVSTA TI, the main route of exposure explored in this SLERA is the migration of chemicals in groundwater to offshore areas adjacent to Sites 09 and 10, and the potential risk to aquatic receptors that is associated with this groundwater-surface water (San Francisco Bay) interaction.

2.1.3.2 Offshore Habitat

Information was compiled on the environmental setting, habitats, animal, and plant species, including special status species, which could be potentially exposed to site-related chemicals of potential ecological concern (COPEC).

NAVSTA TI is an island in San Francisco Bay, which is the largest estuary on the Pacific coast of the United States. The predominant marine habitat surrounding NAVSTA TI is subtidal with hard-bottom and soft-bottom mud substrate. A limited intertidal habitat composed of riprap, docks, and pier pilings is present along the entire perimeter of TI. A sandy beach/mudflat intertidal shoreline is present at the base of Clipper Cove and a portion of the southeastern and southwestern shores of YBI. Intertidal mudflats are inundated and exposed twice a day by tidal action and occur in a zone between 2.5 feet below the mean lower low water and mean tide level in central San Francisco Bay (San Francisco Estuary Project 1992). No freshwater or wetland habitats exist on NAVSTA TI (Naval Facilities Engineering Command, Western Division [WESTDIV] 1990).

The primary residents offshore of NAVSTA TI are species of phytoplankton, algae and plants, zooplankton, benthic invertebrates, and fish. Larger marine mammals are limited to species such

as the harbor seal (*Phoca vitulina*) and the California sea lion (*Zalophus californianus*). These species are the only mammals known to use the open water habitat offshore of NAVSTA TI.

The following birds also migrate through the marine habitat offshore of NAVSTA TI:

- Loons
- Grebes
- California brown pelicans *(Pelecanus occidentalis californicus*)
- Mallards (*Anas platyrhynchos*)
- Cormorants
- Diving ducks such as the canvasback (*Aythya valisineria*), buffleheads (*Bucephala clangula*), scaups, surf scoters, and American coots
- Gulls
- Terns (California Fish and Wildlife Service [FWS] 1992b)

Most of these species also use the shoreline areas of YBI. Shorebirds that feed on invertebrates found in rocky shore habitat in central San Francisco Bay include the ruddy turnstone (*Arenaria interpres*), black turnstone *(A. melanocephala*), surfbird (*Aphriza virgata*), willet (*Catoptrophorus semipalmatus*), black-bellied plover (*Pluvialis squatarola*), wandering tattler (*Heteroscelus incanum*), and black oystercatcher (*Haematopus bachmani*).

2.1.3.3 Special Status Plants and Animals

Species that are threatened or endangered according to state and federal laws and guidelines, including California Species of Special Concern (CSC), are discussed in this section. Several species of federal or state special conservation status, including listed and candidate species, occur or potentially occur offshore at NAVSTA TI.

Three special-status fish species are known to occur in the offshore area of NAVSTA TI, including one federally protected species (chinook salmon), one state-protected species (longfin smelt), and one state species of special concern (river lamprey). The delta smelt (*Hypomesus transpacificus*), a species protected by state and federal governments, does not typically occur in the Central Bay but could be an infrequent visitor in periods of high outflow. Likewise, the green sturgeon (*Acipenser medirostris*), a species of special concern, may visit NAVSTA TI but has not been recorded in the area.

Additionally, three species of birds classified as rare and endangered by either the state or federal governments have been reported to intermittently forage or roost at NAVSTA TI (WESTDIV 1990): the peregrine falcon (*Falco peregrinus*), California least tern (*Sterna antillarum*), and California brown pelican. A number of CSC birds potentially occur offshore at NAVSTA TI, including the common loon (*Gavia immer*), American white pelican (*Pelecanus erythrorhynchos*), double-crested cormorant (*Phalacrocorax auritus*), Barrow's goldeneye (*Bucephala islandica*), osprey (*Pandion haliaetus*), western snowy plover (*Charadrius alexandrinus nivosus*), long-billed curlew (*Numenius americanus*), and California gull (*Larus argentatus*). Of these birds, the presence of the double-crested cormorant, the common loon, and the California gull has been confirmed at NAVSTA TI during the past 10 years (California Department of Fish and Game 1997; Audubon Society 1996; Bailey 1992).

Although no threatened or endangered mammals are known to occur offshore NAVSTA TI, all marine mammals are protected under the Marine Mammal Protection Act of 1972. Similarly, no threatened or endangered plants or invertebrates are known or suspected to occur offshore at NAVSTA TI.

2.1.4 Conceptual Site Model

The CSM illustrates exposure pathways to be evaluated in the ERA and provides other key information such as chemical sources, release and transport mechanisms, and the relative importance of exposure pathways to specific receptor groups. The CSM includes the following components:

- **Stressors:** identification of site stressors in an ecological context. Stressors can be defined as any factor causing adverse ecological impacts on natural resources at the site; in this SLERA, chemical stressors are addressed directly. Other types of stressors are also identified when pertinent to the interpretation of ecological risks.

- **Exposure pathways:** identification of complete ecological exposure pathways, such as ingestion and dermal contact, as well as the representative receptors that may be exposed. Representative receptors usually include members of important feeding guilds and may include special-status species.

- **Fate and transport:** description of potential pathways of chemical transport and the ultimate fate of site chemicals, including the potential for biogeochemical transformation of the chemicals, potential for on-site and off-site migration of chemicals, and biotic transfer.

- **Assessment and measurement endpoints:** identification of assessment and measurement endpoints used to characterize risk at the site. Assessment endpoints are environmental characteristics or values which, if found to be significantly affected, would indicate a need for action by risk managers. Measurement endpoints more closely reflect technical considerations in the risk assessment process; that is,

measurement endpoints are focused on more direct measures of ecological affects that allow for an evaluation of risk to assessment endpoints.

The following sections briefly describe the components of the CSM at Sites 09 and 10 NAVSTA TI, which is illustrated in Figure J-1.

2.1.4.1 Stressors in the Offshore Habitat

Stressors can be defined as any factor that causes adverse ecological impacts at the sites. Based on previous investigations and the ecological characterization of the sites, stressors considered in the SLERA are COPECs. Although these chemicals are defined in Section 2.2.3, the chemical stressors generally considered and evaluated in this SLERA are metals and pesticides. Other stressors, such as introduced species (FWS 1992a), are not assessed in this report.

2.1.4.2 Exposure Pathways and Exposure Routes

Receptors residing in or migrating through the offshore habitat may be exposed to site-related chemicals transported off site in groundwater. Potentially complete exposure pathways to offshore receptors present at Sites 09 and 10 were evaluated based on the fate and transport processes. For an exposure pathway to be considered complete, a chemical must be able to travel from the source to the representative receptor and must be taken up by the receptor through one or more exposure routes. These pathways present the greatest potential risk of adverse effects for receptors of concern at a given site. Potential exposure pathways resulting in receptor contact could include sediments, soil, surface water, groundwater, and food-chain transfer. Because of the nature of the onshore sites and the lack of terrestrial habitat on NAVSTA TI, however, the Sites 09 and 10 SLERA specifically evaluates chemicals in groundwater migrating from Sites 09 and 10 to the offshore habitat of the San Francisco Bay.

Both major and minor potential exposure pathways at Sites 09 and 10 are diagrammed in the CSM (Figure J-1). Additionally, ingestion of and dermal contact with San Francisco Bay surface water constitute the primary routes of exposure to chemicals that will be evaluated for both Sites 09 and 10.

2.1.4.3 Fate and Transport

Although exposure is a simple concept, accurately describing the fate and transport of chemicals from their source to a site of toxic action in living organisms can be quite complicated. In general, for exposure to occur, a chemical must leave the environmental matrix, move across several biological membranes, and concentrate in a tissue to the extent that its toxic action is exerted. A chemical that can move from the environmental matrix to the tissue of a receptor is said to be bioavailable to that receptor.

Groundwater is not of ecological concern at NAVSTA TI until it meets or becomes surface water or until it can transport dissolved chemicals into the offshore environment. The Sites 09 and 10 SLERA focuses on chemicals in groundwater that migrate to the offshore environment and are bioavailable or potentially bioavailable to aquatic receptors.

The geologic and hydrogeologic conditions at Sites 09 and 10 are relatively uniform and homogeneous. The sites are underlain by artificial fill consisting mainly of poorly sorted fine- to coarse-grained sands. Although flow reversals occur in the tidally influenced strip along the shoreline, groundwater flow is generally uniform towards the shoreline.

In general, the groundwater at TI is under unconfined conditions at an average depth of approximately 5 feet below grade. Groundwater flows radially from the center of the island toward the shoreline at average gradients ranging from 0.001 to 0.003. Groundwater recharge occurs primarily from infiltration of precipitation, with some contribution from landscape irrigation (TtEMI 2002a). Approximately one third of the island's surface is paved. Tidal influence on groundwater elevations at TI was not observed at wells more than 250 feet from the shoreline (TtEMI 2002a).

2.1.4.4 Assessment and Measurement Endpoints

EPA defines assessment endpoints as "explicit expressions of the actual environmental values (e.g., ecological resources) that are to be protected" (EPA 1997). Assessment endpoints are environmental characteristics that, if significantly impaired, would indicate a need for action by risk managers. Various definitions of valuable ecological resources include those without which ecosystem function would be significantly impaired; those providing critical resources, such as habitat or fisheries; and those perceived by humans as being valuable, such as endangered species and other issues addressed by legislation. Useful assessment endpoints define both the valuable ecological entities at the site and a characteristic of the entity to protect, such as reproductive success or production per unit area.

During this assessment, the focus is on endpoints most likely to be affected given the fate and transport mechanisms of the chemicals, the ecotoxicological properties of the chemicals, the offshore habitats at the site, and the potential offshore receptors existing adjacent to the site. The assessment endpoint used to evaluate the potential ecological risk at Sites 09 and 10 was the protection of populations of benthic invertebrates and other aquatic biota. This assessment endpoint was chosen to address the risk posed through the major exposure pathway considered important at these sites.

Assessment endpoints are usually not amenable to direct measurement; therefore, measurement endpoints related to assessment endpoints were identified. A measurement endpoint is defined by EPA as "a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint and is a measure of biological effects (such as mortality, reproduction, or growth)" (EPA 1997). Measurement endpoints are often expressed as statistical

or arithmetic summaries of observations and can include both measures of effect and measures of exposure. The measurement endpoint correlates directly with the defined assessment endpoints and was based on available literature regarding mechanisms of toxicity. The following measurement endpoint was used for evaluating potential ecological impacts to the assessment endpoints identified for the Sites 09 and 10 SLERA:

- For benthic invertebrates and other aquatic biota offshore of Sites 09 and 10, groundwater concentrations of chemicals were compared to groundwater screening criteria.

2.2 METHODOLOGY FOR EVALUATION AND EFFECTS ON ECOLOGICAL RECEPTORS

The following sections describe the methodology used to evaluate exposure to the assessment endpoints offshore of Sites 09 and 10.

2.2.1 Groundwater Data Reduction

All available historic data from Sites 09 and 10 groundwater monitoring wells were included in the ERA database. No hydropunch (groundwater grab sample) data were used in the ERA. Concentrations measured in samples collected with this sampling approach are not generally considered representative of aquifer conditions, particularly with regard to estimating ecological health risks related to groundwater water migration and eventual discharge into the San Francisco Bay.

Although historic data provide a good summary of overall conditions, important changes to the groundwater sampling methodology were implemented during 2002. In particular, low-flow sampling was implemented to better estimate actual aquifer concentrations of both volatile organic compounds (VOC) (where bailer sampling may disturb VOC concentrations and result in lower measured concentrations) and inorganic compounds (where bailer sampling may result in entrained sediments not reflective of dissolved inorganic compounds in a more natural state). In addition, the basewide ambient study to document naturally occurring inorganic compounds was conducted with low-flow sampling techniques.

To have representative and comparable data sets, therefore, the more recent (2002) groundwater data were considered most representative for the ERA when COPEC selection and eventual risk analysis were conducted at the sites.

All seven wells (09MW01 through 09MW07) on Site 09 remain functional and were sampled in 2002, so the Site 09 data set is robust for fall 2002. By October 2002, only MW02 and MW03 remained on Site 10. The upgradient, control well for Site 14 that was placed on Site 10 (well 14MW03) was destroyed some time between 1998 and 2002. Similarly, although MW01 previously existed on Site 10, it was also destroyed or buried some time between 1998 and 2002. No results reflecting current conditions are available for these wells. The 2002 data from the

two newer wells (MW02 and MW03) provide a conservative "snapshot" of representative conditions in the aquifer underlying Site 10. Unfortunately, MW02 was only sampled for the pesticide/polychlorinated biphenyl (PCB) analytical suite in 2002; both MW02 and MW03 have only been sampled once, in 2002. Still, because of the small size of Site 10 and the biased sampling location (nearest to suspected release), the data are sufficient to characterize the migration and eventual discharge of groundwater into the San Francisco Bay and the effects this may potentially have on offshore aquatic biota.

2.2.2 Groundwater Screening Criteria

The toxicity criteria presented in Table J-1 were compiled through comprehensive reviews of the following published regulatory standards, goals, and guidance:

- "Water Quality Control Plan, San Francisco Bay Basin Region" (Regional Water Quality Control Board [RWQCB] 1995)
- "A Compilation of Water Quality Goals" (RWQCB 2000)
- "The Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California.", "National Recommended Water Quality Criteria: 2002.", and "Revision of National Recommended Water Quality Criteria." (EPA 2000, 2002a, 2002b)
- Other sources, as appropriate (RWQCB 1998, Tetra Tech 1999)

The types of screening criteria and methodological approach for selecting screening criteria used in the Sites 09 and 10 SLERA are detailed in the following text.

Individual toxicity criteria were selected using a methodology that sorts and selects criteria according to applicability and quality of data. First, identified criteria were sorted by applicability and quality of data into one of five tiers (Table J-2). Chronic exposure toxicity criteria were identified as most applicable for the exposure scenario at NAVSTA TI and more protective (lower concentration values) than short duration acute or instantaneous exposure toxicity criteria (higher concentration values). As a result, applicable chronic exposure toxicity criteria were placed in the first tier of applicability. Where more than one applicable toxicity value was available in the same tier, the most protective (lowest) value was selected for screening purposes.

If no first tier exposure toxicity criterion was available for a specific analyte, an acute value was selected as a second tier criterion. To make acute criteria more appropriate for use in chronic exposure scenarios, however, each acute criterion was made more protective, and thus conservative, by applying the standard convention of lowering the values by 80 percent. Where no first or second tier criteria were available, instantaneous criteria were compiled and used as third tier criteria. To make instantaneous criteria more appropriate for use in chronic exposure

scenarios, however, each instantaneous criterion was made more protective by applying the standard convention of lowering the values by 90 percent.

Additionally, toxicity criteria were evaluated for applicability and compared in terms of regulatory status and scientific data quality. For example, promulgated federal or state regulatory toxicity standards and recommended criteria were used in this compendium, whereas unique research values, such as those presented by individuals, industry research groups, or academic research groups where study methodology and data quality is unknown, were not used. In those cases where no first, second, or third tier criteria were available, published EPA lowest-observable-effects criteria were included for screening purposes. Finally, where no first through fourth tier criteria were available for specific analytes of concern (methyl-tert-butyl ether and total petroleum hydrocarbons), a RWQCB interim water quality objective (RWQCB 1998) and a NAVSTA TI-derived value (TtEMI 1999) were used, respectively.

Shaded values in Table J-1 were selected as the screening criteria for analytes of concern for the Sites 09 and 10 SLERA at NAVSTA TI. Where more than one applicable toxicity value was available in the same tier, the most protective (lowest) value was selected for screening purposes. Using the tiered methodology detailed previously, when no first tier criterion was identified, the most protective second tier criterion was selected, and so on. In most cases, screening values for this SLERA usually comprised of either first or second tier toxicity criteria.

2.2.3 Selection of Chemicals of Potential Ecological Concern

A step-wise approach for evaluating chemicals in groundwater was used to identify COPECs and chemicals of ecological concern (COEC) for the offshore point of exposure areas at NAVSTA TI. The more recent (2002) groundwater data were considered most representative for this SLERA, and specifically, the selection of COPECs at Sites 09 and 10. The fate and transport of Sites 09 and 10 COPECs detected in groundwater were later simulated in a BIOSCREEN model to determine COECs. The BIOSCREEN model is summarized in further detail in Section 2.2.4.

The evaluation of COPECs included a comparison of groundwater chemical data to individual screening criterion selected using the methodology described in Section 2.2.2. If inorganic or organic chemical data exceeded a specific screening criterion, then the chemical was deemed a COPEC. This primary screening process identified a number of COPECs that were later determined to pose little or no risk at the site; the screening methodology and values themselves were designed to be very conservative to account for potential false negatives in the screening process. All COPECs for both Sites 09 and 10 are listed in Table J-3.

2.2.3.1 Inorganic Chemicals of Potential Ecological Concern at Sites 09 and 10

Nickel was considered to pose potential risk to offshore aquatic receptors at Site 09 because the maximum groundwater concentration (11.9 micrograms per liter [µg/L]) exceeded the ambient

water quality criterion (AWQC) of 8.2 µg/L (Table J-3). Nickel was the only inorganic chemical determined to be a COPEC at Site 09.

No inorganic COPECs were identified at Site 10.

2.2.3.2 Organic Chemicals of Potential Ecological Concern at Sites 09 and 10

Alpha-chlordane was considered to pose potential risk to offshore aquatic receptors at Site 09 because the maximum groundwater concentration (0.0067 µg/L) exceeded the AWQC of 0.004 µg/L (Table J-3).

Endosulfan II was also considered to pose potential risk to offshore aquatic receptors at Site 09 because the maximum groundwater concentration (0.014 µg/L) exceeded the AWQC of 0.0087 µg/L (Table J-3).

No organic COPECs were identified at Site 10.

2.2.3.3 Detected Chemicals with No Screening Values

Chemicals for which no groundwater screening values were available are identified in the following text with the exception of chemicals that are essential nutrients and not considered priority pollutants, such as calcium, iron, magnesium, potassium, and sodium.

Chemicals detected in groundwater for which no screening criteria were available at Site 09 include aluminum, antimony, barium, cobalt, manganese, molybdenum, vanadium, m,p-xylenes, and 2-methylnaphthalene. Additionally, chemicals detected in groundwater for which no screening criteria were available at Site 10 included aluminum, antimony, barium, manganese, and molybdenum.

In most cases, inorganic concentrations identified in groundwater slightly exceeded the ambient concentration of individual metals in groundwater identified at NAVSTA TI (Table J-4). Additionally, at Site 10, antimony, barium, manganese, and molybdenum were all identified below the estimated ambient concentrations for metals in groundwater.

The maximum concentrations of aluminum at both Sites 09 and 10 (2,040 µg/L and 349 µg/L, respectively) significantly exceeded the NAVSTA TI ambient concentration (27 µg/L). Although aluminum bioaccumulates in aquatic invertebrates, toxicity depends on pH and is most significant to wildlife in acidic habitats. At low pHs (less than 6.0 to 6.5), aluminum is likely to be more toxic and accumulate more, with asphyxiation, gill tissue damage, and impaired ion regulation occurring in fish at pH 4.5 to 6.5 (Sparling and Lowe 1996; Spry and Wiener 1991 as cited in Hamelink and others 1994). Additionally, aluminum was evaluated in the offshore RI using pH; porewater and sediment sample pHs collected for the offshore

areas of Sites 09 and 10 ranged from 6.8 to 8.3 (TtEMI 2001a). Considering these pHs are relatively neutral, aluminum was not considered a major source of uncertainty for this SLERA.

Specific to organic compounds at Site 09, the maximum 2-methylnaphthalene concentration identified in groundwater was 0.025 µg/L, which only slightly exceeded the detection limit of 0.012 µg/L. Similarly, m,p-xylenes was only detected once (0.3 µg/L), and that maximum concentration was below the detection limit of 1.0 µg/L.

2.2.4 Fate and Transport Modeling

This section provides a brief summary of the fate and transport modeling used to establish chemical concentrations of COPECs once they reach the point of ecological exposure at NAVSTA TI for both Sites 09 and 10. A detailed summary of the modeling and specific parameters used is located in Appendix H.

The modeling approach in this SLERA used an analytical model (BIOSCREEN), which simulated the migration of COPECs (nickel, alpha-chlordane, and endosulfan II) in groundwater at Sites 09 and 10, NAVSTA TI, to the ecological point of exposure. The approach to groundwater modeling included the selection of model input parameters that would result in the most conservative modeling results possible. For this assessment, "conservative model results" are defined as those results that would yield reasonable worst-case concentrations of COPECs at the ecological point of exposure.

To this end, the BIOSCREEN model was constructed by incorporating a steady-state continuing source, equal in concentration to the maximum detected concentration in source area monitoring wells at Sites 09 and 10. The contaminant source zone was defined as the vertical plane perpendicular to the groundwater flow direction. The width and thickness of the source zone were conservatively determined based on concentrations of COPECs in soil. The concentrations of COPECs in soils are below preliminary remediation goals for residential soil scenario or non-detected and appear to decrease with depth to non-detectable levels at the water table. Therefore, it is unlikely that the concentrations of COPECs in soil will continue contributing to groundwater contamination. Because at both sites the utility lines appear to be continuously above the water table, the preferential pathways for groundwater contaminants to reach the ecological point of exposure were not considered.

Additionally, a decrease in contaminant concentrations (attenuation) was assumed to result only from dispersion. Other natural processes, such as chemical transformation and biodegradation (which would act to reduce contaminant concentrations), were not considered. Furthermore, the modeling used the point of exposure for ecological receptors as the inland edge of the tidal mixing zone and not the shoreline. The lateral dispersion and dilution of contaminants within the tidal mixing zone and the tidal fluctuations that increase vertical dispersion of contaminants near the shoreline were not considered. This approach resulted in model simulations that likely significantly overestimate concentrations of COPECs at the ecological point of exposure.

3.0 RISK CHARACTERIZATION

The following text characterizes the risk to aquatic receptors offshore of NAVSTA TI and lists the results of the fate and transport modeling of the initial COPECs identified in Section 2.2.3.

This section identifies the inorganic and organic COECs in environmental media (San Francisco Bay surface water) at NAVSTA TI for Sites 09 and 10. COECs are identified as those chemicals that continued to exceed individual screening criteria after their eventual fate and transport to the point of ecological exposure offshore of NAVSTA TI. Determination of initial COPEC chemical concentrations was simulated via a fate and transport model described in Section 2.2.4 and Appendix H. Final COECs and the concentrations of individual chemicals that were modeled are listed in Table J-5.

Nickel

At Site 09, nickel was the only inorganic chemical identified as a groundwater COPEC because groundwater concentrations exceeded the screening criteria of 8.2 µg/L. The fate and transport of the maximum concentration of nickel (11.9 µg/L) was then simulated using the BIOSCREEN model. The final concentration at the ecological point of exposure was determined to be 0.93 µg/L. This concentration is well within the acceptable range for nickel in groundwater, and therefore, is not considered a COEC at Site 09.

Alpha-chlordane

At Site 09, alpha-chlordane was identified as a groundwater COPEC, because groundwater concentrations exceeded the screening criteria of 0.004 µg/L. The fate and transport of the maximum concentration of alpha-chlordane (0.0067 µg/L) was then simulated using the BIOSCREEN model. The final concentration at the ecological point of exposure was determined to be 0.0005 µg/L. This concentration is below the screening value for alpha-chlordane in groundwater; therefore, alpha-chlordane is not considered a COEC at Site 09.

Endosulfan II

At Site 09, endosulfan II was identified as a groundwater COPEC because groundwater concentrations exceeded the screening criteria of .0087 µg/L. The fate and transport of the maximum concentration of endosulfan II (0.014 µg/L) was then simulated using the BIOSCREEN model. The final concentration at the ecological point of exposure was determined to be 0.0017 µg/L. This concentration is below the screening value for endosulfan II in groundwater; therefore, Endosulfan II is not considered a COEC at Site 09.

In summary, the original COPECs at Site 09 were not determined to be COECs. Additionally, at Site 10, COPECs did not exist; therefore, COECs were not identified.

4.0 UNCERTAINTY ANALYSIS

Uncertainty plays an important role in risk-based decision-making and is therefore incorporated explicitly into the risk characterization. Identifying known sources of uncertainty is more useful than using conservative default assumptions because potential error is made more explicit in the risk management process (Suter 1993).

Three sources of uncertainty in ecological risk assessments are described in Suter (1993):

1. Mistakes in execution of assessment activities (errors such as incorrect measurements, data recording errors, and computational errors)

2. Imperfect knowledge of factors that could be known (ignorance about some aspect of the ecosystem that may be relevant such as assumptions used in dose models, practical constraints on the ability to measure everything, and lack of knowledge on toxicological effects of all chemicals on all species)

3. Inherent randomness of the world (stochasticity in physical or biological processes that may affect assumptions or actual risk such as variation in population parameters or rainfall patterns)

The complexity of ecological systems tends to increase the level of uncertainty involved in ERAs as compared to human health risk assessments. Using realistic assumptions and multiple lines of evidence is the best approach to reducing the uncertainty associated with ERA conclusions. The following sections briefly review some sources of uncertainty identified for the Sites 09 and 10 SLERA at NAVSTA TI.

4.1 SAMPLING DATA AND ANALYSIS

Sample data collected from each respective site were used to evaluate conditions of that whole site individually; all measured parameters are therefore only estimates with associated error. Inorganic and organic data from seven monitoring wells were used in the SLERA at Site 09. The sample size was adequate for characterization of groundwater concentrations at Site 09. At Site 10, the 2002 data from the two newer wells (10-MW02 and 10-MW03) provided a "snapshot" of conditions in the aquifer underlying Site 10. Monitoring well 10-MW03 was sampled for VOCs, SVOCs, metals, total petroleum hydrocarbons (TPH), and pesticides/PCBs. Monitoring well 10-MW02 was only sampled for pesticides and PCBs. Because Site 10 is a small site and sampling locations were biased near a suspected release, data from the two monitoring wells were considered sufficient to characterize groundwater conditions at the site. Both monitoring wells 10-MW02 and 10-MW03 were only sampled once in 2002.

Data were validated and determined to be of high usability; data computations and summary tables were double-checked. With the exception of elevated detection limits for some organic

chemicals, data quality, as identified and defined in the quality control summary report (Appendix E), was not considered a source of uncertainty.

The risk assessment was based on analytical data presented in the RI. The uncertainties associated with the data were identified the risk assessment.

4.2 ANALYTE DETECTION LIMITS GREATER THAN SCREENING CRITERIA

Several pesticides, PCBs, semivolatile organic compounds, and mercury samples at Sites 09 and 10 were identified as below the method detection limit; however, the detection limits for these analytes exceed the ecological aquatic criteria. The fate and transport modeling was conducted for both sites to address the uncertainty associated with the nondetected analytes for which the reported detection limits are above screening criteria.

The reported nondetectable results for individual analytes in this evaluation were replaced by the one half detection limits (Table J-6). Using the results of the chemical fate and transport modeling at Site 09 and 10, the maximum concentrations of the nondetected analytes were predicted at the ecological point of exposure, which is defined as the inland edge of the tidal mixing zone. Table J-6 lists (1) the reported detection limits for chemicals analyzed, (2) DAFs developed as part of fate and transport modeling (see Appendix H), and (3) comparisons of predicted concentrations versus screening criteria.

Based on the fate and transport evaluation of the nondetected analytes whose reported detection limits exceed screening criteria, only toxaphene at both Site 09 and 10 has predicted concentrations in groundwater at the ecological point of exposure still below the detection limits but above the screening criteria. Toxaphene tends strongly to sorb to aquifer materials, however, and its mobility is low. Moreover, the predicted theoretically possible concentrations of this chemical cannot be detected at the ecological point of exposure with available laboratory analytical methods.

In summary, the uncertainty associated with the nondetected analytes for which the reported detection limits are above screening criteria does not appear to be significant.

4.3 SCREENING VALUES

As discussed in Section 2.2.2, groundwater screening criteria used to identify COPECs and determine level of risk to aquatic receptors include multiple sources of uncertainty. Although these values were based on numerous studies, they include taxa not relevant to site receptors and only represent an estimate of real effects. Effects on aquatic receptors at the sites may be underestimated or overestimated based on this approach; however, this is currently the best method available for preliminary screening of chemical levels. These types of screening values were not available for all chemicals detected in groundwater at Sites 09 and 10 at NAVSTA TI; some chemicals could not be adequately evaluated given current knowledge. Most of the

screening values employed were based on single contaminant scenarios; the effect of multiple chemical stressors operating synergistically or antagonistically was not incorporated into this level of screening.

Screening values are based on total bulk concentrations and do not address uncertainty associated with chemical speciation (some forms are more harmful than others) or the bioavailability of chemicals. Bulk chemistry results from the site likely overestimate the bioavailable fraction. Nevertheless, the lack of screening values for chemicals in groundwater is source of uncertainty in the assessment of risk to aquatic receptors offshore of NAVSTA TI.

5.0 RISK CHARACTERIZATION SUMMARY AND RISK ASSESSMENT CONCLUSIONS

This SLERA evaluated detected chemicals in groundwater at Sites 09 and 10, NAVSTA TI, and the potential risk to aquatic receptors associated with chemical groundwater migration to the offshore surface waters of the San Francisco Bay. Despite the sources of uncertainty described in Section 4.0, adequate information was available to evaluate the potential risk to receptors from groundwater chemicals migrating offshore from Sites 09 and 10. The risk characterization summaries for each of these assessment endpoints are discussed in the following sections, along with the SLERA conclusions and risk management recommendations.

5.1 RISK CHARACTERIZATION SUMMARY FOR BENTHIC INVERTEBRATES AND AQUATIC BIOTA

For aquatic receptors offshore of Site 09 at NAVSTA TI, three chemicals were originally identified as COPECs (nickel, alpha-chlordane, and endosulfan II). After simulating the fate and transport of these chemicals to the ecological point of exposure at Site 09, however, the specific groundwater chemical concentrations decreased to levels well within the limits of the respective screening criteria (see Section 3.1). Thus, no COECs were identified at either Sites 09 or 10.

5.2 RISK ASSESSMENT CONCLUSION AND RISK MANAGEMENT RECOMMENDATIONS

The purpose of the SLERA is to identify potential exposure pathways and compare ecological exposure point concentrations to established screening values. The SLERA consists of two steps: (1) problem formulation and (2) exposure estimate and risk calculation. Upon completion of steps 1 and 2, if the site passes the SLERA, it is considered to pose acceptable ecological risk, and no further work is required. If the site fails the SLERA because of the presence of complete exposure pathways and unacceptable or uncertain risk, the site must either be further evaluated in a Tier II (baseline) ERA, which corresponds to step 3 of the EPA (1997) and Navy (1999) ERA processes, or undergo an interim cleanup action.

In conclusion, chemical migration in groundwater from Sites 09 and 10 does not pose an unacceptable risk to benthic invertebrates or other aquatic biota offshore of NAVSTA TI.

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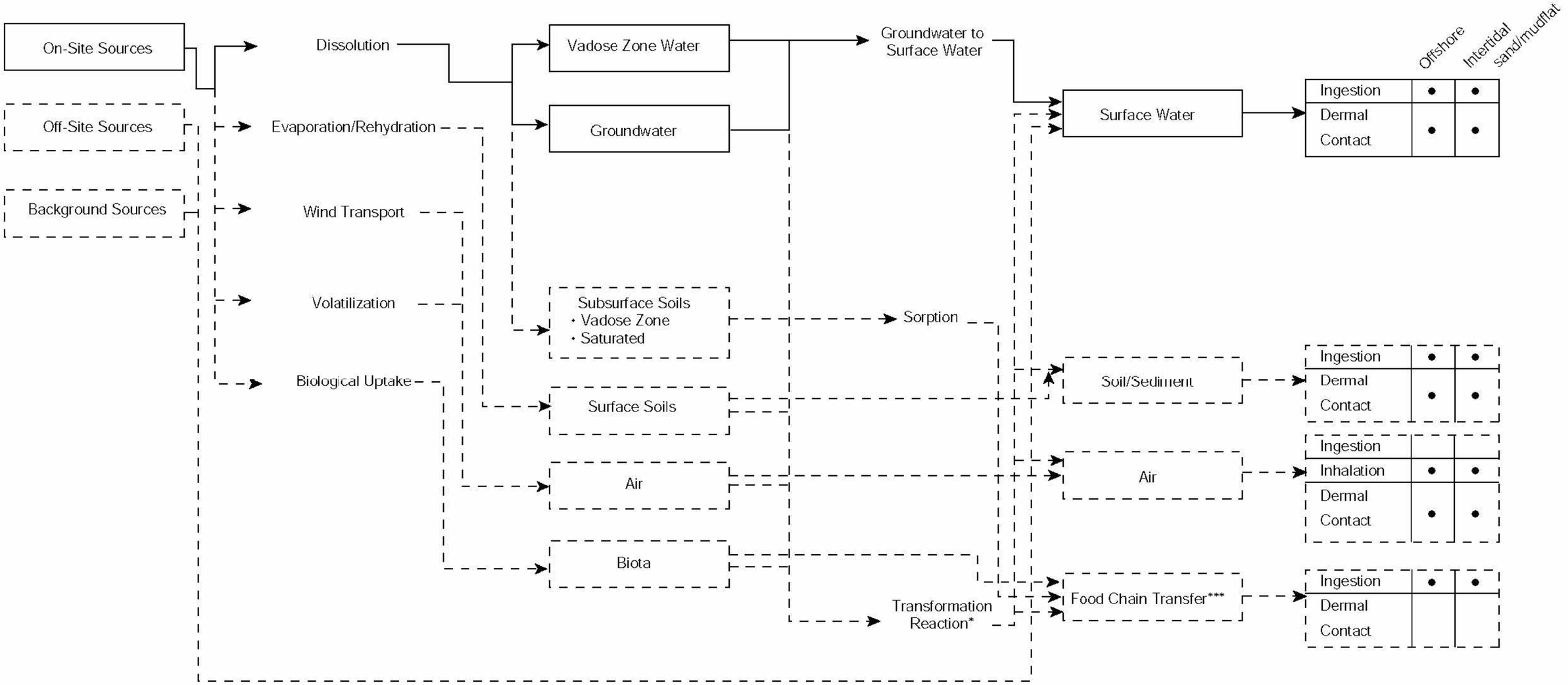
FIGURES

PRIMARY SOURCES (Original Source to Site)	PRIMARY RELEASE MECHANISM (Initial Release)	SECONDARY SOURCES (Receiving Media)	SECONDARY RELEASE MECHANISM	EXPOSURE PATHWAY** (Receptor Contact)	EXPOSURE ROUTE (Biota)



LEGEND

* Transformation reactions may also occur as a primary release mechanism

** Additional interaction may occur between each of these pathways that may not be shown

*** Includes detritivores and consumers

——— Major Pathway (evaluated)

– – – – Minor Pathway (not evaluated)

Note:
Surface water = a receiving water body such as the San Francisco Bay.

Naval Station Treasure Island
U.S. Navy Southwest Division NAVFAC, San Diego

FIGURE J-1
ECOLOGICAL
CONCEPTUAL SITE MODEL
SITES 9 AND 10

TABLES

TABLE J-1: GROUNDWATER SCREENING CRITERIA
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Analyte Monitored Under Naval Station Treasure Island Groundwater Program	Pseudonym	San Francisco Bay Basin Plan[a] (µg/L)		California Toxics Rule Criteria for Enclosed Bays and Estuaries[e] (µg/L)								National Recommended Water Quality Criteria[k] (µg/L)					National Ambient Water Quality Criteria (AWQC) for Protection of Saltwater Aquatic Life[i] (µg/L)						Other Criteria (footnotes indicate source) (µg/L)		Selected Screening Criteria** (µg/L)
				Chronic[g]		Acute[g]			Instantaneous Maximum			Saltwater Aquatic Life					Lowest Observed Effect Level (LOEL)								
		Concentration	Footnotes	Concentration	Footnotes	Concentration	20% of	Concentration[f]	Footnotes	Concentration	10% of	Concentration[f]	Footnotes	Chronic[g] Concentration	Chronic[g] Footnotes	Acute[g] Concentration	Acute[g] 20% of	Acute[g] Concentration[f]	Acute[g] Footnotes	Chronic[h] Concentration	Chronic[h] Footnotes	Acute[i] Concentration	Acute[i] 20% of	Acute[i] Concentration[f]	Acute[i] Footnotes	Other[j] Concentration	Other[j] Footnotes	Other	Footnotes	
1,1,1-Trichloroethane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	31,200	6,240	--	--	--	--	--	6,240
1,1,2,2-Tetrachloroethane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9,020	1,804	--	--	--	--	--	1804
1,1-Dichloroethene	1,1-Dichloroethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	224,000	44800	(27)	--	--	--	--	44,800
1,2,4,5-Tetrachlorobenzene		--	--	--	--	--	--	--	--	--	--	--	--					--	--	250	50	(22)	50	(22.23)	--	--	50
1,2,4-Trichlorobenzene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	129	(22)	160	--	(22)	--	--	--	129
1,2-Dichlorobenzene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	129	(22)	1,970	--	(24)	--	--	--	129
1,2-Dichloroethane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	113,000	22,600	--	--	--	--	22,600
1,2-Dichloroethene (total)	1,2-Dichloroethene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	224,000	44,800	(27)	--	--	--	44,800
1,2-Dichloropropane	Propylene dichloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,040	(28)	10,300	--	(28)			--	3,040
1,3-Dichlorobenzene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	129	(22)	1,970	--	(24)			--	129
1,3-Dichloropropene (total)		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	790	158	(29)	--	--	--	158
1,4-Dichlorobenzene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	129	(22)	1,970	--	(24)	--	--	--	129
2,4-Dinitrophenol		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	230	46	(88)	150	(38,88)		46
2,4-Dinitrotoluene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	590	118	(53)	370	(53, 82)	--	118
2,6-Dinitrotoluene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	590	118	(53)	370	(53, 82)	--	118
2-Chloronaphthalene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.5	1.5	(48)	--	--	--	1.5
2-Nitrophenol	Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4,850	970	(88)	--	--	--	970
4,4'-DDD	2,4-DDD; DDD	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.6	0.72	--	--	--	--	.72
4,4'-DDE	2,4-DDE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14	2.8	--	--	--	--	2.8
4,4'-DDT		--	--	0.001	(114)	0.13	--	--	--	--	--	--	--	0.001	G,aa,ii	0.13	--	G,ii	--	--	--	--	--	--	--	--	.001
4,6-Dinitro-2-methylphenol	4,6-Dinitro-o-cresol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4,850	970	(88)	--	--	--	970
4-Amino-2,6-dinitrotoluene	Dinitrotoluenes; 4-Methyl-3,5-dinitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	590	118	--	370	(82)	--	118
4-Nitrophenol		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4,850	970	(88)	--	--	--	970
Acenaphthene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	710	--	970	--	--	500	(38)	--	710
Acenaphthylene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	60
Aldrin		--	--	--	--	--	--	--	1.3	--	II	--	--	--	--	1.3	0.26	G	--	--	--	--	--	--	--	--	.26
Alpha-chlordane	Chlordane	--	--	0.004	(114)	--	--	--	0.09	--	--	0.004	G,aa,o	0.09	--	G,o	--	--	--	--	--	--	--	--	--	--	.004
Anthracene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	60
Aroclor 1016	Polychlorinated biphenyls (PCBs)	--	--	0.03	rr	--	--	--	--	--	--	0.03	N,aa	--	--	--	--	--	--	--	10	--	--	--	--	--	.03
Aroclor 1221	Polychlorinated biphenyls (PCBs)	--	--	0.03	rr	--	--	--	--	--	--	0.03	N,aa	--	--	--	--	--	--	--	10	--	--	--	--	--	.03
Aroclor 1232	Polychlorinated biphenyls (PCBs)	--	--	0.03	rr	--	--	--	--	--	--	0.03	N,aa	--	--	--	--	--	--	--	10	--	--	--	--	--	.03
Aroclor 1242	Polychlorinated biphenyls (PCBs)	--	--	0.03	rr	--	--	--	--	--	--	0.03	N,aa	--	--	--	--	--	--	--	10	--	--	--	--	--	.03
Aroclor 1248	Polychlorinated biphenyls (PCBs)	--	--	0.03	rr	--	--	--	--	--	--	0.03	N,aa	--	--	--	--	--	--	--	10	--	--	--	--	--	.03
Aroclor 1254	Polychlorinated biphenyls (PCBs)	--	--	0.03	rr	--	--	--	--	--	--	0.03	N,aa	--	--	--	--	--	--	--	10	--	--	--	--	--	.03
Aroclor 1260	Polychlorinated biphenyls (PCBs)	--	--	0.03	rr	--	--	--	--	--	--	0.03	N,aa	--	--	--	--	--	--	--	10	--	--	--	--	--	.03
Arsenic		36	b	36	mm, oo	69	--	mm, oo	--	--	--	36	A,D,bb	69	--	A,D,bb	--	--	--	--	2,319	--	(95)	13	(6)	--	36
Atrazine		--	--	--	--	--	--	--	--	--	--	11	r,(68)	310	--	r,(68)	--	--	--	--	--	--	--	--	--	--	11
Benzene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5,100	--	--	700	--	--	700
Benzo(a)anthracene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	60
Benzo(a)pyrene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	60
Benzo(b)fluoranthene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	60
Benzo(g,h,i)perylene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	60
Benzo(k)fluoranthene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	60
Bromochloromethane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,400	(20)	12,000	--	(20)	11,500	(20, 83)	--	6,400
Bromodichloromethane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,400	(20)	12,000	--	(20)	11,500	(20, 83)	--	6,400
Bromoform		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,400	(20)	12,000	--	(20)	11,500	(20, 83)	--	6,400
Bromomethane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,400	(20)	12,000	--	(20)	11,500	(20, 83)	--	6,400
Butylbenzylphthalate	n-Butyl benzyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,944	588.8	(45)	3.4	(38, 45)	--	588.8
Cadmium		9.3	b	9.3	(1, 142)	42	--	(1, 142)	--	--	--	8.8	D,bb,gg	40	--	D,bb,gg	--	--	--	--	--	--	--	--	--	--	8.8
Carbon tetrachloride		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,400	(20)	50,000	--	--	11,500	(20, 82)	--	6,400
Chlordane				0.004	(114)	--	--	--	0.09	0.009	--	0.004	G,aa	0.09	0.009	G	--	--	--	--	--	--	--	--	--	--	--	.004
Chlorobenzene	Monochlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	129	(22)	160	--	(22)	--	--	--	129
Chloroform		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,400	(20)	12,000	--	(20)	11,500	(20, 82)	--	6,400
Chloromethane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,400	(20)	12,000	--	(20)	11,500	(20, 82)	--	6,400
Chromium (total)		50 (VI)	b,o	50 (VI)	o	1100 (VI)	--	--	--	--	--	50 (VI)	D,bb,o	1100 (VI)	--	D,bb,o	--	--	--	--	--	--	--	--	--	--	50

TABLE J-1: GROUNDWATER SCREENING CRITERIA
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Analyte Monitored Under Naval Station Treasure Island Groundwater Program	Pseudonym	San Francisco Bay Basin Plan[a] (µg/L)		California Toxics Rule Criteria for Enclosed Bays and Estuaries[e] (µg/L)								National Recommended Water Quality Criteria[k] (µg/L) Saltwater Aquatic Life					National Ambient Water Quality Criteria (AWQC) for Protection of Saltwater Aquatic Life[i] (µg/L) Lowest Observed Effect Level (LOEL)						Other Criteria (footnotes indicate source) (µg/L)		Selected Screening Criteria** (µg/L)
				Chronic[g]		Acute[g]			Instantaneous Maximum			Chronic[g]		Acute[g]			Chronic[h]		Acute[i]			Other[j]			
		Concentration	Footnotes	Concentration	Footnotes	Concentration	20% of	Concentration[f] Footnotes	Concentration	10% of	Concentration[f] Footnotes	Concentration	Footnotes	Concentration	20% of	Concentration[f] Footnotes	Concentration	Footnotes	Concentration	20% of	Concentration[f] Footnotes	Concentration	Footnotes	Other	Footnotes	
Chrysene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	--	60
Cis-1,2-dichloroethene	Cis-1,2-dichloroethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	224,000	44,800	(27)	--	--	--	--	44,800
Copper		4.9	c	3.1	nn, oo	4.8	--	oo	--	--	--	3.1	D,cc,ff	4.8	--	D,cc,ff	--	--	--	--	--	--	--	--	--	3.1
Cyanide		5	c	1	pp	1	--	pp	--	--	--	1	Q,bb	1	--	Q,bb	--	--	--	--	--	--	--			1
Dibenz(a,h)anthracene	1,2:5,6-Dibenzanthracene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	--	60
Dibromochloromethane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,400	(20)	12,000	--	(20)	11,500	(20, 83)	--	--	6,400
Dieldrin		--	--	0.0019	(114), II	--	--	--	0.71	--	II	0.0019	G,aa	0.71	.142	G	--	--	--	--	--	--	--	--	--	.142
Diethylphthalate		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,944	588.8	(45)	3.4	(38, 45)	--	--	588.8
Dimethylphthalate		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,944	--	(45)	3.4	(38, 45)	--	--	3.4
Di-n-butylphthalate	Dibutyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,944	588.8	(45)	3.4	(38, 45)	--	--	588.8
Di-n-octylphthalate	Bis-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,944	588.8	(45)	3.4	(38, 45)	--	--	588.8
Endosulfan I	Endosulfan (alpha)	--	--	0.0087	II	--	--	--	0.034	--	(115), II	0.0087	G,Y,o	0.034	--	G,Y,o	--	--	--	--	--	--	--	--	--	0.0087
Endosulfan II	Endosulfan (beta)	--	--	0.0087	II	--	--	--	0.034	--	(115), II	0.0087	G,Y,o	0.034	--	G,Y,o	--	--	--	--	--	--	--	--	--	0.0087
Endrin		--	--	0.0023	(114), II	--	--	--	0.037	--	II	0.0023	G,aa	0.037	--	G	--	--	--	--	--	--	--	--	--	0.0023
Ethylbenzene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	430	86	--	--	--	--	--	86
Fluoranthene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16	--	40	--	--	--	--	--	--	16
Fluorene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	--	60
Gamma-BHC (lindane)	Gamma-Benzene hexachloride	--	--	--	--	--	--	--	0.16	--	II	--	--	0.16	0.032	G	--	--	--	--	--	--	--	--	--	.032
Gamma-chlordane	Chlordane	--	--	0.004	(114)	--	--	--	0.09	--	--	0.004	G,aa,o	0.09	--	G,o	--	--	--	--	--	--	--	--	--	.004
Heptachlor		--	--	0.0036	(114)	II	--	--	0.053	--	II	0.0036	G,aa	0.053	--	G	--	--	--	--	--	--	--	--	--	.0036
Heptachlor epoxide		--	--	0.0036	(114)	II		--	0.053	--	II	0.0036	G,V,aa	0.053	--	G,V	--	--	--	--	--	--	--	--	--	.0036
Hexachlorobenzene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	129	(22)	160	--	(22)	--	--	--	--	129
Hexachlorobutadiene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	32	6.4	--	--	--	--	--	6.4
Hexachlorocyclopentadiene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.0	1.4	--	--	--	--	--	1.4
Hexachloroethane		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	940	188	--	--	--	--	--	188
Indeno(1,2,3-cd)pyrene	Ideno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	--	60
Isophorone		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12,900	2,580	--	--	--	--	--	2,580
Lead		5.6	b	8.1	(1, 142), m	210	--	(1, 142), m	--	--	--	8.1	D,bb	210	--	D,bb	--	--	--	--	--	--	--	--	--	5.6
Mercury	Mercury, inorganic	0.025	b	--	--	--	--	--	--	--	--	0.94	D,ee,hh	1.8	--	D,ee,hh	--	--	--	--	--	--	--	--	--	0.025
Methoxychlor		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	(51),f	0.003
Methyl-tert-butyl-ether	butylether	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8,000	p	8,000
Methylene chloride	Dichloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,400	(20)	12,000	--	(20)	11,500	(20, 82)	--	--	6,400
Mirex		--	--	--	--	--	--	--	--	--	--	0.001	F	--	--	--	--	--	--	--	--	--	--	--	--	0.001
Naphthalene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,350	470	--	--	--	--	--	470
Nickel		8.3	b	8.2	(2, 142), oo	74	--	(1, 142), oo	--	--	--	8.2	D,bb	74	--	D,bb	--	--	--	--	--	--	--	--	--	8.2
Nitrobenzene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,680	1,336	--	--	--	--	--	1,336
N-Nitroso-di-n-propylamine	propylamine	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,300,000	660,000	(56)	--	--	--	--	660,000
N-nitrosodiphenylamine		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,300,000	660,000	(56)	--	--	--	--	660,000
Pentachlorophenol		--	--	7.9	--	13	--	--	--	--	--	7.9	bb	13	--	bb	--	--	--	--	--	--	--	--	--	7.9
Phenanthrene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	--	60
Phenol		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5,800	1,160	--	--	--	--	--	1,160
Pyrene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300	60	(52)	--	--	--	--	60
Selenium		--	--	71	(1, 142)	290	--	(1, 142)	--	--	--	71	D,bb,dd	290	--	D,bb,dd	--	--	--	--	--	--	--	--	--	71
Silver		2.3	d	--	--	1.9	0.38	(1, 142)	--	--	--	--	--	1.9	0.38	D,G	--	--	--	--	--	--	--	--	--	0.38
Sulfide	Sulfide-Hydrogen Sulfide	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.2	(51),f	0.2
Tetrachloroethene	Tetrachloroethylene (PCE)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	450	--	10,200	--	--	--	--	--	--	450
Thallium		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,130	426	--	--	--	--	--	426
Toluene		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5,000	--	6,300	--	--	--	--	--	--	5,000
Toxaphene		--	--	0.0002	--	0.21	--	--	--	--	--	0.0002	aa	0.21	--	--	--	--	--	--	--	--	--	--	--	0.0002
TPH-Diesel	Diesel range organics; Diesel Fuel; Diesel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,400	q	1,400
TPH-Gasoline	Gasoline range organics; Gasoline	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,400	q	1,400
TPH-Motor Oil	Motor oil; motor oil range organics	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,400	q	1,400
trans-1,2-Dichloroethene	trans-1,2-Dichloroethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	224,000	44,800	(27)	--	--	--	--	44,800
Trichloroethene	Trichloroethylene (TCE)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,000	400	--	--	--	--	--	400
Zinc		58	c	81	mm, oo	90	--	oo	--	--	--	81	D,bb	90	--	D,bb	--	--	--	--	--	--	--	--	--	81

TABLE J-1: GROUNDWATER SCREENING CRITERIA (Continued)

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Notes: **Values shaded are those selected as screening criteria at Naval Station Treasure Island.**
Footnotes and references are detailed below.
-- No criterion available

Footnotes:

a California Environmental Protection Agency, Regional Water Quality Control Board, San Francisco Bay Area Region (RWQCB). 1995. "San Francisco Bay Basin Plan Water Quality Control Plan." June 21. Table 3-3 Water Quality Objectives for Toxic Pollutants for Surface Water With Salinities Greater Than 5 Parts Per Billion.

b From RWQCB "Basin Plan" 4-Day Average (Chronic)

c From RWQCB "Basin Plan" 24-Hour and 1-Hour Average (Acute)

d From RWQCB "Basin Plan" Instantaneous Maximum

e From "Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California" (CTR) (EPA 2000) and "Water Quality Control Plan, San Francisco Bay Basin Region" (RWQCB 1995). The most appropriate criteria were used.

f Criterion made more suitably protective by means of standard convention of lowering acute values by 80 percent and instantaneous values by 90 percent to make them more appropriate for use under chronic exposure scenarios.

g An acute criterion (EPA identified as Criteria Maximum Concentration [CMC]) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The chronic concentration (EPA identified as Criterion Continuous Concentration [CCC]) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. The CMC and CCC are just two if the six parts of an aquatic life criterion; the other four parts are the acute averaging period, chronic averaging period, acute frequency of allowed exceedence, and chronic frequency of allowed exceedence. Because 304(a) aquatic life criteria are national guidance, they are intended to be protective of the vast majority of the aquatic communities in the United States (EPA 2002a).

h EPA National "AWQC Lowest Observed Effect Level (Chronic)" (RWQCB 2000)

i EPA National "AWQC Lowest Observed Effect Level (Acute)" (RWQCB 2000)

j EPA National "AWQC Lowest Observed Effect Level (Other)" (RWQCB 2000)

k From "National Recommended Water Quality Criteria: 2002" (EPA 2002a) and "Revision of National Recommended Water Quality Criteria." (EPA 2002b), unless otherwise noted.

m In instances where criteria from "Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California" (EPA 2000) refer to the "Water Quality Control Plan, San Francisco Bay Basin Region" (RWQCB 1995), RWQCB 1995 criteria were used. The RWQCB 1995 criteria are distinguished by an "m" in the footnote column.

o Detailed application of this toxicity criterion may require the review and/or summation of analyte isomer, congener, or speciation results, as applicable. Please see applicable regulatory agency source document for additional detail.

p RWQCB 1998

q Tetra Tech EM Inc. 1999

r RWQCB 2000

s The methodology used for selecting applicable toxicity screening values for use in the Naval Station Treasure Island facilitywide groundwater monitoring program is identified in the introduction to this appendix.

The following lettered footnotes are derived from EPA "National Recommended Water Quality Criteria: 2002" (EPA 2002a), Table 1 - Priority Toxic Pollutants:

A This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. In the arsenic criteria document (EAP 440/5-84-033, January 1985), Species Mean Acute Values (SMAVs) are given for both arsenic (III) and arsenic (V) for five species, and the ratios of the SMAVs for each species range from 0.6 to 1.7. Chronic values are available for both arsenic (III) and arsenic (V) for one species; for the fathead minnow, the chronic value for arsenic (V) is 0.29 times the chronic value for arsenic (III). No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive.

D Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The recommended water quality criteria value was calculated by using the previous 304(a) aquatic life criteria expressed in terms of total recoverable metal, and mulitplying it by a conversion factor (CF). The term "Conversion Factor" (CF) represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable fraction in the water column to a criterion expressed as the dissolved fraction in the water column. (Conversion Factors for saltwater CCCs are currently unavailable. Conversion factors derived for saltwater CMCs have been used for both saltwater CMCs and CCCs). See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria," October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available from the Water Resource center, USEPA, 401 M St., SW, mail code RC4100, Washington DC 20460; and 40CFR 131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble - Conversion Factors for Dissolved Metals.

F The deviation of this value is presented in the Red Book (EPA 440/9-76-023, July 1976).

G The criterion is based on 304(a) aquatic life criterion issued in 1980 and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), Dichlorodiphenyltrichloroethane (DDT) (EPA 440/5-80-38), Endosulfan (EPA 440/5-80-046), Endrin (EPA 440/5-80-047), Heptachlor (EPA 440/5-80-052), Hexachlorocyclohexane (EPA 440/5-80-054), Silver (EPA 440/5-80-071), The minimum data requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. For example, a "CMC" derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.

N This criterion applies to total polychlorinated biphenyls (e.g. the sum of all congener or all isomer or homolog or Aroclor analyses.)

Q This recommended water quality criterion is expressed as mg free cyanide (as CN)/L.

V This value was derived from data for heptachlor, and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide.

Y This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

aa This criterion is based on a 304(a) aquatic life criterion issued in 1980 or 1986, and was issued in one of the following documents : Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endrin (EPA 4405-80-047), Heptachlor (EPA 440/5-80-052), Polychlorinated biphenyls (EPA 440/5-80-068), Toxaphene (EPA 440/5-86-006). This CCC is currently based on the Final Residue Value (FRV) procedure. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60 FR 15393-15399, March 23, 1995), the EPA no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria. Therefore, the EPA anticipates that future revisions of this CCC will not be based on FRV procedure.

bb This water quality criterion is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227046, January 1985) and was issued in one of the following criteria documents: Arsenic (EPA 440/5-84-033), Cadmium (EPA 882-R-01-001), Chromium (EPA 440/5-84-029), Copper (EPA 440/5-84-031), Cyanide (EPA 440/5-84-028), Lead (EPA 440/5-84-027), Nickel (EPA 440/5-86-004), Pentachlorophenol (EPA 440/5-86-009), Toxaphene (EPA 440/5-86-006), Zinc (EPA 440/5-87-003).

cc When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic, and use of Water-Effect Rations might be appropriate.

dd The selenium criteria document (EPA 440/5-87-006, September 1987) provides that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fish in the field, the status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 mg/L in salt water because the saltwater CCC does not take into account uptake via the food chain.

ee This recommended water quality criterion was derived on page 43 of the mercury document (EPA 440/5-84-026, January1985). The saltwater CCC of 0.025 µg/L given on page 23 of the criteria document is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60 FR 15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

ff This recommended water quality criterion was derived in Ambient Water Quality Criteria Saltwater Copper Addendum (draft, April 14, 1995) and was promulgated in the Interim final National Toxics Rule (60 FR 22228-222237, May 4, 1995).

gg EPA is actively working on this criterion, and so this recommended water quality criterion may change substantially in the near future.

hh This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury, and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.

ii This criterion applies to DDT and its metabolites (that is, the total concentration of DDT and its metabolites should not exceed this value.)

TABLE J-1: GROUNDWATER SCREENING CRITERIA (Continued)
Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

The following lettered footnotes are derived from EPA "Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California" (EPA 2000).

ll This criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/ Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endosulfan (EPA 440/5-80-046), Endrin (EPA 440/5-80-047), Heptochlor (440/5-80-025), Hexachlorocyclohexane (EPA 440/5/80/054), Silver (EPA 440/5-80-071) (originally footnote g in CTR).

mm Criteria for these metals are expressed as a function of the water-effect ratio (WER) (originally footnote I in the CTR).

nn No criterion for protection of human health from consumption of aquatic organisms (excluding water) was presented in the 1980 criteria document or in the 1986 Quality Criteria for Water. Nevertheless, sufficient information was presented in the 1980 document to allow a calculation of a criterion, even though the results of such calculations were not shown in the document.

oo These freshwater and saltwater criteria for metals are expressed in terms of dissolved fraction of the metal in the water column. Criterion values were calculated by using EPA's Clean Water Act 304(a) guidance values (described in the total recoverable fraction) and then applying the conversion factors in 131.36(b)() and (2).

pp These criteria were promulgated for specific waters in California in the National Toxics Rule (NTR). The specific waters to which the NTR criteria apply include Waters of the State defined as bays or estuaries, including the San Francisco Bay upstream to and including Suisun Bay and the Sacramento-San Joaquin Delta. This section does not apply instead of the NTR for these criteria.

rr PCBs are a class of chemicals that include Aroclors 1242,1254,1221,1232,1248,1260, and 1016. The aquatic life criteria apply to the sum of this set of seven Aroclors.

The following lettered footnotes are derived from EPA "National Recommended Water Quality Criteria: 2002" (EPA 2002b), Table 2 - Non-Priority Pollutants:

AA This human health criterion is the same as originally published in the Red Book, which predates the 1980 methodology and did not utilize the fish ingestion BCF approach. This same criterion value is now published in the Gold Book.

The following numbered footnotes are derived from "A Compilation of Water Quality Goals" (RWQCB 2000). These footnotes directly correlate with the source document.

1 Expressed as dissolved
2 Expressed as total recoverable
6 Pentavalent arsenic [As(V)] effects on plants.
20 For halomethanes
22 For chlorinated benzenes
23 Toxicity to a fish species exposed for 7.5 days
24 For dichlorobenzenes
27 For dichloroethylenes
28 For dichloropropanes
29 For dichloropropenes
38 Toxicity to algae occurs
45 For phthalate esters
48 For chlorinated naphthalenes
51 From U.S. Environmental Protection Agency, *Quality Criteria for Water* (1976) "The Red Book."
52 For polycyclic aromatic hydrocarbons
53 For dinitrotoluenes
56 For nitrosamines
68 Draft/tentative/provisional; applies only to second value if more than one value is listed.
82 A decrease in the number of algal cells occurs.
83 Adverse effects on a fish species exposed for 168 days.
88 For nitrophenols
95 For the pentavalent form
114 Developed as 24-hour average using 1980 EPA guidelines, but applied as 4-day average in the National Toxics Rule and/or Proposed California Toxics Rule.
115 Criterion most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.
116 Applies separately to Aroclors 1242, 1254, 1221, 1232, 1248, 1260, and 1016; based on carcinogenicity at 1-in-a-million risk level.
142 Criteria do not apply to waters subject to water quality objectives in Tables III-2A and III-2B of the San Francisco Bay Regional Water Quality Control Board's 1986 Basin Plan.
143 These criteria were promulgated for specific California waters in the National Toxics Rule.

References:

Regional Water Quality Control Board (RWQCB). 1995. "San Francisco Bay Basin Plan." San Francisco Bay Region. June 21.
RWQCB. 1998. "Recommended Interim Water Quality Objectives (or Aquatic Life Criteria) for Methyl Tertiary-Butyl Ether (MTBE)." San Francisco Bay Region. October 1.
RWQCB. 2000. "A Compilation of Water Quality Goals." Prepared by Jon B. Marshack, Central Valley Region. August.
RWQCB. 2001. "Water Quality Goals Update." Central Valley Region. April 18.
Tetra Tech EM Inc. 1999. “Draft Remedial Investigation Report, Site 12 Operable Unit, Naval Station Treasure Island, San Francisco, California.” June 1.
U.S. Environmental Protection Agency (EPA). 2000. "Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California." 40 CFR Part 131, RIN 2040-AC44. May 18.
EPA. 2002a. "National Recommended Water Quality Criteria: 2002." EPA-822-R-02-047. November.
EPA. 2002b. "Revision of National Recommended Water Quality Criteria." FRL-OW-7431-3. December 27.

TABLE J-2: TIERED APPROACH TO THE DETERMINATION OF GROUNDWATER SCREENING CRITERION

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Criteria Tier	San Francisco Bay Region Water Quality Control Plan (Basin Plan)	California Toxic Rule	National Ambient Water Quality Criteria
First Tier Chronic Criteria	Chronic criteria	Chronic criteria	Recommended chronic criteria Chronic lowest-observable-effect level
Second Tier Acute Criteria (lowered by 80%)	Acute criteria	Acute criteria	Acute recommended criteria Acute lowest-observable-effect-level criteria
Third Tier Instantaneous Criteria (lowered by 90%)	Instantaneous criteria	Instantaneous maximum criteria	Instantaneous recommended criteria
Fourth Tier Other Lowest-Observable-Effects-Level Criteria	NA	NA	Other lowest-observable-effect-level criteria
Fifth Tier Other Criteria: Methyl-tert-butyl ether (Regional Water Quality Control Board 1998) and total petroleum hydrocarbons (Tetra Tech EM Inc. 1999)			

TABLE J-3: CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Site	Area of Concern, Exceedance Well	Sample Identification	Sample Date	Analyte Exceeding Criteria	Max Concentration (µg/L)	Data Qualifier	Unit	Screening Criteria (µg/L)	Exceedance?
09	09-MW05	30209GW05001	31-Oct-02	Alpha-Chlordane	0.0067	J	µg/L	0.004[a]	Yes
09	09-MW05	30209GW05001	31-Oct-02	Nickel	11.9	--	µg/L	8.2[a]	Yes
09	09-MW07	30209GW07001	04-Nov-02	Endosulfan II	0.014	--	µg/L	0.0087[a]	Yes

Note:

a EPA 2002a

-- No qualifier

TABLE J-4: DETECTED CHEMICALS WITH NO SCREENING CRITERION

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Site	Well	Sample Identification	Sample Date	Analyte	Maximum Concentration	Data Qualifier	Ambient Groundwater Chemical Concentrations at NAVSTA TI (µg/L)
09	09-MW02	30209GW02001	31-Oct-02	2-Methylnaphthalene	0.025	J	NA
09	09-MW02	30209GW02001	31-Oct-02	Molybdenum	11.4	--	6.5
09	09-MW04	30209GW04001	30-Oct-02	Antimony	2.46	--	1.7
09	09-MW05	30209GW05001	31-Oct-02	Aluminum	2040	--	27
09	09-MW05	30209GW05001	31-Oct-02	m,p-Xylenes	0.3	J	NA
09	09-MW05	30209GW05001	31-Oct-02	Vanadium	6.8	J	4.2
09	09-MW07	30209GW07001	04-Nov-02	Barium	123	--	120
09	09-MW07	30209GW07001	04-Nov-02	Cobalt	2.4	J	1.4
09	09-MW07	30209GW07001	04-Nov-02	Manganese	710	--	900
10	10-MW03	30210GW03001	30-Oct-02	Aluminum	349	--	27
10	10-MW03	30210GW03001	30-Oct-02	Antimony	0.48	J	1.7
10	10-MW03	30210GW03001	30-Oct-02	Barium	16.3	--	120
10	10-MW03	30210GW03001	30-Oct-02	Manganese	628	--	900
10	10-MW03	30210GW03001	30-Oct-02	Molybdenum	5.43	--	6.5

Notes:

-- No data qualifier
J Estimated
NA Not available
µg/L Micrograms per liter

TABLE J-5: PREDICTED CONCENTRATIONS AND DETERMINATIONS OF CHEMICALS OF ECOLOGICAL CONCERN

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Area of Concern Exceedance Well	Analyte Exceeding Screening Criteria	Distance to Exposure Point (Inland Edge of the Tidal Mixing Zone)	Highest Measured Concentration at Source (µg/L)	Maximum Predicted Concentration at Exposure Point[a] (µg/L)	DAF	Screening Criteria (µg/L)		Applicable Screening Criteria Exceeded at Exposure Point?
						AWQC	Ambient	
09-MW05	Nickel	260	11.9	0.93	12.82	8.2	5.8	No
	Alpha-Chlordane	260	0.0067	0.0005	12.82	0.004	NA	No
09-MW07	Endosulfan II	185	0.014	0.0017	8.13	0.0087	NA	No

Notes:

a Contaminant concentrations are predicted using BIOSCREEN (EPA 1996) model for solute transport with no decay. The only attenuation mechanism is dispersion in the longitudinal, transverse, and vertical directions. No adsorption of contaminants to the soil matrix is assumed.

b The ambient level was set at or below the minimum reported detection limit (Tetra Tech 2001b)

c The tidal mixing zone factor (Tetra Tech 2002b) applied in place of the DAF

DAF Dilution attenuation factor (a ratio of concentration in source well to a predicted concentration at the point of exposure)
DL Detection limit
NA Not applicable
µg/L Micrograms per liter

TABLE J-6: MODELING RESULTS FOR NON-DETECTED ANALYTES WITH DETECTION LIMITS ABOVE SCREENING CRITERIA

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Sample Date	Analyte Group	Analyte	Reported Detection Limit (µg/L)	Qualifier	1/2 of Reported Detection Limit (µg/L)	Screening Criteria[a] (µg/L)	DAF	Maximum Predicted Concentration at Exposure Point (µg/L)	Exceeds the Criteria?
Site 09										
09-MW01	31-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	8.62	2.9E-03	Yes
09-MW01	31-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	8.62	3.0E-04	No
09-MW01	31-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	8.62	2.7E-04	No
09-MW01	31-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	8.62	4.0E-04	No
09-MW01	31-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	8.62	2.8E-04	No
09-MW01	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	8.62	4.9E-04	No
09-MW01	31-Oct-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	8.62	3.5E-04	No
09-MW01	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	8.62	4.4E-04	No
09-MW01	31-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	8.62	2.4E-03	No
09-MW01	31-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	8.62	3.5E-03	No
09-MW01	31-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	8.62	2.1E-03	No
09-MW01	31-Oct-02	Metals	Mercury	0.1	U	0.05	0.025	8.62	5.8E-03	No
09-MW02	31-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	11.63	2.1E-03	Yes
09-MW02	31-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	11.63	2.2E-04	No
09-MW02	31-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	11.63	2.0E-04	No
09-MW02	31-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	11.63	3.0E-04	No
09-MW02	31-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	11.63	2.1E-04	No
09-MW02	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	11.63	3.6E-04	No
09-MW02	31-Oct-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	11.63	2.6E-04	No
09-MW02	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	11.63	3.2E-04	No
09-MW02	31-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	11.63	1.8E-03	No
09-MW02	31-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	11.63	2.6E-03	No
09-MW02	31-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	11.63	1.5E-03	No

TABLE J-6: MODELING RESULTS FOR NON-DETECTED ANALYTES WITH DETECTION LIMITS ABOVE SCREENING CRITERIA

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Sample Date	Analyte Group	Analyte	Reported Detection Limit (µg/L)	Qualifier	1/2 of Reported Detection Limit (µg/L)	Screening Criteria[a] (µg/L)	DAF	Maximum Predicted Concentration at Exposure Point (µg/L)	Exceeds the Criteria?
09-MW03	31-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	9.80	2.6E-03	Yes
09-MW03	31-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	9.80	2.6E-04	No
09-MW03	31-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	9.80	2.4E-04	No
09-MW03	31-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	9.80	3.5E-04	No
09-MW03	31-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	9.80	2.5E-04	No
09-MW03	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	9.80	4.3E-04	No
09-MW03	31-Oct-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	9.80	3.1E-04	No
09-MW03	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	9.80	3.8E-04	No
09-MW03	31-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	9.80	2.1E-03	No
09-MW03	31-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	9.80	3.1E-03	No
09-MW03	31-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	9.80	1.8E-03	No
09-MW04	30-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	9.35	2.7E-03	Yes
09-MW04	30-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	9.35	2.7E-04	No
09-MW04	30-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	9.35	2.5E-04	No
09-MW04	30-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	9.35	3.7E-04	No
09-MW04	30-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	9.35	2.6E-04	No
09-MW04	30-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	9.35	4.5E-04	No
09-MW04	30-Oct-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	9.35	3.3E-04	No
09-MW04	30-Oct-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	9.35	4.0E-04	No
09-MW04	30-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	9.35	2.2E-03	No
09-MW04	30-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	9.35	3.2E-03	No
09-MW04	30-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	9.35	1.9E-03	No
09-MW05	31-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	14.71	1.7E-03	Yes
09-MW05	31-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	14.71	1.7E-04	No

TABLE J-6: MODELING RESULTS FOR NON-DETECTED ANALYTES WITH DETECTION LIMITS ABOVE SCREENING CRITERIA

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Sample Date	Analyte Group	Analyte	Reported Detection Limit (µg/L)	Qualifier	1/2 of Reported Detection Limit (µg/L)	Screening Criteria[a] (µg/L)	DAF	Maximum Predicted Concentration at Exposure Point (µg/L)	Exceeds the Criteria?
09-MW05	31-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	14.71	1.6E-04	No
09-MW05	31-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	14.71	2.3E-04	No
09-MW05	31-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	14.71	1.7E-04	No
09-MW05	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	14.71	2.9E-04	No
09-MW05	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	14.71	2.5E-04	No
09-MW05	31-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	14.71	1.4E-03	No
09-MW05	31-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	14.71	2.0E-03	No
09-MW05	31-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	14.71	1.2E-03	No
09-MW06	31-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	17.24	1.5E-03	Yes
09-MW06	31-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	17.24	1.5E-04	No
09-MW06	31-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	17.24	1.4E-04	No
09-MW06	31-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	17.24	2.0E-04	No
09-MW06	31-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	17.24	1.4E-04	No
09-MW06	31-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	17.24	2.4E-04	No
09-MW06	31-Oct-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	17.24	1.8E-04	No
09-MW06	31-Oct-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	17.24	2.2E-04	No
09-MW06	31-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	17.24	1.2E-03	No
09-MW06	31-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	17.24	1.7E-03	No
09-MW06	31-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	17.24	1.0E-03	No
09-MW07	4-Nov-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	7.87	3.2E-03	Yes
09-MW07	4-Nov-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	7.87	3.2E-04	No
09-MW07	4-Nov-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	7.87	3.0E-04	No
09-MW07	4-Nov-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	7.87	4.4E-04	No
09-MW07	4-Nov-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	7.87	3.1E-04	No

TABLE J-6: MODELING RESULTS FOR NON-DETECTED ANALYTES WITH DETECTION LIMITS ABOVE SCREENING CRITERIA

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Sample Date	Analyte Group	Analyte	Reported Detection Limit (µg/L)	Qualifier	1/2 of Reported Detection Limit (µg/L)	Screening Criteria[a] (µg/L)	DAF	Maximum Predicted Concentration at Exposure Point (µg/L)	Exceeds the Criteria?
09-MW07	4-Nov-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	7.87	5.3E-04	No
09-MW07	4-Nov-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	7.87	3.9E-04	No
09-MW07	4-Nov-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	7.87	4.8E-04	No
09-MW07	4-Nov-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	7.87	2.6E-03	No
09-MW07	4-Nov-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	7.87	3.8E-03	No
09-MW07	4-Nov-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	7.87	2.3E-03	No
Site 10										
10-MW02	30-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	3.30	7.7E-04	No
10-MW02	30-Oct-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	3.30	9.2E-04	No
10-MW02	30-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	3.30	6.2E-03	No
10-MW02	30-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	3.30	9.1E-03	No
10-MW02	30-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	3.30	5.5E-03	No
10-MW02	30-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	3.30	7.1E-04	No
10-MW02	30-Oct-02	Pesticides	Gamma-Chlordane	0.02	U	0.01	0.004	3.30	3.0E-03	No
10-MW02	30-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	3.30	7.4E-04	No
10-MW02	30-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	3.30	1.3E-03	No
10-MW02	30-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	3.30	1.0E-03	No
10-MW02	30-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	3.30	7.6E-03	Yes
10-MW03	30-Oct-02	Pesticides	4,4'-DDT	0.0051	U	0.00255	0.001	3.37	7.6E-04	No
10-MW03	30-Oct-02	Pesticides	Alpha-Chlordane	0.0061	U	0.00305	0.004	3.37	9.1E-04	No
10-MW03	30-Oct-02	PCB	Aroclor 1221	0.041	U	0.0205	0.03	3.37	6.1E-03	No
10-MW03	30-Oct-02	PCB	Aroclor 1232	0.06	U	0.03	0.03	3.37	8.9E-03	No
10-MW03	30-Oct-02	PCB	Aroclor 1242	0.036	U	0.018	0.03	3.37	5.3E-03	No
10-MW03	30-Oct-02	Pesticides	Endrin	0.0047	U	0.00235	0.0023	3.37	7.0E-04	No

TABLE J-6: MODELING RESULTS FOR NON-DETECTED ANALYTES WITH DETECTION LIMITS ABOVE SCREENING CRITERIA

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Monitoring Well	Sample Date	Analyte Group	Analyte	Reported Detection Limit (µg/L)	Qualifier	1/2 of Reported Detection Limit (µg/L)	Screening Criteria[a] (µg/L)	DAF	Maximum Predicted Concentration at Exposure Point (µg/L)	Exceeds the Criteria?
10-MW03	30-Oct-02	Pesticides	Gamma-Chlordane	0.0075	U	0.00375	0.004	3.37	1.1E-03	No
10-MW03	30-Oct-02	Pesticides	Heptachlor	0.0049	U	0.00245	0.0036	3.37	7.3E-04	No
10-MW03	30-Oct-02	Pesticides	Heptachlor Epoxide	0.0084	U	0.0042	0.0036	3.37	1.2E-03	No
10-MW03	30-Oct-02	Pesticides	Methoxychlor	0.0069	U	0.00345	0.003	3.37	1.0E-03	No
10-MW03	30-Oct-02	Pesticides	Toxaphene	0.05	U	0.025	0.0002	3.37	7.4E-03	Yes

Notes:

a See Table J-1 for details.

DAF Dilution attenuation factor
J Estimated
PCB Polychlorinated biphenyls
U Nondetected

APPENDIX K
CHEMICAL CHARACTERISTICS AND TRANSPORT MECHANISMS

TABLE K-1: CHEMICAL CHARACTERISTICS FOR PESTICIDES

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical (CAS Number)	Molecular Weight	Solubility[a] (mg/L)	Vapor Pressure[a] (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Log K_{oc} (mL/g)	Log K_{ow}
Endosulfan II (1031-07-8)	423	0.117	NA	NA	3.37	3.66
Chlordane (57-74-9)	409	0.056	1×10^{-5}	4.86×10^{-5}	5.15	6.00

Notes:

[a] at 25ºC unless otherwise noted

atm atmospheres
CAS Chemical Abstracts Service
Hg mercury
K_{oc} organic carbon partitioning coefficient
K_{ow} Octanol-water partitioning coefficient
mg,g milligrams, grams
mL, L milliliters, liters
mm millimeter
m^3 cubic meters
mol mole
NA data not available

TABLE K-2: CHEMICAL CHARACTERISTICS FOR POLYCYCLIC AROMATIC HYDROCARBONS

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Chemical (CAS Number)	Molecular Weight	Solubility[a] (mg/L)	Vapor Pressure[a] (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Log K_{oc} (mL/g)	Log K_{ow}
Benzo(a)pyrene (50-32-8)	252	3.8×10^{-3}	5.49×10^{-9}	2.4×10^{-6}	5.59	6.03
Dibenz(a,h)anthracene (53-70-3)	278	2.6×10^{-4}	1.8×10^{-10}	2×10^{-9}	6.89	7.10

Notes:

[a] at 25ºC unless otherwise noted

atm atmospheres
CAS Chemical Abstracts Service
Hg mercury
K_{oc} organic carbon partitioning coefficient
K_{ow} Octanol-water partitioning coefficient
mg,g milligrams, grams
mL, L milliliters, liters
mm millimeter
m^3 cubic meters
mol mole
NA data not available

TABLE K-3: PRIMARY FATE AND TRANSPORT MECHANISMS

Sites 09 and 10 Remedial Investigation, NAVSTA Treasure Island

Contaminants	Fate and Transport Mechanisms in Soil	Fate and Transport Mechanisms in Water	Tendancy to Bioaccumulate
Pesticides			
Chlordane	Sorption Some Volatilization Slow Biodegradation	Low Solubility	Yes
Endosulfan II	Sorption No Volatilization	Low Solubility	Yes
Semivolatile Organic Compounds			
Polycyclic Aromatic Hydrocarbons Benzo(a)pyrene Dibenz(ah)anthracene	Sorption	Low Volatilization Low Solubility	Yes
Metals			
Nickel	Strong Sorption		Yes

APPENDIX L
PETROLEUM SCREENING LEVELS

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract Number N62474-94-D-7609
Contract Task Order 0257

Prepared for

DEPARTMENT OF THE NAVY
Southwest Division
Naval Facilities Engineering Command
San Diego, California

FINAL
CORRECTIVE ACTION PLAN, SITES 06, 14/22, 15, AND 25 NAVAL STATION TREASURE ISLAND SAN FRANCISCO, CALIFORNIA

DS.0257.16185

June 28, 2002

Prepared by

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GROUNDWATER TPH SCREENING CRITERIA
CORRECTIVE ACTION PLAN
NAVAL STATION TREASURE ISLAND

Analyte	Ambient (Metals)		Ecological Screening Evaluation	Human Health Screening Evaluation		Criteria Selected For Screening Evaluation	
				RBSL (HH)	Human Health Consumption Criteria		
	95th Percentile	Maximum	NAVSTA	Not Drinking Water		Ecological	Human Health
Petroleum Hydrocarbon (µg/L)							
Diesel Range Organics	--	--	1,400	NA	--	1,400	--
Motor Oil Range Organics	--	--	1,400	NA	--	1,400	--
Gasoline Range Organics	--	--	1,400	NA	--	1,400	--

SHALLOW SOIL TPH SCREENING CRITERIA
CORRECTIVE ACTION PLAN
NAVAL STATION TREASURE ISLAND

Analyte	Ambient (Metals)		Industrial Screening Criteria				Criteria Selected For Screening Evaluation
	95th Percentile	Maximum	PRG	RBSL	Presidio	RWQCB	
Petroleum Hydrocarbon (mg/kg)							
Diesel Range Organics	--	--	--	500	6,700	1,500	6,700
Motor Oil Range Organics	--	--	--	1,000	9,400	1,850	9,400
Gasoline Range Organics	--	--	--	400	5,900	315	5,900

Notes:
Taken from the Final Corrective Action Plan, Sites 06, 14/22, 15, and 25, Naval Station Treasure Island (June 28, 2002)
TPH – Total Petroleum Hydrocarbons
RBSL – Risk Based Screening Levels
HH – Human Health
PRG – Preliminary Remediation Goal
RWQCB – Regional Water Quality Control Board
µg/L – micrograms per liter
mg/kg – milligrams per kilogram
NAVSTA – Naval Station Treasure Island
-- Not determined

A-E CERCLA/RCRA/UST Contract Number N68711-03-D-5104
Contract Task Order 0024

RESPONSE TO COMMENTS DRAFT REMEDIAL INVESTIGATION REPORT, INSTALLATION RESTORATION SITES 09 AND 10

Naval Station Treasure Island, San Francisco, California

May 3, 2004

Prepared for

NAVFAC Naval Facilities Engineering Command SOUTHWEST DIVISION

DEPARTMENT OF THE NAVY
Naval Facilities Engineering Command
Southwest Division
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A DEPARTMENT OF TOXIC SUBSTANCES CONTROL AMBIENT METALS LETTER AND REGIONAL WATER QUALITY CONTROL BUREAU GROUNDWATER CONCURRENCE LETTER

B BIOSCREEN MODEL INPUT AND OUTPUT SCREENS

C CONCEPTUAL SITE MODEL

RESPONSES TO DEPARTMENT OF TOXIC SUBSTANCES CONTROL COMMENTS ON THE DRAFT REMEDIAL INVESTIGATION REPORT, INSTALLATION RESTORATION SITES 09 AND 10 NAVAL STATION TREASURE ISLAND, CALIFORNIA

This document presents the U.S. Department of the Navy's (Navy) responses to comments from the Department of Toxic Substances Control (DTSC), Brian Davis, Ph.D., Staff Toxicologist, Human and Ecological Risk Division on the "Draft Remedial Investigation for Sites 09 and 10, Naval Station Treasure Island, California," dated July 2003. The Navy received the comments addressed below on November 12, 2003.

GENERAL COMMENTS

1. Comment: BACKGROUND FOR INORGANIC CHEMICALS.

A. Appendix F presents the evaluation of background for inorganic chemicals in soil. Appendix G presents the evaluation of background for inorganic chemicals in ground water. Please state whether the regulatory agencies have agreed to these evaluations. If there is agreement, please document this. Please state the applicability of each evaluation. That is, state whether the background estimates for soil are applicable to all of Treasure Island or to a subset of sites. State the same for the background estimates for ground water.

B. Whenever background estimates are applied at Treasure Island, the text should note that the island soil is composed of fill dredged from the Bay. Neither the island nor its soils are "naturally occurring". Risk managers should be cognizant of this fact.

Response: As discussed during the March 8, 2004 BCT meeting, the draft and final ambient concentration of metals in groundwater report, finalized in March 2001, was reviewed by the regulatory agencies (Tetra Tech 2001). Comments were received on the draft report, and addressed in the document prior to the Navy's completion of the final report. A letter from Dr. James Polisini of DTSC, dated August 3, 2001, stated that the majority of comments contained in a previous memorandum from DTSC have been addressed, but DTSC will evaluate and discuss the ambient concentrations used in any site specific ecological risk assessment. The letter from Dr. Polisini is included in Attachment A.

The estimation of background and ambient metals concentrations in soils study was completed in June 1996 (PRC 1996). In November 1995, the U.S. Environmental Protection Agency (EPA) and DTSC recommended that background and ambient metal concentrations at Naval Station

(NAVSTA) Treasure Island (TI) be evaluated using the estimation procedures that were applied at other Navy installations. The technical memorandum completed in 1996, and used to complete the RI risk assessments, incorporated these regulatory comments and estimation procedures. No additional documentation from the regulatory agencies was located.

The soil background assessment is applicable to all of TI, since the entire island (including Sites 09 and10) was built upon fill dredged from the bay. Although ambient concentrations of metals in groundwater vary over space and time, statistical analysis and derivation of the 95th percentile value allow for the use of this ambient groundwater assessment for simple screening purposes applicable to all of TI.

The following changes will be made to remove "naturally occurring" from Appendix I (underlined text denotes new text and deleted text is crossed out).

Section 5.3, Page I-20 – "In addition, the base-wide ambient study to document ~~naturally occurring~~ inorganic compounds was conducted with low-flow sampling techniques."

Section 6.1, page I-23 – "If an inorganic chemical is considered ~~naturally occurring (~~present at ambient levels~~)~~, a further step in risk characterization includes a statistical analysis of whether the analyte is present below the ambient levels documented at NAVSTA TI (PRC Environmental Management, Inc. [PRC] 1996). In these cases, ambient concentrations could have been excluded as a COPC. In the case of Sites 09 and 10, however, all inorganic compounds with ambient data sets from NAVSTA TI media (with the single exception of silver at Site 09) were present below their ~~residential PRGs and thus, no ambient screen was included in the HHRA~~ ambient levels (see Attachment I-3). ~~Arsenic was reported to have maxima above the 10 mg/kg background value and the cancer-based residential Region IX PRG of 0.39 mg/kg but below the noncancer EPA Region IX PRG of 22 mg/kg. For this reason, a more detailed analysis of arsenic was conducted (see Section 6.1.3.1).~~ Although iron may be <u>present at ambient levels</u> ~~naturally occurring~~, no ambient data set was available to conduct such an analysis."

2. Comment: CHEMICALS OF POTENTIAL CONCERN

A. Sections 7.1.2.1 and 11.1.2 state that two criteria were used in selecting chemicals of potential concern, based on U.S. EPA and Navy guidance. These two criteria are comparison to Preliminary Remediation Goals (PRGs) and essentiality as a nutrient. The

guidance cited in Section 7.1.2.1 (U.S. EPA, 1989) is in fact not consistent with the first criterion. The Risk Assessment Guidance for Superfund (U.S. EPA, 1989) has explicit guidance for the selection of chemicals of potential concern. This explicit guidance does not include the use of screening criteria. As was discussed in the May 19, 2003 conference call, DTSC also excludes the use of screening criteria in the selection of chemicals of potential concern. DTSC does allow the elimination of inorganic chemicals of potential concern by comparison to background concentrations, but not by comparison to PRGs.

Section 6.1 of Appendix I lists the same two criteria as does Section 7.1.2.1, but adds a third criterion – elimination of inorganic chemicals based on comparison to ambient levels. Section 6.1 states that this criterion was not used "…*no ambient screen was included in the HHRA.*"

Recent guidance (U.S. EPA, 2002) proposes retention of inorganic chemicals even if they are within background concentrations and removal of chemicals of potential concern based on comparison to screening criteria. DTSC has not adopted this method. See also General Comment 10 and Specific Comment 11.

B. Section 7.1.2.1 states that arsenic was eliminated as a chemical of potential concern, based on comparison to ambient levels and comparison to the noncancer residential PRG. Section 11.1.1.4 shows that the first comparison was of exposure point concentrations to ambient concentrations. Comparison to ambient concentrations is inconsistent with the two proposed criteria of Section 7.1.2.1. Use of exposure point concentrations for comparison to ambient concentrations is inconsistent with any guidance. Comparison to the noncancer PRG is inconsistent with any guidance. Arsenic is a well-established carcinogen and must be treated as such (General Comment 3). This was also discussed in the May 19, 2003 conference call.

Response: As discussed during the March 8, 2004 BCT meeting, 2004 DTSC and Navy guidance has been adopted to formally exclude inorganic contaminants below ambient. All inorganics (including arsenic) are below ambient at Site 10, and all inorganics (except silver) are below ambient at Site 09. As discussed and agreed to at the BCT meeting, the "total risk" screening assessment has been revised (see response to human health risk assessment (HHRA) Comment (2) to address the concern with use of preliminary remediation goals (PRG) to screen contaminants of potential concern (COPC). Because use of screening criteria (for example, PRGs) to select COPCs is consistent with (1) Navy tiered guidance (Navy 2001);

(2) EPA RAGS Part A (EPA 1989); and (3) EPA RAGS Part D Table 2 sample tables (EPA 2001), the Navy presents "incremental risk" using the PRG screen against maxima as well as the "total risk" evaluation without a PRG screen. A new Attachment I-3 will be included with Appendix I in the revised draft HHRA for Sites 09 and 10.

3. Comment: ARSENIC

A. Four of 23 soil samples in the 0 to 2 feet below ground surface range of Site 9 had arsenic levels exceeding the ambient level (Section 6.1.3.1 of Appendix I). Therefore, arsenic is a chemical of potential concern for both 0 to 2 feet below ground surface and 0 to 8 feet below ground surface. The discussion in Sections 6.1.3.1, 7.1.2.1, and 11.1.1.4 of Appendix I provide useful information, but it does not alter this fact. Please evaluate arsenic as a carcinogen and noncarcinogen for all exposure scenarios at Site 9.

B. Two of 28 soil samples in the 0 to 8 feet below ground surface range of Site 10 had arsenic levels exceeding the ambient level (Section 6.1.3.1 of Appendix I). Therefore, arsenic is a chemical of potential concern for the 0 to 8 feet below ground surface soil data. Please evaluate arsenic as a carcinogen and noncarcinogen for Site 10.

C. The uncertainty section (Section 11.3.3 of Appendix I) states that "*The uncertainties associated with the ingestion of inorganic arsenic are such that estimated cancer-based PRGs for arsenic are overly conservative and could be modified upwards as much as an order-of-magnitude relative to risk estimates associated with most other carcinogens.*" Whether the PRGs are "*overly conservative*" is a value judgment, not supported scientifically by Section 11.3.3. The suggestion that it would be appropriate to increase the PRGs by a factor of ten "*relative to risk estimates associated with most other carcinogens.*" is completely speculative. Please revise this discussion for accuracy.

Response: As discussed during the March 8, 2004 BCT meeting, arsenic is statistically below ambient fill concentrations, as demonstrated in a new Attachment I-3 to the HHRA. As requested at the BCT meeting, the arsenic outliers are now discussed in relation to their spatial distribution and propensity to present a hot spot in a hypothetical residential yard in Section 7.3. The following text was added to Section 7.3.

"Arsenic was not considered significantly greater than background at either Site 09 or 10, as demonstrated in Attachment I-3 in the revised draft HHRA. However, there were three samples (09-SB10, 09-SB12, and 09-SB18) collected from the surface soil (0.5 to 2 feet below ground surface

{bgs}) at Site 09 that were considered outliers, as their concentrations were greater than the 80 percent lower confidence limit on the 95th percentile (10 milligrams per kilogram {mg/kg}) for fill material dredged from the Bay. The three outlier concentrations of arsenic (15.4, 16.9, and 17.7 mg/kg) may be considered part of the natural variability of a dataset, as would concentrations of arsenic that are lower than the 10 mg/kg concentration in fill material (that is, the minimum detected concentration for arsenic at Site 09 is 2.5 mg/kg). Also, these three locations with elevated arsenic are not in the same vicinity (see Figure 2-3 in the RI Report); soil sample 09-SB12 would be located (even in a residential yard) remotely from the other two samples in a different exposure area. Therefore, a future resident or commercial/industrial worker would likely not be exposed to these three highest concentrations of arsenic over time. This is especially true for residents who have small residential properties and are not regularly exposed to surface soil on another residential property. These three arsenic locations are not considered to be significant outliers that warrant a hotspot evaluation (in part because of their failure to exceed the noncancer EPA Region IX PRG), but were considered part of the natural variation of a dataset. Further, the entire dataset was statistically below ambient fill concentrations in a two-population test (see Attachment I-3)."

Because of the above reasons, (and DTSC and Navy guidance concerning chemicals below ambient), arsenic is not a soil COPC for either site at either depth, and no forward risks for arsenic have been included following Navy (2004) guidance. The arsenic uncertainty discussion from Section 11.3.3 will be subsequently removed.

4. Comment: LEAD

A. Table I-3 summarizes the exposure point concentrations for lead in Site 9 and Site 10 soils. Please add a footnote to explain how the lead data from boring 09-SB03 were treated (see General Comment 6B).

B. No exposure point concentrations for lead in Site 10 soils were given in Table I-3 because the maximum concentrations were below the U.S. EPA Region IX PRG of 400 mg/kg. This PRG has been applied as a ceiling remediation goal at Treasure Island. This results in an exposure concentration less than 400 mg/kg for the area under remediation. DTSC does not accept comparison to any PRGs for baseline risk assessments. For the residential scenario, the DTSC lead model should be used for both Sites 9 and Site 10.

Response: Lead data for boring 09-SB03 were averaged with those for boring 09-SB05 as requested by DTSC during the HHRA conference call in May 2003. The RAGS Part D Table 2 and Table 3 series were corrected to show maximum based on these average data. Exposure point concentrations (EPC) for lead in soil were added to the Sites 09 and 10 Table 3 series.

As discussed during the March 8, 2004 BCT meeting, the EPCs are 2 to 20 times below even the California-modified residential lead PRG of 150 mg/kg, which is back-calculated to be protective based on the LEADSPREAD model. Since no inputs other than soil would be changed from the default (that is, the contribution from airborne sources of lead would be the default, and the contribution from a water ingestion pathway would be that which is presented by the municipal water supply, conservatively set to the full action level for lead of 15 micrograms per litter {ug/L}), LEADSPREAD results cannot show an unacceptable child resident blood lead level based on these EPCs. Therefore, the DTSC agreed at the March 8, 2004 BCT meeting that, based on these site-specific conditions, LEADSPREAD is not required.

The following text will be inserted into Section 8.5: "Surface and subsurface soil EPCs that are less the California-modified residential lead PRG of 150 mg/kg are not further evaluated because the PRGs are considered protective of residential exposure. Even if a surface or subsurface soil EPC that is less than the California-modified residential lead PRG of 150 mg/kg was modeled, the LEADSPREAD model would not indicate potential deleterious effects because the only site-specific input that changed (that is, soil EPC) was reduced; because the soil EPC is reduced, the potential deleterious effects are likewise reduced. Therefore, surface and subsurface soil EPCs that are less the California-modified residential lead PRG of 150 mg/kg are not further evaluated."

5. Comment: HEXAVALENT CHROMIUM

Since activities which may have used hexavalent chromium (painting; metal work) took place at both Sites 9 and 10, this carcinogenic chemical must be addressed. Section 8.4 of Appendix I mentions in passing that "*…hexavalent chromium was analyzed in soils but found to be nondetect in all samples.*" Section 11.3.1 of Appendix I, in discussing uncertainty, states that three samples from each site were analyzed for hexavalent chromium. Please discuss hexavalent chromium in the body of the risk assessment, including potential sources, location and depth of the samples analyzed for hexavalent chromium, any ground water analysis for hexavalent chromium, and a rationale for why this effort was sufficient.

Response: As presented at the March 8, 2004, BCT meeting, the following are analytical results reported from the August 1995 sampling events.

Sample Location	Cr 6+ Result (mg/kg)	Total Cr Result (mg/kg)	Depth Interval (ft bgs)	Date Sampled
Site 09				
09-HP001	0.05 UJ	38.6	1.25-1.75	8/3/95
09-HP002	0.05 UJ	25.1	6.5-7	8/3/95
09-HP003	0.05 UJ	23.2	5.5-6	8/3/95
Site 10				
07/10-HP012	0.05 U	52.4	7.25-7.75	8/10/95
07/10-HP013	0.05 U	36.1	3.25-3.75	8/10/95
07/10-HP013	0.05 U	33.8	7.25-7.75	8/10/95

The locations and depths for hexavalent chromium samples were selected as described in the draft final RI report (TtEMI 1997). The inclusion of hexavalent chromium analysis is described in Section 8.4.2 and 10.4.2. The Navy agreed to analyze for chromium VI at selected sites during the phase I investigation.

Based on the small site sizes, three samples from each site are sufficient to demonstrate the absence of hexavalent chromium. Painting and metalwork occurred at each site, and the type (color and vintage) of paint and nature of the metalwork are important in concluding that a hexavalent chromium source actually exists. The data indicate an absence of release. Furthermore, as discussed at the BCT meeting, the chromium results were evaluated as "total chromium" (which is assumed to be one-to-six hexavalent to trivalent chromium), rather than the less conservative 100 percent trivalent chromium assumption. Given the statistical test provided in a new Attachment I-3 to the RI, total chromium at Sites 09 and 10 is below the ambient fill concentrations of total chromium. This indicates little likelihood of any incremental Navy impact to what was preexisting when Site 09 and 10 went into operation. The following insert will be added to the main body of the HHRA in Section 8.4, after the bullet list:

"Hexavalent chromium was evaluated at Sites 09 and 10 because historical operations (for example, painting and metal work) are associated with the use of hexavalent chromium. Therefore, six soil samples were collected from Sites 09 and 10 (three at each site) and analyzed for trivalent and hexavalent chromium. Although trivalent chromium was detected in all six samples, hexavalent chromium was not detected in any of the samples (see table below). The reporting limits for the nondetect

hexavalent chromium samples (0.05 mg/kg) were significantly less than the EPA Region IX PRG for residential exposure (30 mg/kg) so reporting limits were determined to be adequate for this evaluation. Although hexavalent chromium was not detected at either Site 09 or 10, chromium was evaluated as "total chromium" in the HHRA. Total chromium is assumed to be comprised of a one-to-six ratio of hexavalent chromium, the most toxic form of chromium, to trivalent chromium, a less toxic form of chromium. The effect of using total chromium in the HHRA was conservative (that is, overly protective) but had no net effect on the results of the risk assessment as chromium concentrations were determined to be significantly less than background. Chromium was not included in the forward risk characterization." The table of hexavalent chromium results listed in this response to comments above will then be placed into Section 8.4.

6. Comment: REPLACEMENT DATA.

A. In several instances, resampling in the same location failed to confirm an elevated concentration of some chemical. This has led (Section 5.2 of Appendix I) to the proposal of discarding the original high value in favor of the lower resampled value ("*Replacement Data*"). This cannot be done without strong justification. It appears that no consideration is given to the possibility that both results are correct. Heterogeneity in the soil or imprecision in identifying the location provide plausible alternative explanations to the findings.

B. Section 5.2.1 of Appendix I discusses the report of 974 J mg of lead per kg of soil in 09-SB03. The text states that this result was anomalous and that all results from the boring were J-qualified. For these reasons the location was resampled. The maximum concentration of lead in the new boring was 76 mg/kg. Nonetheless, "*…regulators have not been comfortable with the complete replacement of 09-SB03 lead results with the 09-SB05 results.*" It is unclear what was done in the risk assessment. Section 5.2.1 of Appendix I references Section 5.1.1.5, but little information about these lead samples is found there. Section 9.4.1 of Appendix I discusses the exposure point concentration for Site 9, but doesn't state which value (09-SB03 or the resampling boring) was used. Please provide this information.

C. Section 6.1.3.1 of Appendix I dismisses the arsenic concentration from 09-SB03 because the resampling boring (09-SB05) had a lower concentration. As noted in General Comment 6A, the text states that all results from 09-SB03 were J-qualified. It is generally unacceptable to dismiss data based on finding lower concentrations in later sampling of the same location. In this case, all of the results

from 09-SB03 do seem questionable. Therefore, we accept the proposed substitution.

D. Section 5.2.2 of Appendix I dismisses the finding of polycyclic aromatic hydrocarbons in 10-SB03 at Site 10. The basis is that resampling boring (10-SB24) had lower detection limits and state-of-the-art laboratory analysis. Since fluoranthene, phenanthrene, and pyrene were measured at one mg/kg and five other polycyclic aromatic hydrocarbons had estimated concentrations in 10-SB03, the detection limits do not provide an adequate explanation. Since there is no reason to suspect that these results are artifactual, they should be included in the risk assessment for Site 10.

E. Section 5.2.2 of Appendix I dismisses the finding of chlordane in 07/10-HP06 at Site 10. The basis is that resampling boring (10-SB19) had lower detection limits. Since alpha-chlordane was measured at 21 mg/kg and gamma-chlordane was measured at 1.9 mg/kg in 07/10-HP06, the detection limits do not appear to have been a limitation. Since there is no reason to suspect that these results are artifactual, they should be included in the risk assessment for Site 10.

Response: As discussed at the March 8, 2004, BCT meeting, (1) lead was averaged, as requested by DTSC, as detailed in the response to Comment 4 above, (2) arsenic does not require a response since DTSC concurred with the replacement, and arsenic is below ambient, (3) polycyclic aromatic hydrocarbon (PAH) reductions for the light-end PAHs are indicative of 10 years of biodegradation and the change for the high molecular weight PAHs would not change the HHRA significantly, and (4) the results seven years later for chlordane follow the half-life of chlordane in soil. None of the data sets or EPCs in the HHRA were changed since the agencies agree that this additional information would suffice.

Below is the PAH data table presented in a PowerPoint slide shown at the BCT meeting:

Chemical	1992 Concentration (mg/kg) 6 to 6.5 feet bgs 10-SB03	2002 Concentration (mg/kg) 6 to 7.5 feet bgs 10-SB24	Notes
Benzo(a)anthracene	0.38 J	ND (0.014 U)	Reduction reflects 10 years of biodegradation and improved analytical techniques. Samples were collected from the exact same location. These three detects from 1992 are for noncarcinogens; hence, there is no effect on the cancer risk estimate and the kidney target organ hazard index(HI) isn't near 1.
Benzo(a)pyrene	0.3 J	ND (0.022 U)	
Benzo(b)fluoranthene	0.27 J	ND (0.02 U)	
Benzo(k)fluoranthene	0.27 J	ND (0.022 U)	
Chrysene	0.52 J	0.015 J	
Fluoranthene	1	ND (0.043 UJ)	
Phenanthrene	1	ND (0.012 U)	
Pyrene	1	0.05 J	
Benzo(ghi)perylene	ND (0.8 U)	0.024 J	

Ten years of degradation have occurred, and although there were detections of the smaller, noncarcinogenic PAHs in 1992, the carcinogenic actors Benzo(a)anthracene (BAA), Benzo(a)pyrene (BAP), Benzo(b)fluoranthene (BBF), and Benzo(k)fluoranthene (BKF) were not detected in the sample collected in 2002. Further, Benzo(ghi)perylene (BGHIP) was detected in 2002, whereas it was not in 1992. Therefore, one data set over the other would have a negligible impact on the final risk characterization. It was agreed at the BCT meeting that the PAH EPCs would not be revised to include 1992 results from this boring.

Below is the table of data for chlordane previously presented in a PowerPoint slide shown at the BCT meeting:

1995 Concentration (mg/kg) 3 to 4 ft bgs 07/10-HP06	2002 Concentration (mg/kg) 2.5 to 5ft bgs 10-SB19
2.1	0.0018J
1.9	0.0026J

- As noted at the BCT meeting, use of the historic data would not be reflective of present-day conditions as it disregards seven years of biodegradation. Use of historic data would not change the risk characterization significantly. The residential PRG for chlordane is 1.6 mg/kg.

- The half-life of chlordane in soil is 350 days (OSU 1994). Therefore, the reduced concentrations measured in 2002 reflect seven years of biodegradation. (For example, 2.1/2 = 1.1 after 1 year; 1.1/2 = 0.56 after 2 years; 0.56/2 = 0.28 after 3 years; 0.28/2 = 0.14 after 4 years; 0.14/2 = 0.07 after 5 years; 0.07/2 = 0.035 after 6 years; 0.018 after 7 years).

- The DTSC commented that this half-life for chlordane in soil seemed low; however, it was confirmed as accurate and still current in the reference cited (OSU 1994) at the BCT meeting.

The uncertainty associated with use of replacement data will be clarified in the uncertainty evaluation (Section 11.1.1). However, as agreed at the BCT meeting, no changes were made to the text with regard to replacement data for arsenic, PAHs, or chlordane; the averaging approach for lead is discussed in the response to Geomatrix Comment for Appendix I, Comment 1.

7. Comment: GROUND WATER

A. Section 4.3.1.4 states that the Region Water Quality Control Board's 1996 Pilot Beneficial Use Designation Project report "*…recommended that the basin plan be revised to no longer designate groundwater at NAVSTA TI as a potential municipal or domestic water supply but retain designation for potential agricultural, process, and industrial supply.*" Section 5.3.1 of Appendix I reiterates this "*recommendation*". Please state whether the recommendation was implemented and if it was, where that is documented.

B. It is surprising to learn (Section 7.1.1.2; Section 5.3.2 of Appendix I) that the control well for Site 10, 14MW03, "*was destroyed some time between 1998 and 2002*" and MW01, "*was also destroyed or buried some time between 1998 and 2002*". We defer to the Regional Water Quality Control Board to determine the implications of this uncertain record keeping.

C. Ground water data for Site 10 are limited to one round of sampling from two monitoring wells. The sample from one of the two wells (MW02) was analyzed only for pesticides and polychlorinated biphenyls (Section 5.3.2 of Appendix I). These data are described (Section 5.3.2 of Appendix I; Section 2.2.1 of Appendix J) as "*…a conservative snapshot of representative conditions in the aquifer underlying Site 10.*" This is not "*conservative*". It may or may not be representative. Please revise the text to give a more accurate description, including an acknowledgment that the data are highly uncertain.

Response: Please also see response to Geomatrix HHRA general comment 21. At the March 8, 2004 BCT meeting, there was concurrence that the data would not change the findings of the HHRAs because the pathways for human health exposure are incomplete at NAVSTA TI Sites 09 and 10. The RWQCB has officially provided Navy with concurrence that the shallow groundwater at TI is not a current or potential source of drinking water. A copy of the concurrence letter is included in Attachment A. In the

uncertainty analysis, the following text will be added to indicate that the exposure assessment was based on a limited data set, accompanied by the following changes (underlined text denotes new text and deleted text is crossed out).

From Section 5.3.2, Page I-22: "The 2002 data from the two newer wells (10-MW02 and 10-MW03) provide a ~~conservative~~ "snapshot" of likely ~~representative~~ conditions in the aquifer underlying Site 10. Unfortunately, although monitoring well 10-MW03 was sampled for VOCs, SVOCs, metals, total petroleum hydrocarbons (TPH), and pesticides/PCBs, MW02 was only sampled for the pesticide/PCB analytical suite in 2002; both monitoring wells 10-MW02 and 10-MW03 have only been sampled once, in 2002. Despite this, data from the two monitoring wells are considered sufficient to characterize Site 10 groundwater conditions for three reasons. First, Site 10 is a small site; second, sampling locations are biased, near a suspected release; and third, groundwater underlying Site 10 is not a drinking water source."

In Section 11.1.1, Site Characterization Data: "The risk assessment is based on analytical data presented in the RI. Each of the strengths and weaknesses associated with the data is then carried through to the risk assessment. The very small (0.25-acre and 0.75-acre, respectively) sizes of Sites 09 and 10 and the appropriate , if somewhat limited (for example, groundwater data collected for Site 10)**,** ~~relatively large~~ number of samples collected from site media indicate that sufficient data are available to detect human health risks. As with any small data set, uncertainty is associated with the data and subsequently characterized risks. Since groundwater is not a source of drinking water and VOCs were not detected for intrusion to overlying indoor air, the impact of the small data set on protection of human health is negligible, as no complete human health exposure pathways exist."

8. Comment: EXPOSURE ASSESSMENT

A. Section 7.1.3 engages in hyperbole in describing reasonable maximum exposure (RME). Example 1: "*An RME scenario represents a plausible worst-case situation (not likely to occur)…*" RME is intended to capture the upper end of the distribution of potential exposures. It is not intended to describe worst case exposure or to describe exposures that are unlikely to occur. It is intended to assess exposure which can plausibly occur. Example 2: "*It is assumed that in evaluating an RME scenario, potential health impacts to extremely sensitive individuals (emphasis added) within a particular receptor population will be adequately addressed.*" Standard risk assessments, including this one, clearly do not address extremely sensitive individuals. Perhaps the most significant, though

by no means the only, overlooked group of highly sensitive individuals is pica children. Pica behavior is common among children and can result in daily consumption of gram quantities of soil and other contaminated material. Standard risk assessments never address pica children. Risk assessments, including this one (e.g. Table I-4.1), assume that no child ingests more than 200 mg of soil per day. Please revise Section 7.1.3.

B. Sections 10.1.2 and 10.2.2 of Appendix I also use hyperbole. "*This predicted value is, however, based on conservative assumptions (for example, ingesting 200 mg-soil/day for 350 days per year) that are unlikely to occur and may be considered within the range of accepted values.*" As discussed above, the reasonable maximum exposure is not intended to describe exposure conditions that are unlikely to occur. It is intended to be plausible, upper end exposure. With respect to soil ingestion, not only do some children ingest the assumed amounts of soil, but pica children may ingest greater amounts of soil than is assumed. Please revise Sections 10.1.2 and 10.2.2 of Appendix I.

C. During the May 19, 2003 conference call, it was stated that the reuse plan specified residential use. Please check the accuracy of the statement that the Naval Station, Treasure Island, reuse plan specifies retail, restaurant, and community facilities, but not residential use for Site 10 (Section 7.1.2.2 of Appendix I and elsewhere).

D. Soil data were divided by depth in 0 to 2 feet below ground surface and 0 to 8 feet below ground surface. The former set was only used to evaluate the industrial scenario (Section 7.3.1 of Appendix I). The latter set was used to evaluate all three (industrial, construction, and residential) exposure scenarios (Section 7.3.2 of Appendix I). DTSC requires that consideration be given to exposure of residents to deeper soils, because swimming pools are common in California and excavation for swimming pools often results in deeper soils being distributed on the surface of the yard. However, this does not occur in all yards. It may be unlikely on Treasure Island because of the shallow ground water. It was our understanding from the May 19, 2003 conference call that the residential scenario would be evaluated for both sets of soil data. If the Navy wishes to evaluate the residential scenario at only one soil depth, it should be the one with the higher contaminant concentrations.

E. DTSC (2000) guidance assumes that dermal exposure is greater in California because of the moderate climate. Please use 5700 cm^2 for Exposed Skin Surface Area for both the industrial worker and the

construction worker (Section 7.4.2.3 of Appendix I; Table I-4.1). Please use 2900 cm^2 for Exposed Skin Surface Area for the residential child. Please use 0.8 mg/ cm^2 for the Soil Adherence Factor for the construction worker.

Response: Revisions will be made to the HHRA text as requested in Comments 8A and 8B. However, regarding Comment 8B, the Navy disagrees that 200 milligrams per day (mg/day) is not protective of a pica child, noting specifically that DTSC's LEADSPREAD model recommends a default of 200 mg/day for the "pica child resident" ingestion rate.

In response to Comment 8A, the following sentences have been edited in Section 7.1.2 (underlined text denotes new text and deleted text is crossed out): "An RME scenario represents a plausible upper-end exposure ~~worst-case~~ situation ~~(not likely to occur)~~ while a CTE scenario represents an average or more typical exposure. ~~believed most likely to occur~~. ~~It is assumed that in e~~ Evaluating an RME scenario will address potential health impacts to most of an exposed population, absent those extremely sensitive individuals within a particular receptor population. ~~will be adequately addressed.~~

In response to Comment 8B , the following sentences have been removed from Sections 10.1.2 and 10.2.2 of Appendix I: "This predicted value is, however, based on conservative assumptions (for example, ingesting 200 mg-soil/day for 350 days per year) that are unlikely to occur and may be considered within the range of accepted values."

In response to Comment 8C, please see also response to City HHRA comment 4 regarding residential reuse. As noted in the response to the City, and as discussed during the BCT meeting, the "residential" reuse in the 1996 plan has short-term housing for filmmakers and other intermittent workers.

Regarding Comment 8D, as discussed at the BCT meeting, the Navy has already evaluated the soil interval that presents the greatest risk to a future resident. Benzo(a)pyrene was the only COPC in surface soil for Site 09 and dibenz(a,h)anthracene was the only COPC in surface soil for Site 10 (see Table I-3.1). However, benzo(a)pyrene and dibenz(a,h)anthracene, in addition to iron, were COPCs in subsurface soil at Sites 09 and 10 (see Table I-3.2). Also, EPCs for subsurface soil were equal to or greater than EPCs in surface soil. The total risk screening for residents and commercial/industrial worker exposure using Region IX PRGs predicts similar or slightly increased risks from exposure to subsurface soil versus surface soil. Because all inorganics (except silver at Site 09) were not significantly greater than background, the evaluation would primarily be an evaluation of organics in soil, which have higher concentrations in subsurface soil than in surface soil (see RAGS D Table 2 series and total risk screens). Based on these factors,

evaluating residential exposure to subsurface soils is considered the most protective of the two exposure scenarios. Thus, as discussed at the BCT meeting, residential exposure to surface soils would show lower risks and thus will not be incorporated into Appendix I.

Regarding Comment 8E, as discussed at the BCT meeting, the incorporation of the requested minor changes to the exposure factors for the Sites 09 and 10 HHRAs would not significantly affect the findings. These exposure parameters will be incorporated into future NAVSTA TI HHRAs, as requested and agreed to during the March 8, 2004 BCT meeting.

Specifically, DTSC concurred that a 100 square centimeter (cm^2) change to the child resident will not affect risk findings for the Site 09 and 10 residential HHRA, so risks for the resident will not be recalculated.

At the BCT meeting, it was noted that the requested exposure parameter change for the commercial/industrial worker would increase dermal risk by 73 percent, but since dermal risk is only a minimal contributor to industrial risk, change to industrial risk would be insignificant. The risk conclusions would not change.

Similarly, for the construction worker, dermal risks would increase by more than 73 percent, but since dermal risk is only a minor contributor to already very low risks, the change to construction worker risks would be insignificant. No construction worker risks will be unacceptable, and risk management decisions at Sites 09 and 10 are being made with the assumption of unrestricted (including residential) land use, and will not be made solely on a construction worker risk.

For these reasons, the exposure parameters were not readjusted in the RAGS Part D Table 4s, as the level of effort required to update Tables 7 through 10 for the two worker scenarios was considerable given the fact that risk characterization would not change, and the goal for the Sites 09 and 10 RI is to obtain a no further action without an institutional control.

To demonstrate that the changes in exposure parameters will not alter the conclusions of the risk assessment, a sample calculation was completed for exposure to subsurface soil (0 to 8 feet bgs) for the commercial/industrial and construction workers at Site 09. The exposed skin surface area for the commercial/industrial and construction workers was increased to 5,700 cm^2 and the soil adherence factor was increased to 0.8 mg/cm^2 for the construction worker. As noted from the table below, carcinogenic risks for the ingestion and inhalation pathways are not altered by the change in exposure parameters. The total receptor risk for the commercial/industrial worker increased from 1.1E-6 to 1.6E-6 and the total receptor risk for the construction worker increased from 1.1E-7 to 2.3E-7; neither change in

exposure parameter would change the conclusions or risk management decisions derived from the HHRA. The risks were reported to two significant figures to facilitate checks for mathematical accuracy.

Receptor	Commercial/Industrial Worker		Construction Worker	
Pathway	Current Values	Alternative Values	Current Values	Alternative Values
Ingestion	5.8E-07	5.8E-07	7.7E-08	7.7E-08
Dermal	5.6E-07	9.7E-07	3.4E-08	1.6E-07
Inhalation	8.8E-11	8.8E-11	3.5E-12	3.5E-12
Total Receptor Risk	1.1E-06	1.6E-06	1.1E-07	2.3E-07

9. Comment: TOXICITY ASSESSMENT

A. Section 3.2.2 of Appendix I indicates that California toxicity values are used only when "*significant differences exist between the DTSC and EPA Region IX toxicity value.*" Section 8.0 states that DTSC toxicity values were used only if they were "*4 times more conservative*" than the U.S. EPA values. To be precise, neither DTSC nor U.S. EPA Region IX generates toxicity criteria. California toxicity criteria are developed by the California Office of Environmental Health Hazard Assessment (OEHHA), not DTSC. Federal toxicity criteria are developed by U.S. EPA Headquarters, not the regions. More importantly, DTSC requires that all California toxicity criteria, not a subset of criteria, be used to evaluate facilities in California. Please add the OEHHA website (www.oehha.ca.gov/risk) as a source of toxicity criteria (Section 7.1.4). Please incorporate all California toxicity criteria into all risk assessments for Naval Station, Treasure Island.

B. Section 7.1.4 states that no California toxicity criteria were available for any of the chemicals of potential concern. Section 7.1.4 states that "*No California-specific noncancer toxicity values were available for the two PAH COPCs, benzo(a)pyrene or dibenz(ah)anthracene.*" Since both of these compounds are potent carcinogens, this is indeed a curious statement. Section 8.0 does acknowledge that OEHHA provides an oral cancer slope factor of 12 $[mg/(kg \times day)]^{-1}$ and an inhalation cancer slope factor of 3.9 $[mg/(kg \times day)]^{-1}$ for benzo(a)pyrene and provides an oral cancer slope factor of 4.1 $[mg/(kg \times day)]^{-1}$ and an inhalation cancer slope factor of 4.1 $[mg/(kg \times day)]^{-1}$ for dibenz(ah)anthracene. These California toxicity criteria should be used in all risk assessments for Naval Station, Treasure Island.

C. Section 7.1.4 states that route to route extrapolation was used for organic compounds, but not for inorganic compounds. Since no dermal toxicity criteria are available, they are all derived from oral toxicity criteria for both organic and inorganic compounds (Section 8.3; Table I-5.1). Furthermore, route to route extrapolation may be appropriate for other routes of exposure with inorganic compounds. No contaminant or route of exposure should be excluded from the risk assessment based on the failure to find a toxicity criterion. The selection of appropriate toxicity criteria should be done in consultation with the DTSC toxicologist.

Response: As discussed during the March 8, 2004, BCT meeting, no dual tracking of California and EPA toxicity values is necessary, given the nature of the site-specific concentrations (and resultant low risks) at Sites 09 and 10. For the two COPCs for incremental risk (the risk drivers for residential re-use), the effective difference in the California toxicity values versus those used in the draft HHRA from EPA sources is negligible.

As discussed at the March 8, 2004 BCT meeting, the assumption that use of California toxicity values would cancel each other out at Sites 09 and 10 assumes equivalent EPCs (and equivalent doses) between the two PAHs. Therefore, further assessment was requested to ensure that use of EPA toxicity values would not impact the risk characterization in this site-specific instance. A comparison of the toxicity values and potential change are provided in the table below.

Federal (EPA) Toxicity Value	DTSC-Requested Value	Effective Change
BAP: 7.3	BAP: 12	BAP California risks would be 61% higher.
DBA: 7.3	DBA: 4.1	DBA California risks would be 56% lower.

To demonstrate that the changes in toxicity values will not alter the conclusions of the risk assessment, a sample calculation was completed for exposure to subsurface soil (0 to 8 feet bgs) for the commercial/industrial worker at Site 09. An oral cancer slope factor of 12 $[mg/(kg \times day)]^{-1}$ and an inhalation cancer slope factor of 3.9 $[mg/(kg \times day)]^{-1}$ was used for benzo(a)pyrene and an oral cancer slope factor of 4.1 $[mg/(kg \times day)]^{-1}$ and an inhalation cancer slope factor of 4.1 $[mg/(kg \times day)]^{-1}$ was used for dibenz(ah)anthracene.

The total receptor risk for the commercial/industrial worker increased from 1.1E-6 to 1.5E-6. The above tables demonstrate how a change to the toxicity criteria (using California sources) would not influence the risk

characterization significantly. Risks were reported to two significant figures to facilitate checks for mathematical accuracy.

For future assessments, DTSC has indicated California values should be used. Therefore, for other HHRAs at NAVSTA TI, dual tracking of the toxicity assessment consistent with Navy's (September 2003) guidance (issued after the draft HHRA was submitted to the agencies in July 2003) will be implemented.

The Navy disagrees with Comment 9C. Attachment I-3 demonstrates that all inorganics (other than iron, for which no background data set exists) are below ambient concentrations in fill, with the exception of silver at Site 09. Therefore, a change to the dermal toxicity assessment for inorganics would not impact the findings of the HHRA. In addition, the toxicity assessment followed EPA Region IX practice for extrapolation, as well as the recommendations of EPA dermal guidance (RAGS Part E) and Navy dermal guidance (Navy 2001). No contaminants or routes of exposure were excluded from the HHRA. The "exclusion" of some chemicals from the dermal assessment was based on EPA dermal exposure guidance for Superfund, not a failure to find toxicity criteria. The Navy's toxicologists will continue to identify toxicity values for use in future Navy HHRAs for DTSC review and comment.

10. Comment: CUMULATIVE RISKS AND HAZARDS

A. During the May 19, 2003 conference call, we stated that chemicals of potential concern cannot be eliminated based on screening criteria (see General Comment 2). The document has attempted to address this by calculating risk estimates and hazard indices for all chemicals which were excluded from the main risk assessment. This was done by comparison to PRGs (Section 9.3). The following table compares the results for the residential scenario. Risks and hazards for additional chemicals were not presented for the industrial scenario or construction scenario. In the table, we have used "Risk Drivers" to designate the results from the baseline risk assessment in the document and "Other Chemicals" to designate the results from the comparisons to PRGs of those chemicals eliminated in the selection of chemicals of potential concern.

	SITE 9		SITE 10	
	Cancer risk	Hazard index	Cancer risk	Hazard index
"Risk Drivers"	3.8×10^{-6}	0.5	4.3×10^{-6}	0.6
Other chemicals	1.9×10^{-6}	3.6	3.6×10^{-6}	1.6
Total	5.7×10^{-6}	4.1	7.9×10^{-6}	2.2

B. Comparison of the cancer risk estimates and hazard indices from the subset of contaminants judged to be "risk drivers" with the cancer risk estimates and hazard indices from the contaminants that were eliminated appears to show that the risk assessment has greatly underestimated risks and hazards. For Site 9 the "risk drivers" account for only 12% of the total hazard and 67% of the total risk. For Site 10 the "risk drivers" account for only 27% of the total hazard and 54% of the total risk.

C. This illustrates the potential pitfalls of eliminating chemicals based on screening criteria. Ten contaminants at Site 9 had cancer risk levels between 1 x 10^{-7} and 1 x 10^{-6} (Table I-5). Although each of these ten contaminants taken individually passes the screen, their cumulative risk estimate is 3.6 x 10^{-6}.

D. The hazard indices for the chemicals that were eliminated from the risk assessment greatly exceed the hazard indices for the "risk drivers" for both Site 9 and Site 10.

E. In discussing the uncertainty associated with the selection of chemicals of potential concern, Section 11.1.2 of Appendix I) states that "*None of these criteria is likely to significantly underestimate risks.*" This statement flies in the face of the analysis of cumulative risks and hazards.

F. The estimates are not actually comparable because the "Risk Driver" risk and hazards estimates are based on forward risk assessment calculations and the "Other Chemicals" risk and hazard estimates are based on PRGs.

G. The human health risk assessment needs to be revised to estimate total risks and hazards from all exposure pathways and all chemicals in a meaningful way. 1) All potential contaminants must be evaluated in one risk assessment. 2) Arsenic must be included and evaluated as a carcinogen and as a noncarcinogen. 3) Inorganic chemicals that are consistent with background levels should be identified. Risks and hazards should be presented with and without these inorganic chemicals. 4) Hazard indices should be recalculated based on the critical organ. 5) This should be done for all exposure scenarios.

Response: As presented at the March 8, 2004 BCT meeting, the "total risk" screen will be completely updated (following the two examples presented to the BCT). First, the recommendations of Comment 10G were implemented to update the total risk screening.

Secondly, in conjunction with the ambient screen (which demonstrated inorganics are not related to former site operations as they are below ambient fill concentrations), the updated total risk screen demonstrates that no significant underestimate or change in conclusions would result if "total risk" were evaluated. Specifically, the total risk screen using Region IX residential PRGs demonstrates that the total carcinogenic risk from all analytes that were not excluded in the ambient evaluation was approximately 3E-6 for Site 09 surface soil, 6E-6 for Site 09 subsurface soil, 3E-6 for Site 10 surface soil, and 7E-6 for Site 10 subsurface soil; also, no target organ hazard index exceeds 1 using Region IX residential PRGs in the total risk screen. These risks are similar to those presented in the HHRA (see RAGS Part D 9 series tables). Thus, it was agreed at the BCT meeting that (specific to Sites 09 & 10), excluding the Region IX PRG screen as part of the COPC selection process is not necessary. However, DTSC requested that the PRG screen to identify COPCs for future NAVSTA TI HHRAs be dropped. Since Navy tiered HHRA guidance (Navy 2001) recommends the PRG screen in the COPC selection stage, the Navy agrees that future assessments will show an "incremental" (with PRG screen – per Navy request) risk as well as the "total" (without PRG screen – per DTSC request) risk.

SPECIFIC COMMENTS

1. Comment: **Section 1.2.2, paragraph 2. Please clarify the sentence, "*Approximately 29 million cubic yards of fill…was transported to or dredged from the Bay and the Sacramento River delta and used for construction of the island.*" It is unclear what is meant by saying that the fill "*was transported to or dredged*".**

Response: The fill material was either dredged from the bay adjacent to the island and deposited directly to the island or dredged from the river delta and then transported to the island via truck or barge. The text will be revised to clarify this issue.

2. Comment: **Section 1.2.2, paragraph 4. The text states that Figure 1-3 is a 1942 aerial photograph, but then refers to changes since 1947. The legend of Figure 1-3 identifies it as a 1945 aerial photograph. Please correct the text and legend as appropriate.**

Response: Figure 1-3 is a 1945 aerial photograph. The text will be revised to correlate with the correct date.

3. Comment: **Sections 2 and 5. Section 2.2.2.4 names the hydraulic punch borings "*09-HP001 through 09-HP009*". Section 5 sometimes (5.1.1.2, 5.1.1.4,**

5.1.1.5) uses the notation "*09-HP01, 09-HP02, etc.*" and sometimes (5.1.1.2, 5.1.1.3) uses "*09-HP001, 09-HP002, etc.*", apparently for the same borings. Similarly, the Figures 5-1 through 5-8 use both notations for the same borings in Site 9. The notations for Site 10 are more consistent, except for the figures. Figures 5-9 through 5-17 use both notations for the same borings. Please use the correct nomenclature throughout the document.

Response: The nomenclature from the sample locations will be standardized throughout the document.

4. **Comment:** **Section 5.2. The text describes "*four soul borings*". Perhaps "*four soul barings*" was intended.**

Response: The text will be revised to state "...four soil borings...".

5. **Comment:** **Section 6.1.1.1. Please correct the text, "*…the vapor pressure of carbon dioxide is 4.3 x 104 mm Hg.*"**

Response: The text will be revised to read "…4.3 x 10^4 mmHg."

6. **Comment:** **Section 7.1.3. The text states that the particulate emission factor is "*1.3 x 10^9 cubic mg/kg*". Please correct the units to "*m^3/kg*".**

Response: The units will be revised to m^3/kg.

7. **Comment:** **Section 7.2.1.2. The text refers to "*the acceptable agency target risk range of 10^{-6}*". The risk number 1 x 10^{-6} is the point of departure. It is a number, not a range. Any risk levels greater than 1 x 10^{-6} are potentially of concern.**

Response: The text will be changed as follows (underlined text denotes new text, and stricken text reflects deleted text): "A future construction worker in contact with soil (0 to 8 feet bgs) was calculated to have no unacceptable noncancer risk (HI of 0.13), and this receptor's cancer risk ($1.\cancel{11} \times 10^{-7}$) was also below the acceptable ~~agency target risk range~~ risk point of departure of 10^{-6} (Table 7-1)."

8. **Comment:** **Sections 8.1.4 and 10.1.5. Please find a more accurate description to replace "*reasonable worst-case*".**

Response: The text will be changed to "*reasonable maximum exposure,*" as appropriate.

9. Comment: **Section 10.1.4. The text states that the human health risk assessment is based in part on "*basewide groundwater monitoring data*". It isn't. It is based on seven wells at Site 9 and two wells at Site 10.**

Response: The text will be changed to indicate the assessment is based on "site-specific groundwater monitoring data from the basewide groundwater monitoring program."

10. Comment: **Appendix G. It is confusing to have appendices to an appendix to a document. Please label Appendices A, B, and C, associated with Appendix G, in some other manner.**

Response: Appendix G in the draft RI report is a copy of a document completed in 2001. Because the document included as Appendix G is a final document, revisions are not warranted.

11. Comment: **Appendix I, Section 3.2.1. The methods described for screening human health risk assessment are inconsistent with DTSC (1994) guidance and should not be used for any future risk assessments at Treasure Island. See General Comment 2.**

Response: Please see response to General Comment 2 and the revised total risk screen. As discussed in the response to DTSC's comments on total risk characterization, DSTC and Navy agreed to this approach for Sites 09 and 10 at the BCT meeting. The Navy's contractor explained at the BCT meeting that because Navy tiered HHRA guidance (Navy 2001) recommends the PRG screen in the COPC selection stage, future assessments would show an "incremental" risk as well as the "total" risk that DTSC has requested.

12. Comment: **Appendix J, Section 4.1. The text states that "*The sample size was adequate for characterization of inorganic and organic groundwater concentrations at both Sites 09 and 10. The nature and extent of contamination at NAVSTA TI was considered well characterized, leaving little uncertainty in this regard.*" Please revise this text for accuracy (see General Comment 7).**

Response: The text will be revised to address the sample size.

RESPONSES TO REGIONAL WATER QUALITY CONTROL BOARD (RWQCB) COMMENTS ON THE DRAFT REMEDIAL INVESTIGATION REPORT, IR SITES 09 AND 10
NAVAL STATION TREASURE ISLAND, CALIFORNIA

This document presents the Navy's responses to comments from the Regional Water Quality Control Board (RWQCB), Sara L. Raker, Engineering Geologist on the "Draft Remedial Investigation for Sites 09 and 10, NAVSTA Treasure Island, California." The Navy received the comments addressed below via email on November 03, 2003.

1. Comment: Executive Summary, page ES-3

The statement "Because groundwater at Sites 09 and 10 is nonpotable…" is incorrect. The text should be revised to state that "Because groundwater at Sites 09 and 10 is not a source of drinking water…"

Response: The text will be revised accordingly.

2. Comment: Executive Summary, page ES-5

An evaluation of ARARs is not needed if the results of the RI indicate no further action is required. Suggest deleting this section. It is normally part of an FS.

Please see my comments on the final recommendations.

Response: The Navy will remove the evaluation of applicable or relevant and appropriate requirements (ARAR) section from the final RI report.

3. Comment: Section 4.3.1.4 Treasure Island Groundwater Quality and Beneficial Uses

Please revise this text to be consistent with the description provided in the *Final Corrective Action Plan, Sites 06, 14/22, 15, and 25*, June 28, 2002 (Section 2.5.5). The text in the draft RI is missing the RWQCB's finding that the quality and the hydrogeologic conditions of the groundwater beneath Treasure Island is such that this water is not a potential source of drinking water pursuant to SWRCB Resolution 88-63 and Regional Water Quality Control Board (RWQCB) Resolution No. 89-39. Please note that there is no mention of potable or nonpotable water.

Response: The text will be revised to be consistent with the description of groundwater quality and beneficial use provided in the final corrective action plan document.

4. Comment: Section 7.1.2.2 Groundwater Chemicals of Potential Concern

The statement "Because groundwater at Sites 09 and 10 is nonpotable…" is incorrect. The text should be revised to state that "Because groundwater at Sites 09 and 10 is not a source of drinking water…"

Response: The text will be revised to state that groundwater is not a source of drinking water.

5. Comment: Section 8.1.3 Identification of Chemicals of Potential Ecological Concern

Is the table of screening criteria presented in Table J-1 the same as the table of criteria presented in the *Final Groundwater Status Report, Summary of Groundwater Monitoring from May 2001 to August 2002, Treasure Island, San Francisco, California*, dated August 18, 2003? If so, please reference the facility wide groundwater monitoring program for consistency.

Response: Table J-1 is a revised edition of Table A-1 in the above referenced Groundwater Status Report. Table J-1 includes only the screening criteria for protection of saltwater aquatic life (mainly the 20 percent of acute lowest observed effect level {LOEL} values). The selected screening criteria in Table J-1 are for protection of aquatic life while selected criteria in Table A-1 are based on protection of human health.

6. Comment: Section 10.2 Recommendations

The recommendations for Sites 09 and 10 should be revised to clearly state the Navy's position. For example, "The current level of site characterization is adequate to complete no further action…" what does this mean? In addition, "The IRP effort for soil and groundwater should move on to the remedial action plan", yet why is a remedial action plan needed for a site where no further action is needed? The following revised text may clarify these points, as follows:

1) **No additional soil or groundwater data are needed at Sites 09 and 10. The current level of site characterization is adequate to complete the human health and ecological risk assessments.**

2) **Based on the results of the human health risk assessment, remedial action is not required for soil or groundwater at Sites 09 and 10.**

3) **Based on the results of the ecological risk assessment, remedial action is not required for soil or groundwater at Sites 09 and 10.**

4) **The IRP effort for soil and groundwater at Sites 09 and 10 should be to pursue site closure through a No Action Record of Decision.**

Response: The text will be revised to clarify the Navy's position for pursuing a No Further Action Record of Decision.

7. Comment: Appendix L Petroleum Screening Levels
Please revise this text to be consistent with the description provided in the *Final Corrective Action Plan, Sites 06, 14/22, 15, and 25*, June 28, 2002 (Tables 3-1 and 3-2). The document provided in Appendix L was not approved by the RWQCB. Where is Appendix L referenced in the RI?

Response: The text and tables in Appendix L will be revised to be consistent with Tables 3-1 and 3-2 from the Final CAP (2002). References to Appendix L will be given in the TPH discussion for Site 9 in Section 5.1.1.

RESPONSES TO GEOMATRIX CONSULTANTS, INC. COMMENTS ON THE DRAFT REMEDIAL INVESTIGATION REPORT, IR SITES 09 AND 10 NAVAL STATION TREASURE ISLAND, CALIFORNIA

This document presents the Navy's responses to comments from Geomatrix Consultants, Inc. on the "Draft Remedial Investigation for Sites 09 and 10, NAVSTA Treasure Island, California." The Navy received the comments addressed below from Stephen Proud, Treasure Island Development Authority, on November 20, 2003.

GENERAL COMMENTS

1. Comment: ***TPH Concentrations at Site 9 that Exceed Screening Criteria.*** **At Site 9, total petroleum hydrocarbon (TPH) concentrations in the diesel range (TPH-d) and motor oil range (TPH-m) exceed residential screening criteria (1,380 and 1,900 milligrams per kilogram [mg/kg], respectively) at two locations:**

- **near the former hydraulic lift station inside Building 41 (where TPH-d and TPH-m were detected at 38,000 and 12,000 mg/kg respectively in a sample from boring 09-HP-002), and**
- **near the southeast corner of the site (where TPH-d was detected at 7,100 and 7,600 mg/kg, respectively, in a sample collected near the water table from borings 09-SB-07 and 09-SB23).**

In accordance with standard practice for conducting risk assessments, TPH values were not considered in the human health risk assessment; the risk assessment results provided the basis for the conclusion that no risk-based remedial action was necessary to protect human health. The document needs to discuss whether any remedial action (including institutional controls) would be necessary to address the TPH concentrations that exceed the residential screening criteria.

Response: The human health and ecological risk assessments determine the total petroleum hydrocarbons (TPH) risk based on TPH constituent concentrations such as benzene, toluene, ethylbenzene, and xylene (BTEX), and PAH. The risk assessments have determined that there is no risk at the site in relation to TPH constituents. Remedial actions for soil at NAVSTA TI in the past have addressed shallow soils that pose a risk to human health and the environment. The TPH contamination in question is near the water table at a depth of approximately seven feet bgs. Since it does not contain BTEX and PAH constituents as risk drivers and occurs at depth, it does not pose an unacceptable health risk. This decision is consistent with other petroleum contaminated sites at NAVSTA TI.

In addition, since groundwater is not a source of drinking water and is not being significantly impacted, soil contamination in the smear zone does not require remediation. No institutional control is necessary since there is no risk.

2. **Comment:** ***Extent of TPH at Site 9.*** **We concur with the document's conclusion that elevated TPH in the vicinity of the former hydraulic lift (boring 09-HP002) appears to be isolated based on data from a boring drilled adjacent to this location and several borings drilled within 10 to 15 feet of this location. However, the extent of TPH is less constrained in the southeast corner of the Site (borings 09-SB07 and 09-SB23). In both borings, elevated TPH was detected in samples collected near the water table, where petroleum staining and odor also was noted on boring logs. The extent may be laterally continuous between the two borings, and may extend beneath Building 3 to the north. It does not appear that a source for the TPH has been identified; however, the TPH does not appear to be a significant source to groundwater based on data from wells 09MW04 and 09MW07.**

Response: While elevated levels of TPH were detected in soil samples collected from borings SB-07 and SB-23, concentrations in soil samples collected from borings upgradient, downgradient, and crossgradient of the borings in question, (SB-10, SB-11, SB-22, SB-24 and SB-25) had maximum TPH concentrations well below screening criteria. Analytical results from groundwater samples collected from monitoring wells MW-04 and MW-07 also indicate that TPH concentrations in soil do not significantly impact groundwater. Based on the low level TPH concentrations detected in borings surrounding SB-07 and SB-23, the lack of significant impacts to groundwater, and the lack of human health and ecological risks associated with the TPH contamination, no further investigation is warranted in this area.

3. **Comment:** ***Future Land Use Restrictions.*** **In light of the Navy's conclusion that no remedial action is necessary to protect human health (under a residential scenario) or the environment and that no further action is necessary, we infer that the Navy believes that no land use restrictions (including a soil management plan) will be necessary for Sites 9 and 10. One possible exception may be a restriction on use of groundwater because the Navy's human health risk assessment assumed that groundwater would not be used; therefore, human exposure to groundwater was not evaluated. We request that the Navy confirm this understanding with respect to future land use restrictions.**

Response: Sites 09 and 10 are part of the early transfer parcels. A prohibition on groundwater use will be included as part of the transfer document.

SPECIFIC COMMENTS ON TEXT

1. Comment: ***Executive Summary (p. ES-3, first two paragraphs).*** **The last sentence in the first paragraph states "Both TPH-d and TPH-m concentrations are below TPH screening criteria." This sentence should clarify which criteria are being used for comparison (i.e., residential) and should clarify that this statement only applies to the additional RI data (not to the phase II RI data discussed in the same paragraph, where TPH-d was 38,000 mg/kg and TPH-m was 12,000 mg/kg). In the second paragraph on this page, the text should discuss how the "elevated concentrations of TPH-d at 7,600 mg/kg and 7,100 mg/kg…near the southeast corner of the IR Site 09 boundary" compare to the residential screening criterion (both are above it). This comment also applies to Section 10.1.3 (in Conclusions, page 10-4) where identical language is used.**

Response: The text will be revised to clarify that TPH concentrations were compared to NAVSTA TI residential PRGs as outlined in the "Final Preliminary Remediation Critieria for Petroleum and Petroleum Constituents, Technical Memorandum, Naval Station Treasure Island, November 2001." The text will be revised to clarify that the statement regarding TPH levels below criteria applies to the additional RI data. The text will also be revised, where necessary, to clarify TPH levels in comparison to the screening criteria.

2. Comment: ***Executive Summary (p. ES-5, last bullet in Recommendations).*** **It is unclear why the last bullet recommends moving to the "remedial action plan stage" in light of the previous three bullets that state no remedial action is necessary to protect human health or the environment and no further action is recommended. This comment also applies to Section 10.2, which uses identical language.**

Response: The executive summary will be revised to state that the Navy will pursue site closure through a No Action Record of Decision.

3. Comment: ***Section 2.1.1 Site 09 (top of page 2-2).*** **The text states that the 30-gallon underground storage tank (UST) for the hydraulic lift inside Building 41 has been removed. However, the document does not provide the basis or citation for this statement. The text states that the lift system itself was concluded to be removed based on a site inspection; however, it does not provide the basis for the conclusion that the UST was removed. Table 2-1, which provides a summary of previous reports, states "No USTs have been located on Sites 09 or 10" according to Tetra Tech's April 2003 Draft Facility-wide UST Summary Report. According to this table, the UST summary report states that one AST was present at Site 09 (not discussed in this RI). Please resolve the apparent discrepancies.**

Response: The phase II RI report indicated that two concrete trenches, apparently remaining structures from a hydraulic lifting system, were present in building 41. The hydraulic lift system and tank were apparently removed between 1995 and 1997 by SPORTS (personal communication between Tetra Tech EM Inc and Michael Mentik, NAVSTA TI). The SPORTS documentation has not been located at this time. The RI report also noted that a 30-gallon storage tank, presumably used to contain hydraulic oil for use with the hydraulic lift, was located in a concrete-lined pit at the east end of one trench. The tank was subsequently removed and the lined pit also filled with concrete.

Table 2-1 summarizes information contained in other reports specific to Sites 09 and 10. The reference to one above ground storage tank (AST) located at Site 09 was only on a figure in the April 2003 Draft Facility-wide UST Summary Report (Tetra Tech 2003). No description of this AST and no other documentation for the AST were found in Navy files.

4. Comment: ***Section 2.2.2.5 Sampling and Analysis–Site 10.*** **During the Phase IIB RI, sediment samples were collected from two catch basins (335R and C). What was the rationale for sampling these two catch basins, but not the two additional catch basins at the site (2640 and 2641)? (Also pertains to Section 5.2 discussion.)**

Response: The phase IIB remedial investigation work plan outlined that any storm drains on Sites 07 and 10 would be sampled if they contained sediment. Sediment samples were collected for analysis from catch basins 335R and C. Catch basins 2640 and 2641 were not sampled, as they did not contain enough sediment for an adequate sample.

5. Comment: ***Section 2.3.2 Remedial Investigation Objectives and Sampling–Site 10.*** **This section should include the objective for the two borings inside Building 335 and the two borings located southeast of this building. Figure 2-6 identifies the area southeast of Building 335 as an "Area of Potential Soil Contamination." Why was it believed that this area had potential soil contamination?**

Response: The two borings inside Building 335 were drilled to investigate the former floor drain; the text will be revised to clarify the sampling objective. During the review of the Environmental Baseline Survey (EBS) (Tetra Tech 1997), a discolored area was identified south of Building 335 in a 1968 aerial photograph. The Navy and DTSC agreed that this area would be included as part of the Site 10 additional investigation to determine whether or not the discoloration was due to soil contamination. The discolored area is the "area of potential soil contamination".

6. Comment: ***Section 3.0 Investigation Procedures and Field Methods.*** **Have the monitoring wells (sometimes referred to as temporary monitoring wells) been destroyed? If so, well destruction procedures should be documented.**

Response: The monitoring wells have not been destroyed or abandoned and are still intact. The text will be revised to clarify the condition of the wells.

7. Comment: ***Section 4.3.1.1 Treasure Island Aquifer Testing.*** **The second to last sentence of this section states "Site-specific hydraulic conductivities for Sites 09 and 10 are found in Section 4.4.2 and 4.5.2." This statement is not correct. No site-specific hydraulic conductivities were measured at these two sites. Rather, hydraulic conductivities were assumed using base-wide data or data from nearby sites.**

Response: The text will be revised to indicate that the hydraulic conductivities used for Site 09 were derived from base wide data since no site specific data were available for Site 09. Hydraulic conductivities for Site 10 were derived from site specific data from Site 14 due to its proximity to Site 10 and similar lithology.

8. Comment: ***Section 4.4.2 and 4.5.2 (Hydrogeology discussions for Sites 09 and 10, respectively).*** **These two sections identify single hydraulic conductivity values (K) for Sites 09 and 10 that are used in the fate and transport analysis (Appendix H); the fate and transport analysis was used to estimate chemical concentrations at a point of exposure (POE) for an ecological receptor (i.e., San Francisco Bay). The document cites the Treasure Island average K (10.12 feet per day [ft/k]) as appropriate to use for Site 09; however, hydraulic conductivities measured at nearby Site 21 were considerably higher (average of 108 ft/d in the shallow zone). K values at Treasure Island are likely to be variable and the fate and transport analyses are likely to be highly sensitive to this parameter. Therefore, Sections 4.4.2 and 4.5.2 should provide a range of likely values for K (Site 9 should include data from nearby Site 21) and the fate and transport analysis in Appendix H should include a sensitivity analysis using the range of potential K values. Statements such as "The hydraulic conductivity for Site 09 is approximately 10.12 ft/d." (top of page 4-8) are not correct. This is an assumed value in the absence of actual data from Site 09.**

Response: To evaluate the sensitivity of the model in relation to changes in the hydraulic conductivity parameter value, the model was re-run as suggested, and model output for the simulations was compared (see Attachment B). Specifically, the BIOSCREEN model was run for monitoring well 09-MW02 using the original hydraulic conductivity model parameter value in Appendix H equal to 10.12 feet per day (ft/d)

(Run 1). The model was then re-run keeping all parameter values the same except for hydraulic conductivity which was set equal to 101.2 ft/d (Run 2). Model results for Run 1 and Run 2 in Attachment B to this response to comments indicate the resulting concentrations at the point of exposure are identical even though the hydraulic conductivity for Run 2 is an order of magnitude greater than Run 1. The relative insensitivity of the model is likely the result of (1) the relatively short travel distance (hundreds of feet) and (2) the long time period for simulation (100 years). The long time period of simulation relative to the short travel distance results in steady state conditions at the point of exposure (POE).

9. Comment: ***Section 5.1.1.1 Site 09 Soil Sample Results for Volatile Organic Compounds (VOCs).*** **We note that many of the samples from the 2002 investigation had low concentrations of carbon disulfide. Was carbon disulfide used as a preservative with the Encore sampling method? If so, it should be identified as a potential source of the detections. Additionally, we note that several samples had low concentrations of methylene chloride, acetone, and toluene (all common laboratory contaminants that were frequently detected in method blanks–see Appendix E). If these detections have been attributed to laboratory contamination, they should be identified as such in the text, tables and figures.**

Response: Carbon disulfide was not used in the Encore sampling procedures. It was reported at low concentrations in some samples. It is qualified as estimated (Jg), at concentrations reported below contract required quantification limit (CRQL), and considered quantitatively unreliable. Information on carbon disulfide qualifications are found in Appendix E of the draft RI report.

The detections of methylene chloride, acetone and toluene in field blanks indicates the possibility of laboratory introduced contamination, as noted in Appendix E. Reference to possible laboratory contamination will be included in the RI report.

10. Comment: ***Section 5.2 Site 10.*** **Please describe soil sampling and analysis for the EBS investigation (fourth paragraph, page 5-12) consistent with descriptions of other investigations.**

Response: The sampling and analysis for the EBS will be described in a method consistent with the descriptions of the other investigations.

11. Comment: ***Section 5.2.1.1 and 5.2.1.2.*** **These sections describe significantly elevated concentrations of TPH and related compounds (toluene, ethylbenzene and xylenes) in samples from the two catch basins that were sampled and states "These catch basins have been cleaned out." (Page 5-14). Please provide information or citation to support this statement.**

Response: The 1997 draft final RI report will be referenced to support this statement.

12. Comment: ***Section 5.2.1.2 Site 10, Soil Sample Results--Total Petroleum Hydrocarbons.*** **Under the discussion for the Phase II RI, the text should note that 1,200 mg/kg TPH was detected in sample 07/10-HP013 (0.75-1.25 feet).**

Response: The text will be revised to note the detected TPH concentration in the sample collected from boring 07/10-HP013.

13. Comment: ***Section 5.2.1.3 Site 10, Soil Sample Results–Semivolatile Organic Compounds (SVOCs).*** **One of the objectives of the 2002 investigation was to assess SVOCs detected on previous boring 10-SB03. However, the text does not discuss the results within context of this objective. This comment also pertains to Section 10.1.3, where SVOC impacts at Site 10 are not even mentioned. Additionally, if it has not done so, the Navy should confirm that phenol, which was detected in many of the Phase II RI samples, is not a lab or field contaminant.**

Response: The text will be revised to state the objective and results of SVOC sampling at boring 10-SB03. While phenol is not commonly a laboratory introduced contaminant, laboratory blanks will be checked again to determine that possibility.

14. Comment: ***Section 5.2.1.4 Site 10, Soil Sample Results–Pesticides and Polychlorinated Biphenyls.*** **The text should discuss the DDD, DDT and DDE detections in sample 10-SB12 (0.5-2') (2002 investigation).**

Response: The text will be revised to include a discussion of the DDD, DDT and DDE detections.

15. Comment: ***Section 5.2.2.1 Site 10, Groundwater Sample Results–Volatile Organic Compounds (VOCs).*** **Under quarterly groundwater sampling, it would be helpful if the text noted that the single tetrachloroethene (PCE) and carbon disulfide detections were "J" values (estimated concentrations below the reporting limit) and not reproduced in subsequent sampling events.**

Response: The text will be revised to note the aforementioned "J" values and indicate they were not reproduced in subsequent sampling events.

16. Comment: ***Figure 5-10 Site 10 SVOC Soil Sampling Results.*** **Geomatrix has not checked data presented on tables and in figures for accuracy. However, we note that data from borings 10-SB24 and 10-SB26 are missing from this figure.**

Response: The figures will be revised to include data from borings 10-SB24 and 10-SB26.

17. Comment: ***Table 5-1. Analytical Results for Site 09 Soil Samples.*** **Geomatrix has not checked data presented on tables and in figures for accuracy. However, we note that Sample 09-HP002 (6.5 to 7.0 feet) had concentrations of 12 mg/kg reported for four PAHs (benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, and benzo[k]fluoranthene); these detections were flagged as "rejected." Because these detections are significantly higher than others at the site (and well above screening criteria), please provide information in the footnote about why these detections were rejected.**

Response: Sample 09-HP002 was located in Building 41 and associated with elevated concentrations of TPH-diesel and TPH-motor oil. The footnote will be revised to include information as to why the data were rejected.

18. Comment: ***Section 6.1.1.3.*** **Please provide information that supports the statement that "utility lines appear to be continuously above the water table" at Sites 09 and 10. The accuracy of this statement is fundamental to the conclusion that there are no preferential pathways for contaminant migration.**

Response: The petroleum program and groundwater monitoring program completed a coordinated effort to address this issue for storm drains and sanitary sewers at UST and Pipeline sites, as well as associated IR sites. Based on this effort, data indicate that the utility lines at IR Sites 09 and 10 are located above groundwater. The reference will be added to the text.

19. Comment: ***Section 7.0 (Human Health Risk Assessment).*** **This section of the main text is intended to be a summary of Appendix I; however, there are several issues addressed in the appendix that are omitted from this section. For example, there is no mention of arsenic in soil and ambient concentrations. In addition, there is no mention of several data quality issues and how data were included or excluded in the risk calculations. Finally, the appendix presents a relatively detailed uncertainty analysis that is essentially absent from this section of the main text.**

Response: The Section 7.0 summary was intended to be concise, and details of the data anomalies, ambient screen, and uncertainty were originally considered too detailed for the RI report summary. However, we will add the requested details here. Arsenic, as part of the ambient evaluation, is addressed further in the HHHRA Comment 3. The Section 7.0 summary will be updated to include a summary of the ambient evaluation, with text as suggested below:

To be added as a new third bullet in the bullet list of Section 7.1.2.1: "Consistent with Navy (2004) and DTSC guidance, inorganic analytes statistically shown to be below ambient concentrations in fill material (see Attachment I-3) were eliminated as COPCs." This third bullet will replace the first paragraph on page 7-3 ("One inorganic… Appendix I.").

To be added as a new paragraph at the end of Section 7.1.1 on page 7-1: "See Appendix I, Section 5 for details of the data reduction. In summary, all data without qualifiers and all data qualified as estimated (J) were used in the HHRA, with the exception of the data quality issues noted in Appendix I, Section 5. Data qualified as not detected (U) were incorporated into the HHRA by using a proxy concentration of one-half of the sample quantitation limit (EPA 1989). Consistent with EPA guidance, only data qualified as rejected (R) were considered unusable for risk assessment purposes (EPA 1989, 1992a). None of the rejected data (summarized in Appendix I, Section 5) presented a data gap for the HHRA."

To be added to the end of Section 7.1.6: **"**The following summary presents information related to the main uncertainties in the Site 09 and 10 HHRA; detail is provided in Section 11 of Appendix I.

Uncertainty is introduced during the data evaluation and selection of COPCs. Each of the strengths and weaknesses associated with the data is carried through to the risk assessment. Fortunately, the very small sizes of Sites 09 and 10 (0.25-acre and 0.75-acre, respectively) and the relatively large number of samples collected from site media indicate that sufficient data are available to detect human health risks, and no underestimate is presented. To ensure that risks were not underestimated by use of the COPC selection process, a quantitative assessment of the impact of a "no screen" HHRA is presented as a "total risk" assessment for soil (see end of Section 9 in Appendix I). This discussion concluded that no risk drivers were excluded from the HHRA and that the conclusions of the HHRA would not change had the COPC screen not been followed in accordance with Navy (2001) guidance.

Uncertainties were identified in association with four areas of the exposure assessment process: (1) the selection of exposure scenarios, (2) the selection of exposure pathways, (3) the estimation of EPCs, and (4) the selection of exposure variables used to estimate chemical intake. All parameters are expected to err on the conservative side, rather than underpredicting unforeseen human health risks.

The primary uncertainties associated with the toxicity assessment are related to derivation of toxicity values for COPCs. Standard RfDs and SFs developed by EPA were used to estimate potential cancer and noncancer health effects from exposure to COPCs at the site. These values are derived by applying conservative (health-protective) assumptions and are intended to protect the most sensitive potentially exposed individuals. Although the State of California has its own toxicity values to describe the cancer potency of the two organic risk drivers (BAP and DBA), one California value is higher, and one is lower, resulting in an insignificant change to the risk characterization if one toxicity assessment were chosen over the other. Application of dual toxicity assessments (per Navy 2003 guidance) was not needed in this site-specific case, as uncertainty was not significant to the risk characterization findings.

Standard EPA methodologies were used for the risk characterization step. Using these methods, the risks from exposure to multiple carcinogens were added to estimate the total cancer risk associated with exposures at the site. The underlying assumption with this approach is that the risks from carcinogens with different target organs are additive. This assumption contributes to the uncertainty in the risk assessment and may result in underestimated or overestimated risks, depending on whether there are synergistic or antagonistic interactions between the site COPCs. Because information on such interactions, however, is generally not available, most possible interactions were not evaluated in this HHRA. The target organ-specific analyses may be conducted if additive effects contributed to HIs greater than unity; however, for Sites 09 and 10, no unacceptable HIs were found, so no target organ breakdown was necessary.

In summary, the HHRA was developed based upon a series of assumptions, almost all conservative, that are expected to yield an overestimate of risks."

20. Comment: ***Section 7.0 (Human Health Risk Assessment).*** **A number of specific comments on Appendix I also apply to this summary section. For example, noncancer hazard indexes and excess cancer risks should be limited to one significant figure. This is especially important in the absence of a discussion on uncertainty in these estimates. The other**

issues identified above should be addressed in this section of the main text.

Response: At the March 8, 2004 BCT meeting, this comment and others related to significant figures presented in the HHRA were discussed. It was agreed that the revised HHRA text will present the risks to one significant figure. The statement, "Risks and health hazards discussed in the text and main tables of the RI report and the HHRA appendix are limited to one significant figure, as recommended by RAGS Part A (EPA 1989). However, to enable checks for mathematical accuracy to additional decimals, the tables of Appendix I include results beyond the single significant figure." The other issues identified above will be addressed in the main text, where relevant.

21. Comment: ***Sections 7.0 and 8.0 (Human Health Risk Assessment and Screening Level Ecological Risk Assessment).*** **Both of these assessments only utilized groundwater data collected in 2002. While there is a good distribution of 2002 data at Site 9, only two monitoring wells at Site 10 were sampled in 2002, and samples from only one of these two wells (10-MW03) was analyzed for a full suite of constituents (the sample from 10-MW02 was only analyzed for pesticides). While we generally support the concept of utilizing recent groundwater data, the general paucity of data from 2002 necessitates consideration of historic data (including hydropunch data). We believe that consideration of earlier data is not likely to change the findings from these two assessments, but will provide a more robust data set for supporting the findings.**

Response: At the March 8, 2004 BCT meeting discussing this comment, it was agreed that the revised HHRA will not summarize the entire historical dataset (and will continue to exclude hydropunch data from the tables and discussion), particularly since readers can review all data (including the screening-level hydropunch data) in Appendices C and D of the RI report. We concur that the data would not change the findings of the HHRAs, because the pathways for human health exposure are incomplete at NAVSTA TI Sites 09 and 10. In addition, the RWQCB has officially provided the Navy with concurrence that the groundwater is not a potential source of drinking water, pursuant to SWRCB Resolution 88-63 and RWQCB Resolution 89-39. A copy of the concurrence letter is included in Attachment A.

APPENDIX H—CONTAMINANT FATE AND TRANSPORT MODELING

1. Comment: We did not perform a detailed review of the fate and transport modeling; however, we note that there are several places where the text claims that the modeling approach and assumptions used would "result in the most conservative model results possible." (pages H-2, H-3 and H-9). Statements such as this are highly debatable and

should be deleted, especially in light of the fact that an argument could be made that the modeling for Site 09 should have used a hydraulic conductivity that is an order of magnitude higher than what was used (See specific comment #8). On another note, it appears that the distance from monitoring well to the POE for Site 10 (approximately 90 feet) should be revised to about 160 feet (in-text table, page H-7).

Response: In some cases, a range of input parameter values could be used to represent field conditions at the site. BIOSCREEN Model input parameter values were selected to ensure the model calculated DAF values resulted in conservatively high concentrations of constituents in groundwater for use in the screening level risk assessment. The Navy agrees that the phrase "most conservative model results possible" could be misleading. Pages H-2, H-3, and H-9 will be revised to indicate that the modeling approach and assumptions used would result in "relatively conservative model results."

Contrary to the conclusion presented in this comment, the BIOSCREEN models for Sites 9 and 10 are insensitive to the value for the hydraulic conductivity parameter. Model results are conservative, regardless of the value for hydraulic conductivity used. A full explanation of the model sensitivity to variations in the hydraulic conductivity parameter is provided in the response to Geomatrix specific comment 8.

Page H-2 of Appendix H states that the point of exposure (POE) for the modeling evaluation is defined "as the inland margin of the tidal mixing zone adjacent to San Francisco Bay." The distance from Site 10 monitoring wells to the inland margin of the tidal mixing zone is, in fact, approximately 90 feet. The in-text table on page H-7 is correct, and does not require revision.

APPENDIX I—HUMAN HEALTH RISK ASSESSMENT

1. Comment: **<u>Section 5.2.1, p. I-9</u> – The last paragraph of this section refers the reader to Section 5.1.1.5 of the main text "… for further details regarding the intended use of the 09-SB05 data and this data anomaly." However, no additional information, and in fact, substantially less information is provided in the main text. Most importantly, the primary reason given for discounting the original lead detection of 974 milligrams per kilogram (mg/kg) in Site 9—i.e., the value was estimated and of questionable quality—is not even mentioned in the main text of the report. While this section could be corrected by deleting this sentence, it would be preferable if the additional information provided in Section 5.2.1 of Appendix I is provided in Section 5.1.1.5 of the main text as originally intended.**

Finally, in the second-to-last paragraph of this section, there are several references to "regulators" making suggestions, concurring, or not being comfortable; however, the specific regulators are not identified nor are any citations provided.

Response: Information from Section 5.2.1 of Appendix I will be provided in Section 5.1.1.5 of the main text, as follows:

"At Site 09, lead results collected from location 09SB03 (1 to 1.5 feet bgs) included an estimated measurement of 974 mg/kg (J-qualified). The sample was collected just below the asphalt and gravel cover and was considered anomalous in comparison to other results from the Site 09 yard. Because all results from this 1992 boring were estimated (J-qualified) detections, the location was resampled in 1995. Resampling results identified 2.41 mg/kg of lead at the 1- to 2-foot bgs depth interval and 76.2 mg/kg in the 0.5- to 1-foot bgs depth interval. The working hypothesis of the Navy and its contractors has been that either the data quality for the original result was poor (as evidenced by estimated concentrations) or the 1992 lead result represented a flake of lead-based paint from the nearby structure.

The collection of two samples from the same spatial location is problematic for subsequent spatially based statistics. Multiple measurements of the same spatial location gives more weight to the data characterizing that single location. To offset this, a simple mean (average) of the two borings' results could be calculated. The net effect of averaging the original 1992 09SB03 lead measurement and the 1995 confirmation 09SB05 lead measurement in the relevant interval would be an average result of 488 mg/kg. However, the use of a simple mean in this manner is also in technical violation of generally-accepted statistical principles, but is preferred by DTSC in this specific situation. Averaged data should not be subsequently subjected to further statistical treatment. While the resampling of this location is similar to confirmation (also known as clearance) sampling, the DTSC has requested that rather than the complete replacement of 09SB03 lead results with the 09SB05 results, that the two results be averaged for this assessment. Thus, the concentration for lead at this spatial location is the average of the two borings' depths at each interval sampled."

2. Comment: **<u>Section 6.1, p. I-13</u> – This section describes the methods by which chemicals of potential concern (COPCs) in soil were identified. As discussed in this section and during the May 19, 2003, conference call, maximum detected concentrations were compared to EPA Region IX preliminary remediation goals (PRGs) for residential soil on a chemical-by-chemical basis. While there is nothing necessarily wrong with this approach, the draft RI does not address a comment made by**

DTSC on May 19, 2003; i.e., the DTSC and the Department of Defense entered into an agreement in 1994 that required potential cumulative effects to be considered in such a screening evaluation, and that this procedure needed to be adhered to in the RI report. While the Navy addressed this issue in a separate analysis (Section 9.3 – "'Total Risk' versus 'Incremental Risk'"), there is no mention of the 1994 DTSC/DOD agreement or how the Navy actually addressed DTSC's concern in this section of the draft appendix.

Response: As presented at the March 8, 2004, BCT meeting, the total risk evaluation has been updated to address DTSC's concerns with the draft HHRA "total risk" presentation. As DTSC agreed at the BCT meeting, total risk has been addressed sufficiently at Sites 09 and 10 after revision. However, for future HHRAs at NAVSTA TI, a more detailed forward risk evaluation (rather than a Navy Tier 1 screening-level evaluation that was appropriate for Sites 09 and 10 given the site-specific concentrations) may be required to establish total risk to DTSC's satisfaction. The revised draft HHRA appendix text has been revised to reflect the revised total risk screen demonstrated at the BCT meeting.

3. Comment: **<u>Section 6.1.3.1, p. I-16</u> – This section is intended to be a more detailed evaluation of arsenic data from Sites 9 and 10 with respect to ambient concentrations at Treasure Island, as agreed to during the May 19, 2003, conference call. In addition, "…the more detailed analyses … were conducted by comparison to the 95th percentile ambient level, which is consistent with the 1997 DTSC guidance for background comparisons." While it is true that a comparison of the maximum detected concentration to the 95th percentile ambient concentration is consistent with the referenced DTSC guidance, the remainder of the Navy's analysis, which consisted of comparing the data to the EPA Region IX PRG based on non-cancer effects and/or comparing the data to the maximum detected ambient concentration (rather than the 95the percentile concentration), is not. Furthermore, the reason for not doing a more rigorous statistical comparison between the site data and the ambient data as agreed to during the May 19, 2003, conference call appears to be that the Navy and its contractors could not locate the actual ambient data, but were forced to rely on a summary table provided in a 1996 report. Finally, despite concluding that arsenic was not a COPC in soil in either Site 9 or Site 10, the potential health risks associated with residual arsenic concentrations were actually evaluated as part of the uncertainty section. As such, the Navy should (1) attempt to locate the ambient data or acknowledge that they cannot conduct a more rigorous statistical analysis as requested by DTSC but that the distribution of detected concentrations does not suggest that the sites have been affected, (2) remove any reference to the non-cancer PRG because it is irrelevant**

to whether or not arsenic is present at Sites 9 and 10 at background concentrations, and (3) direct the reader to the uncertainty section. It should also be noted that this issue is further confused in Tables 1-2.1, 1-2.2, 1-2.5, and 1-2.6. These tables identify COPCs in soil based on comparisons of maximum detected concentrations to EPA Region IX PRGs or ambient levels or because the chemicals are essential nutrients. With respect to arsenic in Site 9, the reason given for not identifying arsenic as a COPC in soil is "BSL," or below screening level, whereas the reason given for arsenic in Site 10 is "BSL/BAL," or below screening level and below ambient level. The screening level listed for arsenic in the tables is the noncancer PRG of 22 mg/kg, not the cancer PRG of 0.39 mg/kg. At a minimum, this table should list both the cancer and noncancer PRGs for arsenic and acknowledge that the primary reason for not identifying arsenic as a COPC in soil in both areas is the belief that the detected concentrations are within background, as stated in Section 6.1.3.1 of the appendix.

Response: As discussed at the March 8, 2004 BCT meeting, the original 1995 ambient fill dataset has been located, and two-population statistical tests have now been conducted for the inorganics at NAVSTA TI Sites 09 and 10. The specific arsenic example at Site 09 (commented on above) was demonstrated during the BCT meeting, along with the Site 10 arsenic outliers. All inorganics are below ambient with the exception of silver at Site 09 (as demonstrated in new statistical Attachment I-3); all RAGS Part D Table 2 series tables will be revised accordingly. In addition, the contribution of inorganics to EPA's requested ambient risk will be presented in the uncertainty analysis according to Navy's January 30, 2004 guidance on this issue. Thus, inorganics that are not considered significantly greater than ambient will not be shown in the forward risk calculations of either the incremental evaluation or "total risk" evaluation (risk without a COPC selection except based on ambient levels and frequency of detection).

4. **Comment:** **<u>Section 7.0, p. I-19</u> – Figure I-3, the conceptual site model, was not included in the report. However, based on the information contained in the text and in Table I-1.1, it appears that two issues raised during the May 19, 2003, conference call were not addressed. First, it appears that volatilization from groundwater to indoor air was considered a complete pathway, whereas volatilization from soil to indoor air was not. While it does not affect the conclusion of the report, because essentially no volatile organic compounds were detected in soil or groundwater, it does not make sense that one of the pathways is considered complete when the other one is not. Second, the potential for future onsite residents to be exposed to residual chemicals in soil via ingestion of homegrown produce was not addressed adequately. There is no mention of this potential exposure**

pathway in the text. Whether or not it is mentioned in the conceptual site model is unknown; however, Table I-1.1 includes the following statement: "Because of the light industrial and commercial reuse plan for Sites 09 and 10, future homegrown produce pathways in a residential setting are incomplete. Vegetable gardening is not a reasonable anticipated future activity for Sites 09 and 10." However, based on the information provided, there is no reason to believe that exposure to residual chemicals in soil via ingestion of homegrown produce is any more or less likely than potential exposure via the other pathways evaluated for a future onsite resident (i.e., incidental soil ingestion, dermal contact with soil, and inhalation of vapors or particulates). Preferably, this pathway will be included in the assessment. At a minimum, another rationale for considering this pathway to be "incomplete" should be provided and/or the exclusion of this pathway should be addressed in the uncertainty section of the report.

Response: The conceptual site model (CSM) was inadvertently left out of the copy provided to reviewers, but had been modified as agreed to during the May 19, 2003, conference call. The figure is provided in Attachment C, and will also be included in revisions to the RI. Revisions to Figure I-3 responsive to this comment will include:

- Addition of a new footnote c to Figure I-3, stating, "All receptors were evaluated for soil sampled between 0 and 8 feet bgs because these soils were generally more impacted than soil sampled between 0 and 2 feet bgs. Soil sampled between 0 and 2 feet bgs were evaluated for the commercial/industrial worker because of the potential for exposure to soils in the absence of intrusive redevelopment activities, which are likely to disturb deeper soils.
- Addition of the callout to footnote b to the box for indoor air derived from groundwater.

Volatilization from groundwater to indoor air is considered a potentially complete pathway, but volatilization from soil to indoor air is not considered a complete pathway. During the RAGS Part D Table 2 stage (selection of COPCs), the Navy determines whether the pathway is actually (not just conceptually) complete: presence of a VOC in soil would be required; however, no VOCs were present in soil at great enough concentrations to result in indoor air impacts. This was agreed to during the May 19, 2003, conference call; specifically, the concentrations of infrequently detected VOCs in soil are minor. For example, toluene was detected in 2 of 69 soil samples collected from the 0 to 8 foot depth interval at Site 09; the maximum concentration was estimated (J-qualified) at 0.003 mg/kg. Also, no VOCs were present in soil collected from the 0

to 8 foot depth interval at Site 10. Even if the pathway was complete, the evaluation of subsurface soil volatilization to indoor air is not recommended by the EPA *Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (Subsurface Vapor Intrusion Guidance) because of the "large uncertainties associated with measuring concentrations of volatile contaminants introduced during soil sampling, preservation, and chemical analysis, as well as the uncertainties associated with soil partitioning calculations" (EPA 2002).

As discussed during the BCT meeting, the "residential" reuse in the 1996 plan is short-term housing for filmmakers and other intermittent workers who are not likely to plant vegetable gardens. In the event that long-term individual family housing becomes a likely future reuse scenario, the pathway is further incomplete because all inorganics are below ambient fill concentrations (this will be demonstrated in a new statistical Attachment I-3), which is to be expected as fill material was used to create all of TI. Therefore, Navy has not impacted the inorganics with operations at Sites 09 and 10. Because inorganics are the most likely class of compounds to be taken up from soil into produce, no forward risk calculations would be required for this pathway; this protocol is supported by DTSC and Navy (January 30, 2004) guidance on ambient metals. Further, the only surface soil (0 to 2 feet bgs) COPCs were large molecular weight PAHs (benzo(a)pyrene and dibenz(a,h)anthracene) that are fairly insoluble in water (inhibiting uptake) and are unlikely to accumulate in homegrown produce. Because homegrown produce does not have extensive root systems likely to exceed 2 feet in depth, soil collected from greater than 2 feet bgs and groundwater are not considered potential sources to homegrown produce. The text will be adjusted to address these incomplete pathways in Section 7.2 with the following revision:

> "Volatilization from groundwater to indoor air is considered a potentially complete pathway, but volatilization from soil to indoor air was found to be an incomplete pathway. At the RAGS Part D Table 2 stage (selection of COPCs) where it is determined whether the pathway is actually (not just conceptually) complete, the presence of a VOC in soil would be required. However, no VOCs were present in soil at great enough concentrations to result in indoor air impacts. Specifically, the minor concentrations of infrequently detected VOCs in soil did not require quantification. For example, toluene was detected in 2 of 69 soil samples collected from the 0 to 8 foot depth interval at Site 09; the maximum concentration was estimated (J-qualified) at 0.003 mg/kg. Also, no VOCs were present in soil collected from the 0 to 8 foot depth interval at Site 10. Even if the pathway was complete, the evaluation of subsurface soil volatilization to indoor air is not

recommended by the EPA *Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (Subsurface Vapor Intrusion Guidance) because of the 'large uncertainties associated with measuring concentrations of volatile contaminants introduced during soil sampling, preservation, and chemical analysis, as well as the uncertainties associated with soil partitioning calculations' (EPA 2002)."

Ingestion of homegrown produce is considered an incomplete pathway. The "residential" reuse in the 1996 plan has short-term housing for filmmakers and other intermittent workers who are not likely to plant vegetable gardens. In the event that long-term individual family housing becomes a likely future reuse scenario, the pathway is further incomplete because all inorganics (with the exception of silver at Site 09) are below ambient fill concentrations (see Attachment I-3), which is to be expected as fill material was used to create all of TI. Therefore, the Navy has not impacted the inorganics with operations at Sites 09 and 10. Because inorganics are the most likely class of compounds to be taken up from soil into produce, no forward risk calculations would be required for this pathway (see Navy 2004). Further, the only surface soil (from 0 to 2 feet bgs) COPCs were large molecular weight PAHs (benzo[a]pyrene and dibenz[a,h]anthracene) that are fairly insoluble in water (inhibiting uptake) and are unlikely to accumulate in homegrown produce. Because homegrown produce does not have extensive root systems likely to exceed 2 feet in depth, soil collected from greater than 2 feet bgs and groundwater are not considered potential sources to homegrown produce.

The uncertainty associated with these pathways will be addressed in the Section 11.2.2 of the report with an insert as follows:

"Volatilization from groundwater to indoor air was considered a potentially complete pathway, but volatilization from soil to indoor air was not considered a complete pathway. The likelihood that potential risks are underestimated is negligible because VOC concentrations in soil and groundwater were very low (that is, below respective screening criteria).

Ingestion of homegrown produce was considered an incomplete pathway. The likelihood that potential risks are underestimated are negligible because: the 1996 planned reuse indicates receptors are unlikely to spend significant time at the site; all inorganics (except silver) are below ambient fill concentrations (see Attachment I-3); and the only surface soil COPCs were large molecular weight PAHs that are fairly insoluble in water, which inhibits uptake and

thus makes these COPCs likely to accumulate in hypothetical produce."

5. **Comment:** **<u>Section 7.2, p. I-22</u> – At the top of this page, there is a sentence that states: "Because no groundwater COPCs were identified in Section 6.2, no complete groundwater exposure pathways were carried through the evaluation." This sentence is in direct conflict with statements made later in this section and in Table I-1.1, which suggest that volatilization from groundwater to indoor air was quantitatively evaluated. In actuality, it appears that the first sentence is correct, and that the later sentences should be removed and the table corrected.**

Response: Table I-1.1 indicates that the vapor intrusion pathway for the commercial/industrial worker and adult/child resident will be quantitatively evaluated in the risk assessment. The intent of the RAGS Part D Table 1 is to portray *conceptually* complete pathways; however, actual completed pathways depend on the data collected from the site. Upon compilation of the RAGS Part D Table 2 series, groundwater was found to lack VOCs requiring quantitative assessment. Table I-1.1 will be changed to note that the vapor intrusion pathway is not quantitatively evaluated in the risk assessment based on an absence of VOCs requiring assessment. Also, the following sentences that appear on page I-32 in Section 7.2 (intended to show that the pathway was considered for quantitative evaluation) will be deleted to avoid confusion:

"The only complete groundwater-related exposure would be for volatile chemicals migrating upward through overlying vadose zone soils. Based on expected behavior (that is, the potential for working in a building or warehouse) in addition to the previously listed pathways, potential exposure to chemicals migrating from groundwater into indoor air was evaluated for the commercial/industrial worker. In addition, though much less likely, a residential scenario evaluating migration of volatiles into indoor residential air was also evaluated."

6. **Comment:** **<u>Section 8.3, p. I-33</u> – The last paragraph of this section is confusing. It would be helpful to clarify that, for noncancer effects, which is limited to iron, the oral absorption efficiency was assumed to be 100%, whereas for cancer effects, which is limited to PAHs, the oral absorption efficiency was assumed to be 89%.**

Response: The paragraph in question will be changed as follows (underlined text denotes new text and deleted text is crossed out):
"In addition, the dermal pathway was evaluated using oral toxicity values, <u>which were</u> adjusted for oral absorption efficiencies where appropriate ~~following recommendations in~~ (EPA ~~(~~2001b; Navy 2001). For <u>iron</u>, the

~~TI Sites 09 and 10 COPCs,~~ oral absorption efficiency was ~~considered~~ 100 percent and ~~thus~~ no conversion was applied to the oral RfD to adjust for dermal exposure. For the PAH COPCs, the oral SF values were divided by a chemical-specific oral ~~gastrointestinal~~ absorption factor (0.89) to transform administered doses into absorbed doses for dermal contact (see Tables I-5.1 and I-6.1)."

7. Comment: **Section 8.4, p. I-33 – The basis for the chosen surrogates should be provided, although this issue is partially addressed in Section 11.3.4 (Surrogates for Preliminary Remediation Goals Screening).**

Response: The text in question will be changed as follows (underlined text denotes new text and deleted text is crossed out):
"Because of a lack of EPA Region IX PRGs for screening chemicals to identify COPCs, surrogate chemicals were chosen for the following chemicals based upon structural similarity ~~the following surrogates were employed~~ to avoid leaving data gaps ~~in the HHRA~~:

- Pyrene was used as a surrogate to represent phenanthrene and benzo(ghi)perylene, which have no EPA Region IX PRG or chemical-specific toxicity factors. Pyrene was chosen as a surrogate chemical for phenanthrene because of the similar structure; phenanthrene is a three-ringed PAH and pyrene is a four-ringed PAH. The three-ringed PAH pyrene was chosen as the surrogate chemical for the six-ringed PAH benzo(ghi)perylene because it was the closest surrogate with a non-carcinogenic endpoint. Other PAHs that were more structurally similar to benzo(ghi)perylene (for example, indeno(123-cd)pyrene) were not considered because they had carcinogenic endpoints and EPA toxicity information on benzo(ghi)perylene was insufficient to classify the chemical as a carcinogen.

- ~~While not completely a "surrogate" as such, t~~ Total chromium toxicity values and PRGs were chosen to ~~appropriately and conservatively~~ represent~~ed~~ all chromium ~~the total chromium~~ detected at Sites 09 and 10. This is considered protective because the total chromium toxicity value and PRG are based on a one-to-six ratio of hexavalent chromium, the most toxic form of chromium, to trivalent chromium, a less toxic form of chromium. Because ~~since~~ hexavalent chromium was analyzed in soils but found to be nondetect in all samples (see Section 11.3.1)**,** this surrogate is considered appropriately conservative.

- Many pesticide analogs did not have their own PRGs. However the following detected pesticides were structurally similar to other pesticides in their class: Endosulfan's PRG was used to screen detected endosulfan sulfate~~;~~ endrin was used to screen endrin aldehyde

and endrin ketone~~,~~ technical chlordane was used to screen both gamma- and alpha-chlordane~~,~~**;** and DDT was used to screen DDE.

Although the selection and use of surrogates for PRG screening is not ideal, the surrogates selected for use in the COPC screening process were all very closely structurally related to the contaminants they were chosen to represent. A lack of a PRG would otherwise remain a data gap. The degree of uncertainty contributed by the use of surrogates in this manner is addressed in the uncertainty section (see Section 11).**"**

8. Comment: **Section 9.2, p. I-35 – The quotation from 40 CFR 300.430 is not exactly correct. Importantly, the range for residual cancer risk is actually between "10^{-4} and 10^{-6}," reflecting that these estimates should be reported to only one significant figure (see comments below).**

Response: Navy agrees that risk estimates are only significant to one figure. The quotation in question will be replaced by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) language, "an excess upper bound lifetime cancer risk to an individual of between10^{-4} and 10^{-6}" rather than the version in the draft showing, "between 1.0 x 10^{-4} and 1.0 x 10^{-6}." The original text was meant to be consistent with the numerical format of the risk estimates so that the lay public could try to compare risk estimates to the NCP range. Please see response to general comment 20. At the March 8, 2004 BCT meeting, it was agreed that the revised HHRA text will present the risks to one significant figure.

The following statement will be added to the end of the second paragraph of Section 9.2 on page I-35 to clarify: "Risks and health hazards discussed in the text and main tables of the RI report and the HHRA appendix are limited to one significant figure, as recommended by RAGS Part A (EPA 1989). However, to enable checks for mathematical accuracy to additional decimals, the tables of Appendix I include results beyond the single significant figure."

9. Comment: **Sections 9.3 through 9.5, pp. I-36 through I-38 – It does not make sense that these "alternative" results are presented prior to the primary results in Section 10.0. Further, the estimated noncancer hazard indices and excess cancer risks in Section 9.3 (and elsewhere) should be limited to one significant figure.**

Response: The Navy agrees that the alternative results (that is, total risk, lead, and TPH evaluations) should be removed from Section 9 and placed in Section 10 after the results of the HHRA; thus Sections 9.3 through 9.5 will become Sections 10.3 through 10.5. Also, the total risk screening will be updated to incorporate agreements made at the March 8, 2004 BCT meeting.

Please see response to general comment 20 and specific comment 8.

10. Comment: **<u>Section 10.0, p. I-38</u> – As discussed above, the estimated noncancer hazard indices and excess cancer risks should be limited to one significant figure.**

Response: Please see response to general comment 20 and specific comment 8.

11. Comment: **<u>Section 10.1, p. I-39</u> – It appears that the incorrect exposure-point concentration (EPC) may have been used for benzo(a)pyrene in some of the calculations. As shown in Table I-3.1, the 95% upper confidence limit of the mean (UCL_{95}) for benzo(a)pyrene in soil from 0 to 2 feet below ground surface is 0.244 mg/kg, whereas the maximum detected concentration is 0.1 mg/kg. Nevertheless, the value listed as the EPC is the UCL_{95}, which would be contrary to standard practice and contrary to what was assumed for dibenz(a,h)anthracene in soil from 0 to 2 feet below ground surface (i.e., the UCL_{95} was greater than the maximum detected concentration; therefore, the maximum detected concentration was used as the EPC, which is standard practice).**

Response: As noted, the incorrect EPC was used and the lower maximum will be corrected in the RAGS Part D tables (Table I-3.1 and Tables I-7.1.1 through I-10.1.1). This change will only affect the future commercial/industrial worker exposure to surface soils at Site 09; the carcinogenic risk for this receptor will be changed from an estimate of 1.2E-6 to an estimate of 5.0E-7, which is less than the risk management range of 1E-4 to 1E-6. Results were reported to two significant figures to check for mathematical accuracy. Hence, conclusions are unaffected.

12. Comment: **<u>Section 10.1.1, p. I-39</u> – Even though earlier sections of the report conclude that there are no current uses of Site 9, potential noncancer hazard indexes and excess cancer risks were calculated for this scenario (see Tables I-7.1.1 and I-8.1.1). The report should be consistent with respect to the scenarios evaluated.**

Response: The text and Table I-1.1 indicate that the commercial/industrial worker is exposed to Site 09 surface soils (0 to 2 feet bgs) in the future scenario only. Because there is very infrequent "current" use of Site 09 by commercial/industrial workers (short-term walk-through type exposures), Tables I-7.1.1 through I-10.1.1 will be changed to indicate future use only.

13. Comment: **<u>Sections 10.1 and 10.2, p. I-39</u> – The majority of the risk summary tables (I-10 series) appear to be blank. These tables should be**

corrected or some explanation added as to why there is a series of blank tables in the appendix.

Response: For transparency, when no risk drivers were identified, the RAGS Part D Table 10 was still included. A footnote has been added to the blank Table 10 to state, "No risk drivers were identified for this receptor."

14. Comment: <u>References, p. I-49</u> – The references are missing from the draft report.

Response: References were inadvertently omitted from the hard copy and will be included in the revised draft HHRA. References cited in these responses to comments were added to the reference section as appropriate.

APPENDIX J—ECOLOGICAL RISK ASSESSMENT

1. Comment: The ecological risk assessment appears to have been completed in accordance with the procedures discussed during the May 19, 2003, conference call. A detailed evaluation of the basic methodology and assumptions used (e.g., fate-and-transport modeling, ecological screening criteria, etc.) was beyond the scope of this review; however, the approach presented appears logical and consistent with my understanding of these types of screening assessments.

Response: Comment noted.

References:

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U.S. Department of the Navy (Navy). 2001. Memorandum Regarding Conducting Human Health Risk Assessments Under the Environmental Restoration Program. From William G. Mattheis, Deputy Director, Environmental Protection, Safety and Occupational Health Division. To Commander, Naval Facilities Engineering Command. February 12.

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APPENDIX N
RESPONSE TO COMMENTS REVISED DRAFT HUMAN HEALTH RISK ASSESSMENT, INSTALLATION RESTORATION SITES 09 AND 10

A-E CERCLA/RCRA/UST Contract Number N68711-03-D-5104
Contract Task Order 0024

Response to Comments

REVISED DRAFT HUMAN HEALTH RISK ASSESSMENT, INSTALLATION RESTORATION SITES 09 AND 10

Naval Station Treasure Island, San Francisco, California

December 15, 2004

Prepared for

DEPARTMENT OF THE NAVY
Base Realignment and Closure
Program Management Office West
San Diego, California

Prepared by

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_____
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RESPONSES TO DEPARTMENT OF TOXIC SUBSTANCES CONTROL COMMENTS ON THE REVISED DRAFT HUMAN HEALTH RISK ASSESSMENT, INSTALLATION RESTORATION SITES 09 AND 10 NAVAL STATION TREASURE ISLAND, CALIFORNIA

BACKGROUND

This document presents the U.S. Department of the Navy's (Navy) responses to comments received from David Rist and Brian Davis, Ph.D., Staff Toxicologist, of the Department of Toxic Substances Control (DTSC), on the "Revised Draft Human Health Risk Assessment for Installation Restoration Sites 09 and 10, Naval Station Treasure Island, California," dated September 2004. The Navy received the comments addressed below on November 3, 2004 via fax.

Prior to the submittal of the "Revised Draft Human Health Risk Assessment," the Draft Remedial Investigation Report for Installation Restoration Sites 09 and 10 dated July 2003 was submitted, reviewed, and commented on by DTSC in a memorandum dated November 12, 2003. Representatives of the Navy and its consultants, the City of San Francisco's consultants, and the DTSC took part in a conference call on May 19, 2003, to discuss risk assessment for Sites 09 and 10. On March 8, 2004, a meeting was held at the Regional Water Quality Control Board offices in Oakland, California to discuss resolution of risk assessment issues for Sites 09 and 10. Responses to comments on the Draft Remedial Investigation (RI) report for Sites 09 and 10, which also provided the revised human health risk assessment (HHRA) approach that was agreed upon in the March 8, 2004 meeting, was submitted to the Base Realignment and Closure (BRAC) Cleanup Team (BCT). DTSC provided comments on the May 3, 2004 Final Response to Comments on the Draft Remedial Investigation Report, Installation Restoration Sites 09 and 10 in a memorandum dated June 9, 2004. Based on these meetings and discussions, the Navy revised the HHRA for Sites 09 and 10 and submitted it to the BCT in July 2003.

The comments are organized by general comments and specific comments. Navy response to the comments follows each comment.

GENERAL COMMENTS

1. Comment: SELECTION OF CHEMICALS OF POTENTIAL CONCERN.

A. Our understanding of the agreement made in the March 8, 2004 BCT meeting and described in the responses to comments is that two risk estimates were to be provided, one risk estimate in which chemicals were eliminated as chemicals of potential concern if the concentrations were less than the corresponding preliminary remediation goals (PRGs) and one risk estimate without such a screen. We have consistently stated that the Department of Toxic Substances Control (DTSC) does not accept the elimination of chemicals of potential concern based on screening criteria. Because of the nature of Sites 9 and 10, and in order to move the process

forward, we agreed to the inclusion of two sets of risk and hazard estimates. This risk assessment fails to provide these two sets.

Response: The Navy provided two sets of risk and hazard estimates in the revised draft human health risk assessment as agreed to during the March 8, 2004 meeting. The "Total Risk" screen included a ratiometric comparison of exposure point concentrations (EPCs) and PRGs (US EPA Region IX and Cal-modified) to provide an estimate of risks and hazards. The "Total Risk" screen did not include chemicals of potential concern (COPCs) that were greater than the PRGs because those risks were estimated using RAGS A equations (EPA 1989). To provide complete "Total Risk" estimates, the risk associated with the analytes identified as COPCs will be added to the "Total Risk" screening results.

B. Section 7.2 (Results) reports only on the Navy's preferred method. The DTSC method is relegated to Appendix I. Section 7.2.3 (Total Risk Sensitivity Analysis) makes a qualitative statement that the analysis in Section 10.3 of Appendix I shows that the inclusion of all contaminants would not alter the general conclusions about either site.

Response: To facilitate a full understanding of the "Total Risk" results in Section 7.2 of the Remedial Investigation (RI), the estimates of risks and hazards using the "Total Risk" screen will be summarized similar to the Navy's preferred method. The Section will present "Total Risk" results in accordance with the method described in response to General Comment 1A.

C. Section 10.3 of Appendix I is titled "*Total Risk versus Incremental Risk*", but like Section 7.2 the DTSC method is not quantitated. Instead, a qualitative statement is made that the inclusion of all contaminants would not alter the general conclusions about either site.

Response: As indicated in the response to General Comment 1A, the "Total Risk" estimates will be updated by adding the risk associated with analytes identified as COPCs. The "Total Risk" screening results discussion for Sites 9 and 10 in Section 10.3 of Appendix I will be revised accordingly. The following statement from Appendix I and RI main text: "Thus, the findings of this residual (non-COPC) risk assessment screen would not change the conclusions of the HHRA presented in Section 10.1." will be modified to read as follows: "Thus, the results associated with 'Total Risk' would not change the conclusions of the HHRA presented in Section 10.1."

D. Section 7.1.2.1 states that "*In addition, in response to DTSC requests to evaluate the contribution of all detected analytes to total risk without applying the EPA and Navy guidance for COPC selection, a sensitivity analysis was presented in Section 10.3 of Appendix I…As noted in Section 10.3 of Appendix I, the total risk findings from the residential scenario did not affect the overall conclusions of the*

***HHRA, including use of the COPC selection process…*". This is incorrect. Section 10.3 doesn't present total risks and therefore, any conclusions are questionable.**

Response: As indicated in the response to General Comment 1A, the "Total Risk" estimates will be updated by adding in the risk associated with analytes identified as COPCs. This update will hence present the "Total Risk." The document will thereby provide the supporting documentation for the conclusions in question.

E. Section 10.3.1 of Appendix I is titled "*Total Risk Based on Site 09 Soil*" and Section 10.3.2 of Appendix I is titled "*Total Risk Based on Site 10 Soil*". However, total risks and hazards do not appear. Instead, the additional risks and hazards are estimated by comparing the excluded contaminants to their respective PRGs and summing the ratios. The reader is left to take this information from Section 10.3 and combine it with the previous information from Section 7.2 to find total risk and hazard estimates.

Response: As indicated in the response to General Comment 1A, the "Total Risk" estimates will be updated by adding in the risk associated with analytes identified as COPCs to the Total Risk screening results. Sections 10.3.1 and 10.3.2 of Appendix I will reflect this revision.

F. The additional risks and hazards are evaluated only for the residential scenario (Sections 10.3.1 and 10.3.2).

Response: "Total Risks" were evaluated for residential and commercial/industrial scenarios. A summary of the "Total Risk" screening results was included for both scenarios in Section 10.3.1 for Site 09 soil and 10.3.2 for Site 10 soil. As indicated in the response to General Comment 1A, these risk estimates will be updated by adding in the risk associated with analytes identified as COPCs to the Total Risk screening results. Sections 10.3.1 and 10.3.2 of Appendix I will be modified accordingly for residential and commercial/industrial worker scenarios.

G. We do not agree with the Section 10.3 interpretation of "*incremental risk*" and "*total risk*". The text states that "*DTSC has voiced an interest in insuring that not only 'incremental risk' contributed by Superfund releases and former site operations at Treasure Island be characterized, but that 'total risk' (with no risk-based screen, such that all detected analytes above ambient concentrations were included in the risk assessment) be communicated as well.*" As discussed above, Section 10.3 fails to report total risk. Furthermore, the quoted statement suggests that comparison to PRGs somehow distinguishes between chemicals which are present because of past releases by the Navy and those which must be attributed to other sources. Clearly, this is incorrect. Releases of

contaminants by the Navy may or may not result in concentrations exceeding PRGs.

Response: The text will be modified to read as follows: "DTSC has voiced an interest in insuring that "total risk" (with no risk-based screen, such that all detected analytes above ambient concentrations were included in the risk assessment) be communicated in addition to the incremental risk."

H. The final paragraphs in Sections 10.3.1 and 10.3.2 conclude that "*A total risk evaluation (with no risk-based screen, such that all detected analytes were included in the risk assessment) should have no impact on the risk management decisions based on the conclusions of Section 10.1.*" The purpose of risk assessment is to provide the best estimates of risk and hazard. The purpose of risk management is to consider the results of the risk assessment as part of the decision-making process. It is not appropriate to draw risk management decisions in the risk assessment.

Response: The sentence will be removed from Appendix I and RI main text.

I. Please provide quantitative estimates of total risks and hazards for all receptor categories. Please include these estimates in Section 7.2 as well as in Appendix I. Please provide a table to summarize what was done. We acknowledge and the document should also, that the uncertainty of these estimates is increased because part of the risks and hazards was evaluated by baseline risk assessment methods and part was evaluated by comparison to PRGs.

Response: Quantitative estimates of Total Risks and hazards will be provided as indicated in response to General Comment 1A. Tables 7-1 and 7-2 of the RI will be updated to include the surface soil (0 to 2 feet below ground surface) evaluation for hypothetical future residents and the revised "Total Risk" results. The uncertainty associated with providing risk estimates using the two methods will be addressed in the uncertainty section of the HHRA in Appendix I.

J. Agreement was reached in the March 8, 2004 BCT meeting to provide a dual track risk assessment for Sites 9 and 10. The agreement was specifically for this Remedial Investigation Report for Sites 9 and 10. The difficulties in this approach are illustrated by this comment. As discussed in the March 8, 2004 BCT meeting, future risk assessments should follow DTSC procedures.

Response: Comment noted.

2. Comment: SOIL DEPTH.

The Navy version of the risk assessment evaluates the residential scenario for soils from 0 to 8 feet below ground surface (Sections 7.2.1.2 and 7.2.2.2; Sections 10.1.2

and 10.2.2 of Appendix I). The "*Sensitivity Analysis*" (Sections 10.3.1 and 10.3.2 of Appendix I) evaluates the residential scenario for soils from 0 to 2 feet below ground surface as well as soils from 0 to 8 feet below ground surface. This inconsistency further complicates the consideration of total risks and hazards (General Comment 1).

DTSC requests that deeper soils (0 to 8 feet below ground surface in this case) be considered for residential scenarios because swimming pools are common in California, frequently resulting in deeper soils being brought to the surface of yards. However, both shallow and deeper soils should be evaluated for residential scenarios, so that surface soil contamination is not ignored if it is higher than deeper soil contamination.

Response: Risk and hazard estimates were not provided for residential exposure to surface soil (0 to 2 feet below ground surface) because no current residential exposure exists. The hypothetical future residential exposure scenario was evaluated assuming exposure to deeper soil (0 to 8 feet below ground surface). To facilitate a full understanding of risks and hazards, the residential exposure scenario will include an evaluation of surface soil (0 to 2 feet below ground surface) using RAGS A equations (EPA 1989). The "Total Risk" screen already provides an evaluation of surface soil (0 to 2 feet below ground surface) for residential and commercial/industrial exposure.

3. Comment: ARSENIC

A. As illustrated in Figure I3-3, the distributions of arsenic include outliers for both Site 9 and Site 10. The two outliers for Site 10 are of less concern because they fall within the range of ambient concentrations and are lower concentrations than the Site 9 outliers. The three Site 9 outliers all fall outside range of ambient concentrations and may be of concern.

Response: The discussion of arsenic at Site 09 will be revised to indicate that the on-site distribution of arsenic is not significantly greater than background, but may contain potential outliers.

The arsenic concentrations between 15.4 to 17.7 milligrams per kilogram (mg/kg) are well within the range of naturally occurring arsenic in the United States (1 to 100 mg/kg; Shacklette and Boerngen 1984). These higher concentrations (i.e., potential outliers) and lower concentrations are likely a manifestation of two different soil types from different geologic deposits (i.e., native soils and fill/dredged material). There are general correlations between arsenic, chromium, molybdenum, selenium, and vanadium, which are oxyanion-forming metals that tend to behave similarly under certain environmental conditions. This correlation further supports

that the arsenic concentrations are naturally occurring, although the concentrations are still considered potential outliers for Site 09 soils.

Shacklette, H.T. and Boerngen, J.G. 1984. Element concentrations in soils and other surficial materials of the conterminous United States. USGS Professional Paper 1270.

B. The distributions of arsenic at Sites 9 and 10 were discussed at length in the March 8, 2004 BCT meeting. It was agreed to accept the statistical conclusion that the site distributions of arsenic are not different from the ambient distribution, with the caveat that the three Site 9 outliers required attention.

Response: As stated in response to General Comment 3A, the discussion of arsenic at Site 09 will be revised to indicate that although the distribution of arsenic is not significantly greater than background, it may contain potential outliers. However, although still considered potential outliers, geochemical correlations indicate that these arsenic concentrations are naturally occurring.

C. During the March 8, 2004 BCT meeting, we pointed out that nonparametric tests, such as the Wilcoxon Rank Sum Test and the Gehan-Wilcoxon Test are insensitive to the magnitude of values in the tails of the distribution. The distribution of arsenic at Site 9 provides an excellent illustration of this insensitivity. The three outliers have concentrations of 15.4 mg/kg, 16.9 mg/kg, and 17.7 mg/kg. Their ranking is 1, 2, and 3 in the pooled ambient and site population. This ranking and the outcome of the statistical test would be the same if the concentrations were 154 mg/kg, 169 mg/kg, and 177 mg/kg or even if the concentrations were 154,000 mg/kg, 169,000 mg/kg, and 177,000 mg/kg. The results of any statistical test must be evaluated critically. In this case, the fact that the statistical test ignores the magnitude of the highest concentrations must be taken into account.

Response: As stated in response to General Comment 3A, the discussion of arsenic at Site 09 will be revised to indicate that although the distribution of arsenic is not significantly greater than background, it may contain potential outliers. The uncertainty associated with using tests that do not account for the magnitude of the values in the tails of distribution will be addressed in the uncertainty section (Section 11) of the HHRA in Appendix I.

D. We do not agree with the conclusions stated in the document (page I3-7) that "*The three outlier concentrations of arsenic (15.4, 16.9, and 17.7 mg/kg) are considered part of the natural variability of a data set…*" and that "*These three arsenic locations are not considered to be significant outliers that warrant a hot spot evaluation but were considered part of the natural variation of the data set.*" As we pointed out in our review of the responses to comments (DTSC, 2004), it is unlikely that these three concentrations are natural variation in a Site 9 population with a median of 2.9

mg/kg, a 90th percentile of 7.3 mg/kg, and a next highest concentration of about 9 mg/kg.

Response: The discussion of arsenic at Site 09 will be revised to indicate that although the on-site distribution of arsenic is not significantly greater than background, it may contain potential outliers. The text will also indicate that that the three potential outlier concentrations of arsenic (15.4, 16.9, and 17.7 mg/kg) are likely a manifestation of two different soil types from different geologic deposits (i.e., native soils and fill/dredged material).

E. The text in Table I3-1 states that "*Because long-term exposure is represented by an average concentration over time and is not based on exposure to the values in the extreme upper tail of a dataset, the overall distribution of the data should be given more weight. Based on this weight-of-evidence evaluation, arsenic is not considered significantly greater than ambient for Site 9.*" Exposure in the residential scenario may not be well represented by using concentrations averaged over a site. Residents get their exposure primarily in their own yards. Children may get their exposure primarily in some portion of the yard. Because of this, DTSC (1992) recommends using residential lot-sized areas to determine exposure point concentrations. However, we recognize that Site 9 is only 11,000 square feet (Section 2.1) and Site 10 is only 32,000 square feet (Section 2.2).

Response: Comment noted. The following sentence will be removed from Table I3-1: "Because long-term exposure is represented by an average concentration over time and is not based on exposure to the values in the extreme upper tail of a dataset, the overall distribution of the data should be given more weight.*"*

F. Please add a discussion of the three outliers to Section 7.1.2.1 and to Sections 6.1 and 6.1.3 of Appendix I and to Table I-10 of Appendix I. This discussion should provide sufficient information to allow the risk managers and other readers to be aware of the issue and to make an informed decision regarding the significance of the outliers.

Response: The discussion of arsenic at Site 09 will be revised to indicate that the distribution of arsenic, although not significantly greater than background, may contain potential outliers. As indicated in response to comment 3A, the text will also provide information regarding the significance of the geologic conditions and associated arsenic results.

SPECIFIC COMMENT

1. Comment: Section 10.2.1 of Appendix I, paragraph 1. The reference should be to Section 10.2.2, rather than Section 10.1.2.

Response: The reference to Section 10.2.1 will be changed to reference Section 10.2.2.

2. Conclusions **The human health risk assessment must provide a balanced presentation of total risks and hazards at Sites 9 and 10, as required by DTSC for all hazardous waste sites in California. Evaluation of residential scenarios should consider exposure to those soil depths with the highest concentrations of contaminants. The three outliers in the distribution of arsenic at Site 9 must be acknowledged as such in the risk assessment.**

Response: Comments noted. See previous response to comments**.**

RESPONSES TO GEOMATRIX CONSULTANTS, INC. COMMENTS ON THE REVISED DRAFT HUMAN HEALTH RISK ASSESSMENT, IR SITES 09 AND 10 NAVAL STATION TREASURE ISLAND, CALIFORNIA

This document presents the Navy's responses to comments received from Geomatrix Consultants, Inc. on the "Revised Draft Human Health Risk Assessment for Sites 09 and 10, NAVSTA Treasure Island, California." The Navy received the comments from Gary Foote of Geomatrix, on October 18, 2004 via email.

GENERAL COMMENT

1. Comment: It is my understanding that dioxins were recently detected in soil samples collected at Site 10. The results of these samples should be considered in the HHRA prior to completion of the final document.

Response: Recent discussions at the BCT meetings indicate that the dioxin issue at Site 10 will be handled as part of a removal action. The removal action will be documented as part of the Record of Decision (ROD) and not addressed in the RI. The Navy and DTSC are currently discussing the appropriate approach to complete the removal of dioxins in soils at Site 10.

SPECIFIC COMMENTS

1. Comment: <u>Executive Summary, p. ES-3 and ES-4</u> – There is no mention of the "Total Risk" vs. "Incremental Risk" analysis in the Executive Summary (or in what will be Section 7.0 of the RI report). At a minimum, a summary of the discussion of this analysis, which is presented in Appendix I, should be included in the Executive Summary (and Section 7.0).

Response: The "total risk" vs. "incremental risk" discussion will be added to the following sections of the RI: Executive Summary, Section 7.0, and Results and Conclusions**.**

2. Comment: <u>Section 7.1.1.2, p. 7-2</u> – The use of the word "snapshot" in the second bullet regarding Site 10 groundwater data does not make sense. A similar sentence appears in Appendix I (see p. I-12); however, the word "sufficient" is used in place of "snapshot," which does make sense within the context of the paragraph.

Response: The sentence "*As detailed in Section 5.3.2 of Appendix I, the 2002 data from the two newer wells (10-MW02 and 10-MW03) provide a "snapshot" of likely conditions in the aquifer underlying Site 10.*" will be replaced by "*As detailed in Section 5.3.2 of Appendix I, the 2002 data*

from the two newer wells (10-MW02 and 10-MW03) are considered sufficient to characterize likely conditions in the aquifer underlying Site 10."

3. **Comment:** **Section 7.1.2.2, p. 7-3 – This section is confusing because, on the one hand, it states that only volatile chemicals are screened, but in the very next sentence, it states that all data, including data for non-volatile chemicals, were screened. After reviewing Appendix I, it appears that tap water preliminary remediation goals (PRGs) were used to "screen" non-volatile chemicals (see p. I-18). These sections need to be made consistent as to which chemicals were evaluated in the process of identifying chemicals of potential concern in groundwater.**

Response: The following sentence will be removed from Section 7.1.2.2 to make the RI text consistent with the HHRA text in Appendix I: "For this reason, only VOCs were evaluated as potential COPCs in groundwater."

4. **Comment:** **Section 7.1.3, p. 7-4 and Figure 7-1 – There is still no acknowledgement that ingestion of homegrown produce is a potentially complete pathway under a residential scenario. While I do not necessarily disagree with the Navy's decision not to evaluate this pathway quantitatively, the potential for this pathway to be complete should be addressed qualitatively in the final report. This comment also applies to Appendix I.**

Response: The ingestion of homegrown produce was addressed in the Navy's response to DTSCs comment number 4 in the May 3, 2004 response to comments. As noted in the response to comments, the ingestion of produce pathway was addressed in the uncertainty section (Section 11.2.2) of the HHRA in Appendix I. A brief summary of the uncertainty associated with this pathway will be placed in HHRA uncertainty summary (Section 7.1.6) of the RI.

5. **Comment:** **Section 7.2.3, p. 7-11 – The results of the "total risk evaluation" should be provided in this section rather than simply stating that there would not be a significant change to the HHRA conclusions. This comment also applies to Appendix I.**

Response: Estimates of "Total Risks" will be provided and summarized in Section 7.2.3 and Appendix I. See response to DTSC General Comment 1A.

6. **Comment:** **Section I-5.2.1, p. I-8 – The first sentence in this paragraph states that the initial sampling results from boring 09-SB03 were "deleted before the soil statistics were calculated." However, later in this section, there is a long discussion as to how those results were used**

and how they affected the statistics. Further, at the very end of this section, it states that lead was evaluated separately from other chemicals yet later sections state that lead was not a chemical of potential concern in soil (see Section 6-3). Such discrepancies in the report need to be resolved prior to completion of the final HHRA.

Response: The word "deleted" will be replaced with "averaged" in the following sentence: "At Site 09, sample boring 09-SB03 results were *deleted* before the soil statistics were calculated for the HHRA because sample boring 09-SB05 was later drilled in the exact same location to verify results." The following sentence will be removed from Section I-5.2.1: "Because lead is a unique contaminant with regard to its toxicity (Tetra Tech 2003), it was evaluated separately, as discussed in Section 8.5, with lead risks characterized in Section 10.4."

7. Comment: **<u>Section I-6.1, p. I-14</u> – There is no mention of hexavalent chromium in this section as agreed to by the Navy during the March 8, 2004 meeting on the HHRA for Sites 9 and 10.**

Response: As identified in the Navy's response to DTSCs comment number 5 in the May 3, 2004 response to comments, hexavalent chromium has been added to Section 8.4 of the revised draft HHRA, Appendix I. In addition, a new table, Table I-3, that provides the results of hexavalent and total chromium sampling results, has been provided in Appendix I.

8. Comment: **<u>Section I-6.2.1, p. I-17</u> – The second paragraph states that the California Regional Water Quality Control Board (CRWQCB) screening values for inhalation of chemical vapors in indoor air have not been updated recently (based on a 2001 citation); however, the CRWQCB issued revised values in 2003, which were updated further in 2004.**

Response: The statement was correct at the time when the first draft of this report was issued in June 2003. The sentence will be updated (strikethrough text denotes deleted text) as follows: Although risk-based screening levels (RBSL) developed by the CRWQCB are available to account for the inhalation of chemical vapors while indoors (CRWQCB 2004), these values ~~have not been updated recently. The values~~ presently lack ~~(1) updated~~ building default values recommended by federal EPA guidance (EPA 2002c) ~~and (2) updated toxicity values recommended by DTSC and EPA Region IX, including updated toxicity factors developed in 2002 and 2003~~.

9. Comment: **<u>Attachment I1</u> – There are many blank tables in this attachment (see Tables I2-10.1.1.through the end of the attachment). These tables should be removed if truly not necessary or the appropriate data should be provided.**

Response: RAGS D Table 10s are an important part of the RAGS D series tables and provide a summary of the "risk drivers" (i.e., those analytes with a carcinogenic risk greater than 1E-06 or an noncarcinogenic hazard greater than one). "Blank tables" are necessary because they inform the reviewer that there are no "risk drivers" for the particular exposure scenario in question. No changes will be made to the RAGS D Table 10s.

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November 1998

CLIMATIC WIND DATA FOR THE UNITED STATES

The climatic wind data contained in this summary was extracted from the NCDC's Local Climatological Data publication, Navy & Air
Force climatic briefs, and other sources. Locations are not all inclusive and wind data may be available for sites not listed in this summary.
The total period of this summary is 1930-1996. The period of record (POR) for which wind data is summarized varies for individual sites
and may begin and end at any time during the 1930-1996 period. All available wind data is provided regardless of POR or source.
Updated data for many sites can be obtained from post 1996 Local Climatological Data annual publications.
In the table, prevailing wind directions (DIR) are given in compass points; mean wind speeds (SPD) and peak gust (PGU) are in miles per
hour (mph). When peak gust (PGU) wind velocities are not available, fastest-mile or 5-second winds may be substituted. This will be
indicated by a $ for fastest-mile and # for 5-second winds preceding PGU (ie: $PGU = fastest-mile winds). Wind types may be combined
to reflect the highest reported wind. When appropriate wind data is not available, an N/A will appear in lieu of data.
Conversion tables of miles per hour to knots and compass points to degrees are provided at the end of this wind table.

30
CALIFORNIA

Alameda NAS	DIR	NNW	W	W	W	W	W	W	W	W	W	NNW	W
	SPD	7	7	8	9	9	9	9	9	8	7	6	6	8
	PGU	69	68	58	53	53	49	40	40	48	63	70	71	71
	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANN**
Barstow/	DIR	W	W	W	W	W	W	W	W	W	W	W	W
Daggett/San	SPD	8	9	13	14	14	14	13	12	10	10	9	8	10
Bernardino	PGU	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bakersfield	DIR	ESE	ESE	ESE	ESE	NNW	NNW	NNW	NNW	NNW	NNW	NW	NW	NW
	SPD	5	6	7	7	8	8	7	7	6	6	5	5	6
	PGU	35	44	38	40	40	41	25	30	35	38	35	46	46
Bishop	DIR	N	N	N	N	N	N	N	N	N	N	S	S	N
	SPD	8	8	10	11	9	9	8	8	8	9	8	7	9
	PGU	60	63	58	62	62	54	60	70	47	52	66	68	70
Camp	DIR	W	W	W	W	SSW	WSW	SSW	WSW	WSW	W	W	WSW	W
Pendleton	SPD	5	5	6	7	7	7	7	6	6	5	5	5	6
MCAS	PGU	46	45	43	51	32	26	23	30	33	35	40	46	51
China Lake	DIR	SW	S	SSW	SSW	W	SSW	SSW	SSW	SSW	SSW	SW	SW	SSW
NAS	SPD	5	6	7	8	8	7	7	6	6	5	5	3	6
	PGU	77	79	81	74	82	68	60	58	69	68	71	71	82
Edwards AFB	DIR	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	SPD	5	6	8	9	10	9	9	8	7	6	6	5	7
	PGU	60	67	74	60	62	59	59	61	75	75	55	57	75
Eureka	DIR	SE	SE	N	N	N	N	N	NW	N	N	SE	SE	N
	SPD	7	7	8	8	8	7	7	6	6	6	6	6	7

PGU 70 60 72 53 60 51 45 45 49 52 62 62 72
Fairfield/ DIR N N WSW WSW WSW SW SW WSW SW SW N N SW
Travis AFB SPD 6 7 7 8 12 14 14 14 10 7 6 6 9
PGU 69 75 67 61 53 54 53 52 54 59 62 62 75
Fresno DIR ESE ESE NW NW WNW WNW WNW WNW WNW WNW WNW ESE WNW
SPD 5 6 7 7 8 8 7 7 6 5 5 5 6
PGU 43 40 49 46 43 40 28 28 29 39 54 45 54
Long Beach DIR WNW WNW W S S S S WNW WNW WNW WNW WNW WNW
SPD 6 6 7 7 7 7 7 7 6 6 6 5 6
PGU 43 40 49 46 43 40 28 28 29 38 54 45 44
Los Angeles DIR WSW WSW WSW WSW WSW WSW WSW WSW WSW WSW W W WSW
IAP SPD 7 7 8 9 8 8 8 8 7 7 7 7 8
PGU 51 57 62 59 49 40 31 33 39 46 60 49 62
Los Angeles DIR NE W W W W W W W W W W NE W
City Office SPD 7 7 7 7 6 6 5 5 5 6 6 7 6
$PGU 49 40 47 40 39 32 21 24 27 48 42 44 49
Marysville/ DIR SSE SSE SSE SSE SSE S S S S NNW SSE NNW SSE
Beal AFB SPD 5 5 6 6 6 6 5 5 5 3 5 5 5
PGU 59 62 51 53 43 44 38 35 48 53 64 67 67
Monterey/ DIR SE SW W W W W W W W SW SE W
Fort Ord SPD 5 5 7 8 9 8 8 7 6 6 5 5 7
PGU N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
Mountain DIR N N NNW NNW NNW NNW NNW NNW NNW NNW NNW NNW NNW
View/ SPD 5 5 6 6 7 7 7 7 5 5 5 3 6
Moffett NAS PGU 64 64 51 49 44 46 38 39 38 55 53 62 64
Palmdale DIR SW SW SW SW SW SW SW SW SW SW SW SW SW
SPD 8 9 12 13 13 13 12 10 9 8 8 8 10
PGU 46 63 46 46 46 46 46 46 38 46 46 46 63
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC ANN
Pt. Mugu NAS DIR NE W W W W W W W W W NE W
SPD 6 6 6 6 6 5 5 5 5 5 5 6 6
PGU 70 56 54 58 51 40 38 29 46 49 64 67 70
Red Bluff DIR SSE SSE SSE SSE SSE SSE SSE SSE SSE NW NW NW SSE
SPD 9 9 10 10 9 9 8 8 8 8 8 9
PGU 47 55 60 47 45 41 39 35 43 48 54 49 60
Redding DIR N N N N S S S S S S NNW NNW N
SPD 7 7 8 7 8 8 7 7 6 7 6 7 7
PGU 70 64 74 47 54 60 36 46 44 66 58 85 85
Riverside/ DIR NNW WNW WNW WNW WNW WNW WNW WNW WNW WNW WNW NNW NNW
March AFB SPD 3 3 3 5 5 5 5 5 3 3 3 3 3
PGU 53 52 55 46 44 45 49 41 45 47 51 56 56
Sacramento DIR SE SE SE SE SE SE SE SE SE SW SW SW SE
SPD 7 8 9 9 9 10 9 9 8 7 6 7 8
$PGU 60 51 66 45 74 47 36 38 42 68 70 70 74
San Diego DIR WNW WNW WNW WNW WNW WNW WNW WNW WNW WNW WNW WNW WNW
SPD 6 7 8 8 8 8 8 7 7 7 6 6 7
PGU 64 46 44 40 40 35 30 29 35 32 37 44 64
San Clemente DIR WNW WNW WNW W W W W W W W W W
SPD 7 7 9 8 8 8 7 7 7 7 7 6 7
PGU 47 53 51 52 49 36 32 32 33 47 46 53 53
San DIR WNW WNW WNW WNW WNW WNW WNW WNW WNW WNW WNW WNW WNW
Francisco AP SPD 8 9 11 13 14 14 14 13 12 10 8 8 11
PGU 61 69 64 54 58 51 52 45 44 58 60 74 74
San Nicholas DIR NW NW NW NW NW NW NW NW NW NW NW NW NW
SPD 9 10 13 13 12 12 10 10 9 9 9 8 10
PGU 60 74 62 64 64 60 52 47 54 58 60 63 74
Santa Ana/ DIR W WSW WSW WSW WSW WSW WSW WSW WSW WSW W W WSW
El Toro SPD 3 5 5 5 5 5 5 3 3 3 3 3 3
MCAS PGU 66 61 48 52 46 33 31 36 46 46 63 68 68
Santa DIR N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
Barbara SPD 5 6 7 8 7 7 7 6 6 6 5 5 6
PGU N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A
Santa Maria DIR WNW WNW WNW WNW WNW WNW WNW NW WNW W WNW WNW WNW

SPD 6 7 8 9 9 8 7 6 6 6 6 6 7
PGU 54 58 53 47 45 45 41 35 38 37 38 52 58
Stockton DIR SE SE WNW WNW W W WNW WNW WNW WNW SE SE WNW
SPD 7 6 8 8 9 9 8 8 7 6 6 6 7
PGU 46 40 39 35 35 35 29 30 33 37 40 44 46

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA COUNTIES
1850 - 2000

	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
California	**33,871,648**	**29,760,021**	**23,667,902**	**19,953,134**	**15,717,204**	**10,586,223**	**6,907,387**	**5,677,251**	**3,426,861**	**2,377,549**	**1,485,053**	**1,213,398**	**864,694**	**560,247**	**379,994**	**92,597**
Alameda	1,443,741	1,279,182	1,105,379	1,073,184	908,209	740,315	513,011	474,883	344,177	246,131	130,197	93,864	62,976	24,237	8,927	--
Alpine	1,208	1,113	1,097	484	397	241	323	241	243	309	509	667	539	685	--	--
Amador	35,100	30,039	19,314	11,821	9,990	9,151	8,973	8,494	7,793	9,086	11,116	10,320	11,384	9,582	10,930	--
Butte	203,171	182,120	143,851	101,969	82,030	64,930	42,840	34,093	30,030	27,301	17,117	17,939	18,721	11,403	12,106	3,574
Calaveras	40,554	31,998	20,710	13,585	10,289	9,902	8,221	6,008	6,183	9,171	11,200	8,882	9,094	8,895	16,299	16,884
Colusa	18,804	16,275	12,791	12,430	12,075	11,651	9,788	10,258	9,290	7,732	7,364	14,640	13,118	6,165	2,274	115
Contra Costa	948,816	803,732	656,380	558,389	409,030	298,984	100,450	78,608	53,889	31,674	18,046	13,515	12,525	8,461	5,328	--
Del Norte	27,507	23,460	18,217	14,580	17,771	8,078	4,745	4,739	2,759	2,417	2,408	2,592	2,584	2,022	1,993	--
El Dorado	156,299	125,995	85,812	43,833	29,390	16,207	13,229	8,325	6,426	7,492	8,986	9,232	10,683	10,309	20,562	20,057
Fresno	799,407	667,490	514,621	413,053	365,945	276,515	178,565	144,379	128,779	75,657	37,862	32,026	9,478	6,336	4,605	--
Glenn	26,453	24,798	21,350	17,521	17,245	15,448	12,195	10,935	11,853	7,172	5,150	--	--	--	--	--
Humboldt	126,518	119,118	108,514	99,692	104,892	69,241	45,812	43,233	37,413	33,857	27,104	23,469	15,512	6,140	2,694	--
Imperial	142,361	109,303	92,110	74,492	72,105	62,975	59,740	60,903	43,453	13,591	--	--	--	--	--	--
Inyo	17,945	18,281	17,895	15,571	11,684	11,658	7,625	6,555	7,031	6,974	4,377	3,544	2,928	1,956	--	--
Kern	661,645	543,477	403,089	329,162	291,984	228,309	135,124	82,570	54,843	37,715	16,480	9,808	5,601	2,925	--	--
Kings	129,461	101,469	73,738	64,610	49,954	46,768	35,168	25,385	22,031	16,230	9,871	--	--	--	--	--
Klamath	--	--	--	--	--	--	--	--	--	--	--	--	--	1,686	1,803	--
Lake	58,309	50,631	36,366	19,548	13,786	11,481	8,069	7,166	5,402	5,526	6,017	7,101	6,596	2,969	--	--
Lassen	33,828	27,598	21,661	14,960	13,597	18,474	14,479	12,589	8,507	4,802	4,511	4,239	3,340	1,327	--	--
Los Angeles	9,519,338	8,863,164	7,477,503	7,032,075	6,038,771	4,151,687	2,785,643	2,208,492	936,455	504,131	170,298	101,454	33,381	15,309	11,333	3,530
Madera	123,109	88,090	63,116	41,519	40,468	36,964	23,314	17,164	12,203	8,368	6,364	--	--	--	--	--
Marin	247,289	230,096	222,568	206,038	146,820	85,619	52,907	41,648	27,342	25,114	15,702	13,072	11,324	6,903	3,334	323
Mariposa	17,130	14,302	11,108	6,015	5,064	5,145	5,605	3,233	2,775	3,956	4,720	3,787	4,339	4,572	6,243	4,379
Mendocino	86,265	80,345	66,738	51,101	51,059	40,854	27,864	23,505	24,116	23,929	20,465	17,612	12,800	7,545	3,967	55
Merced	210,554	178,403	134,560	104,629	90,446	69,780	46,988	36,748	24,579	15,148	9,215	8,085	5,656	2,807	1,141	--
Modoc	9,449	9,678	8,610	7,469	8,308	9,678	8,713	8,038	5,425	6,191	5,076	4,986	4,399	--	--	--
Mono	12,853	9,956	8,577	4,016	2,213	2,115	2,299	1,360	960	2,042	2,167	2,002	7,499	430	--	--
Monterey	401,762	355,660	290,444	250,071	198,351	130,498	73,032	53,705	27,980	24,146	19,380	18,637	11,302	9,876	4,739	1,872
Napa	124,279	110,765	99,199	79,140	65,890	46,603	28,503	22,897	20,678	19,800	16,451	16,411	13,235	7,163	5,521	405
Nevada	92,033	78,510	51,645	26,346	20,911	19,888	19,283	10,596	10,850	14,955	17,789	17,369	20,823	19,134	16,446	--
Orange	2,846,289	2,410,556	1,932,709	1,420,386	703,925	216,224	130,760	118,674	61,375	34,436	19,696	13,589	--	--	--	--
Placer	248,399	172,796	117,247	77,306	56,998	41,649	28,108	24,468	18,584	18,237	15,786	15,101	14,232	11,357	13,270	--
Plumas	20,824	19,739	17,340	11,707	11,620	13,519	11,548	7,913	5,681	5,259	4,657	4,933	6,180	4,489	4,363	--
Riverside	1,545,387	1,170,413	663,166	459,074	306,191	170,046	105,524	81,024	50,297	34,696	17,897	--	--	--	--	--
Sacramento	1,223,499	1,041,219	783,381	631,498	502,778	277,140	170,333	141,999	91,029	67,806	45,915	40,339	34,390	26,830	24,142	9,087
San Benito	53,234	36,697	25,005	18,226	15,396	14,370	11,392	11,311	8,995	8,041	6,633	6,412	5,584	--	--	--
San Bernardino	1,709,434	1,418,380	895,016	684,072	503,591	281,642	161,108	133,900	73,401	56,706	27,929	25,497	7,786	3,988	5,551	--
San Diego	2,813,833	2,498,016	1,861,846	1,357,854	1,033,011	556,808	289,348	209,659	112,248	61,665	35,090	34,987	8,618	4,951	4,324	798
San Francisco	776,733	723,959	678,974	715,674	740,316	775,357	634,536	634,394	506,676	416,912	342,782	298,997	233,959	149,473	56,802	--
San Joaquin	563,598	480,628	347,342	290,208	249,989	200,750	134,207	102,940	79,905	50,731	35,452	28,629	24,349	21,050	9,435	3,647
San Luis Obispo	246,681	217,162	155,435	105,690	81,044	51,417	33,246	29,613	21,893	19,383	16,637	16,072	9,142	4,772	1,782	336
San Mateo	707,161	649,623	587,329	556,234	444,387	235,659	111,782	77,405	36,781	26,585	12,094	10,087	8,669	6,635	3,214	--
Santa Barbara	399,347	369,608	298,694	264,324	168,962	98,220	70,555	65,167	41,097	27,738	18,934	15,754	9,513	7,784	3,543	1,185
Santa Clara	1,682,585	1,497,577	1,295,071	1,064,714	642,315	290,547	174,949	145,118	100,676	83,539	60,216	48,005	35,039	26,246	11,912	--
Santa Cruz	255,602	229,734	188141	123790	84219	66534	45057	37433	26269	26140	21512	19,270	12,802	8,743	4,944	643
Shasta	163,256	147,036	115,715	77,640	59,468	36,413	28,800	13,927	13,361	18,920	17,318	12,133	9,492	4,173	4,360	378
Sierra	3,555	3,318	3,073	2,365	2,247	2,410	3,025	2,422	1,783	4,098	4,017	5,051	6,623	5,619	11,387	--
Siskiyou	44,301	43,531	39,732	33,225	32,885	30,733	28,598	25,480	18,545	18,801	16,962	12,163	8,610	6,848	7,629	--
Solano	394,542	340,421	235,203	169,941	134,597	104,833	49,118	40,834	40,602	27,559	24,143	20,946	18,475	16,871	7,169	580
Sonoma	458,614	388,222	299,681	204,885	147,375	103,405	69,052	62,222	52,090	48,394	38,480	32,721	25,926	19,819	11,867	560
Stanislaus	446,997	370,522	265,900	194,506	157,294	127,231	74,866	56,641	43,557	22,522	9,550	10,040	8,751	6,499	2,245	--
Sutter	78,930	64,415	52,246	41,935	33,380	26,239	18,680	14,618	10,115	6,328	5,886	5,469	5,159	5,030	3,390	3,444
Tehama	56,039	49,625	38,888	29,517	25,305	19,276	14,316	13,866	12,882	11,401	10,996	9,916	9,301	3,587	4,044	--
Trinity	13,022	13,063	11,858	7,615	9,706	5,087	3,970	2,809	2,551	3,301	4,383	3,719	4,999	3,213	5,125	1,635
Tulare	368,021	311,921	245,738	188,322	168,403	149,264	107,152	77,442	59,031	35,440	18,375	24,574	11,281	4,533	4,638	--
Tuolumne	54,501	48,456	33,928	22,169	14,404	12,584	10,887	9,271	7,768	9,979	11,166	6,082	7,848	8,150	16,229	8,351
Ventura	753,197	669,016	529,174	376,430	199,138	114,647	69,685	54,976	28,724	18,347	14,367	10,071	5,073	--	--	--
Yolo	168,660	141,092	113,374	91,788	65,727	40,640	27,243	23,644	17,105	13,926	13,618	12,684	11,772	9,899	4,716	1,086
Yuba	60,219	58,228	49,733	44,736	33,859	24,420	17,034	11,331	10,375	10,042	8,620	9,636	11,284	10,851	13,668	9,673

Source: U.S. Department of Commerce
U.S. Census Bureau

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Los Angeles	Acton	2,390	1,471														
1970	San Bernardino	Adelanto	18,130	8,517	2,164	2,115												
	Modoc	Adin													217			
1982	Los Angeles	Agoura Hills	20,537	20,390	11,399													
	Stanislaus	Airport					3,689											
1854	Alameda	Alameda	72,259	76,459	63,852	70,968	63,855	64,430	36,256	35,033	28,806	23,383	16,464	11,165	5,708			
	Contra Costa	Alamo	15,626	12,277	8,505		1,791											
	Contra Costa	Alamo-Danville				14,059												
1908	Alameda	Albany	16,444	16,327	15,130	14,674	14,804	17,590	11,493	8,569	2,462	808						
	Mendocino	Albion														115		
1903	Los Angeles	Alhambra	85,804	82,106	64,767	62,125	54,807	51,359	38,935	29,472	9,096	5,021		808				
	Orange	Alieso Viejo	40,166	7,612														
	Monterey	Alisal					16,473	16,714										
	Sierra	Alleghany													277	240		
		Almanor																
	Los Angeles	Alondra Park	8,622	12,215	12,096	12,193												
	Tulare	Alpaugh	761															
	San Diego	Alpine	13,143	9,695	5,368	1,570	1,044											
	Alpine	Alpine Village	136															
	Placer	Alta													120			
	Nevada	Alta Hill			1,229	1,185	1,078											
	Nevada	Alta Sierra	6,522	5,709	2,168													
	Los Angeles	Altadena	42,610	42,658	40,510	42,380	40,568											
	Calaveras	Altaville													71			
1901	Modoc	Alturas	2,892	3,231	3,025	2,799	2,819	2,819	2,090	2,338	979	916			148			
	Santa Clara	Alum Rock	13,479		16,890	18,355	18,942											
	Alameda	Alvarado													364	315		
	Santa Clara	Alviso					1,174	652	677	381	517	402			141			
1915	Amador	Amador	196	196	136	156	202	151	249	171	377			984	824			
	Riverside	American															629	
1992	Napa	American Canyon	9,774	7,706	5,712													
	Placer	American Hills													16			
	Santa Cruz	Amesti	2,436															
1878	Orange	Anaheim	328,014	266,406	219,494	166,408	104,184	14,556	11,031	10,995	5,526	2,628	1,456	1,273	833			
	Mendocino	Anderson														623	293	
1956	Shasta	Anderson	9,022	8,299	7,381	5,492	4,492	1,501						508				
	Marin	Angel Island													305			
1912	Calaveras	Angels Camp	3,004	2,409	2,302	1,710	1,121	1,147	1,163	915	941			917	330			
	Napa	Angwin	3,148	3,503	3,526	2,690												
1872	Contra Costa	Antioch	90,532	62,195	42,683	28,060	17,305	11,051	5,106	3,563	1,936	1,124	674	635	626			
1988	San Bernardino	Apple Valley	54,239	46,079	14,305	6,702												
	Santa Cruz	Aptos	9,396	9,061	7,039	8,704												
	Santa Cruz	Aptos Hills-Larkin Valley	2,361	2,205														
	Amador	Aqueduct													22			
	Colusa	Arbuckle	2,332	1,912	1,306	1,037							1,459	375	187			
1903	Los Angeles	Arcadia	53,054	48,290	45,993	42,868	41,005	23,066	9,122	5,216	2,239	696						
1858	Humboldt	Arcata	16,651	15,197	12,340	8,985	5,235	3,729	1,855	1,709	1,486	1,121	952	962	702			
	Sacramento	Arden-Arcade	96,025	92,040	87,570	82,492	73,352											
	Kings	Armona	3,239	3,122	2,644	1,392	1,302	1,274										
	Calaveras	Arnold	4,218	3,788	2,385													
	Monterey-San Benito	Aromas	2,797	2,275														
	Mendocino	Arranus															336	
1911	San Luis Obispo	Arroyo Grande	15,851	14,378	11,290	7,454	3,291	1,723	1,090	892	760			466				
1959	Los Angeles	Artesia	16,380	15,464	14,301	14,757	9,993											
1960	Kern	Arvin	12,956	9,286	6,863	5,199	5,310	5,007										
	Alameda	Ashland	20,793	16,590	13,893	14,810												

Source: U.S. Census Bureau
General Population Characteristics California

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
1979	San Luis Obispo	Atascadero	26,411	23,138	16,232	10,290	5,983	3,443										
1923	San Mateo	Atherton	7,194	7,163	7,797	8,085	7,717	3,630	1,908	1,242								
1922	Merced	Atwater	23,113	22,282	17,530	11,640	7,318	2,856	1,235	917								
	Fresno	Auberry	2,053	1,866														
1888	Placer	Auburn	12,462	10,592	7,540	6,570	5,586	4,653	4,013	2,661	2,289	2,376	2,050	1,595	1,229	800	811	
	Sutter	Auburn & vicinity																1302
	San Joaquin	August	7,808	6,376	5,445													
	San Joaquin	August School Area				6,293												
1913	Los Angeles	Avalon	3,127	2,918	2,022	1,520	1,536	1,506	1,637	1,897	586							
1979	Kings	Avenal	14,674	9,770	4,137	3,035	3,147	3,982										
	Calaveras	Avery	672															
	Los Angeles	Avocado Heights	15,148	14,232	11,721	9,810												
1898	Los Angeles	Azusa	44,712	41,333	29,380	25,217	20,497	11,042	5,209	4,808	2,460	1,477	863			320	363	
1898	Kern	Bakersfield	247,057	174,820	105,611	69,515	56,848	34,784	29,252	26,015	18,638	12,727	4,836	2,626	801			
1956	Los Angeles	Baldwin Park	75,837	69,330	50,554	47,285	33,951											
1913	Riverside	Banning	23,562	20,570	14,020	12,034	10,250	7,034	3,874	2,752	1,810					520		
1947	San Bernardino	Barstow	21,119	21,472	17,690	17,442	11,644	6,135										
	Fresno	Bartlett Colony						1,515										
	Solano	Batavia														200		
	Placer	Bath													172			
	Humboldt	Batview-Rosewood-Cutten						2,779										
	Contra Costa	Bay Point	21,534															
	Humboldt	Bayview	2,359	1,318														
	Contra Costa	Bayview-Montalvin	5,004	3,988														
	Humboldt	Bayview-Pine Hills				2,340												
	Humboldt	Bayview-Rosewood					2,980											
	San Luis Obispo	Baywood-Los Osas	14,351	14,377	10,933	3,487												
	Yuba	Beale AFB	5,115	6,912														
	Yuba	Beale AFB East			6,329	7,029												
	Yuba	Beale AFB North				2,325												
	Sutter	Beal's Bar and Dead Man's Bar																42
	Sutter	Beal's Bar, Forkville																378
	Mariposa	Bear Valley	133												150			
	Kern	Bear Valley Springs	4,232	1,593														
1912	Riverside	Beaumont	11,384	9,685	6,818	5,484	4,288	3,152	2,208	1,332	857							
	Plumas	Beckwourth	342															
	Plumas	Belden	26															
1927	Los Angeles	Bell	36,664	34,365	25,450	21,836	19,450	15,430	11,264	7,884								
1961	Los Angeles	Bell Gardens	44,054	42,355	34,117	29,308	26,467											
1957	Los Angeles	Bellflower	72,878	61,815	53,441	51,454	45,909											
1926	San Mateo	Belmont	25,123	24,127	24,505	23,667	15,996	5,567	1,229	984					202			
1896	Marin	Belvedere	2,125	2,147	2,401	2,599	2,148	800	457	500	616	481	434					
	Santa Cruz	Ben Lomond	2,364	7,884	7,238	2,793	1,814											
1850	Solano	Benicia	26,865	24,437	15,376	8,783	6,070	7,284	2,419	2,913	2,693	2,360	2,751	2,361	1,794			480
	Mono	Benton													154			
1878	Alameda	Berkeley	102,743	102,724	103,328	116,716	111,268	113,805	85,547	82,109	56,036	40,434	13,214	5,101				
	Riverside	Bermuda Dunes	6,229	4,571														
	Siskiyou	Berryvale													58			
	Del Norte	Bertsch-Oceanview	2,238															
	Contra Costa	Bethel Island	2,312	2,115	1,774	1,398												
1914	Los Angeles	Beverly Hills	33,784	31,971	32,646	33,416	30,817	29,032	26,823	17,429	674							
	Lassen	Bieber													43			
	San Bernardino	Big Bear City	5,779	4,920	11,151													
1980	San Bernardino	Big Bear Lake	5,438	5,351	4,896	5,268	1,562	1,434										
	Shasta	Big Bend	149															

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General Population Characteristics California

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Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Plumas	Big Meadows													300			
	Tuolumne	Big Oak Flat													73			
	Inyo	Big Pine	1,350	1,158	1,510													
	Mendocino	Big River	1,266														473	
	Siskiyou	Big Shasta Valley													56			
1903	Butte	Biggs	1,793	1,581	1,413	1,115	831	784	547	463	683	403		571	95			
	Solano	Binghamton														80		
	Humboldt	Biola Junction						1,002										
	Nevada	Birchville													182			
	Placer	Bird Flat													48			
	Fresno	Biola	1,037															
	Inyo	Bishop	3,575					2,891	1,490	1,159	1,304	1,190		340				
1903	Inyo	Bishop - Bishop Creek		3,475	3,333	3,498	2,875									624		
	Inyo	Bishops Creek													159			
	Contra Costa	Blackhawk-Camino Tassajara	10,048	6,199														
	Marin	Black Point-Green Point	1,143															
	Plumas	Blairsden	50															
	Yolo	Blacks													85			
	Humboldt	Blocksburg													121			
	Sonoma	Bloomfield													192			
	San Bernardino	Bloomington	19,318	15,116	12,781	11,957												
	Placer	Blue Canyon													162			
1910	Humboldt	Blue Lake	1,135	1,235	1,201	1,112	1,234	824	503	555	441	507						
	San Bernardino	Bluewater	265	261														
	Nevada	Blue Tent													350			
	Riverside	Bly					1,554											
1916	Riverside	Blythe	12,155	8,428	6,805	7,047	6,023	4,089	2,355	1,020	1,622							
	Nevada	Boca												266	123			
	Sonoma	Bodega Bay	1,423	1,127														
	Sonoma	Bodega Corners													157			
	Kern	Bodfish	1,823	1,283	1,379													
	Mono	Bodie												595	2,712			
	Marin	Bolinas	1,246	1,098	1,225													
	Imperial	Bombay Beach	366															
	Madera	Bonadelle Ranchos - Madera Ranchos	7,300	5,705	3,272													
	San Diego	Bonita	12,401	12,542	6,257													
	Shasta	Bonnyville				4,882	4,686											
	San Diego	Bonsall	3,401	1,881														
	Mariposa	Bootjack	1,588	1,295														
	Fresno	Borden													203			
	Kern	Boron	2,025	2,101	2,040	1,999												
	San Diego	Borrego Springs	2,535	2,244	1,405													
	Monterey	Boronda	1,325															
	San Diego	Bostonia	15,169	13,670														
	Calaveras	Bostwick Bar													50			
	Santa Cruz	Boulder Creek	4,081	6,725	5,662	1,806	1,306	1,497				544		489				
	Fresno	Bowles	182															
	Mendocino	Bourn's Landing														40		
	Yuba	Bowling Green																126
	Placer	Bowman-Auburn North				2,089												
	Sonoma	Boyes Hot Springs	6,665	5,973	4,177	3,558	2,462											
	Sonoma	Boyes Springs - Fetter Springs						2,391										
1957	Los Angeles	Bradbury	855	829	846	1,098	618											
	Monterey	Bradley	120															
1908	Imperial	Brawley	22,052	18,923	14,946	13,746	12,703	11,922	11,718	10,439	5,389	881						
1917	Orange	Brea	35,410	32,873	27,913	18,447	8,487	3,208	2,567	2,435	1,037							
1948	Contra Costa	Brentwood	23,302	7,563	4,434	2,649	2,186	1,729										

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		Bret Harte	5,161															
	Mono	Bridgeport													335	60		
	Solano	Bridgeport														80		
	Humboldt	Bridgeville													25			
1961	San Mateo	Brisbane	3,597	2,952	2,969	3,003												
	San Mateo	Broadmoor	4,026	3,739														
	Yolo	Broderick-Bryte			10,194	12,782												
	Nevada	Bronco													30			
	Alameda	Brooklyn														1,603	1,341	
	Yuba	Browns Valley													168			
	Plumas	Bucks Lake	17															
1992	Santa Barbara	Buellton	3,828	3,506	2,364	1,402												
1953	Orange	Buena Park	78,282	68,784	64,165	63,646	46,401	5,483										
	Santa Clara	Buena Vista	1,704															
1911	Los Angeles	Burbank	100,316	93,643	84,625	88,871	90,155	78,577	34,337	16,662	2,913							
	Santa Clara	Burbank CDP	5,239	4,902														
1908	San Mateo	Burlingame	28,158	26,801	26,173	27,320	24,036	19,886	15,940	13,270	4,107	1,565						
	Shasta	Burney	3,217	3,423	3,187	2,190	1,294	1,513										
	Tulare	Burton					4,635	2,381										
	Placer	Butchers Ranch													227			
	Colusa	Butte Creek															153	
	Butte	Butte Creek Mines													159			
	Siskiyou	Butteville													60			
	Kern	Buttonwillow	1,266	1,301	1,350	1,193												
	Contra Costa	Byron	916															
	Stanislaus	Bystrom	4,518															
	Riverside	Cabazon	2,229	1,588		598	498											
	Yolo	Cache Creek																275
	Yolo	Cacheville													213			
1991	Los Angeles	Calabasas	20,033															
1908	Imperial	Calexico	27,109	18,633	14,412	10,625	7,992	6,433	5,415	6,299	6,223	797						
1965	Kern	California City	8,385	5,955	2,743	1,309												
1990	San Bernardino	Calimesa	7,139	4,647														
1919	Imperial	Calipatria	7,289	2,690	2,636	1,824	2,548	1,428	1,799	1,554	785							
1886	Napa	Calistoga	5,190	4,468	3,879	1,882	1,514	1,418	1,124	1,000	850	751	690		467			
	Siskiyou	Callahan													145			
	Fresno	Calwa	762		6,640	5,191												
1964	Ventura	Camarillo	57,077	52,303	37,797	19,219	2,359											
	Ventura	Camarillo Heights			6,341	5,892	1,704											
	San Luis Obispo	Cambria	6,232	5,382	3,061	1,716								288				
	Santa Clara	Cambrian Park	3,258	2,998		5,371												
	El Dorado	Cameron Park	14,549	11,897	5,607													
	Klamath	Camp Gaston														118		
	San Diego	Camp Pendleton North	8,197	10,373	2,065													
	San Diego	Camp Pendleton South	8,854	11,299	7,952													
1952	Santa Clara	Campbell	38,138	36,048	27,067	24,770	11,863											
	Calaveras	Campo Seco													105			
	Placer	Canada Hill													35			
	Fresno	Cantua Creek	655															
	Trinity	Canyon City														130		
	Los Angeles	Canyon Country			15,728													
	El Dorado	Canyon Creek																252
	Plumas	Canyondam	37															
1990	Riverside	Canyon Lake	9,952	7,938	2,039													
	Orange	Capistrano Beach			6,168	4,149	2,026											
1949	Santa Cruz	Capitola	10,033	10,171	9,095	5,080	2,021	1,848										

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	San Diego	Cardiff-by-the-Sea			10,054	5,724	3,149											
1952	San Diego	Carlsbad	78,247	63,126	35,490	14,944	9,253	4,383										
	Monterey	Carmel Valley Village	4,700	4,407	4,013	3,026	1,143											
	Monterey	Carmel Woods					1,043											
	Monterey	Carmel Woods-Hatten Fields-Carmel Point						1,929										
1916	Monterey	Carmel-By-The-Sea	4,081	4,239	4,707	4,525	4,580	4,351	2,837	2,260	638							
	Sacramento	Carmichael	49,742	48,702	43,108	37,625	20,455	4,499										
1965	Santa Barbara	Carpinteria	14,194	13,747	10,835	6,982	4,998	2,864										
	Siskiyou	Carrick	156															
1968	Los Angeles	Carson	89,730	83,995	81,221	71,150	38,059											
	Calaveras	Carson Hill													22			
	Inyo	Cartago	109															
	Fresno	Caruthers	2,103	1,603	1,514													
	Ventura	Casa Conejo	3,180	3,286														
	San Diego	Casa de Oro - Mount Helix	18,874	30,727	19,651													
	Ventura	Casitas Springs			1,038	1,113												
	Mendocino	Caspar												206		196		
	Merced	Castle				1,903												
	San Diego	Castle Park-Otay			21,049													
	Alameda	Castro Valley	57,292	48,619	44,011	44,760	37,120											
	Monterey	Castroville	6,724	5,272	4,396	3,235	2,838	1,865						641	533	436		
1981	Riverside	Cathedral City	42,647	30,085	4,130	3,640	1,855											
	San Luis Obispo	Cayucos	2,943	2,960	2,301	1,772												
	Modoc	Cedarville													219			
	Alameda	Centerville						1,401							203			
	El Dorado	Centerville													91			
	Mendocino	Centerville													56			
	Fresno	Central colony												510	257			
	Shasta	Central Valley		4,340	3,424	2,361	2,854	2,202										
	Butte	Centreville													50			
	Fresno	Centreville													108			
	El Dorado	Centreville & vicinity																84
1918	Stanislaus	Ceres	34,609	26,314	13,281	6,029	4,406	2,351	1,332	981	637							
	Stanislaus	Ceres Northwest					1,126											
1956	Los Angeles	Cerritos	51,488	53,240	53,020	15,856	3,508								166			
	Inyo	Cerro Gordo													55	474		
	Yuba	Challenge-Brownsville	1,069	1,096														
	Ventura	Channel Islands Beach	3,142	3,317														
	Los Angeles	Charter Oak	9,027	8,858	6,840													
	Santa Clara	Chemeketa Park - Redwood Estates			1,847	1,427	1,284											
	Butte	Cherokee													699			
	Nevada	Cherokee													48			
	Riverside	Cherry Valley	5,891	5,945	5,012	3,165												
	Alameda	Cherryland	13,837	11,088	9,425	9,969												
	Plumas	Chester	2,316	2,082	1,756	1,531	1,553	1,197										
1872	Butte	Chico	59,954	40,079	26,603	19,580	14,757	12,272	9,287	7,961	9,339	3,750	2,640	2,894	3,300			
	Butte	Chico North			11,733	6,656												
	Butte	Chico Vecino					4,688	3,967										
	Butte	Chico West			6,378	4,687												
	Plumas	Chilcoot-Vinton	387															
	Kern	China Lake			4,275	11,105												
	Kern	China Lake Acres	1,761															
	Tuolumne	Chinese Camp	146												184			
1910	San Bernardino	Chino	67,168	59,682	40,165	20,411	10,305	5,784	4,204	3,118	2,132	1,444						
1991	San Bernardino	Chino Hills	66,787	27,608														
1923	Madera	Chowchilla	11,127	5,930	5,122	4,349	4,525	3,893	1,957	847								

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	Ventura	Chrisman					3,923	4,211										
	Monterey	Chualar	1,444												46			
1911	San Diego	Chula Vista	173,556	135,163	83,927	67,901	42,034	15,927	5,138	3,869	1,718							
	El Dorado	Cincinnati & vicinity																168
	Placer	Cisco													73			
	Los Angeles	Citrus	10,581	9,481	12,450													
1997	Sacramento	Citrus Heights	85,071	107,439	85,911	21,760												
	Alameda	Claremont												272				
1907	Los Angeles	Claremont	33,998	32,503	30,950	23,998	12,633	6,327	3,057	2,719	1,728	1,114						
1964	Contra Costa	Clayton	10,762	7,317	4,325	1,385												
1980	Lake	Clearlake	13,142	11,804														
	Lake	Clearlake Highlands				2,836												
	Lake	Clearlake Highlands-Clearlake Park			4,983													
	Lake	Clearlake Oaks	2,402	2,419	1,610													
	San Joaquin	Clements												333				
	Nevada	Clinton													82			
	Plumas	Clio	90															
1872	Sonoma	Cloverdale	6,831	4,924	3,989	3,251	2,848	1,292	809	759	718	823	750	763	430			
1912	Fresno	Clovis	68,468	50,323	33,021	13,856	5,546	2,766	1,626	1,316	1,157							
	Contra Costa	Clyde	694															
1946	Riverside	Coachella	22,724	16,896	9,129	8,353	4,854	2,755										
1906	Fresno	Coalinga	11,668	8,212	6,593	6,161	5,965	5,539	5,026	2,851	2,934	4,199						
	Lake	Cobb	1,638	1,477														
	Plumas	Cobb Valley													67			
	El Dorado	Cold Springs															120	
	Placer	Coldstream													54			
1910	Placer	Colfax	1,496	1,306	981	798	915	820	794	912	573	621		670	591			
	Colusa	College Town												387	237			
	San Joaquin	Collegeville															53	
1924	San Mateo	Colma	1,191	1,103	395	537	500	297	354	369					188			
	El Dorado	Coloma													231		888	588
	San Diego	Colorado														229	310	
1887	San Bernardino	Colton	47,662	40,213	21,310	19,974	18,666	14,465	9,686	8,014	4,282	3,980	1,285	1,315				
	Tulare	Columbia													650			
	Tuolumne	Columbia	2,405	1,799												1,123	2,062	
	El Dorado	Columbia Flat													29			
	Colusa	Colusa	5,402	4,934	4,075	3,842	3,518	3,031	2,285	2,116	1,846	1,582	1,441	1,336	1,779	1,051	348	
	Calaveras	Comanche													104			
1960	Los Angeles	Commerce	12,568	12,135	10,509	10,536	9,555											
1888	Los Angeles	Compton	93,493	90,454	81,286	78,611	71,812	47,991	16,198	12,516	1,478	922		636		160		
1905	Contra Costa	Concord	121,780	111,348	103,255	85,164	36,000	6,953	1,373	1,125	912	703		373	399			
	Butte	Concow	1,095	1,392														
	Sutter	Condemned Bar																42
	Calaveras	Copperopolis	2,363											232	148			
	Shasta	Coram									32	666						
1914	Kings	Corcoran	14,458	13,364	6,454	5,249	4,976	3,150	2,092	1,768	1,101							
1907	Tehama	Corning	6,741	5,870	4,745	3,573	3,006	2,537	1,472	1,377	1,449	972		210				
1896	Riverside	Corona	124,966	76,095	37,791	27,519	13,336	10,223	8,764	7,018	4,129	3,540	1,434					
1890	San Diego	Coronado	24,100	26,540	18,790	20,910	18,039	12,700	6,932	5,425	3,289	1,477	935					
	Santa Cruz	Corralitos	2,431	2,513														
1916	Marin	Corte Madera	9,100	8,272	8,074	8,464	5,962	1,933	1,098		607							
1953	Orange	Costa Mesa	108,724	96,357	82,562	72,660	37,550	11,844										
	Sacramento	Cosumnes															1,215	335
	El Dorado	Cosumnes																1092
1963	Sonoma	Cotati	6,471	5,714	3,475	1,368	1,852											
	Orange	Coto de Caza	13,057	2,853														

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	Shasta	Cottonwood	2,960	1,747	1,553	1,288								269				
	Mariposa	Coulterville												525	224			
	San Joaquin	Country Club	9,462	9,325	9,585													
	Mendocino	Covelo	1,175	1,057	1,448										183			
1901	Los Angeles	Covina	46,837	43,207	32,751	30,380	20,124	3,956	3,049	2,774	1,999	1,652						
	Del Norte	Crescent															289	
1854	Del Norte	Crescent City	4,006	4,380	3,075	2,586	2,958	1,706	1,363	1,720	955	1,114	699	907		458	638	
	Del Norte	Crescent City North	4,028	3,853	2,846	3,053	3,086											
	Plumas	Crescent Mills	258												202			
	San Diego	Crest	2,716															
	Merced	Cressy													63			
	San Bernardino	Crest Forest				3,509												
	San Bernardino	Crestline	10,218	8,594	6,715		1,290											
	Plumas	C-Road	152															
	San Bernardino	Crestline-Cedar Pines						1,369										
	Contra Costa	Crockett	3,194	3,228										301				
	Plumas	Cromberg	290															
	Tulare	Crowley					3,950											
	Nevada	Cuba													24			
	San Bernardino	Cucamonga				5,796		1,255										
1960	Los Angeles	Cudahy	24,208	22,817	17,984	16,998												
	Mendocino	Cuffy's Cove														158		
	El Dorado	Culloma, vicinity of																42
1917	Los Angeles	Culver City	38,816	38,793	38,139	31,035	32,163	19,720	8,976	5,669	503							
1955	Santa Clara	Cupertino	50,546	40,263	34,015	18,216	3,664	2,438										
	Tulare	Cutler	4,491	4,450	3,149	2,503	2,191	1,768										
	Humboldt	Cutten	2,933	1,516	2,375	2,228	1,572											
1956	Orange	Cypress	46,229	42,655	40,391	31,569	1,753	1,318										
	Los Angeles	Dairy Valley					3,508											
	Orange	Dairyland					622											
1911	San Mateo	Daly City	103,621	92,311	78,519	66,922	44,791	15,191	9,625	7,838	3,779							
	Placer	Damascus													44			
1989	Orange	Dana Point	35,110	31,896	10,602	4,745	1,186											
1982	Contra Costa	Danville	41,715	31,306	26,446		3,585											
	Inyo	Darwin	54															
1917	Yolo	Davis	60,308	46,209	36,640	23,488	8,910	3,554	1,672	1,243	939			547	441			
	Modoc	Day Valley	3,587	2,842														
	Butte	Dayton													142			
	Placer	Deadwood													31			
	Alameda	Decoto						2,830										
	Yuba	Deer Creek																378
	Napa	Deer Park	1,433	1,825	1,454													
	Los Angeles	Del Aire	9,012	8,040	8,487													
1959	San Diego	Del Mar	4,389	4,860	5,017	3,956	3,124											
	Monterey	Del Monte Forest	4,531	5,069														
	Monterey	Del Monte Heights					1,174											
	Monterey	Del Monte Park					2,177											
	Sacramento	Del Paso Heights - Robla					11,495											
1953	Monterey	Del Rey Oaks	1,650	1,661	1,557	1,823	1,831											
	Monterey	Del Rey	950	1,150	1,126													
	Stanislaus	Del Rio	1,168															
1915	Kern	Delano	38,824	22,762	16,491	14,559	11,913	8,717	4,573	2,632	805				401			
	Merced	Delhi	8,022	3,280	2,832	2,063	1,175											
	Plumas	Delleker	674															
	Shasta	Delta													25			
	Stanislaus	Denair	3,446	3,693	2,892	1,128												

Source: U.S. Census Bureau
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Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Kern	Derby Acres	376															
	Solano	Denverton													31			
1963	Riverside	Desert Hot Springs	16,582	11,668	5,941	2,738	1,472											
	Imperial	Desert Shores	792															
	Los Angeles	Desert View Highlands	2,337	2,154	2,175	2,172												
	Contra Costa	Diablo	988				2,096											
1989	Los Angeles	Diamond Bar	56,287	53,672	28,045	12,234												
	El Dorado	Diamond Springs	4,888	2,872	2,287												2,142	420
	Marin	Dillon Beach	319															
1906	Tulare	Dinuba	16,844	12,743	9,907	7,917	6,103	4,971	3,790	2,968	3,400	970						
	Contra Costa	Discovery Bay	8,981	5,351	1,326													
1878	Solano	Dixon	16,103	10,401	7,541	4,432	2,970	1,714	1,108	1,000	926	827	783	1,082		317		
	Inyo	Dixon Lane - Meadow Creek	2,702	2,561														
	Butte	Dogtown													152			
	Placer	Dollar Point	1,539	1,449														
	Los Angeles	Dominguez				5,980												
	Calaveras	Dorrington	727															
	Sonoma	Donahue													97			
1908	Siskiyou	Dorris	886	892	836	840	973	892	863	762	424	214						
1935	Merced	Dos Palos	4,581	4,196	3,121	2,496	2,028	1,394	978									
	Sutter	Doton's Bar and Long's Bar																84
	Trinity	Douglas City														411		
	Calaveras	Douglas Flat													165			
1956	Los Angeles	Downey	107,323	91,444	82,602	88,573	82,505								237			
	Sierra	Downieville											500		650	704	940	
	El Dorado	Dry Creek																210
1957	Los Angeles	Duarte	21,486	20,688	16,766	14,981	13,962											
1982	Alameda	Dublin	29,973	23,229	13,496	13,641												
	Tulare	Ducor	504															
1909	Siskiyou	Dunsmuir	1,923	2,129	2,253	2,214	2,873	2,256	2,359	2,256	2,528	1,719						
	Kern	Dustin Acres	585															
	Butte	Durham	5,220	4,784														
	El Dorado	Dutch Creek																504
	Placer	Dutch Flat												682	939			
	Riverside	Eagle Mountain			1,890	2,453												
	Los Angeles	Eagle Rock									2,256							
	Tulare	Earlimart	6,583	5,881	4,578	3,080	2,897	2,162										
	Kern	East Bakersfield								38,177				622	242			
	Riverside	East Blythe	3	1,511	1,660													
	El Dorado	East Canyon																42
	Los Angeles	East Compton	9,286	7,967	6,435	5,853												
	Santa Clara	East Foothills	8,133	14,898														
	Riverside	East Hemet	14,823	17,611	14,712													
	Los Angeles	East La Mirada	9,538	9,367	9,688	12,339												
	Los Angeles	East Los Angeles	124,283	126,379	110,017	105,035	104,270											
	Stanislaus	East Modesto					2,084											
	Stanislaus	East Oakdale	2,742															
	Tulare	East Orosi	426															
1983	San Mateo	East Palo Alto	29,506	23,451	18,191	18,727												
	Los Angeles	East Pasadena	6,045	5,910														
	Tulare	East Porterville	6,730	5,790	5,218	4,042	3,538											
	Plumas	East Quincy	2,398															
	Contra Costa	East Richmond Heights	3,357	3,266														
	San Diego	East San Diego									4,148							
	Los Angeles	East San Gabriel	14,512	12,736														
	Santa Clara	East San Jose										1,661						

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Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Plumas	East Shore	177															
	Tuolumne	East Sonora	2,078	1,675														
	Tulare	East Tulare					1,342											
	Los Angeles	East Whittier					19,884											
	Fresno	Easton	1,966	1,877	1,710	1,065												
	Siskiyou	Edgewood	67															
	Riverside	Edgemont					1,628											
	Kern	Edwards				10,331												
	Kern	Edwards AFB	5,909	7,423	8,554													
1912	San Diego	El Cajon	94,869	88,693	73,892	52,273	37,618	5,600	1,471	1,050	469							
1918	Imperial	El Centro	37,835	31,384	23,996	19,272	16,811	12,590	10,017	8,434	5,464	1,610						
1917	Contra Costa	El Cerrito	23,171	22,869	22,731	25,190	25,437	18,011	6,137	3,870	1,505							
	Imperial	El Cerrito CDP	4,590	4,490														
	El Dorado	El Dorado													200			
	El Dorado	El Dorado Hills	18,016	6,395	3,453											1,055	558	
	Santa Barbara	El Encanto Heights				6,225												
	San Mateo	El Granada	5,724	4,426	3,582	1,473												
	Contra Costa	El Monte					4,186	2,502										
1912	Los Angeles	El Monte	115,965	106,209	79,494	69,892	13,163	8,101	4,746	3,479	1,283							
1889	San Luis Obispo	El Paso de Robles	24,297	18,583	9,163	7,168	6,677	4,835	3,045	2,573	1,919	1,441	1,224	827				
	San Diego	El Rio													114			
	Ventura	El Rio	6,193	6,419	5,674	6,173	6,966	1,376										
1917	Los Angeles	El Segundo	16,033	15,223	13,752	15,620	14,219	8,011	3,738	3,503	1,563							
	Contra Costa	El Sobrante	12,260	9,852	10,535													
	Orange	El Toro		62,685	38,153	8,654												
	Orange	El Toro Station		6,869	7,632	6,970												
	Sonoma	El Verano	3,954	3,498	2,384	1,753	1,236											
	Sonoma	Eldridge	1,534	1,144														
	Mendocino	Elk												216				
2000	Sacramento	Elk Grove	59,984	17,483	10,959	3,721	2,205							202				
	Monterey	Elkhorn	1,591	1,458														
	Solano	Elmira	205											317	240			
	Riverside	Elsinore (aka Lake Elsinore)				3,530	2,432	2,068	1,552	1,350	633	488	279					
	San Mateo	Emerald Lake Hills	3,899	3,328														
1896	Alameda	Emeryville	6,882	5,740	3,714	2,681	2,686	2,889	2,521	2,336	2,390	2,613	1,016	228				
	Placer	Emigrant Gap													137			
	Stanislaus	Empire	3,903			2,016	1,635	1,448										
	El Dorado	Empire Canyon																84
1986	San Diego	Encinitas	58,014	55,386	10,796	5,375	2,786											
	Shasta	Enterprise			10,796	11,486	4,946											
1957	San Joaquin	Escalon	5,963	4,437	3,127	2,366	1,763	1,569										
1888	San Diego	Escondido	133,559	108,635	64,355	36,792	16,377	6,544	4,560	3,421	1,789	1,334	755	541				
	Yolo	Esparto	1,858	1,487	1,303	1,088												
1878	Siskiyou	Etna	781	835	754	667	596	649	456		425	518	500	271	361			
1856	Humboldt	Eureka	26,128	27,025	24,153	24,337	28,137	23,058	17,055	15,752	12,923	11,845	7,327	4,858	2,639			55
	Nevada	Eureka													224			
	Plumas	Eureka Mills													370			
1911	Tulare	Exeter	9,168	7,276	5,606	4,475	4,264	4,078	3,883	2,685	1,852							
	Sacramento	Fair Oaks	28,008	26,867	22,602	11,256	1,622											
	San Diego	Fairbanks Ranch	2,244															
1931	Marin	Fairfax	7,319	6,931	7,391	7,661	5,813	4,078	2,198									
1903	Solano	Fairfield	96,178	77,211	58,099	44,146	14,968	3,118	1,312	1,131	1,008	834		505	424	329		
	El Dorado	Fairplay													24			
	Alameda	Fairview	9,470	9,045			3,586											
	Shasta	Fall River Mills													122			
	San Diego	Fallbrook	29,100	22,095	14,041	6,945	4,814	1,735										

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Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Shasta	Fall River Mills	648															
1960	Tulare	Farmersville	8,737	6,235	5,544	3,456	3,101							763				
	San Joaquin	Farmington	262															
	Kern	Fellows	153															
	Santa Cruz	Felton	1,051	5,350	4,564	2,062	1,380							259	271			
1893	Humboldt	Ferndale	1,382	1,331	1,367	1,352	1,371	1,032	901	889	919	905	846	763	178			
	Sonoma	Fetters Hot Springs - Agua Caliente	2,505	2,024	1,675													
	Amador	Fiddletown													295			
1914	Ventura	Fillmore	13,643	11,992	9,602	6,285	4,808	3,884	3,252	2,893	1,597							
	Sierra	Fir Cap													78			
1914	Fresno	Firebaugh	5,743	4,429	3,740	2,517	2,070	821	704	506								
	Los Angeles	Florence												750				
	Los Angeles	Florence-Graham	60,197	57,147	48,662	42,895	38,164											
	Sacramento	Florin	27,653	24,330	16,523	9,646												
1946	Sacramento	Folsom	51,884	29,802	11,003	5,810	3,925	1,690						609				
1952	San Bernardino	Fontana	128,929	87,535	37,111	20,673	14,659											
	Sacramento	Foothill Farms	17,426	17,135	13,700													
	Orange	Foothill Ranch	10,899															
	Kern	Ford City	3,512	3,781	3,392	3,503	3,926	4,347										
	Sierra	Forest City												238	620	152		
	Calaveras	Forest Meadows	1,197															
	Placer	Foresthill	1,791	1,409	1,304									650	688			
	Sonoma	Forestville	2,370	2,443											84			
	Modoc	Fort Bidwell													146			
	Modoc	Fort Bidwell (govt. barracks)													114			
1889	Mendocino	Fort Bragg	7,026	6,078	5,019	4,455	4,433	3,826	3,235	3,022	2,616	2,408	1,590	945				
	San Bernardino	Fort Irwin				2,991												
1872	Siskiyou	Fort Jones	660	639	544	515	483	525	360	302	331	316	356	266				
1906	Humboldt	Fortuna	10,497	8,788	7,591	4,203	3,523	1,762	1,413	1,239	986	883						
1971	San Mateo	Foster City	28,803	28,176	23,287	9,327												
1957	Orange	Fountain Valley	54,978	53,691	55,080	31,826	2,068											
1908	Fresno	Fowler	3,979	3,208	2,496	2,239	1,892	1,857	1,531	1,171	1,528	675						
	Kern	Frazier Park	2,348	2,201	1,444	1,167												
	Santa Cruz	Freedom	6,000	8,361	6,416	5,563	4,206	2,765										
1956	Alameda	Fremont	203,413	173,339	131,945	100,869	43,790										1,085	
	Solano	Fremont															377	
	Yolo	Fremont																130
	Shasta	Fremont Station													30			
	San Joaquin	French Camp	4,109	3,018														
	El Dorado	French Canyon																168
	Nevada	French Corral													522			
	Shasta	French Gulch	254												199			
1885	Fresno	Fresno	427,652	354,202	218,202	165,972	133,929	91,669	60,685	52,513	45,086	24,892	12,470	10,818	1,112			
	Fresno	Friant	519															
	Santa Clara	Fruitdale	895															
1904	Orange	Fullerton	126,003	114,144	102,634	85,826	56,180	13,958	10,442	10,860	4,415	1,725						
	Sonoma	Fulton													76			
	Mendocino	Furguson's Cove														40		
	Inyo	Furnace Creek	31															
1946	Sacramento	Galt	19,472	8,889	5,514	3,200	1,868	1,333										
	Humboldt	Garberville													48			
	San Joaquin	Garden Acres	9,747	8,547	7,361	7,870												
1956	Orange	Garden Grove	165,196	143,050	123,307	122,524	84,238	3,762										
1930	Los Angeles	Gardena	57,746	49,847	45,165	41,021	35,943	14,405	5,909									
	Los Angeles	Garvanza												411				
	Siskiyou	Gazelle	136															

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	San Bernardino	George				7,404												
	San Bernardino	George AFB		5,085	7,061													
	El Dorado	Georgetown	962											320	415			462
	Tehama	Gerber-Las Flores	1,389	1,143														
	Sonoma	Geyserville														68		
1870	Santa Clara	Gilroy	41,464	31,487	21,641	12,665	7,348	4,951	3,615	3,502	2,862	2,437	1,820	1,694	1,621	1,625		
	Riverside	Glen Avon	14,853	12,663	8,444	5,759	3,416											
	Sonoma	Glen Ellen	992	1,191	1,014													
1906	Los Angeles	Glendale	194,973	180,038	139,060	132,752	119,442	95,702	82,582	62,736	13,536	2,746						
1911	Los Angeles	Glendora	49,415	47,828	38,654	31,349	20,752	3,988	2,822	2,761	2,028							
	Nevada	Glenshire-Devonshire		2,133														
	El Dorado	Gold Hill													47		160	
	Sacramento	Gold River	8,023															
	Placer	Gold Run												211	377			
	Tuolumne	Golden City													56			
	Kern	Golden Hills	7,434	5,423														
	Alameda	Goldengate												788				
	Santa Barbara	Goleta	55,204															
1947	Monterey	Gonzales	7,525	4,660	2,891	2,575	2,138	1,821						359	233			
	Tulare	Goshen	2,394		1,809	1,324	1,061											
	Plumas	Graeagle	831															
1978	San Bernardino	Grand Terrace	11,626	10,946	8,498	5,901												
	Placer	Granite Bay	19,388															
	El Dorado	Granite Creek																126
	San Diego	Granite Hills	3,246	3,157														
	Nevada	Graniteville												234				
1861	Nevada	Grass Valley	10,922	9,048	6,697	5,149	4,876	5,283	5,701	3,817	4,006	4,520	4,719					454
	Sonoma	Graton	1,815	1,409	1,286		1,055											
	Stanislaus	Grayson	1,077											331	133			
	Kern	Greenacres		7,379	5,381	2,116												
1947	Monterey	Greenfield	12,583	7,464	4,181	2,608	1,680	1,309										
	Plumas	Greenhorn	146															
	Solano	Green Valley	1,859															
	Siskiyou	Greenview	200															
	Plumas	Greenville	1,160	1,396	1,537	1,073	1,140	1,153							403			
	Siskiyou	Grenada	351															
	El Dorado	Greenwood Valley													181			336
1905	Butte	Gridley	5,382	4,631	3,982	3,534	3,343	3,054	2,338	1,941	1,636	987		686	352			
	El Dorado	Grizzly Flat													76			
	Placer	Grizzly Flat													48			
	San Diego	Grossmont - Mt. Helix				8,723												
	Tuolumne	Groveland													59			
	Tuolumne	Groveland-Big Oak Flat	3,388	2,753														
1959	San Luis Obispo	Grover Beach City	13,067	11,656	8,827	5,939	5,210											
	San Luis Obispo	Grover City-Fair Oaks						2,788										
1946	Santa Barbara	Guadalupe	5,659	5,479	3,629	3,145	2,614	2,429						174				
	Santa Clara	Guadalupe													431			
	Mendocino	Gualala														235		
	Sonoma	Guerneville	2,441	1,966	1,525										363			
1915	Merced	Gustine	4,698	3,931	3,142	2,793	2,300	1,984	1,355	1,016	716							
	Los Angeles	Hacienda Heights	53,122	52,354	49,422	35,969												
	Sacramento	Hagginwood					11,469											
1959	San Mateo	Half Moon Bay	11,842	8,886	7,282	4,023	1,957	1,168										
	Plumas	Hamilton Branch	587															
	Glenn	Hamilton City	1,903	1,811	1,337													
1891	Kings	Hanford	41,686	30,897	20,958	15,179	10,133	10,028	8,234	7,028	5,888	4,829	2,929	942	269			

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	Kings	Hanford Northwest				1,476	1,364											
	Kings	Hanford South				2,494												
	Del Norte	Happy Camp													142			
	Siskiyou	Happy Camp			1,110													
	San Diego	Harbison Canyon	3,645	2,122														
	Monterey	Hatlon Fields					2,362											
	Kern	Havilah													196			
1964	Los Angeles	Hawaiian Gardens	14,779	13,639	10,548	8,811												
	Siskiyou	Hawkinsville													313			
1922	Los Angeles	Hawthorne	84,112	71,349	56,447	53,304	33,035	16,316	8,263	6,596								
	Trinity	Hay Fork Valley														172	198	
	Lassen	Hayden Hill													131			
	Trinity	Hayfork	2,315	2,605	1,788											178		
1876	Alameda	Hayward	140,030	111,498	94,167	93,058	72,700	14,272	6,736	5,530	3,487	2,746	1,965	1,419	1,231	504		
1867	Sonoma	Healdsburg	10,722	9,469	7,217	5,438	4,816	3,258	2,507	2,296	2,412	2,011	1,869	1,485	1,133	959	334	
	Imperial	Heber	2,988	2,566	2,221													
	Butte	Helltown													150			
1910	Riverside	Hemet	58,812	36,094	22,454	12,252	5,416	3,386	2,595	2,235	1,480	992						
	Riverside	Hemet East				8,598	1,936											
	Siskiyou	Henley													90			
1900	Contra Costa	Hercules	19,488	16,829	5,963	252	310	343	343	392	373	279						
	Lassen	Herlong			1,188													
1907	Los Angeles	Hermosa Beach	18,566	18,219	18,070	17,412	16,115	11,826	7,197	4,796	2,327	679						
1988	San Bernardino	Hesperia	62,582	50,418	13,540	4,592												
	Stanislaus	Hickman	457															
1961	Los Angeles	Hidden Hills	1,875	1,729	1,760	1,529												
	Los Angeles	Hidden Meadows	3,463	2,371														
	Los Angeles	Hidden Valley Lake	3,777	1,961														
	Riverside	Highgrove	3,445	3,175														
1987	San Bernardino	Highland	44,605	34,439	10,908	12,669												
	San Mateo	Highlands-Baywood Park	4,210															
	Fresno	Highway City					1,381											
	Stanislaus	Hill's Ferry													161			
	Los Angeles	Hillgrove					14,669											
	Merced	Hilmar-Irwin	4,807	3,392	1,706													
1910	San Mateo	Hillsborough	10,825	10,667	10,451	8,753	7,554	3,552	2,747		931							
1874	San Benito	Hollister	34,413	19,212	11,488	7,663	6,071	4,903	3,881	3,757	2,781	2,308	1,315	1,234	1,034			
1908	Imperial	Holtville	5,612	4,820	4,399	3,496	3,080	2,472	1,772	1,758	1,347	729						
	Kings	Home Garden	1,702	1,549	1,495													
	Riverside	Home Gardens	9,461	7,780	5,783	5,116	1,541											
	Riverside	Homeland	3,710	3,312	2,616	1,187												
	Mono	Homer													88			
	San Joaquin	Homestead												637	367			
	Inyo	Homewood Canyon-Valley Wells	75															
	Klamath	Hoopa Valley Indian Res.														12		
	Siskiyou	Hornbrook CDP	286															
	Mariposa	Hornitos					73	126	159	62	100	160	205	276	350			
	Sutter	Horse Shoe Bar																125
	Placer	Hot Spring													56			
	Mono	Hot Spring Valley													70			
	Sierra	Howland Flat													218			
	Ventura	Hueneme													166			
1972	Stanislaus	Hughson	3,980	3,259	2,943	2,144	1,898	1,816										
	Humboldt	Humboldt Hill	3,246	2,865														
	Placer	Humbug Canyon													50			
	Plumas	Humbug Valley													37			

Source: U.S. Census Bureau
General Population Characteristics California

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
1909	Orange	Huntington Beach	189,594	181,519	170,505	115,960	11,492	5,237	3,738	3,690	1,687	815						
1906	Los Angeles	Huntington Park	61,348	56,065	46,223	33,744	29,920	29,450	28,648	24,591	4,513	1,299						
1951	Fresno	Huron	6,306	4,766	2,768	1,525	1,269											
	Humboldt	Hydesville	1,209	1,131														
	Riverside	Idyllwild-Pine Cove	3,504	2,853	2,959													
	Shasta	Igo													225			
	El Dorado	Illinois Canyon																84
1904	Imperial	Imperial	7,560	4,113	3,451	3,094	2,658	1,759	1,493	1,943	1,885	1,257						
1956	San Diego	Imperial Beach	26,992	26,512	22,689	20,244	17,773											
	Inyo	Independence	574													400		
	Lake	Indian													293			
	Trinity	Indian Creek														183	200	
	El Dorado	Indian Diggings													72			
	Plumas	Indian Falls	37															
1967	Riverside	Indian Wells	3,816	2,647	1,394	760												
1930	Riverside	Indio	49,116	36,793	21,611	14,459	9,745	5,300	2,296									
1957	Los Angeles	Industry	777	631	412	714	778											
1908	Los Angeles	Inglewood	112,580	109,602	94,162	89,985	63,390	46,185	30,114	19,480	3,286	1,536						
	Butte	Inskip													50			
	Santa Cruz	Interlaken	7,328	6,404														
	Marin	Inverness	1,421	1,422														
	Kern	Inyokern	984															
1953	Amador	Ione	7,129	6,516	2,207	2,369	1,118	1,071						806	636			
	Placer	Iowa Hill													456			
	El Dorado	Irish Creek																252
	Plumas	Iron Horse	321															
1971	Orange	Irvine	143,072	110,330	62,134													
1957	Los Angeles	Irwindale	1,446	1,050	1,030	784	1,518											
	Santa Barbara	Isla Vista	18,344	20,395		13,441												
1923	Sacramento	Isleton	828	833	914	909	1,039	1,597	1,837	2,090								
	Los Angeles	Ivanhoe												332				
	Tulare	Ivanhoe	4,474	3,293	2,684	1,595	1,616	1,172										
1905	Amador	Jackson	3,989	3,545	2,331	1,924	1,852	1,879	2,024		1,601	2,035			1,040			
	Tuolumne	Jacksonville													32			
	Tuolumne	Jamestown	3,017	2,178											212			
	Plumas	Jamison													150			
	San Diego	Jamul	5,920	2,258	1,826													
	Calaveras	Jenny Lind													54			
	Kern	Johannesburg	176															
	Shasta	Johnson Park			1,008													
	Plumas	Johnsville	21												50			
	San Bernardino	Joshua Tree	4,207	3,898	2,083	1,211												
	Contra Costa	Judsonville													301			
	San Diego	Julian	1,621	1,284	1,320													
	Placer	Julian Mine													63			
	Trinity	Junction City														440		
	Alameda	Kamondorski					1,006											
	Plumas	Keddie	96															
	Inyo	Keeler	66															
	Kern	Keene	339															
	El Dorado	Kelsey													30			714
	Lake	Kelseyville	2,928	2,861	1,567									282				
	San Joaquin	Kennedy	3,275															
	Shasta	Kennett									464							
	Contra Costa	Kensington	4,936	4,974	5,200	5,823												
	Marin	Kentfield	6,351	6,030														

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HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
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Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
1946	Fresno	Kerman	8,551	5,448	4,002	2,667	1,970	1,563										
	Kern	Kernville	1,736	1,656	1,660										490			
	Kings	Kettleman City	1,499	1,411	1,051													
	Stanislaus	Keyes	4,575	2,878		1,875	1,546											
	Butte	Kimshew													99			
1911	Monterey	King City	11,094	7,634	5,495	3,717	2,937	2,347	1,768	1,483	1,048			253				
	Placer	Kings Beach	4,037	2,796	1,942													
1908	Fresno	Kingsburg	9,199	7,205	5,115	3,843	3,093	2,310	1,504	1,322	1,316	634		291	88			
	Alpine	Kirkwood	96															
	Del Norte	Klamath	651	827														
	Contra Costa	Knightsen	861															
	Stanislaus	Knight's Ferry													191			
	Yolo	Knights Landing												287	367			
	Lake	Knoxville Mines														164		
	Sonoma	Korbels													42			
1976	Los Angeles	La Canada Flintridge	20,318	19,378	20,153	20,652	18,338											
	Los Angeles	La Crescenta-Montrose	18,532	16,968	16,531	19,594												
	Stanislaus	La Grange													145			
1925	Orange	La Habra	58,974	51,266	45,232	41,350	25,136	4,961	2,499	2,273								
1978	Los Angeles	La Habra Heights	5,712	6,226	4,786													
	Stanislaus	La Loma - Airport						7,866										
1912	San Diego	La Mesa	54,749	52,931	50,308	39,178	30,441	10,946	3,925	2,513	1,004							
1960	Los Angeles	La Mirada	46,783	40,452	40,986	30,808	22,444											
1955	Orange	La Palma	15,408	15,392	15,399	9,687	622											
	Plumas	La Porte	43											214	274			
	San Diego	La Presa	32,721															
1958	Los Angeles	La Puente	41,063	36,955	30,882	31,092	24,723											
1982	Riverside	La Quinta	23,694	11,215	3,328													
	Sacramento	La Riviera	10,273	10,986	10,906													
	Santa Cruz	La Selva Beach			1,603	1,171												
	Riverside	La Sierra						3,802										
1906	Los Angeles	La Verne	31,638	30,897	23,508	12,965	6,516	4,198	3,092	2,860	1,698	954						
	Sutter	Lacy's Bar and vicinity, and Manhattan Bar																420
	Los Angeles	Ladera Heights	6,568	6,316	6,647	6,079												
1968	Contra Costa	Lafayette	23,908	23,501	20,837	20,484	7,114											
	Sacramento	Laguna	34,309	9,828														
1927	Orange	Laguna Beach	23,727	23,170	17,858	14,550	9,288	6,661	4,460	1,981								
1991	Orange	Laguna Hills	31,178	46,731	33,600	13,676												
1989	Orange	Laguna Niguel	61,891	44,400	12,237	4,644												
	Sacramento	Laguna West-Lakeside	8,414															
1999	Orange	Laguna Woods	16,507															
	Marin	Lagunitas-Forest Knolls	1,835	1,821	1,465													
	Plumas	Lake Almanor Country Club	847															
	Plumas	Lake Almanor Peninsula	336															
	Plumas	Lake Almanor West	329															
	San Bernardino	Lake Arrowhead	8,934	6,539	6,272	2,682												
	Modoc	Lake City													121			
	Nevada	Lake City													93			
	Plumas	Lake Davis	23															
1888	Riverside	Lake Elsinore	28,928	18,285	5,982													
1991	Orange	Lake Forest	58,707															
	Shasta	Lakehead-Lakeshore	549															
	Kern	Lake Isabella	3,315	3,323	3,428													
	Los Angeles	Lake Los Angeles	11,523	7,977														
	San Luis Obispo	Lake Naciemento	2,176	1,556														
	Nevada	Lake Wildwood	4,868															

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HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
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Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Nevada	Lake of the Pines	3,956	3,890														
	Kern	Lake of the Woods	833															
	San Diego	Lake San Marcos	4,138	3,802														
	Placer	Lake Valley													20			
	Riverside	Lakeland Village	5,626	5,159	2,796	1,724	3,539											
	Lake	Lakeport	4,820	4,390	3,675	3,005	2,303	1,983	1,490	1,318	1,024	870	726	991	562	248		
	San Diego	Lakeside	19,560	39,412	23,921	11,991												
	Riverside	Lakeview	1,619	1,448														
	Sonoma	Lakeville													46			
1954	Los Angeles	Lakewood	79,345	73,557	74,654	83,973	67,126											
	Kern	Lamont	13,296	11,517	9,616	7,007	6,177	3,571										
	Fresno	Lanare	540															
1977	Los Angeles	Lancaster	118,718	97,291	48,027	30,948	26,012	3,594										
	Amador	Lancha Plana													168			
	Yolo	Langville													151			
	Sonoma	Larkfield-Wikiup	7,479	6,779														
1908	Marin	Larkspur	12,014	11,070	11,064	10,487	5,710	2,905	1,558	1,241	612	594						
	Orange	Las Flores	5,625															
	Monterey	Las Lomas	3,078	2,127	1,740													
	Placer	Last Chance													26			
1989	San Joaquin	Lathrop	10,445	6,841	3,717	2,137	1,123							577				
	Fresno	Laton	1,236	1,415	1,100	1,071	1,052							1,150				
	El Dorado	Latrobe													108			
1959	Los Angeles	Lawndale	31,711	27,331	23,460	24,825	21,740											
	Mendocino	Laytonville	1,301	1,133	1,096													
	Kern	Lebec	1,285															
	Merced	Le Grand	1,760	1,205														
	Colusa	Leesville													35			
	Tulare	Lemon Cove	298															
1977	San Diego	Lemon Grove	24,918	23,984	20,780	19,690	19,348											
1900	Kings	Lemoore	19,712	13,622	8,832	4,219	2,561	2,153	1,711	1,399	1,355	1,000		651	463			
	Kings	Lemoore Station	5,749		5,888	8,512												
	Los Angeles	Lennox	22,950	22,757	18,445	16,121	31,224											
	San Bernardino	Lenwood	3,222	3,190	2,974	3,834	2,407											
	San Diego	Leucadia			9,478		5,665											
	Trinity	Lewiston	1,305	1,187												338		
	Santa Clara	Lexington Hills	2,454	2,064														
	Fresno	Liberty													228			
1890	Placer	Lincoln	11,205	7,248	4,132	3,176	3,197	2,410	2,044	2,094	1,325	1,402	1,061	961	275			
	San Joaquin	Lincoln Village	4,216	4,236	6,476	6,722												
	Yuba	Linda	13,474	13,033	10,225	7,731	6,129											
	San Joaquin	Linden	1,103	1,339														
1910	Tulare	Lindsay	10,297	8,338	6,936	5,206	5,397	5,060	4,397	3,878	2,576	1,814						
	Plumas	Little Grass Valley	0															
	Mendocino	Little Lake													49			
	Mendocino	Little River												243		158		
	Nevada	Little York													100			
	Los Angeles	Littlerock	1,402	1,320														
1947	Sutter	Live Oak City	6,229	4,320	3,103	2,645	2,276	1,770										
	Santa Cruz	Live Oak (CDP)	16,628	15,212	11,482	6,443	3,518											
1876	Alameda	Livermore	73,345	56,741	48,349	37,703	16,058	4,364	2,885		1,916	2,030	1,493	1,391	855			
1922	Merced	Livingston	10,473	7,317	5,326	2,588	2,188	1,502	895	803								
	San Joaquin	Lockeford	3,179	2,722	1,852									472	322			
1906	San Joaquin	Lodi	56,999	51,874	35,221	28,691	22,229	13,798	11,079	6,788	4,850	2,697		1,013	606			
	Sierra	Loganville													83			
	El Dorado	Logtown & vicinity																420

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1970	San Bernardino	Loma Linda	18,681	17,400	10,694	9,797												
	Yuba	Loma Rica	2,075	1,852														
1964	Los Angeles	Lomita	20,046	19,382	18,807	19,784	14,983											
1888	Santa Barbara	Lompoc	41,103	37,649	26,267	25,284	14,415	5,520	3,379	2,845	1,876	1,482	972	1,015	226			
	Santa Barbara	Lompoc North				2,699												
	Santa Barbara	Lompoc Northwest				4,874												
	Tulare	London	1,848	1,638	1,257													
	Inyo	Lone Pine	1,655	1,818	1,684	1,241	1,310	1,415								458		
1897	Los Angeles	Long Beach	461,522	429,433	361,334	358,633	344,168	250,767	164,271	142,032	55,593	17,809	2,252	564				
	Placer	Long Canyon													25			
	Plumas	Longville													50			
1984	Placer	Loomis	6,260	5,705	1,284	1,108												
	Alameda	Lorin												743				
1960	Orange	Los Alamitos	11,536	11,676	11,529	11,346	4,312											
	Santa Barbara	Los Alamos	1,372												47			
1952	Santa Clara	Los Altos	27,693	26,303	25,769	24,956	19,696											
1956	Santa Clara	Los Altos Hills	7,902	7,514	7,421	6,865	3,412											
1850	Los Angeles	Los Angeles	3,694,820	3,485,398	2,966,850	2,816,061	2,479,015	1,970,358	1,504,277	1,238,048	576,673	319,198	102,479	50,395	11,183	5,728	4,385	1610
1907	Merced	Los Banos	25,869	14,519	10,341	9,188	5,272	3,868	2,214		1,276	745						
1887	Santa Clara	Los Gatos	28,592	27,357	26,906	23,735	9,036	4,907	3,597	3,168	2,317	2,232	1,915	1,652	555			
	Tehama	Los Molinos	1,952	1,709	1,241													
	San Bernardino	Los Serranos		7,099														
	Kern	Lost Hills	1,938	1,212														
	El Dorado	Louisville and vicinity																420
	Butte	Lovelock													100			
	Nevada	Lowell Hill													100			
	Lake	Lower Lake	1,755	1,217	1,043										259	692	965	
1901	Sierra	Loyalton	862	931	1,030	945	936	911	925		442	983			84			
	Santa Clara	Loyola	3,478	3,076														
	Marin	Lucas Valley-Marinwood	6,357	5,982	6,409													
	Lake	Lucerne	2,870	2,011	1,767	1,300												
	Mono	Lundy													100			
1921	Los Angeles	Lynwood	69,845	61,945	48,548	43,354	31,614	25,823	10,982	7,323								
1907	Madera	Madera	43,207	29,281	21,732	16,044	14,430	10,497	6,457	4,665	3,444	2,404		950	217			
	Madera	Madera Acres	7,741	5,245	2,173													
	Butte	Magalia	10,569	8,987														
	Solano	Main Prairie														160		
1991	Los Angeles	Malibu	12,575															
	Mono	Mammoth													473			
1984	Mono	Mammoth Lakes	7,093	4,785	3,929													
1912	Los Angeles	Manhattan Beach	33,852	32,063	31,542	35,352	33,934	17,330	6,398	1,891	859							
1918	San Joaquin	Manteca	49,258	40,773	24,925	13,845	8,242	3,804	1,981	1,614	1,286							
	Tehama	Manton	372															
	Riverside	March				2,002												
	Riverside	March AFB	370	5,523	3,607													
1911	Kern	Maricopa	1,111	1,193	946	740	648	800	670	1,071	1,121							
1975	Monterey	Marina	25,101	26,436	20,647	8,343	3,310											
	Los Angeles	Marina del Rey	8,176	7,431	8,065													
	Mariposa	Mariposa	1,373	1,152	1,150									366	342			
	Alpine	Markleeville	197											149	80			
1876	Contra Costa	Martinez	35,866	31,808	22,582	16,506	9,604	8,268	7,381	6,569	3,858	2,115	1,380	1,600		560		
	Contra Costa	Martinez East					3,958											
	Nevada	Martis Creek													9			
1851	Yuba	Marysville	12,268	12,324	9,898	9,353	9,553	7,826	6,646	5,763	5,461	5,430	3,497	3,991	4,321	4,738	4,740	
	El Dorado	Mathenias																672
	Sacramento	Mather				7,027												

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	Sacramento	Mather AFB		4,885	5,245													
	Colusa	Maxwell												500				
	Santa Clara	Mayfield									1,127	1,041			425			
	Los Angeles	Mayflower Village	5,081	4,978	5,018													
1924	Los Angeles	Maywood	28,083	27,850	21,810	16,996	14,588	13,292	10,731	6,794								
	Shasta	McArthur	365															
	Siskiyou	McCloud	1,343	1,555	1,656	1,643	2,140	1,394										
	Siskiyou	Macdoel	140															
1957	Kern	McFarland	9,618	7,005	5,151	4,177	3,686	2,183										
	Humboldt	McKinleyville	13,599	10,749	7,772													
	Kern	McKittrick	160								207							
	Ventura	McMillan Manor					1,193											
	El Dorado	Mead Springs and vicinity																462
	Nevada	Meadow Lake													15			
	Plumas	Meadow Valley	575															
	Placer	Meadow Vista	3,096	3,067	2,683													
	Riverside	Mecca	5,406	1,966	1,698													
	Ventura	Meiners Oaks	3,750	3,329			3,513	2,446										
	Ventura	Meiners Oaks- Mira Monte			9,512	7,025												
	Mendocino	Mendocino	824		1,008									806				
	Sonoma	Mendocino															1,193	
1942	Fresno	Mendota	7,890	6,821	5,038	2,705	2,099	1,516										
1927	San Mateo	Menlo Park	30,785	28,040	26,369	26,826	26,957	13,587	3,258	2,254								
	San Bernardino	Mentone	7,803	5,675														
1889	Merced	Merced	63,893	56,216	36,499	22,670	20,068	15,278	10,135	7,066	3,974	3,102	1,969	2,009	1,446			
	Merced	Merced Falls													150			
	Sutter	Meridian													196			
	Tehama	Merrills														124	154	
	Fresno	Merrit-Peck Colonies					1,299											
	Inyo	Mesa	214															
	Alpine	Mesa Vista	182															
	Kern	Mettler	157															
	Tuolumne	Mi-Wuk Village	1,485	1,175														
	Sacramento	Michigan Bar													100			
	Placer	Michigan Bluff													468	377		
	Placer	Middle Fork													45			
	El Dorado	Middle Fork, Am River																1722
	Lake	Middletown Village												327	271			
	Orange	Midway City						1,421										
1900	Marin	Mill Valley	13,600	13,038	12,967	12,942	10,411	7,331	4,847	4,164	2,554	2,551						
	Lake	Middletown	1,020															
1948	San Mateo	Millbrae	20,718	20,412	20,058	20,920	15,873	8,972						243	195			
	Shasta	Millville	610												253			
1954	Santa Clara	Milpitas	62,698	50,686	37,820	26,561	6,572											
	Calaveras	Milton													87			
	Tehama	Mineral	143															
	Mono	Mineral Park													17			
	Trinity	Minersville														102	80	
	Riverside	Mira Loma	17,617	15,786	8,707	8,482	3,982	1,555										
	Ventura	Mira Monte	7,177	7,744														
	Los Angeles	Mirada Hills					22,444											
	Santa Barbara	Mirro Beach					1,907											
	Santa Barbara	Mission Canyon	2,610															
	Santa Barbara	Mission Hills	3,142	3,112	2,797													
1988	Orange	Mission Viejo	93,102	72,820	50,666	11,933												
	Sacramento	Mississippi Bar													220			168

Source: U.S. Census Bureau
General Population Characteristics California

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	El Dorado	Missouri Canyon																84
1884	Stanislaus	Modesto	188,856	164,730	106,602	61,712	36,585	17,389	16,379	13,842	9,241	4,034	2,024	2,402	1,693			
	Plumas	Mohawk Vista	121												100			
	Kern	Mojave	3,836	3,763	2,886	2,573	1,845	2,055										
	Calaveras	Mokelumne Hill	774											573	515			
	Tuolumne	Mono Vista	3,072	2,599	1,154													
	Placer	Monona Flat													47			
1887	Los Angeles	Monrovia	36,929	35,761	30,531	30,562	27,079	20,186	12,807	10,890	5,480	3,576	1,205	907				
1909	Siskiyou	Montague	1,456	1,415	1,285	890	782	579	463	507	453	274		250				
	Ventura	Montalvo					2,028											
	San Mateo	Montara	2,950	2,552	1,972	1,459												
1956	San Bernardino	Montclair	33,049	28,434	22,628	22,546	13,546											
	Sonoma	Monte Rio	1,104	1,058	1,137													
1957	Santa Clara	Monte Sereno	3,483	3,287	3,434	2,847	1,506											
1920	Los Angeles	Montebello	62,150	59,564	52,929	42,807	32,097	21,735	8,016	5,498								
	Santa Barbara	Montecito	10,000															
1889	Monterey	Monterey	29,674	31,954	27,558	26,302	22,618	16,205	10,084	9,141	5,479	4,923	1,748	1,662	1,396	1,112		1092
1916	Los Angeles	Monterey Park	60,051	60,738	54,338	49,166	37,821	20,395	8,531	6,406	4,108							
	Solano	Montezuma															315	
	Tuolumne	Montezuma													42			
	Shasta	Montgomery Creek	96															
	Napa	Monticello													102			
	Butte	Moore Station												437				
	Nevada	Moore's Flat													459			
1983	Ventura	Moorpark	31,415	25,494	4,030	3,380	2,902	1,146										
	San Joaquin	Morada	3,726	3,570		2,936	2,156											
1974	Contra Costa	Moraga	16,290	15,852	15,014	14,205												
	Riverside	Moreno			1,175													
1984	Riverside	Moreno Valley	142,381	118,779														
1906	Santa Clara	Morgan Hill	33,556	23,928	17,060	5,579	3,151	1,627	1,014		646	607						
	Sutter	Morman Bar																42
	Sacramento	Mormon Island																252
	Riverside	Morongo Valley	1,929	1,544	1,137													
	San Luis Obispo	Morro													183			
1964	San Luis Obispo	Morro Bay	10,350	9,664	9,064	7,109	3,692	1,659										
	El Dorado	Mosquito Canyon																116
	San Mateo	Moss Beach	1,953	3,002	1,868													
	Monterey	Moss Landing	300															
	Siskiyou	Mount Hebron	92															
	Placer	Mount Pleasant													99			
	Plumas	Mount Pleasant															160	
1905	Siskiyou	Mount Shasta	3,621	3,460	2,837	2,256	1,936	1,909	1,618	1,009								
	Kern	Mountain Mesa	716	1,153														
	Calaveras	Mountain Ranch	1,557															
1902	Santa Clara	Mountain View	70,708	67,460	58,655	54,132	30,889	6,563	3,946	3,308	1,888	1,161			250			
	Contra Costa	Mountain View	2,468															
	San Bernardino	Mountain View Acres	2,521	2,469	1,686													
	El Dorado	Mud Springs														1,572	2,080	
	Marin	Muir Beach	295															
	Butte	Mulberry			1,946	1,795	2,643	2,545										
	Calaveras	Murphys	2,061	1,517	1,183									580	384			
1991	Riverside	Murrieta	44,282	1,628														
	Riverside	Murrieta Hot Springs	2,948	1,938	1,091													
	San Bernardino	Muscoy	8,919	7,541	6,188	7,091												
	Humboldt	Myrtletown	4,459	4,413	3,959													
	Nevada	Mystic													19			

Source: U.S. Census Bureau

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
1872	Napa	Napa	72,585	61,842	50,879	35,978	22,170	13,579	7,740	6,437	6,757	5,791	4,036	4,395	3,731	1,879	2,378	159
	El Dorado	Nashville													47			
1887	San Diego	National City	54,260	54,249	48,772	43,184	32,771	21,199	10,344	7,301	3,116	1,733	1,086	1,353	248			
	Mendocino	Navarro												202		315		
	San Bernardino	Nebo Center	1,174	1,459	1,749	1,828												
1913	San Bernardino	Needles	4,830	5,191	4,120	4,051	4,590	4,051	3,624	3,144	2,807							
	Sacramento	Negro Bar																336
1856	Nevada	Nevada City	3,001	2,855	2,431	2,314	2,353	2,505	2,445	1,701	1,782	2,689	3,250	2,524	4,022			2683
	Santa Clara	New Almaden Hacienda													275			
	Santa Clara	New Almaden Hill													993			
	Sutter	New England Co., Chase's Ranch & C.																42
1955	Alameda	Newark	42,471	37,861	32,126	27,153	9,884	1,532							179			
	Placer	Newcastle												335	162	551		
	Los Angeles	Newhall			12,029	9,651	4,705	2,527							61			
1908	Stanislaus	Newman	7,093	4,151	2,785	2,505	2,148	1,815	1,214	1,269	1,251	892		621				
1906	Orange	Newport Beach	70,032	66,643	62,556	49,582	26,564	12,120	4,438	2,203	894	445						
	Orange	Newport Coast	2,671															
	Nevada	Newtown																672
	Colusa	Newville													105			
	Marin	Nicassio														592		
	Lake	Nice	2,509	2,126														
	Sutter	Nicolaus													136			
	Imperial	Niland	1,143	1,183	1,042													
	Alameda	Niles						1,519							136			
	San Luis Obispo	Nipomo	12,626	7,109	5,247	3,642								215				
1964	Riverside	Norco	24,157	23,302	21,126	14,511	4,964	1,584										
	Ventura	Nordhoff												244				
	Placer	North Auburn	11,847	10,301	7,619													
	Nevada	North Bloomfield												497	724			
	Nevada	North Colombia													290			
	Kern	North Edwards	1,227	1,259	1,107													
	Los Angeles	North El Monte	3,703	3,384														
	San Mateo	North Fair Oaks	15,440	13,912	10,308	9,740												
	Sacramento	North Highlands	44,187	42,105	37,825	31,854	21,271											
	Lake	North Lakeport	2,879															
	San Diego	North Island				6,892												
	Stanislaus	North Modesto - College Gardens						5,046										
	Sacramento	North Sacramento					12,922	6,029	3,053	2,097								
	Nevada	North San Juan												303	656			
	Stanislaus	North Turlock					2,535	1,586										
	San Joaquin	North Woodbridge	1,320															
	Del Norte	Northcrest					1,945											
1957	Los Angeles	Norwalk	103,298	94,279	85,286	90,164	88,739											
	Sacramento	Notoma															654	
1960	Marin	Novato	47,630	47,585	43,916	31,006	17,881	3,496										
	Mendocino	Noyo														80		
	Riverside	Nuevo	4,135	3,010	1,628													
	Ventura	Nyeland Acres					1,619											
	Ventura	Oak Park	2,320	2,412														
	Ventura	Oak View	4,199	3,606	4,671	4,872	2,448	1,648										
1906	Stanislaus	Oakdale	15,503	11,961	8,474	6,594	4,980	4,064	2,592	2,112	1,745	1,035		1,012	376			
	Madera	Oakhurst	2,868	2,602	1,959													
1852	Alameda	Oakland	399,484	372,242	339,337	361,561	367,548	384,575	302,163	284,063	216,261	150,174	66,960	48,682	34,555	10,500	1,543	
1999	Contra Costa	Oakley	25,619	18,374	2,816	1,306												
	Sonoma	Occidental	1,272	1,300											97			
	San Luis Obispo	Oceano	7,260	6,169	4,478	2,564	1,317	1,446										

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HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
1888	San Diego	Oceanside	161,029	128,398	76,698	40,494	24,971	12,881	4,651	3,508	1,161	673	330					
	Imperial	Ocotillo	296															
	Kern	Oildale	27,885	26,553	23,382	20,879		16,615										
1921	Ventura	Ojai	7,862	7,613	6,816	5,591	4,495	2,519	1,622	1,468								
	Santa Clara	Old Mountain View													125			
	Inyo	Olancha	134															
	Yuba	Olivehurst	11,061	9,738	8,929	8,100	4,835	3,588										
1891	San Bernardino	Ontario	158,007	133,179	88,820	64,118	46,617	22,872	14,197	13,583	7,280	4,274	722	683				
	Kern	Onyx	476															
	Santa Cruz	Opal Cliffs	6,458	5,940	5,041	5,425	3,825											
	Butte	Ophir														2,430	645	
	Placer	Ophir													595			
1888	Orange	Orange	128,821	110,658	91,788	77,365	26,444	10,027	7,901	8,066	4,884	2,920	1,216	866	679			
1948	Fresno	Orange Cove	7,722	5,604	4,026	3,392	2,885	2,395										
	Sacramento	Orangevale	26,705	26,266	20,585													
	Santa Barbara	Orcutt	28,830			8,500	1,414	1,001										
	Sutter	Oregon Bar and Rock Spring																42
	El Dorado	Oregon Canyon																126
1985	Contra Costa	Orinda	17,599	16,642	16,825	6,790	4,712											
	Contra Costa	Orinda Village					5,568											
1909	Glenn	Orland	6,281	5,052	4,031	2,884	2,534	2,067	1,366	1,195	1,582	836		440	292			
	Tulare	Orosi	7,318	5,486	4,076	2,757	1,048											
1906	Butte	Oroville	13,004	11,960	8,693	7,536	6,115	5,387	4,421	3,698	3,340	3,859		1,787	1,743	1,425	2,499	
	Butte	Oroville East	8,680	8,462														
	San Diego	Otay						1,774										
	San Diego	Otay-Castle Park																
1903	Ventura	Oxnard	170,358	142,216	108,195	71,225	40,265	21,567	8,519	6,285	4,417	2,555						
	Contra Costa	Pacheco	3,562	3,325			1,518							232	400			
1889	Monterey	Pacific Grove	15,522	16,117	15,755	13,505	12,121	9,623	6,249	5,558	2,974	2,384	1,411	1,336				
1957	San Mateo	Pacifica	38,390	37,670	36,866	36,020	20,995											
	Monterey	Pajaro	3,384	3,332	1,426	1,407	1,273	1,487								761	593	
	San Diego	Pala Valley Indian Reservation														46		
	Butte	Palermo	5,720	5,260	2,572	1,966												
1973	Riverside	Palm Desert	41,155	23,252	11,801	6,171	1,295											
	Riverside	Palm Desert Country		5,626														
1938	Riverside	Palm Springs	42,807	40,181	32,271	20,936	13,468	7,660	3,434									
1962	Los Angeles	Palmdale	116,670	68,842	12,277	8,511	11,522											
	Los Angeles	Palmdale East		3,052	2,920	3,560												
1894	Santa Clara	Palo Alto	58,598	55,900	55,225	56,040	52,287	25,475	16,774	13,652	5,900	4,486	1,658					
	Shasta	Palo Cedro	1,247															
	Imperial	Palo Verde	236															
1939	Los Angeles	Palos Verdes Estates	13,340	13,512	14,376	13,631	9,564	1,963	987									
	Los Angeles	Palos Verdes Peninsula				39,616				0								
1979	Butte	Paradise	26,408	25,408	22,571	14,539	8,268											
	Stanislaus	Paradise					5,616	4,426										
	Butte	Paradise Ridge													299			
1957	Los Angeles	Paramount	55,266	47,669	36,407	34,734	27,249											
	Madera	Parksdale	2,688	1,911	1,267													
	Sacramento	Parkway-South Sacramento	36,468	31,903	26,815	28,574												
	Madera	Parkwood	2,119	1,659	1,146													
1921	Fresno	Parlier	11,145	7,938	2,902	1,993	1,366	1,419	776	564								
1886	Los Angeles	Pasadena	133,936	131,591	118,550	112,951	116,407	104,577	81,864	76,086	45,354	30,291	9,117	4,882	391			
	Santa Cruz	Pasatiempo				1,115												
1919	Stanislaus	Patterson	11,606	8,626	3,908	3,147	2,246	1,343	1,109	905	694							
	Plumas	Paxton	21															
	Inyo	Pearsonville	27															

Source: U.S. Census Bureau
General Population Characteristics California

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Riverside	Pedley	11,207	8,869				2,226										
	San Diego	Pendleton - North				11,803												
	San Diego	Pendleton - South				13,962												
	Nevada	Penn Valley	1,387	1,242	1,032													
	Placer	Penryn												210	238			
	Alameda	Peralta												774				
1911	Riverside	Perris	36,189	21,460	6,827	4,228	2,950	1,807	1,011	763	499							
	El Dorado	Peru & vicinity																168
	San Mateo	Pescadero												221	238			
1858	Sonoma	Petaluma	54,548	43,184	33,834	24,870	14,035	10,315	8,034	8,245	6,226	5,880	3,871	3,692	3,326		1,505	
	Tuolumne	Phoenix Lake - Cedar Ridge	5,123	3,569														
1958	Los Angeles	Pico Rivera	63,428	59,177	53,459	54,170	49,150											
1907	Alameda	Piedmont	10,952	10,602	10,498	10,917	11,117	10,132	9,866	9,333	4,282	1,719		634				
	El Dorado	Pilot Hill & vicinity																420
	Mono	Pine City													17			
	Amador	Pine Grove													104			
	Shasta	Pine Grove			1,049													
	Humboldt	Pine Hills	3,108	2,947	2,686													
	Kern	Pine Mountain Club	1,600															
	San Diego	Pine Valley	1,501															
	Fresno	Pinedale						2,220										
	Placer	Pino														191		
1903	Contra Costa	Pinole	19,039	17,460	14,253	13,266	6,064	1,147	934	781	967	798		340				
	Ventura	Piru	1,196	1,157	1,284													
1946	San Luis Obispo	Pismo Beach	8,551	7,669	5,364	4,043	1,762	1,425										
1903	Contra Costa	Pittsburg	56,769	47,564	33,034	20,651	19,062	12,763	9,520	9,610	4,715	2,372						
	Contra Costa	Pittsburg East					1,977											
	Contra Costa	Pittsburg West					5,188											
	Tulare	Pixley	2,586	2,457	2,488	1,584	1,327											
1926	Orange	Placentia	46,488	41,259	35,041	21,948	5,861	1,682	1,472	1,606								
1854	El Dorado	Placerville	9,610	8,355	6,739	5,416	4,439	3,749	3,064	2,322	1,650	1,914	1,748	1,690	1,951	1,562	1,754	
	El Dorado	Placerville & Vicinity																5623
	Merced	Planada	4,369	3,531	2,406	2,056	1,704											
	Tulare	Plane-Doyle Colony					5,686	2,100										
1961	Contra Costa	Pleasant Hill	32,837	31,585	25,124	24,610	23,844	5,686										
	El Dorado	Pleasant Hill & vicinity																378
1894	Alameda	Pleasanton	63,654	50,553	35,160	18,328	4,203	2,244	1,278	1,237	991	1,254	1,100					
	Plumas	Plumas Eureka	320															
1917	Amador	Plymouth	980	811	699	501	489	382	460	343	657			768	740			
1908	Mendocino	Point Arena	474	407	425	424	596	372	374	385	394	497		709	198			
	Los Angeles	Point Dume		2,809	2,438													
	Ventura	Point Mugu			2,701	3,351												
	Marin	Point Reyes Station	818															
	El Dorado	Pollock Pines	4,728	4,291	1,941													
1888	Los Angeles	Pomona	149,473	131,723	92,742	87,384	67,157	35,405	23,539	20,804	13,505	10,207	5,526	3,634				
	Tulare	Poplar				1,239	1,478											
	Tulare	Poplar-Cotton Center	1,496	1,901	1,295													
	Contra Costa	Port Chicago					1,746											
	Contra Costa	Port Costa	232											607				
1948	Ventura	Port Hueneme	21,845	20,319	17,803	14,295	11,067	3,024										
1902	Tulare	Porterville	39,615	29,563	19,707	12,602	7,991	6,904	6,270	5,303	4,097	2,696		606	202			
	Tulare	Porterville Northwest				2,517												
	Tulare	Porterville West				6,200												
1946	Plumas	Portola	2,227	2,193	1,885	1,625	1,874	2,261										
	Orange	Portola Hills	6,391	2,677														
1964	San Mateo	Portola Valley	4,462	4,194	3,939	4,996												

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HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Mendocino	Potter Valley									512	576	563					
1980	San Diego	Poway	48,044	43,516	32,263	9,422	1,921											
	Colusa	Princeton														132		
	Shasta	Project City			1,657	1,431												
	Shasta	Project City - Pine Grove						1,078										
	Monterey	Prattville	28															
	Monterey	Prunedale	16,432	7,393														
	Mendocino	Punta Arenas														956		
	Yolo	Putah															707	
	Riverside	Quail Valley	1,639	1,937														
	Los Angeles	Quartz Hill	9,890	9,626	7,421	4,935	3,325											
	Plumas	Quincy	1,879			3,343		1,330						546	432	208	192	
	Plumas	Quincy-East Quincy		4,271	4,451		2,723											
	Calaveras	Rail Road Flat	549															
	San Diego	Rainbow	2,026	2,006	1,092													
	Fresno	Raisin City	165															
	San Diego	Ramona	15,691	13,040	8,173	3,554	2,449	1,158										
	Calaveras	Rancho Calaveras	4,182															
1973	Riverside	Rancho Mirage	13,249	9,778	6,281	1,298												
	Sacramento	Rancho Cordova	55,060	48,731	42,881	30,451	7,429											
1977	San Bernardino	Rancho Cucamonga	127,743	101,409	55,250													
	Sacramento	Rancho Murieta	4,193	2,336														
1973	Los Angeles	Rancho Palos Verdes	41,145	41,659	36,577													
	Santa Clara	Rancho Rinconada		4,206		5,152												
	San Diego	Rancho San Diego	20,155	6,977														
	Los Angeles	Rancho Santa Clarita				4,860												
	San Diego	Rancho Santa Fe	3,252		4,014													
2000	Orange	Rancho Santa Margarita	47,214	11,390														
	Tehama	Rancho Tehama Reserve	1,406															
	Kern	Randsburg	77															
	Sutter	Rattlesnake Bar and James Point																206
1876	Tehama	Red Bluff	13,147	12,363	9,490	7,676	7,202	4,905	3,824	3,517	3,104	3,530	2,750	2,608	2,106	992		
1887	Shasta	Redding	80,865	66,462	41,995	16,659	12,773	10,256	8,109	4,188	2,962	3,572	2,946	1,821	600			
1888	San Bernardino	Redlands	63,591	60,394	43,619	36,355	26,829	18,429	14,324	14,177	9,571	10,449	4,797	1,904				
1892	Los Angeles	Redondo Beach	63,261	60,167	57,102	57,451	46,986	25,226	13,092	9,347	4,913	2,935	855	603				
	Humboldt	Redway	1,188	1,212	1,094													
1868	San Mateo	Redwood City	75,402	66,072	54,951	55,686	46,290	25,544	12,453	8,962	4,020	2,442	1,653	1,572	1,383	727		
1913	Fresno	Reedley	20,756	15,791	11,071	8,131	5,850	4,135	3,170	2,589	2,447							
1911	San Bernardino	Rialto	91,873	72,388	37,474	28,370	18,567	3,156	1,770	1,642	961							
	Tulare	Richgrove	2,723	1,899	1,398	1,023												
1905	Contra Costa	Richmond	99,216	87,425	74,676	79,043	71,854	99,545	23,642	20,093	16,843	6,802						
1963	Kern	Ridgecrest	24,927	27,725	15,929	7,629	5,099	2,028										
	San Benito	Ridgemark	2,741															
	El Dorado	Ringold & vicinity																253
	Santa Cruz	Rio del Mar	9,198	8,919	7,067													
1965	Humboldt	Rio Dell	3,174	3,012	2,687	2,817	3,222	1,862						213				
	Sacramento	Rio Linda	10,466	9,481	7,359	7,524	2,189											
1894	Solano	Rio Vista	4,571	3,316	3,142	3,135	2,616	1,831	1,666	1,309	1,104	884	682	648	666	319		
1945	San Joaquin	Ripon	10,146	7,455	3,509	2,679	1,894	1,550										
1922	Stanislaus	Riverbank	15,826	8,547	5,695	3,949	2,786	2,662	1,130	803								
	Fresno	Riverdale	2,416	1,980	1,866	1,722	1,012											
	Fresno	Riverdale Park	1,094															
1883	Riverside	Riverside	255,166	226,505	170,876	140,089	84,332	46,764	34,696	29,696	19,341	15,212	7,973	4,683				
1893	Placer	Rocklin	36,330	19,033	7,344	3,039	1,495	1,155	795	724	643	1,026	1,050	1,056	624	542		
	Contra Costa	Rodeo	8,717	7,589	8,286	5,356												
1962	Sonoma	Rohnert Park	42,236	36,326	22,965	6,133												

Source: U.S. Census Bureau
General Population Characteristics California

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Humboldt	Rohnerville				2,781	2,268	1,500										
1957	Los Angeles	Rolling Hills	1,871	1,871	2,049	2,050	1,664											
1957	Los Angeles	Rolling Hills Estates	7,676	7,789	7,701	6,735	3,941											
	Contra Costa	Rollingwood	2,900															
	Riverside	Romoland	2,764	2,319	1,349													
	Kern	Rosamond	14,349	7,430	2,869	2,281												
	Kern	Rosedale	8,445	4,673														
	Sonoma	Roseland	6,369	8,779	7,915	5,105	4,510	1,552										
1959	Los Angeles	Rosemead	53,505	51,638	42,604	40,972	15,476											
	Sacramento	Rosemont	22,904	22,851	18,888													
1909	Placer	Roseville	79,921	44,685	24,347	18,221	13,421	8,723	6,653	6,425	4,477	2,608		345	258	115		
1908	Marin	Ross	2,329	2,123	2,801	2,742	2,551	2,179	1,751	1,355	727	556						
	Orange	Rossmoor	10,298	9,893	10,457	12,922												
	Nevada	Rough and Ready												1,131	1,564	1,210	1,719	672
	Shasta	Round Mountain	122															
	Inyo	Round Valley	278															
	Mendocino	Round Valley Indian Reservation														15		
	Los Angeles	Rowland Heights	48,553	42,647	28,252	16,881												
	Riverside	Rubidoux	29,180	24,367	16,763	13,969												
	San Bernardino	Running Springs	5,125	4,195														
	Yuba	Rupert						4,490										
	Humboldt	Ryans Slough				3,922	3,634	1,727										
1850	Sacramento	Sacramento	407,018	369,365	275,741	257,105	191,667	137,572	105,958	93,750	65,908	44,696	29,282	26,386	21,420	16,283	13,785	6820
	Sierra	Saint Louis													94			
	Stanislaus	Salida	12,560	4,499		1,456	1,109	1,300										
1874	Monterey	Salinas	151,060	108,777	80,479	58,896	28,957	13,917	11,586	10,263	4,308	3,736	3,304	2,339	1,854	599		
	El Dorado	Salmon Falls																210
	Sonoma	Salt River															243	
	Imperial	Salton City	978															
	Imperial	Salton City	392															
	Calaveras	San Andreas	2,615	2,115	1,912	1,564	1,416	1,263					1,683	462	597			
1907	Marin	San Anselmo	12,378	11,743	12,067	13,031	11,584	9,188	5,790	4,650	2,475	1,531						
	Monterey	San Antonio														761	281	
	San Bernardino	San Antonio Heights	3,122	2,935														
	Monterey	San Ardo	501															
1869	San Bernardino	San Bernardino	185,401	164,164	117,490	106,869	91,922	63,058	43,646	37,481	18,721	12,779	6,150	4,012	1,673		940	
1914	San Mateo	San Bruno	40,165	38,961	35,417	36,254	29,063	12,478	6,519	3,610	1,562							
1866	Ventura	San Buenaventura	100,916	92,575	74,393	57,964	29,114	16,534	13,264	11,603	4,156	2,901	2,470	2,320	1,370		628	
1925	San Mateo	San Carlos	27,718	26,167	24,710	26,053	21,370	14,371	3,520	1,132								
1928	Orange	San Clemente	49,936	41,100	27,325	17,063	8,527	2,008	479	667								
	Monterey	Sand City	261															
1850	San Diego	San Diego	1,223,400	1,110,549	875,538	697,027	573,224	334,387	203,341	147,995	74,361	39,578	17,700	16,159	2,637	2,300	731	
	San Diego	San Diego Country Estates	9,262	6,874														
1960	Los Angeles	San Dimas	34,980	32,397	24,014	15,692		1,840										
1911	Los Angeles	San Fernando	23,564	22,580	17,731	16,571	16,093	12,922	9,094	7,567	3,204							
1850	San Francisco	San Francisco	776,733	723,959	678,974	715,674	740,316	775,357	634,536	634,394	506,676	416,912	342,782	######	######	######	56,802	
1913	Los Angeles	San Gabriel	39,804	37,120	30,072	29,336	22,561	20,343	11,867	7,224	2,640			737				
	San Mateo	San Gregorio													26			
	Marin	San Geronimo	436															
1888	Riverside	San Jacinto	23,779	16,210	7,098	4,385	2,553	1,778	1,356	1,346	945	898	583	661		92		
1920	Fresno	San Joaquin	3,270	2,311	1,930	1,506	879	632	240	163								
	Orange	San Joaquin Hills	2,959															
1850	Santa Clara	San Jose	894,943	782,248	629,442	459,913	204,196	95,280	68,457	57,651	39,642	28,946	21,500	18,060	12,567	9,089		
	Alameda	San Jose Mission													246			
	Monterey	San Juan															1,460	
1896	San Benito	San Juan Bautista	1,549	1,570	1,276	1,164	1,046	1,031	678		501	326	449	463	484			

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General Population Characteristics California

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1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
1961	Orange	San Juan Capistrano	33,826	26,183	18,959	3,781	1,120								376		1,460	
1872	Alameda	San Leandro	79,452	68,223	63,952	68,698	65,962	27,542	14,601	11,455	5,703	3,471	2,253		1,369	426		
	Alameda	San Lorenzo	21,898	19,987	20,545	24,633	23,773								158			
	Monterey	San Lucas	419															
1856	San Luis Obispo	San Luis Obispo	44,174	41,958	34,252	28,036	20,437	14,180	8,881	8,276	5,895	5,157	3,021	2,995	2,243			
1963	San Diego	San Marcos	54,977	38,974	17,479	3,896												
1913	Los Angeles	San Marino	12,945	12,959	13,307	14,177	13,658	11,230	8,175	3,730	584							
	Santa Clara	San Martin	4,230	1,713	1,731	1,429	1,162											
1894	San Mateo	San Mateo	92,482	85,486	77,561	78,991	69,870	41,782	19,403	13,444	5,979	4,384	1,832		932			
	San Luis Obispo	San Miguel	1,427	1,123										458				
1948	Contra Costa	San Pablo	30,215	25,158	19,750	21,461	19,687	14,476						367		1,075		
	San Diego	San Pasqual Indian Reservation														117		
	Los Angeles	San Pedro												1,240				
1874	Marin	San Rafael	56,063	48,404	44,700	38,977	20,460	13,848	8,573	8,022	5,512	5,934	3,879	3,290	2,276	841		
1983	Contra Costa	San Ramon	44,722	35,303	22,356	4,084									75			
	San Diego	San Ysidro						2,381										
1960	Monterey	Sand City		192	182	212												
	?	Sand Hill			2,606													
1911	Fresno	Sanger	18,931	16,839	12,542	10,088	8,072	6,400	4,017	2,967	2,578			428				
1886	Orange	Santa Ana	337,977	293,742	203,713	155,710	100,350	45,533	31,921	30,322	15,485	8,429	4,933	3,628	711	1,145		
	Orange	Santa Ana Air Facility				2,106												
1850	Santa Barbara	Santa Barbara	92,325	85,571	74,414	70,215	58,768	44,913	34,958	33,613	19,441	11,659	6,587	5,864	3,460			
1857	Santa Clara	Santa Clara	102,361	93,613	87,746	86,118	58,880	11,702	6,650	6,302	5,220	4,348	3,650	2,891	2,416			
1987	Los Angeles	Santa Clarita	151,088	110,642														
1866	Santa Cruz	Santa Cruz	54,593	49,040	41,483	32,076	25,596	21,970	16,896	14,395	10,917	11,146	5,659	5,596	3,898	2,561	950	
1957	Los Angeles	Santa Fe Springs	17,438	15,520	14,520	14,750	16,342											
1905	Santa Barbara	Santa Maria	77,423	61,284	39,685	32,749	20,027	10,440	8,522	7,057	3,943	2,260						
	Santa Barbara	Santa Maria South				7,129												
1886	Los Angeles	Santa Monica	84,084	86,905	88,314	88,289	83,249	71,595	53,500	37,146	15,252	7,847	3,057	1,580	417			
1902	Ventura	Santa Paula	28,598	25,062	20,552	18,001	13,279	11,049	8,986	7,452	3,967	2,216		1,047	188			
1868	Sonoma	Santa Rosa	147,595	113,313	83,320	50,006	31,027	17,902	12,605	10,636	8,758	7,817	6,673	5,220	3,616	2,898	1,623	
	Ventura	Santa Susana					2,310											
	Marin	Santa Venetia	4,298	3,362														
	Santa Barbara	Santa Ynez	4,584	4,200	3,335									211				
1980	San Diego	Santee	52,975	52,902	47,080	21,107												
	Contra Costa	Saranap					6,450	2,362										
1956	Santa Clara	Saratoga	29,843	28,061	29,261	26,810	14,861	1,329							297			
	Ventura	Saticoy					2,283	2,216						218				
	Los Angeles	Saugus-Bouquet Canyon			16,283													
1893	Marin	Sausalito	7,330	7,152	7,338	6,158	5,331	4,828	3,540	3,667	2,790	2,383	1,628	1,334	476			
	Los Angeles	Sawtelle										2,143						
	Klamath	Sawyers Bar														160		
	Siskiyou	Sawyers Bar													88			
	Humboldt	Scotia					1,122	1,017						454				
1966	Santa Cruz	Scotts Valley	11,385	8,615	6,891	3,621												
1915	Orange	Seal Beach	24,157	25,098	25,975	24,441	6,994	3,553	1,553	1,156	669							
	San Bernardino	Searles Valley	1,885	2,740	3,439	3,828												
1954	Monterey	Seaside	31,696	38,901	36,567	35,935	19,353	10,226										
	Nevada	Sebastopol													165			
1902	Sonoma	Sebastopol	7,774	7,004	5,595	3,993	2,694	2,601	1,856	1,762	1,493	1,233			197			
	Riverside	Sedco Hills	3,078	3,008	2,678													
	Imperial	Seeley	1,624	1,228	1,058													
1893	Fresno	Selma	19,444	14,757	10,942	7,459	6,934	5,964	3,667	3,047	3,158	1,750	1,083	1,150				
	Santa Clara	Seven Trees	1,666															
	Stanislaus	Shackelford	5,170															
1938	Kern	Shafter	12,736	8,409	7,010	5,327	4,576	2,207	1,258									

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HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	San Luis Obispo	Shandon	986															
	Siskiyou	Shasta													34			
1993	Shasta	Shasta Lake	9,008															
	Fresno	Shaver Lake	705															
	Tuolumne	Shaws Flat													136			
	Calaveras	Sheep Ranch												358				
	San Luis Obispo	Shell Beach					1,820											
	Contra Costa	Shell Point						4,674										
	Placer	Sheridan													125			
	El Dorado	Shingle Springs	2,643	2,049	1,268										126			
	Shasta	Shingletown	2,222															
	Contra Costa	Shore Acres			1,266		3,093											
	Inyo	Shoshone	52															
	Sierra	Sierra Butte Mines													247			
	Sierra	Sierra City												632	401			
1907	Los Angeles	Sierra Madre	10,578	10,762	10,837	12,140	9,732	7,273	4,581	3,550	2,026	1,303			350			
	Sierra	Sierra Valley													350			
	Sierra	Sierraville													126			
1924	Los Angeles	Signal Hill	9,333	8,371	5,734	5,588	4,627	4,040	3,184									
	Alpine	Silver Mountain													26			
	Ventura	Silver Strand					1,192											
	Ventura	Silver Strand Beach - Hollywood-By-The-Sea						1,000										
	Solano	Silveyville														279		
	Ventura	Simi					2,107											
1969	Ventura	Simi Valley	111,351	100,217	77,500	59,832												
	Shasta	Sisson												556				
	Siskiyou	Sisson									542	636		256				
	El Dorado	Slate Creek																42
	Yuba	Smartville													372			
	Sutter	Smith's Bar and Long Bar																84
	El Dorado	Smith's Flat													162			
	Merced	Snelling													187			
1986	San Diego	Solana Beach	12,979	12,962	13,047	5,023												
1921	Monterey	Soledad	11,263	7,146	5,928	4,222	2,837	2,441	861	594				217	136	265		
1985	Santa Barbara	Solvang	5,332	4,741	3,091	2,004	1,325											
	Contra Costa	Sommersville												371				
1900	Sonoma	Sonoma	9,128	8,121	6,054	4,112	3,023	2,015	1,158	980	801	957	652	757		1,513	597	
1851	Tuolumne	Sonora	4,423	4,153	3,247	3,100	2,725	2,448	2,257	2,278	1,684	2,029	1,922	1,441	1,492	1,322	1,960	
	Santa Cruz	Soquel	5,081	9,188	6,212	5,795							2,987	2,982	328			
	Napa	Soscol													332			
	Tuolumne	Soulsbyville	1,729	1,732														
	Kern	South Bakersfield						12,120										
	Merced	South Dos Palos	1,385	1,214														
1958	Los Angeles	South El Monte	21,144	20,850	16,623	13,443	4,850											
	El Dorado	South Fork of American River																1386
1923	Los Angeles	South Gate	96,375	86,284	66,784	56,909	53,831	51,116	26,945	19,632								
	Orange	South Laguna			6,013	2,566	2,000											
	Kern	South Lake		1,059														
1965	El Dorado	South Lake Tahoe	23,609	21,586	20,681	12,921												
	Stanislaus	South Modesto			12,492	7,889	5,465											
	Stanislaus	South Modesto - River Road																
	Butte	South Oroville	7,695	7,463	7,246	4,111	3,704											
	Sonoma	South Park					3,261	1,837										
1888	Los Angeles	South Pasadena	24,292	23,936	22,681	22,979	19,706	16,935	14,356	13,730	7,652	4,649	1,001	623				
	San Bernardino	South Riverside												280				
	Sacramento	South Sacramento-Fruitridge					16,443											

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General Population Characteristics California

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
1908	San Mateo	South San Francisco	60,552	54,312	49,393	46,646	39,418	19,351	6,629	6,193	4,411	1,989						
	Los Angeles	South San Gabriel	7,595	7,700	5,421	5,051	26,213											
	Los Angeles	South San Jose Hills	20,218	17,814	16,049	12,386												
	Sonoma	South Santa Rosa		4,128														
	Kern	South Taft	1,898	2,170	2,073	2,214	1,910	2,918										
	Stanislaus	South Turlock			1,700	1,762	1,577	1,492										
	Los Angeles	South Whittier	55,193	49,514	43,815	46,641												
	San Joaquin	South Woodbridge	2,825															
	Sutter	South Yuba City	12,651	8,816	7,530	5,352	3,200											
	El Dorado	Spanish Canyon																373
	San Mateo	Spanishtown													461			
	Monterey	Spreckels	485															
	Plumas	Spring Garden	55															
	Colusa	Spring Valley														850	283	
	San Diego	Spring Valley	26,663	55,331	40,191	29,742												
	Tuolumne	Springfield													44			
	Humboldt	Springville													163			
	Tulare	Springville	1,109															
	Fresno	Squaw Valley	2,691	2,161														
	Kern	Squirrel Mountain Valley	498															
1876	Napa	St. Helena	5,950	4,990	4,898	3,173	2,722	2,297	1,758	1,701	1,346	1,603	1,582	1,705	1,339			
	Kern	Stallion Springs	1,522															
	Santa Clara	Stanford	13,315	18,097	11,045	8,691												
1956	Orange	Stanton	37,403	30,491	23,723	18,186	11,163	1,762			695							
	Napa	State Insane Asylum													877			
	Marin	Stinson Beach	751															
1850	San Joaquin	Stockton	243,771	210,943	149,779	109,963	86,321	70,853	54,714	47,963	40,296	23,253	17,506	14,424	10,282	10,066	3,679	
	San Joaquin	Stockton Homestead												656	367			
	Tehama	Stoney Creek														76		
	Plumas	Storrie	5															
	Santa Clara	Stratford	1,264															
	Tulare	Strathmore	2,584	2,353	1,955	1,221	1,095											
	Marin	Strawberry	5,302	4,377														
	Placer	Sucker Flat													21			
1868	Solano	Suisun City	26,118	22,686	11,087	2,917	2,470	946	706	905	769	641	625	499	554	462		
	Santa Barbara	Summerland	1,545															
	Placer	Summit													28			
	Shasta	Summit City			1,136													
	Kern	Sumner													242			
	Riverside	Sun City	17,773	14,930	8,460	5,519												
	Riverside	Sunnymead			11,554	6,708	3,404											
	Placer	Sunnyside-Tahoe City	1,761	1,643	1,836													
	Riverside	Sunnyslope	4,437	3,766														
	Placer	Sunnysouth													145			
1912	Santa Clara	Sunnyvale	131,760	117,229	106,618	95,976	52,898	9,829	4,373	3,094	1,675							
	Alameda	Sunol	1,332															
	Santa Clara	Sunol-Midtown	748															
1900	Lassen	Susanville	13,541	7,279	6,520	6,608	5,598	5,338	1,575	1,358	918	688		882				
	Sutter	Sutter	2,885	2,606	2,225	1,488	1,219											
1913	Amador	Sutter Creek	2,303	1,835	1,705	1,508	1,161	1,151	1,134		920			1,351	1,324			
	Nevada	Sweetland													247			
1910	Kern	Taft	6,400	5,902	5,316	4,285	3,822	3,707	3,205	3,442	3,317							
	Kern	Taft Heights	1,865	2,050	2,111	2,108	2,661	2,176										
	San Joaquin	Taft Mosswood	1,388															
	Placer	Tahoe City				1,394									32			
	Placer	Tahoe Vista	1,668	1,144														

Source: U.S. Census Bureau
General Population Characteristics California

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	Mendocino	Talmage	1,141		1,514													
	Marin	Tamalpais-Homestead Valley	10,691	9,601	8,511													
	Contra Costa	Tara Hills	5,332	4,998														
	Contra Costa	Tara Hills - Montalvin Manor			9,471													
	Plumas	Taylorsville	154													176		
1909	Kern	Tehachapi	10,957	5,791	4,126	4,211	3,161	1,685	1,264	736	458	385			255			
	Inyo	Tecopa	99															
1906	Tehama	Tehama	432	401	365	317	261	314	175	190	196	221			328			
1989	Riverside	Temecula	57,716	27,099	1,783												839	
	Sonoma	Temelec	1,556	1,594														
	Alameda	Temescal												2,032				
1960	Los Angeles	Temple City	33,377	31,100	28,972	31,034	31,838											
	San Luis Obispo	Templeton	4,687	2,887										308				
	Mendocino	Ten-Mile River														80		
	Siskiyou	Tennant	63															
	Tulare	Terra Bella	3,466	2,740	1,807	1,037												
	Placer	Texas Diggings													34			
	Butte	Thermalito	6,045	5,646	4,961	4,217												
1964	Ventura	Thousand Oaks	117,005	104,352	77,072	35,873	2,934	1,243										
	Riverside	Thousand Palms	5,120	4,122	1,718													
	Tulare	Three Rivers	2,248															
1964	Marin	Tiburon	8,666	7,532	6,685	6,209												
	Sutter	Tierra Buena	4,587	2,878	2,374													
	Yuba	Timbuctoo													86			
	Tulare	Tipton	1,790	1,383	1,185													
	Butte	Toadtown													50			
	Placer	Todd's Valley													226			
	Tulare	Tobin	11															
	Marin	Tomales	210											225				
	Tehama	Toome's Grant														40		
	Santa Barbara	Toro Canyon	1,697															
1921	Los Angeles	Torrance	137,946	133,107	129,881	134,968	100,991	22,241	9,950	7,271								
	Placer	Towles												317	225			
	Orange	Trabuco Highlands		3,191														
1910	San Joaquin	Tracy	56,929	33,558	18,428	14,724	11,289	8,410	4,056	3,829	2,450							
	Fresno	Tranquillity	813															
	Tulare	Traver	732											438				
1870	Humboldt	Trinidad	311	362	379	300	289	188	94	107					104	160	166	
	Trinity	Trinity Centre														160	240	
	Trinity	Trinity River																204
	San Bernardino	Trona					1,138	2,450										
1993	Nevada	Truckee	13,864	3,484	2,389	1,392		1,025						1,350	1,147			
	Placer	Truckee River													38			
1888	Tulare	Tulare	43,994	33,249	22,526	16,235	13,824	12,445	8,259	6,207	3,539	2,758	2,216	2,697	447		120	
	Tulare	Tulare East			2,168	2,361	1,342											
	Tulare	Tulare Northwest			1,932	1,950												
	Tulare	Tule Indian Reservation														12		
1937	Siskiyou	Tulelake	1,020	1,010	783	857	950	1,028	785									
	Kern	Tupman	227															
	Tuolumne	Tuolumne City	1,865	1,686	1,708	1,365	1,403	1,284										
1908	Stanislaus	Turlock	55,810	42,198	26,287	13,992	9,116	6,235	4,839	4,276	3,394	1,573		203	175			
1927	Orange	Tustin	67,504	50,689	32,317	21,099	2,006	1,143	953	926					227			
	Orange	Tustin Foothills	24,044	24,358	26,174	26,699												
	Plumas	Twain	87															
	Tuolumne	Twain Harte	2,586	2,170	1,369	1,484												
1987	San Bernardino	Twentynine Palms	14,764	11,821	7,465	5,667		1,022										

Source: U.S. Census Bureau

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	San Bernardino	Twentynine Palms Base	8,413	10,606	7,079	5,647												
	Santa Cruz	Twin Lakes	5,533	5,379	4,502	3,012	1,849											
	Santa Cruz	Twin Lakes - Delmar						6,733										
1876	Mendocino	Ukiah	15,497	14,599	12,035	10,095	9,900	6,120	3,731	3,124	2,305	2,136	1,850	1,627	933			
	El Dorado	Union													68		320	588
1959	Alameda	Union City	66,869	53,762	39,406	14,724	6,618											
	Trinity	Uniontown																190
1906	San Bernardino	Upland	68,393	63,374	47,647	32,551	15,918	9,203	6,316	4,713	2,912	2,384						
	Lake	Upper Lake Village	989											296	147			
	El Dorado	Upper Placerville															515	
	Solano	Vaca Station														120		
1892	Solano	Vacaville	88,625	71,479	43,367	21,690	10,898	3,169	1,614	1,556	1,254	1,177	1,220	725	361	343		
	Los Angeles	Val Verde		1,689														
	Los Angeles	Valencia			12,163	4,243												
	Los Angeles	Valinda	21,776	18,735	18,700	18,837												
	Calaveras	Vallecito	427															
	Riverside	Valle Vista	10,488	8,751	5,474													
1868	Solano	Vallejo	116,760	109,199	80,303	71,710	60,877	26,038	20,072	16,072	21,107	11,340	7,965	6,343	5,987			
	Kern	Valley Acres	512															
	San Diego	Valley Center	7,323	1,711	1,242													
	Sonoma	Valley Ford													102			
	Plumas	Valley Ranch	92															
	Calaveras	Valley Springs	2,560															
	Los Angeles	Val Verde	1,472															
	Calaveras	Vallicita												200	214			
	Contra Costa	Valona												374				
	Santa Barbara	Vandenberg AFB	6,151	9,846	8,136													
	Santa Barbara	Vandenberg Village	5,802	5,971	5,839													
	Santa Barbara	Vandenburg				13,193												
	Los Angeles	Venice									10,385	3,119						
1905	Los Angeles	Vernon	91	152	90	261	229	432	850	1,269	1,005	772						
1962	San Bernardino	Victorville	64,029	40,674	14,220	10,845		3,241										
	Los Angeles	View Park - Windor Hills	10,958	11,769	12,101	12,268												
1962	Orange	Villa Park	5,999	6,299	7,137	2,723												
	Tehama	Vina Village												232	93			
	Los Angeles	Vincent	15,097	13,713														
	Contra Costa	Vine Hill	3,260	3,214														
	Sacramento	Vineyard	10,109															
	Placer	Virginia													514			
1874	Tulare	Visalia	91,565	75,636	49,729	27,268	15,791	11,749	8,904	7,263	5,753	4,550	3,085	2,885	1,412	913	548	
	San Mateo	Visitation Valley													80			
1963	San Diego	Vista	89,857	71,872	35,834	24,688	14,795	1,705										
	Amador	Volcano												358	499			
		Waldon	5,133															
		Wallace	220															
1959	Los Angeles	Walnut	30,004	29,105	12,478	5,992	934											
1914	Contra Costa	Walnut Creek	64,296	60,569	53,643	39,844	9,903	2,420	1,578	1,014	538				94			
	Contra Costa	Walnut Creek West			5,893	8,330												
	Sacramento	Walnut Grove	669											212				
	Contra Costa	Walnut Heights					5,080											
	Los Angeles	Walnut Park	16,180	14,722	11,811	8,925												
1945	Kern	Wasco	21,263	12,412	9,613	8,269	6,841	5,592										
	Calaveras	Washington													542			
	Nevada	Washington													195			
	Yolo	Washington																320
	Fresno	Washington Colony												929	118			

Source: U.S. Census Bureau

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
1969	Stanislaus	Waterford	6,924	4,771	2,683	2,243	1,780	1,777							63			
1868	Santa Cruz	Watsonville	44,265	31,099	23,662	14,569	13,293	11,572	8,937	8,344	5,013	4,446	3,528	2,149	1,799	1,151	398	
	Los Angeles	Watts									4,529	1,922						
	Trinity	Weaverville	3,554	3,370	2,787	1,489	1,736									816	777	210
	El Dorado	Weaverville & vicinity																966
1961	Siskiyou	Weed	2,978	3,062	2,879	2,983	3,223	2,739										
	Kern	Weedpatch	2,726	1,892	1,553													
	Kern	Weldon	2,387															
	Los Angeles	West Athens	9,101	8,859	8,531	13,311												
	Inyo	West Bishop	2,807	2,908														
	Los Angeles	West Carson	21,138	20,143	17,997	15,918												
	Los Angeles	West Compton	5,435	5,451	5,907	5,605												
1923	Los Angeles	West Covina	105,080	96,086	80,291	68,034	50,645	4,499	1,072	769								
	Placer	West Damascus													27			
1984	Los Angeles	West Hollywood	35,716	36,118	35,703	34,622	28,870											
	San Mateo	West Menlo Park	3,629	3,959														
	Stanislaus	West Modesto	6,096			6,135	1,897	2,038										
	Fresno	West Parlier			2,811													
	Contra Costa	West Pittsburg		17,453	8,773	5,969	5,188											
	Calaveras	West Point	746											266	173			
	Los Angeles	West Puente Valley	22,589	20,254	20,445	20,733												
	Riverside	West Riverside						3,798										
1987	Yolo	West Sacramento	31,615	28,898	10,875	12,002												
	Los Angeles	West Whitter - Los Nietos	25,129	24,164	21,001	20,845												
	Ventura	Westgate-Waverly Park					2,191											
	Humboldt	Westhaven-Moonstone	1,044	1,109														
1981	Los Angeles	Westlake Village	8,368	7,455	6,138													
	Stanislaus	Westley	747															
1957	Orange	Westminster	88,207	78,118	71,133	60,076	25,750	3,131										
	Los Angeles	Westmont	31,623	31,044	27,916	29,310												
1934	Imperial	Westmorland	2,131	1,380	1,590	1,175	1,404	1,213	1,010									
	Lassen	Westwood	1,998	2,017	2,081	1,862	1,209	3,618										
1874	Yuba	Wheatland	2,275	1,631	1,474	1,280	813	581	496	479	435	481	492	630				
	Plumas	Whitehawk	96															
1898	Los Angeles	Whittier	83,680	77,671	69,717	72,863	33,663	23,433	16,115	14,822	7,997	4,550	1,590	585				
	Riverside	Wildomar	14,064	10,411														
	Inyo	Wilkerson	562															
	Colusa	Williams	3,670	2,297	1,658	1,571	1,370	1,134	814	851			918	461	279			
1888	Mendocino	Willits	5,073	5,027	4,008	3,091	3,410	2,691	1,625	2,691	1,468	1,153	791	815	153			
	Humboldt	Willow Creek	1,743	1,576														
	Siskiyou	Willow Creek													115			
	Los Angeles	Willowbrook	34,138	32,772	30,845	32,328												
	Orange	Willowick						2,226										
	Colusa	Willows												1,176	728			
1886	Glenn	Willows	6,220	5,988	4,777	4,085	4,139	3,019	2,215	2,024	2,190	1,139	893	1,176				
	Los Angeles	Wilmington												687	911			
	Sacramento	Wilton	4,551	3,858														
	Riverside	Winchester	2,155	1,689														
1992	Sonoma	Windsor	22,744	13,371		2,359									120			
	San Diego	Winter Gardens	19,771															
	Imperial	Winterhaven	529															
1898	Yolo	Winters	6,125	4,639	2,652	2,419	1,700	1,265	1,133	896	903	910	785		523			
	Merced	Winton	8,832	7,559	4,995	3,393												
	Placer	Wisconsin Hill													66			
	Kern	Wofford Heights	2,276	2,270	2,112													
	Marin	Woodacre	1,393	1,478	1,300													

Source: U.S. Census Bureau

HISTORICAL CENSUS POPULATIONS OF CALIFORNIA CITIES, PLACES, AND TOWNS
1850-2000

Year Incorp.	County	Place/Town/City	2000	1990	1980	1970	1960	1950	1940	1930	1920	1910	1900	1890	1880	1870	1860	1850
	San Joaquin	Woodbridge		3,456	1,672	1,397								288	245			
	Riverside	Woodcrest	8,342	7,796														
1941	Tulare	Woodlake	6,651	5,678	4,343	3,371	2,623	2,525	1,146									
1874	Yolo	Woodland	49,151	39,802	30,235	20,677	13,524	9,386	6,637	5,542	4,147	3,187	2,886	3,069	2,257			
1856	San Mateo	Woodside	5,352	5,035	5,291	4,734	3,592											
	Tulare	Woodville	1,678	1,557	1,507	1,031	1,045											
	San Bernardino	Wrightwood	3,837	3,308	2,511													
	Placer	Yankee Jim's													150			
	San Bernardino	Yermo			1,092	1,304												
1967	Orange	Yorba Linda	58,918	52,422	28,254	11,856	1,198											
	Madera	Yosemite Lakes	4,160	2,367														
	Madera	Yosemite Valley	265		1,073													
	Nevada	You Bet													195			
1956	Napa	Yountville	2,916	3,259	2,893	2,332								231	256			
1857	Siskiyou	Yreka	7,290	6,948	5,916	5,394	4,759	3,227	2,485	2,126	1,277	1,134	1,254	1,100	1,059	1,063	1,631	
1908	Sutter	Yuba City	36,758	27,437	18,736	13,986	11,507	7,861	4,968	3,605	1,708	1,160		562				
	Sutter	Yuba City & Vicinity																336
1989	San Bernardino	Yucaipa	41,207	32,824	23,345	19,284		1,515										
1991	San Bernardino	Yucca Valley	16,865	13,701	8,294	3,893												

Source: U.S. Census Bureau

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Letters to the Editor
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New $30 Million Terminal for Hudson River Ferries
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East Bay Section
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Bill Coolidge's Bay Journal
Bus Rider's Sociology
Wanna Buy a Ferry?
Treasure Island Seeks Ferry Funds

Treasure Island Seeks Mitigation Funds from Caltrans to Start Ferry Service to and From Treasure Island

San Francisco City officials, anticipating traffic chaos as a result of the Bay Bridge retrofit, are trying to persuade Caltrans to fund stopgap ferry service connecting Treasure Island to San Francisco.

Access to and from Treasure and Yerba Buena islands is severely constrained by very limited capacity on the San Francisco-Oakland Bay Bridge. In order to reduce traffic on the San Francisco-Oakland Bay Bridge, the Treasure Island Development Authority has made public transit a priority. Yet current MUNI service to San Francisco does not meet demand and there is no public transit service to and from the East Bay.

Access to and from Treasure and Yerba Buena islands is severely constrained by very limited capacity on the San Francisco-Oakland Bay Bridge. In order to reduce traffic on the San Francisco-Oakland Bay Bridge, the Treasure Island Development Authority has made public transit a priority. Yet current MUNI service to San Francisco does not meet demand and there is no public transit service to and from the East Bay.

The Treasure Island Development Authority recently issued an RFQ for a master developer for the islands. Any plan for redevelopment will be based on the July 1996 Draft Reuse Plan endorsed by the San Francisco Board of Supervisors. The plan states that "Ferries will bring visitors…to Treasure Island".

Vehicular access to Treasure Island is poor due to traffic congestion on the Bay Bridge and the substandard configuration of the on and off ramps. The Reuse Draft Plan estimates that 90% of patrons of the visitor-oriented attractions will use ferry service. Also, the Draft Reuse Plan states that the proposed development plan for TI is only feasible if a ferry transit system is utilized and moreover that development should be limited to those uses which can be accommodated primarily by ferry.

It is estimated that the redevelopment of former Naval Station Treasure Island will generate more than 5,000 permanent jobs, almost twice the number that were lost with Base closure. Construction activity and interim reuse for film and event production will create almost 5,000 short-term jobs. Workers will travel from both the City and East Bay and regularly scheduled ferry service addresses those needs.

Treasure Island's present population is currently 3,500 and growing. Five thousand residents are expected by the end of next year, including renters on Treasure and Yerba Buena Islands, students and staff of the U.S. Department of Labor's Job Corps, the Life Learning Academy, and

the Treasure Island School (K through 8).

Currently water transit is used for "special events", shuttling attendees to Treasure Island for large weddings, parties and other activities. During Labor Day in 1998, approximately 65,000 visitors came to Treasure Island by ferry from both sides of the Bay. Many East Bay ferry riders waited two or more hours in heavy winds despite the availability of buses to whisk them back to the McArthur BART station.

Future redevelopment plans include an exposition gardens area, enlarged marina and other larger scale developments. Current plans for the Marina show an increase in the number of slips from 108 to 400 as well as a public access pier, restaurants, boat storage and other landside attractions.

An allocation of $2,000,000 "to establish a regional water transit system beginning with Treasure Island" was approved by the California Legislature as part of Governor Davis' Traffic Congestion Relief Program. These funds must come through the Bay Area Water Transit Authority and the California Transportation Commission.

Further, an earmark for $879,000 to the Treasure Island Development Authority was awarded from Federal Ferry Boat Discretionary funds. A match of $121,000 must be secured.

The Regional Ferry Plan Capital Program of the Metropolitan Transportation Commission's San Francisco Bay Area Regional Ferry Plan Update (1999) contains *$2.5* million for capital improvements for a ferry dock for Treasure Island.

However, none of these funding sources provides for operating subsidies needed to mitigate the impacts of bridge construction. Without operating subsidies, no operator will initiate or maintain service.

Caltrans' plans for replacement of the existing east span includes five to six years of construction affecting the flow of traffic on the Bay Bridge. Without additional public transit, bridge workers traveling to and from Yerba Buena and Treasure Island, residents and others who work or go to school on Treasure Island will be severely impacted by bridge construction work.

FINAL ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR THE DISPOSAL AND REUSE OF NAVAL STATION TREASURE ISLAND SAN FRANCISCO, CALIFORNIA

Lead Agency for the EIS:	Department of the Navy
Title of Proposed Action:	Disposal and Reuse of Naval Station Treasure Island
Affected Jurisdiction:	City and County of San Francisco
Designation:	Final EIS Submitted Pursuant to 42 U.S.C. § 4332(2)(C)

ABSTRACT

In 1993, the Defense Base Realignment and Closure Commission, pursuant to the Defense Base Closure and Realignment Act of 1990 (Pub. L. 101-510, Title XXIX, 10 U.S.C. § 2687 note), recommended the closure of Naval Station Treasure Island (NSTI). NSTI was closed on September 30, 1997. This EIS has been prepared in accordance with the National Environmental Policy Act (NEPA) (Pub. L. 91-190, 42 U.S.C. §§ 4321-4370f), the implementing regulations of the Council on Environmental Quality (CEQ) (40 C.F.R. Parts 1500-1508), and agency regulations and guidelines to evaluate the environmental consequences of the proposed disposal of surplus Federal property at NSTI and the subsequent reuse of those properties.

The EIS evaluates three reuse alternatives: Alternative 1 (Draft Reuse Plan Alternative); Alternative 2; and Alternative 3. Also evaluated is the No Action Alternative, in which Navy would retain ownership of NSTI surplus federal property in a caretaker status. This EIS analyzes potential environmental impacts relating to land use; visual resources; socioeconomics; cultural resources; transportation; air quality; noise; biological resources; geology and soils; water resources; utilities; public services; and hazardous materials and waste. The only potentially significant and not mitigable impact is demolition of historic buildings that would occur under Alternative 2.

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June 2003

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EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The Defense Base Closure and Realignment Act (DBCRA) (10 United States Code [U.S.C.] § 2687 note) directed the Department of Defense (DoD) to reduce and realign United States (US) military operations. The 1993 Defense Base Realignment and Closure Commission (BRAC '93 Commission) recommended the closure of Naval Station Treasure Island (NSTI). President Clinton approved this recommendation and the 103rd Congress accepted it on September 27, 1993. NSTI closed on September 30, 1997, and US Department of the Navy (Navy) is in the process of disposing of the property in accordance with applicable laws and regulations, including the DBCRA.

This environmental impact statement (EIS) evaluates the potential impacts on the natural and human environment that could result from Navy disposal of surplus federal properties within NSTI and subsequent reuse of those federal properties. NSTI is made up of dry and submerged lands of both Treasure Island and portions of Yerba Buena Island in San Francisco, California. The location of NSTI is shown on Figure ES-1.

This document has been prepared by Navy in accordance with the National Environmental Policy Act of 1969 (NEPA) (Public Law [Pub. L.] 91-190, 42 U.S.C. §§ 4321-4370f); the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [C.F.R.] Parts 1500-1508); Navy regulations implementing NEPA (32 C.F.R. Part 775); and Navy guidelines (Chief of Naval Operations Instruction [OPNAVINST] 5090.1B [2002]).

This EIS was originally prepared as a joint document to fulfill the requirements of both NEPA and the California Environmental Quality Act of 1970 (CEQA) (California Public Resources Code [Cal. Pub. Res. Code] § 21000 et seq., as amended). In 2000 the City and County of San Francisco (San Francisco) elected to prepare a separate environmental impact report (EIR) to analyze the impacts from the reuse of NSTI. The EIR will undergo a separate public review process.

ES.2 PURPOSE AND NEED

The purpose of and need for the proposed federal action is to dispose of surplus federal property at NSTI for subsequent reuse. Navy considered the Local Redevelopment Authority's (LRA) stated purpose and need in developing reasonable reuse alternatives. This purpose and need focused on reusing NSTI property to support the local economic base, enhance the local image and identity, expand the range of recreational and entertainment opportunities available to the community, and enhance the overall livability of the local area and region.

ES.3 DISPOSAL AND REUSE PROCESS

On October 15, 1993, Navy issued a Notice of Availability (NOA) for NSTI (Treasure Island proper) to DoD and other federal agencies indicating that the property was excess to the needs

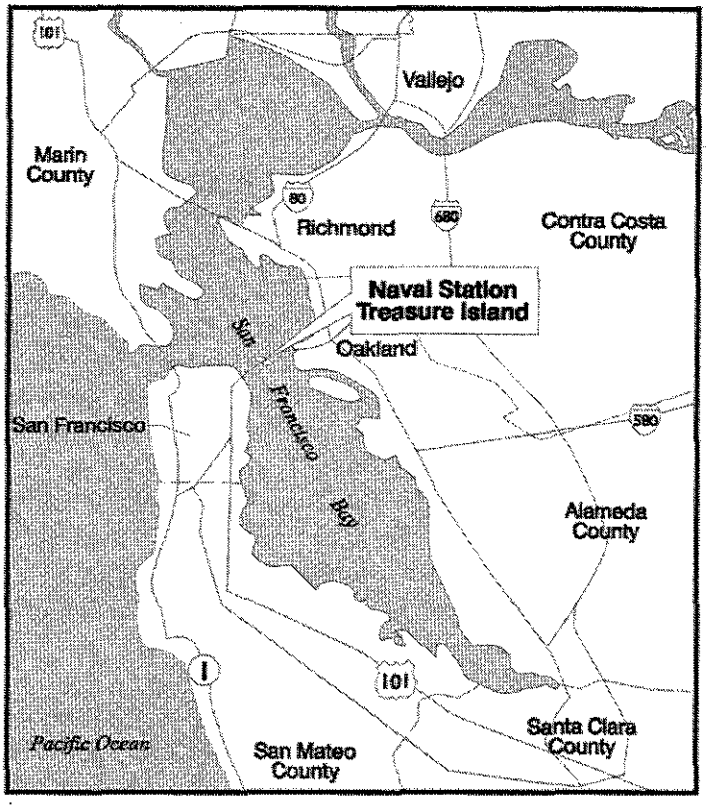


Figure ES-1. Regional Location

of Navy. Between October 1993 and October 1995, nine federal agencies expressed interest in excess property at NSTI. Five of the agencies submitted formal requests for property transfer. Three of these agencies withdrew their requests in 1995 and early 1996. The transfer requests for the remaining two agencies, US Department of Labor and the US Coast Guard, were approved. The US Department of Labor requested approximately 36 acres (15 hectares [ha]) of property and associated facilities on Treasure Island for its Job Corps program, and the Navy authorized the requested property transfer on April 17, 1998. The US Coast Guard requested approximately 22 acres (9 ha), including land, facilities, and submerged areas of Yerba Buena Island. Navy authorized transferring 11 acres (4.5 ha) of dry land on March 3, 1998, and the remaining 11-acre (4.5 ha) parcel of submerged land was transferred on November 27, 2002. These properties are not part of the proposed disposal and subsequent reuse action evaluated in this EIS.

On October 26, 2000, the Federal Highways Administration (FHWA), pursuant to its authority under 23 U.S.C. § 107(d), conveyed 98 acres (40 ha) of dry and submerged Navy land on Yerba Buena Island that was previously declared to be surplus to the needs of the federal government and was considered in the NSTI Draft Reuse Plan (Draft Reuse Plan) (San Francisco 1996e) to the California Department of Transportation (Caltrans). Caltrans sought the property held by the Navy for right-of-way purposes in connection with the construction, operation, and maintenance of the SFOBB east spans retrofit project. Land conveyed to Caltrans includes lands permanently conveyed in fee, temporary construction easements (TCEs) over a substantial part of Yerba Buena Island, and permanent aerial easements over two parcels of land. While the lands conveyed in fee to Caltrans are no longer part of NSTI and are not part of the Navy

disposal considered in this EIS, TCEs and aerial easements are available for disposal and are considered in this EIS. Figure ES-2 illustrates the boundaries of NSTI and the reuse plan area.

The DoD Office of Economic Adjustment (OEA) designated San Francisco as the LRA for NSTI in May 1994. As part of the NSTI reuse planning process, numerous alternatives were proposed and then evaluated using goals established by the LRA. The city's Office of Military Base Conversion, a partnership of San Francisco's Planning Department and Redevelopment Agency and the Port of San Francisco, directed the reuse planning process. On July 22, 1996, the San Francisco Board of Supervisors endorsed the Draft Reuse Plan. The Draft Reuse Plan proposes to maximize a range of public benefits within the major constraints of the site. The plan emphasizes publicly oriented recreational, entertainment, and hospitality uses that maximize the island's central location and outstanding views. The Draft Reuse Plan also incorporates specific users and types of uses from the second homeless screening process.

In 1997 the California State Legislature created a special reuse authority for Treasure Island, transferring the LRA status from San Francisco to the Treasure Island Development Authority (TIDA). TIDA is a state agency staffed by the San Francisco mayor's office and is the entity responsible for planning the reuse of Treasure Island. In March 1998, DoD OEA recognized TIDA as the implementing LRA for NSTI. TIDA submitted an *Economic Development Conveyance (EDC) Application and Business Plan for Naval Station Treasure Island* in June 2000 for land to be used and redeveloped in accordance with the Draft Reuse Plan.

ES.4 PUBLIC INVOLVEMENT PROCESS

The EIS process is designed to involve the public in federal decision-making. Opportunities to comment on, and participate in, the process are provided during preparation of this EIS. Comments from agencies and the public are solicited to help identify the primary issues associated with the federal disposal and proposed reuse of NSTI. San Francisco conducted public meetings and workshops as part of the reuse planning process, and the public was encouraged to comment on the various reuse alternatives. The public's input, as well as feedback from applicable resources and permitting agencies, will be used to evaluate the alternatives and environmental impacts before final decisions are made.

Scoping Process

Scoping is the process used to identify potential significant environmental issues and concerns related to the proposed action. The scoping period was from September 24, 1996, to October 28, 1996. The scoping process was conducted jointly by Navy and San Francisco.

On September 24, 1996, in accordance with NEPA requirements, a Notice of Intent (NOI) to prepare an EIS was published in the *Federal Register*. A copy of the NOI is presented in Appendix D of this document. The NOI was mailed to regulatory agencies, local jurisdictions, elected officials, public service providers, and organizations.

As part of the scoping process, Navy and San Francisco held a public meeting to inform the public about disposal and reuse alternatives and to solicit the public's participation and comments. The scoping meeting was held on October 9, 1996, at the San Francisco Ferry Building. Six individuals from the public provided oral comments at the scoping meeting. Oral

comments addressed alternate land uses on the site related primarily to residential, marine, and wildlife observation uses. Commentors also were concerned with addressing the needs of veterans in the reuse plan and concerns about public notification during the comment period. Additionally, twelve comment letters were received in response to the 1996 NOI. These written comments addressed a variety of concerns, including impacts to traffic, geology and seismology, historic architectural resources, hazardous and waste material, and archeological resources. All issues raised during the scoping period regarding environmental and socioeconomic topics have been addressed in this EIS.

Public Review of the Draft EIS

The public was invited to review and comment on the Draft EIS. An NOA was published in the *Federal Register* on May 10, 2002 and notices were published in the *San Francisco Chronicle* and *Oakland Tribune* on May 25 and 26, 2002. A copy of the NOA is presented in Appendix D of this document. Copies of the Draft EIS and NOA were mailed to those on the mailing list (Chapter 10 of the Draft EIS), beginning a 45-day public comment period. A public hearing on the Draft EIS was also held at Building 140 on Treasure Island on June 11, 2002.

During the public comment period, 22 comment letters on the Draft EIS were received from agencies or individuals. In addition, four persons provided oral comments on the Draft EIS at the public hearing. Comments on the Draft EIS and responses to those comments are provided in Chapter 11, Responses to Comments. The Final EIS has been revised, as appropriate, in response to public comments.

Final EIS

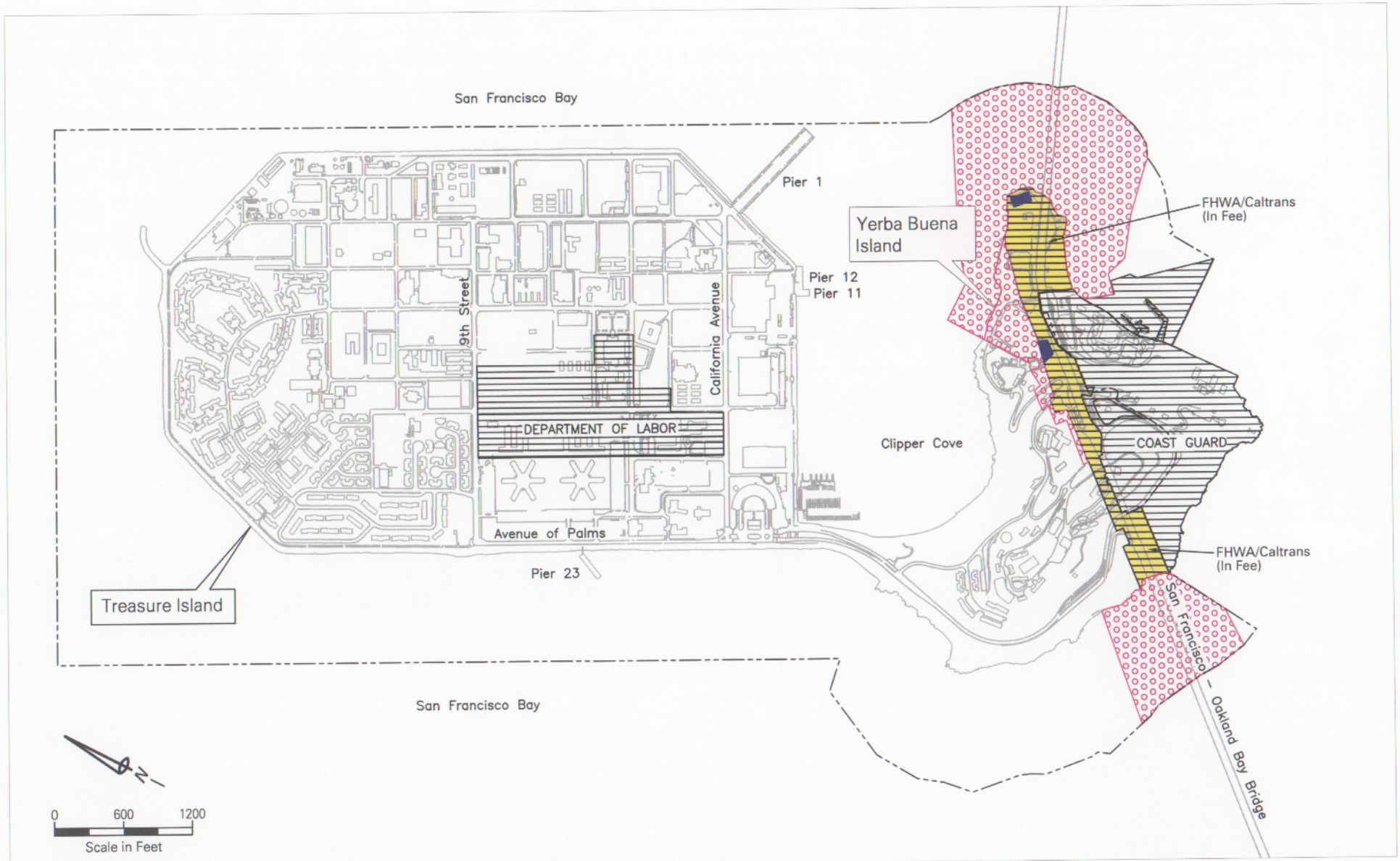
Chapter 11 of the Final EIS incorporates and responds to comments received on the Draft EIS. An NOA of the Final EIS was published in the *Federal Register* on June 27, 2003. As required under NEPA, there will be a 30-day review period after publication of the Final EIS. During this period, the public may comment on the adequacy of responses to comments and the Final EIS. After the 30-day review period, Navy can issue a NEPA Record of Decision (ROD).

ES.5 ALTERNATIVES CONSIDERED

Navy can either retain NSTI surplus property in federal ownership (No Action Alternative) or dispose of the property for subsequent reuse (Disposal Alternative). Navy disposal of surplus property at NSTI is the federal action evaluated in this EIS for potential environmental and socioeconomic impacts. Under the federal action, approximately 997 acres (403 ha) of federal property at NSTI would be conveyed to non-federal entities. Navy disposal is assumed as part of each of the three reuse alternatives.

Reuse Alternatives

This section presents a detailed description of the three reuse alternatives developed and evaluated in this EIS: Alternatives 1, 2, and 3. Alternative 1 represents full implementation of the development scenario described in the Draft Reuse Plan developed by the LRA. Alternative 2 is based on comments received during the scoping process, including the recommendations of



The area proposed for Navy disposal includes submerged lands and upland areas within NSTI. Parcels that were transferred to other Federal agencies are excluded from the proposed disposal.

Legend:

- Areas Excluded from Proposed Navy Disposal
- Naval Station Treasure Island Property Boundary/Reuse Plan Area
- FHWA/Caltrans TCEs (Included in Proposed Navy Disposal)
- FHWA/Caltrans Aerial Eastments (Included in Proposed Navy Disposal)
- FHWA/Caltrans Land Permanently Conveyed in Fee (Excluded From Proposed Navy Disposal)

Reuse Plan Area

Naval Station Treasure Island, California

Figure ES-2

an advisory panel convened by the Urban Land Institute. Alternative 3 represents a lower level of redevelopment than proposed in the Draft Reuse Plan.

Each reuse alternative is a broad conceptual plan characterized by a general land use concept and a development scenario. As such, each has general land use planning designations (residential, publicly oriented, institutional and community, and open space and recreation) that allow for a range of different types of land use. These four land use categories represent slightly revised versions of the land use categories discussed in the Draft Reuse Plan. The proposed land use configurations of the three reuse alternatives are provided on Figures ES-3, ES-4, and ES-5, respectively. Table ES-1 provides a summary comparison of land use development of the three alternatives. The table and figures are intended to help the reader identify specific differences among the three alternatives.

Alternative 1 (Preferred Alternative)

Alternative 1 features a combination of publicly oriented development, open space and recreation, and extensive residential development at full buildout, such as envisioned in the Draft Reuse Plan. Under this alternative, the NSTI project acreage would be occupied in the following manner: publicly oriented land uses, approximately 35 percent; residential, 30 percent; open space and recreation, 26 percent; and institutional and community services, 9 percent. The four land use alternatives initially considered by the LRA were used to develop and further refine a "preferred reuse concept" that formed the basis of the Draft Reuse Plan, represented by Alternative 1. Seismic upgrades would include dike improvements to the entire Treasure Island perimeter. A new underground utility corridor would run along the perimeter of the island, carrying storm and sanitary sewer mains, water mains, reclaimed water mains, and electricity, gas, and telecommunications lines.

Alternative 2

Alternative 2 is a less intensive but similar development compared to Alternative 1. This alternative emphasizes open space and recreation and publicly oriented uses but on a smaller scale. Under Alternative 2, open space and recreation land uses would occupy 58 percent of NSTI acreage, publicly oriented 33 percent, residential 5 percent, and institutional and community services 4 percent. The existing housing would be reused initially. No new housing would be built on Treasure Island. An 18-hole golf course would occupy the present housing area on the northern part of the island. Regarding seismic upgrade, except for the golf course area, full-scale perimeter dike improvements would be implemented around Treasure Island. The utility corridor would be constructed around the perimeter of Treasure Island, but it would not extend along the perimeter adjacent to the proposed golf course.

Alternative 3

Alternative 3 represents the scenario where little new development would occur, and existing facilities would be reused. Under Alternative 3, open space and recreation land uses would occupy 31 percent of NSTI acreage, residential 32 percent, publicly oriented 27 percent, and institutional and community services 10 percent. Seismic upgrade dike improvements would occur along those areas of Treasure Island subject to rotational dike failure.

No Action Alternative

Under the No Action Alternative, Navy would retain ownership of NSTI. Except for existing building leases, all buildings would remain vacant, and all other facilities would remain but would be unused. No new leases would be entered into under the No Action Alternative, and existing leases would continue until they expire or are terminated.

The property would be held in an inactive or caretaker status, as discussed in Chapter 1. Navy and San Francisco executed a cooperative agreement in April 1997 and amended it in September 1997. Under this agreement, San Francisco is responsible for providing those caretaker services. Site environmental cleanup would continue until completed. No construction would occur under this alternative, except as allowed by existing lease authorization.

Preferred Alternative

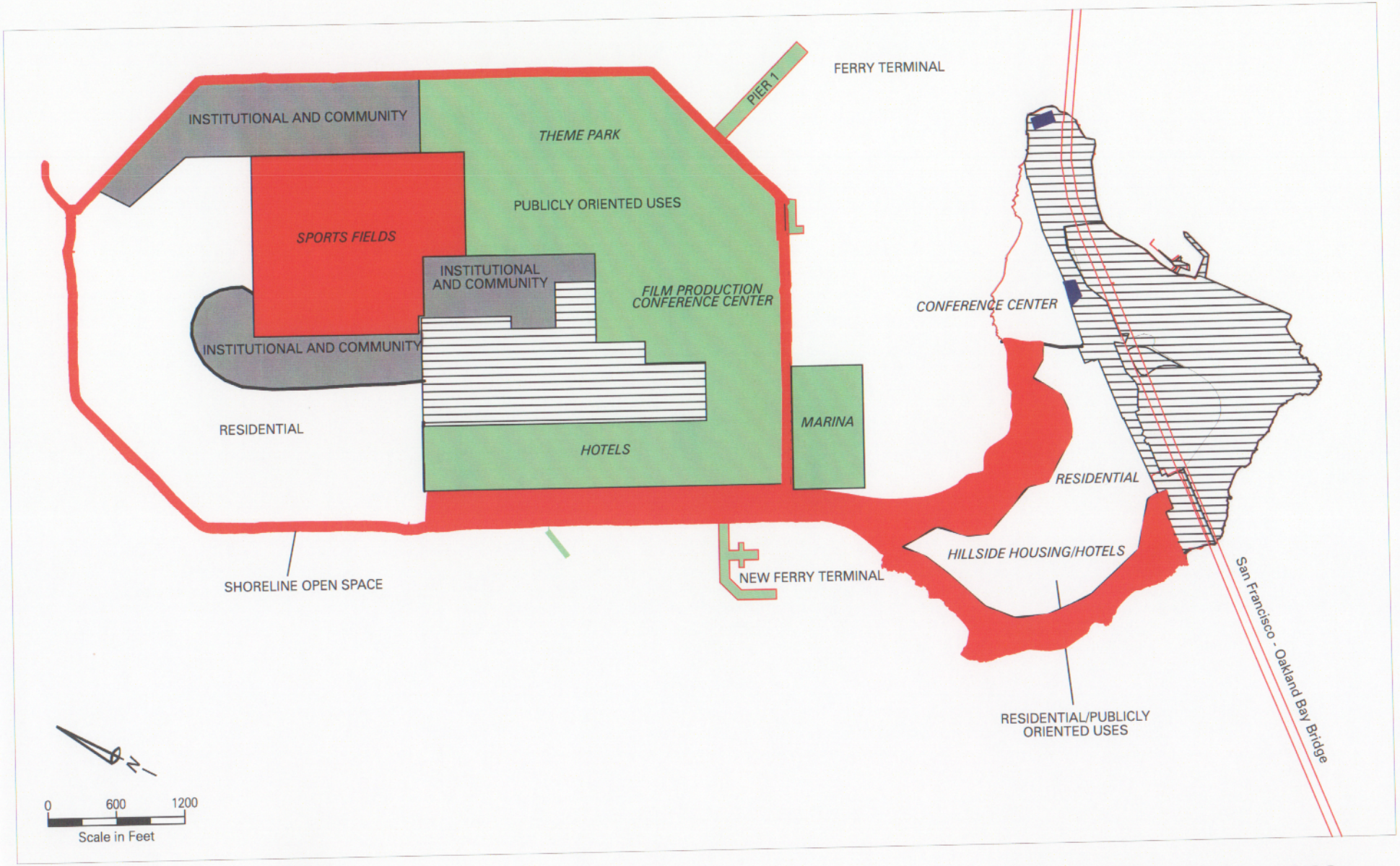
Navy has selected Alternative 1 as the preferred alternative because it best reflects the Draft Reuse Plan, and would result in no significant unavoidable adverse effects.

NEPA also requires that an environmentally preferable alternative be identified. The No Action Alternative would have no significant impacts, and for NEPA purposes it would be the environmentally preferable alternative. However, the No Action Alternative would not meet the Navy's goals of property disposal and rapid economic recovery consistent with DBCRA 1990 and the DoD Rule on Revitalizing Base Closure Communities–Base Closure Community Assistance (32 C.F.R. Part 175 [1998]). It also would not be consistent with former President Clinton's Five-Part Plan for Revitalizing Base Closure Communities, which emphasizes local economic redevelopment of closing military facilities and creation of new jobs as the means to revitalize these communities (32 C.F.R. Part 174 [1998]). The No Action Alternative would result in continued caretaker activities; therefore, socioeconomic gains in terms of new jobs and increased revenue in the region would not be realized.

ES.6 ENVIRONMENTAL CONSEQUENCES

Potential significant impacts and mitigation measures of each alternative are summarized in Table ES-2. Measures that can be taken to reduce impacts to a level below significant are suggested for each alternative, as appropriate. Navy would be responsible for mitigation measures identified in its ROD for the proposed disposal action. Mitigation for impacts associated with reuse are not the responsibility of Navy.

Implementation of suggested mitigation measures would reduce all impacts to a level below significant except for impacts on cultural resources under Alternative 2. Implementation of Alternative 2 would require demolition of two buildings on Treasure Island that are eligible for listing on the National Register of Historic Places (NRHP). This would result in the loss of significant historic resources. This adverse effect can be lessened or reduced by recording the affected resources to the standards of Historic American Buildings Survey (HABS)/Historic American Engineering Record (HAER), but recordation would not eliminate the adverse effect caused by the demolition of NRHP-eligible resources.



Alternative 1 is similar to the development scenario described in the Draft Reuse Plan.

Legend:

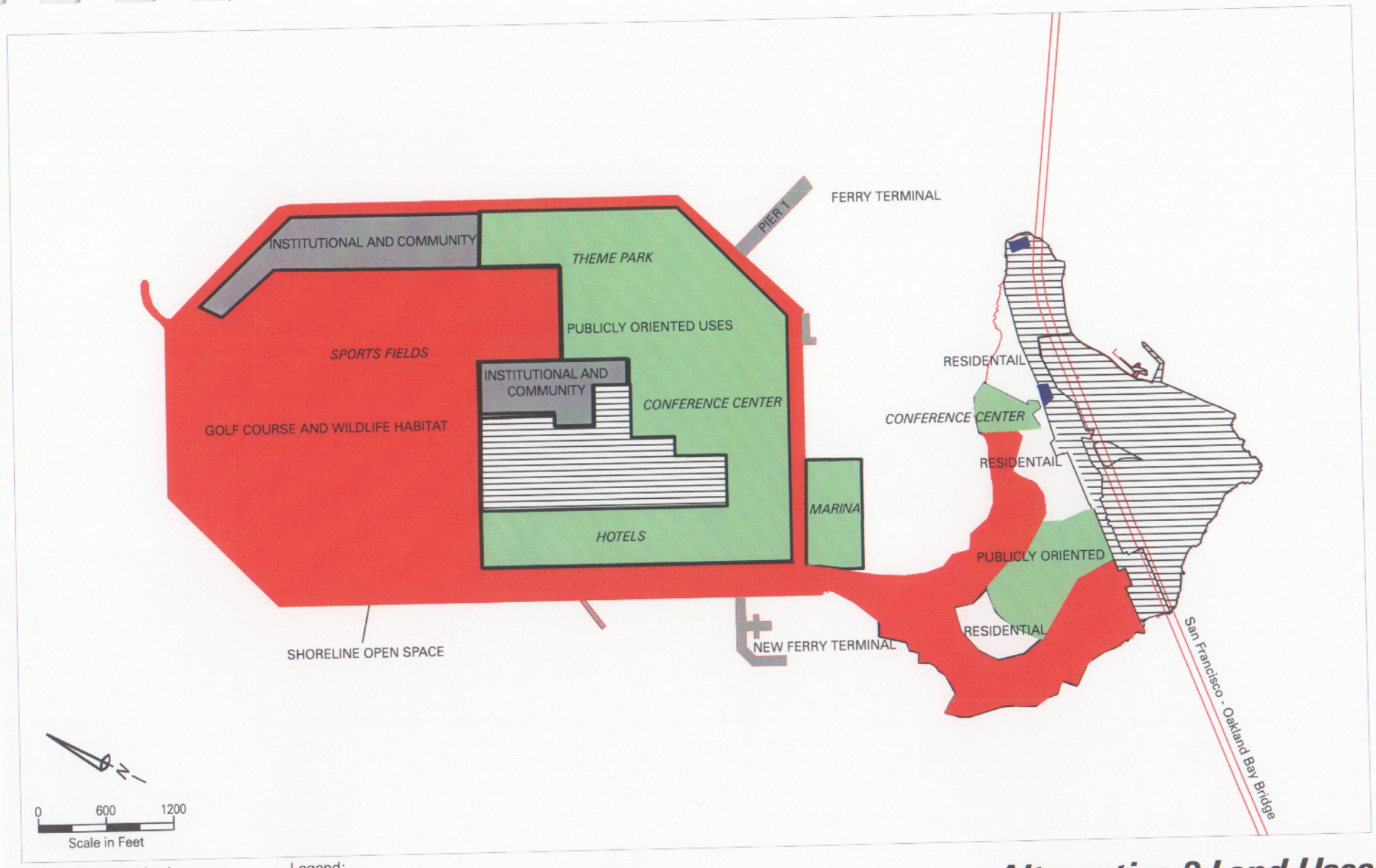
- Publicly Oriented
- Open Space and Recreation
- Institutional and Community
- Areas Excluded from Proposed Navy Disposal
- Residential
- FHWA/Caltrans Aerial Easement

Alternative 1 Land Uses

Naval Station Treasure Island, California

Figure ES-3

Source: CCSF 1996e; Developed by CCSF 1997



Alternative 2 emphasizes open space/recreation and publicly oriented land uses.

Legend:

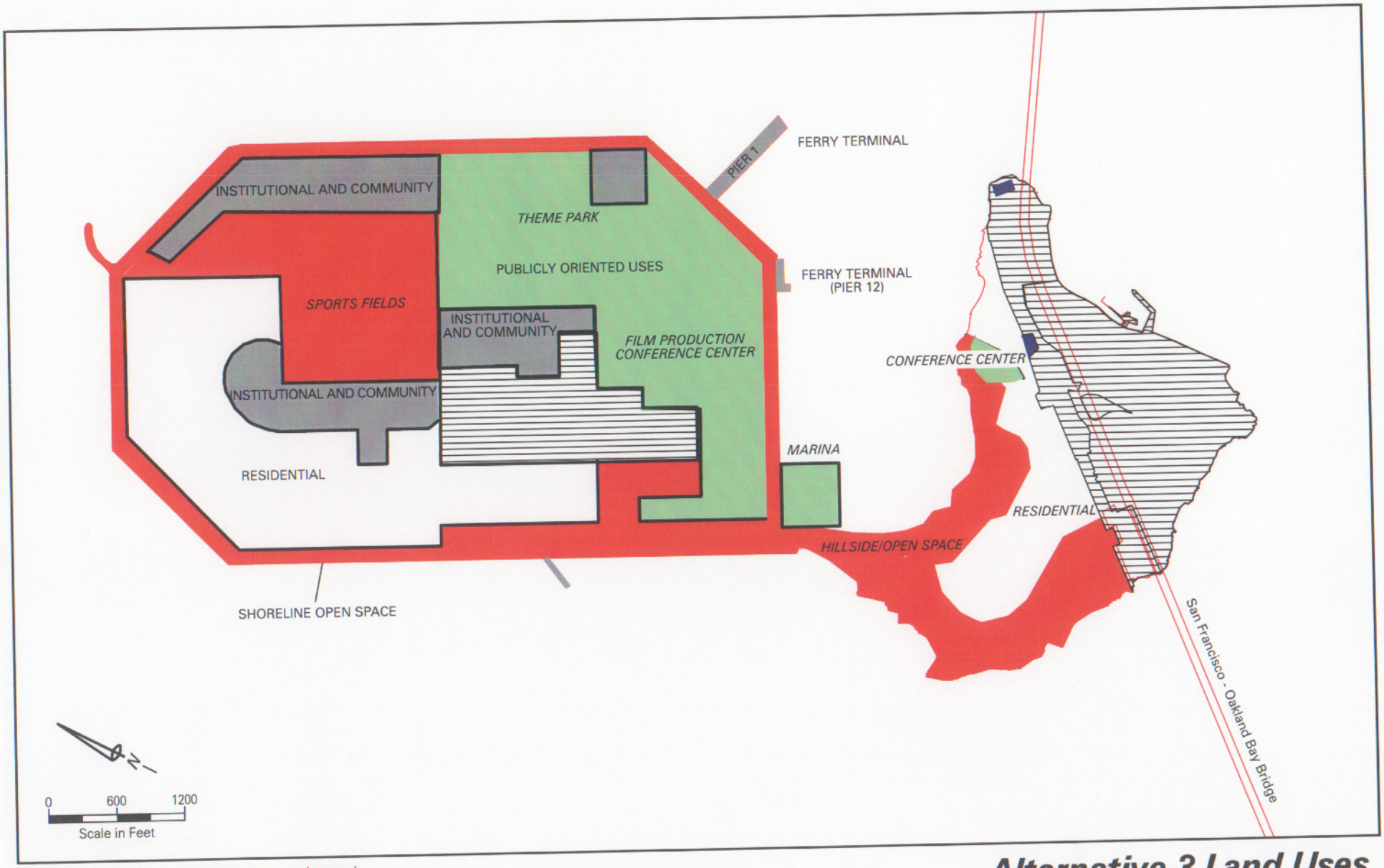
- Publicly Oriented
- Open Space and Recreation
- Institutional and Community
- Areas Excluded from Proposed Navy Disposal
- Residential
- FHWA/Caltrans Aerial Easements

Alternative 2 Land Uses

Naval Station Treasure Island, California

Figure ES-4

Source: CCSF 1996e; Developed by CCSF 1997



Alternative 3 would reuse existing facilities and would involve little new development.

Legend:

- Publicly Oriented
- Open Space and Recreation
- Institutional and Community
- Areas Excluded from Proposed Navy Disposal
- Residential
- FHWA/Caltrans Aerial Easement

Alternative 3 Land Uses

Naval Station Treasure Island, California

Figure ES-5

Source: CCSF 1996e; Developed by CCSF 1997

1

Table ES-1
Summary Comparison of Land Development Characteristics of Reuse Alternatives

Characteristic	*Alternative 1*	*Alternative 2*	*Alternative 3*
Residential	**Dwelling Units**	**Dwelling Units**	**Dwelling Units**
Existing residential	290	50	995[1]
New residential	2,550	200	70
Total dwelling units	**2,840**	**250**	**1,065**
Publicly Oriented	**Acreage**	**Acreage**	**Acreage**
Themed attraction	59	74	39
Hotel/conference/lodging	25	45	14
Retail/specialty/restaurant	10	1	2
Entertainment center	0	6	0
Amphitheater	0	7	0
Wedding chapel	0	1	2
Museum	3	4	4
Mixed use/office	11	0	6
Film production	31	0	33
Marina (yacht club)	2	0	2
Other publicly oriented uses	14	14	20
Subtotal Acres	**155**	**152**	**122**
Institutional and Community			
Elementary school	9	0	9
Child development center	4	0	4
Fire training school	5	5	5
Warehouse/storage	0	0	4
Wastewater treatment plant	10	5	3
Brig	5	4	5
Fire station	4	2	2
Police station	3	2	3
Other institutional facilities	0	0	8
Subtotal Acres	**40**	**18**	**43**
Open Space and Recreation			
Golf course	0	147	0
Sports fields/complex	47	18	40
Shoreline promenade/open space[2]	71	76	102
Wildlife habitat	0	18	0
Subtotal Acres	**118**	**259**	**142**
Land Use Categories[3]			
Public Oriented	155	152	122
Residential	137	21	143
Institutional and Community	40	18	43
Open Space and Recreation	118	259	142
Total Acres	**450**	**450**	**450**
Marina	Expansion	Expansion	Existing only
Ferry Terminals	New (west side) Retrofit (Pier 1)	New (west side) Retrofit (Pier 1)	Retrofit (Pier 12) Retrofit (Pier 1)
Approximate On-site Population	6,895	710	3,510
Approximate Employment	4,920	2,820	2,195
Approximate Average Daily Vehicle Trips	18,100	13,085	6,700

Source: Draft Reuse Plan (San Francisco 1996e).

[1] Does not include 75 beds in barracks on Treasure Island.

[2] Open space on Yerba Buena Island includes small areas of native habitat.

[3] The land use categories represent slightly revised versions of the land use categories discussed in the Draft Reuse Plan.

Note: The numbers provided in this table are estimates only since discussions are on-going between Navy and San Francisco. Estimates in the text and the tables are included for discussion purposes.

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 1 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Land Use	*Impact: Land use policy.* The zone classifications that would be required for Alternative 1 would be inconsistent with the existing San Francisco General Plan designation and zoning classification.	*Impact: Land use policy.* Similar to that described for Alternative 1.	*Impact: Land use policy.* Similar to that described for Alternative 1.	No impacts are expected.
	Mitigation: To achieve consistency between the selected reuse alternative and city policies, it will be necessary to amend the San Francisco General Plan to include land use designations for surplus property on Treasure Island and Yerba Buena Island prior to approving future land use actions.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	
Visual Resources	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.
Socioeconomics	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.
Cultural Resources	No significant impacts are expected.	*Impact: Alteration or demolition of historic resources.* Alternative 2 involves the demolition of Building 2 and Building 3 on Treasure Island, both of which are eligible for listing on the NRHP.	No significant impacts are expected.	No impacts are expected.

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 2 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Cultural Resources (continued)		*Mitigation*: The irreversible loss of significant historic resources cannot be fully mitigated. HABS/HAER recordation would reduce but would not eliminate significant impacts caused by demolition.		
Transportation	*Impact: Increased volumes and queuing on SFOBB/I-80 Yerba Buena Island westbound on-ramp (west side)*. Alternative 1 would result in peak-hour traffic volumes on the SFOBB/I-80 Yerba Buena Island westbound on-ramp on the west side of Yerba Buena Island that would exceed the current ramp capacity of 330 vph. The projected demand would result in a queue ranging from 7 vehicles (during the AM peak hour) to 239 vehicles (during the weekend midday peak hour). This queue would constrain vehicular circulation on the island.	No significant impacts are expected for increased volumes and queuing on SFOBB/I-80 Yerba Buena Island westbound on-ramp (west side).	No significant impacts are expected for increased volumes and queuing on SFOBB/I-80 Yerba Buena Island westbound on-ramp (west side).	No impacts are expected.
	Mitigation. SFOBB/I-80 Yerba Buena Island on-ramps are substandard by current Caltrans standards, primarily in acceleration/deceleration lengths, ramp radii, and sight distances.			

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 3 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	Upgrading the on-ramps would increase ramp capacity and level of operation and decrease queuing impacts. However, upgrades to the on-ramps may be constrained by the geology of the site (elevation change and bedrock) and structural limitations due to the viaduct. Implement measures, including signage and notices to residents, to encourage residents and visitors to use the second westbound on-ramp east of the Yerba Buena Island tunnel. Redirecting traffic during the weekend midday peak hour to the second on-ramp east of the Yerba Buena Island tunnel would reduce the queue at the first westbound on-ramp.			

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 4 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	Implement a Travel Demand Management (TDM) program to further reduce traffic generation during peak hours, especially during the weekend. Implement additional or enhanced TDM measures, such as discounted ferry passes, flex-time, public relations campaigns, and giving employees working on Treasure Island or Yerba Buena Island preferential access to housing on NSTI, to encourage ferry use or to encourage vehicle-trips during the nonpeak period to reduce queues on both westbound on-ramps to tolerable levels. Monitor NSTI ramp traffic volumes to ensure that the transportation goals and objectives established by the Draft Reuse Plan are successfully implemented. Monitor NSTI bus transit demand on an annual basis (or at each phase of development) and ensure that planned services are implemented to meet or exceed demand. Implement a similar monitoring program for ferry demand.			

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 5 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	Restripe the portion of Treasure Island Road between the Main Gate and the westbound on-ramp on the west side of the Yerba Buena Island tunnel from two lanes to accommodate three traffic lanes.			
	Impact: Increased volumes and queuing on SFOBB/I-80 Yerba Buena Island eastbound off-ramp (west side). Alternative 1 would result in a substantial increase in traffic volumes on the eastbound off-ramp on the west side of Yerba Buena Island that would exceed the practical capacity of the off-ramp (500 vph), resulting in a maximum queue of 36 vehicles, or about 700 feet (219 m) on the SFOBB.	No significant impacts are expected for increased volumes and queuing on SFOBB/I-80 Yerba Buena Island eastbound off-ramp (west side).	No significant impacts are expected for increased volumes and queuing on SFOBB/I-80 Yerba Buena Island eastbound off-ramp (west side).	No impacts are expected.
	Mitigation. Use traffic control measures, such as signage, to encourage eastbound motorists to use the second Yerba Buena off-ramp (the off-ramp on the east side of Yerba Buena Island). Implement TDM and monitoring measures to reduce traffic volumes on this off-ramp.			

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 6 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	*Impact: Increased volumes on SFOBB/I-80 Yerba Buena Island eastbound on-ramp (east side).* Alternative 1 would result in substantial increases in traffic volumes during the weekend midday peak hour on the eastbound on-ramp on the east side of Yerba Buena Island. While the increased volumes would be accommodated by the upgrade of this ramp as part of the SFOBB East Span project, it may create a secondary impact on potential traffic delays on SFOBB.	No significant impacts are expected for increased volumes on SFOBB/I-80 Yerba Buena Island eastbound on-ramp (east side).	No significant impacts are expected for increased volumes on SFOBB/I-80 Yerba Buena Island eastbound on-ramp (east side).	No impacts are expected.
	Mitigation: Caltrans should consider the installation of a ramp metering devise in the future if the added traffic onto this on-ramp would cause significant traffic delay on SFOBB mainline.			
	Impact: Increased peak spreading on SFOBB/I-80. Under Alternative 1, increased traffic onto and off of the SFOBB during the AM peak period (6:30 to 9:30) and PM peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS F during the last hour of the AM peak period (8:30 to 9:30) and to deteriorate from LOS B to LOS E	*Impact: Increased peak spreading on SFOBB/I-80.* Under Alternative 2, increased traffic onto and off of the SFOBB during the AM peak period (6:30 to 9:30) and PM peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS E or LOS F	*Impact: Increased peak spreading on SFOBB/I-80.* Under Alternative 3, increased traffic onto and off of the SFOBB during the AM peak period (6:30 to 9:30) and PM peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS F during the last hour of the AM peak	No impacts are expected.

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	or LOS F during the first hour of the PM peak period (3:30 to 4:30).	during the last hour of the AM peak period (8:30 to 9:30) and to deteriorate from LOS B to LOS E or LOS F during the first hour of the PM peak period (3:30 to 4:30).	period (8:30 to 9:30) and to deteriorate from LOS B to LOS E or LOS F during the first hour of the PM peak period (3:30 to 4:30).	
	Mitigation. Monitor traffic volumes at each phase of development and if it is determined that traffic from NSTI is constraining the capacity of the SFOBB, either more aggressive TDM and transit improvements must be implemented or additional developments should be delayed until such improvements are implemented.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	
	Impact: Transit operations – bus service to East Bay. Lack of direct bus service between NSTI and the East Bay is a significant and mitigable impact.	*Impact: Transit operations – bus service to East Bay.* The impact would be similar to that described under Alternative 1.	*Impact: Transit operations – bus service to East Bay.* The impact would be less than that described under Alternative 1 but would remain significant but mitigable.	No impacts are expected.

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 8 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	*Mitigation*: Establishing direct transit service between NSTI and the East Bay would mitigate this impact to a not significant level. Bus service would need to be at 10-minute headways (the interval between the trips of 2 successive vehicles) throughout the day during the weekday and at 15-munite headways throughout the day during the weekend. Monitor NSTI bus transit demand on an annual basis (or at each phase of development) and ensure that planned services are implemented to meet or exceed demand. Implement TDM measures to encourage transit rather than auto use.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1. However, at build-out, bus service would need to be at 15-minute headways throughout the day during both weekdays and weekends.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1. However, at build-out, bus service would need to be at 20-minute headways throughout the day during weekdays and 15-minute headways throughout the day during weekends.	
Air Quality	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No impacts are expected.
Noise	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No impacts are expected.

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 9 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Biological Resources	*Impact: Mudflat Habitat Disturbance.* Significant impacts to mudflat habitat, including eelgrass beds, may occur as a result of increased pedestrian and boating activity around Clipper Cove. Expanding the marina or constructing a yacht harbor, new docks, or other structures that would cover the surface of the water would impact Waters of the United States but would require a permit from the BCDC and the COE.	*Impact: Disturbance to sensitive mudflat habitat.* The impacts on mudflat habitat associated with pedestrians and boating activity would be similar, but reduced, from that described for Alternative 1. Pedestrian impacts would be approximately half of Alternative 1 while boating traffic impacts would be approximately 20 percent higher than Alternative 1.	*Impact: Mudflat Habitat Disturbance.* The impacts on mudflat habitat associated with pedestrians and boating activity would be reduced from that described for Alternative 1 but would remain significant but mitigable.	No impacts are expected.
	Mitigation: Minimize disturbance to sensitive habitats during construction. Prepare and implement a plan to minimize disturbance of sensitive habitats due to recreational activity. Permittee could be required to post signs along the shore adjacent to the mudflats and at the marina to inform pedestrians and recreational boaters that the mudflats are a protected sensitive area and that trespassing is not permitted. Buoys could be placed in the bay to identify the restricted mudflat area. A 5-mph (8 kph) zone could be established in Clipper Cove to minimize shoreline and mudflat	*Mitigation*. Mitigation measures would be the same as described for Alternative 1.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1.	

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 10 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Biological Resources (continued)	erosion. Any impacts related to construction or fill would be addressed during the COE Section 404 permitting process.			
	Impact: Pedestrian and Boating Impacts on Migratory Birds. Increased pedestrian and boating activity around Clipper Cove could have a significant impact on shorebirds by affecting mudflats and eelgrass beds where shorebirds forage.	*Impact: Pedestrian and Boating Impacts on Wading Shorebirds.* Increased pedestrian and boating activity around Clipper Cove could have a significant impact on shorebirds by affecting mudflats and eelgrass beds where shorebirds forage. Pedestrian impacts would be approximately half of Alternative 1 while boating traffic impacts would be approximately 20 percent higher than Alternative 1.	*Impact: Pedestrian and Boating Impacts on Wading Shorebirds.* Increased pedestrian and boating activity around Clipper Cove could have a significant impact on shorebirds by affecting mudflats and eelgrass beds where shorebirds forage. These impacts are likely to be reduced under Alternative 3 as there would be less of an increase in boating traffic compared with Alternative 1.	No impacts are expected.

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Biological Resources (continued)	*Mitigation.* In conjunction with permitting by COE and BCDC, permittee could be required to post signs along the shore adjacent to the mudflats and at the marina, informing pedestrians and boaters that the mudflats are a protected and sensitive area. Placing buoys in the bay, identifying the mudflat area as restricted, and establishing a five-mph (8 kph) zone in Clipper Cove could also reduce impacts.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	
	Impact: Pedestrian and Boating Impacts on EFH. Increased boat and pedestrian activity around Clipper Cove could have an indirect significant impact on EFH by degrading eelgrass vegetated areas and shallow water and mudflat areas that provide important fish spawning, rearing, and foraging habitat.	*Impact: Pedestrian and Boating Impacts on EFH.* Increased pedestrian and boating activity around Clipper Cove and along the perimeter of the islands could have a significant impact on EFH, as described under Alternative 1.	*Impact: Pedestrian and Boating Impacts on EFH.* Increased pedestrian and boating activity around Clipper Cove and along the perimeter of the islands could have a significant impact on EFH, as described under Alternative 1.	No impacts are expected.
	Mitigation. Proposed mitigation measures are the same as those discussed under impacts to mudflat habitat above.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 12 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Geology and Soils	*Impact: Exposure of individuals and property to liquefaction.* Seismically induced liquefaction could result in ground disturbances associated with lateral spreading and differential settlement.	*Impact: Exposure of individuals and property to liquefaction.* Seismically induced liquefaction could result in ground disturbances associated with lateral spreading and differential settlement.	*Impact: Exposure of individuals and property to liquefaction.* Seismically induced liquefaction could result in ground disturbances associated with lateral spreading and differential settlement.	No impacts are expected.
	Mitigation. A zone of "improved ground" would be created around the perimeter of the island to reduce lateral spreading. Interior island areas shall be similarly improved to reduce large differential settlement. All sensitive structures (e.g., buildings greater than three stories, buildings intended for public occupancy, structures supporting essential services, and buildings housing schools, medical, police, and fire facilities) shall be supported on pile systems or other specially designed foundations. Detailed geotechnical studies shall be completed in accordance with San Francisco requirements for individual development sites.	*Mitigation:* Mitigation measures would be the same as described for Alternative 1.	*Mitigation:* Mitigation measures would be the same as described for Alternative 1.	

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 13 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Water Resources	*Impact: Exposure of individuals and property to ponding from high tides.* The installation of residential development in low-lying areas on Treasure Island would result in increased exposure of occupants, visitors, and property to ponding hazards due to seepage through the dike during some high tide events.	No significant impacts are expected from exposure of individuals and property to ponding from high tides.	*Impact: Exposure of individuals and property to ponding from high tides.* The impact would be similar to that described for Alternative 1.	No impacts are expected.
	Mitigation: Filling low-lying portions of the residential area to at least 9 feet (3 m) National Geodetic Vertical Datum (NGVD) prior to development would mitigate this impact. In addition, other low-lying areas within 500 feet (152 m) of the Treasure Island perimeter should be similarly filled before development is allowed.		*Mitigation*: Mitigation measures would be the same as described for Alternative 1.	

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 14 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Water Resources (continued)	*Impact: Exposure of individuals and property to flooding*. Developing and reusing Treasure Island under Alternative 1 could expose occupants, visitors, and property to flooding hazards caused by dike overtopping during storms.	*Impact: Exposure of individuals and property to flooding*. This alternative would subject residents and daily visitors on the northern half of Treasure Island, where a golf course is proposed, to existing flood hazards. Flood hazards on the southern portion of the site would be similar to those described for Alternative 1.	*Impact: Exposure of individuals and property to flooding*. Alternative 3 could subject occupants, visitors, and property to substantial flooding hazards throughout Treasure Island.	No impacts are expected.
	Mitigation: Set back development inboard of the perimeter dike to allow room for periodic dike raising without substantially increasing Bay fill. Raise the dike as necessary to account for site settlement, changes in maximum tidal heights, and rises in sea levels. In addition, inspect the dike after each major storm to identify repair needs, and repair the dike promptly.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1.	
Utilities	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No impacts are expected.
Public Services	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No impacts are expected.

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Hazardous Materials and Waste	*Impact: Installation Restoration Program (IRP).* Construction activities at NSTI associated with future development of the housing unit area, including demolition of existing structures, may interfere with remedial actions under CERCLA.	*Impact: Installation Restoration Program (IRP).* Development of a golf course in the northern part of the island would involve demolition of existing structures and the grading and reconfiguring of the soil, which may interfere with remedial actions under CERCLA.	*Impact: Installation Restoration Program (IRP).* If subsequent redevelopment of the housing area involving demolition of existing structures and the grading and reconfiguring of the soil were to occur, it may interfere with remedial actions conducted under CERCLA.	No impacts are expected.
	Mitigation. The Navy is in the process of implementing various remedial actions at NSTI pursuant to and in accordance with the requirements of CERCLA and the NCP that will remove, manage, or isolate any potentially hazardous substances present on the property prior to conveyance. These remedial actions will ensure that human health and the environment will be protected based on the land uses specified in the Draft Reuse Plan. If the CERCLA remedy for a particular site includes land use controls, the acquiring entity or entities will be required to comply with the land use controls during construction or operations to ensure continued protection of human health and the environment.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	

Table ES-2. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 16 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Hazardous Materials and Waste (continued)	Subsequent redevelopment of the housing area which would involve demolition of existing structures and the grading and reconfiguring of the soil would likely be subject to land use controls on the property, including compliance with a City-administered soil management plan that would require soil and groundwater disturbance be permitted subject to proper characterization and management.			
	In addition, deeds conveying the affected property will contain a notice that areas of the property not subject to remediation efforts (such as areas beneath existing foundations) may require additional characterization and possible response actions subject to appropriate regulatory oversight. Adherence to land use controls and regulatory requirements would mitigate potentially significant impacts to an acceptable level.			

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ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	micrograms per cubic meter
3D	three dimensional
AB	Assembly Bill
ABAG	Association of Bay Area Governments
AC Transit	Alameda-Contra Costa Transit District
ACHP	Advisory Council on Historic Preservation
ACM	asbestos-containing material
ADA	Americans with Disabilities Act
ADT	average daily traffic
AST	aboveground storage tank
BAAQMD	Bay Area Air Quality Management District
BART	Bay Area Rapid Transit
BCDC	Bay Conservation and Development Commission
BCP	BRAC cleanup plan
BCT	BRAC cleanup team
BMP	best management practices
BOD	biological oxygen demand
BRAC	Base Realignment and Closure
C_2H_3Cl	vinyl chloride
CAD	computer aided design
Cal. Code Regs.	California Code of Regulations
Cal. Pub. Res. Code	California Public Resources Code
Cal EPA	California Environmental Protection Agency
Cal. Stat.	California Statute
Caltrain	California Train
Caltrans	California Department of Transportation
CAP	corrective action plan
CARB	California Air Resources Board
CATS	consolidated area telephone system
CDFG	California Department of Fish and Game
CDMG	California Division of Mines and Geology
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERFA	Community Environmental Response Facilitation Act
C.F.R.	Code of Federal Regulations
cm	centimeter
CMP	congestion management program

CNEL	community noise equivalent level
CNPS	California Native Plant Society
CO	carbon monoxide
COE	US Army Corps of Engineers
CPOEC	chemicals of potential ecological concern
CRC	Citizens Reuse Committee
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted decibel
DBCRA	Defense Base Closure and Realignment Act
DBI	Department of Building Inspection
DDT	dichlorodiphenyltrichloroethane
DoD	Department of Defense
DON	Department of the Navy
Draft Reuse Plan	Naval Station Treasure Island Draft Reuse Plan (San Francisco 1996e)
DRMO	Defense Reutilization and Marketing Office
DTSC	Department of Toxic Substances Control
EBMUD	East Bay Municipal Utility District
EBS	environmental baseline survey
EDD	California Economic Development Department
EFH	Essential fish habitat
EIS	Environmental Impact Statement
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EMTs	emergency medical technicians
ESU	Evolutionarily Significant Unit
exposition	Golden Gate International Exposition
°F	degrees Fahrenheit
Fed. Reg.	Federal Register
FEMA	Federal Emergency Management Agency
FFSRA	Federal facility site remediation agreement
FHWA	Federal Highways Administration
FISC	Fleet and Industrial Supply Center
FISCO	Fleet and Industrial Supply Center, Oakland
FMP	Fishery management plan
FPMR	federal property management regulations
FS	feasibility study
FY	fiscal year
g	Gravity

GGNRA	Golden Gate National Recreation Area
H_2S	hydrogen sulfide
ha	Hectare
HABS	Historic American Buildings Survey
HAER	Historic American Engineering Record
HAP	Hazardous air pollutant
HOV	high occupancy vehicle
HUD	US Department of Housing and Urban Development
HVAC	heating, ventilation, and air conditioning
I-80	Interstate 80
IEP	Interagency Ecological Program
IR	installation restoration
IRP	Installation Restoration Program
kg	kilograms
km	kilometer
kV	Kilovolts
LBP	lead-based paint
Ldn	day-night average sound level
Leq	equivalent noise level
LOS	level of service
LRA	local redevelopment authority
LTMS	long term management strategy
m	meter
m^2	Square meter
m^3	Cubic meter
MARAD	Maritime Administration
MCLs	maximum contaminant levels
mg/l	milligrams per liter
MGD	million gallons per day
ml/1-hour	settleable matter
MLLW	mean lower low waterline
MOA	memorandum of agreement
mph	miles per hour
MSA	Magnuson-Stevens Fishery Conservation and Management Act
Msl	mean sea level
MTC	Metropolitan Transportation Commission
MTL	Mean tide level
MUNI	San Francisco Municipal Railway
NAGPRA	Native American Graves Protection and Repatriation Act
Navy	Department of the Navy

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollution
NGVD	National Geodetic Vertical Datum
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMFS NWR	National Marine Fisheries Service, Northwest Region
NMFS SWR	National Marine Fisheries Service, Southwest Region
No.	number
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NOA	Notice of availability
NOI	Notice of intent
NOP	Notice of preparation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service
NRHP	National Register of Historic Places
NSTI	Naval Station Treasure Island
NWIC	Northwest Information Center
O_3	ozone
O&M	operation and maintenance
OEA	Office of Economic Adjustment
OES	Office of Emergency Services
OMBC	Office of Military Base Conversion
OPNAVINST	Chief of Naval Operations instruction
OSHA	Occupational Safety and Health Administration
OWS	Oil/water separator
PA	preliminary assessment
PAH	polychlorinated aromatic hydrocarbon
Pb	lead particles
PCBs	polychlorinated biphenyls
pCi/L	picocuries per liter
PFMC	Pacific Fishery Management Council
PG&E	Pacific Gas & Electric Company
$PM_{2.5}$	fine particulate matter
PM_{10}	inhalable particulate matter
ppm	parts per million

PRC	Public Resources Code
PSMFC	Pacific States Marine Fisheries Commission
psi	pounds per square inch
Pub. L.	Public Law
PUC	Public Utilities Commission
PVC	polyvinyl chloride
RA	remedial action
RAB	Restoration advisory board
RAP	Remedial Action Plan
RBHSS	Richmond Bridge Harbor Seal Survey
RCRA	Resource Conservation and Recovery Act
RD	remedial design
Redevelopment Act	Base Closure Community Redevelopment and Homeless Assistance Act
RI	remedial investigation
ROD	record of decision
ROG	reactive organic compounds
RWQCB	Regional Water Quality Control Board
RONA	Record of Non-Applicability
SamTrans	San Mateo County Transit District
San Francisco	City and County of San Francisco
SD	site discovery
sf	square feet
SFEP	San Francisco Estuary Project
SFOBB	San Francisco-Oakland Bay Bridge
SFTA	San Francisco Transit Authority
SFUSD	San Francisco Unified School District
SFWD	San Francisco Water Department
SHL	State Historic Landmark
SHPO	State Historic Preservation Officer
SHSZ	Seismic Hazards Studies Zone
SI	site inspection
SMP	site mitigation plan
SO_2	sulfur dioxide
SO_4	sulfate particles
SPCC	Spill Prevention Control and Countermeasure
SVOC	semivolatile organic compound
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TAC	toxic air contaminant
TCE	temporary construction easement

TCM	transportation control measure
TDM	transportation demand management
TICA	Treasure Island Conversion Act
TIDA	Treasure Island Development Authority
TIHDI	Treasure Island Homeless Development Initiative
tit.	title
TPH	total petroleum hydrocarbon
TSCA	Toxic Substances Control Act
TSS	total suspended solids
UBC	Uniform building code
ULI	Urban Land Institute
US	United States
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
UST	underground storage tank
VOC	volatile organic compound
vph	vehicles per hour
VTS	vehicle tracking system
WAPA	Western Area Power Administration

CHAPTER 1.0
Purpose and Need

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1.0 PURPOSE AND NEED

This environmental impact statement (EIS) evaluates the potential impacts on the natural and human environment that could result from United States Department of the Navy (Navy) disposal of surplus federal properties within Naval Station Treasure Island (NSTI) and subsequent reuse of those federal properties. NSTI is made up of dry and submerged lands of both Treasure Island and portions of Yerba Buena Island in San Francisco, California.

This document has been prepared by Navy in accordance with the National Environmental Policy Act of 1969 (NEPA) (Public Law [Pub. L.] 91-190, 42 United States Code [U.S.C.] §§ 4321-4370f); the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [C.F.R.] Parts 1500-1508); Navy regulations implementing NEPA (32 C.F.R. Part 775); and Navy guidelines (Chief of Naval Operations Instruction [OPNAVINST] 5090.1B [2002]).

This EIS was originally prepared as a joint document to fulfill the requirements of both NEPA and the California Environmental Quality Act of 1970 (CEQA) (California Public Resources Code [Cal. Pub. Res. Code] § 21000 et seq., as amended). In 2000, the City and County of San Francisco (San Francisco) elected to prepare a separate environmental impact report (EIR) to analyze the impacts from the reuse of NSTI. The EIR will undergo a separate public review process.

1.1 PURPOSE AND NEED

The purpose of and need for the proposed federal action is to dispose of surplus federal property at NSTI for subsequent reuse. The Defense Base Closure and Realignment Act (DBCRA) (10 U.S.C. § 2687 note) directed the Department of Defense (DoD) to reduce and realign United States (US) military operations. The 1993 Defense Base Realignment and Closure Commission (BRAC '93 Commission) recommended the closure of NSTI. President Clinton approved this recommendation and the 103rd Congress accepted it on September 27, 1993. NSTI closed on September 30, 1997, and Navy is in the process of disposing of the property in accordance with applicable laws and regulations, including the DBCRA. DBCRA requirements related to disposal of surplus property include the following:

- Compliance with NEPA;
- Environmental restoration of the property;
- Consideration of the local community's reuse plan before Navy disposes of the property; and
- Compliance with specific federal property disposal laws and regulations.

Under the DBCRA the decision to close, relocate, or realign bases is exempt from NEPA documentation requirements. However, once the decision has been made to close, relocate, or realign a specified base, the cognizant military service is required to prepare appropriate NEPA documentation evaluating the environmental effects of the disposal and subsequent reuse of the property.

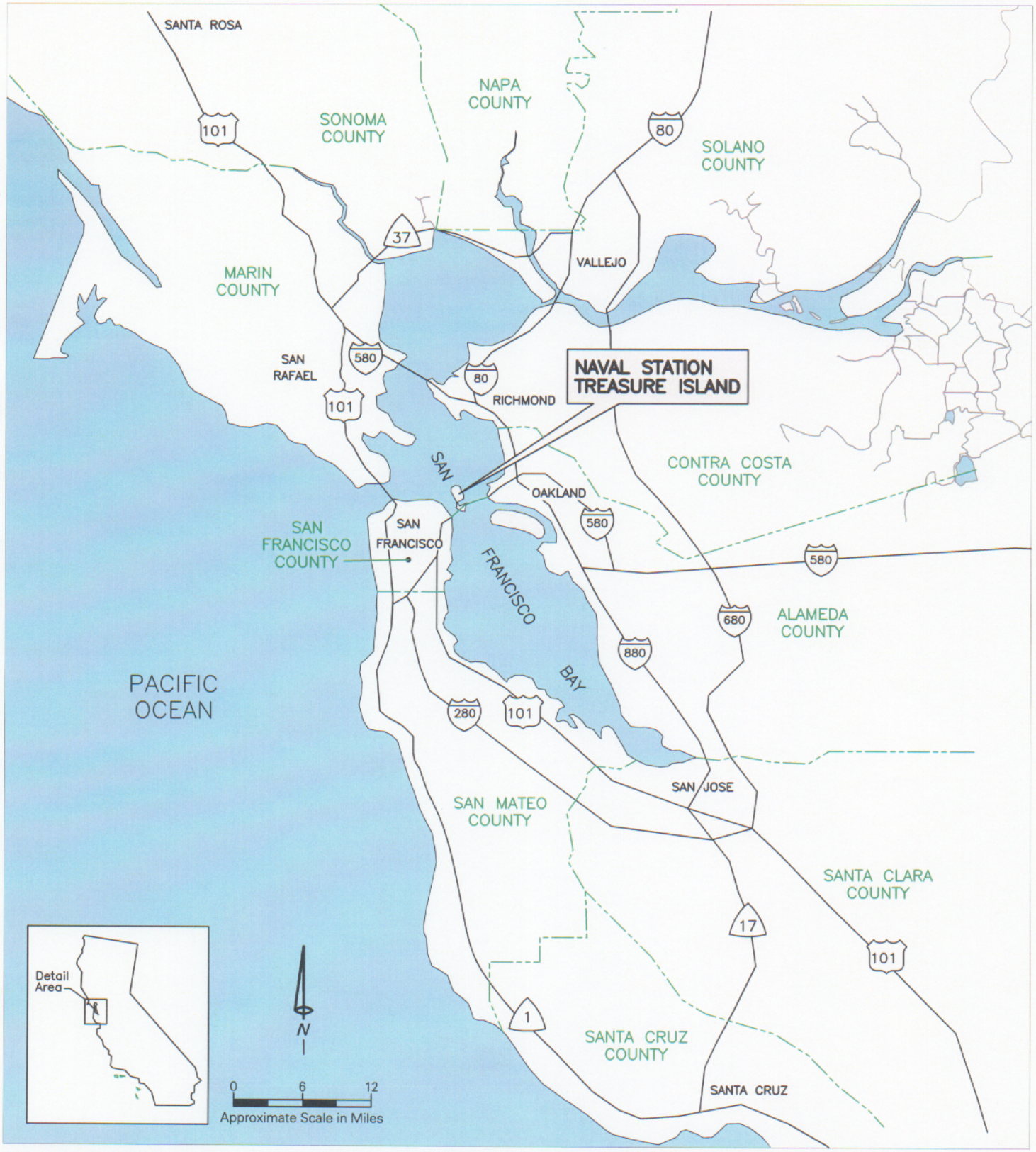
Navy considered the stated purpose and need of the Local Redevelopment Authority (LRA) in developing reasonable reuse alternatives (the LRA is discussed further in section 2.2, Reuse Planning Process). This purpose and need focused on reusing NSTI property to support the local economic base, enhance the local image and identity, expand the range of recreational and entertainment opportunities available to the community, and enhance the overall livability of the local area and region. To meet these overall objectives, reuse alternatives must provide employment and housing opportunities and generate sufficient revenue (e.g., property tax) to support the investment necessary to upgrade the Treasure Island perimeter dike and to undertake facility ground improvements for seismic safety of the site (San Francisco 1996e). In addition, reuse alternatives must consider current access constraints (e.g., limited access via the San Francisco-Oakland Bay Bridge [SFOBB], inadequate on-ramp and off-ramp design, and traffic congestion during peak hours) and must propose alternative access options, such as ferry service, to solve existing vehicular access deficiencies.

On October 26, 2000, the Federal Highways Administration (FHWA), pursuant to its authority under 23 U.S.C. § 107(d), conveyed 98 acres (40 hectare [ha]) of dry and submerged Navy land on Yerba Buena Island that was previously declared to be surplus to the needs of the federal government and was considered in the NSTI Draft Reuse Plan (Draft Reuse Plan) (San Francisco 1996e) to the California Department of Transportation (Caltrans). Caltrans sought the property held by the Navy for right-of-way purposes in connection with the construction, operation, and maintenance of the SFOBB east spans retrofit project. Land conveyed to Caltrans includes lands permanently conveyed in fee, temporary construction easements (TCEs) over a substantial part of Yerba Buena Island, and permanent aerial easements over two parcels of land. While the lands conveyed in fee to Caltrans are no longer part of NSTI and are not part of the Navy disposal considered in this EIS, TCEs and aerial easements are available for disposal and are considered in this EIS.

Navy will use this EIS to make disposal decisions concerning the surplus federal property at NSTI suitable for conveyance. Following the completion of the Final EIS, Navy will issue its Record of Decision (ROD) that will identify the significant impacts that would occur as a result of disposal and reuse. Following disposal, no additional NEPA review by Navy will be required.

1.2 OVERVIEW OF NSTI

At the time of operational closure (September 1997), NSTI totaled approximately 1,075 acres (435 ha) of dry and submerged land within San Francisco. NSTI is on two islands in San Francisco Bay about midway between the shores of the cities of San Francisco and Oakland (Figure 1-1). The larger island, called Treasure Island, consists of 402 acres (160 ha) of dry land created with artificial fill in the 1930s. Yerba Buena Island, a natural island of approximately 150 acres (60 ha), is connected to Treasure Island by a causeway that also forms part of Clipper Cove. Vehicular access to NSTI is via the SFOBB on Yerba Buena Island. The SFOBB is part of the Interstate-80 (I-80) freeway system and provides an east-west link between the cities of San Francisco and Oakland. The reuse plan area is shown in Figure 1-2.



NSTI is located in San Francisco, about midway between the East Bay and West Bay shores.

Legend:

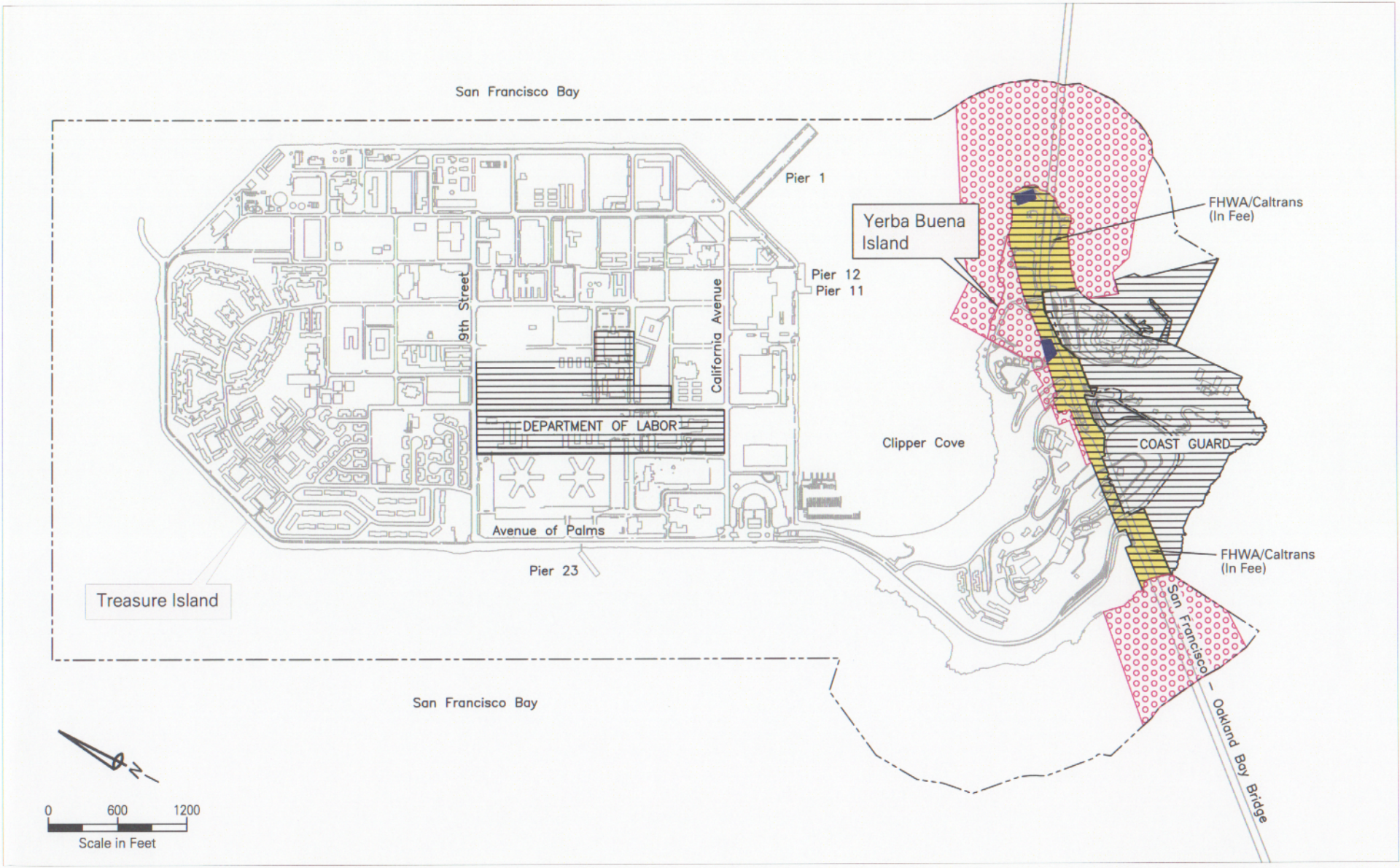
County Lines

Federal and State Highways

Regional Site Map

Bay Area, California

Figure 1-1



The area proposed for Navy disposal includes submerged lands and upland areas within NSTI. Some parcels that were transferred to other Federal Agencies are excluded from the proposed disposal.

Legend:

- Areas Excluded from Proposed Navy Disposal
- Naval Station Treasure Island Property Boundary/Reuse Plan Area
- FHWA/Caltrans TCEs (Included in Proposed Navy Disposal)
- FHWA/Caltrans Aerial Eastments (Included in Proposed Navy Disposal)
- FHWA/Caltrans Land Permanently Conveyed in Fee (Excluded From Proposed Navy Disposal)

Reuse Plan Area

Naval Station Treasure Island, California

Figure 1-2

Treasure Island

Treasure Island is an artificial island built in the mid-1930s on shoals immediately north of and adjacent to Yerba Buena Island. The site is an area of tidal and submerged lands granted to San Francisco in 1933 by the State of California for constructing a public airport, for wharf and dock facilities, and for use as an airfield (California Statutes [Cal. Stat.] 1933, Chapter 912, August 21, 1933). In 1935, this legislative grant was amended to allow the site to be used for a fair. The legislative grant contained a restriction that prevented San Francisco from selling the property to private parties. Treasure Island was constructed over 19 months in 1936 and 1937 by San Francisco and the US Army Corps of Engineers (COE) as a project of the New Deal-era Works Progress Administration. The initial purpose of the island was to host the Golden Gate International Exposition (Exposition). The Exposition ran from February 1939 to September 1940 and was held to celebrate the engineering marvels of the just completed Golden Gate Bridge and SFOBB.

After the Exposition the island was to be converted to an international airport, but during the final months of the Exposition, and with increasing expectations of American involvement in World War II, plans were made to convert the island to a Navy base.

The federal government initiated a condemnation action in 1942 to acquire ownership of all lands that now make up Treasure Island. This condemnation action eventually was settled in conjunction with another condemnation action concerning San Francisco Airport property. The settlement of these two condemnation actions gave the federal government fee title to Treasure Island.

During the war years the island served as a center for receiving, training, and dispatching service personnel. After World War II, the Navy used the installation primarily as a training and administrative center. Treasure Island has approximately 150 nonresidential buildings, totaling about 2.5 million square feet (232,257 square meters [m^2]), and approximately 900 housing units. The housing units are mostly in four-, six-, and eight-unit two-story buildings, as well as in barracks for service personnel. The nonresidential buildings include an administration building, several classroom buildings used for training schools, former aircraft hangars, a fire training facility, a brig, offices, a conference center, restaurants, a school, a chapel, and storage and equipment buildings. Recreation facilities on the island include a marina, ball fields, a gym, a theater, a bowling alley, a fitness center, tennis courts, a picnic area, and open space.

Yerba Buena Island

Yerba Buena Island was used periodically by Native Americans before Europeans settled in the San Francisco Bay Area around 1835. In 1867, the US Army established a post on the northeastern side of the island adjacent to present day Clipper Cove. The post was established as an artillery base and quartermaster depot at the eastern end of the island. The Army was active there from 1868 through 1879. In the 1890s, the Army built a small torpedo station complex on the island, one building of which, the Torpedo Depot (Building 262), remains.

In 1898, Navy acquired the East Cove area of Yerba Buena Island from the Army. This area became the site for a Naval training station, which was active at the site between 1900 and 1923.

During this period, several prominent buildings were constructed. The Commander's Quarters, or Quarters 1 (also referred to as "Nimitz House"), was completed in 1900, and seven other Senior Officers' Quarters (Quarters 2 through 8) were completed between 1901 and 1905. Quarters 1 through 7, referred to as the "Great Whites" because of their exterior color and distinct architectural character, are clustered in a neighborhood on the north side of the SFOBB. Quarters 1 was listed individually on the National Register of Historic Places (NRHP) in 1991, and Quarters 1 through 7, which form the Senior Officers Quarters Historic District, along with associated buildings and landscaping elements, are eligible for listing on the NRHP.

In 1946, Yerba Buena Island became primarily a residential facility and home to the US Coast Guard; these functions have continued to the present (San Francisco 1996e). The Navy transferred ownership of approximately 30 acres (12.1 ha) of Yerba Buena Island to the US Coast Guard in 1973; this US Coast Guard facility is on the southeast side of Yerba Buena Island (DON 1995a). An additional 11 acres (4.5 ha) of dry land was transferred in 1998, and another 11 acres (4.5 ha) of submerged land was transferred in 2002. The US Coast Guard will continue to operate on its property at Yerba Buena Island after the Navy disposes of NSTI.

Navy owns approximately 100 housing units and about ten other buildings used for storage, communications, fire safety, and administration on Yerba Buena Island.

1.3 DISPOSAL OF NSTI PROPERTY

1.3.1 Predisposal Actions

The disposal process encompasses several sequential actions, further described below. The federal government is responsible for environmental cleanup and disposal of the property.

Caretaker Activities

NSTI is in caretaker status (inactive status under Navy control). On-site activities are limited to security, maintenance, cleanup, and other caretaker actions. Navy and San Francisco executed a cooperative agreement in 1997 in which San Francisco is responsible for providing caretaker services on NSTI. Approximately 50 persons are assigned to perform caretaker activities.

Contaminated Sites Cleanup

Navy is in the process of completing environmental cleanup of past releases of hazardous substances that pose a threat to human health and the environment. Navy cleanup efforts are being carried out in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Pub. L. 96-510, 42 U.S.C.§§ 9601–9675).

Interim Lease Activities

Navy currently leases approximately 160 acres (65 ha) on NSTI to the LRA for a variety of uses, including film production facilities, residential housing, a marina, a fire-fighting school, special events and meeting center, warehouses, and multipurpose office space. In addition, space on NSTI is currently leased for reuse planning and stewardship, as well as for housing and other services supporting homeless persons.

1.3.2 Disposal Process Requirements

This section briefly highlights some of the key laws and regulations that guide BRAC disposal and reuse. An expanded discussion is provided in Appendix B.

The Federal Property and Administrative Services Act of 1949 (40 U.S.C. §§ 471 et seq.) establishes methods for the disposal of federal property and is implemented by the Federal Property Management Regulations (FPMR) (41 C.F.R. Part 101-47). The FPMR requires Navy to notify other military departments and DoD entities, as well as other federal agencies, that a property or facility is "excess." Any DoD or other federal agency that expresses an interest in the site during the process is given consideration before the property is determined to be "surplus." Once the property has been transferred, federal restrictions on reuse can only be imposed where it is authorized by statute.

Under the Stewart B. McKinney Homeless Assistance Act of 1987 (Pub. L. 100-77, codified as amended, at 42 U.S.C. §§ 11341-11448) (McKinney Act), a homeless services provider can prepare and submit an application to acquire surplus federal property to assist the homeless (see Appendix B). The homeless component of the Draft Reuse Plan was developed through negotiation with Treasure Island Homeless Development Initiative (TIHDI), an association formed in June 1994 and composed of 14 nonprofit homeless and social service organizations. Section 2.2 describes the details of this process.

On October 15, 1993, Navy issued a Notice of Availability (NOA) for NSTI (Treasure Island proper)to DoD and other federal agencies indicating that the property was excess to the needs of Navy. After the property had been screened to federal agencies, Navy declared the property at Treasure Island surplus to the needs of the US on July 11, 1994.

In March 1995, the Bureau of Land Management, as the former managing agency of Yerba Buena Island (prior to Navy), determined that the property on Yerba Buena Island was not suitable for return as Bureau of Land Management lands and concurred that Yerba Buena Island should be disposed pursuant to base closure law (Bureau of Land Management 1995). Therefore, a separate NOA for NSTI (Yerba Buena Island proper) was issued on July 6, 1995. DoD declared this property surplus in May 1996.

No DoD agency requested transfer of excess NSTI properties. Between October 1993 and October 1995, nine federal agencies expressed interest in excess property at NSTI. Five of the agencies submitted formal requests for property transfer. Three of these agencies withdrew their requests in 1995 and early 1996. The transfer requests for the remaining two agencies, US Department of Labor and the US Coast Guard, were approved. The US Department of Labor requested approximately 36 acres (15 ha) of property and associated facilities on Treasure Island for its Job Corps program, and the Navy authorized the requested property transfer on April 17, 1998. The US Coast Guard requested approximately 22 acres (9 ha), including land, facilities, and submerged areas of Yerba Buena Island (see Figure 1-2). Navy authorized transferring 11 acres (4.5 ha) of dry land on March 3, 1998, and the remaining 11-acre (4.5 ha) parcel of submerged land was transferred on November 27, 2002. These properties are not part of the proposed disposal and subsequent reuse action evaluated in this EIS.

Subsequent to completion of the federal screening process, the FHWA, pursuant to its authority under 23 U.S.C. § 107(d), conveyed 98 acres (40 ha) on Yerba Buena Island held by Navy to Caltrans for construction of the east span of the SFOBB. Approximately 20 acres (8 ha) of dry land were permanently conveyed in fee and are not part of the disposal action evaluated in this EIS. The remaining 78 acres (32 ha) comprises five separate easements: 51 acre (21 ha) and 18 acre (7 ha) TCEs over submerged land, an 8 acre (3 ha) TCE over dry land, and two 0.3 acre (0.1 ha) permanent aerial easements over dry land. (Permanent aerial easements are defined over certain historic structures and are discussed further in section 3.4, Cultural Resources.) The TCEs and aerial easements are available for disposal and are considered in this EIS. See Figure 1-2 for the location of lands excluded from disposal, TCEs, and aerial easements.

Table 1-1 provides a categorized description of the historic acreage of NSTI on Treasure Island and Yerba Buena Island, which includes the areas previously transferred to US Department of Labor, US Coast Guard, and FHWA. The remaining NSTI property proposed for Navy disposal includes 681 acres (276 ha) at Treasure Island and 316 acres (127 ha) at Yerba Buena Island, for a total of approximately 997 acres (403 ha).

1.4 RELATED STUDIES

Several project-related studies have been undertaken or are ongoing at NSTI. The major planning and restoration programs are the Environmental Baseline Survey (EBS), the CERCLA Installation Restoration Program (IRP) and the Compliance Program.

The EBS, completed in May 1995, is a broad evaluation and summary of all known and suspected areas where hazardous materials or petroleum products have been handled, stored, disposed of, or released within the boundaries of NSTI and adjacent areas (DON 1995c). A Supplemental EBS was prepared in 2003. Two major restoration programs (IRP and the Compliance Program) have been established in response to releases of hazardous substances, pollutants, contaminants, petroleum hydrocarbons, and hazardous and solid waste. The IRP identifies, assesses, characterizes, and cleans up or controls contaminants from past hazardous waste disposal operations and hazardous materials spills. The Compliance Program addresses solid waste management, underground storage tanks (USTs) and fuel lines, aboveground storage tanks (ASTs), oil/water separators (OWS), asbestos-containing materials, polychlorinated biphenyls (PCBs), radon, lead-based paint, lead in drinking water, septic tanks, and indoor and outdoor small arms ranges.

1.5 PUBLIC INVOLVEMENT PROCESS

The EIS process is designed to involve the public in federal decision-making. Opportunities to comment on, and participate in, the process are provided during preparation of this EIS as outlined in the following sections. Comments from agencies and the public are solicited to help identify the primary issues associated with the federal disposal and proposed reuse of NSTI. San Francisco conducted public meetings and workshops as part of the reuse planning process, and the public was encouraged to comment on the various reuse alternatives. The public's input, as well as feedback from applicable resources and permitting agencies, will be used to evaluate the alternatives and environmental impacts before final decisions are made. Chapter 7 includes a brief discussion of the public involvement process, and Chapter 10 contains the mailing list for this EIS.

Table 1-1. NSTI Acreage on Treasure Island and Yerba Buena Island

	Acres
Treasure Island	
NSTI Acreage Proposed for Disposal	
Dry	366
Submerged	315
NSTI Treasure Island Disposal Subtotal	*681*
NSTI land transferred to US Department of Labor[1]	36
Treasure Island Subtotal	*717*
Yerba Buena Island	
NSTI Acreage Proposed for Disposal	
Dry	84
Submerged	232
NSTI Yerba Buena Island Disposal Subtotal	*316*
NSTI land transferred to US Coast Guard[2]	22
NSTI land transferred to FHWA/Caltrans[3]	20
Yerba Buena Island Subtotal	*358*
Total NSTI Acreage (including transferred land)[4]	**1,075**
Total NSTI Acreage Proposed For Disposal[5]	**997**
Total Dry Acreage Proposed For Disposal	**450**
Total Submerged Acreage Proposed For Disposal	**547**

[1]Approximately 36 acres was transferred from Navy to the US Department of Labor in 1998.

[2]Approximately 11 acres of dry land was transferred to the US Coast Guard in 1998. An additional 11 acres of submerged land was transferred to US Coast Guard in 2002.

[3] Approximately 98 acres of dry and submerged land was transferred to FHWA on October 26, 2000, which then conveyed it to Caltrans for the construction of the east span of the SFOBB. All but 20 acres of this land will revert to the federal government upon completion of the SFOBB and is part of the disposal action evaluated in this EIS.

[4]Total NSTI acreage = Treasure Island Subtotal + Yerba Buena Island Subtotal (this equals the total acreage of NSTI at the time of operational closure).

[5]Total NSTI acreage proposed for disposal = NSTI Treasure Island Disposal Subtotal + NSTI Yerba Buena Island Disposal Subtotal. Total does not include property transferred in fee to the US Department of Labor, US Coast Guard, and FHWA/Caltrans.

1.5.1 Scoping Process

Scoping is the process used to identify potential significant environmental issues and concerns related to the proposed action. The scoping period was from September 24, 1996, to October 28, 1996. The scoping process was conducted jointly by Navy and San Francisco.

On September 24, 1996, in accordance with NEPA requirements, a Notice of Intent (NOI) to prepare an EIS was published in the *Federal Register*. A copy of the NOI is presented in Appendix D of this document. The NOI was mailed to regulatory agencies, local jurisdictions, elected officials, public service providers, and organizations.

As part of the scoping process, Navy and San Francisco held a public meeting to inform the public about disposal and reuse alternatives and to solicit the public's participation and comments. The scoping meeting was held on October 9, 1996, at the San Francisco Ferry Building. The meeting was advertised in the *San Francisco Chronicle, Marin Independent Journal, San Jose Mercury News,* and *Oakland Tribune* on Sunday, September 29, 1996, and Tuesday, October 1, 1996. At the meeting, Navy and local representatives presented an overview of the proposed action and the environmental review process. This presentation was followed by an opportunity for public oral or written comment. Six individuals from the public provided oral comments at the scoping meeting. Oral comments addressed alternate land uses on the site related primarily to residential, marine, and wildlife observation uses. Commentors also were concerned with addressing the needs of veterans in the reuse plan and concerns about public notification during the comment period.

Additionally, twelve comment letters were received in response to the 1996 NOI. These written comments addressed a variety of concerns, including impacts to traffic, geology and seismology, historic architectural resources, hazardous and waste material, and archeological resources. All issues raised during the scoping period regarding environmental and socioeconomic topics have been addressed in this EIS. A more detailed summary of the scoping comments is included in Chapter 7.

1.5.2 Public Review of the Draft EIS

The public was invited to review and comment on the Draft EIS. An NOA was published in the *Federal Register* on May 10, 2002 and notices were published in the *San Francisco Chronicle* and *Oakland Tribune* on May 25 and 26, 2002. A copy of the NOA is presented in Appendix D of this document. Copies of the Draft EIS and NOA were mailed to those on the mailing list (Chapter 10 of the Draft EIS), beginning a 45-day public comment period. A public hearing on the Draft EIS was also held at Building 140 on Treasure Island on June 11, 2002.

During the public comment period, 22 comment letters on the Draft EIS were received from agencies or individuals. In addition, four persons provided oral comments on the Draft EIS at the public hearing. Comments on the Draft EIS and responses to those comments are provided in Chapter 11, Responses to Comments. The Final EIS has been revised, as appropriate, in response to public comments.

1.5.3 Final EIS

The Final EIS incorporates and responds to comments received on the Draft EIS and has been provided to all agencies or individuals that officially commented on the document or otherwise requested a copy (see Chapter 10, EIS Distribution List). An NOA of the Final EIS was published in the Federal Register on June 27, 2003.

As required under NEPA, there will be a 30-day review period after publication of the Final EIS. During this period, the public may comment on the adequacy of responses to comments and the Final EIS. After the 30-day review period, Navy can issue a NEPA ROD.

CHAPTER 2.0

Proposed Action and Alternatives

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2.0 PROPOSED ACTION AND ALTERNATIVES

This chapter describes alternatives for the proposed action and considers Navy *disposal* alternatives and subsequent *reuse* alternatives. NEPA requires that an EIS objectively evaluate a "reasonable" range of alternatives. Under NEPA, reasonable alternatives are those that are practical or feasible from a technical and economic perspective and that are based on common sense (Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations [CEQ 40 Most Asked Questions], 46 Fed. Reg. 18026, March 23, 1981; as amended, 51 Fed. Reg. 15618, April 25, 1986).

This chapter of the EIS is organized into seven primary sections. Section 2.1 discusses Navy disposal alternatives. Section 2.2 describes the generation of reuse alternatives. Alternatives eliminated from review in this EIS, and the reasons for their elimination, are addressed in section 2.3. Section 2.4 provides detailed descriptions of the reuse alternatives evaluated in this EIS. Section 2.5 identifies Navy's preferred alternative and the environmentally preferable alternative, and section 2.6 provides a list of permits and approvals required for disposal and subsequent reuse of NSTI. Finally, section 2.7 provides a summary comparison of the potential impacts and corresponding mitigation for each alternative.

2.1 NAVY DISPOSAL

Navy can either retain NSTI surplus property in federal ownership (No Action Alternative) or dispose of the property for subsequent reuse (Disposal Alternative). The description of retaining NSTI in federal ownership is included in the No Action Alternative (section 2.4.5). Navy disposal of surplus property at NSTI is the federal action evaluated in this EIS for potential environmental and socioeconomic impacts. Under the federal action, approximately 997 acres (403 ha) of federal property at NSTI would be conveyed to non-federal entities.

Although it will not retain control of the properties after their disposal, Navy is required, in accordance with DBCRA, to evaluate the reasonably foreseeable impacts arising from reuse. Consequently, this EIS evaluates the potential environmental and socioeconomic impacts associated with the reuse of NSTI property. The Federal Action, Navy disposal, is assumed as part of each reuse alternative.

2.2 REUSE PLANNING PROCESS

DoD Office of Economic Adjustment (OEA) designated San Francisco as the LRA for NSTI in May 1994. In late June 1994, the Mayor of San Francisco appointed the Treasure Island Citizens Reuse Committee (CRC) to make recommendations for the consideration of the Planning and Redevelopment Commissions and the San Francisco Board of Supervisors. The CRC consisted of a diverse group of community professionals and activists represented by environmentalists, architects, labor union members, educators, municipal finance experts, developers, homeless service providers, real estate analysts, neighborhood and cultural leaders, planners, and lawyers. The CRC convened its first public workshop in June 1994 and met regularly until it had completed its work in 1996.

As part of the NSTI reuse planning process, numerous alternatives were proposed and then evaluated using goals established by the LRA. The city's Office of Military Base Conversion (OMBC), a partnership of San Francisco's Planning Department and Redevelopment Agency and the Port of San Francisco, directed the reuse planning process. This process, described in detail in the Draft Reuse Plan (San Francisco 1996e), included substantial public input and technical direction from city departments, as summarized below.

Before, during, and after the approval of the Draft Reuse Plan, a continued effort was sustained in soliciting meaningful public involvement by the OMBC and the CRC. CRC meetings were open to the public, and public comment was invited and considered. CRC meeting minutes were made available to the public and were regularly distributed to more than 100 organizations and individuals in the Bay Area.

The public also was informed about the progress of reuse planning through a regular newsletter, Treasure of the Bay, the first issue of which was published in Spring 1994. Several issues of the newsletter were published thereafter and mailed to over 2,400 community leaders, neighborhood organizations, and citizens of San Francisco and the Bay Area. Newsletter issues focused on important aspects of the reuse planning process, informed the public about other ways to get information, and advertised the availability of reuse planning reports, which present a more detailed account of NSTI reuse planning.

The OMBC and CRC, through their consultants, conducted public workshops and prepared a number of publicly available documents to assist in formulating a reuse plan for NSTI. Two widely publicized public planning workshops on the reuse planning process (including bus tours of the islands) were held in June 1994 and August 1995. In July 1995, the CRC prepared exhibits for public display at the Treasure Island Museum and the San Francisco Main Library, accompanied by newsletters and questionnaires soliciting public input on the proposed reuse plan. A draft set of reuse planning goals and objectives was produced as a result of these workshops, and the goals and objectives were subsequently refined and approved by the CRC on December 1, 1995.

Documents prepared include a two-volume Existing Conditions Report in August 1995 (San Francisco 1995a; 1995b), with findings summarized in the August 1995 Issues and Opportunities Report (San Francisco 1995d) and the January 1996 Alternatives Report (San Francisco 1996a). The adopted goals and objectives address six specific topics—economics, community, character, transportation, environment, and safety. For a detailed listing and discussion of the goals and objectives envisioned by the CRC, refer to the Draft Reuse Plan (San Francisco 1996e).

From information in these documents and based on public input, a concept plan, entitled Conceptual Planning Framework, Treasure Island - Yerba Buena Island (San Francisco 1996d), was developed and approved by the CRC in February 1996; this plan led to the publication of the Draft Reuse Plan (San Francisco 1996e). Recommendations for the "preferred reuse concept" included an emphasis on visitor-oriented recreational, commercial, and entertainment uses to serve as a major jobs and revenue generator to support needed improvements and services. Due to the instability of fill material on Treasure Island, phased implementation of seismic upgrades to structures and utilities was also recommended to reduce the risk of failure during an earthquake. The earlier phases of improvements focus on accommodating major

visitor-oriented uses. Another recommendation was that the reuse plan be developed to allow substantial flexibility to adapt to market conditions and emerging information.

On July 22, 1996, the San Francisco Board of Supervisors endorsed the Draft Reuse Plan. In September 1996, the San Francisco Redevelopment Agency contracted the Urban Land Institute (ULI), a non-government organization (NGO), to convene an advisory panel to evaluate the feasibility of the Draft Reuse Plan. The resulting report, entitled Treasure Island Naval Station San Francisco, California: An Evaluation of Reuse Opportunities and a Strategy for Development and Implementation (ULI 1996), suggested changes and revisions that were considered in the development of the reuse alternatives. Alternative 2 incorporates many of the changes suggested by the ULI study.

The Draft Reuse Plan proposes to maximize a range of public benefits within the major constraints of the site. The plan emphasizes publicly oriented recreational, entertainment, and hospitality uses that recall the spirit of the 1939 Golden Gate International Exposition (Exposition). These uses maximize the island's central location and outstanding views, and the plan links NSTI to San Francisco and the Bay Area by ferry. The Draft Reuse Plan also incorporates specific users and types of uses from the second homeless screening process. The Draft Reuse Plan was approved by the Department of Housing and Urban Development (HUD) on November 26, 1996 (see Appendix C). The Draft Reuse Plan is described in section 2.4.2 (Alternative 1), along with two other reuse scenarios, Alternative 2 and Alternative 3 (sections 2.4.3 and 2.4.4, respectively).

In 1997, the California State Legislature created a special reuse authority for Treasure Island, transferring the LRA status from San Francisco to the Treasure Island Development Authority (TIDA). TIDA is a state agency staffed by the San Francisco mayor's office and is the entity responsible for planning the reuse of Treasure Island. In March 1998, DoD OEA recognized TIDA as the implementing LRA for NSTI. TIDA submitted an *Economic Development Conveyance (EDC) Application and Business Plan for Naval Station Treasure Island* in June 2000 for land to be used and redeveloped in accordance with the Draft Reuse Plan.

2.2.1 Homeless Assistance Planning Process

Federal base closure law and regulations were changed during the period of reuse planning for NSTI. The Stewart B. McKinney Homeless Assistance Act of 1987 (McKinney Act) (Pub. L. 100-77, codified as amended, at 42 U.S.C. §§ 11341-11448) requires DoD and other federal agencies to give priority consideration for homeless assistance over other uses for property considered excess, surplus, or underutilized by federal agencies. HUD screens properties in these categories for suitability for homeless assistance (42 U.S.C. § 11411). Because NSTI was closed in 1993 under the '93 round of BRAC, homeless assistance screening was originally initiated under this law. In October 1994, the Treasure Island Homeless Development Initiative (TIHDI), a coalition of 14 nonprofit social service and homeless service organizations, submitted a revised plan to the San Francisco Department of Health and Human Services under the McKinney Act for providing homeless services.

The first TIHDI plan submitted to the San Francisco Department of Health and Human Services in October 1994 was building-specific. In the fall of 1994, the Base Closure Community Redevelopment and Homeless Assistance Act of 1994 (Redevelopment Act) (Pub. L. 103-421, 10

U.S.C. § 2687) modified the federal process for accommodating the needs of the homeless in connection with disposal of military installations. This act provided the affected local community greater opportunity to participate in the decision regarding disposal of military properties by requiring homeless providers to work through LRAs. In 1995, the LRA notified Navy of its intent to conduct a second homeless screening process under this act. DoD approved this action on May 9, 1995.

TIHDI conducted an extensive solicitation process throughout 1995. TIHDI submitted a comprehensive Notice of Interest for surplus property at NSTI to the LRA on November 1, 1995, for incorporation into the LRA's reuse plan. The TIHDI Notice of Interest includes homeless housing, support services, employment, and economic development programs and services.

The 1995 plan provides economic development opportunities and employment for homeless individuals. TIHDI organizations may provide contract services, such as landscaping and grounds maintenance, and operate businesses, such as restaurants and convenience stores, at a level that is proportionate to overall development on the islands. These businesses would provide employment and job training and would be an important part of the ongoing transition of NSTI to civilian use.

According to the Draft Reuse Plan, up to 375 existing housing units will be leased to TIHDI to provide shelter for individuals and families, including 90 housing units on Yerba Buena Island and 285 housing units on Treasure Island. Discussions regarding the number of homeless housing to be leased are on-going, and they are currently proposed at approximately 218 units on Treasure Island, and none at Yerba Buena Island. If substantial new residential development occurs on NSTI in the future, TIHDI will be offered sites for constructing additional affordable housing.

The plan sets goals for providing long-term jobs for homeless persons and the working poor as a part of new uses on NSTI. The overall employment goals for NSTI include offering 25 percent of permanent jobs to homeless or other economically disadvantaged persons within a larger goal of setting aside 50 percent of all new jobs for San Francisco residents.

2.3 ALTERNATIVES ELIMINATED FROM DETAILED REVIEW

In determining the scope of alternatives to be considered under NEPA, the emphasis is on what is "reasonable." The term "reasonable" is used primarily to insure that federal agencies preparing NEPA documents make the effort to explore a number of common sense-based alternatives that meet the purpose and need of the project. Reasonable alternatives include those that are practical or feasible from a technical and economic standpoint (Question 2a, CEQ 40 Most Asked Questions, 46 Fed. Reg. 18026 [March 23, 1981]). An alternative can be eliminated from further discussion if it does not meet the purpose and need of the project.

During the reuse planning process, the LRA developed a purpose and need statement that served as the basis for evaluating reuse alternatives and for refining the Draft Reuse Plan. This purpose and need focused on reuse of NSTI property to support the local economic base, enhance the local image and identity, expand the range of recreational and entertainment opportunities available to the community, and enhance the overall livability of the local area and region. To meet these overall objectives, the proposed reuse alternatives must have

provided employment and housing opportunities and generated sufficient revenue (e.g., property tax) to support the investment necessary to upgrade the Treasure Island perimeter dike and to undertake other facility ground improvements that would improve the seismic safety of the site (San Francisco 1996e). In addition, reuse alternatives must have considered current access constraints (e.g., limited access via the SFOBB, inadequate on- and off-ramp design, and traffic congestion during peak hours) and proposed alternative access options, such as ferry service, to solve existing vehicular access deficiencies.

The Alternatives Report (San Francisco 1996a) that preceded the Draft Reuse Plan identified four preliminary land use alternatives. These four alternatives evolved in an iterative process with a series of meetings and discussions with the CRC. Table 2-1 lists the land use requirements of the four preliminary reuse alternatives that were considered by the LRA in 1995 to meet their reuse objectives. From these alternatives, a screening process was initiated by the LRA to determine if these alternatives would 1) attain the objectives of the LRA; 2) avoid or substantially lessen environmental effects of the project; 3) be technically feasible; and 4) be economically feasible. Although these four alternatives were eliminated from analysis by the LRA as a single plan to guide the redevelopment of NSTI, elements of each were included in the Draft Reuse Plan.

Navy reviewed the Draft Reuse Plan (San Francisco 1996e), the ULI report (ULI 1996), the Alternatives Report (San Francisco 1996a), scoping comments and letters, and newspaper articles related to reuse of NSTI to identify a range of reasonable alternatives and to determine which alternatives would be eliminated from detailed review in the EIS. While many reuse scenarios have been suggested, most major elements of the alternatives eliminated from review have been incorporated into one of the three reuse alternatives evaluated. For instance, some reuse suggestions, such as a public park or a sports center, were not feasible as a single use; however, they have been incorporated as elements in the three reuse alternatives evaluated. The four reuse alternatives that were eliminated by the Navy mirror the four preliminary alternatives studied in the Alternatives Report (San Francisco 1996a). Table 2-1 and subsequent discussions (sections 2.3.1 through 2.3.4) provide a description of those alternatives that were eliminated from further review.

2.3.1 Harbor-oriented Themed Attraction Alternative

This alternative envisioned Treasure Island as a major visitor destination. A large themed attraction occupying approximately 86 acres (35 ha) on the scale of Disneyland would be built primarily on Treasure Island, but it also would include Clipper Cove and the eastern tip of Yerba Buena Island. Visitors to the Treasure Island themed attraction would arrive by ferry to a new terminal on the west side of the island. Pier 1 would be incorporated into the themed attraction.

Under this alternative, the west side of Treasure Island would be devoted to visitor-serving uses, primarily hotels and supporting retail and entertainment uses, which would complement and support the new themed attraction. The remainder of the island would be unprotected by shoreline improvements and held in open space. The center of the island, which is more geologically stable, could be used for active recreational uses, such as a sports complex

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Table 2-1. NSTI Land Development Program for Alternatives Initially Considered by the LRA in 1995

Land Use	Alternatives							
	Harbor-oriented Themed Attraction		*Destination Entertainment District*		*Residential Neighborhood*		*Major Themed Attraction*	
	Acres	**Program**	**Acres**	**Program**	**Acres**	**Program**	**Acres**	**Program**
Treasure Island								
Themed Attraction	86.0	1 million s.f.						
Hotel/Entertainment	30.0	1,200 rooms 500,000 s.f.					30.0	2,000 rooms
Sports Complex	80.0							
Public Promenade	6.0		4.0		7.0		7.0	
Destination Entertainment			23.0	500,000 s.f.				
Film/Institutional			11.0	300,000 s.f.	14.0	300,000 s.f.		
Resort Hotel			18.0	600 rooms				
Business Hotel			13.0	400 rooms				
Golf Course			144.0	18 holes				
Marina				500 slips		500 slips		500 slips
Residential					88.0	3,520 units		
Residential/Mixed Use					37.0	1,480 units 200,000 s.f.		
Hotel/Conference					8.0	400 rooms		
School/Child Care/Gym					22.0			
Park/Open Space					125.0			
Roads					13.0			
Themed Attraction/Entertainment							263.0	
Film Production								300,000 s.f.
Job Corps	36.0		36.0		36.5		36.0	
Open Space	165.0		154.0		52.5		67.0	
Subtotal Acres	403		403		403		403	
Yerba Buena Island								
Themed Attraction	7.0	200 rooms 100,000 s.f.						
Hotel/Conference			7.0	200 rooms			7.0	200 rooms
Residential (new)					7.0	140 units		
Existing Housing	36.0	95 units	36.0	95 units	36.0	95 units	36.0	95 units
Open Space	72.0		72.0		72.0		72.0	
Subtotal Acres	115		115		115		115	

Source: Draft Reuse Plan (San Francisco 1996a).

Notes for all alternatives:

Improved land acreage includes stabilized land area within a footprint defined by an improved perimeter dike, including the Job Corps site. Land within the core is excluded for the Harbor-oriented Themed Attraction and Destination Entertainment District alternatives.

Initial alternatives include 39 acres (16 ha) of dry land on Yerba Buena Island that was subsequently transferred to the U.S. Coast Guard and FHWA.

s.f. = square feet

consisting of amateur athletic fields. New uses on Treasure Island would be focused around a central roadway and utility corridor that provides access and services to each of the uses.

On Yerba Buena Island, it is assumed that one small 200-room hotel could be part of development on the flatter, eastern area. The Senior Officers Quarters would be preserved and incorporated into the themed attraction, either as lodging or as an attraction. The remainder of Yerba Buena Island would be primarily devoted to housing and open space uses.

Major elements of this alternative were incorporated into two of the reuse alternatives that are already included in this EIS. For example, the major themed attraction and use of the west side of Treasure Island for visitor-serving uses, such as hotels, is part of Alternative 1. Providing shoreline improvements only to portions of Treasure Island and dedicating the less reinforced part to open space and recreation is similar to Alternative 2. In addition, this alternative was found to be marginally economically feasible due to the single source of revenue and the reliance on supplemental funding from tax increment financing (San Francisco 1996a). Therefore, this alternative was eliminated from further review.

2.3.2 Destination Entertainment District Alternative

This alternative would include developing a resort hotel and a visitor-serving entertainment district along the Clipper Cove shoreline of Treasure Island. For illustrative purposes, this alternative envisions a fairly large facility similar in scale to the Inn at Spanish Bay in Pebble Beach. Another hotel and conference center would be established on the western side of the island. The area between the two hotels and along the Clipper Cove shoreline would be a visitor-oriented entertainment zone, similar in concept to Citywalk in Universal City in Los Angeles, incorporating themed attractions, along with clubs, restaurants, and shops oriented to the waterfront promenade. This alternative also provides an area for existing film production or a similar employment use, such as recording or multimedia studios, which could be related to the entertainment themes of the island.

Open space on Treasure Island would be developed as an 18-hole golf course to complement the hotels. Similar to the Harbor-oriented Themed Attraction Alternative, the outer perimeter of the island would be set aside as natural open space with limited public access. This alternative also envisions a small hotel and conference center on the eastern tip of Yerba Buena Island, with reuse of existing residential units and potentially up to 90 infill units.

This alternative was eliminated from further consideration due to economic factors. The principal source of revenue to support development of NSTI is the value that private development can pay for the land. Compared to the other three preliminary alternatives, the Destination Entertainment District Alternative would result in the lowest residual land values, which would not be sufficient to cover all costs even with supplemental tax revenues (San Francisco 1996a), therefore, this alternative was eliminated from further review. However, elements of this alternative have been integrated into the EIS reuse alternatives. For example, the golf course is represented in Alternative 2.

2.3.3 Residential Neighborhood Alternative

Under this alternative, both Treasure Island and Yerba Buena Island would be devoted primarily to residential uses; up to 4,000 new housing units would be added to the existing approximately 1,000 units at NSTI (approximately 900 units on Treasure Island and approximately 100 units on Yerba Buena Island). New residential uses on Treasure Island would be oriented around shoreline open space areas and a central park. A commercial residential mixed-use center would be established along the Clipper Cove shoreline. A new marina would be established on Treasure Island at Clipper Cove for recreational uses. On the west side of the island, a small business hotel and conference center would be located to take advantage of views and ferry access to downtown San Francisco. Redevelopment on Yerba Buena Island would include new housing units developed at townhouse densities (i.e., up to 20 units per acre for the level portion of the island and 10 units per acre for sloping and redeveloped areas). Up to 230 new dwelling units could be established on Yerba Buena Island in addition to rehabilitating existing housing units.

This alternative was eliminated from further consideration because of both economic and environmental factors. Economic feasibility studies during the master planning process revealed that given the high dike reinforcement, infrastructure, and service costs and the expected rate of absorption for residential uses, an alternative that relied primarily on residential uses would be economically infeasible. For example, it was estimated to take 25 years for this alternative to be built out. Even with the inclusion of tax increment financing, the revenues generated, primarily consisting of land sales, were found to be insufficient to cover the high costs associated with this alternative (San Francisco 1996a). It was also questionable whether a suitably amenable residential environment could be established in the early phases to establish new market-rate housing on Treasure Island.

This alternative also would be expected to generate unacceptably high traffic volumes on the SFOBB, based on a likely greater reliance on the private automobile for transportation and access to and from NSTI. Based on a residential trip generation rate of ten trips per day, this alternative would generate approximately 49,950 vehicle trips per day. Vehicle use would have to be stringently curtailed for this alternative to be feasible from a transportation standpoint, and the anticipated level of non-auto use (e.g., ferry and shuttle systems) that would be required of new residents would be generally unprecedented in the U.S. This alternative would not meet the LRA's purpose and need to enhance the overall livability of the local area and region because it would worsen existing vehicular access deficiencies on the SFOBB. For these reasons, this alternative was eliminated from further consideration.

2.3.4 Major Themed Attraction Alternative

This alternative would develop an extensive themed attraction on Treasure Island. The themed attraction would occupy approximately 260 acres (105 ha), on the scale of Universal Studios in Los Angeles, and would include film production. The western portion of Treasure Island would be developed primarily as hotels and visitor-serving uses. In this alternative, Clipper Cove and the associated shoreline would be for public use and would not be included within the themed attraction. Public access to the themed attraction would be through the west side ferry terminal and through Building 1. Pier 1 would serve as a ferry terminal and a second entrance to the themed attraction. This alternative also would include construction of a new

200-room hotel on the eastern tip of Yerba Buena Island. The existing housing would be reused and infilled, as feasible.

This alternative would meet the basic project purpose and need to enhance local image and identity and to expand the range of recreational and entertainment opportunities available to the community. However, this alternative was regarded as too narrowly drawn, relying too much on a very large themed attraction. The marketability of this alternative is questionable due to the unlikelihood that a developer or corporation would purchase such a large area of land for themed attraction purposes, particularly given the costs associated with land improvements and that the intensive use area is generally around 60 to 80 acres (24 to 32 ha) (San Francisco 1996a). For these reasons, this alternative was eliminated from consideration as a single development plan. However, the major themed attraction elements were incorporated in all three of the EIS reuse alternatives at a reduced scale.

2.4 DETAILED DESCRIPTION OF REUSE ALTERNATIVES

This section presents a detailed description of the three reuse alternatives developed and evaluated in this EIS—Alternatives 1, 2, and 3. Navy disposal is assumed as part of each of the three reuse alternatives. Alternative 1 represents full implementation of the development scenario described in the Draft Reuse Plan (San Francisco 1996e) developed by the LRA. Whereas the Draft Reuse Plan envisions buildout by 2030, this EIS alternative assumes buildout by 2015. Year 2015 was used as the EIS buildout year because it was the year for which there was the most representative data concerning projected population and economic growth at the time of the analysis. Alternative 2 is based on comments received during the scoping process, including the recommendations of an advisory panel convened by the ULI (ULI 1996). Alternative 3 represents a lower level of redevelopment than proposed in the Draft Reuse Plan.

Each reuse alternative is a broad conceptual plan characterized by a general land use concept and a development scenario. For example, residential uses for the three alternatives range from 250 to 2,840 dwelling units, while open space and recreation uses range from a combination of shoreline promenades and sports fields on 118 acres (47.8 ha) to a combination of these uses plus an 18-hole golf course on approximately 259 acres (104.8 ha). Alternative 1 proposes the largest population (employees, residents, and visitors). Alternative 3 proposes approximately half as much employment and resident population compared to Alternative 1. Alternative 2 provides more jobs than Alternative 3 and the fewest residents of all the reuse alternatives. Alternatives 1, 2, and 3 have different perimeter dike improvements to seismically upgrade Treasure Island. Alternative 3 includes a lower level of development, and many existing buildings are reused.

Each reuse alternative has general land use planning designations (residential, publicly oriented, institutional and community, and open space and recreation) that allow for a range of different types of land use. These four land use categories represent slightly revised versions of the land use categories discussed in the Draft Reuse Plan. The publicly oriented and institutional and community categories are composites and would include a range of land uses. For example, the publicly oriented category would include such uses as a themed attraction, hotels, and an expanded marina. The institutional and community category would include such uses as police and fire stations, schools, and the wastewater treatment plant. The residential land use category would include a range of housing options on both Treasure Island

and Yerba Buena Island. The open space and recreation land use category would include shoreline open space at Treasure Island and hillside open space on Yerba Buena Island. Figure 2-1 compares land use development proposed for each of the three alternatives.

Table 2-2 provides a summary comparison of land use development of the three alternatives. This table is intended to help the reader identify specific differences among the three alternatives. The resulting combination of the use categories provides a level of reuse intensity that is analyzed and compared as part of this EIS. Analyses of the three reuse alternatives, which include a range of possible uses, provide a basis for decision-makers and the public to consider the environmental impacts of reuse.

The reuse alternatives are general, representative, and appropriate for the level of environmental analysis needed to make a disposal decision. Use categories, such as a themed attraction, sports fields, or residential developments, are representative of but are not the only specific uses for a parcel or building. The use categories analyzed provide a basis for estimating the potential numbers of future residents, employees, and visitors for environmental impact analysis purposes. The numbers provided in Table 2-2 are estimates only since discussions are on-going between Navy and San Francisco, and most uses depend on future conditions and circumstances.

This section describes reuse alternative assumptions, followed by a more detailed description of land use development for each alternative. The discussion of each alternative is organized by the four general land use planning categories. For reference, Figure E-1 in Appendix E identifies NSTI building numbers used in the following discussion.

2.4.1 Assumptions for Reuse Alternatives

Construction and Demolition

Development is expected to occur in phases in accordance with infrastructure improvements. Phasing in the Draft Reuse Plan is illustrative and is expected to vary depending on actual market conditions, funding, and policy decision. Each phase would include some demolition and construction activities and would lead to additional employment and housing development (San Francisco 1996e).

Facility Improvements

The extent of perimeter dike improvements and other seismic improvements on Treasure Island would vary with each reuse alternative, as indicated in the alternative descriptions in sections 2.4.2, 2.4.3, and 2.4.4, and as shown on Figure 2-2.

Existing utility systems would be improved to provide better service and upgrades needed to meet applicable codes. Water system upgrades, for example, would include improving the chlorinating system, installing new water pumps, and replacing existing pipes and valves, meters, back-flow preventers, and air valves, as needed. Sanitary sewer system upgrades would include replacing sewage pipes or lining them for low-flow use. Storm drainage improvements would include inspecting and replacing selected storm drains, rebuilding or

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Table 2-2
Summary Comparison of Land Development Characteristics of Reuse Alternatives

Characteristic	*Alternative 1*	*Alternative 2*	*Alternative 3*
Residential	**Dwelling Units**	**Dwelling Units**	**Dwelling Units**
Existing residential	290	50	995[1]
New residential	2,550	200	70
Total dwelling units	**2,840**	**250**	**1,065**
Publicly Oriented	**Acreage**	**Acreage**	**Acreage**
Themed attraction	59	74	39
Hotel/conference/lodging	25	45	14
Retail/specialty/restaurant	10	1	2
Entertainment center	0	6	0
Amphitheater	0	7	0
Wedding chapel	0	1	2
Museum	3	4	4
Mixed use/office	11	0	6
Film production	31	0	33
Marina (yacht club)	2	0	2
Other publicly oriented uses	14	14	20
Subtotal Acres	**155**	**152**	**122**
Institutional and Community			
Elementary school	9	0	9
Child development center	4	0	4
Fire training school	5	5	5
Warehouse/storage	0	0	4
Wastewater treatment plant	10	5	3
Brig	5	4	5
Fire station	4	2	2
Police station	3	2	3
Other institutional facilities	0	0	8
Subtotal Acres	**40**	**18**	**43**
Open Space and Recreation			
Golf course	0	147	0
Sports fields/complex	47	18	40
Shoreline promenade/open space[2]	71	76	102
Wildlife habitat	0	18	0
Subtotal Acres	**118**	**259**	**142**
Land Use Categories[3]			
Public Oriented	155	152	122
Residential	137	21	143
Institutional and Community	40	18	43
Open Space and Recreation	118	259	142
Total Acres	**450**	**450**	**450**
Marina	Expansion	Expansion	Existing only
Ferry Terminals	New (west side) Retrofit (Pier 1)	New (west side) Retrofit (Pier 1)	Retrofit (Pier 12) Retrofit (Pier 1)
Approximate On-site Population	6,895	710	3,510
Approximate Employment	4,920	2,820	2,195
Approximate Average Daily Vehicle Trips	18,100	13,085	6,700

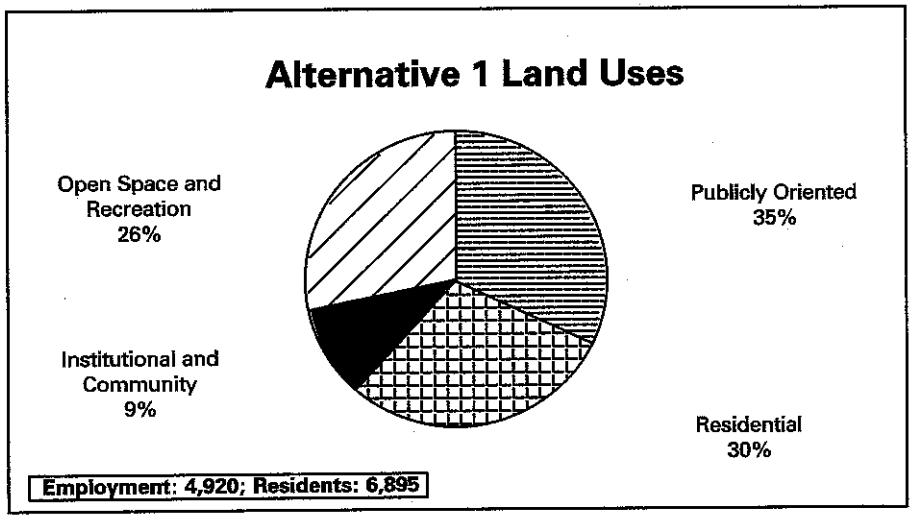
Source: Draft Reuse Plan (San Francisco 1996e).

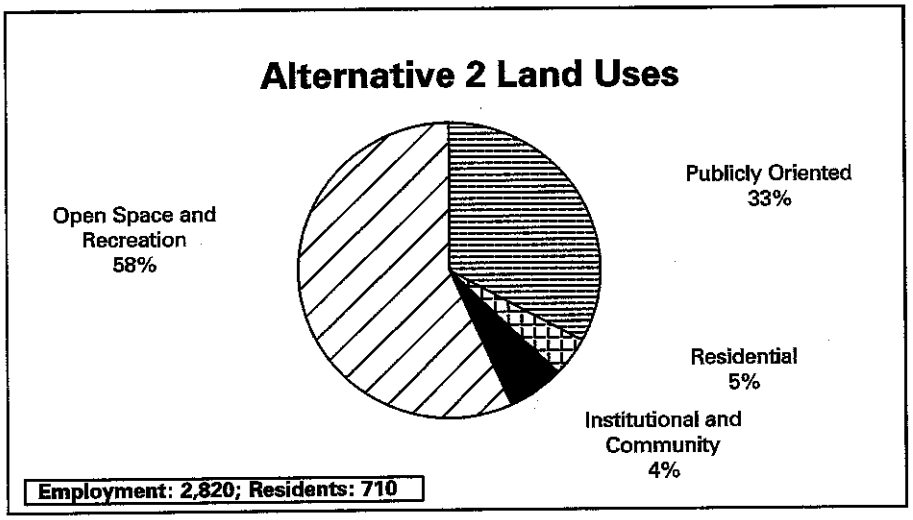
[1] Does not include 75 beds in barracks on Treasure Island.

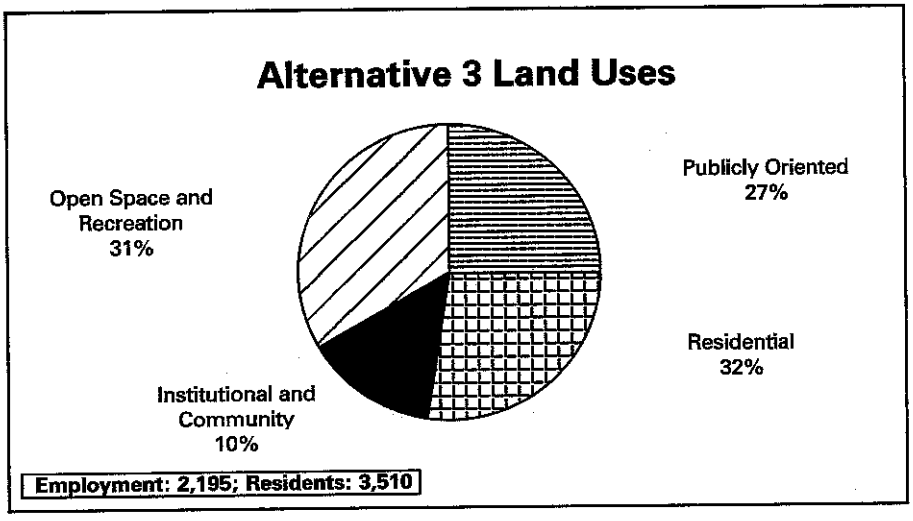
[2] Open space on Yerba Buena Island includes small areas of native habitat.

[3] The land use categories represent slightly revised versions of the land use categories discussed in the Draft Reuse Plan.

Note: The numbers provided in this table are estimates only since discussions are on-going between Navy and San Francisco. Estimates in the text and the tables are included for discussion purposes.







Percentages of land uses may vary somewhat within each alternative, especially in the area of residential and open space/recreation use.

Comparison of Reuse Alternatives

Naval Station Treasure Island, California

Source: CCSF 1996e, Developed by CCSF 1987

Figure 2-1

replacing pump stations, and repairing and replacing outfalls. Alternative technologies, including establishing wetlands, may be considered as part of required improvements.

Ferry Service

Ferries would be an important mode of transportation to the islands under all of the reuse alternatives. Under Alternatives 1 and 2, a new ferry terminal would be built on the west side of Treasure Island. In all alternatives, Pier 1 would be retrofitted to serve as a ferry landing on the east side of the island. Under Alternative 3, Pier 12 would be adapted to accommodate ferry service rather than constructing a new ferry terminal.

Under all three reuse alternatives, ferry service would be provided between NSTI and San Francisco and the East Bay, with service to and from the Ferry Building in San Francisco at the foot of Market Street and Jack London Square in the Oakland/Main Street terminal in Alameda. Additional ferry service under Alternatives 1 and 2 would be provided between NSTI and Candlestick Point in San Francisco and Golden Gate Fields on the Berkeley and Albany border in the East Bay.

Dredging

Dredging may be associated with modifications necessary for ferry service (new ferry terminal and retrofitted piers). Dredging also may be necessary for maintenance of the marina under all alternatives and expansion of the marina under Alternatives 1 and 2. The exact location and amount of potential dredging is not known at present and therefore, this EIS can necessarily evaluate potential impacts from dredging in only a general way. All dredging activities would require permits and approvals from Bay Conservation and Development Commission (BCDC), San Francisco Bay Regional Water Quality Control Board (RWQCB), and the COE, which would require measures to minimize potential environmental impacts. (Disposal of dredge material is discussed in section 4.10, Water Resources.)

2.4.2 Alternative 1 (Preferred Alternative)

Alternative 1 features a combination of publicly oriented development, open space and recreation, and extensive residential development at full buildout, such as envisioned in the Draft Reuse Plan. Under this alternative, the NSTI project acreage would be occupied in the following manner: publicly oriented land uses, approximately 35 percent; residential, 30 percent; open space and recreation, 26 percent; and institutional and community services, 9 percent (see Figure 2-1 and Table 2-2). The four land use alternatives initially considered by the LRA (see section 2.3) were used to develop and further refine a "preferred reuse concept" that formed the basis of the Draft Reuse Plan, represented by Alternative 1. Figure 2-3 shows proposed land uses for Alternative 1. Table E-2 in Appendix E provides detailed assumptions for this alternative.

Seismic upgrades would include dike improvements to the entire Treasure Island perimeter, using soil cement columns in areas subject to rotational dike failure and stone columns in the other areas (see Figure 2-2). A new underground utility corridor would run along the perimeter of the island, carrying storm and sanitary sewer mains, water mains, reclaimed water mains,

and electricity, gas, and telecommunications lines. The utility corridor also would cross Treasure Island along 9th Street.

Publicly Oriented Uses

Alternative 1 proposes 155 acres (63 ha) of publicly oriented uses. Unlike the preliminary alternative, Harbor-oriented Themed Attraction, Alternative 1 has a broader diversification of uses, while still proposing a Disneyland-like attraction. The major publicly oriented development on Treasure Island would be a themed attraction with the potential to attract an average of approximately 13,700 daily visitors and to employ up to approximately 3,500 seasonal and permanent workers (1,750 full-time equivalent jobs). This themed attraction would be similar to Disneyland, with lighting displays, some tall structures, such as a roller coaster, and at least one landmark structure assumed to be up to 100 feet (305 meters [m]) tall. Maximum building density at the themed attraction would be similar to existing conditions. Development also would include a 300-room and a 1,000-room hotel with three restaurants and offices. Existing film production uses would be expanded by an additional 100,000 square feet (9,290 m^2). The total number of jobs expected to be generated by publicly oriented uses on Treasure Island is 4,482.

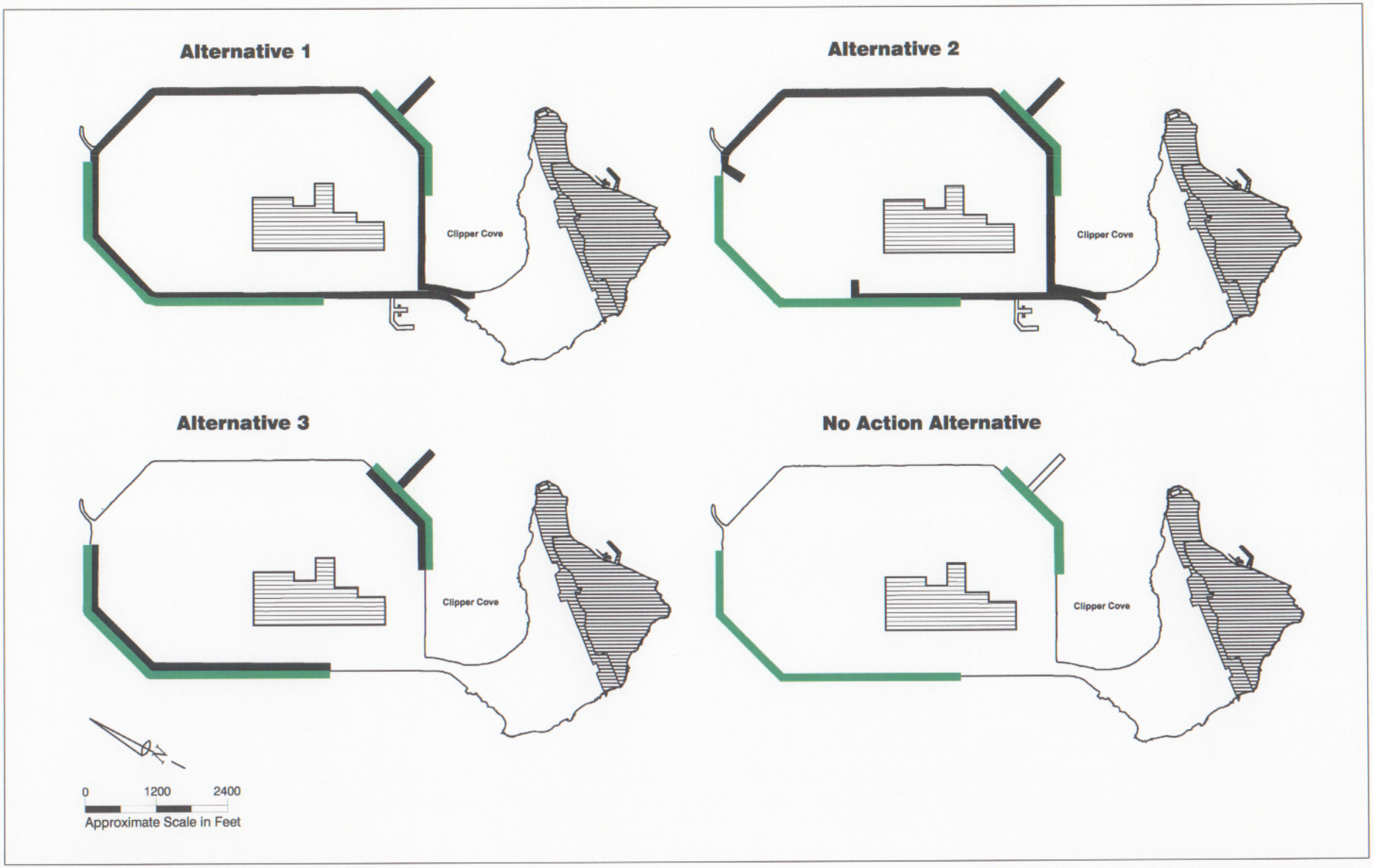
Publicly oriented uses on Yerba Buena Island would include a 150-room hotel, conference facilities, and a restaurant, and would generate approximately 168 new jobs. The approximately 100-slip Clipper Cove Marina would be expanded to 300 slips and 100 tie-up buoys, and a new 20,000 square-foot (1,858 square-meter [m^2]) yacht club would be developed. Existing structures also would be reused for publicly oriented activities, such as a conference and reception center, and these buildings would be seismically upgraded.

Residential Uses

Alternative 1 proposes 137 acres (55 ha) of residential uses. Unlike the rejected Residential Neighborhood Alternative, this alternative has mixed uses including the themed attraction discussed above. On Treasure Island, about 200 of the approximately 900 existing housing units would be reused, and about 2,300 units would be built. On Yerba Buena Island, approximately 100 units of existing housing would remain in use, and 250 units would be built. The Torpedo building (Building 262) would be reused as live-work units. The total number of housing units associated with this reuse alternative would be about 2,850. TIHDI initially would manage the leasing of 375 units from the existing housing stock on the two islands, with promise of additional land for TIHDI housing if new housing is developed.

Institutional

Alternative 1 proposes 40 acres (16 ha) of institutional and community uses on Treasure Island, generating an estimated 200 jobs. A new wastewater treatment plant would be built to replace the existing plant. A new police station and a new fire station also would replace those existing on Treasure Island; these facilities and an existing fire station on Yerba Buena Island would be staffed with fire, paramedic, and police personnel. The elementary school, child development center, fire training school, and brig would be retained and reused, for their original uses, with some modifications.



Stabilizing the Treasure Island causeway shoreline to reduce earthquake-induced lateral spreading would vary under each alternative. Full scale stabilization under Alternative 1 would be achieved by sinking rows of stone columns within 50-foot wide band along the shoreline and soil cement columns in the 6,700 linear feet of shoreline that is subject to rotational dike failure. There would be no stabilization under the No Action Alternative.

Legend:

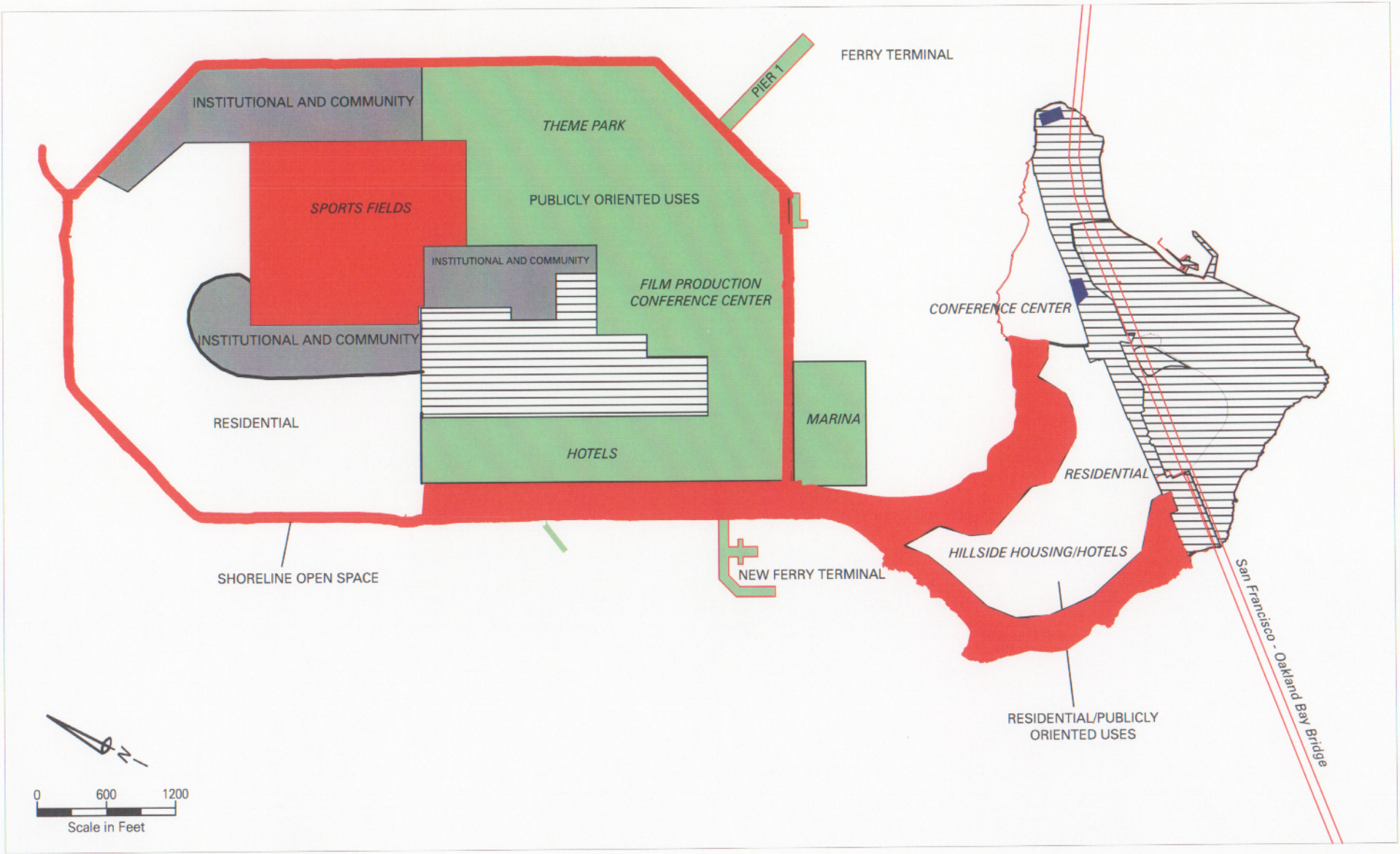
- Areas Excluded from Proposed Navy Disposal
- Shoreline Subject to Rotational Dike Failure
- Seismic Stabilization Improvements

Source: CCSF 1996e

Extent of Perimeter and Seismic Stabilization

Naval Station Treasure Island, California

Figure 2-2



Alternative 1 is similar to the development scenario described in the Draft Reuse Plan.

Legend:

- Publicly Oriented
- Open Space and Recreation
- Institutional and Community
- Areas Excluded from Proposed Navy Disposal
- Residential
- FHWA/Caltrans Aerial Easement

Alternative 1 Land Uses

Naval Station Treasure Island, California

Figure 2-3

Source: CCSF 1996e; Developed by CCSF 1997

Open Space and Recreation Uses

Alternative 1 proposes 118 acres (48 ha) of open space and recreation uses on NSTI. The existing Treasure Island shoreline open space would be widened from 25 to 50 feet (7.5 to 15 m) to approximately 100 feet (30 m) and would feature a bikeway and pedestrian path. The proposed perimeter band would surround Treasure Island and would be linked to a series of parks, plazas, greens, and overlooks. The existing fitness center and gym would be retained, and there would be new spectator and competitive sports facilities. The majority of this area would consist of open playing fields for soccer, basketball courts, and tennis courts expected to generate 7 new jobs. Beach areas and picnic grounds at the foot of the cove would be retained, and existing mudflats would remain for shorebird forage and habitat. The hillside open space extending to the water on Yerba Buena Island's steep side, including interspersed native habitat, would remain as open space.

2.4.3 Alternative 2

Redevelopment under Alternative 2 is similar to Alternative 1, but less extensive. This alternative emphasizes open space and recreation and publicly oriented uses but on a smaller scale. Figure 2-4 identifies proposed land uses for Alternative 2. Table E-3 in Appendix E provides detailed assumptions for this alternative.

Under Alternative 2, open space and recreation land uses would occupy 58 percent of NSTI acreage, publicly oriented 33 percent, residential 5 percent, and institutional and community services 4 percent (see Figure 2-1 and Table 2-2). The existing housing would be reused initially. No new housing would be built on Treasure Island. An 18-hole golf course would occupy the present housing area on the northern part of the island.

Regarding seismic upgrade, except for the golf course area, full-scale perimeter dike improvements would be implemented around Treasure Island (see Figure 2-2). Extending a stone column dike reinforcement on the east to beyond Building 461 and on the west to 9th Street would reduce damage to structures, such as the brig and fire training center, in the event of an earthquake. Where dike improvements would end, an approximately 500-foot (152-m) soil cement column would be extended into the island (see Figure 2-2). The utility corridor would be constructed around the perimeter of Treasure Island, but it would not extend along the perimeter adjacent to the proposed golf course.

Publicly Oriented Uses

Alternative 2 proposes 152 acres (62 ha) of publicly oriented uses. A themed attraction would draw up to approximately 5,500 daily visitors and would employ approximately 1,400 seasonal and permanent employees (700 full-time equivalent jobs). As with Alternative 1, this themed attraction would be similar to Disneyland, with lighting displays, some tall structures, such as a roller coaster, and at least one landmark structure assumed to be up to 100 feet (305 m) tall. However, maximum building density at the themed attraction would be less dense and would include more open space and landscaping. Development would include a 700-room and 500-room hotel, a 5,000-seat amphitheater, and an entertainment and retail center. The total number of jobs expected to be generated by publicly oriented uses on Treasure Island is 2,513.

The Clipper Cove Marina would be expanded to have 500 to 675 slips and tie-up buoys. Existing facilities (e.g., Senior Officers Quarters 1 through 7) would be reused for publicly oriented uses, such as a 100,000 square-foot (9,290 m^2) conference and reception center or bed and breakfast facilities. The Torpedo building (Building 262) would be reused as a restaurant. The number of jobs expected to be generated by publicly oriented uses on Yerba Buena Island is 180.

Residential Uses

Alternative 2 proposes 21 acres (8 ha) of residential uses. On Treasure Island, all housing would eventually be demolished. There may be replacement homeless housing for TIHDI to manage and lease elsewhere off-island. On Yerba Buena Island, approximately 50 existing housing units would remain and approximately 200 new units would be added, for a total of about 250 units.

Institutional and Community Uses

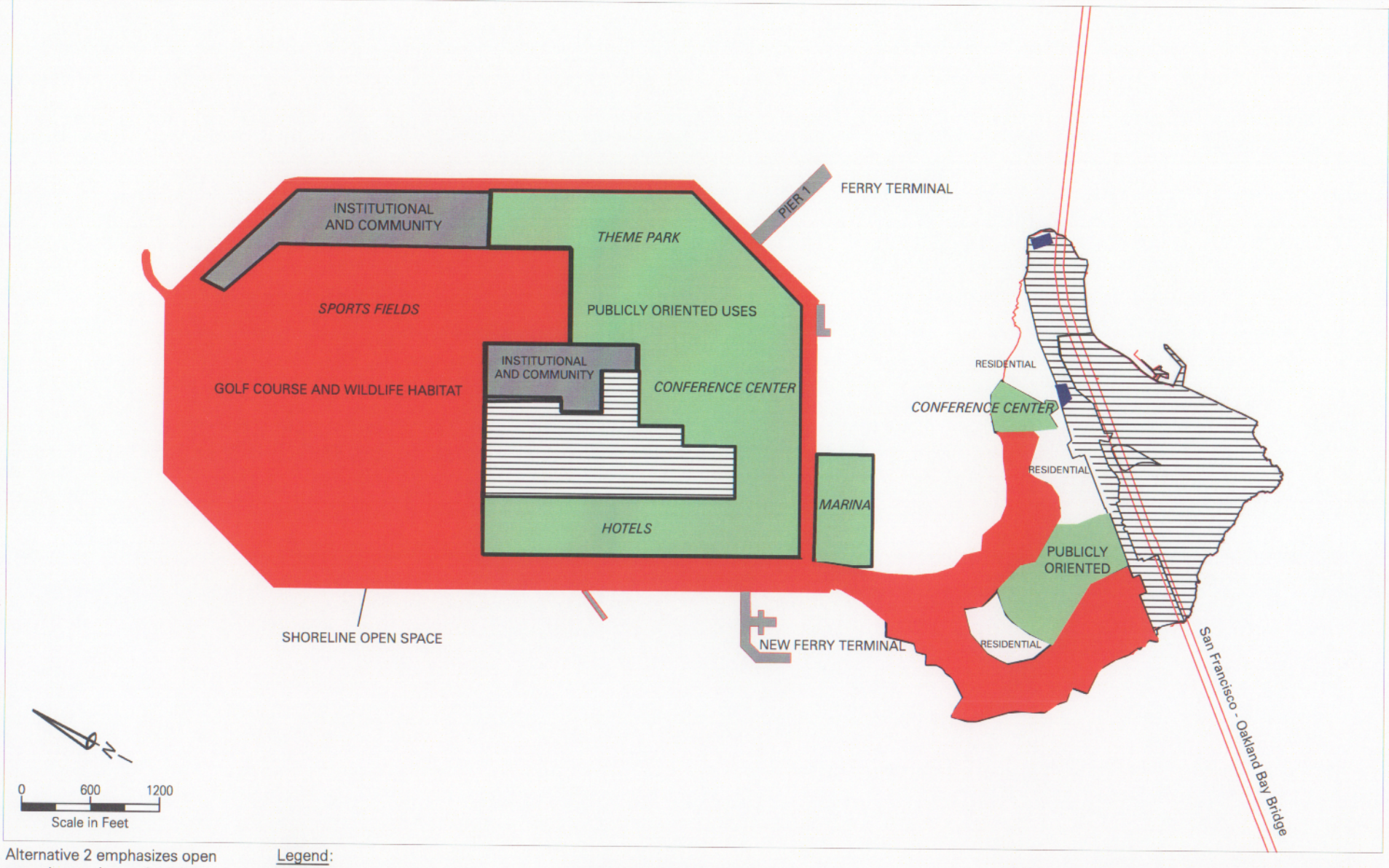
Alternative 2 proposes 18 acres (7 ha) of institutional and community uses on Treasure Island, generating an estimated 103 jobs. A new wastewater treatment plant would be built to replace the existing plant. Wetlands also could be constructed for treating stormwater runoff (see description below under Open Space and Recreation Uses). The elementary school and the child development center would ultimately be removed. A new fire station and police station would be built; these facilities and an existing fire station on Yerba Buena Island would be staffed with fire, paramedic, and police personnel. The brig and the fire training school would remain and be reused, for their original uses, with some modifications. The fire training school would be modified to include passenger aircraft fire-fighting training.

Open Space and Recreation Uses

Alternative 2 proposes 259 acres (104 ha) of open space and recreation uses. Similar to Alternative 1, the shoreline open space would be widened to approximately 100 feet (30 m) and would feature a bikeway and pedestrian path. An 18-hole golf course would be developed on the northern half of Treasure Island. An approximately 20-acre (8-ha) area near the proposed golf course would be set aside for wildlife habitat, for wildlife observation, and possibly for wetlands. There are no wetlands on NSTI. If wetlands were proposed, the type of wetlands would need to be defined and further studies conducted as part of site-specific environmental documentation. Wetlands could be introduced and analyzed as part of proposed infrastructure (e.g., stormwater system) improvements. The hillside open space extending to the water on Yerba Buena Island's steep side, including interspersed native habitat, would remain as open space.

2.4.4 Alternative 3

Alternative 3 represents the scenario where little new development would occur, and existing facilities would be reused. The wastewater treatment facility would be retained, and the existing housing and other structures would be reused. Building upgrades would include rehabilitation to meet life safety requirements recommended by the Federal Emergency



Alternative 2 emphasizes open space/recreation and publicly oriented land uses.

Legend:

- Publicly Oriented
- Open Space and Recreation
- Institutional and Community
- Areas Excluded from Proposed Navy Disposal
- Residential
- FHWA/Caltrans Aerial Easements

Alternative 2 Land Uses

Naval Station Treasure Island, California

Source: CCSF 1996e; Developed by CCSF 1997

Figure 2-4

Management Agency (FEMA)-178 evaluations and other code requirements. Minimal development would occur.

Figure 2-5 identifies proposed land uses for Alternative 3. Table E-4 in Appendix E provides detailed assumptions for this alternative. Under Alternative 3, open space and recreation land uses would occupy 31 percent of NSTI acreage, residential 32 percent, publicly oriented 27 percent, and institutional and community services 10 percent (see Figure 2-1 and Table 2-2). Reuse under this alternative could include uses similar to those under existing leasing actions, such as film production, the conference center, fire-fighting school, marina, and elementary school. These uses would continue through 2015 under this alternative.

Seismic upgrade dike improvements would occur along those areas of Treasure Island subject to rotational dike failure (Figure 2-2).

Publicly Oriented Uses

Alternative 3 proposes 122 acres (49 ha) of publicly oriented uses. A themed attraction would reuse existing facilities and draw up to an average of approximately 2,740 daily visitors and employ up to approximately 700 seasonal and permanent workers (350 full-time equivalent jobs). Compared to Alternatives 1 and 2, the themed attraction would be much smaller in size with less extensive development. It would include at least one landmark structure assumed to be up to 100 feet (305 m) tall, and other new buildings would be similar in height to existing conditions.

On Yerba Buena Island, the Nimitz Conference Center (Building 140) would be reused, and the Torpedo building (Building 262) would be reused as a restaurant (building numbers are shown on Figure E-1 in Appendix E). On Treasure Island, the Fogwatch Restaurant (Building 227) would continue to be a restaurant and the existing film production uses would be expanded. Building 450 would be reused either for film production or for other publicly oriented uses, such as mixed use or office space. The existing marina would be retained but would not be expanded, and a new 20,000 square-foot (1,858 m^2) yacht club would be developed. The number of jobs expected to be generated by publicly oriented uses on Treasure Island is 1,736.

On Yerba Buena Island, Quarters 1-7 would be reused for conference and reception and lodging. The number of jobs expected to be generated by publicly oriented uses on Yerba Buena Island is 180.

Residential Uses

Alternative 3 proposes 143 acres (58 ha) of residential uses. On Treasure Island, approximately 900 existing housing units (as well as approximately 75 beds in barracks) would be reused, but no new units would be constructed. Approximately 200 units of the existing housing units would be made available to TIHDI for leasing. On Yerba Buena Island, approximately 100 units would be reused, and about 70 housing units would be constructed by 2015. The number of housing units associated with this alternative would be approximately 1,100.

Institutional and Community Uses

Alternative 3 proposes 43 acres (17 ha) of institutional and community uses on Treasure Island, generating an estimated 276 jobs. Some of the same institutional and community facilities identified under Alternative 1 would be retained under this alternative, such as the school, the brig, the fire-fighting training school, and the fire station. A new police station would be constructed on Treasure Island. The fire and police facilities, including an existing fire station on Yerba Buena Island, would be staffed with fire, paramedic, and police personnel. The existing wastewater treatment plant would continue to be used. This alternative would include 4 acres (1.5 ha) of warehouse use.

Open Space and Recreation Uses

Alternative 3 proposes 142 acres (57 ha) of open space and recreation uses. Similar to Alternative 1, the shoreline open space would be widened to approximately 100 feet (30 m) and would feature a bikeway and pedestrian path. Existing indoor recreation facilities, such as the gym and fitness center, would become part of a larger sports facility. A series of open spaces would be created north of Building 1. The hillside open space extending to the water on Yerba Buena Island's steep side, including interspersed native habitat, would remain as open space.

2.4.5 No Action Alternative

No action may be defined as the continuation of an existing plan, policy, or procedure or as failure to implement an action. The No Action Alternative provides a benchmark to compare the magnitude of the environmental effects of the various alternatives.

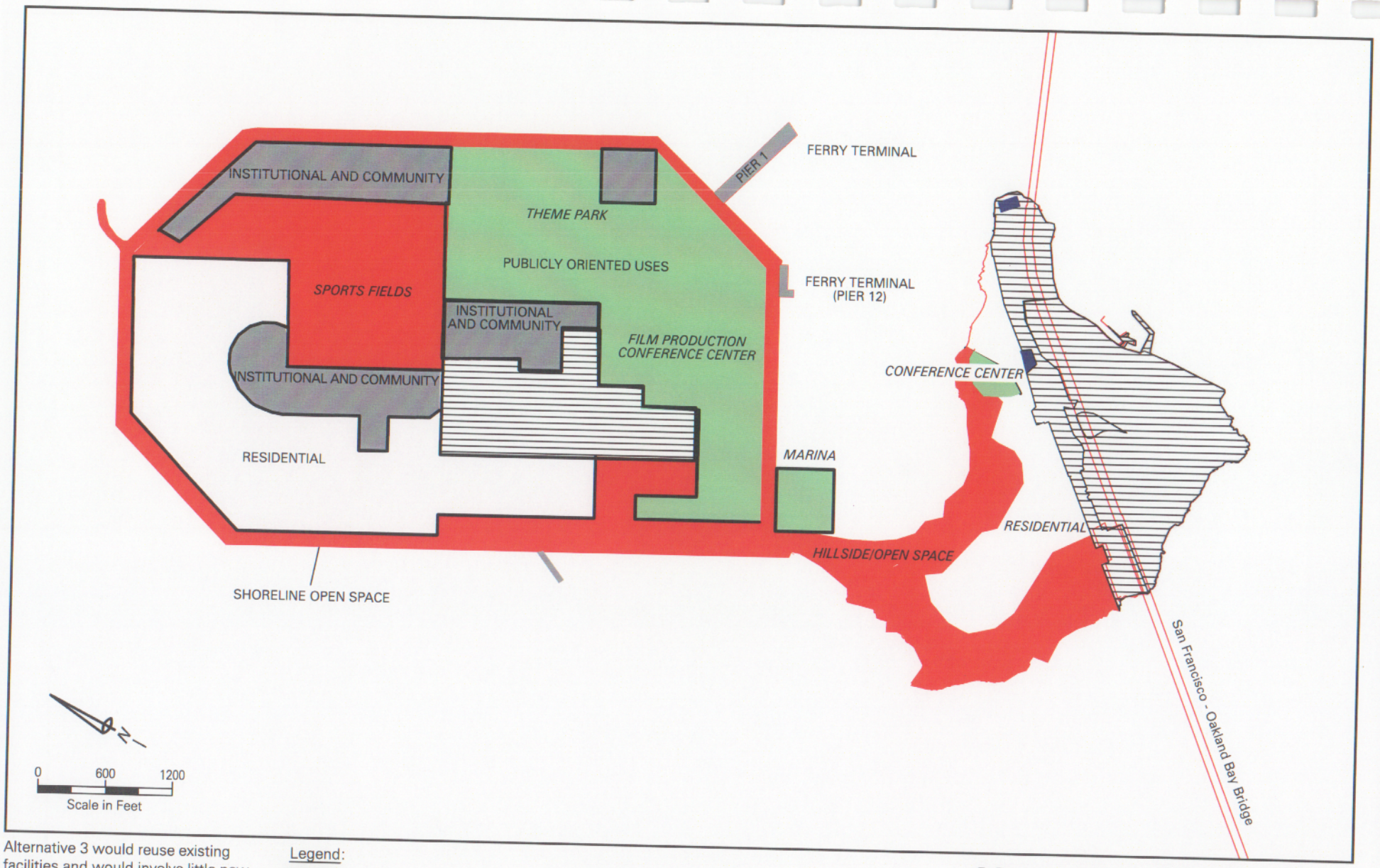
Under the No Action Alternative, Navy would retain ownership of NSTI. Except for existing building leases, all buildings would remain vacant, and all other facilities would remain but would be unused. Existing interim uses on NSTI include film production facilities, residential housing, a marina, a fire-fighting school, special events and meeting center, warehouses, and multipurpose office space. No new leases would be entered into under the No Action Alternative, and existing leases would continue until they expire or are terminated.

The property would be held in an inactive or caretaker status, as discussed in Chapter 1. Navy and San Francisco executed a cooperative agreement in April 1997 and amended it in September 1997. Under this agreement, San Francisco is responsible for providing those caretaker services. Site environmental cleanup would continue until completed. No construction would occur under this alternative, except as allowed by existing lease authorization. Approximately 50 persons are assigned to perform caretaker activities.

2.5 PREFERRED ALTERNATIVE

Navy has selected Alternative 1 as the preferred alternative because it best reflects the Draft Reuse Plan, and would result in no significant unavoidable adverse effects.

NEPA also requires that an environmentally preferable alternative be identified. The No Action Alternative would have no significant impacts, and for NEPA purposes it would be the environmentally preferable alternative. However, the No Action Alternative would not meet



Alternative 3 would reuse existing facilities and would involve little new development.

Legend:

- Publicly Oriented
- Open Space and Recreation
- Institutional and Community
- Areas Excluded from Proposed Navy Disposal
- Residential
- FHWA/Caltrans Aerial Easement

Alternative 3 Land Uses

Naval Station Treasure Island, California

Source: CCSF 1996e; Developed by CCSF 1997

Figure 2-5

the Navy's goals of property disposal and rapid economic recovery consistent with DBCRA 1990 and the Department of Defense Rule on Revitalizing Base Closure Communities–Base Closure Community Assistance (DoD Rule) (32 C.F.R. Part 175 [1998]). It also would not be consistent with former President Clinton's Five-Part Plan for Revitalizing Base Closure Communities, which emphasizes local economic redevelopment of closing military facilities and creation of new jobs as the means to revitalize these communities (32 C.F.R. Part 174 [1998]). The No Action Alternative would result in continued caretaker activities; therefore, socioeconomic gains in terms of new jobs and increased revenue in the region would not be realized.

2.6 PERMIT REQUIREMENTS AND RELATED COORDINATION

Approvals and permits would be required for disposal and subsequent reuse of NSTI. Table 2-3 lists the federal, state, and local permits, policies, and actions that may be required and lists the agencies that may use the information presented in the EIS to make decisions regarding issuance of permits or approvals.

2.7 COMPARISON OF ALTERNATIVES, INCLUDING IMPACTS AND MITIGATION

NEPA requires that the EIS include a presentation of the alternatives in comparative form, to define the issues and to provide a clear basis for choice among options by the decision-makers and the public. Table 2-4 lists potential significant impacts and corresponding mitigation measures for each alternative. Impacts that are not significant are described in Chapter 4 but are not included on this table.

Navy cannot control reuse after the property is conveyed from federal ownership; therefore, implementation of mitigation measures for reuse-related environmental impacts would be the responsibility of the LRA and not the responsibility of Navy.

Implementation of suggested mitigation measures would reduce all impacts to a level below significant except for impacts on cultural resources under Alternative 2. Implementation of Alternative 2 would require demolition of Building 2 and Building 3 on Treasure Island, buildings eligible for listing on the National Register of Historic Places (NRHP). This would result in the loss of significant historic resources. This adverse effect can be lessened or reduced by recording the affected resources to the standards of Historic American Buildings Survey (HABS)/Historic American Engineering Record (HAER), but recordation would not eliminate the adverse effect caused by the demolition of NRHP-eligible resources.

1

Table 2-3. Permits or Actions Potentially Required

Issuing Agency	*Permit or Action*	*Requirement*
Permits Required Prior to Disposal		
U.S. Environmental Protection Agency; California Department of Toxic Substances Control	CERCLA, 42 U.S.C. §§ 9601-9675	Requires deed that contains hazardous substance information and covenant warranting necessary remedial action has been taken or, in an early transfer, deferral with governor's approval.
San Francisco Bay Regional Water Quality Control Board (SFBRWQCB)	Porter-Cologne Water Quality Control Act (Cal. Water Code §§ 13000-13999.19)	Compliance with remedial action plans relative to groundwater.
State Historic Preservation Officer/Advisory Council on History Preservation	National Historic Preservation Act, Section 106 Compliance, 16 U.S.C. § 470f (West 1985 & Supp. 1998)	Requires a memorandum of agreement to mitigate impacts to NSTI historic buildings.
Permits Related to Reuse/Responsibility of Local Reuse Authority		
San Francisco Bay Conservation and Development Commission	McAteer-Petris Act, Cal. Gov't Code §§ 66600-66682 (West 1997 & Supp. 1999) and San Francisco Bay Plan	Permit for fill, dredging, and construction in shoreline band.
U.S. Environmental Protection Agency; U.S. Army Corps of Engineers	Clean Water Act, Section 404, 33 U.S.C. § 1344 River and Harbors Act, Sections 9 and 10, 33 U.S.C. §§ 401, 403	Permit required for discharging dredged material, placing fill and pilings in waters of the U.S. Permit required for construction in navigable waters of the U.S.
Bay Area Air Quality Management District	Permit to Construct and Permit to Operate	Depends on specific future construction/operation activities
U.S. Environmental Protection Agency; San Francisco Bay Regional Water Quality Control Board	National Pollutant Discharge Elimination System (NPDES) Permit under Clean Water Act Section 402, 33 U.S.C. § 1342	Required for discharge of pollutants from any point source in waters of the U.S. and for stormwater discharges associated with industrial activity and from large and medium municipal storm sewer systems. US EPA must endorse NPDES permits issued by the RWQCB.
US Coast Guard	Aid to Navigation Permit	Permit required for navigational hazards.
City and County of San Francisco	EIR certification Adopt mitigation monitoring program General plan amendments Consistency with Priority Policies Building and demolition permits Redevelopment Plan adoption	Various permits and approvals required to accommodate proposed reuse development.

2

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 1 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Land Use	*Impact: Land use policy.* The zone classifications that would be required for Alternative 1 would be inconsistent with the existing San Francisco General Plan designation and zoning classification.	*Impact: Land use policy.* Similar to that described for Alternative 1.	*Impact: Land use policy.* Similar to that described for Alternative 1.	No impacts are expected.
	Mitigation: To achieve consistency between the selected reuse alternative and city policies, it will be necessary to amend the San Francisco General Plan to include land use designations for surplus property on Treasure Island and Yerba Buena Island prior to approving future land use actions.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	
Visual Resources	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.
Socioeconomics	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.
Cultural Resources	No significant impacts are expected.	*Impact: Alteration or demolition of historic resources.* Alternative 2 involves the demolition of Building 2 and Building 3 on Treasure Island, both of which are eligible for listing on the NRHP.	No significant impacts are expected.	No impacts are expected.

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 2 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Cultural Resources (continued)		*Mitigation*: The irreversible loss of significant historic resources cannot be fully mitigated. HABS/HAER recordation would reduce but would not eliminate significant impacts caused by demolition.		
Transportation	*Impact: Increased volumes and queuing on SFOBB/I-80 Yerba Buena Island westbound on-ramp (west side).* Alternative 1 would result in peak-hour traffic volumes on the SFOBB/I-80 Yerba Buena Island westbound on-ramp on the west side of Yerba Buena Island that would exceed the current ramp capacity of 330 vph. The projected demand would result in a queue ranging from 7 vehicles (during the AM peak hour) to 239 vehicles (during the weekend midday peak hour). This queue would constrain vehicular circulation on the island.	No significant impacts are expected for increased volumes and queuing on SFOBB/I-80 Yerba Buena Island westbound on-ramp (west side).	No significant impacts are expected for increased volumes and queuing on SFOBB/I-80 Yerba Buena Island westbound on-ramp (west side).	No impacts are expected.
	Mitigation. SFOBB/I-80 Yerba Buena Island on-ramps are substandard by current Caltrans standards, primarily in acceleration/deceleration lengths, ramp radii, and sight distances.			

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 3 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	Upgrading the on-ramps would increase ramp capacity and level of operation and decrease queuing impacts. However, upgrades to the on-ramps may be constrained by the geology of the site (elevation change and bedrock) and structural limitations due to the viaduct. Implement measures, including signage and notices to residents, to encourage residents and visitors to use the second westbound on-ramp east of the Yerba Buena Island tunnel. Redirecting traffic during the weekend midday peak hour to the second on-ramp east of the Yerba Buena Island tunnel would reduce the queue at the first westbound on-ramp.			

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 4 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	Implement a Travel Demand Management (TDM) program to further reduce traffic generation during peak hours, especially during the weekend. Implement additional or enhanced TDM measures, such as discounted ferry passes, flex-time, public relations campaigns, and giving employees working on Treasure Island or Yerba Buena Island preferential access to housing on NSTI, to encourage ferry use or to encourage vehicle-trips during the nonpeak period to reduce queues on both westbound on-ramps to tolerable levels. Monitor NSTI ramp traffic volumes to ensure that the transportation goals and objectives established by the Draft Reuse Plan are successfully implemented. Monitor NSTI bus transit demand on an annual basis (or at each phase of development) and ensure that planned services are implemented to meet or exceed demand. Implement a similar monitoring program for ferry demand.			

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 5 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	Restripe the portion of Treasure Island Road between the Main Gate and the westbound on-ramp on the west side of the Yerba Buena Island tunnel from two lanes to accommodate three traffic lanes.			
	Impact: Increased volumes and queuing on SFOBB/I-80 Yerba Buena Island eastbound off-ramp (west side). Alternative 1 would result in a substantial increase in traffic volumes on the eastbound off-ramp on the west side of Yerba Buena Island that would exceed the practical capacity of the off-ramp (500 vph), resulting in a maximum queue of 36 vehicles, or about 700 feet (219 m) on the SFOBB.	No significant impacts are expected for increased volumes and queuing on SFOBB/I-80 Yerba Buena Island eastbound off-ramp (west side).	No significant impacts are expected for increased volumes and queuing on SFOBB/I-80 Yerba Buena Island eastbound off-ramp (west side).	No impacts are expected.
	Mitigation. Use traffic control measures, such as signage, to encourage eastbound motorists to use the second Yerba Buena off-ramp (the off-ramp on the east side of Yerba Buena Island). Implement TDM and monitoring measures to reduce traffic volumes on this off-ramp.			

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 6 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	*Impact: Increased volumes on SFOBB/I-80 Yerba Buena Island eastbound on-ramp (east side).* Alternative 1 would result in substantial increases in traffic volumes during the weekend midday peak hour on the eastbound on-ramp on the east side of Yerba Buena Island. While the increased volumes would be accommodated by the upgrade of this ramp as part of the SFOBB East Span project, it may create a secondary impact on potential traffic delays on SFOBB.	No significant impacts are expected for increased volumes on SFOBB/I-80 Yerba Buena Island eastbound on-ramp (east side).	No significant impacts are expected for increased volumes on SFOBB/I-80 Yerba Buena Island eastbound on-ramp (east side).	No impacts are expected.
	Mitigation: Caltrans should consider the installation of a ramp metering devise in the future if the added traffic onto this on-ramp would cause significant traffic delay on SFOBB mainline.			
	Impact: Increased peak spreading on SFOBB/I-80. Under Alternative 1, increased traffic onto and off of the SFOBB during the AM peak period (6:30 to 9:30) and PM peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS F during the last hour of the AM peak period (8:30 to 9:30) and to deteriorate from LOS B to LOS E	*Impact: Increased peak spreading on SFOBB/I-80.* Under Alternative 2, increased traffic onto and off of the SFOBB during the AM peak period (6:30 to 9:30) and PM peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS E or LOS F	*Impact: Increased peak spreading on SFOBB/I-80.* Under Alternative 3, increased traffic onto and off of the SFOBB during the AM peak period (6:30 to 9:30) and PM peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS F during the last hour of the AM peak	No impacts are expected.

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 7 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	or LOS F during the first hour of the PM peak period (3:30 to 4:30).	during the last hour of the AM peak period (8:30 to 9:30) and to deteriorate from LOS B to LOS E or LOS F during the first hour of the PM peak period (3:30 to 4:30).	period (8:30 to 9:30) and to deteriorate from LOS B to LOS E or LOS F during the first hour of the PM peak period (3:30 to 4:30).	
	Mitigation. Monitor traffic volumes at each phase of development and if it is determined that traffic from NSTI is constraining the capacity of the SFOBB, either more aggressive TDM and transit improvements must be implemented or additional developments should be delayed until such improvements are implemented.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	
	Impact: Transit operations – bus service to East Bay. Lack of direct bus service between NSTI and the East Bay is a significant and mitigable impact.	*Impact: Transit operations – bus service to East Bay.* The impact would be similar to that described under Alternative 1.	*Impact: Transit operations – bus service to East Bay.* The impact would be less than that described under Alternative 1 but would remain significant but mitigable.	No impacts are expected.

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 8 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Transportation (continued)	*Mitigation*: Establishing direct transit service between NSTI and the East Bay would mitigate this impact to a not significant level. Bus service would need to be at 10-minute headways (the interval between the trips of 2 successive vehicles) throughout the day during the weekday and at 15-munite headways throughout the day during the weekend. Monitor NSTI bus transit demand on an annual basis (or at each phase of development) and ensure that planned services are implemented to meet or exceed demand. Implement TDM measures to encourage transit rather than auto use.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1. However, at build-out, bus service would need to be at 15-minute headways throughout the day during both weekdays and weekends.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1. However, at build-out, bus service would need to be at 20-minute headways throughout the day during weekdays and 15-minute headways throughout the day during weekends.	
Air Quality	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No impacts are expected.
Noise	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No impacts are expected.

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 9 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Biological Resources	*Impact: Mudflat Habitat Disturbance.* Significant impacts to mudflat habitat, including eelgrass beds, may occur as a result of increased pedestrian and boating activity around Clipper Cove. Expanding the marina or constructing a yacht harbor, new docks, or other structures that would cover the surface of the water would impact Waters of the United States but would require a permit from the BCDC and the COE.	*Impact: Disturbance to sensitive mudflat habitat.* The impacts on mudflat habitat associated with pedestrians and boating activity would be similar, but reduced, from that described for Alternative 1. Pedestrian impacts would be approximately half of Alternative 1 while boating traffic impacts would be approximately 20 percent higher than Alternative 1.	*Impact: Mudflat Habitat Disturbance.* The impacts on mudflat habitat associated with pedestrians and boating activity would be reduced from that described for Alternative 1 but would remain significant but mitigable.	No impacts are expected.
	Mitigation: Minimize disturbance to sensitive habitats during construction. Prepare and implement a plan to minimize disturbance of sensitive habitats due to recreational activity. Permittee could be required to post signs along the shore adjacent to the mudflats and at the marina to inform pedestrians and recreational boaters that the mudflats are a protected sensitive area and that trespassing is not permitted. Buoys could be placed in the bay to identify the restricted mudflat area. A 5-mph (8 kph) zone could be established in Clipper Cove to minimize shoreline and mudflat	*Mitigation*. Mitigation measures would be the same as described for Alternative 1.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1.	

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 10 of 16)

Resource Area	Alternative 1	Alternative 2	Alternative 3	No Action Alternative
Biological Resources (continued)	erosion. Any impacts related to construction or fill would be addressed during the COE Section 404 permitting process.			
	Impact: Pedestrian and Boating Impacts on Migratory Birds. Increased pedestrian and boating activity around Clipper Cove could have a significant impact on shorebirds by affecting mudflats and eelgrass beds where shorebirds forage.	*Impact: Pedestrian and Boating Impacts on Wading Shorebirds.* Increased pedestrian and boating activity around Clipper Cove could have a significant impact on shorebirds by affecting mudflats and eelgrass beds where shorebirds forage. Pedestrian impacts would be approximately half of Alternative 1 while boating traffic impacts would be approximately 20 percent higher than Alternative 1.	*Impact: Pedestrian and Boating Impacts on Wading Shorebirds.* Increased pedestrian and boating activity around Clipper Cove could have a significant impact on shorebirds by affecting mudflats and eelgrass beds where shorebirds forage. These impacts are likely to be reduced under Alternative 3 as there would be less of an increase in boating traffic compared with Alternative 1.	No impacts are expected.

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 11 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Biological Resources (continued)	*Mitigation.* In conjunction with permitting by COE and BCDC, permittee could be required to post signs along the shore adjacent to the mudflats and at the marina, informing pedestrians and boaters that the mudflats are a protected and sensitive area. Placing buoys in the bay, identifying the mudflat area as restricted, and establishing a five-mph (8 kph) zone in Clipper Cove could also reduce impacts.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	
	Impact: Pedestrian and Boating Impacts on EFH. Increased boat and pedestrian activity around Clipper Cove could have an indirect significant impact on EFH by degrading eelgrass vegetated areas and shallow water and mudflat areas that provide important fish spawning, rearing, and foraging habitat.	*Impact: Pedestrian and Boating Impacts on EFH.* Increased pedestrian and boating activity around Clipper Cove and along the perimeter of the islands could have a significant impact on EFH, as described under Alternative 1.	*Impact: Pedestrian and Boating Impacts on EFH.* Increased pedestrian and boating activity around Clipper Cove and along the perimeter of the islands could have a significant impact on EFH, as described under Alternative 1.	No impacts are expected.
	Mitigation. Proposed mitigation measures are the same as those discussed under impacts to mudflat habitat above.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 12 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Geology and Soils	*Impact: Exposure of individuals and property to liquefaction.* Seismically induced liquefaction could result in ground disturbances associated with lateral spreading and differential settlement.	*Impact: Exposure of individuals and property to liquefaction.* Seismically induced liquefaction could result in ground disturbances associated with lateral spreading and differential settlement.	*Impact: Exposure of individuals and property to liquefaction.* Seismically induced liquefaction could result in ground disturbances associated with lateral spreading and differential settlement.	No impacts are expected.
	Mitigation. A zone of "improved ground" would be created around the perimeter of the island to reduce lateral spreading. Interior island areas shall be similarly improved to reduce large differential settlement. All sensitive structures (e.g., buildings greater than three stories, buildings intended for public occupancy, structures supporting essential services, and buildings housing schools, medical, police, and fire facilities) shall be supported on pile systems or other specially designed foundations. Detailed geotechnical studies shall be completed in accordance with San Francisco requirements for individual development sites.	*Mitigation:* Mitigation measures would be the same as described for Alternative 1.	*Mitigation:* Mitigation measures would be the same as described for Alternative 1.	

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 13 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Water Resources	*Impact: Exposure of individuals and property to ponding from high tides.* The installation of residential development in low-lying areas on Treasure Island would result in increased exposure of occupants, visitors, and property to ponding hazards due to seepage through the dike during some high tide events.	No significant impacts are expected from exposure of individuals and property to ponding from high tides.	*Impact: Exposure of individuals and property to ponding from high tides.* The impact would be similar to that described for Alternative 1.	No impacts are expected.
	Mitigation: Filling low-lying portions of the residential area to at least 9 feet (3 m) National Geodetic Vertical Datum (NGVD) prior to development would mitigate this impact. In addition, other low-lying areas within 500 feet (152 m) of the Treasure Island perimeter should be similarly filled before development is allowed.		*Mitigation*: Mitigation measures would be the same as described for Alternative 1.	

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 14 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Water Resources (continued)	*Impact: Exposure of individuals and property to flooding*. Developing and reusing Treasure Island under Alternative 1 could expose occupants, visitors, and property to flooding hazards caused by dike overtopping during storms.	*Impact: Exposure of individuals and property to flooding*. This alternative would subject residents and daily visitors on the northern half of Treasure Island, where a golf course is proposed, to existing flood hazards. Flood hazards on the southern portion of the site would be similar to those described for Alternative 1.	*Impact: Exposure of individuals and property to flooding*. Alternative 3 could subject occupants, visitors, and property to substantial flooding hazards throughout Treasure Island.	No impacts are expected.
	Mitigation: Set back development inboard of the perimeter dike to allow room for periodic dike raising without substantially increasing Bay fill. Raise the dike as necessary to account for site settlement, changes in maximum tidal heights, and rises in sea levels. In addition, inspect the dike after each major storm to identify repair needs, and repair the dike promptly.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1.	*Mitigation*: Mitigation measures would be the same as described for Alternative 1.	
Utilities	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No impacts are expected.
Public Services	No significant impacts are expected.	No significant impacts are expected.	No significant impacts are expected.	No impacts are expected.

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 15 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Hazardous Materials and Waste	*Impact: Installation Restoration Program (IRP).* Construction activities at NSTI associated with future development of the housing unit area, including demolition of existing structures, may interfere with remedial actions under CERCLA.	*Impact: Installation Restoration Program (IRP).* Development of a golf course in the northern part of the island would involve demolition of existing structures and the grading and reconfiguring of the soil, which may interfere with remedial actions under CERCLA.	*Impact: Installation Restoration Program (IRP).* If subsequent redevelopment of the housing area involving demolition of existing structures and the grading and reconfiguring of the soil were to occur, it may interfere with remedial actions conducted under CERCLA.	No impacts are expected.
	Mitigation. The Navy is in the process of implementing various remedial actions at NSTI pursuant to and in accordance with the requirements of CERCLA and the NCP that will remove, manage, or isolate any potentially hazardous substances present on the property prior to conveyance. These remedial actions will ensure that human health and the environment will be protected based on the land uses specified in the Draft Reuse Plan. If the CERCLA remedy for a particular site includes land use controls, the acquiring entity or entities will be required to comply with the land use controls during construction or operations to ensure continued protection of human health and the environment.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	*Mitigation.* Mitigation measures would be the same as described for Alternative 1.	

Table 2-4. Summary of Potential Significant Environmental Consequences and Mitigation Measures

(Page 16 of 16)

Resource Area	*Alternative 1*	*Alternative 2*	*Alternative 3*	*No Action Alternative*
Hazardous Materials and Waste (continued)	Subsequent redevelopment of the housing area which would involve demolition of existing structures and the grading and reconfiguring of the soil would likely be subject to land use controls on the property, including compliance with a City-administered soil management plan that would require soil and groundwater disturbance be permitted subject to proper characterization and management.			
	In addition, deeds conveying the affected property will contain a notice that areas of the property not subject to remediation efforts (such as areas beneath existing foundations) may require additional characterization and possible response actions subject to appropriate regulatory oversight. Adherence to land use controls and regulatory requirements would mitigate potentially significant impacts to an acceptable level.			

CHAPTER 3.0

Affected Environment

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3.0 AFFECTED ENVIRONMENT

Chapter 3 sets forth the affected environment of the proposed action. The affected environment describes the present physical conditions within the area of the proposed action. The area, or region of influence, is defined for each environmental issue based upon the aerial extent of physical resources that may be affected directly or indirectly by the proposed action and appropriate guidelines of regulatory agencies or common professional practice. Table 3.1-1 summarizes the environmental issues and associated region of influence described in the affected environment sections of this EIS.

Table 3.1-1. Environmental Issues and Region of Influence

Environmental Issue	*Region of Influence*
Land Use	Reuse plan area
Visual Resources	Reuse plan area and viewshed
Socioeconomics	San Francisco and Alameda Counties
Cultural Resources	Reuse plan area
Transportation	Reuse plan area, SFOBB/I-80 freeway system, and areas adjacent to ferry terminals in San Francisco and Oakland
Air Quality	San Francisco Bay Area air basin
Noise	Reuse plan area
Biological Resources	Reuse plan area and surrounding aquatic habitat within 2-mile radius
Geology and Soils	Geology: San Francisco Bay Area Soils: Reuse plan area
Water Resources	Reuse plan area and receiving waters of Central San Francisco Bay
Utilities	San Francisco and regional utility service areas
Public Services	San Francisco
Hazardous Materials and Waste	Reuse plan area

This section of the EIS describes the baseline conditions for each environmental resource against which the potential impacts of the proposed action will be compared. Generally, the baseline used for the analysis of environmental impacts under NEPA reflects the conditions present at or about the time the EIS is initiated. However, in the case of closures of military installations, EIS documents often are initiated in the trough between full-scale military operations at the former military installation and commencement of the civilian redevelopment project being studied. The trough is temporary, constantly changing, and a wholly artificial situation that cannot provide a stable and meaningful basis for measuring the environmental impact of subsequent redevelopment. It is more appropriate to use the pre-closure conditions during full operations as a baseline to realistically reflect the environmental impact of reuse. The State of California also specifically has recognized that the last operating year of military bases is the most appropriate baseline for EIRs prepared pursuant to the CEQA (Cal. Pub. Res. Code § 21083.1.8, Cal. Code Regs. tit. 14, § 15229).

The environmental baseline year for the EIS is 1993, which reflects conditions before NSTI was designated for closure. This follows Navy BRAC policy, which recommends using the last year the installation was in full operational use as the baseline year instead of a baseline year portrayed as the property under caretaker status. Since data from 1993 was not available for some resource areas, the baseline for those resources relies on data from the closest year that is representative of 1993 conditions. The analysis of hazardous materials and waste is unique in that, because hazardous materials remediation is ongoing, it is based on current conditions at NSTI. The physical conditions present in 1993 are the same as the physical conditions present in later years; the entire infrastructure for NSTI is still physically present on the property and has not been significantly altered since 1993.

3.1 LAND USE

This section describes regulatory considerations (section 3.1.1) and land uses in the reuse plan area (section 3.1.2) and in the surrounding community (section 3.1.3). Land uses in the reuse plan area reflect baseline (1993) conditions.

3.1.1 Regulatory Considerations

The following subsections discuss the public plans, policies, and regulatory agencies that affect disposal and reuse of NSTI. Planning and regulatory control over NSTI will be exercised by many government agencies, including the City and County of San Francisco, and regional, state, and federal agencies. Agencies that will have jurisdiction over NSTI and a description of the responsibilities of each agency with respect to approval and implementation of the alternatives are discussed below.

City and County of San Francisco

NSTI is within the jurisdictional boundaries of the City and County of San Francisco. As discussed below, upon transfer NSTI will be controlled primarily by San Francisco policies, plans, and regulations, while portions of the islands also will be subject to additional regulations and policies of other agencies. The San Francisco Planning Commission and/or San Francisco Planning Department and TIDA will determine future reuse conformance with city policies and plans. The San Francisco Board of Supervisors must adopt General Plan amendments and approve zoning ordinances incorporating the selected development plan for the islands.

San Francisco General Plan

The San Francisco General Plan is relevant to the reuse of NSTI, which is located within San Francisco. The San Francisco General Plan is the comprehensive, long-term plan that contains the land use policies for San Francisco. Elements of the General Plan that provide broad policy guidance to reuse planning include Recreation and Open Space, Urban Design, Transportation, Environmental Protection, Community Safety, Community Facilities, Commerce and Industry, and the Residence Element.

Following conveyance of NSTI to San Francisco or other non-federal entities, future development of most portions of the islands would be under city jurisdiction. San Francisco's

existing General Plan land use designation for NSTI (*Military*) does not encompass all the proposed reuse land uses and does not define development opportunities and constraints for the land use designations.

To achieve consistency between the selected reuse alternative and San Francisco policies, it will be necessary to amend the San Francisco General Plan to include land use designations for surplus property on Treasure Island and Yerba Buena Island prior to approving future land use actions. The amendments would need to be based on the goals and policies of the selected reuse alternative while maintaining consistency with the goals, policies, and land use designations in the General Plan.

The San Francisco Planning Department is preparing an Area Plan and amendments to the General Plan to ensure consistency with the final reuse plan. Following certification of San Francisco's EIR for reuse, the city would amend its General Plan and would adopt a Redevelopment Plan to provide land use designations consistent with the reuse plan for NSTI lands conveyed out of federal control. These plans would incorporate policies from the Draft Reuse Plan and would guide future development on NSTI.

Planning Code

The San Francisco Planning Code (ordinances enacted through Ordinance 241-01, Approved December 7, 2001) sets forth specific objective standards that define the range of allowable physical characteristics of proposed development, such as the floor area ratio, the height and bulk of buildings, and the land uses permitted within zoning districts. The San Francisco agency responsible for implementing the Planning Code is the Planning Department. NSTI is currently zoned "P" (Public) and would not be rezoned until the reuse plan is adopted, at which time the San Francisco Planning Code would be amended. Upon receiving a zoning designation, the area would be subject to the land use and height and bulk regulations established by the zoning designation. These controls would be subject to the Redevelopment Plan and its design for development standards.

The Sustainability Plan for the City of San Francisco

The Sustainability Plan for the City of San Francisco (San Francisco 1997) was endorsed by the Board of Supervisors on July 21, 1997 (Resolution No. 692-97), as a non-binding guideline for policy and practice in San Francisco. The goal of the Sustainability Plan is to enable the city and its people to meet their present needs without sacrificing the ability of future generations to meet their own needs.

Treasure Island Development Authority

TIDA is a nonprofit public benefit corporation established by the City and County of San Francisco and the State of California. It has redevelopment authority to implement the final reuse plan, related General Plan amendments, and any other adopted plans, such as an Area Plan or Redevelopment Plan, via appropriate implementing ordinances subject to final approvals by the San Francisco Board of Supervisors.

San Francisco Bay Conservation and Development Commission

The federal Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. §§ 1451-1465), as amended, grants coastal states with the authority to evaluate projects that could affect the coastline. The Bay Conservation and Development Commission (BCDC), created by the McAteer-Petris Act (Cal. Gov't. Code § 66600 et seq.), functions as the state coastal management agency for the San Francisco Bay, having jurisdiction over all areas subject to tidal action up to the mean high tide line and including all sloughs, tidelands, submerged lands, and marshlands lying between the mean high tide and 5 feet (1.5 m) above mean sea level for the nine Bay Area counties with Bay frontage (BCDC 1969). Its jurisdiction in shoreline areas includes a band measured 100 feet (30.5 m) landward of and parallel to the shoreline of the Bay.

In accordance with its role in implementing CZMA, BCDC reviews federal projects affecting the coastal zone to ensure that they are, to the maximum extent practicable, consistent with the provisions of the approved coastal plans. The Bay Area Seaport Plan and the San Francisco Bay Plan, discussed below, are the approved local coastal plans in the portion of San Francisco Bay around NSTI and, in conjunction with other BCDC laws, Special Area Plans, and other guidance, form BCDC's management program for complying with CZMA. Federal property is considered to be outside the state coastal zone, as defined under the CZMA. Under the provisions of 15 C.F.R Part 930, Federal Consistency with Approved Coastal Management Programs, the Navy has determined that neither a consistency determination, nor a negative determination is required for the proposed disposal action. The proposed disposal of surplus federal property at NSTI for subsequent reuse is not an action that has been identified by a State agency as an action likely to directly affect the coastal zone, is not an action similar to other actions for which consistency determinations have been prepared in the past, and is not an action for which the Navy developed initial findings on any effects on the coastal zone. Consequently, Navy has determined that no state notification (or negative determination) is required. (Consistency of reuse with the approved coastal plans is discussed further in the sections on the Bay Plan and the Seaport Plan.)

BCDC activities also include the following:

- Regulating all filling, dredging, and changes in use in San Francisco Bay;
- Regulating new development within the first 100 feet (30.5 m) inland from the shoreline of the Bay to ensure that maximum feasible public access to the Bay is provided;
- Ensuring that the limited amount of available shoreline property suitable for regional high priority water-oriented uses is reserved for these purposes. Priority use areas include ports, water-related industry, water-oriented recreation, airports, and wildlife areas;
- Pursuing an active planning program to study all aspects of the Bay; and
- Participating in the region-wide state and federal program to prepare the Long-term Management Strategy (LTMS), as discussed in section 3.10 Water Resources, for dredging and disposing of material dredged from the Bay.

San Francisco Bay Plan

The San Francisco Bay Plan, adopted by BCDC in January 1969 and amended through 2002, includes policies that protect the Bay's economic and natural resources, including the designation of shoreline regional priority use areas. BCDC priority designated areas include ports, airports, waterfront parks and beaches, wildlife areas, tidal areas, marinas, fishing piers, recreational ferries, boat-launching ramps, commercial recreation, and vista points. Areas without priority designation in the Bay Plan are subject to the plan's policies detailed under "Other Uses of the Bay and Shoreline"; these policies call for areas without priority designation to be used for any purpose that uses the bay as an asset and that in no way affects the bay adversely.

Although Treasure Island and Yerba Buena Island are federal property and outside the defined coastal zone addressed in the Bay Plan, the Bay Plan does state that, if and when Navy no longer needs Treasure Island, it should be redeveloped for public use and continuous access to San Francisco Bay should be provided. The Bay Plan also states that if and when Navy or US Coast Guard no longer needs Yerba Buena Island, it should be redeveloped for recreational use (BCDC 1996, revised 1997). After property is conveyed out of federal ownership, reuse activities undertaken by nonfederal entities would be subject to BCDC permitting authority and review as to the final determination of proposed reuse consistency with the Bay Plan. Where proposed land uses are not consistent, the Bay Plan could be amended to be consistent with proposed land uses, or these uses could not be developed. BCDC has indicated preliminary support of reuse planning efforts at NSTI because the reuse plan "denotes a perimeter public promenade around Treasure Island, including a small park at the proposed ferry dock, and considerable open space on Yerba Buena Island at the connection to the Treasure Island causeway" (BCDC 1996, revised 1997).

BCDC would also require a permit for any fill, materials extraction, or substantial changes in use of any water, land, or structure in the bay. Permits for priority use and water-related industry areas within the 100-foot (30.5-m) shoreline would be granted or denied based on the appropriate Bay Plan policies for ports, water-related industry, water-oriented recreation, airports, and wildlife areas.

San Francisco Bay Area Seaport Plan

The San Francisco Bay Area Seaport Plan was jointly developed by BCDC and the Metropolitan Transportation Commission (MTC) in response to a state law that requires the addition of a maritime element to MTC's regional transportation plan and BCDC's Bay Plan. The Seaport Plan was adopted in 1982, was revised in 1988, and was comprehensively updated in April 1996. The Seaport Plan designates sites for port priority uses, such as marine terminals and water-related industry. The port priority use designation is intended to reserve adequate waterfront areas for future port and water-related development and to prevent unnecessary filling of the Bay. Other shoreline uses, such as public access and public and commercial recreational development may be permitted as long as they do not substantially impair the efficient utilization of the port areas. Treasure Island and Yerba Buena Island, as federal property, are not addressed in the Seaport Plan. Furthermore, these islands do not offer adequate terminal backland or rail and road access and therefore are geographically unsuitable for port development.

State Lands Commission and Public Trust

California received title to tide and submerged lands and the beds of navigable waters within its boundaries upon its admission to the Union in 1850. Under the state constitution, such land is held in trust for the people of California for particular uses of public benefit; these lands commonly are referred to as tidelands trust or public trust lands. In general, if the public trust applies, land subject to it must be used for commerce, navigation, fisheries, water-oriented recreation, preserved in its natural condition for wildlife habitat and study, or other recognized public trust uses. The purpose of the trust is to assure that trust land remains committed to water-oriented uses benefiting the greatest number of people. The public trust generally applies to land that is or was submerged or that is subject to tidal action, including land created by filling tidelands or submerged lands.

Portions of NSTI were constructed on submerged land and tideland located within the City and County of San Francisco. In 1933, the State of California granted to the City and County of San Francisco a parcel of land in San Francisco Bay for construction of a public airport, wharfage and dock facilities, and for use as an airfield. The parcel of land to be filled by dredged material was a rectangular area measuring 4,500 feet by 8,000 feet (1,370 m by 2,438 m) located adjacent to Yerba Buena Island. The City was authorized to reclaim fill and raise the submerged land. The City of San Francisco also received the right to construct a toll free bridge or causeway between the lands to be filled and Yerba Buena Island. The grant contained a restriction that prevented the City of San Francisco from selling the property to private parties. In 1935, the State granted to the City and County of San Francisco the right to use Treasure Island for exposition and fair purposes. The City and County of San Francisco then created Treasure Island by dredging adjacent submerged land.

Subsequent to the Naval Appropriations Act of 1942 (Pub. L. 441) in which Congress appropriated funds for the acquisition of Treasure Island, the government pursued the condemnation process for the property now known as NSTI in the US District Court of San Francisco. The declaration of taking was filed on April 17, 1942. The parties reached a joint settlement of the condemnation case on April 3, 1944. As compensation for the taking, the Government completed construction of $10 million of permanent improvements at San Francisco Airport. Chapter 3 of the California Statutes of 1942 authorized the transfer of Treasure Island to the government including all tide and submerged lands and further stated that the transfer "shall be free and clear of all conditions and reservations respecting the title to or use of said lands..." The State made no provisions for the reservation of a tideland trust or public trust easement over tidelands or submerged land nor was there any reversion rights contained in the statute. Therefore, the Navy's position is that the United States acquired full fee simple absolute title to all the property, including the tidelands and submerged lands, and that the property would not be subject to the public trust upon disposal by the Navy.

The State of California believes, however, that all former and existing tide and submerged lands on Treasure Island would be subject to the public trust in the event of a transfer of the property from the Navy. In 1997, the Treasure Island Conversion Act (TICA) (1997 Cal. Stat. 898, AB 699) authorized the City and County of San Francisco to establish TIDA as the redevelopment agency responsible for redeveloping NSTI. The Act also granted TIDA power to administer and control property at NSTI, which was identified by the State of California as land that will be subject to the public trust upon its release from federal ownership. Thus, the City and County

of San Francisco's reuse planning process assumes the public trust applies, despite the Navy's contention that it does not.

3.1.2 Reuse Plan Area

Former Navy land use at NSTI consists of residential facilities, recreation and open space areas, institutional and community facilities, commissary and office facilities, industrial and support facilities, and parking and roads. Figure 3-1 illustrates these land uses at NSTI.

Treasure Island

Table 3.1-2 identifies former Navy land uses at Treasure Island. In 1993, residential, recreation and open space, and institutional and community uses made up the largest percentage of land uses at NSTI; parking and roadways accounted for almost a quarter of the island. Retail and office and industrial and support land comprised the remaining uses.

Table 3.1-2. Treasure Island 1993 Navy Land Uses

Land Use	*Area (approximate acres)*
Residential	110
Recreation and Open Space	90
Institutional and Community	30
Retail and Office	20
Industrial and Support	20
Parking and Roads	95
Total	**365**

Source: DON 1988b.
Note: Does not include approximately 36-acre (14-ha) parcel transferred to the Job Corps.

Residential

Housing is a prominent land use at Treasure Island, occupying approximately 110 acres (44.5 ha). The housing area includes family housing and bachelor enlisted quarters (barracks). Family housing occupies the northwest corner of the island, with the barracks located in the center-west part of the island. Approximately 900 family units in 8-unit, 6-unit, and 4-unit buildings are arranged around curving streets and cul-de-sacs with large driveways and lawns. Uses and other features surrounding the family housing area include the Bay to the north and west and open space, institutional, and industrial uses to the south and east. The barracks are star-shaped structures constructed in the late 1960s.

Recreation and Open Space

Recreation and open space uses at Treasure Island include water-related recreation and boating facilities, indoor and outdoor recreation facilities, and a variety of walking and bike trails and picnic areas.

Outdoor marine facilities include an approximate 100-slip recreation marina in Clipper Cove between Treasure Island and Yerba Buena Island. There also are two piers (Piers 11 and 12) on the southern edge of Treasure Island used for small military craft and a fishing pier (Pier 23) on the west side of Treasure Island. Pier 1, on the southeastern side of Treasure Island, was used to moor large military ships.

Indoor recreation facilities include the Shipshape Fitness Center, a gymnasium, a skating rink, a 1,000-seat movie theater, and a 12-lane bowling alley, all on the eastern side of Treasure Island. A youth center and pizzeria are also on the east side of Treasure Island.

Outdoor recreation facilities include baseball fields, a pitching green, a miniature golf course, two tennis courts, basketball courts, and two playgrounds. The outdoor recreation facilities are concentrated in the interior of Treasure Island. Open space areas include four parks and picnic areas and walking and bike trails. The dike around Treasure Island also is used as a jogging trail (San Francisco 1994a; San Francisco 1995a).

Institutional and Community

Institutional uses at Treasure Island include public service, educational, public works facilities, and a chapel. Navy headquarters occupied Building 1, a historic structure built originally for the Exposition. This building presently is occupied by city offices, including a San Francisco Police Department substation, and Navy caretaker site office.

Public service and government facilities include a fire station, a police station, the former brig, the new brig built in 1991, and a post office. Educational facilities include an auto and hobby shop, an elementary school, and a child development center. These facilities are all in the interior of the island in the northwestern quadrant. Public services include the emergency power generator, wastewater treatment plant, steam plant substations, reservoirs, and other utilities.

Retail and Office

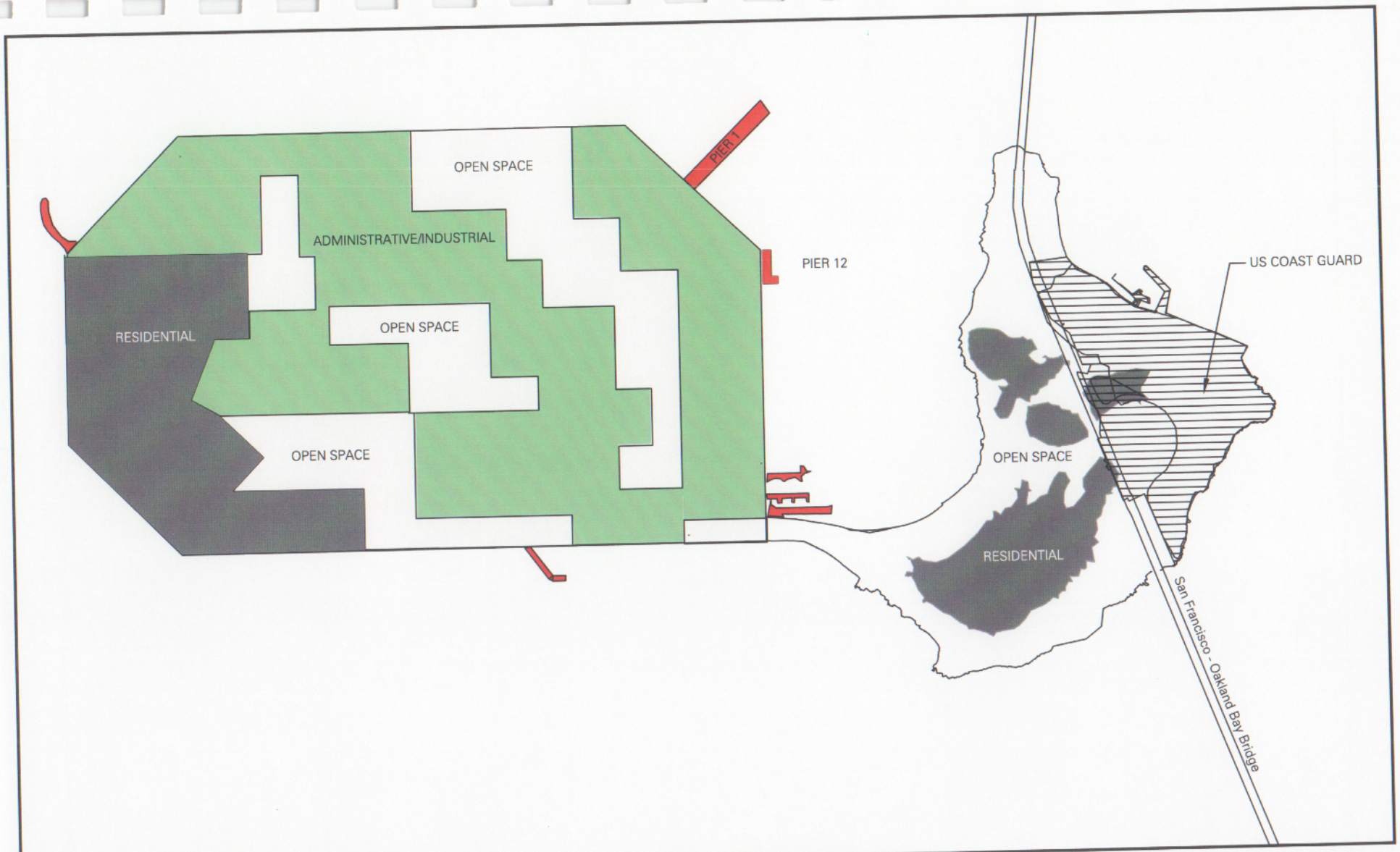
Retail and administrative uses comprise a relatively small portion of land use on Treasure Island and include administrative, commissary, conference facilities, food service facilities, and a medical and dental facility.

Industrial and Support

Industrial uses are distributed in buildings in the northeastern and southeastern quadrants of Treasure Island. These include a former tear gas training building, a government printing office, fuel storage facilities, a storm lift station, two hangars, warehouses, a maintenance building, and training facilities.

Parking and Roads

The Treasure Island road system is laid out in a grid with parking areas located throughout the island (Figure 3-1). The only vehicle access to the island is from the on- and off-ramps from the SFOBB. The main access road to Treasure Island is Avenue of Palms. There are a number of on- and off-street parking areas.



Land uses in 1993 primarily included recreation/open space, residential, and industrial. Land uses presented are generalized such that, within the areas indicated, there may be small areas of a different use.

Legend:

- Administrative/Industrial
- Open Space and Recreation
- Residential
- US Coast Guard

1993 Land Use

Naval Station Treasure Island, California

Figure 3-1

Source: Navy 1988b

Yerba Buena Island

Former Navy land uses at Yerba Buena Island are identified in Table 3.1-3. Yerba Buena Island primarily is comprised of open space, utilities facilities and military housing, as well as about ten buildings used by Navy in 1993 for storage, communications, fire safety, and administration. The SFOBB crosses the island. Non-Navy land uses on Yerba Buena Island include the US Coast Guard Station.

Table 3.1-3. Yerba Buena Island 1993 Navy Land Uses

Land Use	*Area (approximate dry acres)*
Open Space and Utilities	75
Residential	30
SFOBB	**10**
Total	**115**

Source: DON 1988b.
Note: Total acreage includes approximately 11-acres (4-ha) that was transferred to US Coast Guard in 1998 and approximately 20-acres (8-ha), inclusive of previous 10 acres (4 ha), that was transferred to FHWA in 2000.

Open Space and Utilities

The steep slopes (up to 75 percent) at Yerba Buena Island preclude development along the northeastern and southwestern edges of the island. These areas are predominantly open space but also included ten acres to support SFOBB utilities.

Residential

There are approximately 100 existing housing units at Yerba Buena Island, ten of which are large single-family residences with the remainder being 2-, 4-, and 8-unit buildings, generally single-story, although there are some 2-story buildings. Housing is concentrated in the interior of the island, north of the SFOBB and southeast of Treasure Island Road. Historic officers quarters (Quarters 1-7), including the Nimitz House (Quarters 1), are located on the northern part of the island.

3.1.3 Surrounding Land Uses

San Francisco Bay waters surround NSTI. Alameda County is approximately 2 miles (3 km) to the east and San Francisco is approximately 2 miles (3 km) to the west. NSTI is within the municipal boundaries of San Francisco. A discussion of non-Navy land uses on NSTI and land uses at the ferry terminals potentially affected by the proposed increase in ferry service at NSTI is presented below.

Non-Navy Land Uses

US Department of Labor

As a result of the DoD and federal agency screening process for NSTI, approximately 36 acres (15 ha) of land on Treasure Island and approximately 12 buildings and structures were provided to the US Department of Labor for developing a Job Corps facility. The parcel includes former barracks for officers, constructed in 1958, barracks for Chief Petty Officers, constructed in 1975, a medical and dental clinic on the southern end of the island, and a dining facility. The Job Corps facility trains underprivileged youth to serve local communities. It will provide resident employment training to approximately 850 persons, approximately 750 of which would reside on Treasure Island.

US Coast Guard

An active US Coast Guard Station occupies approximately 30 acres (12 ha) of dry, upland area on the southeast side of Yerba Buena Island. The US Coast Guard is responsible for water vessel traffic in and out of the Bay using the vehicle tracking system (VTS) facility on the northwest hillside of the island. The US Coast Guard Station includes Coast Guard Group San Francisco facilities, including housing, administrative, open storage and docks, and buoy maintenance facilities. The station also includes a lighthouse built by the US Lighthouse Service in 1872 on the southeastern side of Yerba Buena Island. Following the DoD and federal agency screening process, approximately 11 acres (5 ha) in the central portion of Yerba Buena Island were granted to the US Coast Guard in 1998, and another 11 acres of submerged land were transferred in 2002.

SFOBB

The FHWA conveyed 98 acres (40 ha) on Yerba Buena Island held by Navy to Caltrans for right-of-way purposes in connection with the construction, operation, and maintenance of the SFOBB east spans retrofit project. Approximately 20 acres (8 ha) of dry land were permanently conveyed in fee and are not part of the disposal action evaluated in this EIS. The remaining 78 acres (32 ha) comprises TCE or permanent aerial easements of dry and submerged land on Yerba Buena Island. Land within the TCEs and aerial easements are available for disposal and are part of the proposed disposal action evaluated in this EIS.

Existing Off-island Ferry Terminal Land Uses

Future transportation to NSTI may be provided through increased ferry service at the existing San Francisco Ferry Building, Main Street terminal in Alameda, Jack London Square in Oakland, and at two proposed new terminals—Candlestick Point in San Francisco and Golden Gate Fields on the Berkeley and Albany border. A general land use description of existing ferry terminals is provided here. Ferry service from these terminals is described in section 3.5, Transportation.

San Francisco Ferry Building

The San Francisco Ferry Building, including its ferry terminals, is located at the terminus of Market Street at The Embarcadero. The Ferry Building is used mostly for offices, including the

Port of San Francisco administrative headquarters (San Francisco 1996d). It is one of the few remaining water-dependent land uses in the immediate area. The Ferry Building, a San Francisco landmark listed on the National Register of Historic Places (NRHP), is being expanded and renovated by the Port of San Francisco. A waterfront promenade parallels The Embarcadero and adjoins the Ferry Building.

The Ferry Building is adjoined by commercial and institutional facilities and parking areas. None of the parking areas include spaces designated for ferry users. The San Francisco downtown core is across The Embarcadero to the west and comprises offices, hotels, restaurants, and other retail and commercial uses. The Ferry Building is a transit hub, with service from Bay Area Rapid Transit (BART), San Francisco Municipal Railway (Muni), and several ferry lines nearby. An Amtrak bus connection is provided at the Ferry Building to and from Amtrak's Emeryville and Jack London Square stations.

Alameda Main Street

The Alameda ferry terminal is in the City of Alameda in Alameda County. The ferry pier is at the foot of Main Street adjacent to the former Alameda Naval Air Station. Adjacent land uses include a parking lot, winemaking and storage facilities, warehouses, a commercial self-storage facility, offices, and ship repair facilities.

Jack London Square

The Jack London Square ferry terminal is in the City of Oakland in Alameda County. The ferry pier is in the Alameda Harbor at the terminus of Clay Street. Jack London Square is a destination for entertainment, retail, and waterfront recreation.

Adjacent land uses include a recreational marina with a parking lot and lawn area to the southeast, the Waterfront Plaza Hotel south of the parking lot, a multi-story mixed-use facility to the northeast, and the Franklin D. Roosevelt Pier to the north. The pier provides opportunities for fishing and scenic viewing.

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3.2 VISUAL RESOURCES

Visual resources address the appearance of the landscape and the factors influencing how the landscape is perceived by the viewing public. Landscape includes both natural and engineered features. Treasure Island and Yerba Buena Island are two of the Bay Area's prominent scenic resources, seen by millions of residents, commuters, and visitors every year. Prominent visual features and viewpoints of and from NSTI are shown on Figure 3-2.

3.2.1 Visual Character of Reuse Plan Area

The visual character of NSTI, including features and visual characteristics of Treasure Island and Yerba Buena Island, is discussed below.

Treasure Island

Treasure Island has a geometric form with straight edges along its shores that produces a seven-sided shape in plan view. Topographic relief is low and flat. Existing Treasure Island development is characterized by various military support facilities, including housing, institutional, commissary, administrative, and industrial facilities of a generally functional appearance without a strong design theme. Buildings are generally two to four stories high (Photos 1 and 3 in Appendix F). Approximately 25 percent of the island is in open space, much of which is dedicated to recreation uses. The extent and distribution of this open space, along with wide streets and generous building setbacks, give the island a feeling of spaciousness.

Treasure Island's approximately 3 miles (5 km) of shoreline is protected by a rock-filled seawall. The seawall height limits ground-based views of the surrounding bay from many Treasure Island locations. Pier 23, a public-access fishing and sightseeing pier, is on the west side of the island across from the northern San Francisco waterfront. Public access is restricted at Piers 1, 11, and 12 on the island's southeast corner, where mooring and maintenance for former Navy vessels was provided. Pier 2 is a floating structure at the Clipper Cove marina and is used by recreational watercraft.

Entering NSTI from the Treasure Island causeway, views include the bay and San Francisco skyline to the left, Building 1 to the right, and Avenue of Palms ahead. Building 1 is a large, striking, Art Deco building with a curved façade that was constructed as the headquarters building for the 1939-1940 Exposition. Painted with light pastel colors, it is visible from points along the San Francisco waterfront.

The west side of Treasure Island is distinguished by the regularly spaced row of palm trees with landscape shrubs and ground cover along the bay side of Avenue of Palms, originally developed as part of the Exposition. Spectacular panoramic views of the bay, the San Francisco waterfront and skyline, the west span of the SFOBB, and the Golden Gate Bridge are available here. East of Building 1, the two largest buildings on Treasure Island, originally constructed as aircraft hangars, dominate the landscape (Photo 5, Appendix F). The similar style and color of Building 1 and the hangars ties the three buildings together visually.

Clipper Cove is in a protected area of the San Francisco Bay on the east side of the causeway connecting Treasure Island with Yerba Buena Island (Photos 1 and 6, Appendix F). Densely

wooded Yerba Buena Island slopes rise steeply on the cove's south side, with a steep wooden staircase leading down to a narrow sandy beach. From Treasure Island looking toward Yerba Buena Island, the scene appears mostly natural except for glimpses of buildings on the upper slopes of Yerba Buena Island, Building 262, an historic torpedo assembly building on the eastern tip of this island, and the high span of the SFOBB to the east. On the Treasure Island side of the cove are Pier 2 and the marina, where about 100 pleasure craft are moored.

Yerba Buena Island

In contrast to Treasure Island, Yerba Buena Island is a natural island with high topographic relief. Most of the island is steeply sloped with a few low-lying fill areas along the eastern side. Dense vegetation covers much of the island. Considerable soil erosion and disturbance is visible as strong color contrasts in the vicinity of the ramps and causeway on the steep west-facing slopes of the island.

Light and Glare

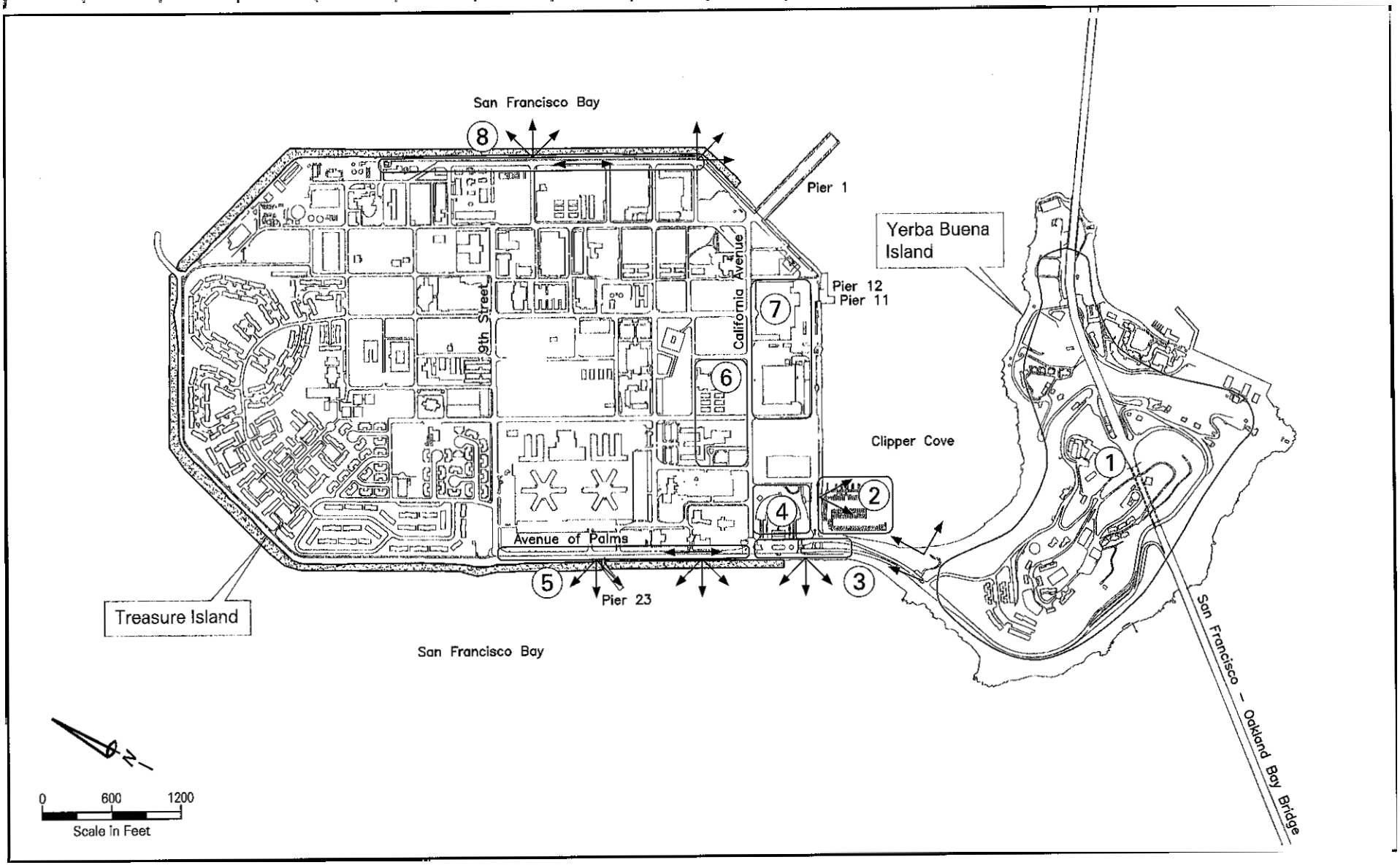
Light sources in the reuse plan area include street lights, building lighting for safety and security, and parking lot lighting. Glare is reflective light that can be visually unpleasant or possibly unsafe due to the potential for temporary "blindness." Glare is created by light (usually from the sun) reflecting off smooth surfaces such as glass, metal, or polished stone. As a military facility, the buildings and structures at NSTI were primarily designed and constructed for utility rather than aesthetics. There is generally a lack of decorative surfaces, including those that could cause glare. The majority of buildings have nonreflective surfaces.

3.2.2 Visual Characteristics of Surrounding Area

Treasure Island and Yerba Buena Island lie near the center of San Francisco Bay between downtown San Francisco and Oakland. The bay is about 50 miles (80 km) long and from 3 to 12 miles (5 to 19 km) wide. The topography around the bay features prominent hills, such as those to the northwest in Marin County and to the east in Alameda County. These ridges and other hills in the area afford distinctive panoramic views that often include Treasure Island and Yerba Buena Island. The surrounding region features a mixture of dense urban development and relatively extensive natural open space area, dominated by San Francisco Bay. Bay waterfront uses include industrial, commercial, and recreation and open space.

3.2.3 Key Views and Visibility of NSTI

Available views onto a site are affected by distance, viewing angle, and the number or type of visual obstacles, both natural and manmade. Views can be from stationary sources, such as homes and businesses, or from mobile sources, predominantly from motor vehicles. The visibility of an object depends, to a great extent, on the distance from the observer—the further the building is from the viewer, the less distinct the building becomes, and there is a greater possibility of intervening objects blocking some or all of the view of that building. With distance, more objects enter into the viewing panorama and specific features become visually "lost."



Situated in San Francisco Bay, NSTI provides panoramic views.

Prominent Visual Features:

1. Wooded Slopes of Yerba Buena Island
2. Clipper Cove Marina
3. Entry to Treasure Island
4. Museum
5. Avenue of Palms
6. Conference Center Complex
7. Hangar Buildings
8. East Side Frontage Road and

← Major Views

Prominent Visual Features and Major Views

Naval Station Treasure Island, California

Figure 3-2

For this analysis, viewing distances have been characterized as foreground views (0 to 0.5 miles [0 to 0.8 km]), middleground views (0.5 to 3 miles [0.8 to 5 km]), and background views (greater than 3 miles [5 km]). Foreground viewing distances permit perception of detail on individual small-scale landscape features. Middleground viewing distances permit relationships between large and moderately sized objects to be perceived, with some perception of colors, textures, individual forms, and details visible. Background viewing distances generally permit only the broad perception of large features, such as land masses and large-scale landscape patterns, with little distinction of color, texture, and detail.

Foreground Views

The only available close range views of NSTI are from the SFOBB (I-80) and from the immediately surrounding waters. Yerba Buena Island is clearly visible from both the eastbound and westbound directions, but Treasure Island is much less so. The bridge guardrails block views of Treasure Island from most passenger cars. From taller vehicles, such as buses, vans, or trucks, Treasure Island is visible, especially to westbound traffic in the right-hand lane (Photo 11, Appendix F). Several passenger ferry routes provide views of NSTI, and some pass within a mile (1.5 km). Boaters also experience close up foreground views of NSTI.

Middleground Views

Public middleground views of NSTI are available from many San Francisco locations, most notably from The Embarcadero and from the Northern and Central Waterfront areas of the city (from the SFOBB to the Pier 39 area). Other viewing locations include waterfront restaurants, recreational piers (Photo 7, Appendix F), ferry terminals, the San Francisco Ferry Plaza, and the future Rincon Point Park at The Embarcadero near Folsom Street. Coit Tower is a well-known landmark, which provides a panoramic view of NSTI and Yerba Buena Island at a distance of over 2 miles (3 km) (Photo 8, Appendix F).

Public scenic views of Treasure Island from Alcatraz Island, at a distance of just over 2 miles (3 km), are some of the closest ground-based views available. Angel Island, a state park, provides middleground views of NSTI from the north. The distinctive buildings on Treasure Island, which are found on its south side, are not clearly seen from this viewing point.

Background Views

The Golden Gate National Recreation Area (GGNRA), including the Presidio of San Francisco, and Golden Gate Bridge represent intensively used viewing points. However, NSTI is in the background of these views (over 5 miles [8 km] from Fort Point), which are dominated by more noticeable landscape features, such as the bridge, Alcatraz Island, the Presidio, and the Transamerica Pyramid.

The East Bay shore, extending from the City of Richmond on the north to the City of Oakland on the south, contains a series of parks and open space areas with views to NSTI from distances of approximately 3 to 6 miles (5 to 9.5 km). Under certain lighting conditions, such as morning sunshine, the larger NSTI buildings become quite conspicuous, most notably the former hangar buildings (similar to conditions shown in Photo 9, Appendix F). NSTI is also a prominent landmark in background views from the East Bay hills.

The Emeryville waterfront, about 3 miles (5 km) from NSTI, represents one of the closer East Bay views (Photo 10, Appendix F). The northern half of Treasure Island is seen against the horizon of the Golden Gate.

Background views of NSTI also are available from several major Bay Area highways, including I-80, I-580, I-280, and US 101. In most cases, Yerba Buena Island is readily visible, while Treasure Island, with its low flat profile, is less visible.

A variety of viewers obtain background views of NSTI from urban areas around the bay. The most notable views are obtained from high-rise buildings in San Francisco and Emeryville and from streets within San Francisco that provide view corridors towards the bay (Photo 12, Appendix F). These view corridors, some of which focus viewer attention toward Yerba Buena Island or Treasure Island, are recognized and addressed in the San Francisco General Plan's goals, objectives, and policies.

3.2.4 Views from NSTI

Treasure Island

Public scenic views within NSTI are found at the entrance to Treasure Island (from the northbound direction on Treasure Island Road when leaving Yerba Buena Island), along Avenue of Palms, in the vicinity of the Convention Center and the former hangar buildings, and in the Clipper Cove area. The most scenic views from the site are of the surrounding waters and Bay Area. From Treasure Island these occur from perimeter areas, although at the north end of the island the height of the seawall blocks views of the water. The most distinctive views occur from Avenue of Palms towards the Golden Gate and San Francisco waterfront and skyline. These viewing points are unique within the Bay Area for their panoramic aspect (Photo 13, Appendix F) and proximity to San Francisco. Distinctive views toward the east occur from Avenue N.

Yerba Buena Island

On Yerba Buena Island, public scenic views include views of the steep hillsides and beach at Clipper Cove, and the view of Treasure Island from Macalla Road. From several locations at the higher elevations on Yerba Buena Island, there are sweeping panoramas of the Bay Area.

3.2.5 Viewer Group/Sensitivity

Visual sensitivity is dependent upon viewer attitudes, the types of activities in which people are engaged when viewing the site, and the distance from which the site will be seen. Overall, higher degrees of visual sensitivity are correlated with areas where people live, are engaged in recreational outdoor pursuits, or participate in scenic or pleasure driving. Conversely, visual sensitivity is considered low to moderate in industrial or commercial areas where the scenic quality of the environment does not affect the value of the activity.

There are a number of viewing opportunities onto the site from the surrounding area. These opportunities are available from the SFOBB, from bay waterfront uses, including industrial, commercial, and recreation and open space, from intensively used regional public areas, including Alcatraz Island, the GGNRA, and Angel Island, and from boats on the bay. The

waterfront views toward NSTI are important both to tourists and to area residents. Given the unique and distinct character of NSTI and its central location in San Francisco Bay, viewer sensitivity from all of these areas is considered high.

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3.3 SOCIOECONOMICS

This section describes the regional socioeconomic setting. Socioeconomics includes employment, population, housing, and schools. Data are presented for San Francisco and Alameda counties, as well as for NSTI. It is expected that most future workers at NSTI would commute from these two counties, which are connected to the site by the SFOBB.

3.3.1 Plans and Policies

Socioeconomic considerations that are applicable to NSTI closure and reuse are addressed in Section 2903(c) of the National Defense Authorization Act for Fiscal Year 1994 (Pub. L. 103-160), and amendments, and in the Report of the California Military Base Reuse Task Force to Governor Pete Wilson: A Strategic Response to Base Reuse Opportunities (Task Force Report) (California Military Base Reuse Task Force January 1994). Generally, the intent is to provide economic stimulus and consider local areas in base disposal. These two aspects are discussed briefly below.

National Defense Authorization Act (Pub. L. 103-160)

Consideration of Economic Needs with Respect to Revitalization and Redevelopment of Closed Military Installations (Pub. L. 103-160 § 2903[c], Nov. 30, 1993, 107 Stat. 1547, 1915) states that economic needs must be considered with regard to reutilization and redevelopment of closed military installations. It goes on to state:

> In order to maximize the local and regional benefit from the reutilization and redevelopment of military installations that are closed, or approved for closure, pursuant to the operation of a base closure law, the Secretary of Defense shall consider locally and regionally delineated economic development needs and priorities into the process by which the Secretary disposes of real property and personal property as part of the closure of a military installation under a base closure law.

California Military Base Reuse Task Force

In the Task Force Report, the task force developed six principles to be considered in the closure and reuse of military bases in the state. These include the following:

- Treat closing military bases as economic engines for job creation.
- The state should assist local officials in the process of base reuse and evaluating potential uses that may have overriding state or regional importance.
- Provide a variety of financing for base reuse.
- Streamline regulatory processes so that the state is not in danger of stifling local efforts to devise workable reuse plans.
- The federal government must clean up closed bases as soon as possible to a level appropriate to the reuse and consistent with long-term protection goals.

- The federal government must assume responsibility for a smooth transfer of military base property to local control.

3.3.2 Economic Trends and Conditions

Economic growth trends and projections for the nine-county Bay Area, and for San Francisco and Alameda counties in particular, provide a context for understanding changes in jobs and employment at NSTI from implementing any of the reuse alternatives under consideration. Economic trend information, provided for 1980 and 1990, is based primarily on U.S. census data. The year 1990 is the closest to the 1993 baseline for which comprehensive socioeconomic data are available that are comparable on a local, regional, and national basis. NSTI census data is from Census Tract 179.02, which encompasses both Treasure Island and Yerba Buena Island. Although this data captures both NSTI and US Coast Guard operations, it is representative of Navy baseline conditions in 1993. Projections, by geographic area, for the number of jobs by sector and the number of employed residents in 2015 are from the Association of Bay Area Governments (ABAG) *Projections 2002* (ABAG 2001). The 1990 annual average unemployment rate by area was obtained from the California Employment Development Department (EDD) and is indicated for each area.

Bay Area

The nine Bay Area counties share a diversified and interconnected regional economy. In general, San Francisco has served as the major financial and commercial center, and East Bay counties have become the industrial and manufacturing center. Silicon Valley in the South Bay has emerged as a world center for computer and electronic technology.

In the context of the past several decades, regional economic growth rates were substantial until the mid-1970s, but have been slower since. Through the 1970s, the regional economy was strong and robust. Since that time, growth has been moderated, at times, by recessions. Regional economic recessions or slowdowns occurred in 1975-1976, 1982-1983, and during the first half of the 1990s. While the recession of the early 1990s was no deeper than the previous ones, its duration was longer and its effect broader in terms of weaknesses across economic sectors. Regional job loss during this recent recession was greater than during the recession of the early 1980s.

Regional economic recovery began in the mid-1990s. The next decade was one of economic growth, fueled principally by the technological innovation of the Internet, particularly in the Bay Area. The limits on the value of this technology, along with the terrorist attacks of September 11, 2001, caused an economic downturn in late 2001 and 2002. Although short-term (2000 to 2005) job growth in the region is expected to be limited, long-term economic prospects in the Bay Area continue to grow due to existing technological infrastructure and economic diversity. Between 1990 and 2015, the total number of Bay Area jobs is projected to increase from approximately 3.2 million to approximately 4.5 million, an increase of 39.9 percent over the 25-year period (ABAG 2001).

Jobs by Sector

Between 1980 and 1990, the number of jobs in the Bay Area increased by 23 percent, which was less than half the job growth experienced during the prior decade. In 1990, there were 3,073,000 jobs in the region. Approximately 33 percent of all jobs in 1990 were in services. Manufacturing and wholesale trade represented 22 percent of all jobs, and retail trade accounted for 17 percent of all jobs. Jobs in other sectors represented 27 percent of all Bay Area jobs. Agriculture, forestry, mining, and fisheries accounted for only one percent of Bay Area jobs (ABAG 1995b). Table 3.3-1 presents census data on the breakdown of Bay Area jobs by sector.

Table 3.3-1. Jobs by Sector, 1990

Location	*Agriculture, Forestry, Mining, Fisheries*	*Manufacturing & Wholesale Trade*	*Retail Trade*	*Services*	*Other**	*Total*
Bay Area	35,220 (1%)	678,800 (22%)	514,920 (17%)	1,019,190 (33%)	824,870 (27%)	3,073,000
San Francisco	2,250 (<1%)	68, 820 (12%)	78,380 (14%)	224, 510 (40%)	192,680 (34%)	566,640
Alameda County	3,760 (1%)	127,080 (21%)	107,560 (17%)	207,650 (33%)	174,930 (28%)	620,980

* Other includes construction, transportation, communications, public utilities, finance, insurance, real estate, and government jobs.
Source: ABAG 1995b.

Between 1980 and 1990, the percentage of regional jobs in the services, wholesale, and retail trade sectors increased, while the percentage of jobs in manufacturing and government decreased. During the 25-year forecast period, only the proportion of jobs in the services sector is expected to increase substantially. By 2015, approximately 39 percent of all Bay Area jobs will be in the services sector, compared to 33 percent in 1990. The percentages of jobs in the retail and wholesale sectors are projected to remain relatively constant over the forecast period—approximately 15.5 and 5.0 percent, respectively. The proportions of manufacturing and government jobs are expected to decline slightly between 1990 and 2015 (ABAG 2001).

Employed Residents

Table 3.3-2 presents information on the total numbers of employed Bay Area residents in 1980 and 1990, as well as employment projections for 2015. The number of employed residents increased from 2,553,002 in 1980 to 3,151,942 in 1990, an increase of 23 percent. In comparison, according to ABAG projections, during the 25-year forecast period, the number of employed residents in the region is expected to increase from 3,151,942 in 1990 to 4,258,200 in 2015, an increase of 35 percent. According to ABAG projections, the rate of growth in employed residents during the 25-year forecast period is projected to be 12 percent higher than the growth rate (23 percent) that took place during the decade between 1980 and 1990 (ABAG 2001).

Unemployment

The civilian unemployment rate in the nine Bay Area counties in 1990 ranged from 2.7 percent in Marin County to 5.6 percent in Solano County. The statewide unemployment rate in 1990 was 5.6 percent.

Table 3.3-2. Region of Influence Employment Trends and Projections, 1980, 1990, and 2015

Location	*1980*	*1990*	*Percent Change 1980-1990*	*2015*	*Percent Change 1990-2015*
Bay Area	2,553,002	3,151,942	23%	4,258,200	35%
San Francisco	347,091	391,292	13%	468,500	20%
Alameda County	522,069	648,461	24%	833,800	29%
NSTI	2,202	2,482	13%	N/A	N/A

Note: 1980 and 1990 figures are actual; 2015 figure is projected.
N/A = not applicable
Sources: U.S. Department of Commerce 1980; 1990; ABAG 2001.

Jobs-Housing Balance

When the number of jobs and the number of available housing units are roughly equal within a certain subregion, people will have an opportunity to live close to where they work. Given proximity, people would not have to commute as far and accordingly, traffic and congestion would be reduced, and air quality would be improved.

To measure the jobs-housing balance, a simple ratio has been formulated, where the number of jobs in a region is divided by the number of households in a region. The result of this process is a number called the jobs-housing ratio. For the entire nine-county Bay Area region, the ratio was 1.36 in 1990 (ABAG 1995b) and was projected to increase to 1.60 by 2015 (ABAG 2001).

San Francisco

The regional economic trends described above also are reflected in San Francisco's economy. San Francisco's economy was affected by the recession of the early 1990s but was recovering steadily during that decade. Employment increased by roughly 1,000 jobs per year between 1993 and 1995, and revenues from retail sales also began to grow by roughly six percent per year during this same period. Construction activity also increased, although as of August 1996, it had not reached pre-recession levels (San Francisco 1996f).

ABAG *Projections 2002* states that long-term economic growth in the future is unlikely to match the economic pace of the mid- to late 1990s, and the economy is more likely to grow at the pace of one to two percent per year. The cost of living in the Bay Area, the changing demographics of the population, and the continued growth in worker productivity are factors expected to limit growth. The limited space for development in the city and local policies were thought to be limiting factors for population growth in San Francisco; however, *Projections 2002* anticipates sustained moderate population growth for the city due to recent housing construction and a renewed interest in urban living. The Mission Bay redevelopment project will provide substantial residential and commercial property. Santa Clara and Alameda counties are expected to generate the greatest job increases; and among the Bay Area cities, San Jose and San Francisco will experience the greatest job increases (200,190 and 140,630, respectively) by 2015 (ABAG 2001).

San Francisco recently developed a 2015 Cumulative Update to the ABAG *Projections '96* land use database. Such data is useful when a project is broadly physically integrated into the larger region. NSTI is connected to the region by one route—the SFOBB/I-80. Since the SFOBB/I-80 is already operating at capacity, the new data would not change the conclusions in this socioeconomics analysis.

Jobs by Sector

Table 3.3-1 presents data on the number of jobs by sector in San Francisco in 1990. The largest sector at that time was services, with approximately 40 percent of all jobs. An additional 34 percent of jobs were in the category "other," which includes 63,490 government jobs (11 percent of all jobs). Manufacturing and wholesale trade represented 12 percent of all jobs, and less than one percent of San Francisco's jobs were in agriculture, forestry, mining, and fisheries. ABAG projects that retail, services, and "other jobs" will experience growth in San Francisco over the next two decades. By 2015, jobs in the services sector are expected to make up almost 45 percent of all jobs in San Francisco (ABAG 2001).

Between 1990 and 2015, San Francisco's overall share of the region's jobs is expected to decline from 18.4 percent to 16.0 percent. Major development projects, such as Mission Bay, and reuse of former military facilities could slow the flow of jobs away from San Francisco, but a reversal of the trend toward job decentralization is not anticipated, given regional economic and policy trends (ABAG 2001).

Employed Residents

Table 3.3-2 presents data on trends and projections of the number of employed residents in San Francisco. The number of employed residents increased 13 percent between 1980 and 1990. Between 1990 and 2015, the number of employed residents is projected to increase by 20 percent (ABAG 2001).

San Francisco shares the regional imbalance between the number of jobs and employed residents; however, the imbalance between jobs and employed residents is greater in San Francisco than in any other county in the region. This imbalance is expected to continue throughout the 25-year forecast period. Between 1990 and 2015, approximately 140,630 new jobs are expected to be created in San Francisco. During this same period, however, ABAG projects an increase of only 77,208 employed residents, indicating that San Francisco will continue to be an important job center for the region (ABAG 2001).

Unemployment

The civilian unemployment rate for San Francisco was 4.2 percent in 1990, compared with a rate of 5.6 percent statewide. Unemployment is particularly a problem among San Francisco's homeless population, which is the second largest homeless population of any city in the nation (TIHDI 1995).

Jobs-Housing Balance

Similar to the regional ratio, a jobs-housing ratio for a subregion also can be formulated. A subregional ratio greater than the regional ratio would indicate that a subregion is, in relative

terms, "jobs rich," which is typical of employment centers, such as traditional business districts. Anything less than the regional ratio would indicate that a subregion is relatively "housing rich," which is typical of more suburban bedroom communities.

San Francisco is an important job center in the regional economy. The jobs-housing ratio for the City and County of San Francisco in 1990 was 1.85 and is projected to increase to 2.08 by 2015 (ABAG 2001).

Job growth in San Francisco is supplied by the labor force of the regional labor market. In 1990, considering only those San Francisco jobs held by people living in the Bay Area, San Francisco residents held 55 percent of the jobs and people living in other parts of the Bay Area held the remaining 45 percent of the jobs (MTC undated in San Francisco 1998b; Keyser Marston Associates and Gabriel Roche 1997 in San Francisco 1998b). ABAG and the MTC project that the percentage of San Francisco employed residents working in San Francisco will stay at about the 1990 level (MTC undated in San Francisco 1998b).

Alameda County

In recent years, Alameda County has experienced a period of continued economic diversification, as well as job growth. The southern portion of the county has attracted numerous high technology industries, while the eastern section has become a center for office employment, communications-related industries, and high technology industries. In the northern portion of the county, the economy has shifted from one dominated by manufacturing industries to a mixture of office employment, government service centers, transportation, and biotechnology.

Jobs by Sector

Table 3.3-1 shows the breakdown of jobs by sector in Alameda County in 1990. As with San Francisco, Alameda County's services sector was strongest, representing about 33 percent of all jobs at that time. Another 21 percent of the county's jobs were in the manufacturing and wholesale trade sectors, and 28 percent were in other sectors, including 66,280 government jobs (11 percent of all jobs in the county). Between 1990 and 1995, Alameda County experienced negative job growth, due in part to the statewide economic slowdown in California and also to military base closures. The greatest job losses occurred in the cities of Oakland and Alameda (ABAG 1995b).

Job growth in Alameda County between 1990 and 2015 is expected to exceed the regional average, with an addition of 270,690 jobs (an increase of 42 percent). ABAG projects that between 1990 and 2015, the economic sectors experiencing growth in Alameda County will be services (increasing from 33 percent to 37 percent of all jobs) and manufacturing and wholesale (increasing from 20 percent to 21 percent) (ABAG 1995b, 2001).

Employed Residents

Table 3.3-2 summarizes trends and projections for employment in Alameda County. Between 1980 and 1990, the number of employed Alameda County residents increased by 24 percent. Employment growth for residents is expected to slow considerably between 1990 and 2015,

however, with a projected increase of 29 percent over the 25-year period (ABAG 2001). Cities in Alameda County that are expected to experience the greatest increase of employed residents during these two decades are Oakland, Livermore, Dublin, and Pleasanton (ABAG 1995b).

Unemployment

Alameda County's unemployment rate in 1990 was 4.2 percent, compared with a 5.6 percent rate statewide.

Jobs-Housing Balance

According to ABAG *Projections '96*, the jobs-housing ratio for Alameda County in 1990 was 1.31 (ABAG 1995b). This number is expected to increase to 1.58 by 2015 (ABAG 2001). The jobs-housing ratio is slightly lower in Alameda County than the region as a whole.

NSTI

During the 1980s, NSTI remained relatively isolated from the rest of San Francisco—not only physically, but also economically and socially. Virtually all employment on the islands was military-related in 1990. Workers were employed either by various branches of DoD or by a small number of nonmilitary organizations providing services to residents, such as banks, the school, and the post office. In 1990, the largest nonmilitary employer at NSTI was the San Francisco Unified School District (SFUSD).

Jobs by Sector

The U.S. census only provides data for civilian (nonmilitary) jobs. The 1988 NSTI Master Plan Update indicates that the following military personnel were employed: 200 officers, 1,215 enlisted, 495 transient, and 975 reserve shipmen, for a total of 2,885 persons (DON 1988b). There were approximately 750 nonmilitary jobs at NSTI in 1990, of which 19 were in manufacturing and wholesale trade, 150 were in retail trade, 31 were in services, and 550 were in various other sectors, including construction, transportation, communications, public utilities, finance, insurance, real estate, and government jobs. The total Navy civilian and military personnel at NSTI was about 3,635 employees.

Employed Residents

Military personnel employed at NSTI did not all necessarily live at NSTI in 1990, as military housing there was available to military personnel from other Bay Area facilities. Census data indicate that in 1990, 40 percent of the workers with jobs at NSTI lived on-site. Another 11 percent lived in other parts of San Francisco and 14 percent lived in Alameda County. Seventeen percent lived in the seven other Bay Area counties, while 18 percent lived outside the Bay Area (San Francisco 1995a). There were 2,202 NSTI employed residents in 1980 and 2,482 in 1990, an increase of 13 percent over the decade.

Unemployment

Census Tract 179.02, which encompasses both Treasure Island and Yerba Buena Island, had a civilian unemployment rate of 7.4 percent in 1990. This rate is based on 56 persons reported to

be unemployed out of a civilian labor force of 750. Using a denominator that includes military personnel and civilians, the unemployment rate would have been 1.5 percent, compared with 4 percent citywide and 5.6 percent statewide (U.S. Department of Commerce 1990).

3.3.3 Population Trends and Projections

This subsection describes population growth trends and projections for the nine-county Bay Area, San Francisco, Alameda County, and NSTI. The information provided below includes population size and distribution, age, household size, and income. Demographic data are not available for 1993. For consistency with other sections of this report, population estimates and projections are provided for each geographic area for the years 1980, 1990, and 2015. Two summary tables are referenced throughout this section. Table 3.3-3 presents data on regional population trends and projections and Table 3.3-4 presents information on regional household characteristics. The main sources used to obtain the information presented in this section are census data (U.S. Department of Commerce 1980, 1990) and ABAG *Projections 2002* (ABAG 2001). Racial composition and poverty are discussed in section 6.4, Environmental Justice.

Bay Area

Population Growth

Table 3.3-3 presents data on regional population trends and projections. The population of the nine-county region increased from 5,179,759 in 1980 to 6,020,147 in 1990, an increase of 16 percent.

Over the 25-year forecast period (1990 to 2015), ABAG projects that regional population growth will slow slightly, with 1,752,053 people added by 2015. This would represent a 29 percent increase over the 25-year period. Population distribution within the Bay Area also has undergone substantial change over the past decades, reflecting the decentralization of both population and employment that has occurred within the region.

Household Characteristics

Table 3.3-4 presents information on household characteristics in the region. The total number of households in the region increased 14 percent between 1980 and 1990. The average household size in the region increased slightly between 1980 and 1990—from 2.57 to 2.61 persons. The median household income in the region increased by 102 percent during the decade, from $20,607 in 1980 to $41,595 in 1990.

Table 3.3-3. Region of Influence Population Trends and Projections, 1980, 1990, and 2015

Location	*1980*	*1990*	*Percent Change 1980-1990*	*2015*	*Percent Change 1990-2015*
Bay Area	5,179,759	6,020,147	16%	7,772,200	29%
San Francisco	678,974	723,959	7%	810,500	12%
Alameda County	1,105,379	1,276,702	15%	1,628,800	28%
NSTI	3,935	4,500	14%	N/A	N/A

Notes: 1980 and 1990 figures are actual; 2015 figure is projected.
N/A = not applicable.
Sources: U.S. Department of Commerce 1980, 1990; ABAG 1995b.

Table 3.3-4. Region of Influence Household Characteristics, 1980 and 1990

Location	Number of Households			Average Household Size		Median Household Income		
	1980	1990	Percent Change	1980	1990	1980	1990	Percent Change
Bay Area	1,970,551	2,246,242	14%	2.57	2.61	$20,607	$41,595	102%
San Francisco	298,956	305,584	2%	2.19	2.29	$15,866	$33,414	111%
Alameda County	426,093	479,518	13%	2.53	2.59	$18,700	$37,544	101%
NSTI	801	962	20%	3.76	3.71	$14,712	$27,909	90%

Sources: U.S. Department of Commerce 1980, 1990.

San Francisco

Population Growth

San Francisco's population increased by about seven percent between 1980 and 1990, from 678,974 to 723,959 persons (Table 3.3-3). This was the second slowest rate of growth of any county in the Bay Area and only a fraction of California's growth rate of 26 percent (EDD 1994). ABAG projects that San Francisco's population growth will be sustained and moderate over the next 25 years, increasing by only 12 percent during the forecast period (ABAG 2001).

Household Characteristics

The number of San Francisco households increased by only two percent between 1980 and 1990 (Table 3.3-4). Although the average household size in San Francisco rose from 2.19 to 2.29 during this decade, the citywide average was still substantially smaller in 1990 than the regional average of 2.61. The median household income in San Francisco increased by 111 percent between 1980 and 1990, from $15,866 in 1980 to $33,414 in 1990.

Alameda County

Population Growth

In 1990, Alameda County had a total population of 1,276,702, making it the most populous county in the Bay Area after Santa Clara County. Alameda County was the only county in the nine-county region to have four cities with 1990 populations of more than 100,000 residents—Oakland, Fremont, Hayward, and Berkeley.

Alameda County's population grew 15 percent between 1980 and 1990, and it is projected to increase by an additional 28 percent between 1990 and 2015 (Table 3.3-3). Most of this growth is expected in the eastern portion of the county, especially in the communities of Dublin, Livermore, and Pleasanton. Growth in the western portion of the county, with the exception of Emeryville, is expected to be slow during this period, as the communities bordering San Francisco Bay approach full buildout (ABAG 2001).

Household Characteristics

The number of households in Alameda County increased by 13 percent between 1980 and 1990 (Table 3.3-4). The average household size in Alameda County was 2.59 persons in 1990, slightly higher than the 1980 average of 2.53 persons but still below the regional average of 2.61 persons. Similar to the region and to San Francisco, the median household income in Alameda County increased by 101 percent between 1980 and 1990, from $18,700 to $37,544.

NSTI

While still an active military base, the resident population at NSTI was approximately 3,935 in 1980. By 1990, the resident population at NSTI had increased to approximately 4,500 (Table 3.3-3). Between 1980 and 1990, the number of NSTI households increased 20 percent, while the median household income increased by approximately 90 percent during this same period (compared with more than 100 percent in most of the rest of the region) (Table 3.3-4).

3.3.4 Housing Characteristics

This subsection presents information about the housing stock in the Bay Area, San Francisco, and Alameda County. Because housing affordability is a critical issue in the region and because reuse could affect the local supply of (and demand for) affordable housing, housing supply and housing costs are described for each geographic location. The data source used is the U.S. Department of Commerce census data. Table 3.3-5 summarizes housing information that is referenced throughout this section.

Bay Area

Census data indicate that the region's housing stock increased by 15 percent between 1980 and 1990. The housing vacancy rate in the region was five percent in 1990. The region's housing stock in 1990 included single-family units (61 percent), multi-family units (35 percent), mobile homes (3 percent), and other types of residences, such as houseboats (1 percent). Of the occupied housing units in the region in 1990, 56 percent were owner-occupied, and 44 percent were renter-occupied.

Table 3.3-5. Region of Influence Housing Characteristics, 1980 and 1990

Location	*Number of Housing Units*			*Percentage of Single-family Units*			*Vacancy Rate*	
	1980	**1990**	**Percent Change**	**1980**	**1990**	**Percent Change**	**1980**	**1990**
Bay Area	2,061,343	2,365,323	15%	56	61	9%	4.2	5.0
San Francisco	316,608	328,471	4%	46	32	-30%	5.7	7.0
Alameda County	444,607	504,109	13%	51	59	16%	4.1	4.9
NSTI	809	1,045	29%	N/A	N/A	N/A	0.9	7.9

Note: N/A = not applicable.
Sources: U.S. Department of Commerce 1980; 1990.

At the time of the 1990 census, housing costs in the Bay Area were among the highest in the nation. In 1990, the median value for an owner-occupied unit in the Bay Area was $255,476. Housing prices in the region increased by more than 160 percent from 1980, when the median value for an owner-occupied unit was $98,100.

San Francisco

San Francisco had 328,471 housing units in 1990 (Table 3.3-5), or approximately 14 percent of the region's housing supply. San Francisco's housing stock increased by approximately four percent between 1980 and 1990. The vacancy rate in San Francisco in 1990 was 7.0 percent, up from 5.7 percent in 1980.

In 1990, 32 percent of San Francisco's housing stock was single-family units—about half the percentage of single-family units in the region. Single-family units are relatively scarce in San Francisco due to the relatively high cost and limited supply of land available for residential development. Two-thirds of San Francisco's housing stock in 1990 was composed of multi-family units. Less than one percent of all units were mobile homes, and two percent were other types of housing units.

In 1990, approximately 35 percent of the housing units were owner-occupied—considerably lower than the regional figure of 56 percent. The median value for an owner-occupied dwelling in San Francisco was $298,900 in 1990, which was 17 percent higher than the regional median value. This is consistent with information published by the San Francisco Planning Department that states the median value for a three-bedroom home in San Francisco in 1990 was $290,250 (San Francisco 1995c). While the median household income increased by 111 percent between 1980 and 1990, the median housing price increased by 188 percent, exacerbating San Francisco's housing affordability problems.

Alameda County

Alameda County had 504,109 housing units in 1990 (Table 3.3-5), approximately 21 percent of the Bay Area's housing supply. The county's housing stock had increased by 13 percent since 1980, when there were 444,607 housing units. In 1990, 4.9 percent of the housing units were vacant, similar to the regional vacancy rate of 5.0 percent.

The composition of Alameda County's housing stock is similar to that of the region as a whole. In 1990, 59 percent of the housing units in Alameda County were single-family units, 38 percent were multi-family units, and the remainder were mobile homes and other types of housing units, such as houseboats. The rate of owner-occupancy in Alameda County in 1990 was 53 percent, similar to the regionwide rate. The median home value in Alameda County was $225,300, which was also similar to the regional median value. Home values in Alameda County increased by more than 165 percent from 1980, when the median home value was $84,900.

NSTI

In 1990, while still an active military base, there were 1,045 housing units at NSTI (Table 3.3-5). The 1990 housing vacancy rate was 7.9 percent, a substantial increase from the vacancy rate of 0.9 percent reported in 1980.

3.3.5 Schools

The information presented in this section is based on interviews with SFUSD personnel.

San Francisco

NSTI is within the boundaries of the SFUSD, where enrollment has remained constant since 1990, averaging approximately 63,000 to 64,000 students. Enrollment at elementary schools throughout the school district is at or near capacity (SFUSD 1996b). At the middle school and high school levels, some schools are at capacity or are experiencing overcrowding, while others are underenrolled. Overcrowding at the middle school and high school level is primarily a problem in schools in the western portion of San Francisco.

The San Francisco school system receives annual funding from the federal government under the provisions of Public Law 101-874. The amount of funding is determined annually by the U.S. Department of Education, then appropriated by the Senate for allocation to schools attended by the children of military personnel who reside on federal property. Receipt of such funds does not alter the per capita funding contributed by California to the school district. In the 1990-1991 school year, money was allocated for the 1,470 eligible students who attended San Francisco public schools and resided either at NSTI or the Presidio. (Roughly two-thirds of the eligible students were from NSTI and one-third were from the Presidio.)

NSTI

Elementary school-aged children that lived at NSTI attended the Treasure Island Elementary School. The school property was leased from Navy by the school district, and the school was staffed by district employees. While most Treasure Island Elementary School students lived at NSTI, some other San Francisco children were taken by bus to the school to achieve court-mandated racial balance.

In 1990, there were 1,134 school-aged children (5 to 19 years of age) at NSTI, representing 25 percent of the NSTI population, about double the citywide ratio. Enrollment projections for the elementary school were not available because the school district's annual enrollment projections are district-wide only. Individual school enrollments are not projected (SFUSD 1996c).

Enrollment at Treasure Island Elementary School was 852 in October 1990. Approximately two-thirds of the enrolled students were children from military families living at NSTI, and one-third were students who were bussed from other parts of San Francisco (Treasure Island Elementary School 1996). Since there is no middle school or high school at NSTI, these students were bussed to schools in San Francisco. Most middle school-aged children at NSTI were bussed to the Potrero Hill Middle School. Most high school students from NSTI were bussed to Galileo High School. Many of the middle school students at NSTI elected to attend the Everett Middle School, as well as the Horace Mann and Martin Luther King Alternative Middle

Schools. Some high school students chose to attend the Thurgood Marshall Academic High School or the Phillip and Sala Burton High School (SFUSD 1996d). The school district continues to lease and operate the Treasure Island Elementary School, which serves students bussed in from other parts of San Francisco (DON 1998f).

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3.4 CULTURAL RESOURCES

"Cultural resources" is a broad term that describes archaeological, architectural, and historical objects, sites, buildings, structures, or districts. Some of these are listed in or eligible for listing in the National Register of Historic Places (NRHP). To qualify as an eligible property, the resource must meet specific criteria established in the National Historic Preservation Act (NHPA). Section 106 of the NHPA requires federal agencies to consider the effects of their actions on properties listed in or eligible for listing in the NRHP. The Section 106 process requires federal agency consultation with the State Historic Preservation Officer (SHPO), Native American tribes, and other appropriate agencies and parties and input from the Advisory Council on Historic Preservation (ACHP).

Cultural resources can be divided into three broad categories: prehistoric, Native American, and historic. Prehistoric resources consist of the physical evidence (often buried) resulting from human activities that occurred before the time of written records. Native American resources are sites, areas, or materials important to living Native Americans for religious, spiritual, ancestral, or traditional reasons. Historic resources can consist of physical properties, archaeological sites, structures, or built items resulting from human activities since the time of written records. Cultural resources that are under water are called maritime or submerged cultural resources, and they can be prehistoric, Native American, or historic. Maritime sites can include inundated cities, harbors, shore installations, shipwrecks, or sunken aircraft.

In addition to the NHPA, cultural resources and Native American resources are protected by: the Archaeological Resources Protection Act of 1979 (16 U.S.C. §§ 469-469c), the American Indian Religious Freedom Act of 1978 (42 U.S.C. §§ 1996-1996a), and the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) (25 U.S.C. §§ 3001-3013). NAGPRA provides for the return of human remains and burial items to identified Native American descendants.

Cultural resources at NSTI have been identified through a number of previous investigations. These investigations identified cultural resources throughout NSTI, including some resources in areas that have since been transferred to other federal agencies and are no longer under Navy control.

In 1998, land on Yerba Buena Island, including two historic buildings, was transferred to the US Coast Guard. Some resources within this area are not part of the evaluation in this EIS. In 2000, FHWA conveyed 98 acres (40 ha) on Yerba Buena Island held by Navy to Caltrans for construction of the east span of the SFOBB. Approximately 20 acres (8 ha) of dry land were permanently conveyed in fee; the remaining 78 acres (32 ha) comprises five separate easements: 51 acre (21 ha) and 18 acre (7 ha) TCEs over submerged land, an 8 acre (3 ha) TCE over dry land, and two 0.3 acre (0.1 ha) permanent aerial easements over dry land. Resources that lie within lands permanently conveyed in fee and were previously transferred are not included in this EIS; however, resources that are within the TCEs or aerial easements are evaluated.

Cultural Background of NSTI

The cultural background for NSTI consists of an overview of the history of the area from prehistoric times to the present. Summarized here, cultural backgrounds are used as contexts

for developing significance criteria to help determine if specific properties are eligible for the NRHP. Specific contexts have been developed for NSTI's prehistoric, Native American, and historic resources (DON 1997f).

Prehistoric

Not much is known about the region's first human inhabitants or when the area became home to the ancestors of modern Native Americans. Several recent discoveries in South America have seriously questioned the theory that the first people on the continent crossed the Bering Straight only 10,000 years ago. Some of the earliest sites recorded in the vicinity, south of the project area in San Jose and Scotts Valley, are dated to as early as 8,000 BC (Moratto 1984). Based on dates and material gathered from extensive archaeological excavations conducted at several large prehistoric shellmounds (i.e., sites where marine resources were consumed), it appears that human occupation of the San Francisco Bay Area also goes back many thousands of years. Evidence suggests that between 5,000 and 2,000 BC, the bay was used by groups of hunters and gatherers who subsisted on a wide variety of land, bayshore, and marsh resources. As time progressed, later groups who occupied the region are believed to have relied primarily on shellfish (Breschini and Haversat 1980; Moratto 1984). Although the aboriginal populations may have been affected by fluctuating sea levels, use of the region appears to have been continual until the historic period.

Native American (Ethnography)

At the time of Euro-American contact (around 1769), Native American groups of the Costanoan language family occupied the area, from San Francisco Bay to southern Monterey. The large area that the Costanoans occupied was subdivided among several individual groups occupying specific territories. Shells, pine nuts, and obsidian for making stone tools were likely traded between coastal and inland groups, as evidence from excavated sites indicates. Costanoans used several semi-permanent camp areas, depending on where food was available during each season, moving locations to take advantage of both marine and land resources. The Ohlone, a Costanoan group that lived along the ocean shore, once occupied the project area. Like most California aboriginal groups, the Ohlone practiced a transient lifestyle and relied heavily on hunting and gathering. With the onset of Euro-American immigration to the area, their traditional way of life essentially disappeared by the mid-1800s (NPS 1976).

Historical Setting of NSTI

Although Navy has managed Yerba Buena Island and Treasure Island as a single facility since 1940, the islands have different histories. Yerba Buena is a natural island that has been used by private parties and by the Army and Navy since the 1840s. Treasure Island is an entirely engineered island, constructed in 1936 and 1937.

Yerba Buena Island. Various parties claimed ownership of Yerba Buena Island (also known as Goat Island) through the Spanish-Mexican era of California history and through the early decades of American control. The Army asserted the right to occupy and use Yerba Buena Island in 1866, and in 1867 it took possession of the island. Troops were stationed on the southeastern part of the island, in a cove near the modern US Coast Guard station. In 1879, the Army reassigned artillery units to the Presidio of San Francisco and abandoned the Yerba

Buena Island garrison. In 1891, the Army Coast Artillery Corps took control of the island to erect a torpedo (i.e., underwater mine) depot.

In 1898, the Navy established a Naval Training Station in the East Cove area, in the location of the 1870s Army base, but the Army retained control of the eastern tip of the island until 1960. The Naval Training Station was active from 1900 until 1923, when Navy relocated it to the Naval Training Center in San Diego, and the Navy facility on Yerba Buena Island became a receiving ship facility. In the mid-1930s, the SFOBB was constructed. Yerba Buena Island became the center anchorage for the SFOBB (anchoring the suspension spans on the west and the cantilever spans on the east), and a tunnel traversed the central hill.

Treasure Island. Treasure Island is an entirely engineered island, consisting of rock and mud fill placed over shallow areas at the northern shore of Yerba Buena Island. The COE constructed the approximately 400-acre (162-ha) island during 1936 and 1937 to provide a short-term site for the Golden Gate International Exposition, with the intent of converting the site into a permanent airport for San Francisco when the exposition closed. The exposition was conceived to celebrate construction of the Golden Gate Bridge and the SFOBB. Most of the buildings constructed for the exposition were built to be temporary, with only three planned to be permanent.

In February 1941, Navy took possession of Treasure Island from San Francisco in exchange for land south of San Francisco on the peninsula. The peninsula property would become the site of the San Francisco International Airport. Following the bombing of Pearl Harbor in December 1941, the Navy built several hundred new buildings on the island, between 1942 and 1945. Most construction at Treasure Island during World War II was designed to function only for the duration of the war. Following World War II, Navy transformed Treasure Island into a training facility and unified various specialized technical schools from throughout the Bay Area into a consolidated facility on the island. Navy demolished dozens of World War II-era temporary structures during the 1960s and 1970s, making way for more modern residential and classroom buildings suited to its instructional needs.

3.4.1 Summary of Previous Investigations

In accordance with Section 106 of the NHPA, Navy conducted cultural resource investigations to determine the presence of cultural resources within the area of potential effect (APE).

Previous studies of buildings and structures at NSTI fall into two categories—those conducted before 1996 and those supporting a comprehensive inventory conducted by JRP Historical Consulting Services in 1996 and 1997. Pre-1996 studies of buildings and structures at Yerba Buena Island are restricted to studies of senior officers' quarters (DON 1982b) and a historical investigation by staff from Mare Island Naval Shipyard conducted in 1995 (DON 1995a). The National Park Service (NPS) inspected and analyzed data from the exposition buildings at Treasure Island in 1987 for potential National Historic Landmark (NHL) status, as part of a thematic study of world's fair sites in the U.S. (NPS 1987). The intent of the NPS study was to determine whether any exposition buildings would qualify for listing in the NRHP, individually or as a historic district.

In 1996-1997, JRP Historical Consulting Services conducted a comprehensive inventory of all buildings and structures at NSTI (DON 1997a). That inventory effort included preparing a historic context for evaluating historic significance, as well as an inspection of all buildings on both islands.

Also in 1996, PAR Environmental Services, Inc., conducted archaeological investigations within NSTI (DON 1997f). In addition to a field survey, personnel of the Northwest Information Center (NWIC) of the Historical Resources File System, Sonoma State University, Rohnert Park, completed a prehistoric and historic site record and literature search (NWIC File No. 96-227).

The California State Lands Commission Shipwreck database was reviewed for reported shipwrecks in the vicinity of NSTI. The SFOBB retrofit project also has been investigated to identify eligible and potentially eligible sites within the APE.

Background studies conducted at both Treasure Island and Yerba Buena Island identified significant archaeological properties and historic buildings and structures that are within the areas that Navy transferred to the US Coast Guard and the FHWA. While not formally part of this analysis, discussions of some transferred resources are included to assist the reader in understanding the project.

3.4.2 Summary of Known Resources

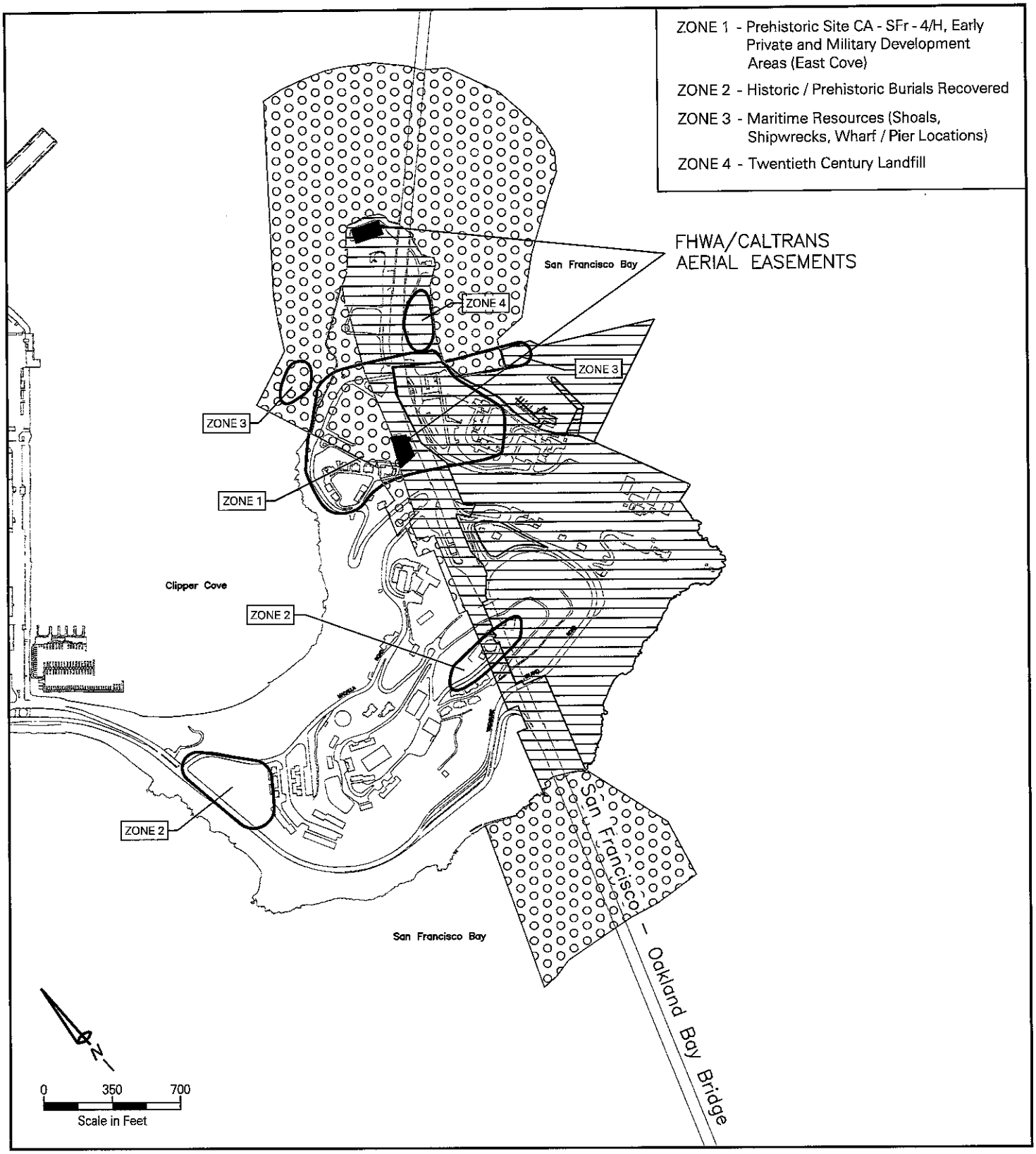
Status of Cultural Resources at Yerba Buena Island

The 1996 cultural resource investigations identified archaeological and historic resources on Yerba Buena Island. Four areas, or zones, of subsurface archaeological sensitivity on Yerba Buena Island were defined and are discussed further below (Figure 3-3). Due to the transfer of Navy property to the US Coast Guard and FHWA, portions of Zone 1, Zone 2, and Zone 3, and much of Zone 4 are no longer Navy property and are not part of the proposed disposal and reuse action considered in this EIS.

Zone 1

Zone 1 contains a prehistoric site with a historic component (CA-SFr-4/H) and early private and military development. The prehistoric component of site CA-SFr-4/H contained burials reportedly removed from the site in 1934 (DON 1997f). The remains are housed at the Phoebe Hearst Museum in Berkeley, California. Following the FHWA transfer, Caltrans conducted additional work at the prehistoric site, including Native American consultation, additional site testing, and development of treatment plans to comply with the NHPA (Caltrans and FHWA 2001). Caltrans determined the historical component of site CA-SFr-4/H to be a noncontributing element for eligibility to the NRHP (Caltrans and FHWA 2001). Caltrans developed treatment plans for the resources, as part of the SFOBB retrofit project (Caltrans and FHWA 2001).

There appear to be no remnant buildings or structures associated with pre-1867 occupation of the island, even though it had been occupied since the 1840s (DON 1996p). One building remaining from the early military period of occupation is the lighthouse, built in 1872 and still used by the US Coast Guard. The lighthouse is not on Navy property and



There are four zones of predictable archeological sensitivity where the likelihood of unexpected discoveries of significant archeological and historical resources is judged high.

Archeologically Sensitive Zones Yerba Buena Island

Legend

- Areas Excluded from Proposed Navy Disposal
- FHWA/Caltrans TCEs
- FHWA/Caltrans Aerial Easement

Figure 3-3

would not be affected by the disposal action. The other remaining structure on Yerba Buena Island from this early period is the reinforced concrete Building 262, the torpedo building constructed in 1891 as the mine assembly building. It is north of and almost directly beneath the SFOBB, at the eastern water's edge and is unoccupied. There is an aerial easement over Building 262, although the structure itself was not transferred to FHWA. Also within Zone 1 are the foundation remnants of the Naval Training Station's original administration complex, its associated outbuildings, and seven unmodified Senior Officers Quarters (Quarters 1 through 7). Other buildings remaining from this period include Quarters 8 and 9, which were constructed between 1900 and 1905. Quarters 8 and 9 were within an area transferred to the US Coast Guard. One historic district and three individual buildings that meet the criteria for listing in the NRHP were identified as part of the comprehensive 1996 investigation.

This Senior Officers Quarters Historic District includes seven senior officers quarters, Quarters 1 through 7, all built between 1900 and 1905 (Figure 3-4). The district also includes three associated garages, Buildings 83, 205, and 230, and formal landscaping elements. In 1997, the SHPO agreed in concept on the proposed historic district. One building within the group, Quarters 1, the Nimitz House, was individually listed on the NRHP in 1991.

Zone 2

Zone 2 is broken into two areas, one that contains prehistoric burials, and the site of the original historic cemetery site dated to 1849 (DON 1997f).

The first part of Zone 2 is an area of reported prehistoric and historic archaeological deposits, including Native American remains removed in the 1930s from the top of the island where the signal tower now stands (DON 1997f). Most of the area where the reported human remains were found is within the area transferred to FWHA.

The second part of Zone 2 is reported as the early cemetery of the island, dated to 1849. Although all known burials were relocated to San Francisco in the 1930s, the zone is considered sensitive because of the possibility of additional unmarked graves (DON 1997f).

Zone 3

Zone 3 contains potential historic maritime resources from before 1835 through 1923 (DON 1997f). Maritime traffic both in prehistoric and historic times seems likely, due to the strategic location of the island. A review of reported shipwrecks using the California State Lands Commission Shipwreck database did not reveal any shipwrecks in the waters surrounding Yerba Buena Island; however, four shipwrecks were reported in the vicinity (Caltrans and FHWA 2001). In investigations conducted for the SFOBB retrofit project EIS, Caltrans included a maritime archaeological survey that extended 1,200 feet on either side of the bridge, within Clipper Cove, and in an area east of Building 262 (Caltrans and FHWA 2001). This survey did not reveal the presence of any shipwrecks. The *Utica*, a boat that burned and sank in 1850, is plotted (using latitude and longitude provided by the shipwreck database) on what would have been the shoals to the north of Yerba Buena. This area has since been filled and is now Treasure Island.

Zone 3 also contains areas where historic wharves were constructed, as shown on archival maps from 1871 that depict a wharf within the East Cove off Yerba Buena (DON 1997f). The Navy transferred some property within Zone 3 to FWHA as part of the SFOBB retrofit project.

Zone 4

Zone 4 is an area along East Cove that includes the site of a historic dump dated to the 1920s through the 1930s associated with the Yerba Buena Naval Training School (DON 1997f). The Navy transferred nearly all property within Zone 4 to FHWA as part of the SFOBB retrofit project. In addition to those resources identified for each of the zones on Yerba Buena Island, the SFOBB also plays a part of the historic record of Yerba Buena Island. The State Historical Resources Commission nominated the SFOBB for listing in the NRHP on September 6, 1999 (Caltrans and FHWA 2001). Completed in 1937, the SFOBB was first determined as eligible for NRHP listing in 1983. The bridge held numerous records when it opened, and it remains a Bay Area centerpiece. (The Navy transferred the land supporting and immediately adjacent to the SFOBB to FWHA, and it is not part of the NSTI disposal and reuse action.)

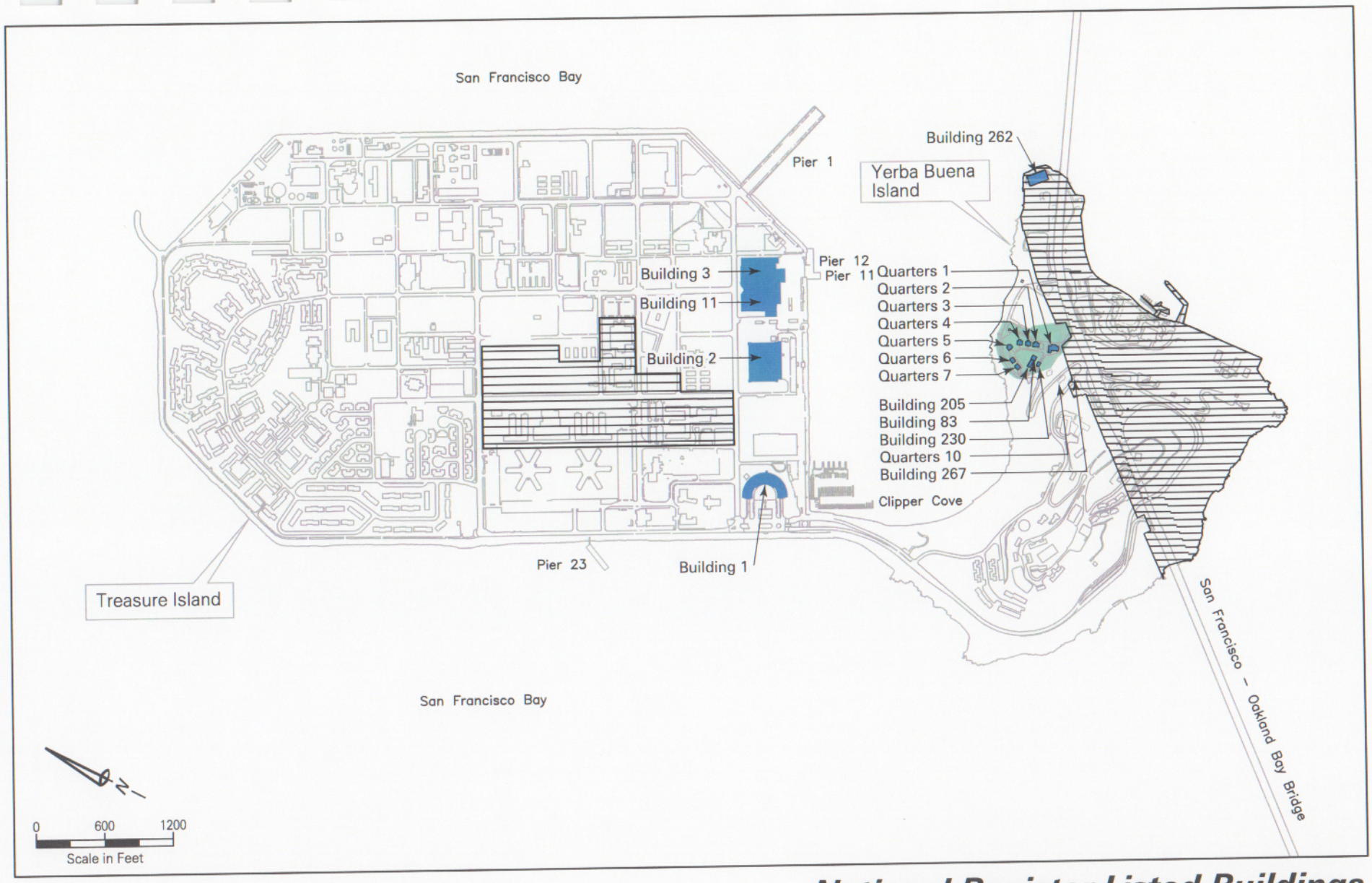
Yerba Buena Consultation and Affected Properties

The SHPO concurred with the Navy that the Senior Officers Quarters Historic District, Quarters 8 and 9, and Building 262 were eligible for listing in the NRHP and that zones 1 through 4 may have properties that qualify for listing (SHPO letter October 15, 1997). The SHPO also commented that further information was needed on several historic features before determinations of eligibility were possible. In response, Navy provided additional information (Navy letter dated March 2, 1998) supporting the argument that the features would not qualify under eligibility criteria. Navy and the SHPO have completed a memorandum of agreement (MOA) in which it is determined that the eligible properties that would be affected by the undertaking are limited to Quarters 1, which is individually listed on the NRHP, Quarters 2 through 7 and their garages (Building 83, Building 205, Building 230), the formal landscaping elements of the area, and any potential undiscovered prehistoric and historic sites on Yerba Buena Island (the MOA is discussed further in section 4.4 and a copy is included as Appendix H).

Status of Cultural Resources at Treasure Island

Because most of Treasure Island consists of fill material, the potential for buried prehistoric or historic archaeological resources related to pre-Navy occupation is considered to be extremely low. The potential for paleontological resources also is considered to be low, based on the soil composition and geological formation of the Treasure Island project area lands. Any marine or submerged cultural resources, such as shipwrecks, also would have been covered by the dredge-and-fill used to create the island.

Treasure Island itself is an engineered island and is over 50 years old. In a letter, the SHPO asked the Navy to consider the potential eligibility of the entire island, specifically the engineering achievements of the San Francisco Army Corps of Engineers in 1936 (SHPO letter October 15, 1997). In response, JRP Historical Consulting Services and Navy evaluated the significance of Treasure Island in the field of engineering and concluded that it did not appear to be a significant example of the dredge-and-fill techniques of the Corps of Engineers, which



National Register Listed Buildings and Eligible Properties on NSTI

Naval Station Treasure Island, California

Legend:

- National Register Listed and Eligible Buildings and Structures
- Areas Excluded from Proposed Navy Disposal

Figure 3-4

had been doing similar work throughout the Bay Area, California, and the U.S. decades before the island was built (Navy letter to SHPO dated March 2, 1998).

Three historic features containing a number of structural foundations built during World War II were encountered on Treasure Island during the 1996 survey. These foundations are clustered on the north end of the island and, except for the Brig Overflow that was constructed in 1943, all date to 1944. They include Buildings 207 (barracks), 222 (brigade guard house), 228 (bachelor officers quarters), 236 (administration and classrooms), 237 (oil tank), 238 (boiler house and shop), 239 (oil separating pit), 240 (forecastle mock-up), 241 (boiler room), 242 (engine room), 243 (flight deck), 244 (diving tank), and 245 through 257 (oil and gas tanks and pits). Though 50 years old, these foundations are from a well-documented phase of Treasure Island's history. The historic remains are limited to surface foundations that are documented on maps and do not contribute significant information for interpreting the island's history. It was recommended that the foundations do not qualify for inclusion in the NRHP.

Of the Golden Gate Exposition buildings that the Navy used during World War II (DON 1995a), five still exist (in whole or in part), with only Building 1 (the Administration Building), Building 2 (the Hall of Transportation), and Building 3 (the former Palace of Fine and Decorative Arts) remaining in relatively unaltered condition. In 1982, a cultural resources inventory of buildings and structures on Treasure Island (DON 1982b) concluded that these three remaining buildings individually meet the criteria for the NRHP. Building 111 also was considered eligible as a structural component of Building 3. The National Park Service analysis in 1987 concluded that insufficient resources from the exposition existed at Treasure Island to warrant additional eligibility recommendations.

Treasure Island Consultation and Affected Properties

In 1984, the SHPO concurred with the Navy's finding that Building 1 was eligible for the NRHP (California Office of Historic Preservation 1984), and in 1992 the SHPO made this same determination for Building 2 and Building 3 (California Office of Historic Preservation 1992). Building 111 also qualifies for the NRHP as a structural element of Building 3 (California Office of Historic Preservation 1992). The SHPO and Navy in their MOA determined that the eligible properties that would be affected by the undertaking are limited to Buildings 1 and 2, Building 3 with its associated Building 111, and any potential undiscovered prehistoric and historic sites on Treasure Island.

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3.5 TRANSPORTATION

This section describes the existing roadway network, traffic volumes and level of service, public transportation (including ferry service), pedestrian and bicycle circulation, parking, and goods movement on and around NSTI.

3.5.1 Roadway Network

Regional Roadway System

Yerba Buena Island connections to and from the SFOBB/I-80 are provided by one off-ramp and two on-ramps in the westbound direction and two off-ramps and one on-ramp in the eastbound direction. The SFOBB/I-80 contains two traffic levels, each with five lanes, with the upper level carrying westbound traffic and the lower level carrying eastbound traffic. Access to Treasure Island is from Yerba Buena Island via a causeway (Treasure Island Road).

The SFOBB/I-80 structure, completed in 1937, is owned by Caltrans. The access ramps to and from Yerba Buena Island are owned by Navy. Figure 3-5 shows the locations of the six ramps and the Caltrans easement across Yerba Buena Island.

Southwest of the SFOBB/I-80, I-80 links NSTI to San Mateo and Santa Clara counties via U.S. 101 and I-280. Through downtown San Francisco, I-80 is generally three to four lanes, with additional lanes added between on-ramps and off-ramps. I-80 connects with U.S. 101 south of the 7th and 8th Street ramps, and U.S. 101 connects with I-280 south of Cesar Chavez Street, near Alemany Boulevard. Northeast of the SFOBB, I-80 connects NSTI to Alameda and Contra Costa counties via I-80 and I-580 north of the toll plaza area. The Cypress structure freeway connection between I-80 and I-880, demolished following the 1989 Loma Prieta earthquake, was reconstructed by Caltrans. A portion of this new freeway connecting I-880 and the SFOBB opened in July 1997. The final link of this new freeway opened at the end of September 1998. The new SFOBB east span is currently under construction. It will include a new structure on the north side of the existing structure. This new structure will have improved on-ramp access from Yerba Buena Island in the eastbound direction.

NSTI Roadway System

The following describes existing roadways on Treasure Island and Yerba Buena Island.

Treasure Island

Roadways on Treasure Island are classified collector or local. Collector roads provide for traffic movement between major streets and local streets.

Local roads provide direct access for local traffic movements. As shown in Figure 3-6, the collector system for Treasure Island is a basic grid. There are two main collector roads serving the east-west direction, California Avenue and 9th Street. Five collector roads carry traffic in the north-south direction—Avenues N, M, H, D, and Avenue of Palms. Avenue of the Palms is the only access road onto Treasure Island from the causeway (Treasure Island Road). The remaining roads on Treasure Island are considered local.

California Avenue is a four-lane two-way roadway. The only traffic control devices on California Avenue are stop signs controlling incoming traffic from the north-south collectors and local roads onto California Avenue. Ninth Street runs from Avenue M to Avenue D as a two-lane roadway and from Avenue D to Avenue of Palms as a four-lane roadway. Ninth Street is controlled by four-way stop signs at its intersections with Avenue M and Avenue H and by a two-way stop sign at its intersection with Avenue D. All five of the north-south collectors are two-lane, two-way roadways. Avenues N, M, H, and D have one curb lane for parking in each direction. Intersections with these collector roads are either two-way or four-way stop sign-controlled. Avenue of Palms does not contain any traffic control devices, except for a stop sign at the Main Gate.

The basic speed limit on Treasure Island roads is 25 miles per hour (mph) (40 km/hour). In the housing areas and school zones the travel speed is 15 mph (24 km/hour). The four-lane roadways have a 35 mph (56 km/hour) speed limit.

The widths of the major four-lane collector streets, such as California Avenue and 9th Street, range from approximately 55 to 75 feet (17 to 23 m) (not including the road right-of-way). The widths of local roads providing access between residential, commercial, and industrial areas range from approximately 25 to 40 feet (7.5 to 12 m).

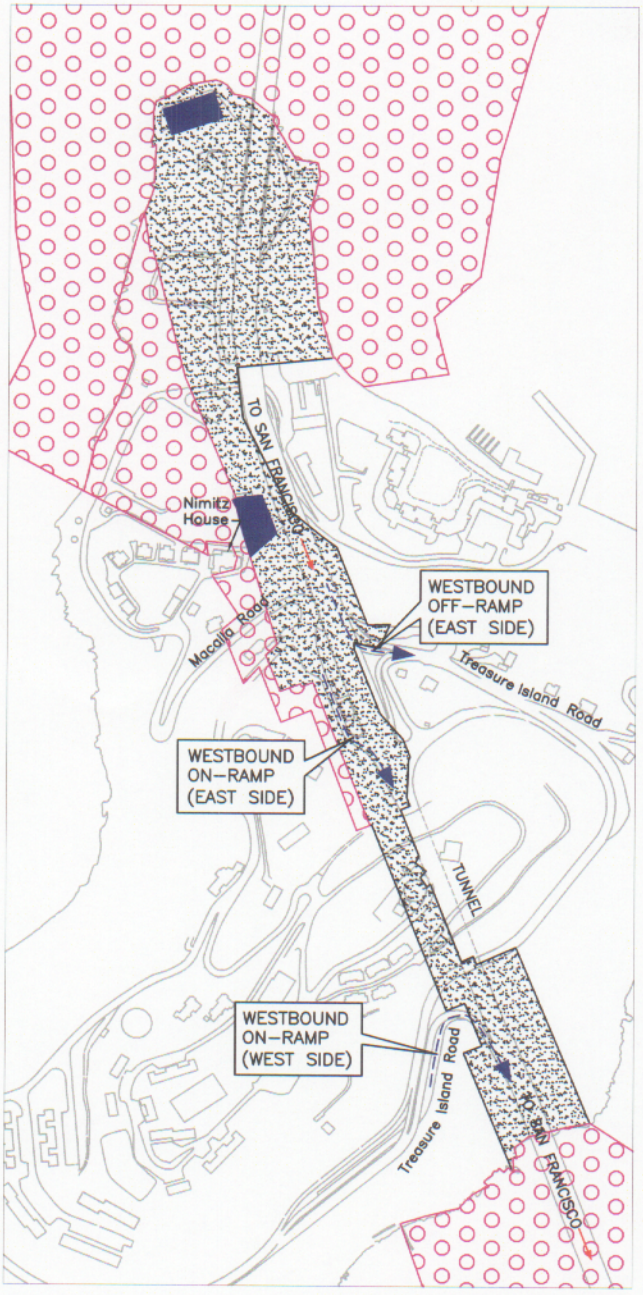
Yerba Buena Island

The roadway network on Yerba Buena Island consists primarily of Treasure Island Road and Macalla Road (Figure 3-7). Treasure Island Road is the primary access road for the SFOBB/I-80 ramps. Macalla Road provides access to the former Navy housing area. Minor streets leading from these two roads provide access to the US Coast Guard Station.

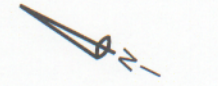
Treasure Island Road, a two-lane two-way roadway that links Treasure Island with Yerba Buena Island, traverses the west and southeast sides of Yerba Buena Island. It provides access for the SFOBB/I-80 ramps, except for the westbound on-ramp at the east side of the tunnel. As it crosses over the SFOBB/I-80 tunnel from west to east, it has a grade of approximately 17 percent. The speed limit on Treasure Island Road varies from 25 to 35 mph (40 to 56 km/hour).

Macalla Road is a narrow two-lane two-way roadway that provides access to the former military housing on Yerba Buena Island and to the US Coast Guard Station. It connects with Treasure Island Road, at which point its grade is approximately 20 percent. Macalla Road provides access to the westbound on-ramp on the east side of Yerba Buena Island at an approximate 12 percent grade. It continues downhill toward former Navy housing and the US Coast Guard Station; access to the US Coast Guard Station is restricted. The speed limit ranges from 10 to 25 mph (16 to 40 km/hour).

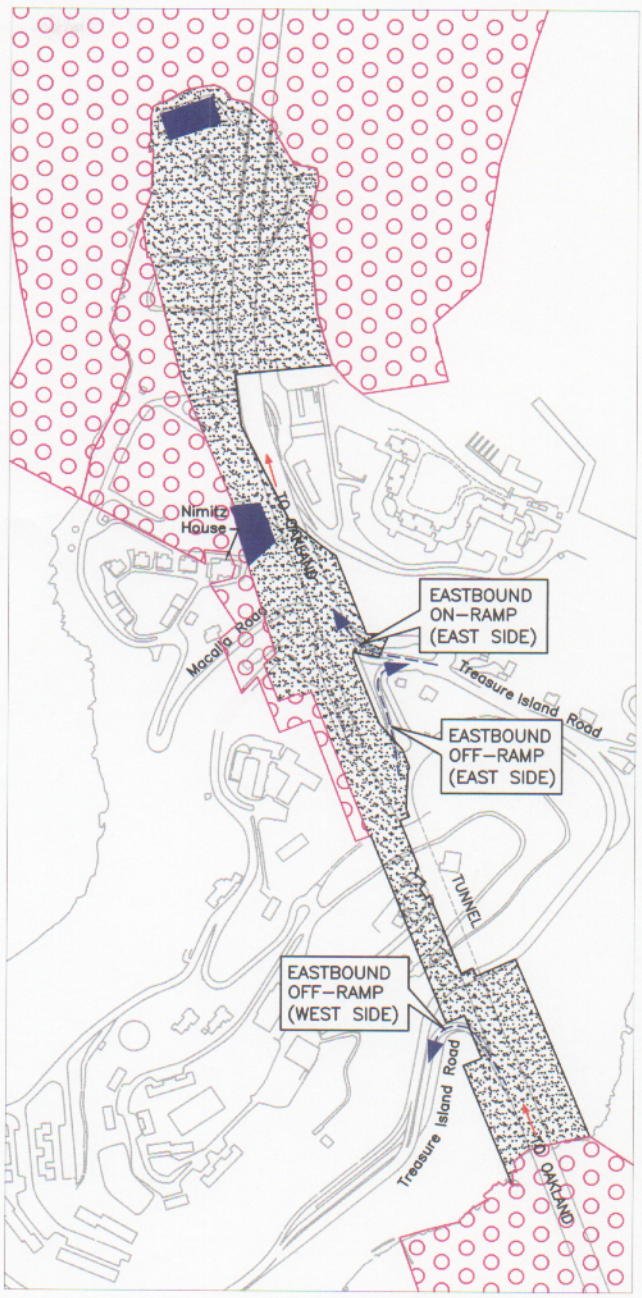
Other roadways include Yerba Buena Road, a narrow two-lane two-way roadway; Signal Road, a two-lane two-way roadway; and Forest Road, a narrow one-lane one-way roadway circling the top of the island. Speeds on these roadways are from 10 to 25 mph (16 to 40 km/hour), and there are a number of sharp turns. Roadway grades on portions of these roadways approach approximately 15 percent. Roadways range from approximately 19 to 32 feet (6 to 10 m) wide, and have no or very narrow (1 to 2 feet [0.3 to 0.6 m] wide) shoulders.



Ramp Configuration
Upper Deck
SFOBB



0 300 600
Scale in Feet



Ramp Configuration
Lower Deck
SFOBB

0 300 600
Scale in Feet

Caltrans has aquired about 98 acres on Yerba Buena Island for existing and proposed SFOBB structures. Six ramps (three on both the upper and lower decks) access the SFOBB. Four ramps are on the east side of the SFOBB tunnel structure, and two ramps are on the west side.

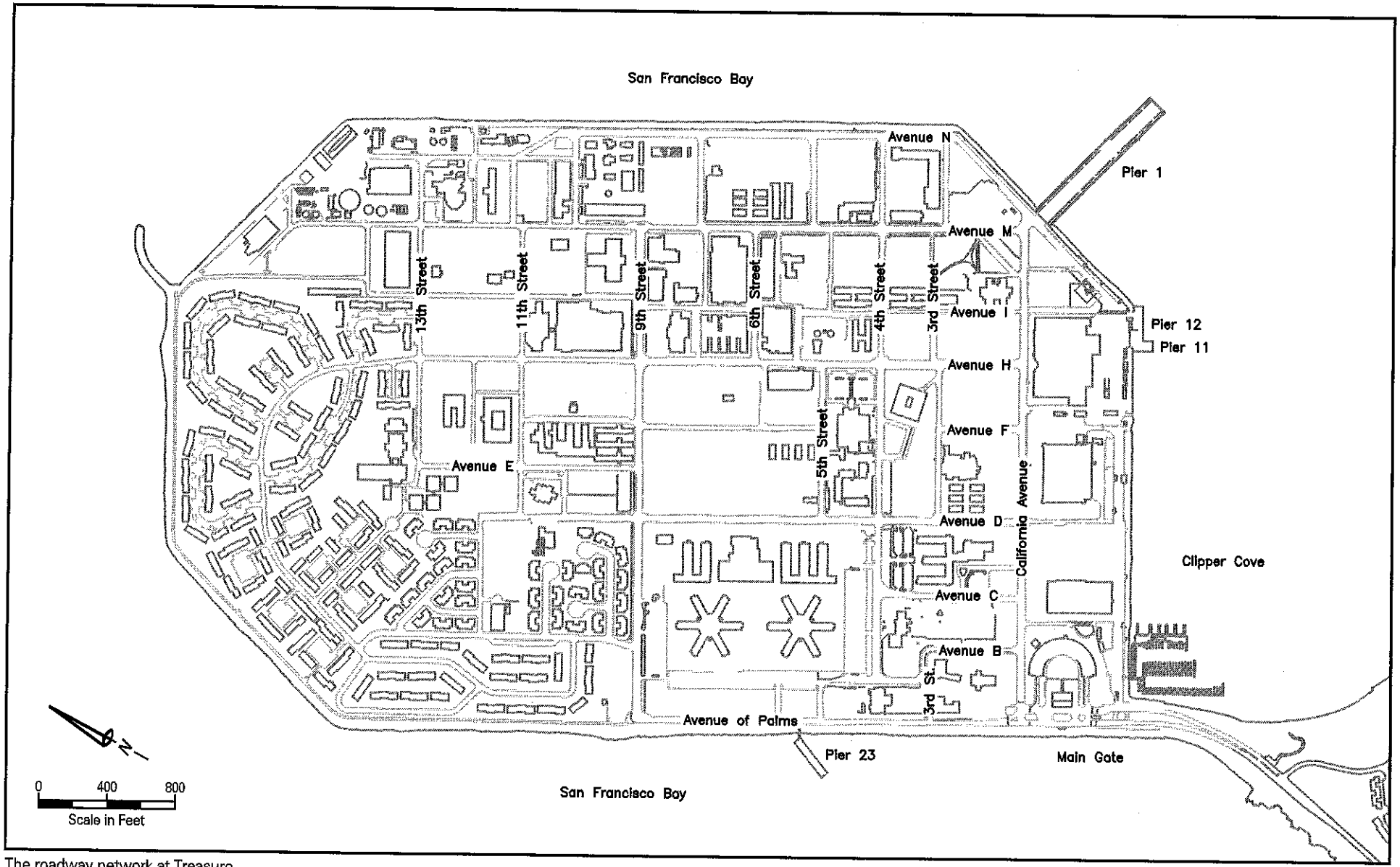
Legend

- FHWA/Caltrans TCEs
- FHWA/Caltrans Land Permanently Conveyed in Fee
- FHWA/Caltrans Aerial Easement

Source: Caltrans 1993, 1994

SFOBB Ramp Configuration through Yerba Buena Island

Figure 3-5

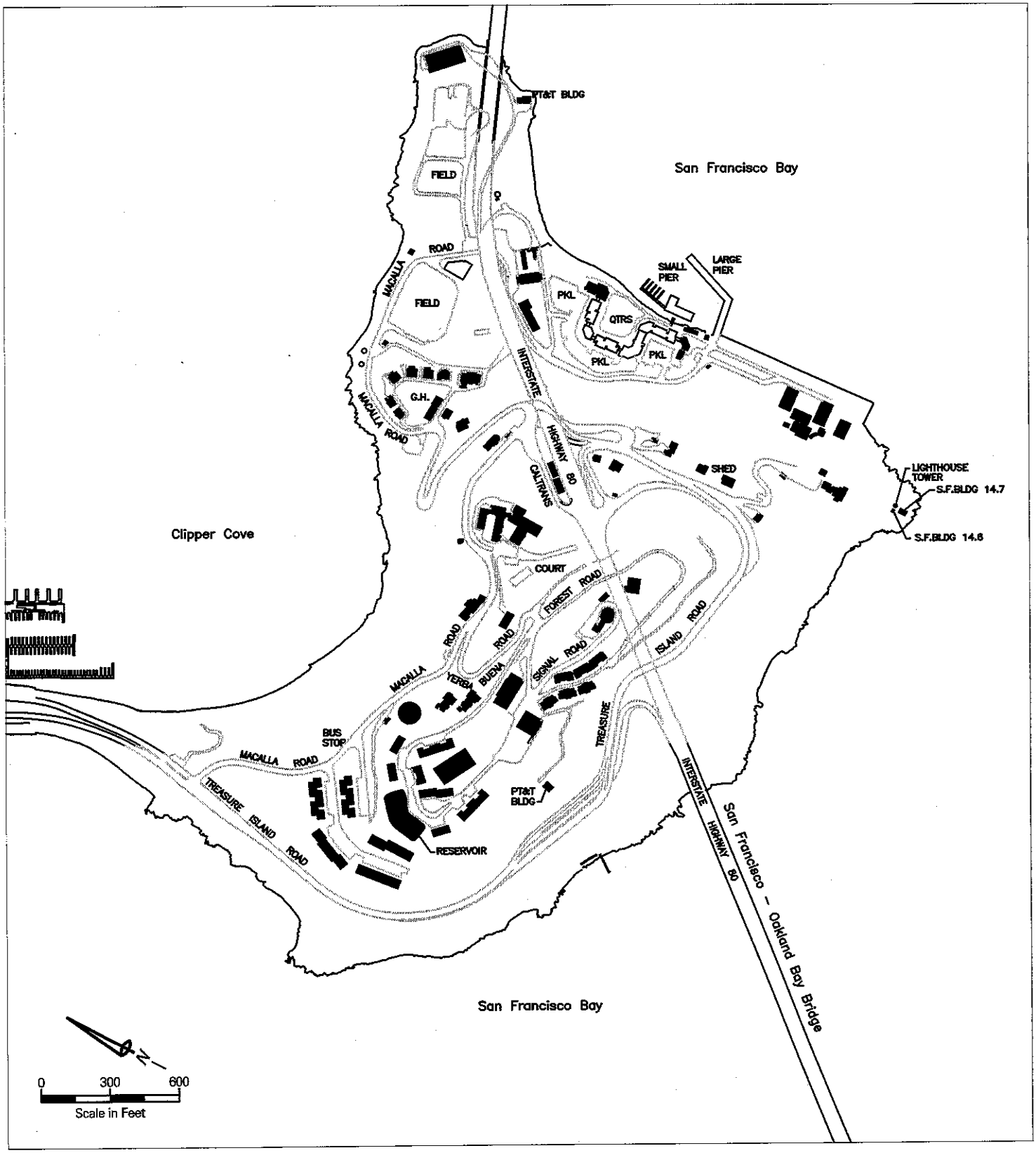


The roadway network at Treasure Island is a basic grid.

Roadway Network at Treasure Island

Source: DON 1988b

Figure 3-6



Macalla Road is a narrow, two-lane two-way roadway that provides access from the SFOBB to the Treasure Island causeway.

Roadway Network at Yerba Buena Island

Source: DON 1988b

Figure 3-7

Emergency Access

Emergency access to NSTI in the event of a bridge or causeway failure could be provided by boat or ferry. The San Francisco Fire Department can access the perimeter of Yerba Buena Island and Treasure Island by fireboat.

Treasure Island has a designated helipad in the vicinity of Pier 1. Air transportation via helicopter is also available to Yerba Buena Island in cases of emergency. The US Coast Guard maintains a designated emergency landing and takeoff area for helicopters on US Coast Guard property (US Coast Guard 1995b).

3.5.2 Traffic Volumes and Level of Service

This analysis and description of existing traffic conditions has been based on traffic data for key freeway access points from Caltrans. The bridge and freeway analysis conducted as part of the September 1996 Alternatives to Replacement of the Embarcadero Freeway and the Terminal Separator Structure EIS/EIR (San Francisco 1996g) has been used to describe existing travel conditions on the SFOBB/I-80.

Existing operating conditions on the SFOBB/I-80 were calculated using the FREQ11 software program. This program evaluates the basic freeway segments, ramp junctions, and weaving areas. The model for the SFOBB/I-80 and I-80/US 101 in downtown San Francisco was developed as part of the Alternatives to Replacement of the Embarcadero Freeway and the Terminal Separator Structure EIS/EIR (San Francisco 1996g). Caltrans 1993 and 1994 traffic data were used for the mainline freeway sections, and 1993 and 1994 traffic data collected for the Alternatives to Replacement of the Embarcadero Freeway EIS/EIR were used for the ramps.

FHWA and Caltrans have approved the proposal to construct a 11,526 foot (3,514 m) new east span of the SFOBB. The new span would be north of the existing east span and the old existing structure would be dismantled (FHWA 2001). This alternative involves constructing a new bridge with two side-by-side bridge decks, each consisting of five lanes. Approximately 1,968 feet (600 m) east of the tunnel on Yerba Buena Island the alignment would transition from a double-deck viaduct structure to two parallel structures. The eastbound on-ramp to the SFOBB would be replaced with a ramp that provides a standard acceleration lane as opposed to the current stop-sign design, resulting in improved eastbound access to the bridge from Yerba Buena Island. The replacement alternative would not increase the SFOBBs vehicular capacity. Shoulders would be added and may improve traffic operations but congestion is unlikely to be affected (Caltrans and FHWA 2001).

Freeway Volumes

Level of Service

Operating characteristics of roadway facilities are described using the term level of service (LOS). LOS designations are a qualitative description of a facility's performance, based on travel speeds, delays, and density (number of cars per unit of lane). The designation for a facility could range from LOS A, representing free-flow conditions, to LOS F, representing severe traffic congestion (Transportation Research Board 1994). See Appendix F.3-B, SFOBB/I-

80 Analysis and Intersection Analysis, for a detailed description of the LOS operating conditions for the various transportation facilities.

Weekday SFOBB/I-80 Traffic Volumes

Westbound traffic on the SFOBB/I-80 is regulated by metering lights west of the toll plaza in Oakland during the peak periods. Two inside and two outside high occupancy vehicle (HOV) bypass lanes for carpools and vanpools with three or more passengers and buses are available upstream of the metering lights on weekdays between 6:00 and 10:00 A.M. and between 3:00 and 6:00 P.M. In the eastbound direction, buses approaching the bridge from San Francisco's Transbay Terminal also receive priority treatment in the form of a dedicated lane that merges downstream with the Essex Street on-ramp traffic, and the Sterling Street on-ramp is dedicated to HOV vehicles only on weekdays between 3:30 and 7:00 P.M.

During the peak hour of the peak period between 6:00 A.M. and 9:00 A.M., the peak direction (westbound) volume is approximately 10,800 vehicles per hour (vph), and the nonpeak direction (eastbound) volume is approximately 8,400 vph (see Appendix F, Freeway Volumes, for 24-hour volumes and average daily vehicle trips). During the peak period of 3:00 P.M. to 7:00 P.M., the peak traffic flow in the eastbound direction is approximately 10,300 vph. Similar to the A.M. eastbound direction, the P.M. peak westbound volume is approximately 8,500 vph. During the nonpeak period of 11:00 A.M. to 2:00 P.M., the traffic volumes drop to approximately 6,500 to 7,000 vph for both the eastbound and westbound directions, resulting in an available capacity on the SFOBB/I-80 of approximately 3,500 to 4,000 vph (total SFOBB/I-80 capacity is 10,500 vph) (Caltrans 1993).

Weekend SFOBB/I-80 Traffic Volumes

In the westbound direction of I-80, the Saturday (weekend) peak period of 10:00 A.M. to 1:00 P.M. has a volume of approximately 8,900 vph. In the eastbound direction, the weekend peak period of 5:00 P.M. to 7:00 P.M. has a volume of approximately 9,600 vph. In both directions, the peak period occurs later in the morning and afternoon than during the weekday peak periods, and additional traffic volume can be accommodated during all times on the mainline because of the lower traffic volumes during all weekend periods.

Congestion Management Network (Weekday SFOBB/I-80 Traffic Volumes)

The segment of the SFOBB/I-80 between San Francisco's Fremont Street and NSTI is within the San Francisco Congestion Management Network. The LOS on this segment (1993 conditions) during the A.M. peak period was LOS E in the westbound direction and LOS D in the eastbound direction, while during the P.M. peak hour it was LOS F in the westbound direction and LOS E in the eastbound direction (SFTA 1993). The segment of the SFOBB/I-80 between the toll plaza and the Alameda and San Francisco county line is within the Alameda County Congestion Management Program's network. The LOS on this segment during the P.M. peak period (1993 conditions) was LOS E in both the westbound and eastbound directions. In 1995, the eastbound segment continued to operate at LOS E, while the westbound segment operated at LOS F (County of Alameda, Congestion Management Agency 1995).

Ramp Volumes

The morning peak hour for traffic on the NSTI ramps is different from the mainline peak hour. In both the westbound and eastbound direction, the morning peak hour for the ramps is between 6:00 and 7:00 A.M. (with a volume of approximately 470 vph for the westbound off-ramp and approximately 170 vph for the eastbound off-ramps), while the mainline peak period is between 7:00 A.M. and 9:00 A.M. (see Appendix F, Ramp Volumes). Similarly, the evening peak for the ramps is earlier than the mainline; the NSTI peak is between 3:00 P.M. and 4:00 P.M., while the mainline peak period is between 4:00 P.M. and 7:00 P.M. The total volume during the peak hour for the two westbound on-ramps is approximately 225 vph, while the volume for the eastbound on-ramp is approximately 310 vph (Caltrans 1994).

Ramp Operations

The SFOBB and NSTI ramps, built in 1937, and especially the westbound and eastbound on-ramps, are substandard by today's requirements. The on-ramp merging distance ranges between approximately 30 and 200 feet (9 and 61 m), far below the Caltrans standard of approximately 600 feet (183 m). The off-ramps are also substandard, primarily in the deceleration lengths provided between the exit point and the first curve (approximately 150 feet [46 m] [existing] versus 300 feet [91.5 m] under today's standard). The radii of the ramps, ranging from approximately 30 feet (9 m) to 100 feet (30.5 m), are less than the desirable 150-foot (46 m) radius currently specified by Caltrans for freeway ramps (Caltrans 1995). The off-ramps do not pose substantial constraints to auto traffic operations but could affect the operation of trucks and buses.

Table 3.5-1 presents a summary of ramp information and identifies the radius of the curve at the tightest point, the approach grade to or from the ramp, and the number and primary causes of accidents reported between January 1992 and April 1995, when use of NSTI by Navy was ending, that is, when the base was not at full activity levels.

Traffic volumes on the Macalla Road westbound on-ramp on the east side of Yerba Buena Island are low, generally less than 50 vph. The westbound on-ramp on the west side of the island carries approximately 140 vph at its peak between 3:00 P.M. and 4:00 P.M. Due to the lower demand in the westbound direction, queues are not substantial during peak periods. These volumes and queues were based on military (former Navy and US Coast Guard) use of the island.

The merging distance for the eastbound on-ramp to Oakland cannot be fully utilized due to the bridge piers that severely restrict sight distance for drivers trying to get onto the bridge. This eastbound on-ramp to the SFOBB/I-80 has an effective merging distance of less than approximately 50 feet (15 m). This is substantially below the design standards (600 feet [183 m]) and severely reduces the number of vehicles that can access the SFOBB/I-80. Based on field observations during site visits, a queue of approximately 1,000 feet (305 m) was reported on Yerba Buena Island during the peak period of 3:00 P.M. to 4:00 P.M.

Table 3.5-1. Summary of Ramp Information

Ramp	*Radius*	*Approach Grade*	*No. of Accidents 1/1997 to 12/2001*
Westbound on-ramp east side of tunnel	60 feet	6.0%	2 (no fatality and injury)
Westbound on-ramp west side of tunnel	90 feet	6.6%	3 (no fatality and injury)
Westbound off-ramp east side of tunnel	30 feet	10.0%	9 (2 injury)
Eastbound off-ramp west side of tunnel	53 feet	7.6%	9 (no fatality and injury)
Eastbound off-ramp east side of tunnel	65 feet	14% at steepest location crossing over tunnel	5 (1 injury)
Eastbound on-ramp east side of tunnel	100 feet	14% at steepest location crossing over tunnel	5 (2 injury)

Note: Caltrans Design Manual indicates that the "ramp profile grades should not exceed 8 percent with the exception of descending entrance ramps and ascending exit ramps, where a 1 percent steeper grade is allowed. However, the 1 percent steeper grade should be avoided on descending loops to minimize overdriving of the ramp."

Source: Caltrans 2002.

Freeway Operations

For the mainline section of I-80 between NSTI and San Francisco, travel speeds were used as the evaluation criteria. During the A.M. peak hour, travel speeds are approximately 35 mph (56 km/hour) in the westbound direction approaching downtown San Francisco, indicating congested travel conditions on the mainline section. Travel speeds in the eastbound direction approaching Treasure Island are approximately 52 mph (84 km/hour).

During the P.M. peak hour, the average mainline travel speeds are somewhat lower than during the A.M. peak hour. Travel speeds in the westbound direction are similar to A.M. peak hour conditions (approximately 33 mph [53 km/hour]), reflecting the congestion on I-80/US 101 that extends upstream onto the SFOBB/I-80. In the eastbound direction, the travel speeds are approximately 47 mph (75.5 km/hour), indicating congested operating conditions (San Francisco 1994b).

Local Intersection Operations

Traffic volumes on NSTI are low throughout the day. Based on field observations, local intersections on Treasure Island and Yerba Buena Island operate with minimal or no delay (LOS A) during both the A.M. and P.M. peak hours.

3.5.3 Public Transportation

San Francisco is a transit hub served by local and regional operators throughout the Bay Area. Limited service is provided to Treasure Island and Yerba Buena Island. The following describes the service provided by Muni, the school bus service for students between NSTI and San Francisco, and the regional ferry service.

Muni Line 108 Service

Muni currently operates the only public transit service to Treasure Island and Yerba Buena Island. This service is designated as Line 108 (Figure 3-8). Muni assumed responsibility and operation of the "T" Route in December 1996 from the Alameda-Contra Costa Transit District (AC Transit), which formerly ran the T service between Alameda and San Francisco via Treasure Island, and renamed it Line 108. Line 108 now operates bidirectional service between Treasure Island and Yerba Buena Island and the Transbay Terminal in San Francisco only; direct service is no longer provided between NSTI and the East Bay. Bus shelters are provided at a number of stops on the islands.

The Line 108 service operates every 20 minutes during weekday A.M. and P.M. peak periods and evening. The rest of the time and weekends, it runs every 60 minutes. Weekday daily ridership is about 520 passengers (San Francisco MUNI 1999-2000).

School Bus Service

The SFUSD provided transportation for students who lived in San Francisco and on Treasure Island and attended the Treasure Island Elementary School and for students that lived on the island and attended middle and high schools in San Francisco. Approximately 240 students were transported to and from the elementary school on Treasure Island. Five buses were used in this service. Five buses arrived on the island during the 7:00 A.M. hour, two during the noon hour, and five during the 2:00 P.M. hour.

Approximately 228 middle and high school students were transported from the island to various school locations in San Francisco. Six buses accessed the island between 7:00 A.M. and 8:00 A.M., and one accessed the island around 9:00 A.M. Five buses accessed the island in the 3:00 P.M. hour, three in the 4:00 P.M. hour, and two in the 5:00 P.M. hour. In addition, seven elementary and three high school special education students were transported at various times of the day on and off the island in vehicles equipped with wheelchair lifts.

Other Land-based Transit Services

Airport shuttle services, taxis, and other private transportation services access the island on an as-called basis. There are no schedules for these services or statistics outlining the frequency they are used.

Ferry Service

None of the regional ferry carriers currently stop at Treasure Island or Yerba Buena Island. The Red and White Fleet provided service following the Loma Prieta Earthquake in 1989 when there was no bridge access to the East Bay. In late March 1995, Harbor Bay Maritime initiated a

shuttle service between Naval Air Station Alameda and Treasure Island. Within the first 2 weeks of service, approximately 40 passengers a day were carried on two A.M. peak and two P.M. peak trips.

The US Coast Guard Station on the southeast side of Yerba Buena Island has both fixed piers and floating docks. On Treasure Island, piers 11 and 12 consist of wooden decking at the parking lot level, supported by deteriorating wood piles. A narrow gangway that does not meet the Americans with Disabilities Act (ADA) access requirements connects the fixed piers to anchored floating barges (no pilings), which are attached to the pier. The piers cannot be used by vessels because they barely extend beyond the riprap shore. Vessels tie up to the floating barges.

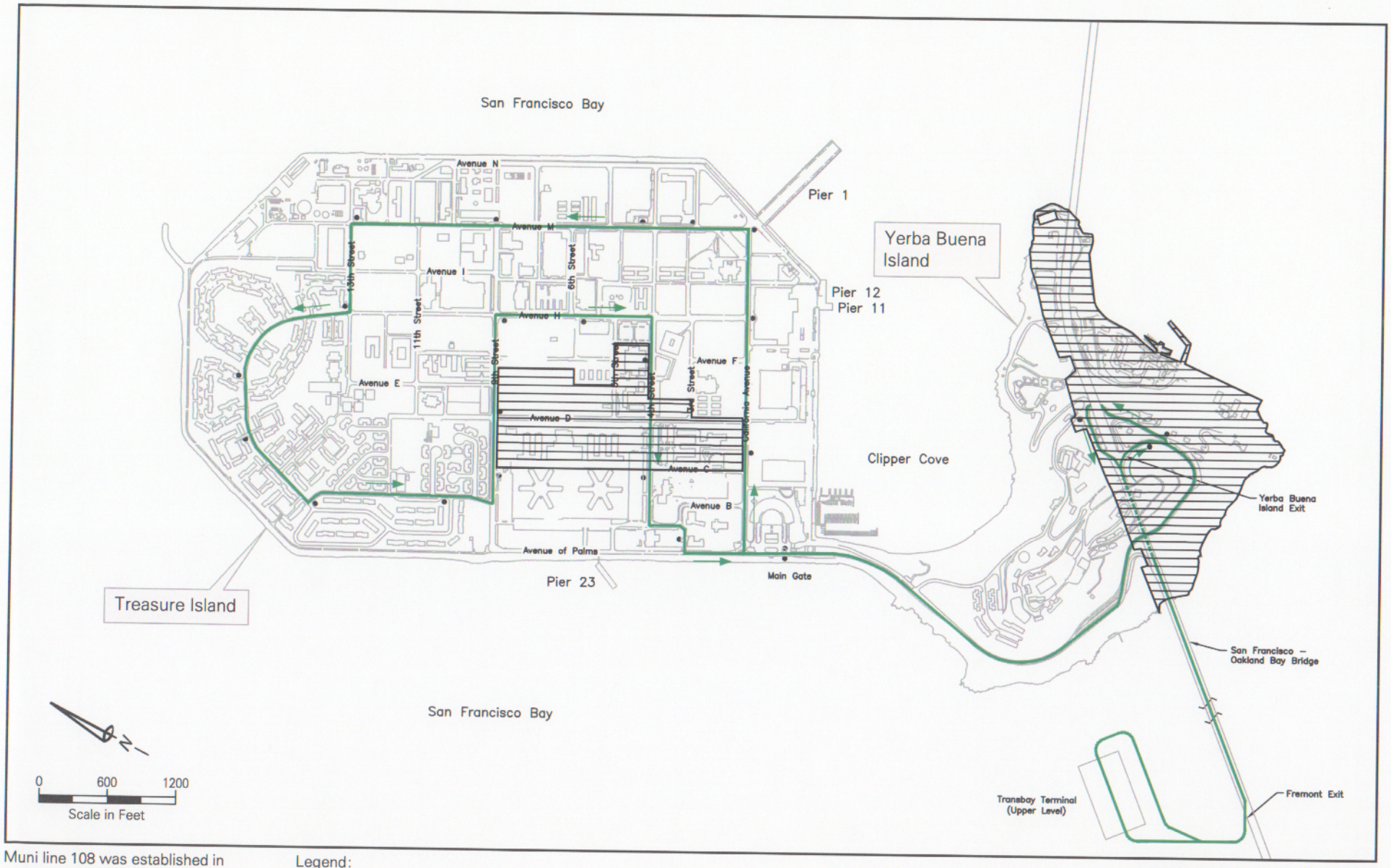
Pier 1 is a fixed concrete pier 930 feet (283 m) long by 125 feet (38 m) wide that is in good condition. Large vessels can tie up to Pier 1. However, the vessels must have a long gangway suitable of reaching the 10- to 13-foot (3- to 4-m) freeboard (height of the deck above the water) of this pier at mean low tide. None of the ferries presently operating in the Bay have this capability, although several large excursion vessels might be able to use the facility during some tidal conditions with a second deck gangway. The current service uses a float with a gangway attached to Pier 1.

There are six active ferry routes in the Bay Area, all of them connecting the San Francisco downtown to Sausalito, Tiburon, Larkspur, Vallejo, Alameda and Oakland, and Bay Farm Island (Figure 3-9). Several of the routes operate to the Fisherman's Wharf/Pier 39 area during off-peak hours. This includes the Sausalito and Tiburon service, and the Vallejo and Alameda and Oakland services. Besides these routes, there is a recreation service providing trips to Angel Island State Park from Tiburon and from San Francisco's Fisherman's Wharf and Pier 39. A summary description of each of the routes and existing conditions at the ferry terminals is included in Table 3.5-2 and Table 3.5-3. Of these existing six routes, only the Alameda and Oakland to San Francisco route would be affected by the proposed action and is described in more detail below.

San Francisco Ferry Building and Pier ½

This location is the primary ferry docking facility in San Francisco. The Golden Gate Bridge, Highway, and Transportation District has a two-berth terminal behind the building with a sheltered waiting room and hydraulic ramps. A small driveway on the south side of the Ferry Building provides vehicular access for autos and shuttle vans; buses provide connecting service along The Embarcadero in front of the building.

All other ferry services use the floating dock at Pier ½, between the north end of the Ferry Building and Pier 1. The parking spaces north of the Ferry Building are reserved for long-term users (Port of San Francisco parking permit required). Transit service is available at the foot of Market Street approximately 800 feet (244 m) from the terminals, with access to many Muni lines. Muni Metro and BART are available at the corner of Market and Drumm Streets, about two blocks away. An Amtrak bus connection also is provided at the Ferry Building, providing service to and from Amtrak's Emeryville and Jack London Square stations.



Muni line 108 was established in December 1996 to service Treasure Island. It is currently the only public transit service to Treasure Island.

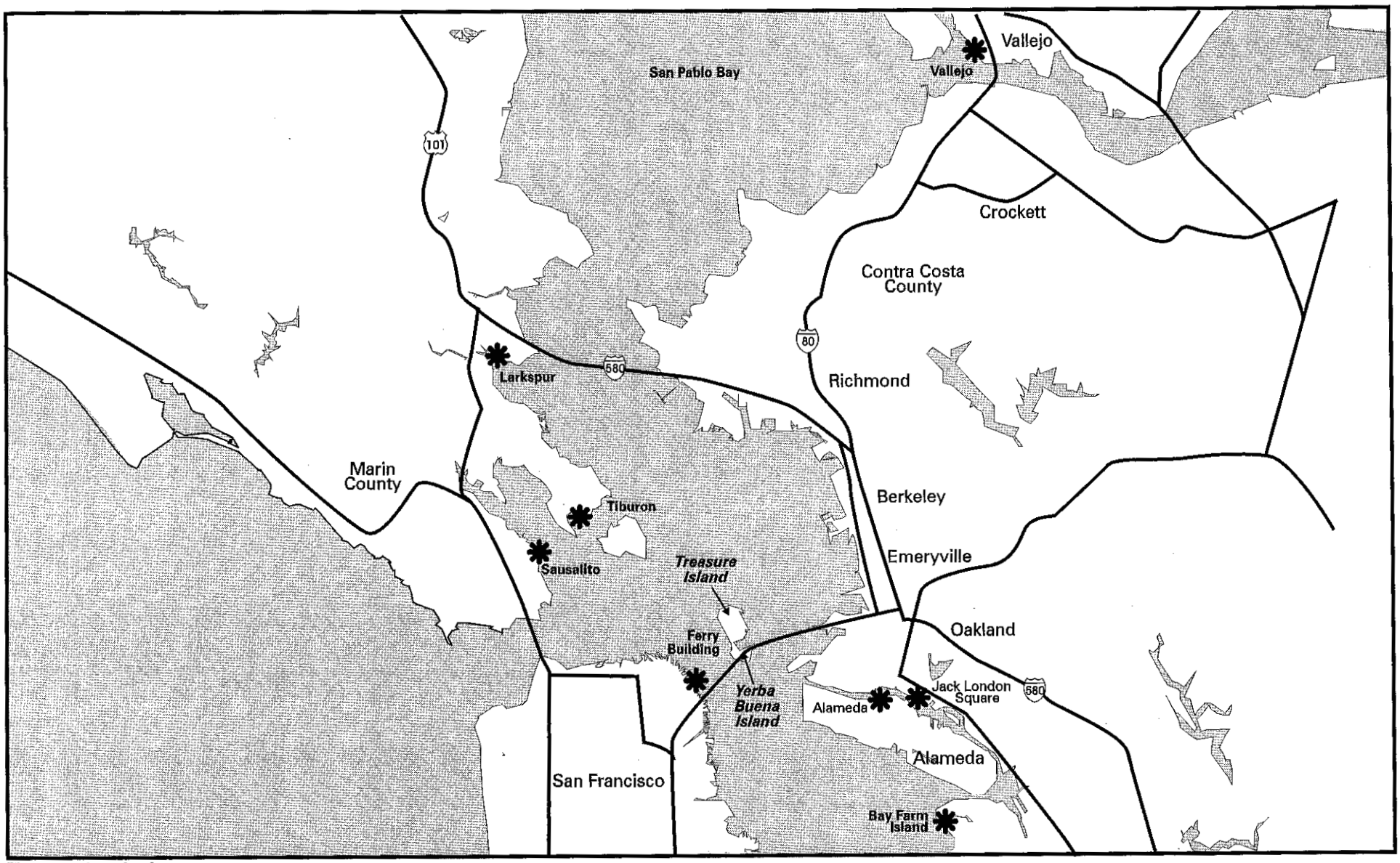
Legend:

- Bus Stop
- Route
- Areas Excluded from Proposed Navy Disposal

Muni Line 108

Naval Station Treasure Island, California

Figure 3-8



There are six active ferry routes in the Bay Area, all of them connecting to the San Francisco Ferry Building. The Jack London Square terminal in Oakland and Alameda terminal are considered one route.

LEGEND:

✱ Ferry Terminal Site

Ferry Terminal Locations

Bay Area, California

Figure 3-9

Table 3.5-2. Profile of Existing Bay Area Ferry Services

Route	*Operator*	*Daily Ferry Round-trips (Weekday)*	*1994 Annual Riders*
Larkspur - San Francisco Ferry Building	Golden Gate Transit	13 – 15	940,000
Sausalito – San Francisco Ferry Building	Golden Gate Transit	9 – 11 (seasonal)	465,000
Sausalito – San Francisco Ferry Fisherman's Wharf	Red & White *	4	354,000
Tiburon – San Francisco Ferry Ferry Building/Fisherman's Wharf	Red & White *	9	301,000
Vallejo - San Francisco Ferry Building/Fisherman's Wharf	Blue & Gold	4	209,000
Alameda/Oakland – San Francisco Ferry Building/Fisherman's Wharf	Blue & Gold	12	278,000
Alameda (Bay Farm) – San Francisco Ferry Building	Harbor Bay Maritime	6	94,000

* Operator changed to Blue and Gold in 1997
Source: San Francisco 1995a.

Alameda-Oakland to San Francisco

The Alameda terminal at the foot of Main Street has approximately 250 parking spaces for ferry patrons, and the Jack London Square facilities have approximately 1,100 undedicated parking spaces. Both Oakland and Alameda have floating docks with covered, accessible piers and gangways.

The 5-mile (8-km) route connecting Jack London Square on the Oakland Estuary with the Ferry Building and Pier 39 (off-peak) includes a stop at a terminal at the foot of Main Street adjacent to the former Alameda Naval Air Station. Approximately 2 miles (3 km) of the route are in the estuary, and 3 miles (5 km) are in open water. Travel time from Oakland to San Francisco is approximately 22 to 25 minutes with the Alameda stop. Travel from the Alameda Terminal to the Ferry Building is about 12 to 15 minutes. A 12-daily round-trip schedule is operated on weekdays, hourly during peak periods, and every other hour during the off-peak. Weekend service includes six to eight ferry round-trips, depending on the season.

Ridership has grown on this route, with 278,000 passenger trips in 1994 compared to about 202,000 in 1990. The introduction of a larger faster vessel, allowing more ferry and passenger trips, led to a 24 percent increase in ridership. Weekday ridership averages 800 to 900 passengers per day, with most commuters traveling between Alameda and San Francisco. Off-peak travelers use the Oakland Terminal to a greater degree. Summer weekend patronage can be upwards of 1,000 passengers a day, and both weekend and afternoon peak ferry trips from San Francisco often approach or exceed the vessel capacity of 250 people.

Table 3.5-3
Traffic Conditions and Parking Supply at Existing Ferry Terminals

Location	Traffic Conditions[1]		Parking Supply	Parking Occupancy	
	WEEKDAY (PM)	WEEKEND (MIDDAY)		WEEKDAY (PM)	WEEKEND (MIDDAY)
Larkspur	heavy	medium	dedicated supply of 1,150 spaces park & ride: 20 spaces 8 bus bays	85-90%	15%
Sausalito	heavy	heavy	around 265 spaces - not dedicated for ferry use	50%	100% (not all ferry passengers)
Tiburon	medium	medium	limited private parking (about 220 spaces) located 300 to 500 feet from dock - not dedicated for ferry use	50%	40-50%
Vallejo	light	light	dedicated supply of 500 spaces	50%	5-10%
Oakland – Jack London Square	medium	medium	Jack London Square area lot and garage total long-term supply of 1,100 spaces - not dedicated for ferry use	80-90% (15% ferry passengers)	10%
Alameda - Main St.	medium	light	dedicated supply of 250 spaces	70-80%	10%
Alameda - Bay Farm Island	light	-	dedicated supply of 250 spaces	30-40%	-
San Francisco - Pier 39 / Fisherman's Wharf & Pier 43 ½ / Fisherman's Wharf	light	medium	total supply of 1,525 spaces directly adjacent to the piers - not dedicated for ferry use	50-60%	70-80%
San Francisco - Pier ½ / Ferry Building	heavy	heavy	*no ferry parking available*	N/A	N/A

[1]Traffic conditions are defined as follows:
Light: low to moderate traffic volumes on roadway, with minimal delays at intersections. Medium: higher traffic volumes on roadways, with some waiting at intersections. Heavy: roadways are crowded, with moderate to long delays at intersections.
N/A = *not applicable*
Source: San Francisco 1995a; revised by Korve 1997.

In Alameda, AC Transit provides a dedicated shuttle (Route 325) between central Alameda and the ferry terminal. The Oakland Terminal, at the foot of Clay Street, uses the Port of Oakland garage one block from the terminal. A number of AC Transit routes provide service within 2 blocks of the ferry terminal, including connections to the 12th Street City Center BART Station, approximately 12 blocks from the terminal. The City of Oakland also operates a midday shuttle service on Broadway, connecting downtown Oakland, including the 19th and 12th street BART stations, to Jack London Square during weekdays.

3.5.4 Pedestrian and Bicycle Circulation

Treasure Island

There are no designated bicycle facilities on Treasure Island, but there is a sidewalk network throughout the island. Sidewalks are provided on at least one side of all the roads on the island, with some streets having sidewalks on both sides. Sidewalks and crosswalks meet ADA standards in nonresidential areas but are not ADA-accessible in residential areas. In addition, crosswalks are available at all intersections. In most cases, landscaping separates the sidewalk and the street curb. On several streets, the sidewalk is not aligned along the road, and the sidewalk distance from the curbside varies from block to block.

Yerba Buena Island

Sidewalks are not provided except on one side of Macalla Road between Treasure Island Road and the Macalla Court former Navy housing. Throughout Yerba Buena Island, concrete stairs provide pedestrian access between facilities and roadways. There are no designated bicycle facilities, but several of this island's narrow roadways are closed to vehicle traffic.

3.5.5 Parking

Treasure Island

On most of the major and minor collector roadways on Treasure Island, 90-degree parking is available, except on the perimeter roads and California Avenue. Parking restrictions are in effect at a number of industrial and retail locations on the island that have allocated parking spaces. Other parking restrictions include painted red zones near bus shelters, most residential areas, and collector streets, such as California and Avenue of Palms. Figure 3-10 presents the locations where on-street parking is allowed.

In the residential areas, covered and uncovered off-street parking spaces are available. Some housing units have garages. The older apartments have parking stalls. On the rest of the island, off-street parking lots are available (Figure 3-10).

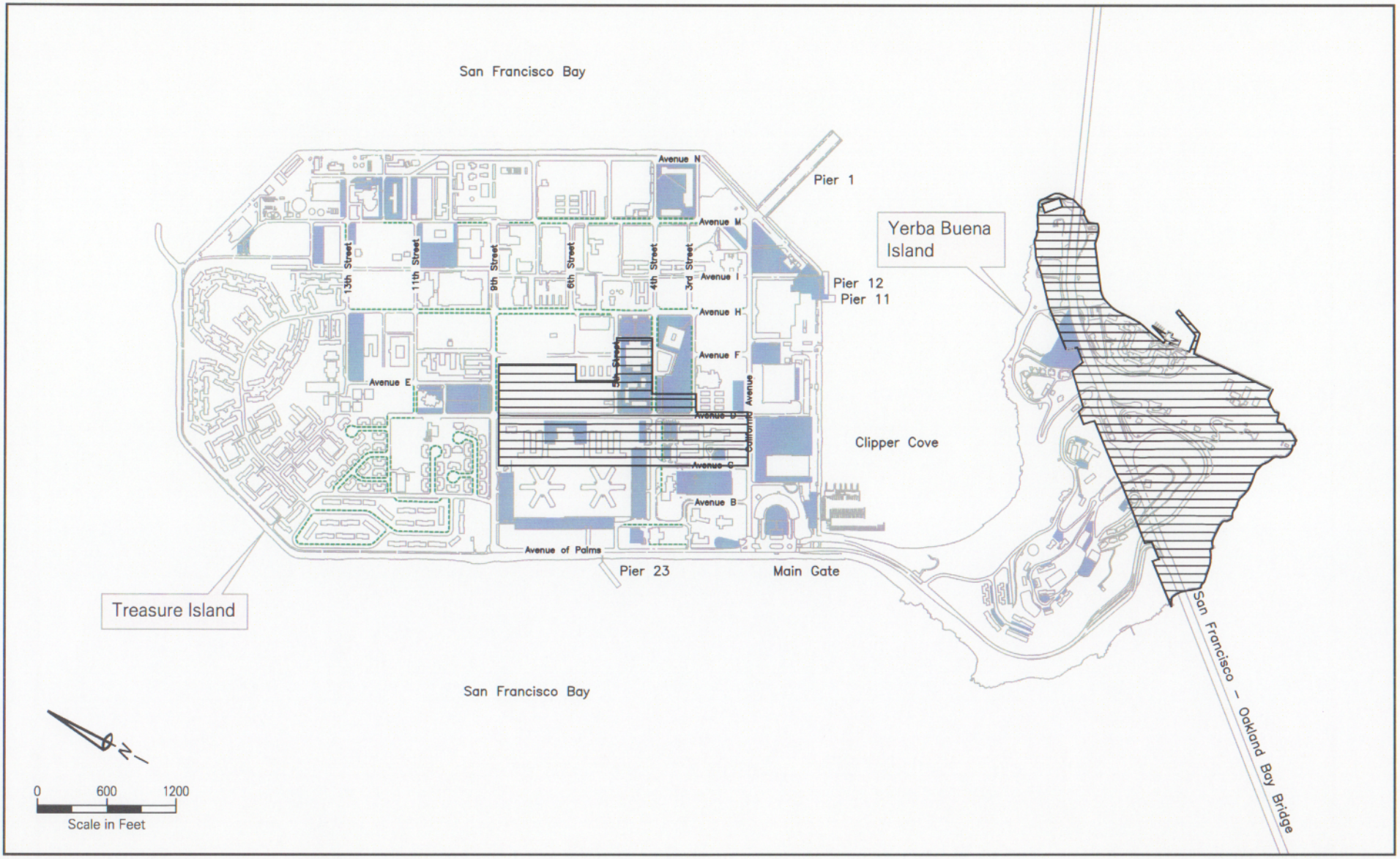
A public viewing area, with views of the downtown San Francisco skyline, is directly outside the base entrance. There are approximately seven parking spaces, including one space for disabled persons, and a yellow zone for bus parking.

Yerba Buena Island

On-street parking is not permitted on Yerba Buena Island roads. Residential areas include off-street parking (Figure 3-10).

3.5.6 Goods Movement

Freight service deliveries to Treasure Island are primarily by truck. The eastbound off-ramp at the east side of the tunnel has a 12-foot (3.5-m) height restriction.



Parking is available on most of the major roadways on Treasure Island, except on the perimeter road and California Avenue. Limited off-street parking is available on Yerba Buena Island.

Legend:

- On-street Parking
- Off-street Parking
- Areas Excluded from Proposed Navy Disposal

Parking at NSTI

Naval Station Treasure Island, California

Source: US Navy 1988b

Figure 3-10

3.6 AIR QUALITY

Air pollutants are characterized as being "primary" or "secondary" pollutants. Primary pollutants are those emitted directly into the atmosphere (e.g., carbon monoxide, sulfur dioxide, lead particles, and hydrogen sulfide). Secondary pollutants are those formed through chemical reactions in the atmosphere (e.g., ozone and sulfate particles); these chemical reactions involve primary pollutants, pollutants present in the atmosphere, and other secondary pollutants.

3.6.1 Climate and Meteorology

The San Francisco Bay Area experiences a Mediterranean-type climate, characterized by mild temperature conditions. Weather conditions are monitored at major airports and various locations in the Bay Area (WeatherDisc Associates 1990a, 1990b, 1990c, 1990d). Daily temperature variations are typically 44 to 58 degrees Fahrenheit (°F) during the winter and 54 to 66 °F during the summer. Annual precipitation averages about 20 inches (51 centimeters [cm]) at sea level locations, with most precipitation falling from October through April. Poor visibility, primarily due to heavy fog, is most likely during late fall and winter.

3.6.2 Applicable Regulations, Plans, and Policies

The federal Clean Air Act (42 U.S.C. §§ 7401-7671q, as amended in 1977 by Pub. L. 95-95, 91 Stat. 685-796 and Pub. L. 95-190, 91 Stat. 1399-1404) requires the adoption of national ambient air quality standards (NAAQS) to protect the public health, safety, and welfare from known or anticipated effects of air pollution. The NAAQS have been updated occasionally. Current standards are set for sulfur dioxide (SO_2), carbon monoxide, nitrogen dioxide (NO_2), ozone (O_3), particulate matter equal to or less than 10 microns in size (PM_{10}), fine particulate matter equal to or less than 2.5 microns in size ($PM_{2.5}$), and lead. These federal standards are shown in Table 3.6-1.

The Clean Air Act Amendments of 1990 (Pub. L. 101-549, 104 Stat. 2399 codified as amended at 42 U.S.C. §§ 7401-7671q) require the US Environmental Protection Agency (EPA) to promulgate rules to ensure that federal actions conform to the appropriate state implementation plan (SIP). These rules, known together as the General Conformity Rule (40 C.F.R. §§ 51.850-51.860 and 40 C.F.R. Part 93), require any federal agency responsible for an action to determine if its action conforms with pertinent guidelines and regulations. Certain actions are exempt from conformity determination, including those actions associated with transfers of land or facilities where the federal agency does not retain continuing authority to control emissions associated with the properties. Federal actions also may be exempt if the projected emissions rates would be less than specified emission rate thresholds, known as de minimis limits.

The Clean Air Act defines a group of pollutants called Hazardous Air Pollutants (HAPs) or air toxics. Exposure to these pollutants is a concern, as they can cause or contribute to cancer, birth defects, genetic damage, and other adverse health effects. The source and effects are generally local rather than regional. Evaluation is based on case studies, not standards for concentrations. Examples of air toxics include benzene and asbestos. Title III of the Clean Air Act provides a program for the control of 189 HAPs. The first stage of the program involves the

Table 3.6-1
Federal Ambient Air Quality Standards

			Standard, as parts per million (ppm) by volume	Standard, as micrograms per cubic meter (µg/m³)	Violation Criteria
Pollutant	*Symbol*	*Averaging Time*	*National*	*National*	*National*
Ozone	O_3	1 Hour	0.12	235	If exceeded on more than 3 days in 3 years
		8 Hours	0.08	157	If exceeded by the mean of annual 4th highest daily values for a 3-year period
Carbon Monoxide	CO	8 Hours	9.0	10,000	If exceeded more than 1 day per year
		1 Hour	35	40,000	If exceeded more than 1 day per year
Inhalable Particulate	PM_{10}	Annual Geometric Mean[1]	---	---	---
Matter		Annual Arithmetic Mean[2]	---	50	If exceeded as a 3-year single station average
		24 Hours	---	150	If exceeded by the mean of annual 99th percentile values over 3 years
Fine Particulate Matter	$PM_{2.5}$	Annual Arithmetic Mean	---	15	If exceeded as a 3-year spatial average of data from designated stations
		24 Hours	---	65	If exceeded by the mean of annual 98th percentile values over 3 years
Nitrogen Dioxide	NO_2	Annual Average	0.053	100	If exceeded
		1 Hour	---	---	---
Sulfur Dioxide	SO_2	Annual Average	0.03	80	If exceeded
		24 Hours	0.14	365	If exceeded more than 1 day per year
		3 Hours	0.5	1,300	If exceeded more than 1 day per year
		1 Hour	---	---	---
Lead Particles	Pb	Calendar Quarter	---	1.5	If exceeded more than 1 day per year
		30 Days	---	---	---
Sulfate Particles	SO_4	24 Hours	---	---	---
Hydrogen Sulfide	H_2S	1 Hour	---	---	---
Vinyl Chloride	C_2H_3Cl	24 Hours	---	---	---

Notes: All standards except the national PM_{10} and $PM_{2.5}$ standards are based on measurements corrected to 25 degrees Celsius and 1 atmosphere pressure.

The national PM_{10} and $PM_{2.5}$ standards are based on direct flow volume data without correction to standard temperature and pressure.

Decimal places shown for standards reflect the rounding precision used for evaluating compliance.

Except for the 3-hour sulfur dioxide standard, the national standards shown are the primary (health effects) standards.

The national 3-hour sulfur dioxide standard is a secondary (welfare effects) standard.

EPA adopted new ozone and particulate matter standards on July 18, 1997; the new standards became effective on September 16, 1997.

The national 1-hour ozone standard will be rescinded for an area when EPA determines that the standard has been achieved in that area.

Previous national PM_{10} standards (which had different violation criteria than the September 1997 standards) will remain in effect for existing PM_{10} nonattainment areas until EPA takes actions required by Section 172(e) of the Clean Air Act or approves emission control programs for the relevant PM_{10} state implementation plan.

Violation criteria for all standards except the national annual standard for $PM_{2.5}$ are applied to data from individual monitoring sites.

Violation criteria for the national annual standard for $PM_{2.5}$ are applied to a spatial average of data from one or more community-oriented monitoring sites representative of exposures at neighborhood or larger spatial scales, 40 C.F.R. Part 58.

The "10" in PM_{10} and the "2.5" in $PM_{2.5}$ are not particle size limits; these numbers identify the particle size class (aerodynamic equivalent diameters in microns) collected with 50 percent mass efficiency by certified sampling equipment. The maximum particle size collected by PM_{10} samplers is about 50 microns aerodynamic equivalent diameter; the maximum particle size collected by $PM_{2.5}$ samplers is about 6 microns aerodynamic equivalent diameter, 40 C.F.R. Part 53.

[1] The annual geometric mean is defined as the "nth" root of the product of "n" observations.

[2] The annual arithmetic mean is defined as the sum of "n" observations divided by the number of observations.

Sources: National Ambient Air Quality Standards (ARB Fact Sheet 39); 40 C.F.R. Parts 50, 53, and 58.

promulgation of National Emissions Standards for HAPs (NESHAPs) to reduce HAP emissions from new and existing sources. Major sources will be required to implement Maximum Available Control Technology. Area sources will be required to implement general achievable control technology. This will be followed by a second phase in which residual risks will be evaluated, and further controls will be considered.

The California Clean Air Act of 1988, as amended in 1992 (CCAA), outlines a program to attain the California ambient air quality standards (CAAQS) for O_3, NO_2, SO_2, and CO by the earliest practical date. Since the CAAQS are more stringent than the NAAQS, emissions reductions beyond what would be required to show attainment of the NAAQS are needed.

The Bay Area Air Quality Management District (BAAQMD) is the regional authority that enforces the state and federal Clean Air Act requirements by promulgating rules for the purpose of regulating stationary emission sources. BAAQMD is also responsible for the preparation of the planning documents that guide the efforts necessary to achieve the national and state ambient air quality standards. The current planning document is the *Bay Area 2001 Ozone Attainment Plan*, which functions as that part of the SIP applicable to the BAAQMD (BAAQMD et al 2001). This plan also contains measures to show progress towards attainment of the state O_3 standard.

3.6.3 Regional and Local Air Quality

Bay Area

With respect to federal ambient air quality standards, specific geographic areas are classified by the EPA as either nonattainment, attainment, or unclassified for each pollutant. For most air pollutants, initial federal status designations are made as either nonattainment or unclassified. In the federal usage, the unclassified designation includes attainment areas that comply with federal standards and areas for which monitoring data are lacking. Unclassified areas are treated as attainment areas for most regulatory purposes. Federal attainment designations generally are used only for areas that change from a nonattainment status to an attainment status.

In June 1998, the San Francisco Bay Area was reclassified from an attainment/maintenance area to an unclassified nonattainment area for the federal one-hour ozone standard. The urbanized portions of the San Francisco Bay Area are categorized presently as attainment areas for the federal carbon monoxide standards. The Bay Area is currently designated as unclassified for the federal PM_{10} standard (BAAQMD 1998).

Ozone, CO, and PM_{10} are the major pollutants of concern in the Bay Area and are monitored at a number of locations. The monitoring station at Arkansas Street in San Francisco (between US 101 and I-280, south of Sixteenth Street) is the major monitoring location for the city. Carbon monoxide levels in San Francisco also are monitored at the BAAQMD office on Ellis Street. Table 3.6-2 summarizes recent (1990-1999) monitoring data for O_3, CO, and PM_{10}.

Table 3.6-2
Summary of Recent Air Quality Monitoring Data for San Francisco Monitoring Stations

Monitoring Station	*Air Quality Indicator*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*
OZONE											
San Francisco - Arkansas St.	Peak 1-hour value (ppm)	0.06	0.05	0.08	0.08	0.06	0.09	0.07	0.07	0.05	0.08
	Days above federal standard	0	0	0	0	0	0	0	0	0	0
CARBON MONOXIDE											
San Francisco - Arkansas St.	Peak 1-hour value (ppm)	8.0	9.0	8.0	7.0	6.0	5.0	5.0	5.0	N/A	N/A
	Peak 8-hour value (ppm)	5.6	6.5	6.4	5.1	4.5	4.4	3.9	3.5	4.0	3.7
	Days above federal standard	0	0	0	0	0	0	0	0	0	0
San Francisco - Ellis St.	Peak 1-hour value (ppm)	12.0	14.0	10.0	10.0	8.0	9.0	9.0	8.0	N/A	N/A
	Peak 8-hour value (ppm)	6.9	8.4	7.4	6.9	5.4	5.5	5.6	5.8	5.7	3.8
	Days above federal standard	0	0	0	0	0	0	0	0	0	0
INHALABLE PARTICULATE MATTER, PM10											
San Francisco - Arkansas St.	Peak 24-hour value ($\mu g/m^3$)	165	109	81	69	93	50	71	81	52	78
	Annual geometric mean ($\mu g/m^3$)	27.8	29.7	27.6	25.1	24.7	22.1	21.4	22.5	20.1	N/A
	Annual arithmetic mean ($\mu g/m^3$)	34.0	34.9	31.6	28.8	28.0	24.9	24.3	25.0	N/A	N/A
	Number of 24-hour samples	61	60	61	61	61	61	61	61	61	61
	% of samples above federal standard	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Notes: ppm = parts per million by volume.
$\mu g/m^3$ = micrograms per cubic meter.
N/A = Data not available.
Federal 1-hour ozone standard is 0.12 ppm.
Federal 1-hour carbon monoxide standard is 35 ppm.
Federal 8-hour carbon monoxide standard is 9 ppm.
Federal PM_{10} standards: 50 $\mu g/m^3$, annual arithmetic mean; 150 $\mu g/m^3$, 24-hour average.
PM_{10} samples are collected approximately once every six days. Other pollutants are monitored continuously (except for instrument calibration and maintenance periods).
Source: CARB 1990-1997; CARB 2000.

The federal 1-hour O_3 standard is 0.12 ppm. The federal 1-hour CO standard is 35 ppm, while the federal 8-hour standard is 9.0 ppm. Federal standards for O_3 and CO were not violated in San Francisco from 1990 to 1999. Several violations of the federal ozone standard occurred in other parts of the Bay Area during 1995, 1996, and 1998 (in Contra Costa, Alameda, and Santa Clara counties) (CARB 1995, 1996; BAAQMD 1997; BAAQMD et al. 1999).

The federal 24-hour average PM_{10} standard is 150 $\mu g/m^3$. The federal PM_{10} standard has not been exceeded in the project region since 1990.

NSTI

Air emission sources at NSTI included stationary sources, where emissions from a source are generated at a fixed point, and mobile sources, where emissions from a source may be generated at multiple locations.

Stationary Sources

Stationary emission sources at NSTI included boilers, fuel storage tanks, gasoline dispensing islands, individual fuel dispensing facilities, a gasoline truck loading rack, an incinerator, a paint spray booth, a sandblasting machine, miscellaneous welding and sheet metal equipment, an electric heating oven, a fire fighter training facility, and a wastewater treatment system.

Approximately 82 percent of the stationary sources at NSTI operated under air quality permits issued by the BAAQMD. Exempt sources are those not requiring permits because the sources are indicated explicitly in relevant BAAQMD rules as exempt from permit requirements. The permit exemption can be based on equipment capacity, material usage, or emissions below certain thresholds. At closure of NSTI, Navy had 32 permitted stationary sources and 7 exempt sources (DON 1997j). As shown in Table 3.6-3, some permitted and exempt sources have been retained by Navy to meet DoD needs, some have been shut down, and some, based on Navy's preliminary allocation plan, may be transferred to the LRA.

Table 3.6-3. Stationary Emission Source Status at NSTI

Sources and Disposition Status	*Number of Sources*
Number of stationary sources	
With BAAQMD permits	32
Exempt from permit requirements	7
Total	**39**
Permitted sources banked by Navy to meet DoD needs	1
Permits or exempt sources that may be transferred to the LRA	13
Permitted sources shut down or transferred to other agencies	25

Source: DON 1997j.

The BAAQMD has an emissions banking program to credit facilities that close or reduce emissions from permitted sources. The emissions reduced may be deposited into the banking program as offsets to meet future permit requirements at DoD facilities. NSTI had one banking certificate as of February 1997.

Mobile Sources

Mobile sources at NSTI included private and government vehicles, heavy trucks, lawn maintenance equipment, ships, and aircraft. The mobile source emission inventory for NSTI documented 1992 emission levels from on-road vehicles and off-road mobile sources, such as marine vessels and ground support equipment. These emissions are shown in Table 3.6-4.

Table 3.6-4. NSTI Mobile Source Emissions Summary

Activity Type or Vehicle Class	*Tons per Year*				
	ROG	**CO**	**NOx**	**PM10**	**SOx**
Privately Owned Vehicles	6.5	54.8	4.9	1.9	0.1
Government-owned Vehicles	0.9	7.6	1.6	0.2	0.0
Commercial Vehicles and Visitors	9.1	65.8	12.5	3.7	0.3
Off-road Equipment	1.7	6.6	0.5	0.0	0.0
Ship Operations	17.0[1]	20.5	88.5	3.0[2]	12.8
Totals	**35.3**	**155.3**	**107.9**	**8.9**	**13.2**

[1] Emissions provided as hydrocarbons
[2] Assumes all particulate emissions are equal to PM_{10}
ROG= reactive organic gases
CO= carbon monoxide
NO_x= nitrogen oxides
PM_{10}= inhalable particulate matter
SO_x= sulfur oxides
Source: DON 1996s.

3.7 NOISE

Most sound consists of a broad range of frequencies. Because the human ear is not equally sensitive to sound at all frequencies, noise is measured using the "A-weighted" decibel scale (dBA), which estimates the way the human ear responds to noise levels.

Average noise exposure over 24 hours often is presented as a day-night average sound level (Ldn) or a community noise equivalent level (CNEL). Ldn values are calculated from hourly equivalent noise level (Leq) values, with the Leq values for the nighttime period (10:00 PM to 7:00 AM) increased by 10 dB to reflect the greater disturbance potential from nighttime noises. Leq values are used to develop single-value descriptions of average noise exposure over various periods. CNEL values are very similar to Ldn values but include a 5 dB annoyance adjustment for the evening period (7:00 PM to 10:00 PM) in addition to the 10 dB adjustment for nighttime Leq values. Unless otherwise noted, Ldn and CNEL values are assumed to be based on dBA measurements.

3.7.1 Noise Standards

Community noise consists of a wide variety of sounds, some near and some distant, that vary over a 24-hour day. Scientists and planners have found that humans respond generally to the 24-hour variation in noise based on the total energy content of the sound over the day, with a greater sensitivity to noise in the evening and at night.

State of California

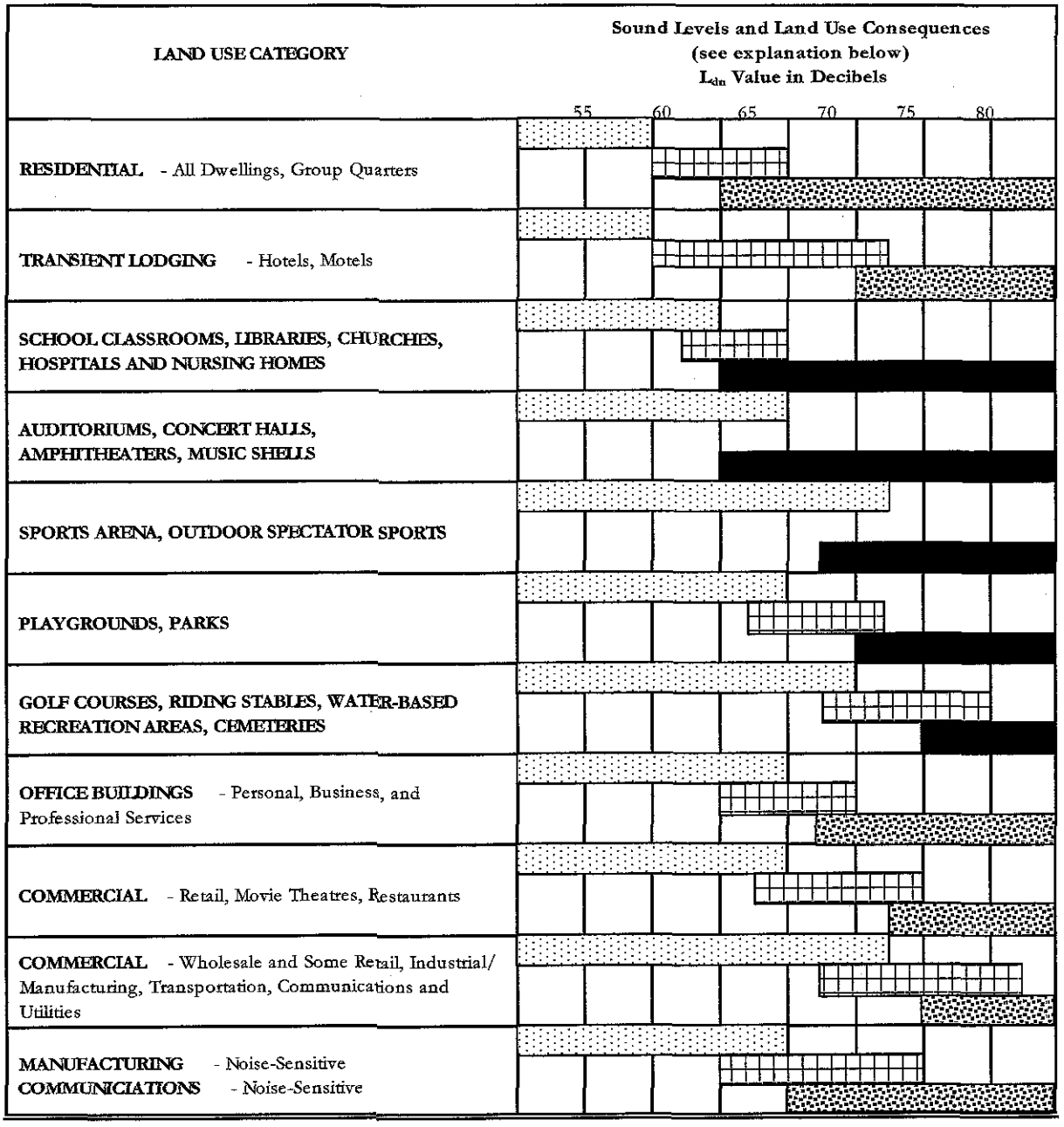
The California Department of Housing and Community Development has adopted noise insulation performance standards for new hotels, motels, and dwellings other than detached single-family structures (Cal. Code Regs. Title 25, § 4370). These standards require that hotels, motels, and multiple-unit dwellings be constructed so that outdoor noise sources will not cause interior noise levels to exceed an annual average CNEL value of 45 dB with windows closed.

City and County of San Francisco

The noise element for the San Francisco General Plan is in the Environmental Protection Element. The noise element includes a land use compatibility chart (Table 3.7-1). An Ldn of 60 dB is identified as the upper limit of satisfactory noise conditions for residential and transient lodging land uses. Ldn levels of 65 to 70 dB are generally satisfactory for most office and retail commercial land uses.

In addition to general policy guidance provided by the General Plan, San Francisco has adopted a noise ordinance (Article 29 of the Police Code) to regulate noise from fixed sources, portable equipment, construction activities, and other sources of unnecessary, excessive, or offensive noise. The ordinance contains general nuisance abatement provisions and specific noise limitations that vary by zoning district, time of day, and type of noise source. The general noise limitations specified in the noise ordinance are summarized in Table 3.7-2. The ordinance contains provisions for emergency work, emergency and safety signaling devices, and various types of impact tools, pavement breakers, and jackhammers. The ordinance provides for a variance process and a permit process for nighttime construction work.

Table 3.7-1. Land Use Compatibility Chart for Community Noise



Source: San Francisco 1974, 1991.

Satisfactory, with no special noise insulation requirements.

New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design.

New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the

New construction or development should generally not be undertaken.

Table 3.7-2. Summary of Noise Limits Established in the San Francisco Noise Ordinance

Noise Source	*Applicable Zoning District*	*Time Period*	*Noise Limits*
Construction Equipment (Except Impact Tools)	All Zoning Districts	7 AM – 8 PM	80 dBA at 100 feet limit does not apply to impact tools and equipment
		7 AM – 8 PM	5 dBA above ambient at property line without special permit
Waste Collection Equipment	All Zoning Districts	Any time	75 dBA at 50 feet
Off-Highway Vehicle Use - Off-Highway Vehicles - Heavy-Duty Vehicles - Motorcycles - Other Highway Vehicles	Public Zones	Any time	 70 dBA at 50 feet 82 dBA at 50 feet 77 dBA at 50 feet 74 dBA at 50 feet
Fixed Noise Sources	Low- and Medium-Density Residential Zones	7 AM – 10 PM	55 dBA at property line
		10 PM - 7 AM	50 dBA at property line
	High-Density Residential,	7 AM – 10 PM	60 dBA at property line
	Neighborhood Commercial, and Residential Commercial Zones	10 PM - 7 PM	50 dBA at property line
	Commercial Zones	7 AM – 10 PM	70 dBA at property line
		10 PM - 7 AM	60 dBA at property line
	Light Industrial Zones	Any time	70 dBA at property line
	H(rI t	Any time	dBA at property line
Engine-Powered Model Vehicle Use	Low- and Medium-Density Residential Zones	7 AM – 10 PM	55 dBA at 50 feet
		10 PM - 7 AM	50 dBA at 50 feet
	High-Density Residential Neighborhood Commercial and Residential Commercial Zones	7 AM – 10 PM	60 dBA at 50 feet
		10 PM - 7 AM	50 dBA at 50 feet
	Commercial Zones	7 AM – 10 PM	70 dBA at 50 feet
		10 PM - 7 AM	60 dBA at 50 feet
	Light Industrial Zones	Any time	70 dBA at 50 feet
	Heavy Industrial Zones	Any time	75 dBA at 50 feet
	Public Zones	Any time	80 dBA at 50 feet

Note: The noise ordinance provi

Source: San Francisco Police Code, Article 29.

3.7.2 Existing Treasure Island Noise Conditions

Most of Treasure Island is more than 0.5 mile (0.8 km) from the open portions of the SFOBB. Consequently, wind, occasional aircraft fly-over, and local traffic are the primary noise sources affecting Treasure Island.

Limited ambient noise monitoring conducted at NSTI during 1986 showed afternoon noise levels of 55 to 58 dBA at each of four different locations on Treasure Island (DON 1987). The noise monitoring locations on Treasure Island included the east side of Building 257 at 9th Avenue and Avenue E, the corner of 9th Avenue and Avenue B, in front of Building 369 (bachelor officer quarters), and the parking lot for Building 3. The 1986 noise monitoring results are a reasonable representation of conditions on Treasure Island at the time of closure (1993). Present noise levels are likely to be similar or lower than conditions in 1986 since there is currently far less activity on Treasure Island. The majority of Treasure Island is too far from the SFOBB to be measurably affected by traffic noise.

Short-term (10-minute) noise measurements conducted in a film studio parking lot near piers 11 and 12 on Treasure Island in 1998 showed a measured noise level of 62 dBA. Noise modeling performed to predict the highest noise period and level for existing SFOBB traffic conditions indicated a peak noise-hour level of 67 dBA at this location (Caltrans and FHWA 1998).

3.7.3 Existing Yerba Buena Island Noise Conditions

SFOBB traffic is the dominant noise source affecting Yerba Buena Island. During 1986 noise monitoring at NSTI, a noise level of 67 dBA was recorded at the north end of Yerba Buena Island near Building 213 (Former Fire Station No. 2), about 300 feet (91 m) from the SFOBB (DON 1987).

Noise monitoring also was conducted on Yerba Buena Island during January 1996 (DON 1996h). One location was monitored for a 24-hour period, and 12 locations were monitored for 15-minute periods. The 24-hour monitoring site was at the eastern end of Yerba Buena Island, approximately 80 feet (24 m) below the SFOBB. The Ldn measurement at this site was 76 dB, with a peak 1-hour noise level of 74 dBA (3:00 PM to 4:00 PM) and a minimum 1-hour noise level of 65 dBA (4:00 AM to 5:00 AM). A noticeable decrease in noise levels occurred during the afternoon rush hour due to reduced vehicle speeds caused by traffic congestion.

Noise levels measured at the short-term monitoring sites depended on proximity to the SFOBB and the extent that terrain shielded the noise source. The noisiest areas were close to the east and west side tunnel openings. Noise levels during the late morning and early afternoon were generally 65 to 73 dBA for sites near the SFOBB and 52 to 58 dBA for distant locations or locations shielded by buildings or terrain.

Additional noise monitoring conducted in 1998 at Yerba Buena Island showed that with the exception of noise measurements taken on US Coast Guard property south of the existing SFOBB, noise levels ranged from 66 to 74 dBA. Yerba Buena Island 24-hour noise measurements ranged from 59 dBA to 72 dBA (Caltrans and FHWA 1998).

3.8 BIOLOGICAL RESOURCES

Biological resources include plant and animal species and the habitats or communities in which they occur. This section is divided into discussions of regulatory considerations, vegetation, wildlife species, sensitive or special status species, sensitive habitats, essential fish habitats, and wetlands. The ROI for biological resources includes Treasure Island and Yerba Buena Island and surrounding aquatic habitat within a half-mile (0.8-km) radius. This radius of the surrounding bay was selected because it includes potential sensitive species and habitats that could be affected by NSTI reuse activities, such as dredging and ferry service to and from NSTI.

Biological data were collected from numerous sources, including the California Department of Fish and Game (CDFG) Natural Diversity Database (CDFG 2001), the California Native Plant Society (CNPS), and environmental documents cited in this section. Data from a November 1996 plant survey of Yerba Buena Island also is included in this section (DON 1996r). Field surveys were conducted on April 12, 22, and 30, May 13 and 28, June 17, and October 4, 18, and 20, 1996, and September 14, 2001, to identify the natural resources at NSTI and to check for the presence of sensitive species. Sensitive species are those that the U.S. Fish and Wildlife Service (USFWS) has proposed for listing as endangered, threatened, or candidates for listing or as species of special concern. USFWS and the National Oceanic and Atmospheric Administration (NOAA)'s National Marine Fisheries Service (NMFS, also referred to as NOAA Fisheries) personnel were consulted regarding the likelihood of finding listed species at NSTI (see Appendix C for copies of correspondence).

3.8.1 Regulatory Considerations

Natural resources in the project area were evaluated in accordance with the applicable provisions of the following statutes, executive orders, and permit requirements.

Endangered Species Act

The Endangered Species Act of 1973 (ESA) (16 U.S.C. §§ 1531-1534) protects plant and animal species (and their designated critical habitats) that are listed under the act as threatened or endangered. Species are listed as endangered if found to be in danger of extinction throughout all or a significant portion of their ranges. Threatened species are those likely to become endangered within the foreseeable future. The ESA also protects designated critical habitat for listed species. This consists of specific geographic areas which are essential to the conservation of the species, which may require special management considerations. ESA-listed species of marine invertebrates, marine and anadromous fishes, marine reptiles, and marine mammals with the exception of the sea otter are under the jurisdiction of NMFS. Remaining ESA-listed species, including the sea otter, are under the jurisdiction of the USFWS. The ESA requires federal agencies to consult with the USFWS or NMFS, as applicable to the species in question, before initiating any action that may adversely affect a listed species.

Migratory Bird Treaty Act and Executive Order 13186

The Migratory Bird Treaty Act of 1918 (MBTA) (16 U.S.C. §§ 703-712) is domestic legislation implementing international agreements made among the United States and England, Mexico, the former Soviet Union, and Japan to protect migratory bird populations. It protects

indigenous species of birds that live, reproduce, or migrate within or across international borders at some point during their life cycles from unauthorized take (possession, injury, or mortality). Executive Order 13186, issued by President Clinton in 2001, provides additional mechanisms for federal agencies to protect migratory birds and promote their conservation.

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) (16 U.S.C. §§ 1361-1421h) protects and conserves marine mammal species by prohibiting harm or harassment of any marine mammal unless specifically authorized by NOAA Fisheries. If a project proponent determines that an action could harm harass marine mammals, the proponent shall consult with either the USFWS or NMFS to determine if a permit to take a marine mammal is required.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (amended by the Sustainable Fisheries Act of 1996, Pub. L. 104-267, as codified in scattered sections of 16 U.S.C. § 1801 et seq.) applies to fisheries resources and fishing activities in federal waters that extend to 200 miles (322 km) offshore. It addresses conserving and managing U.S. fisheries, developing domestic fisheries, and phasing out foreign fishing activities. It also establishes regional fisheries management councils that set fishing quotas and restrictions in U.S. waters in the form of fish management plans (FMPs). All fish included in a FMP are assigned essential fish habitat (EFH)—those waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity. Federal agencies must consult with the NMFS on proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. The act sets forth the enforcement actions that authorized officers may take, including making arrests, boarding, searching, and inspecting fishing vessels and seizing fishing vessels, fish, and other evidence. For more detailed information on FMPs and EFH, refer to section 3.8.6.

Clean Water Act/Federal Water Pollution Control Act

The CWA/Federal Water Pollution Control Act (33 U.S.C. §§ 1251-1387) sets the basic structure for regulating discharges of pollutants to waters of the U.S. This includes those waters used for navigation or those leading to navigable rivers or waters used for interstate commerce (including lakes) and wetlands bordering streams or other waterbodies. The CWA states that it is unlawful for any person to discharge any pollutant from a point source into navigable waters in the absence of a permit. Section 404 of the Clean Water Act (33 U.S.C. § 1344) requires a permit from the COE for the placement of dredged or fill material into the waters of the United States.

Waters of the United States include all waters that are, have been, or are likely to be, important to interstate commerce, including tidal waters, freshwater lakes, rivers and streams, and wetlands that are adjacent to these bodies of water. The landward regulatory limit for nontidal waters (in the absence of adjacent wetlands) is the "ordinary high water mark," which is the line on the shores established by the fluctuations of water and indicated by physical characteristics. Wetlands are defined under the CWA regulations as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically

adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 C.F.R. 328.3). Jurisdictional wetlands exist when the following three criteria are present: wetlands hydrology, hydric soils, and hydrophytic vegetation (COE 1987).

Water quality on and around Treasure Island is regulated by the San Francisco Regional Water Quality Control Board (RWQCB), which operates under authority delegated to it by the EPA and the State Water Resources Control Board (SWRCB). The RWQCB is the local agency that implements the CWA and (the State Porter-Cologne Water Quality Act (Cal. Water Code §§ 13000-13999.19). The RWQCB regulates discharges under the National Pollutant Discharge Elimination System (NPDES) permit regulations. NPDES permitting requirements cover runoff discharged from point sources (e.g., industrial outfall discharges) and specific nonpoint sources (e.g., stormwater runoff), including construction and industrial sites. The RWQCB implements the NPDES program by issuing construction and industrial discharge permits.

The RWQCB, EPA, COE, and BCDC also participate in the San Francisco Bay Long Term Management Strategy (LTMS) for dredging in San Francisco Bay (information at www.epa.gov/region09/water/ltms/ltms.html). The LTMS is intended to identify long-term solutions for dredging and dredged material disposal for a 50-year planning period. An estimated average of approximately 300 million cubic yards (229 million m^3) per year of dredge materials will require disposal through the planning period (1995 to 2045). The LTMS agencies have established a Dredged Material Management Office (DMMO) which provides guidance on sediment testing for new dredging programs, and for disposing of, rehandling, and reusing dredge material in both construction and fill activities.

Rivers and Harbors Appropriations Act of 1899

Section 10 of the Federal Rivers and Harbors Appropriations Act of 1899 (RHA) (30 Stat. 1151, codified at 33 U.S.C. §§ 401, 403) prohibits the unauthorized obstruction or alteration of any navigable water (33 U.S.C. § 403). Navigable waters under the RHA are those "subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce" (33 C.F.R. § 3294). Typical activities requiring Section 10 permits are construction of piers, wharves, bulkheads, marinas, ramps, floats, intake structures, cable or pipeline crossings, and dredging and excavation.

National Environmental Policy Act

NEPA requires federal agencies to evaluate the environmental impacts of proposed projects, programs, and policies that could significantly affect the quality of the human environment.

California Endangered Species Act

Under the California Endangered Species Act (CESA) (Cal. Fish & Game Code §§ 2050-2116), CDFG maintains a list of threatened and endangered species at the state level and a list of candidate species, which are those under review for being added to the state list of endangered or threatened species. The CDFG also maintains watch lists of species of special concern. Pursuant to the requirements of CESA, an agency reviewing a proposed project within its jurisdiction must determine whether any state-listed endangered or threatened species could be

present in the project area and must determine whether the proposed project will have a potentially significant impact on such a species. In addition, the CDFG encourages informal consultation on any proposed project that could affect a candidate species. The CESA applies to state and local government agencies only and not the federal government.

McAteer-Petris Act

The McAteer-Petris Act (Cal. Gov't Code §§ 66600-66682) created BCDC, which regulates dredging and filling and public access within 100 feet (30 m) of the mean high tide line within San Francisco Bay. Under the McAteer-Petris Act, BCDC has jurisdiction over all areas of the bay that are subject to tidal action, including subtidal areas, intertidal areas, and tidal marsh areas that are between mean high tide and five feet above mean sea level. In addition, BCDC has jurisdiction over a 100-foot (30-m) shoreline band surrounding the bay from the mean high tide line. BCDC's jurisdiction does not extend to federally owned areas, such as the Navy or US Coast Guard property on Yerba Buena Island, because they are excluded from state coastal zones pursuant to the Coastal Zone Management Act.

Coastal Zone Management Act

The CZMA (16 U.S.C. §§ 1451-1465) encourages states to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources, such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. To encourage states to participate, the CZMA makes federal financial assistance available to any coastal state or territory that is willing to develop and implement a comprehensive coastal management program. Federal agencies are required to carry out activities that affect any land or water use or natural resource of a state's coastal zone in a manner consistent with the enforceable policies of an approved state management plan.

Executive Order 11990

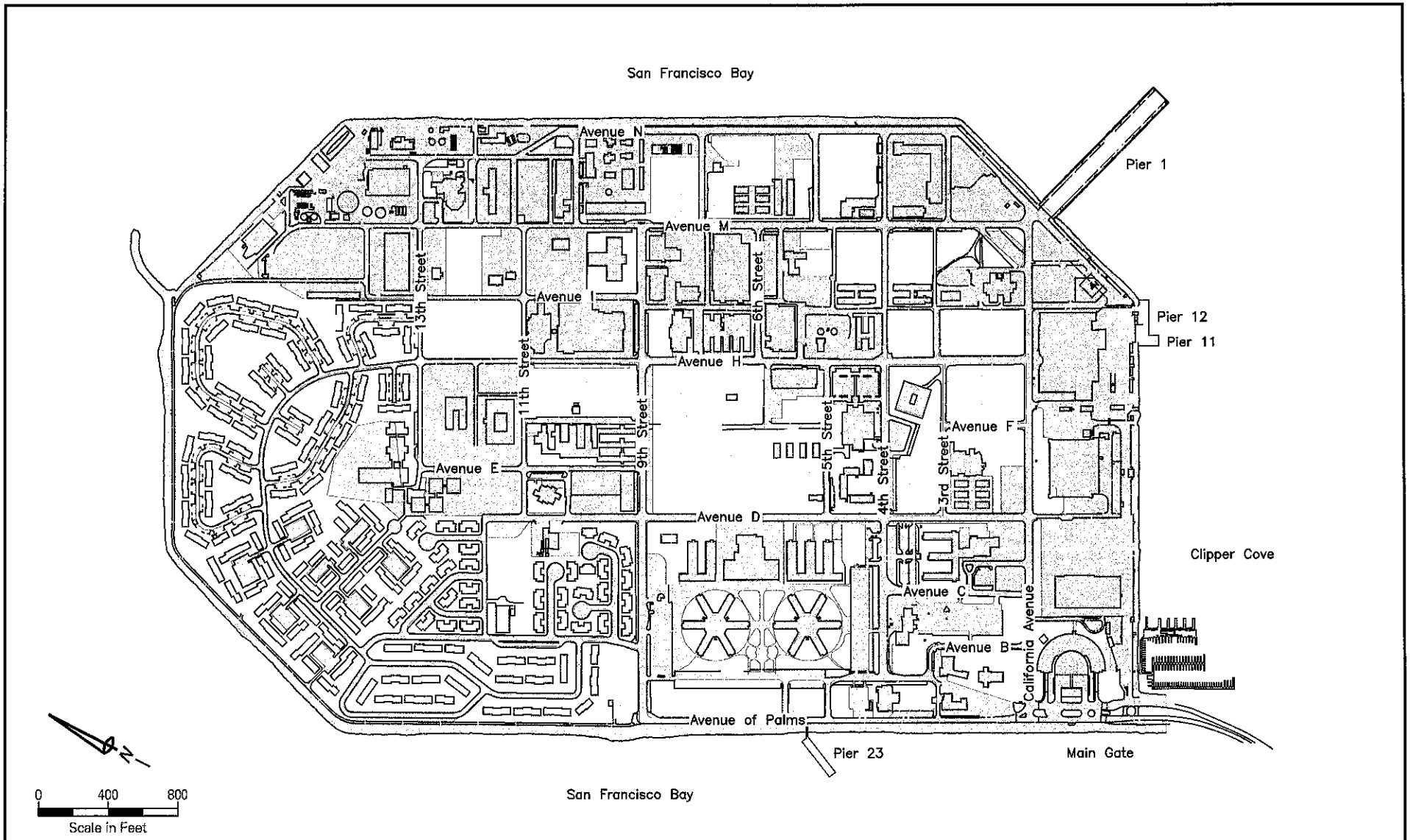
Executive Order 11990, Protection of Wetlands (42 Fed. Reg. 26961, May 24, 1977), was signed by President Carter in 1977 and directs federal agencies to avoid wherever feasible the adverse impacts associated with destroying or modifying wetlands.

US Coast Guard Aid to Navigation Permit

The US Coast Guard's primary responsibility is to preserve and enhance the navigability and safety of navigable waters of the U.S. Placing buoys in the bay to limit access to sensitive mudflat habitat at Clipper Cove (see section 4.8, Biological Resources) would require an aid to navigation permit from the US Coast Guard to ensure that the buoys do not interfere with safe navigation through these parts of the bay (14 U.S.C. § 83).

3.8.2 Vegetation/Habitat Types

Figures 3-11 and 3-12 illustrate the location of the terrestrial habitats on Treasure Island and Yerba Buena Island. Treasure Island is an engineered island and contains little native habitat. Habitat types on Treasure Island are landscaped and developed areas. Landscaped areas include mature ornamental trees, shrubs, and grasses (Figure 3-11). The only undeveloped



Treasure Island is an engineered island composed of artificial fill. Habitat types on Treasure Island are landscaped areas and developed areas. These areas correspond with "landscaped" and "developed" areas, respectively, on the terrestrial habitat type map of Yerba Buena Island.

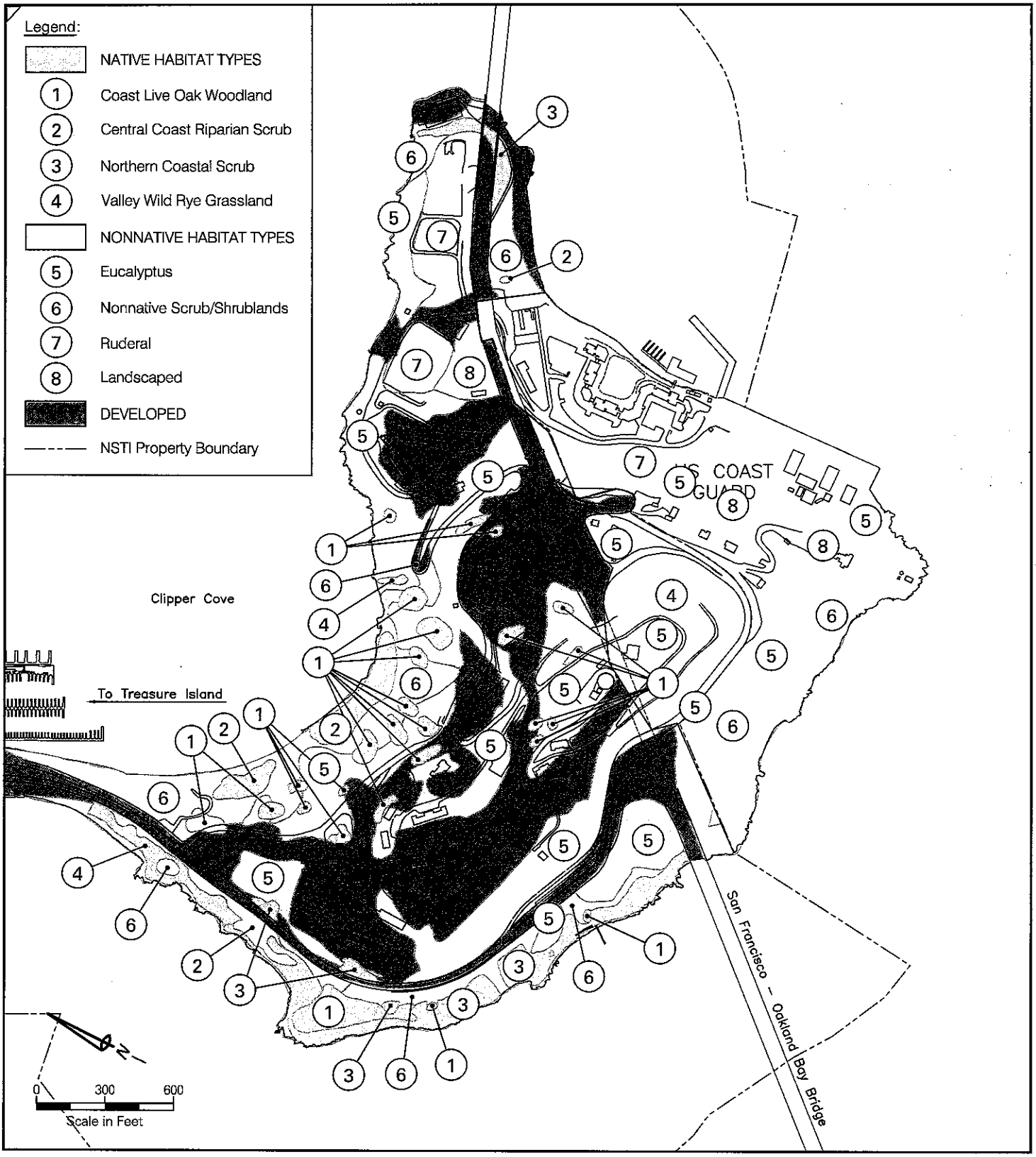
Legend:

- Non-native Habitat Types - Landscaped
- Developed

Terrestrial Habitat Types Treasure Island

Figure 3-11

Sources: DON 1987; 1996c



Habitat types at Yerba Buena Island consist of large areas of nonnative plant communities and developed areas with smaller areas dominated by native vegetation. This figure reflects habitats identified during a series of focused special status plant surveys at the portion of Yerba Buena Island controlled by the Navy.

Terrestrial Habitat Types Yerba Buena Island

Source: US Navy 1987; 1996c; Wood 1996

Figure 3-12

areas on NSTI are on Yerba Buena Island, where eucalyptus woodlands represent the largest habitat. Yerba Buena Island has a mix of five habitat types of predominantly native species, four habitat types of predominantly nonnative species, and developed areas with little or no vegetation, forming a mosaic pattern of habitat types (Figure 3-12) (San Francisco 1995a). The native habitat types are coast live oak woodland, northern coastal scrub, valley wild-rye grassland, central coast riparian scrub, and northern coastal salt marsh. The nonnative habitat types are eucalyptus woodland, nonnative scrub-shrub land (i.e., nonnative invading garden species), ruderal (i.e., weedy), and landscaped (San Francisco 1995a).

Eelgrass beds (*Zostera marina*), common to sheltered areas of water, such as harbors and coves, are located within the project area along the north shore of Yerba Buena Island at Clipper Cove and the east shore of Yerba Buena Island. Eelgrass habitat is described in detail in the Estuarine Habitat section below.

Terrestrial Habitats

Coast Live Oak Woodland

This habitat type is dominated by coast live oak *(Quercus agrifolia)* and consists almost exclusively of closed canopy forests. Coast live oak communities are frequently found on shady clay hillsides and may form a buffer between grasslands and mixed evergreen forests (Zeiner et al. 1990). Coast live oak woodland differs from other oak woodland subclasses in the relative rarity of annual grasses in its understory. The most frequent dominant plant found beneath coast live oak canopies is poison oak *(Toxicodendron diversilobum)*, but other species, such as California blackberry *(Rubus ursinus)* and creeping snowberry *(Symphoricarpus mollis)*, are frequently found there as well.

Coast live oak woodland may offer habitat to such wildlife species as pocket gopher *(Thomomys bottae)*, western gray squirrel *(Sciurus griseus)*, western fence lizard *(Sceloporus occidentalis)*, and Steller's jay *(Cyanocitta stelleri)*. The black-crowned night heron *(Nycticorax nycticorax)* roosts and nests on Yerba Buena Island oak woodland (FHWA 2001). The black-crowned night heron is protected under the MBTA.

Northern Coastal Scrub

Northern coastal scrub is a dense shrub-dominated community that commonly occurs as a buffer between northern oak woodland and southern oak woodland. This habitat type is composed of low-growing shrubs that are able to grow where tree growth is prevented by strong onshore winds and is therefore frequently found on steep slopes with strong prevailing winds (Heady et al. 1977). Coyote brush *(Baccharis pilularis)* is the dominant shrub species, with others being sticky monkey flower *(Mimulus aurantiacus)*, coffeeberry *(Rhamnus californica)*, and poison oak.

The most representative stand of northern coastal scrub on Yerba Buena Island is found in a continuous band along the steep bluffs on the islands western edge, mostly west of Treasure Island Road. Northern coastal scrub habitat often hosts such wildlife species as song sparrow *(Melospiza melodia)*, Bewick's wren *(Thryomanes bewickii)*, and vagrant shrew *(Sorex vagrans)*.

Central Coast Riparian Scrub

Central coast riparian scrub typically consists of a scrubby, streamside, open to impenetrable thicket composed of any of several species of willow. This habitat type is dominated by arroyo willow (*Salix lasiolepis*), with lesser amounts of red willow. Together, these species form a complete canopy supporting virtually no understory.

The most representative growth of central coast riparian scrub on Yerba Buena Island is found at lower elevations of the steep north-facing slope adjacent to Clipper Cove where the water table nears the surface. There is also a single stand on the western side of the island. Wildlife species that may be found in this habitat include white-crowned sparrow (*Zonotrichia leucophrys*) and Steller's jay (*Cyanocitta stellari*).

Valley Wild Rye Grassland

Valley wild rye grassland typically forms dense patches dominated by creeping ryegrass (*Leymus triticoides*). This plant community typically occurs on moist sites at low elevations, often adjacent to riparian or freshwater marsh habitat.

On Yerba Buena Island, valley wildrye grassland can be found above the western shoreline near the causeway connecting Yerba Buena Island and Treasure Island (Figure 3-12). This habitat forms a dense band on the bluffs above the northern coastal scrub and extends into the eucalyptus trees.

Ruderal

Ruderal vegetation is found in heavily disturbed areas, such as roadsides and abandoned dirt lots. Plant species found in these areas are generally weedy species, such as French broom (*Genista monspessuliana*), wild mustard (*Brassica kaber*), and wild radish (*Raphanus raphanistrum*). In general, this habitat is of little value from an ecological standpoint; however, it may provide temporary cover and foraging area for small animal species.

Ruderal habitat may be used on Yerba Buena Island by birds, such as the western sandpiper (*Calidris mauri*), killdeer (*Charadrius vociferous*), and dunlin (*Calidris alpina*), as they escape tidal inundation.

Nonnative, Landscaped

Much of the vegetation found on Treasure Island consists of introduced species, including trees such as blue gum eucalyptus (*Eucalyptus globulus*), Monterey pine (*Pinus radiata*), and Monterey cypress (*Cupressus macrocarpa*). Woodland comprised of blue gum eucalyptus occurs on Yerba Buena Island. These nonnative trees are of some value to wildlife, e.g., as foraging, perching, and nesting habitat for birds. Native plant species are not likely to be found in landscaped areas due to frequent disturbance, human control, and lack of proper soils. For these reasons, this habitat type is of little value to wildlife.

Estuarine Habitats

This section discusses habitat types that fall within the general classification of estuarine, as defined by Cowardin (U.S. Department of Interior 1979). Cowardin defines the estuarine system as "consisting of deepwater habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean and in which ocean water is at least occasionally diluted by freshwater runoff from the land." Subsystems of estuarine habitat are classified as subtidal, which is continuously submerged, and intertidal, which is alternately exposed and flooded by tides and includes the associated splash zone (U.S. Department of Interior 1979). NSTI and the ROI of the proposed action encompass all of these habitat types.

Estuaries are some of the most productive habitats on earth. Varying degrees of salinity, differences in current velocities, a gradient of depths and temperatures and a diversity of intertidal habitat types contribute to this productivity, making estuaries extremely important habitat. The San Francisco Bay is the largest estuary on the West Coast and is very important in terms of fisheries and other wildlife habitat values.

San Francisco Bay has a surface area of approximately 820 square miles (1,312 square km) (Cloern and Nichols 1985), and salt waters extend approximately 40 miles (64 km) inland at some times of the year. The bay is divided into four main sections: Suisun Bay, San Pablo Bay, the Central Bay, and the South Bay (Figure 3-13). Suisun Bay, which is the northeastern portion of San Francisco Bay, supports the prime mixing zone for fresh and salt waters and is lower in salinity than other parts of the bay such as the Central or South bays. NSTI is within the Central Bay.

The Central Bay, including NSTI, delineated in this report by Point Richmond in the north and Candlestick Point in the south, is largely deep bay and channel habitat. Deepwater habitat is found on the western side of NSTI, with water depths growing increasingly shallower to the east. Waters are cold and saline in this portion of the bay and are heavily influenced by tidal action. As the Central Bay is the entrance to the bay, all anadromous and pelagic fish species that occasionally visit the bay pass through the Central Bay.

The predominant aquatic habitat around Treasure Island and Yerba Buena Island is subtidal, with unconsolidated mud (silt and clay) bottom substrate. Water depths around NSTI range from about 7 to 33 feet (2 to 10 m), with the exception of the southeastern tip of the facility, where depth increases to more than 66 feet (20 m). There are no freshwater or wetland habitats on Treasure Island, although a small salt marsh is found on Yerba Buena Island (DON 1990a). There is rocky intertidal shoreline with mudflats on the western side of the cove between Yerba Buena Island and Treasure Island. There is limited intertidal habitat, consisting of concrete riprap and dock and pier pilings, along most of the shoreline surrounding Treasure Island. Yerba Buena Island has a rocky intertidal shoreline, with mudflats extending to the north between it and Treasure Island. Cobble gravel substrate is found off the southern and western edges of Yerba Buena Island (Figure 3-14).

Tidal Salt Marsh

Tidal marsh also once ringed San Francisco Bay but is now confined to a few large contiguous areas and remnant marshes in a variety of locations. This habitat type is generally found along the margins of bays, lagoons, and estuaries sheltered from excessive wave action (Macdonald and Barbour 1974). The existing bay habitat type (referred to by Cowardin as persistent emergent wetland) is typically dominated by pickleweed *(Salicornia virginica).* Saltgrass *(Distichlis spicata)* is common at the upper edges, whereas cordgrass *(Spartina foliosa)* is typically found at the lower edges of this habitat. Nonnative species of cordgrass (*Spartina* spp.) are becoming increasingly established in San Francisco Bay and threaten to displace native cordgrass as well as mudflat habitat. The vegetative composition of tidal marsh varies depending on the part of the bay and the topography of the area in which it is found. Tidal marsh in brackish areas where salt water and freshwater meet, most notably in the Suisun Marsh, tend to be dominated by tules *(Scirpus* spp.) and cattails *(Typha* spp.). There are about 40,000 acres (16,194 ha) of tidal marsh in San Francisco Bay (Goals Project 1999), although very little of this habitat exists in the project area. Non-tidal salt marsh vegetation remains in many diked areas of San Francisco Bay. No salt marsh is found on Treasure Island, but there is a narrow band of it on the eastern side of Clipper Cove on Yerba Buena Island (FHWA 2001).

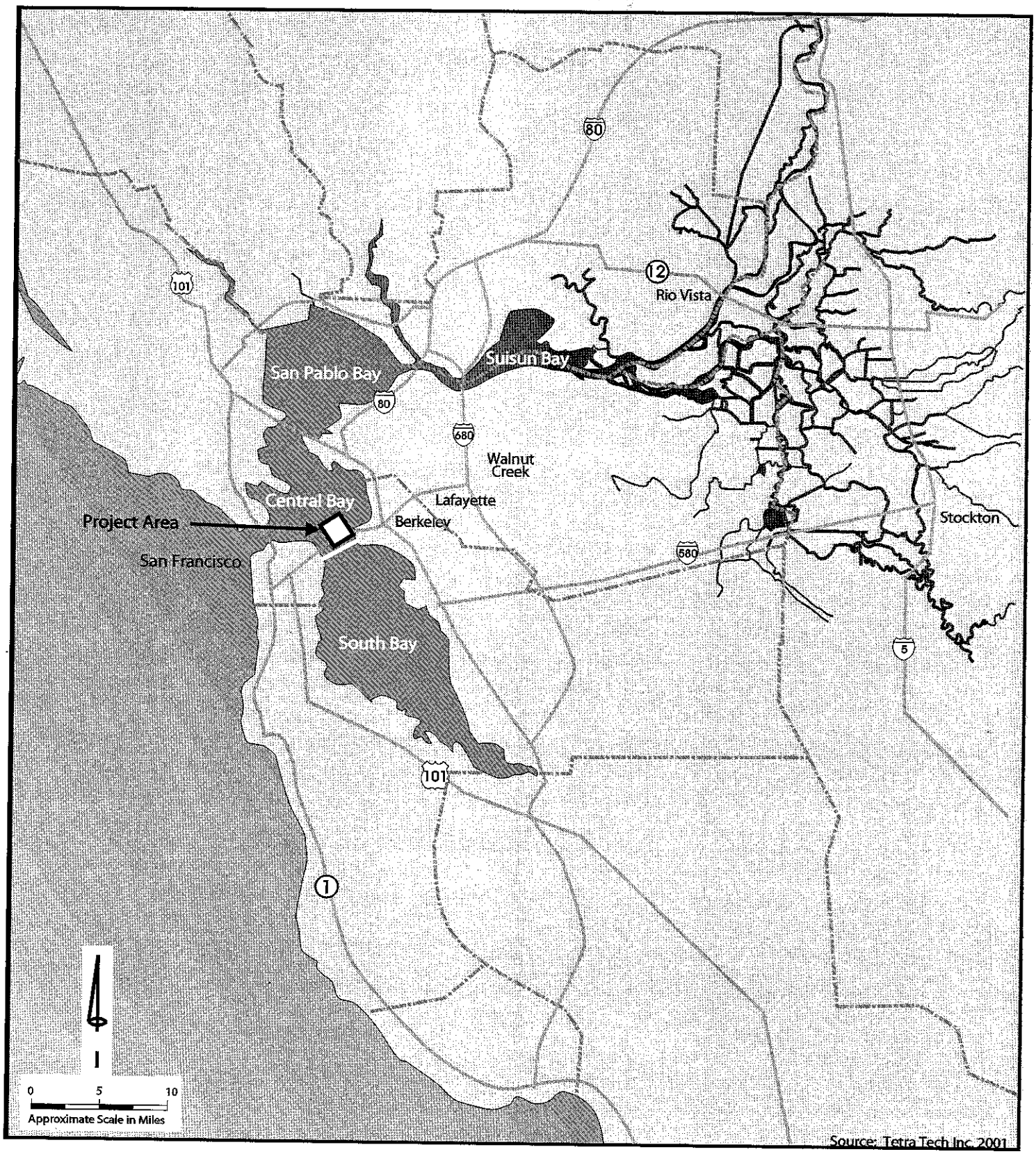
Common tidal salt marsh plants, such as pickleweed, glasswort *(Salicornia subterminalis),* cordgrass, alkali heath *(Frankenia salina),* and saltgrass *(Distichlis spicata),* have differing tolerances for submergence and exposure, and, as a result, are found in distinct elevation zones along the shoreline. Wildlife species found in salt marshes in the bay may include the federally listed endangered California clapper rail *(Rallus longirostris),* the state-listed threatened California black rail *(Laterallus jamaicensis),* and the federally listed endangered salt marsh harvest mouse *(Reithrodontomys raviventris).* None of these species are likely to occur at NSTI. Great blue herons *(Ardea herodius),* great egrets *(Ardea alba),* coots *(Gymnopgyps californicus),* ducks, and many species of shorebirds are also found in tidal salt marshes.

Rocky Shore

The riprapped shoreline of Treasure Island and the natural rocky shoreline of Yerba Buena Island provide rocky intertidal to shallow subtidal habitat. Rocky shores are productive habitats that provide a substrate for algae and sessile invertebrates, which in turn provide food and shelter for mobile invertebrates, fishes, birds, and mammals. Most rocky shores in San Francisco Bay are artificial, being composed of riprap, pier pilings, and wharves, while natural rocky shores are limited to exposed headlands and islands.

Shallow Subtidal Areas and Tidal Flats

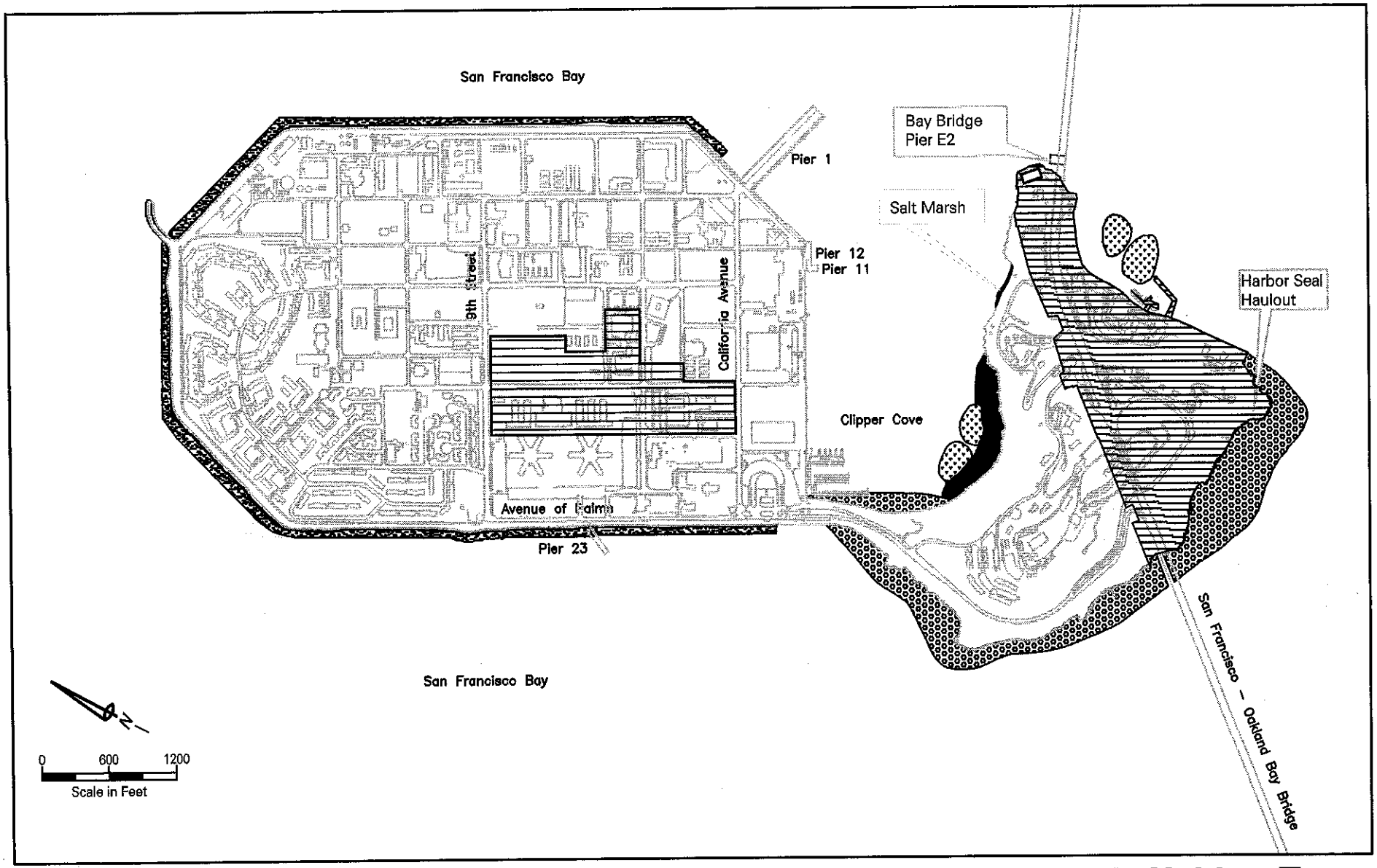
There are about 200,000 acres (80,980 ha) of shallow subtidal habitat and tidal flats in San Francisco Bay (Goals Project 2000). Shallow subtidal areas extend to depths of about 18 feet (5.2 m). Tidal flats generally occur between the mean tide level (MTL), or the lower elevation limit of cordgrass flats, to the lowest tide level, about 2.5 feet (0.7 m) below mean lower low water (MLLW). The semidiurnal (twice daily) tidal cycles that characterize San Francisco Bay submerge and expose tidal flats once or twice daily. There are approximately three acres (1.2 ha) of intertidal mudflats in the project area along the southeasterly edge of Clipper Cove (Figure 3-14).



Major Regions of San Francisco Bay

Naval Station Treasure Island, California

Figure 3-13



Aquatic Habitat Types

Naval Station Treasure Island, California

Yerba Buena Island has a variety of aquatic habitat types, whereas Treasure Island is limited to rocky areas. Harbor seals haul out on the southeastern shoreline of Yerba Buena Island under the SFOBB.

Legend:

- Eelgrass
- Mud flat, Mud bottom
- Cobble gravel bottom
- Rocky
- Areas Excluded from Proposed Navy Disposal

Sources: DON 1987; 1996c

Figure 3-14

Shallow subtidal areas and tidal flats of the bay support few plant communities, compared to other estuaries, such as Humboldt Bay and Tomales Bay. These plant communities include microalgae (such as diatoms), macroalgae (i.e., seaweed), and eelgrass *(Zostera marina)*. Microalgae form the basis for the estuarine food chain, providing a readily available food source for such organisms as worms and clams, which are then consumed by shorebirds and waterfowl. Macroalgae are found throughout the bay, primarily in the more saline areas, such as the Central Bay.

Eelgrass

Although often thought of as seaweed or grass, eelgrass is actually a flowering plant that has adapted to living submerged in the shallow waters of protected bays and estuaries in temperate regions of the world (Phillips and Menez 1988). Eelgrass is the only seagrass in the bay (Phillips and Menez 1998) and is found in intertidal zones that become exposed during the lower spring tides. It is also found in subtidal areas at depths of less than 7 feet (2 m). Eelgrass provides food, shelter, and spawning grounds for many fish and invertebrates, including the Pacific herring *(Clupea harengus)*, which prefers eelgrass beds for spawning (Spratt 1981). Eelgrass provides forage for the black brant *(Branta nigricans)*, which relies on it almost exclusively during migration along the Pacific flyway (Einarsen 1965). Eelgrass provides many important ecological functions, such as stabilizing unconsolidated sediments, providing shelter for many organisms, and improving water quality by reducing nutrients, sediments, and pollutant inputs from land (Williams and Davis 1996).

Surveys in 1999 and 2000 identified eelgrass beds in the project area, four near Yerba Buena Island (FHWA 2001). Two of these were within Clipper Cove on the north side of Yerba Buena Island and two within Coast Guard Cove on the east side of Yerba Buena Island (Figure 3-14). Eelgrass beds are highly dynamic and fluctuate in size, as such variables as light availability and nutrient load change. The most recent surveys indicated that total area of eelgrass beds in the project area is approximately 1.8 acres (0.75 ha) (FHWA 2001). Eelgrass beds in these areas occur along the edges of the shoreline and extend to areas no greater in depth than 4 to 6 feet (1.1 to 1.8 m) (FHWA 2001).

Open Waters

Open waters, also referred to as deep bay and channel habitat, are those parts of the bay that are deeper than 18 feet (5.2 m) below MLLW. Open waters are saline and, where they surround the project area, are strongly influenced by tidal currents. There are about 82,000 acres (33,198 ha) of this habitat in the bay (Goals Project 1999). Approximately 950 acres (384 ha) of open water habitat lies within the project area, mostly to the west of NSTI. Large aquatic invertebrates, such as crab and shrimp, and fish, such as sturgeon and rockfish, are found in this habitat. Anadromous fish, such as chinook salmon *(Oncorhynchus tshawytscha)* and steelhead *(Oncorhynchus mykiss)*, use open water habitat as migratory corridors. Resting and foraging habitat is found in the open water habitat for such species as the brown pelican, double-breasted cormorant *(Phalacrocorax auritus)*, and the Caspian tern *(Sterna caspia)*. Marine mammals, such as harbor seals *(Phoca vitulina richardsi)* and California sea lion *(Zalophus californianus)*, are also found in the open water habitat. The species that are likely to be found in the open water habitat surrounding the project area are discussed in detail below in the Sensitive Wildlife Species section.

3.8.3 Wildlife

Wildlife found in the region, including on NSTI, includes terrestrial and aquatic species of birds, mammals, invertebrates, amphibians, and reptiles. Treasure Island is developed and landscaped and provides little habitat for wildlife, while the habitats on Yerba Buena Island are more diverse and provide greater wildlife value. The entire Bay Area is a crucial resting and foraging area and wintering ground for thousands of birds in the Pacific Flyway, which extends from South America to the Arctic Circle (DON 1986).

Terrestrial Wildlife

Observed bird species on Yerba Buena Island include Lewis' woodpecker *(Melanerpes lewis)*, Steller's jay, white-breasted nuthatch *(Sitta carolinensis)*, and American robin *(Turdus migratorius)*. Birds known to inhabit the brushland habitats on Yerba Buena Island are California quail *(Callipepla californica)*, northern mockingbird *(Mimus polyglottos)*, savannah sparrow *(Passerculus sandwichensis)*, and white-crowned sparrow *(Zonotrichia leucophrys)*. More common bird species on the landscaped or developed regions of NSTI include European starling *(Sturnus vulgaris)*, pigeon *(Columba livia)*, American robin, house sparrow *(Passer domesticus)*, mourning dove *(Zenaida macroura)*, scrub jay *(Aphelocoma coerulescens)*, and flicker *(Colaptes auratus)*. Great blue heron *(Ardea herodias)*, black-crowned night heron, and great egret *(Casmerodius albus)* have been observed foraging along the riprapped shoreline (San Francisco 1995a). Other common species not observed but likely to be found include the California brown pelican and several grebe, cormorant, and gull species. Yerba Buena Island also provides habitat for two small mammal species; the pocket gopher (*Thomomys bottae*) and the California ground squirrel *(Citellus beecheyi)*.

Maritime Wildlife

Rocky shores, tidal marshes and mudflats occupy the intertidal zone, separating the adjacent developed lands from open waters. The mudflats in particular contain substantial surface and subsurface microalgal and macroalgal growth and diverse invertebrate fauna. These invertebrate faunas, consisting of worms, small mollusks, and arthropods, are an important food source for a variety of wintering shorebirds. When the mudflats are exposed at low tide, large congregations of shorebirds gather on them to feed. These feeding areas are important in the yearly migration and winter residence cycle of most of these bird species.

Benthic (those living in or on the floor of a waterbody) species most abundant in the nearshore environment include mollusks, such as the bay mussel *(Mytilus edulis)*, California mactra *(Mactra californica)*, and common littleneck *(Protothaca staminea)*, as well as crustaceans, such as amphipods, copepods, shrimp, graceful rock crab *(Cancer gracilis)*, and Dungeness crab *(C. magister)*. Most of the species of benthic organisms in San Francisco Bay are introduced species, such as the aforementioned bay mussel, the Amur River clam *(Potamocorbula amurensis)*, and the recently introduced Chinese mitten crab *(Eriocheir sinensis)*. Many of these exotic species have been released to the bay in water from cargo ship ballast.

Phytoplankton is found throughout the water column in the bay and is prey for such species as clams, mussels, and barnacles. Copepods, such as ghost shrimp and euphausiids, also known as krill, prey on phytoplankton and are in turn an important food source for juvenile fish. The

amount of phytoplankton in an area is influenced by such factors as water depth and transparency, river inflow and water salinity, or any other factors that influence the amount of light available for phytoplankton to use in photosynthesis. In the Central Bay, phytoplankton levels generally remain relatively low due to tidal mixing. Seasonal variation in degree of turbidity, changes in nutrient load, and filtering organisms influences the amount of phytoplankton.

A wide variety of fish species reside in and migrate through San Francisco Bay. Typical species include the staghorn sculpin *(Leptocottus armatus)*, chameleon goby *(Tridentiger trigonocephalus)*, topsmelt *(Atherinops affinis)*, bay pipefish *(Syngnathus leptorhynchus)*, and Pacific herring *(Clupea pallasii)*. Pacific herring is not listed under ESA, but it is the most important commercial species in the ROI. This species also has significant spawning grounds in the project area. Pacific herring swim in the middle to surface level of the water column. They spend most of their adult lives in coastal waters but use estuaries for spawning and rearing. The Pacific herring feeds on zooplankton and lives in schools.

Adult herring, age two or three, begin their migration into the bay in November (ABAG 1996), and spawning occurs mainly from January to March in intertidal and subtidal habitat (Miller and Schmidtke 1956; Hardwick 1973). Some documented Pacific herring spawning grounds include Angel Island, Alcatraz Island, and Treasure Island (Miller and Schmidtke 1956). Pacific herring are known to spawn in much of the project area, including the shallow water off NSTI. They deposit their eggs on eelgrass, algae, rocks, sand, and other submerged objects off these islands. In San Francisco Bay, the Pacific herring eggs have been shown to hatch in six to eleven days (Miller and Schmidtke 1956). The larvae tend to move out to the coast immediately, but some may remain for longer periods in the surface water of the bay (Eldridge et al. 1973; Wang 1986). Much of the larvae that remain inhabit the shallow waters of the South Bay as juveniles.

Marine mammals have been observed at or near NSTI. The harbor seal is routinely seen in the San Francisco Bay waters at NSTI. The San Francisco Bay harbor seal population of approximately 700 has remained constant since the early 1970s (San Francisco Estuary Project [SFEP] 1993). From December to April, several hundred harbor seals go ashore at "haulout" areas on the southeast shoreline of Yerba Buena Island, near the SFOBB. This area is within the ROI but not within the boundaries of the property for disposal (see Figure 3-14) (SFEP 1993; DON 1990a; Green 2001). Seals typically haul out to rest, sleep, or give birth (pup).

3.8.4 Sensitive Species

This section identifies special status, or sensitive, species that may occur in the project area. Sensitive species include those species that the USFWS or the CDFG lists or has proposed for listing as endangered, threatened, or candidate species. Plants that the CNPS lists as rare or threatened are also considered sensitive. Potential sensitive species at NSTI were identified from USFWS (USFWS 2001), CDFG (CDFG 2001), and the CNPS. USFWS personnel were consulted regarding the likelihood of finding listed species at NSTI (USFWS 2001).

Lists of all sensitive species and any critical habitat found in the region, according to USFWS and NOAA Fisheries, are provided in Appendix C. Critical habitat may be designated only for federally listed threatened and endangered species; no such designation is applicable to other species. As mentioned in the species accounts below, critical habitat designations for some of

the listed salmonids have been vacated (withdrawn) by NOAA Fisheries in response to a court ruling (NOAA Fisheries 2003). An assessment of the likelihood of a species occurring at NSTI was made based on the habitat requirements and geographic distribution of the species, existing on-site habitat quality, and the results of biological surveys of NSTI (DON 1993a, 1996b; FHWA 2001).

The following discussion includes a profile of only those sensitive or special status species that are known or considered likely to be found in the project area.

Sensitive Plant Species

All sensitive plant species listed as potentially occurring in the project area are listed in Table 3-8.1. Of these species, only marsh gumplant *(Grindelia stricta)* is confirmed to occur within the ROI. This species is considered a sensitive plant species because of its limited range and increasing destruction of its habitat. This species is found on the northern portion of Yerba Buena Island, outside of the proposed disposal area (FHWA 2001).

Marsh Gumplant. Although it has no federal or state status, marsh gumplant is considered locally significant because of its association with wildlife species of concern and has been included in the CNPS list of species that have limited distribution. This species was observed during botanical surveys on the northern portion of Yerba Buena Island (FHWA 2001).

Marsh gumplant is a host species for the Alameda song sparrow, a federal species of concern. However, the portion of Yerba Buena Island in which it is found is not within the proposed disposal area.

Table 3.8-1
Sensitive Plant Species that may occur within the Project Area

Common Name *Scientific Name*	*Status*[1] *F/S/CNPS*	*Preferred Habitat*	*Likelihood of Occurrence in Project Area*[2]	*Comments*
Marsh gumplant *Grindelia stricta*	-/-/1B	Northern coastal salt marsh	C	Northern portion of Yerba Buena Island
San Francisco gumplant *Grindelia hirsutula* var. *maritima.*	-/-/1B	Coastal scrub, coastal bluff scrub, valley and foothill grassland	P	Potential habitat occurs on northwestern edge of Yerba Buena Island

Source: CDFG 2001; USFWS 2001; CNPS 2001; FHWA 2001.
[1]Status
F = Federal; S = State; CNPS = California Native Plant Society Listing; 1B = Plants, rare, threatened or endangered in California
[2]Likelihood of occurrence on the project site
C = Confirmed; P = Potentially may occur

San Francisco Gumplant (*Grindelia hirsutula* var. *maritima*). Suitable habitat for the San Francisco gumplant exists on Yerba Buena Island in proximity to marsh gumplant; however, this species was not reported on the island during field surveys.

Sensitive Wildlife Species

Several sensitive animal species may use or are known to use NSTI (USFWS 1994a; CDFG 1996a, 1996b). Numerous other wildlife species that the USFWS and NMFS classified as threatened or endangered are known to occur in the Bay Area and historically have been reported to intermittently forage or roost at NSTI (DON 1990a). These latter species include Sacramento winter-run and Central Valley spring-run chinook salmon, central California coast and Central Valley steelhead, and the California brown pelican.

Sensitive (ESA) Fish Species

Salmonids

Salmonids are members of the Salmonidae family and include trout and salmon. For salmonids, a population (or group of populations) is considered distinct (and may be given consideration for listing under the ESA) if it represents an evolutionarily significant unit (ESU) of the biological species. To be considered an ESU, a population must be reproductively isolated, such that evolutionarily important differences accrue, and it contributes substantially to the ecological and genetic diversity of the species as a whole. Table 3.8-2 lists special status fish species that may occur within the project area.

The salmonids that occur in the San Francisco Bay include chinook salmon, coho salmon, and steelhead trout. Salmonids are anadromous, meaning they are ocean dwellers that migrate to freshwater streams to spawn (lay and fertilize their eggs). There are four runs of chinook salmon that use San Francisco Bay: the Sacramento winter-run, Central Valley spring-run, Central Valley fall-run, and the Central Valley late fall-run chinook salmon. These runs are distinguished by the time of year that they spawn. The central California coast coho salmon, Central Valley steelhead, and the central California coast steelhead are also known to use San Francisco Bay for migrating and rearing. These salmonids share a similar life cycle and use of the bay. As discussed further in section 3.8.6, all of San Francisco Bay is considered Essential Fish Habitat (EFH) for West Coast salmon fisheries.

Adult salmonids leave the ocean and migrate to freshwater streams when they are two or three years old, though this varies according to the species. They follow a migratory route that takes them to deep pools along a river where they may wait several months until they are sexually mature. In order to successfully reproduce, salmon need clean cold water, flowing over a gravel bed. Females search out these conditions and will lay their eggs in a gravel depression they dig, called a redd. Adult chinook and coho salmon die within one to two weeks after spawning. Steelhead, however, do not necessarily die but may live to spawn another year. Salmonid eggs hatch in one to two months and remain in the stream, absorbing essential nutrients from their yolk. Once the hatchlings surface from their gravel covering, they are known as juveniles and feed on larvae and other planktonic (drifting) organisms in the river. The amount of time that juvenile salmonids remain in the bay varies, with some emigrating immediately and others remaining for several months or years. Steelhead juveniles, for example, rear in freshwater streams for up to three years, far longer than Pacific salmon. Once juvenile salmonids have migrated to the ocean they will remain there until they are two to four years of age, and then they will begin their spawning migration.

Table 3.8-2
Special Status Fish Species that may occur within the Project Area

Common Name *Scientific Name*	*Status*[1] *F/S*	*Preferred Habitat*	*Likelihood of Occurrence in Project Area*[2]	*Comments*
Central California coast coho salmon *Oncorhynchus kisutch*	T/E	Migrates from ocean through estuaries to freshwater streams	P	Migrates through bay
Central California coast steelhead trout *O. mykiss*	T/-	Migrates from ocean through estuaries to freshwater streams	P	Migrates through bay
Central Valley fall-run/late fall-run chinook salmon *O. tshawytscha*	C/-	Migrates from ocean through estuaries to freshwater streams	P	Migrates through bay
Central Valley spring-run chinook salmon *O. tshawytscha*	T/-	Migrates from ocean through estuaries to freshwater streams	P	Migrates through bay
Central Valley steelhead trout *O. mykiss*	T/-	Migrates from ocean through estuaries to freshwater streams	P	Migrates through bay
Green sturgeon *Acipenser medirostris*	SC/SC	Marine and estuarine environments	C	Anadromous, migrates into Central Bay
Longfin smelt *Spirinchus thaleichthys*	SC/SC	Open waters of the bay	P	Found throughout open water areas
Sacramento River winter-run chinook salmon *Oncorhynchus tshawytscha*	E/E	Migrates from ocean through estuaries to freshwater streams	P	Migrates through bay

Source: NMFS 2001; CDFG 2001; USFWS 2001; FHWA 2001.
[1]Status
F = Federal; S= State; E = listed as endangered; T = listed as threatened; SC = species of concern; C = candidate
[2]Likelihood of occurrence on the project site
C = Confirmed; P = Potentially may occur.

Sacramento River Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*). Sacramento River winter-run chinook salmon is federally and state-listed as endangered. Winter-run chinook salmon migrate and spawn from mid-December to September, along the Sacramento River, up to Keswick Dam in Shasta County.

Adult winter-run chinook salmon can be found in San Francisco Bay beginning November through December, with individuals remaining only a few days (Herbold et al. 1992). Juveniles emigrate from their initial upstream habitat to the bay in the fall. Although most individual juveniles remain in the bay only for 4 to 10 days (USFWS 1987) some may stay for several months (Myers et al. 1998), using the habitat for rearing (Healey 1991). Winter run chinook may occur in the Central Bay and in the project area in low numbers (Woodbury 2001).

The primary threats to winter-run chinook salmon are the changes to the Sacramento River basin, which include the presence of dams and other water diversions, increasing water temperatures, agricultural and industrial pollution, and drought conditions (CDFG 2001).

Winter-run chinook salmon designated critical habitat includes all waters of San Francisco Bay north of the SFOBB. The project area lies within this critical habitat area (National Marine Fisheries Service Northwest Region [NMFS NWR] 2000a).

Central Valley Spring-Run Chinook Salmon *(O. tshawytscha).* A federally listed threatened ESU, the spring-run chinook salmon has a similar life history to the winter-run salmon but begins its spawning migration to the Sacramento/San Joaquin Delta in late winter to spring. Adults are found in San Francisco Bay during the migratory period in the spring, and juveniles have the potential to inhabit the bay in the fall, winter, and spring. Spring-run chinook may occur in the Central Bay and in the project area in low numbers (Woodbury 2001).

The decline of spring-run chinook is mainly attributed to over fishing and to the degradation and loss of upstream habitat due to development and water diversion (CDFG 1995).

There is currently no critical habitat designated for the Central Valley spring-run chinook salmon; the previous critical habitat designation (NMFS NWR 2000a) has been vacated (NOOA Fisheries 2003).

Central Valley Fall-Run/Late Fall-Run Chinook Salmon *(O. tshawytscha).* The Central Valley fall-run/late fall-run chinook salmon is a federally and state-designated candidate ESU. This ESU constitutes the largest number of chinook salmon in San Francisco Bay (NMFS NWR 2000b).

Adult fall-run/late fall-run chinook salmon begin their migration toward their spawning grounds in June, with a peak in September. They spawn in the Sacramento/San Joaquin Delta during December and January (USFWS 1999). Juvenile salmon potentially occur in San Francisco Bay in the late winter through summer. This ESU can occur in the Central Bay, and in the project area, in low numbers (Woodbury 2001).

The primary threats to the fall-run/late fall-run chinook salmon are the impacts from high hatchery production and harvest levels and from the loss of 40 to 50 percent of spawning and rearing habitat (NMFS 1999).

There is currently no critical habitat designated for this ESU; the previous critical habitat designation has been vacated (NOAA Fisheries 2003).

Central California Coast Coho Salmon *(O. kisutch).* The Central California coast coho salmon is a federally listed threatened and state-listed endangered ESU. Adult coho migrate through San Francisco Bay after heavy late fall or winter rains to spawn in the Sacramento/San Joaquin Delta. Juvenile coho potentially occur in the San Francisco Bay in the spring, summer, and fall. Central California coast coho may occur in the Central Bay, and therefore in the project area, in low numbers (Woodbury 2001).

The primary threats to this ESU are habitat degradation and unfavorable climate conditions in the last few decades, such as droughts and floods (CDFG 2000).

Central California coast coho critical habitat includes all river reaches, including estuarine areas and tributaries accessible to listed coho salmon, from Punta Gorda in northern California south to the San Lorenzo River in central California (NMFS NWR 2000c). The project area lies partially within this critical habitat area, with the water surrounding NSTI north of SFOBB qualifying as Central California coast coho critical habitat (Bybee 2001).

Central California Coast Steelhead Trout *(O. mykiss).* The Central California coast steelhead trout is federally listed as a threatened ESU but has no state status. Steelhead are rare in most streams that are tributary to San Francisco Bay.

Central California coast steelhead migrate from the Pacific coast through San Francisco Bay to spawn in freshwater in the upper Sacramento River. They are also known to migrate to the South Bay, where they spawn in the Guadalupe River, Coyote Creek, and San Francisquito Creek (Woodbury 2001). Upstream migration occurs from December through May, and peak spawning occurs in April. Juveniles may spend a year or more in San Francisco Bay before moving on to the ocean. This ESU is known to occur in the Central Bay, and in the project area, in moderate numbers (Woodbury 2001). The Central California coast steelhead may be present in the ROI at any time of the year.

The primary threats to Central California coast steelhead are degradation and loss of critical spawning and rearing grounds, due to development and water diversions (CDFG 2000).

There is currently no critical habitat designated for this ESU; the previous critical habitat designation has been vacated (NMFS 2003).

Central Valley Steelhead Trout *(O. mykiss).* The Central Valley steelhead is federally listed as threatened ESU and has no state status. Central Valley steelhead migrate between the ocean and the Sacramento and San Joaquin rivers and their tributaries via the San Francisco and San Pablo bays. Upstream migration occurs in the winter, with peak spawning occurring December through April (McEwan and Jackson 1996). Historically, adults may have remained in the delta for several years after spawning, but recent changes to the hydrology of the delta has limited this time frame (Interagency Ecological Program [IEP] 1998). Most Central Valley steelhead juveniles rear in freshwater for one to two years. They can be found migrating downstream at any time of the year, with peak emigration occurring in the spring (IEP 1998). This ESU has the potential to occur in the Central Bay, and therefore in the project area, in low numbers (Woodbury 2001).

The primary threats to Central Valley steelhead are degradation and loss of critical spawning and rearing grounds due to development and water diversions (CDFG 2000).

There is currently no critical habitat designated for this ESU; the previous critical habitat designation has been vacated (NMFS 2003).

Other Fish Species

Green Sturgeon *(Acipenser medirostris).* The green sturgeon is a federal species of concern. Green sturgeon are bottom dwelling fish. Locally they are found in San Francisco Bay, San

Pablo Bay, the lower San Joaquin River, and the delta (Wang 1986). This species may occur in the ROI.

Although little is known about the green sturgeon's life history, it does differ from that of the salmonid species. Green sturgeon are characterized as slow growing and late maturing fish that spawn every 4 to 11 years (Pacific States Marine Fisheries Commission [PSMFC] 1996) and rely on streams, rivers, estuarine habitat, and marine waters during their lifecycle. They prefer to spawn in lower reaches of large rivers with swift currents and large cobble. Adults broadcast eggs into the water column. The fertilized eggs sink and attach to the bottom, where they hatch. Local spawning occurs in the upper Sacramento River (Fry 1973) in the spring to early summer (Moyle 1976). The green sturgeon spends limited time in freshwater, only while young and spawning. Juveniles migrate downstream before they are two years old. While young, green sturgeon feed on algae and small invertebrates (organisms without internal backbones). In general, juveniles remain in estuaries for a short time and migrate to the ocean as they grow larger. However, adult green sturgeon are known to inhabit or forage in estuaries (PSMFC 1996). Adult green sturgeon feed on benthic (bottom dwelling) invertebrates and small fish. Green sturgeon are potentially found in the Central Bay at any time of the year, but adults are more likely found in spring and summer, when they migrate to freshwater for spawning and then return to the ocean.

The primary threats to this species are over fishing, water diversions, and pollution (CDFG 2000).

Longfin Smelt *(Spirinchus thaleichthys).* A federal and state species of special concern, the longfin smelt is a pelagic (living in open ocean) estuarine fish known to inhabit San Francisco Bay, including the waters surrounding NSTI (IEP 2001; Hieb 2001). Longfin smelt feed primarily on planktonic crustaceans, such as the opossum shrimp (*Neomysis mercedis*). Mature adults, nearing the end of their second year, migrate in the fall from the brackish waters of the San Francisco and San Pablo bays to Suisun Bay and the lower delta (Wang 1986). Spawning occurs December through June in the freshwater portions of the delta, along areas with rocks and aquatic plants (Moyle 1976; Wang 1986). Most of the adults die after spawning, though some females survive for a second spawning season (Moyle 1976). Longfin smelt eggs are deposited and adhere to substrates, such as rocks and vegetation. Larvae live in the middle to surface portion of the water column and can be found from Carquinez Strait to the lower reaches of the delta (Wang 1986). Juveniles migrate downstream in the late spring and summer to Suisun, San Pablo, and San Francisco bays, where they spend most of their time in the middle to lower portion of the water column (McAllister 1963; Ganssle 1966). Longfin smelt may be found in the Central Bay at any time of the year. CDFG monitoring stations have detected the species within the project area (IEP 2001).

The primary threats to longfin smelt are low water levels due to water diversions, water pollution, climatic variation, and introduced species.

Delta Smelt *(Hypomesus transpacificus).* Delta smelt are state- and federally listed as threatened and are endemic to the upper Sacramento-San Joaquin estuary. They occur in the delta, primarily below Isleton on the Sacramento River, below Mossdale on the San Joaquin River, and in Suisun Bay. They move into freshwater when spawning. During high outflow periods, they may be washed into San Pablo Bay, but they do not establish permanent

populations there (USFWS 1996). Consequently, delta smelt are rare to the Central Bay and are unlikely to be found in the project area. The USFWS has listed this federally and state-listed threatened species as potentially occurring in the project area (USFWS 2001).

In the fall, adults congregate and begin their swim upstream to spawn in river channels and sloughs. Spawning occurs between January and July. Most spawning occurs in the dead-end sloughs and shallow edge waters of channels in the western delta, though it also has been recorded in Montezuma Slough near Suisun Bay and far upstream in the Sacramento River near Rio Vista (Radtke 1966; Wang 1986). With low levels of vegetation in the winter, it is likely that the eggs are deposited on submerged tree branches or on sandy and rocky substrate (Thelander et al. 1994). It takes 10 to 14 days for eggs to hatch, at which time the current carries the planktonic larvae downstream, where they feed on a steady supply of zooplankton. The final destination for most juvenile smelt is the null zone, an area where saltwater from the ocean meets freshwater from rivers (Thelander et al. 1994).

The primary threats to delta smelt include the decrease in water level in the delta due to water diversions and entrainment (when fish are drawn into hydroelectric turbines on dams or irrigation canals).

There is no critical habitat designated for this species in the project area.

Bird Species

Bird species are protected under the ESA or the MBTA. Information on these statutes and their implementing regulations can be found in section 3.1. Table 3.8-3 lists those bird species of concern that the USFWS states could occur within the project area. With the exception of the listed species (California least tern, the California clapper rail, and the western snowy plover), only those species considered likely to occur or known to occur in the project area are addressed below.

This section is divided into two parts, the first of which discusses ESA listed species or species of concern that could occur or are known to occur in the project area. The second part describes species covered only by the MBTA that are known to occur or have nesting habitat in the area. Because some birds are protected under both the ESA and the MBTA, there may be overlap between the sections.

Sensitive (ESA) Bird Species

American peregrine falcon *(Falco peregrinus anatum).* This species is no longer federally listed but is state-listed as endangered. The peregrine falcon was fairly common in the state before 1947, with at least 100 nesting pairs counted (USFWS 1992). The peregrine falcon was placed on the federal endangered species list in 1970, when fewer than five pairs were believed to nest in all of California. Presently, an estimated 10 to 20 birds range over the San Francisco

Table 3.8-3
Special Status Bird Species that May Occur within the Project Area

Common Name *Scientific Name*	*Status*[1] *(F/S)*	*Habitat Requirements*	*Potential Occurrence within Project Area*[2]	*Comments*
Alameda song sparrow *Melospiza melodia pusillula*	SC/SC	Fresh, brackish, or salt marsh habitats.	C	May be an occasional visitor, breeding populations unlikely.
American peregrine falcon *Falco peregrinus anatum*	DL/E	Woodlands, coastal habitats, riparian areas, coastal and inland waters, human-made structures that may be used as nest or temporary perch sites.	C	Habitat in project area; nests adjacent to project area.
Black-Crowned Night Heron *Nycticorax nycticorax*	*	Lowlands and foothills. Nests and roosts in dense-foliaged trees and dense emergent wetlands.	C	Nests and roosts on YBI in woodland areas.
Black oystercatcher *Haematopus bachmani*	SC/SC	Rocky shores of marine habitats and adjacent islands.	C	Occurs in project area.
Brant's cormorant *Phalacrocorax pencillatus*	*	Yearlong resident of marine subtidal and pelagic zones of California. Nests on rocky headlands or islets.	C	Occurs in project area; nest known on YBI.
California brown pelican *Pelecanus occidentalis*	E/E	Open water, estuaries, beaches; roosts on various structures (e.g., pilings, boat docks, breakwaters, mudflats).	C	Habitat in project area.
California clapper rail *Rallus longirostris obsoletus*	E/E	Salt marshes traversed by tidal sloughs, tidal marshes, pickleweed marshes.	U	Little habitat in project area, unlikely to occur.
California least tern *Sterna antillarum browni*	E/E	Shallow areas of bays estuaries, lagoons, and at the joining points between rivers and estuaries.	U	Foraging habitat in project area offshore.
Double-crested cormorant *Phalacrocorax auritus*	-/SC	Open water, fresh and estuarine waters, near-shore.	C	Habitat in project area.
Pelagic cormorant *P. pelagicus*	*	Frequently in marine subtidal and uncommon to marine pelagic around rocky coasts. Nests on rocky cliffs.	C	Occurs in project area.
Western gull *Larus occidentalis*	*	Occupies coastal islands, cliffs, harbors, bays, river mouths and garbage dumps. Nests in a depression on ground, among vegetation or rocks in a variety of habitats.	C	Occurs in project area.
Western snowy plover *Charadrius alexandrinus nivosus*	T/SC	Sandy beaches, estuarine, inter-tidal mudflats, salt pond levees, alkali lakes, gravel areas near beaches and estuaries.	U	Little habitat in project area, unlikely to occur.

Source: CDFG 2001; USFWS 200[illegible] FHWA 2001.

[1]Status

F = Federal; S = State; * = Protected under MBTA; E = listed as endangered; T = listed as threatened; SC = species of concern
C = candidate; DL = delisted

[2]Likelihood of occurrence on the project site

C = Confirmed; U = Unlikely to occur

Note:

YBI = Yerba Buena Island

Bay Area and delta region (FHWA 2001). Other bird species are prey for the peregrine falcon, including pigeons, terns, blackbirds, sparrows, and shorebirds. Peregrine falcons usually nest in depressions on protected ledges of high cliffs or on rock outcrops (Peterson 1990). They are also known to use tall buildings or bridges in urban areas. During the last few years, four pairs have begun nesting in the Central Bay. Two of these peregrine falcon nests occur on the SFOBB;

one on the support structure east of Yerba Buena Island and one on the central support structure, between the island and San Francisco (Bell 1996). They most likely forage within the project area.

California clapper rail *(Rallus longirostris obsoletus).* Although the USFWS cites the federally and state-listed endangered California clapper rail as occurring in the area (USFWS 2001), very little of the salt marsh habitat preferred by this species exists in the project area. It is unlikely that the species is found in the project area.

California least tern *(Sterna antilarum browni).* Listed as endangered both federally and by the state, this migratory species is found in California and Baja California from April to September (Thelander et al. 1994) and is believed to winter along the Pacific coast of South America (Massey 1971). During the breeding season, from May through September, the California least tern is found in the Central Bay at the former Alameda Naval Air Station and at Oakland International Airport (approximately 3 and 9 miles [5 and 9 km]) respectively, to the southeast of NSTI), where major nesting areas occur. The former Naval Air Station Alameda is the largest nesting spot for least terns in San Francisco Bay, and the terns have been observed occasionally in nearshore waters surrounding NSTI. No least tern nesting colonies have been recorded on Yerba Buena Island (DON 1990a), and the potential habitat for nesting on NSTI is unlikely. The California least tern is believed to be an infrequent visitor to Treasure or Yerba Buena islands and most likely does not occur in the project area. This species has declined in numbers because of coastal development, introduced predators, and human disturbance (USFWS 1992).

California brown pelican *(Pelecanus occidentalis californicus).* A federally and state-listed endangered species, brown pelicans are found in estuarine, marine subtidal, and marine pelagic waters throughout coastal California (Thelander et al. 1994). Important habitat for pelicans during the nonbreeding season includes roosting and resting areas, such as offshore rocks, islands, sandbars, breakwaters, and pilings. Suitable areas need to be free of disturbance. They rest temporarily on the water or isolated rocks, but roosting requires a dry location near food and a buffer from predators and humans. California brown pelicans use open water areas for feeding and use rocks, jetties, and piers for roosting. Brown pelicans feed on small surface-schooling fish, primarily anchovy (Zeiner et al. 1990). Nesting normally begins in the spring but is highly variable, according to colony and year. Breeding occurs from March to early August, with eggs being laid from March to June.

California brown pelicans migrate from their breeding zones in the Channel Islands and Mexico as early as mid-May, to disperse throughout coastal California. Most pelicans return to breed by the following March. Brown pelicans are common in northern California from June to November, are rare to uncommon from December to February and May, and are very rare in March and April (Anderson and Anderson 1976; Cogswell 1977; McCaskie et al. 1979). The California brown pelican is a common post-breeding resident (May through November) of the open waters of the central San Francisco Bay and of San Pablo Bay (USFWS 1992). They can be found roosting at Breakwater Island, near the former Naval Air Station Alameda (Jacques-Strong 1994) and fishing throughout the bay. This species occurs at the project area and occasionally forages at the nearshore areas at NSTI. They are also known to rest on bridge footings and to forage by the SFOBB (FHWA 2001).

This species has been affected by numerous factors that have contributed to its decline, including disease outbreaks, low productivity, colony failure, its primary dependence on the northern anchovy for prey (which has declined), oil and other toxic spills, the presence of relatively high levels of pesticides in the tissues of some pelicans, human and nonnative mammal disturbance at central California coast post-breeding roosts, physical injury and mortality due to fish hooks, entanglement in abandoned fishing line, and El Niño events that cause prey fishes to move well offshore and away from pelican nesting islands.

There is no critical habitat designation for this species (USFWS 2001).

Western snowy plover *(Charadrius alexandrinus nivosus).* A federally listed threatened species and a state species of special concern, they typically occupy sandy beaches, salt ponds, and intertidal areas of marine and estuarine habitats but are known to occur in some inland areas (Thelander et al. 1994). Along the Pacific Coast, snowy plovers are distributed on the mainland and offshore islands, from southern Washington to southern Baja California, Mexico. Some populations, however, reside yearlong in California. Within California, plovers tend to winter along Bodega Bay in Sonoma County and to the south in the Los Angeles vicinity, with a large congregation around the San Francisco Bay Area (Zeiner et al. 1990). Nests are usually established in sparsely vegetated to nonvegetated areas of sandy beaches and estuaries. Western snowy plovers forage on insects and amphipods from the dry sand of upper beaches along the coast and occasionally forage for sand crabs and brine flies. This species is sensitive to human harassment, and direct destruction of nest sites and breeding habitat are some reasons for its decline.

Snowy plovers nest March though September at sandspits and open beaches near rivers and estuaries. The nests can sometimes be found in salt pond levees and dry salt ponds. Western snowy plovers are known to winter in the San Francisco Bay Area, and an estimated 250 individuals have been recorded in the bay during the breeding season (Goals Project 2000). Critical habitat for the western snowy plover falls outside of the project area. Although a small amount of potential foraging habitat exists for the snowy plover at NSTI, there is no nesting habitat. Any occurrences of this species at NSTI would be incidental, and the species is unlikely to be found there.

Alameda song sparrow *(Melospiza melodia pusillula).* A federal species of concern, the Alameda song sparrow is found in freshwater, brackish, and salt marsh habitats. This species occurs in coastal salt marsh habitat bordering South San Francisco Bay and can be found near NSTI, at the Emeryville Crescent, adjacent to the SFOBB toll plaza. The main range of the Alameda song sparrow extends from Coyote Creek, at the southern extremity of the bay, northward along the west shore of south San Francisco Bay to Belmont Slough, and along the east shore to San Lorenzo (Jurek 1974). Small populations also occur in marshes at the northeast shore of Richmond Inner Harbor in El Cerrito, along the shoreline from Emeryville to the SFOBB toll plaza, and at Arrowhead Marsh at the mouth of San Leandro Creek in the bay in San Leandro (Jurek 1974).

There is potential nesting habitat for this species at sites where marsh gumplant occurs, such as on Yerba Buena Island. The Alameda song sparrow has been observed perching on individual gumplants in these areas. The Alameda song sparrow could nest in the project area but has not been observed nesting at NSTI.

The song sparrow has been affected by urbanization and economic development throughout its range. Increasing salinity from diversion of freshwater streams has resulted in only limited areas of brackish marsh, the preferred habitat. Salt marshes have been filled or converted to salt ponds, so few remaining areas of complex salt marsh exist.

Migratory Bird Treaty Act Protected Species

Although numerous bird species covered by the MBTA are found in the project area, only the following species are confirmed as nesting on NSTI or Yerba Buena Island: black-crowned night heron, double-crested cormorant *(Phalacrocorax auritus)*, Brandt's cormorant *(Phalacrocorax pencillatus)*, the pelagic cormorant *(Phalacrocorax pelagicus)*, the western gull *(Larus occidentalis)*, and black oystercatcher *(Haematopus bachmani)* (USFWS 1995c).

Black-crowned night heron *(Nycticorax nycticorax)*. The black-crowned night heron is a fairly common yearlong resident in lowlands and foothills throughout most of California. This species usually nests between February and July. Nesting and roosting occurs in dense foliage trees and dense emergent wetlands. It feeds along the margins of lakes, large rivers, fresh and salt water wetlands and, rarely, on kelp beds in marine subtidal habitats. The black-crowned night heron both nests and roosts in woodland areas on Yerba Buena Island.

Double-crested cormorant *(Phalacrocorax auritus)*. A state species of special concern, the cormorant is a year-long resident along the entire coast of California and is known to frequent inland lakes and fresh, salt, and estuarine waters. Fish make up the bulk of the double-crested cormorant's diet, while crustaceans and amphibians are known to be taken as food items to a lesser degree. It feeds during the day and is known to roost beside water on offshore rocks, islands, steep cliffs, trees, or engineered structures (wharves, jetties, and bridges). Nests are built in habitats similar to those used for roosting, with the further requirements that the area be inaccessible to predators, that it be near a foraging area, and that it have a dependable food supply. Breeding cormorants are very sensitive to human disturbance (Goals Project 2000). Causes of decline include habitat destruction and human disturbance, particularly from boating (Ellison and Cleary 1978), eggshell thinning from DDT contamination, and human disturbance at nest sites.

Double-crested cormorants are fairly common within San Francisco Bay, especially during the winter. The largest colonies are on the SFOBB, where there is a large nesting colony, and on the Richmond-San Rafael Bridge. The species is known to occur within the project area.

Black oystercatcher *(Haematopus bachmani)*. This species is a permanent resident on rocky shores of marine habitats along almost the entire California coast, as well as on adjacent islands. The state breeding population has been estimated at about 1,000 (Sowls et al. 1980).

The black oystercatcher is sensitive to human disturbance and is subject predation by native and nonnative predators, such as rats and feral cats. It may be either uncommon or locally fairly common in northern and central California (Cogswell 1977). It is rare on the mainland coast south of Point Conception (Santa Barbara County), and no recent California nesting records exist south of this locality (Garrett and Dunn 1981). This species tends to be distributed fairly evenly along the mainland where suitable habitat exists, with denser concentrations on offshore islands, such as the Farallons and the Channel Islands.

The black oystercatcher has nesting sites in the San Francisco Bay Area. The USFWS has documented one breeding black oystercatcher on Yerba Buena Island (USFWS 1995c) and it has been observed on Treasure Island (USFWS 1995c).

Western gull (*Larus occidentalis*). This species is quite common along the California coast. It is abundant year round, occurs in the project area, and nests locally. It forages often at low tide on mudflats.

Western gulls nest on the column footings of the SFOBB west span and could nest on the footings of the east span. The USFWS has documented 31 known nest sites for this species on Yerba Buena Island (USFWS 1995c).

Brandt's cormorant (*Phalacrocorax pencillatus*). This species is a common yearlong resident in marine subtidal and pelagic zones of California, especially near rocky shores. Perch sites are usually barren of vegetation. Brandt's cormorants roost communally and tend to nest on rocky headlands or islets along the coast and on islands. This species is common in outer parts of large estuaries but is only an occasional visitor in inner bay areas or on smaller estuaries. It dives for food in shallow or deep water and consumes mostly small saltwater fishes and also some crabs and shrimps. Brandt's cormorant requires a dependable food supply within commuting distance of a suitable roost or nest site, but it is known to commute a relatively great distance (Palmer 1962).

There are large numbers of this species that nest offshore (approximately 22,000 breed on South Farallon Island; DeSante and Ainley 1980). Large numbers have been seen migrating northward past Goleta Point, Santa Barbara County, in February and March (Garrett and Dunn 1981). The population increases south of Morro Bay in the winter, from migrants from the north, Baja California, and the Channel Islands. Many members of the population may be local or distant migrators. Many Southeast Farallon Island juveniles disperse northward as far as Vancouver Island, British Columbia (DeSante and Ainley 1980).

In San Francisco Bay, they rarely feed near their winter roosts and have been known to commute as much as 10 miles (16 km) daily from their roost to feeding areas (Bartholomew 1949). Brandt's cormorant occur in the project area, and the USFWS has documented four known nest sites for this species on Yerba Buena Island (USFWS 1995c). These are the only known nesting sites for this species in San Francisco Bay.

Pelagic cormorant (*Phalacrocorax pelagicus*). The pelagic cormorant is a yearlong resident of California. Pelagic cormorants inhabit marine subtidal areas along the rocky coasts of California and its islands, south to San Luis Obispo County. Less commonly they are found in marine pelagic habitats. Although most pelagic cormorants remain close to their breeding sites throughout the year, some populations migrate within California, heading south after nesting. Locally they are found at the outermost part of bays (Zeiner et al. 1990). The pelagic cormorant breeds on rocky cliffs beginning in April through August (Zeiner et al. 1990). Their diet consists of small fish and crustaceans, to a lesser degree. These cormorants prefer to feed in shallow rocky-bottomed areas (Robertson 1974).

Pelagic cormorants are known to inhabit San Francisco Bay, with a breeding colony on Alcatraz Island (Point Reyes Bird Observatory 2001), and are known to occur in the project area.

Mammals

No special status terrestrial mammal species are found in the project area, but several marine mammal species, all of which are of concern and/or sensitive insofar as they are protected under the ESA and/or MMPA, have been observed at or near NSTI. These commonly include the harbor seal, the California sea lion *(Zalophus californianus)*, and occasionally, the gray whale *(Eschrichtius robustus)*. On rare occasions, the following marine mammal species may occur in the bay as individual transients: humpback whale *(Megaptera novaengliae)*, minke whale *(Balaenoptera acutorostrata)*, steller sea lion *(Eumetopias jubatus)*, and southern sea otter *(Enhydra lutris nereis)*. Table 3.8-4 lists the marine mammal species that may occur within the project area. The marine mammal species considered likely to occur or known to occur are discussed below.

Table 3.8-4
Marine Mammal Species That May Occur Within the Project Area

Common Name *Scientific Name*	*Status[1] (F/S)*	*Habitat Requirements*	*Potential Occurrence within Project Area[2]*	*Comments*
Southern sea otter *Enhydra lutris nereis*	T*/	Coastal California waters	P	May occur in bay.
California sea lion *Zalophus californianus*	*	Coastal California waters	P	May occur in bay.
Gray whale *Eschrichtius robustus*	DL*/-	Coastal arctic and tropical waters	C	May occur in bay.
Harbor seal *Phoca vitulina richardsi*	*	Deep water with gently sloping terrestrial area nearby	C	Occurs throughout the bay.
Steller sea lion *Eumetopias jubatus*	T*/-	Pacific ocean, island and coastal rookeries	U	May occur rarely in bay.

Source: CDFG 2001; USFWS 2001; FHWA 2001.
[1]Status
F = Federal; S = State; T = listed as threatened; DL = delisted; * protected under MMPA
[2]Likelihood of occurrence on the project site
C = Confirmed; P = Potentially may occur; U = Unlikely to occur

The section is divided into two parts. The first part discusses ESA-listed species (which are also protected under the MMPA) and the second discusses species protected by the MMPA only.

ESA-Listed Species

Southern sea otter *(Enhydra lutris nereis)*. This mammal is federally listed as threatened under the ESA. It is not known if California sea otters are migrants or residents in certain areas of California. Southern sea otters in San Francisco Bay are probably not seasonal residents but are more likely to be isolated foragers that ranged north of their generally recognized territory. The northern edge of their range is usually considered to be Half Moon Bay (Allen 2001), although this range keeps extending. They are common at Point Reyes but are considered to occur rarely

in the waters off Treasure Island. One sea otter has been sighted in the waters off Yerba Buena Island (Green 2001)

Steller sea lion *(Eumetopias jubatus).* Federally listed as threatened under the ESA, this species is found in nearshore waters out to and beyond the continental shelf (Marine Mammal Center 2000a). They haul out at various locations, which have changed historically in the San Francisco Bay region. Historically they hauled out at the rocks near the Cliff House and also at Pier 39 in San Francisco, though not regularly (Allen 2001). They occur to the south at Año Nuevo Island, which is the southernmost breeding area for the species (Tetra Tech 1999), and on the Farallon Islands, much farther offshore.

They can occur in the waters off NSTI and Yerba Buena Island rarely as individual and intermittent transients, but their presence in the ROI is unlikely. They have never been sighted hauling out at either Treasure Island or Yerba Buena Island (Allen 2001). Any occurrences of this species in the ROI would most likely correspond to when the herring are running in the bay, as this is a prey species for Steller sea lions (Allen 2001). Typically, however, they are unlikely to occur in the waters of Treasure Island.

The project area is within designated critical habitat for this species, due to considerations other than the species' presence. The critical habitat for the Steller sea lion includes areas where its preferred prey occurs, such as San Francisco Bay, or areas that have been within its historic range. Steller sea lions are not currently found throughout much of their historic range and rarely occur in San Francisco Bay.

Additional Marine Mammal Species (Protected under the MMPA)

Harbor seal *(Phoca vitulina richardsi).* This species is a permanent resident in the San Francisco Bay and is routinely seen in waters at NSTI. They have been observed as far upstream as Sacramento, though their use of the habitat north of Suisun Bay is irregular (Goals Project 2000).

There are several harbor seal haulout sites in the Central Bay, located near feeding sites, including Yerba Buena Island, Sisters Island in Muzzi Marsh, Castro Rocks, Brooks Island, a floating abandoned dock near Sausalito, Angel Island, and a breakwater at the Oakland entrance to Alameda Harbor (Allen 1991; Harvey and Torok 1995). Haulout sites must have gently sloping terrain and deep water immediately nearby and must be free of disturbance (Allen 1991). Only three sites in the bay—Yerba Buena Island, Mowry Slough, and Castro Rocks—show greater than 40 individuals present during the breeding and molting seasons (Kopec and Harvey 1995).

Seals haul out year-round on Yerba Buena Island. The haulout area is within the ROI but not within the boundaries of the property for disposal. The Yerba Buena Island haulout site near the SFOBB is on the southeast side of the island (Figure 3-14), on US Coast Guard property. Individual seals may occasionally haul out farther to the west and southwest of the main haulout site on Yerba Buena Island, depending on space availability and conditions at the main haulout area (Figure 3-14).

Harbor seals feed in the deepest waters of the bay, and the areas from Golden Gate to Treasure Island and from the San Mateo Bridge south are the principle feeding sites (Kopec and Harvey 1995). Harbor seals feed on a variety of fish, such as perch, gobies, herring, and sculpin.

CDFG aerial surveys done since 1998 of the bay population reflect a conservative estimate of approximately 500 animals. Land-based censusing reflects a higher, and probably more accurate, number of approximately 700 animals (Richmond Bridge Harbor Seal Survey [RBHSS] 2001). This number has remained relatively constant since the early 1970s (SFEP 1993).

Several hundred harbor seals use the Yerba Buena Island site as a year-round haulout site, though highest counts occur in the winter, from December to April (SFEP 1993; DON 1990a; RBHSS 2001). This most likely corresponds to the period of high Pacific herring numbers in the bay, Pacific herring being a preferred prey. In January 1999, 296 animals were counted at Yerba Buena Island (Green et al. 2001), and in March 2001, the count was 277 (Green 2001).

Only the most undisturbed sites are used for pupping, which occurs in the spring. The area is not historically identified as a pupping site for harbor seals but pups are occasionally seen there (Kopec and Harvey 1995), as is afterbirth. One dead pup was documented as having been born there (Green 2001). The number of pups sighted on Yerba Buena Island, while still under 10 a year, has increased by one a year for each of the last four years. Males made up 83.1 percent of the seals whose gender could be determined on the haulout site at Yerba Buena Island in a study conducted in 1997 (Spencer 1997).

Harbor seals at Yerba Buena Island are subject to high levels of disturbance, primarily from recreational watercraft. This is particularly true during the summer, when numbers of small boats, jet skis, and kayaks on the bay increase. A minimum distance of 100 yards is recommended as a standard to boaters from the haulout area to avoid disturbing the seals (RBHSS 2001). Researchers have reported seals shifting from a predominantly diurnal (active during the day) hauling pattern to a nocturnal (active at night) pattern in response to human disturbance (Paulbitski 1975). Others have reported that increased disturbance can cause reduced reproductive success and site abandonment (Bartholomew 1949; Calambokidis et al. 1979).

California sea lion *(Zalophus californianus).* The California sea lion occurs year-round in parts of San Francisco Bay though, as with the other seal species, they are most abundant in the winter, corresponding with the herring run. California sea lions are not listed under the ESA but are protected under the MMPA. The largest haulout site in the bay is at Pier 39 in San Francisco. Most of the sea lions hauled out at this site are males, and no pupping has been observed (Goals Project 2001).

Individual sea lions have been observed with some regularity in the shipping channel south of Yerba Buena Island. Individuals have also been sighted in the waters east of Yerba Buena Island (Green 2001). It is unlikely that these animals would occur within the defined ROI of the project.

Gray whale *(Eschrichtius robustus).* Gray whales are found only in the Pacific Ocean, with the current northeastern Pacific population estimated at approximately 26,000 (NMFS 2001). Gray whale populations have begun to rebound, and the species was delisted under the ESA in 1994.

Protected under the MMPA, the gray whale is the most common cetacean along the central California coast during its annual spring migration to northern feeding grounds and during its late fall-winter return to Mexican calving and breeding lagoons (Monterey Bay National Marine Sanctuary 2001).

Gray whales may occur in the waters off Treasure Island. Gray whale populations have been increasing in San Francisco Bay over the last three years. In 1999, they were spotted in the bay on 39 days, in 2000 on 64 days, and in 2001 (to date) on 116 days (Oliver et al. 2001). They are usually sighted traveling alone, but also have been sighted in pairs. A single sighting at the Dumbarton Bridge consisted of a group of five whales (Oliver et al. 2001). Greater than 95 percent of the sightings occur during the northern migration, from February to May.

All age classes have been sighted, though the majority of animals sighted in San Francisco Bay have been juveniles, less than 37 feet (11 m) long. This overall sighting increase may represent an increase in habitat utilization by this species. They have been sighted from the extreme southern end of the bay to the extreme northern end. Behaviors observed in the bay include traveling, milling, socializing, and foraging. Numbers of strandings have also been increasing and range from 17 to 29 animals (Marine Mammal Center 2001b).

Sensitive Amphibian Species

Three amphibian species are listed by USFWS as potentially occurring within the project area. These are the California red-legged frog *(Rana aurora draytonii)*, the Alameda whipsnake *(Masticophis lateralis euryxanthus)*, and the giant garter snake *(Thamnophis gigas)*. No habitat for any of these species is found within the project area; therefore, they are considered unlikely to be present in the project area.

Sensitive Invertebrate Species

The USFWS lists three invertebrate species as potentially occurring within the project area: the Mission blue butterfly *(Icaricia icarioides missionensis)*, the San Bruno elfin butterfly *(Incisalia mossii bayensis)*, and the white abalone *(Haliotis sorensoni)*. However, no habitat for any of these species is found within the project area, and they are considered unlikely to be present in the project area.

Sensitive Reptile Species

Four species of sea turtles occur at least occasionally along the central California coast. These are the federally endangered leatherback turtle *(Dermochelys coriacea schlegelii)* and the federally threatened green turtle *(Chelonia mydas agassizi)*, the olive ridley turtle *(Lepidochelys olivacea)*, and the loggerhead turtle *(Caretta caretta gigas)*. These species are all unlikely to occur in the estuarine waters near NSTI and have no known occurrences in the project area.

3.8.5 Sensitive Habitats

Sensitive habitats are vegetation communities that federal, state, or local agencies or conservation organizations have assigned special status because of declining, restricted, or threatened populations or areas. Habitat areas or vegetation communities that are unique or that offer particular value to wildlife also are considered sensitive.

The mudflats, which may contain eelgrass beds, on the western side of the cove between Treasure Island and Yerba Buena Island are a sensitive habitat at NSTI (DON 1996a). The soft bay mud substrate provides habitat for many invertebrates, including oligochaetes, polychaetes, crustaceans, isopods, gastropods, and bivalves. These species, which typically reside in the top few inches of the substrate, are preyed upon by shorebird species, such as western sandpipers *(Calidris mauri)*, sanderling *(Calidris alba)*, spotted sandpiper *(Actitis macularia)*, and killdeer *(Charadrius vociferus)*, which forage in the area during low tide. Research on stomach contents has shown that the gem clam, the polychaete *Neanthes succina*, and the mud snail are the most common prey species among many shorebirds (USFWS 1992).

Critical Habitat

Areas of habitat considered essential to the conservation of a listed endangered or threatened species may be designated as critical habitat, which is protected under the ESA. Although critical habitat may be designated on private or government land, activities on these lands are not restricted unless there is federal involvement in the activities or direct harm to listed wildlife.

The ROI of the project area contains critical habitat for the following species, as designated by NMFS on the dates shown:

- Sacramento River winter-run chinook salmon, June 16, 1993; and
- Steller sea lion, March 23, 1999.

As mentioned above, previous designations of critical habitat for salmonid ESUs have been withdrawn (NMFS 2003).

3.8.6 Essential Fish Habitat

The MSA defines EFH as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The MSA set forth a number of new mandates for NMFS, regional fishery management councils, and federal action agencies to identify EFH and to protect important marine and anadromous fish habitat. The MSA provided NMFS with legislative authority to regulate fisheries in the U.S., in the area between 3 miles (5 km) and 200 miles (320 km) offshore and established eight regional fishery management councils that manage the harvest of the fish and shellfish resources in these waters. The councils, with assistance from NMFS, are required to delineate EFH in FMPs or FMP amendments for all managed species. A FMP is a plan to achieve specified management goals for a fishery and is composed of data, analyses, and management measures for a fishery. EFH that is sanctioned for an FMP includes all fish managed by the plan. Federal agency actions that fund, permit, or carry out activities that may adversely affect EFH are required to consult with NMFS regarding potential adverse effects of their actions on EFH and to respond in writing to NMFS' recommendations. In addition, NMFS is required to comment on any state agency activity that will affect EFH (NMFS 2000).

The MSA requires that EFH be identified for all species that are federally managed. This includes species managed by the councils' FMPs, as well as those managed by NMFS under FMPs developed by the Secretary of Commerce.

The project area is designated as EFH for fish managed under three FMPs—Pacific groundfish, coastal pelagics, and Pacific coast salmon (National Marine Fisheries Service Southwest Region [NMFS SWR] 2001). All species for which EFH exists in the project area and that are found in the project area are listed in Table 3.8-5. For a comprehensive list of all species included in these three FMPs, refer to Appendix G. A description of the relevant FMPs follows.

West Coast Groundfish FMP

There are 83 species of groundfish that are managed under this FMP. (For a listing of species that are found in the project area, refer to Table 3.8-5; for a comprehensive list of all species included in the west coast groundfish FMP, refer to Appendix G.) The EFH for west coast groundfish includes saltwater from the mean higher high waterline and the upriver extent of saltwater intrusion in river mouths along the coast of California (NMFS 1998). Therefore, the whole project area lies within the west coast groundfish EFH.

Coastal Pelagic FMP

Species managed under this plan include northern anchovy *(Engraulis mordax)*, Pacific sardine *(Sardinops sagax)*, Pacific (chub) mackerel *(Scomber japonicus)*, jack mackerel *(Trachurus symmetricus)*, and market squid *(Loligo opalescens)* (Coastal Pelagic Species Fish Management Plan 1998). San Francisco Bay, including the project area, qualifies as EFH for all species managed under this FMP.

Pacific Coast Salmon FMP

The Pacific coast salmon FMP includes coho, chinook, and Puget Sound pink salmon (Pacific Fishery Management Council [PFMC] 1999). Variation in the timing of migration and spawning of chinook salmon has led to the designation of ESUs, a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout. Four ESUs of chinook and a coho salmon ESU are found in the project area. They are fall, late-fall, winter-run, and spring-run chinook and central California coast coho salmon (Vogel and Marine 1991). The EFH associated with the Pacific coast salmon FMP encompasses all of the project area (PFMC 1999).

3.8.7 Special Aquatic Sites

Under the section 404(b)(1) guidelines of the CWA, the EPA identifies six categories of special aquatic sites: sanctuaries and refuges, wetlands, mudflats, vegetated shallows, coral reefs, and riffle and pool complexes. Discharges of dredged or fill material in special aquatic sites are not authorized under section 404 unless there is no less damaging practicable alternative.

Special aquatic sites in the project area include the mudflats and shallow water habitat in Clipper Cove, sand flats on the eastern side of Yerba Buena Island, and vegetated shallows around the perimeter of the island. The only delineated wetland in the ROI is a small band of northern coastal salt marsh that occurs on the north side of Yerba Buena Island, adjacent to Clipper Cove (FHWA 2001). This salt marsh is not within the proposed disposal area.

Table 3.8-5
FMP Species Abundance in the Central Bay

Common Name *Scientific Name*	*Fish Management Plan (FMP)*	*Abundance*
Big skate *Raja binoculata*	GF	Present
Bocaccio *Sebastes paucispinis*	GF	Rare
Brown rockfish *S. auriculatus*	GF	Abundant
Cabezon *Scorpaenichthys marmoratus*	GF	Few
Chinook salmon *Oncorhynchus tshawytscha*	PCSP	*
Coho salmon *O. kisutch*	PCSP	*
Curlfin turbot *Pleuronichthys decurrens*	GF	Present
English sole *Parophrys vetulus*	GF	Abundant
Jack mackerel *Trachurus symmetricus*	CP	Present
Kelp greenling *Hexagrammos decagrammus*	GF	Present
Leopard shark *Triakis semifasciata*	GF	Present
Lingcod *Ophiodon elongates*	GF	Present
Market squid *Loligo opalescens*	CP	*
Northern anchovy *Engraulis mordax*	CP	Abundant
Pacific sanddab *Citharichthys sordidus*	GF	Present
Pacific sardine *Sardinops sagax*	CP	Rare
Pacific whiting (hake) *Merluccius productus*	GF	Present
Sand sole *Psettichthys melanostictus*	GF	Present
Soupfin shark *Galeorhinus galeus*	GF	Rare
Spiny dogfish *Squalus acanthias*	GF	Present
Starry flounder *Platichthys stellatus*	GF	Abundant

Source: NMFS SWR 2001.
*Abundance not known
GF = Groundfish Fishery Management Plan; CP = Coastal Pelagics Fishery Management Plan; PCSP = Pacific Coast Salmon Plan

3.9 GEOLOGY AND SOILS

NSTI is located in the seismically active San Francisco Bay Area, which is characterized by numerous active faults and historic earthquakes. The following description includes regional, vicinity, and underlying geologic features at NSTI. The principal geologic features and formations at NSTI are discussed in this section in the context of the regional geologic setting.

3.9.1 Regional Geology and Seismicity

NSTI is located within the Coast Ranges Geomorphic Province. Landforms within the region are influenced by geologically young processes, such as active uplift of mountains, rapid erosion of streams, active transform faulting within the San Andreas Fault system, and large fluctuations in sea level brought on by Pleistocene (Ice Age) glaciation.

Treasure Island was constructed in 1936 and 1937 with engineered fill placed on a sandy shoal, located immediately north of Yerba Buena Island. Treasure Island is nearly flat, with interior elevations ranging from about 3.7 to 11.7 feet (1.1 to 3.6 meters [m]) NGVD and with a perimeter dike as high as approximately 13.2 feet (4 m) NGVD. (NGVD is the National Geodetic Vertical Datum of 1929, which is the elevation datum used on U.S. Geological Survey topographic maps.)

Yerba Buena Island is a peak in the bedrock surface that underlies San Francisco Bay. To the east of Yerba Buena Island is a deep erosional trough developed in the Franciscan bedrock surface that extends beneath Alameda Island and the Oakland Airport. As a result, the top of the bedrock extends from an elevation of about 338 feet (103 m) NGVD on Yerba Buena Island to about -1,000 feet (-305 m) NGVD beneath Oakland Airport (US NSF 1992).

Geology in the Vicinity of NSTI

East of the San Andreas Fault, the Bay Area is underlain by marine cherts, sandstone, and volcanic rock belonging to the Franciscan Formation. The region that is now San Francisco Bay was above sea level until about a million years ago. At that time, a combination of basin subsidence and rising sea levels led to sediment deposition in the valleys that had been eroded in the Franciscan bedrock surface. Yerba Buena Island may have been uplifted relative to the surrounding land by faulting along an early offshoot of the Hayward Fault. This offshoot, called the Coyote Shear, is believed to have caused the uplift of the Coyote Hills in Fremont. A deep trough formed adjacent to the Coyote Shear zone extends along the East Bay shore from Emeryville to south of the Oakland Airport. Sediments collected in this trough as streams emptied into the basin.

The first sediments deposited on the Franciscan bedrock surface belong to the Alameda Formation, which spans several cycles of glacial advance and retreat between 700,000 and 135,000 years ago. During this period, sea level was as much as 350 feet (107 m) lower than present (US NSF 1992). The Alameda Formation is about 100 feet (30.5 m) thick on the north, east, and south sides of Yerba Buena Island and increases to over 900 feet (274 m) thick where it fills the trough in the Franciscan bedrock surface beneath Oakland Airport.

The top of the Alameda Formation is an erosional surface caused by downcutting streams. The surface of the Alameda Formation shows evidence of an ancient channel that may have drained to the Pacific Ocean along the southwest side of San Bruno Mountain. Later, the channel changed direction and drained through the Golden Gate via the east side of Yerba Buena Island. Ultimately the channel moved to its current position west of Yerba Buena Island (US NSF 1992).

Around 115,000 years ago, the climate changed dramatically as the huge glaciers covering the interior melted and sea levels rose high enough to inundate the San Francisco basin. The marine silt and clay sediments that were deposited on the surface of the Alameda Formation at this time are known as the Old Bay Mud, and more recently as the Yerba Buena Mud. The thickness of the Yerba Buena Mud ranges from less than 50 feet (15 m) on the west side of NSTI to about 125 feet (38 m) east of NSTI (US NSF 1992). The top of the Yerba Buena Mud is less than 100 feet (30.5 m) below sea level.

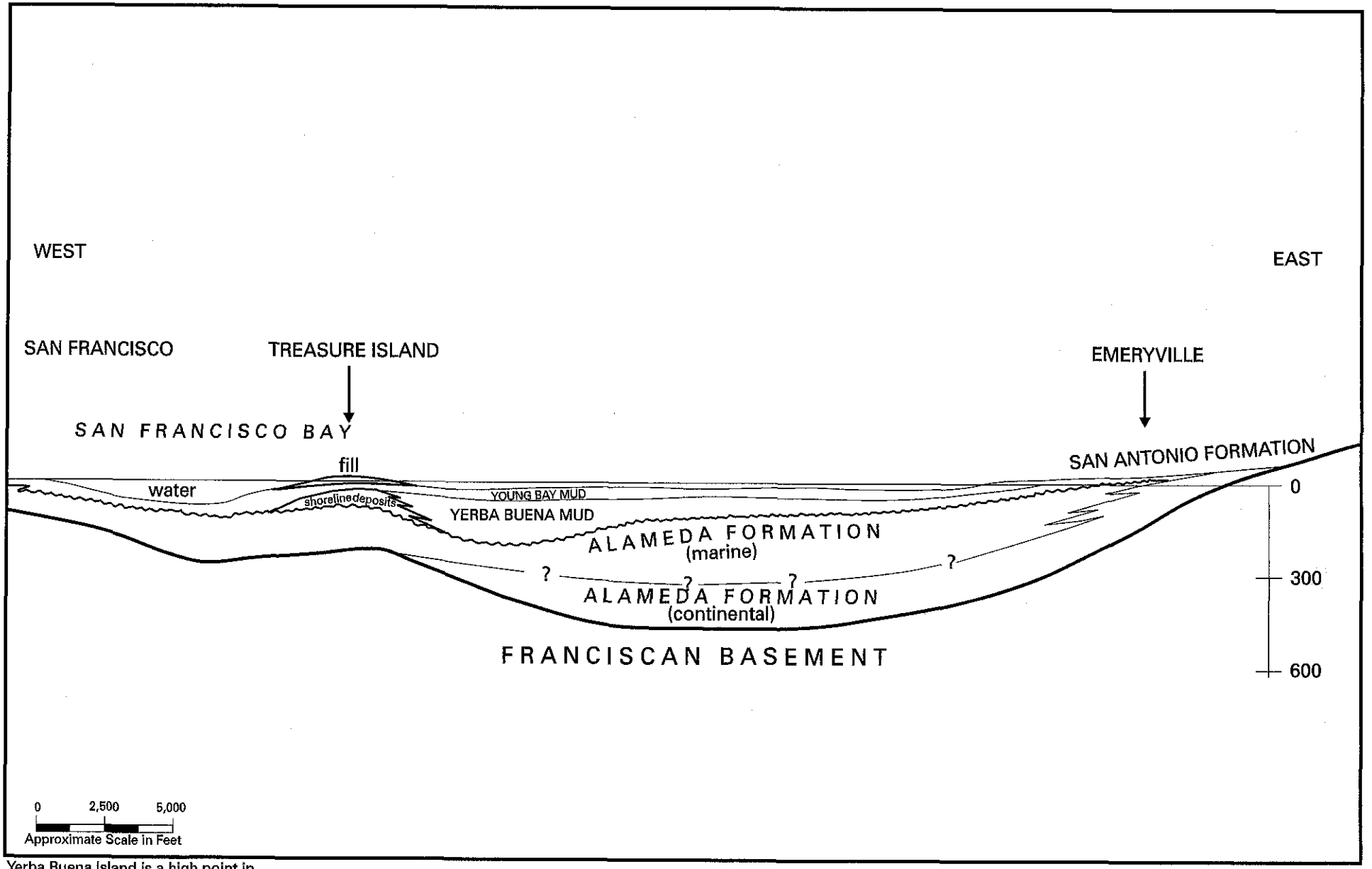
The top of the Yerba Buena Mud is an erosional surface created between about 90,000 and 11,000 years ago when sea levels were lower. Coarser, nonmarine sediments, including silts and sands, were deposited in a variety of estuarine, alluvial, and shoreline dune environments during this period. The classification of these units is not well established. In general, the basin deposits have been lumped together as the San Antonio Formation, which includes the Posey and Merritt sand members that form local aquifers. By the end of the Wisconsin glacial age, a number of deeply incised channels had been eroded in the surface of the San Antonio Formation, including Temescal Creek, San Antonio Creek, San Leandro Creek, and San Lorenzo Creek. Temescal Creek flowed around the south side of Yerba Buena Island from what is now Emeryville, joining the north-flowing main drainage channel of the South Bay.

At the end of the Wisconsin Age, sea levels rose again to approximately existing levels. During this period, the Younger Bay Mud (or Bay Mud) was deposited in the now inundated incised stream channels. Figure 3-15 shows an interpretive east-west cross section of the geology beneath Treasure Island.

Seismicity

NSTI is located within the San Andreas Fault system, which is approximately 44 miles (71 kilometers [km]) wide in the Bay Area (USGS 1990a). The principal active faults include the San Andreas, San Gregorio, Hayward, Rogers Creek, West Napa, Calaveras, Concord, and Green Valley faults (California Division of Mines and Geology 1982), as shown on Figure 3-16. The last major earthquake to affect the Bay Area was the Loma Prieta earthquake in October 1989. The epicenter of this earthquake was approximately 59 and 61 miles (95 and 98 km) south of Yerba Buena Island and Treasure Island, respectively. An active fault is defined by the California Division of Mines and Geology (CDMG) as a fault that has "had surface displacement within Holocene time (about the last 11,000 years)" (CDMG 1992a). In general, it is believed that future earthquakes are more likely to occur on recently active faults than on faults that have not been recently active.

In California, special restrictions apply to construction within "fault-rupture hazard zones," as defined by CDMG under the Alquist-Priolo Earthquake Fault Zoning Act (Cal. Pub. Res. Code § 2621), to prevent structures for human occupancy being built across the traces of active faults.



Yerba Buena Island is a high point in the Franciscan formation, which slopes to more than 300 feet beneath Treasure Island. The line of this cross-section passes north of Yerba Buena Island.

Geologic Cross Section from West to East Beneath Treasure Island

Treasure Island, California

Source: Rogers and Figuers 1992

Figure 3-15

Treasure Island is in an area of liquefaction potential and has been designated a Seismic Hazards Studies Zone (SHSZ) by CDMG (CDMG 1997). No active faults have been identified at NSTI, and NSTI is not in an Alquist-Priolo Earthquake Fault Zone. NSTI is approximately 7 miles (11 km) west of the northern segment of the Hayward Fault and about 18 miles (29 km) east of the San Andreas Fault (CDMG 1994).

The last major earthquake along the Hayward Fault occurred in 1868 (130 years ago) and had an estimated Richter magnitude of 6.8 (CDMG 1992b). It is estimated that the recurrence interval for an earthquake of that size is about 130 ± 60 years (CDMG 1992c). The last major earthquakes on the San Francisco segment of the San Andreas Fault were the 1906 San Francisco earthquake, with an estimated Richter magnitude of 8.3 (USGS 1990b), and the 1989 Loma Prieta earthquake, with an estimated Richter magnitude of 7.1 (USGS 2003).

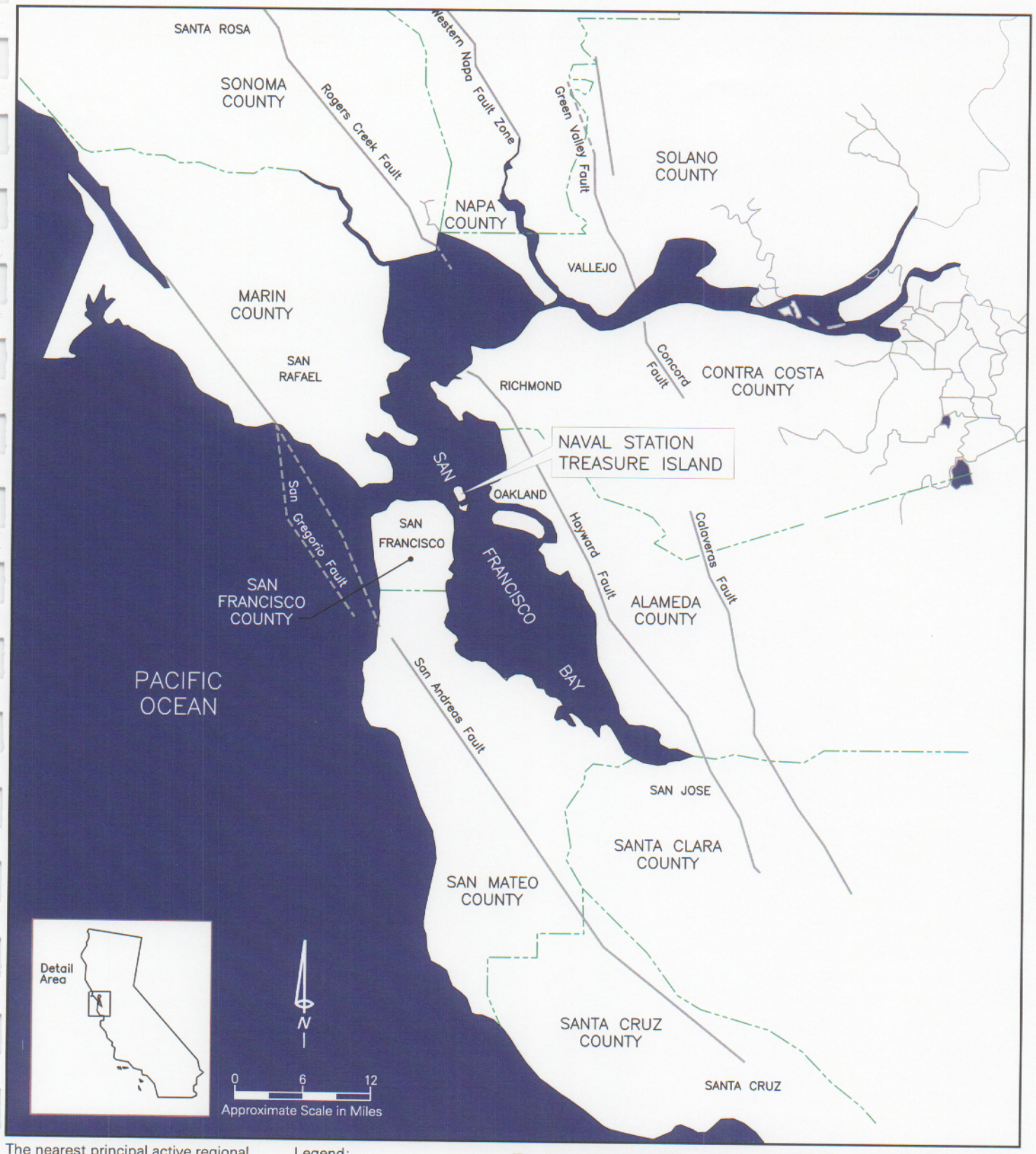
The probability of one or more large earthquakes (Richter magnitude 7.0 or greater) occurring on the San Andreas, Hayward, or Rogers Creek faults has been estimated to be greater than 67 percent for the 30-year period from 1990 to 2020 (USGS 1990c). The estimated individual probabilities of magnitude 7.0 or greater earthquakes for the same period on either the northern segment of the Hayward Fault or the San Francisco Peninsula segment of the San Andreas Fault were estimated to be 27 percent and 23 percent, respectively.

3.9.2 Geology Underlying NSTI

Treasure Island

Treasure Island is connected to Yerba Buena Island by an engineered causeway constructed on a former sand spit. Treasure Island was engineered by placing over 29 million cubic yards (22 million cubic m [m^3]) of fill from various sources (CDMG 1969a). The fill was placed on Yerba Buena Shoals, a submerged area of about 735 acres (298 hectares [ha]), between February 1936 and July 1937. The shoals varied in elevation from -2 feet (-0.6 m) to -26 feet (-8 m) mean lower low waterline (MLLW). About 8 million cubic yards (6 million m^3) of the original fill subsequently was lost to erosion, settlement, and drift of fine material during placement (DON 1990c).

The unconsolidated deposits that constitute and underlie Treasure Island can be divided into four broad categories based on their engineering characteristics—fill, native shoal sand, recent bay sediments, and older bay sediments (USGS 1994). The fill was derived from hydraulic and clamshell dredging and was placed within a retaining dike built of rock. Filling commenced February 11, 1936, and was completed July 2, 1937, except for refill operations from August 1 to 24, 1937 (CDMG 1969a). The retaining dike was placed in two to four stages on a prepared bed of coarse sand placed over the shoal. The retaining dike was later covered with riprap from elevation -6 to +14 feet (-2 to +4 m) MLLW (USGS 1994). Of the 29 million cubic yards (22 million m^3) of artificial fill placed on Treasure Island, 1.3 million cubic yards (0.99 million m^3) (less than 0.5 percent) was described as "heavy sand," consisting of coarse and well-graded sand and gravel from Presidio, Alcatraz, and Knox Shoals. The remaining material was predominantly sand, but much finer-grained, which was transported to the island by pipeline from nearby dredging grounds. Beneath the artificial fill are sand and Bay Mud deposits that formed the Yerba Buena Shoals.



The nearest principal active regional faults to Treasure and Yerba Buena Islands are the San Andreas and Hayward Faults.

Legend:

- Active fault
- Active fault, concealed
- County Lines

Principal Regional Active Faults

Bay Area, California

Source: Wallace 1990

Figure 3-16

Yerba Buena Island

Yerba Buena Island consists predominantly of consolidated sandstone and shale of the Franciscan Formation. Slopes on Yerba Buena Island range from approximately 5 to 75 percent (Figure 3-17) (DON 1986). The Franciscan Formation is overlain in some areas by thin sand deposits belonging to the Pleistocene Colma Formation (USGS 1974) or is derived from the underlying Franciscan sandstone (USGS 1957). Only a small area has been filled, on the northeast tip of the island beneath the SFOBB (USGS 1975b; USGS 1957).

3.9.3 Soils

Treasure Island

Soils on Treasure Island and the extreme northeastern tip of Yerba Buena Island, covering zero to 2 percent slopes, are classified as Urban Land-Orthents complex. Urban Land includes those areas that are more than 85 percent covered by asphalt, concrete, or structures. Underlying these areas are reclaimed soil, gravel, broken concrete, Bay Mud, and other materials that extend to depths of -2 to -26 feet (-0.6 to -8 m). The main characteristics of these soils are subsidence, corrosivity (due to the shallow tidally influenced water table), and highly variable soil properties (USDA 1991; DON 1986).

Yerba Buena Island

Soils on Yerba Buena Island range from fine sandy loam to gravely loam, 10 to 40 inches (25 to 102 cm) deep. The natural soils consist of a complex of Candlestick, Kron, and Buriburi soils. These are generally coarse, loose soils, which reflect the underlying Franciscan sandstone bedrock. The permeability of these soils is moderately low. Stormwater runoff is rapid, and soil erosion potential is high. Candlestick soil is a sandy loam that is very susceptible to failure on steep slopes. The Kron soil, also a sandy loam, is the shallowest of the three subunits, with a depth of 10 to 20 inches (25 to 51 cm) to bedrock. The Buriburi subunit is a gravelly loam, with a depth of 20 to 40 inches (51 to 102 cm) to bedrock.

The soil covering the moderately steep to steep (5 to 75 percent) slopes of north-central Yerba Buena Island are classified as Orthents, Cut and Fill-Urban Land complex. The original soil structure was modified by cutting and filling (Orthents) and is covered by buildings or pavement (Urban Land). On Yerba Buena Island the properties of this soil are expected to be very similar to the Candlestick-Kron-Buriburi complex from which the soil was derived. Limitations to development tend to be steepness of slopes and high erosion (USDA 1991; DON 1986).

3.9.4 Geologic Hazards at NSTI

Figure 3-17 shows geologic hazards at NSTI, including those that would occur in a major seismic event. These hazards consist of areas of fill and areas subject to liquefaction, settlement, lateral spreading, and slope and dike instability. Each of these potential hazards is described briefly below.

Ground Shaking

The Mercalli intensity scale is used to describe the severity of an earthquake and rates earthquake damage based on anticipated damage levels ranging from I to XII (e.g., an intensity of I means that the earthquake is not felt, whereas an intensity of XII is a condition where large rock masses are displaced, objects are thrown into the air, and damage is nearly total). Earthquake intensity depends on many factors, including the distance from the origin of the earthquake and the nature of the geologic materials at the location where the earthquake is felt. Generally, bedrock shakes the least because seismic waves travel quickly and efficiently through these materials. Loose water-saturated materials shake more violently because seismic waves are slowed down and are amplified in these materials.

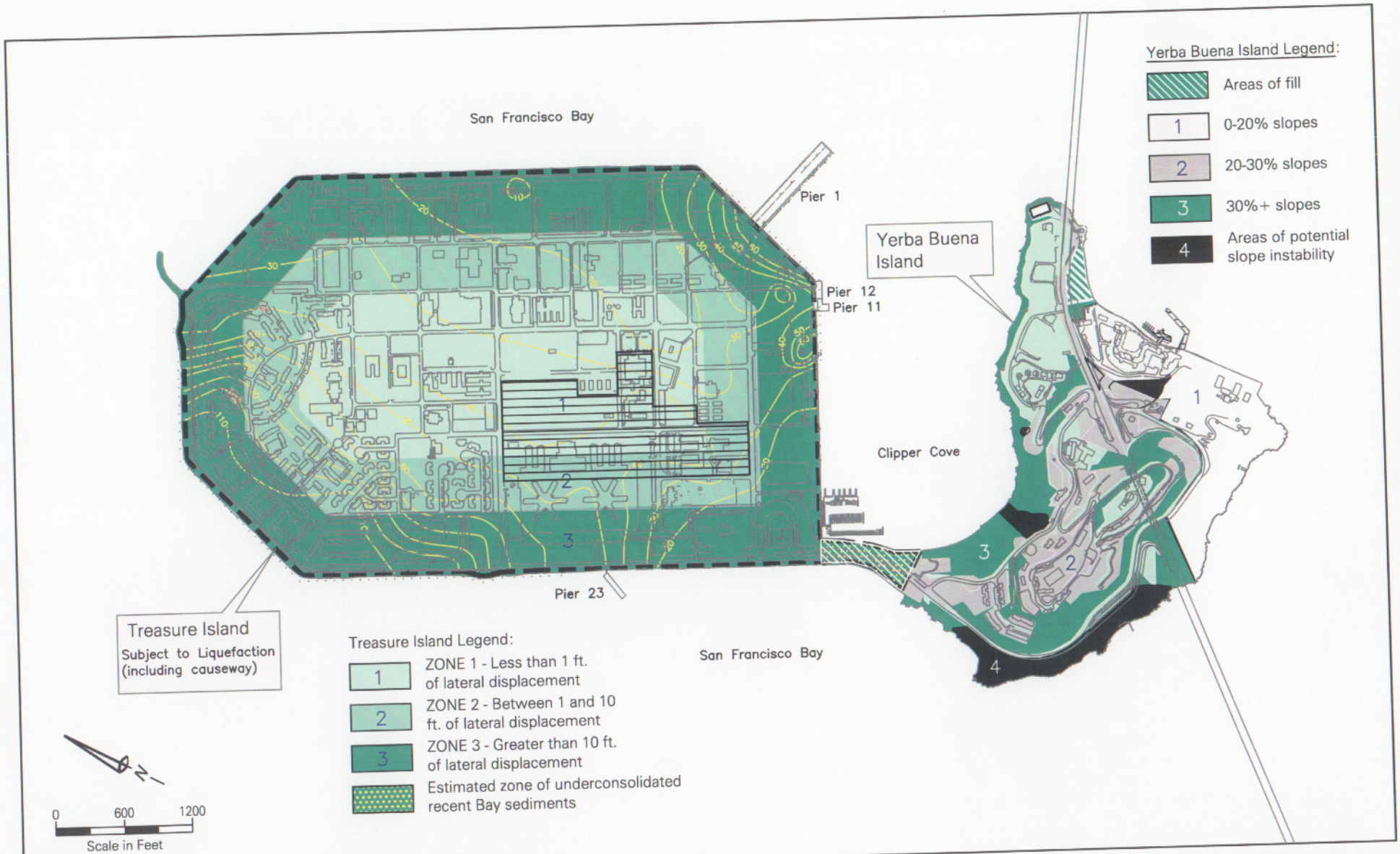
Damage to structures depends not only on the intensity and duration of an earthquake but also on how structures are built, the direction of travel of seismic waves, the orientation of the supporting elements of the structure relative to the direction of seismic wave travel, and the underlying materials (i.e., reclaimed soil, cement, and bedrock).

ABAG has prepared a series of maps projecting the intensity of ground shaking in geologic materials throughout the Bay Area (ABAG 1995a). According to these maps, the fill materials at NSTI are the type of materials that typically increase seismic shaking. The most damaging earthquake at NSTI would be one originating on the northern portion of the Hayward Fault (ABAG 1995a). Such an earthquake, with a Richter magnitude of 7.1, could produce ground shaking on NSTI with an intensity of IX on the Mercalli scale (ABAG 1995a). By comparison, ABAG assigned a Mercalli intensity of VIII to ground shaking on NSTI during the October 17, 1989, Loma Prieta earthquake.

The Loma Prieta earthquake resulted in property damage throughout the greater Bay Area, including Santa Cruz, approximately 65 miles (105 km) south of San Francisco. The 1989 damage in San Francisco was not evenly distributed through the city. Most of the severe property damage occurred in areas built on unengineered artificial fill in the Marina and South of Market districts where the nature of the soils resulted in liquefaction, severe ground shaking, and fire. Bay Area transportation systems were also disrupted, particularly by the collapse of the Cypress Freeway in the West Oakland neighborhood in the City of Oakland and a portion of the SFOBB (San Francisco 1996b).

During the Loma Prieta earthquake, damage varied widely on Treasure Island. Types of damage observed included lateral spreading, slope failure, pavement collapse and cracking, and dike settlement. Liquefaction was pervasive in the interior of Treasure Island, evidenced by numerous large sand boils. Settlement of up to 12 inches (30.5 cm) occurred, causing numerous pipe breaks and ponding water at the surface (USGS 1994). There were no fires.

There is a 67 percent probability that one or more earthquakes of magnitude 7.0 or greater on a nearby portion of the Hayward or San Andreas Faults will occur by 2010 (USGS 1990c). The USGS (1994) predicted that a magnitude 7.0 earthquake on the Hayward Fault would produce a peak bedrock acceleration of about 0.45 times the acceleration of gravity (g) on Yerba Buena Island, or about 7.5 times the acceleration observed during the Loma Prieta earthquake. Even though Treasure Island is underlain by fill, the peak acceleration in a large nearby earthquake



The primary geotechnical hazards induced from earthquakes could include soil liquefaction, settlement, lateral spreading and slope instability.

Thickness contours of recent Bay sediments

Most susceptible to deep failure through recent Bay sediments

Areas subject to liquefaction

Areas Excluded from Proposed Navy Disposal

Geotechnical Hazards

Naval Station Treasure Island, California

Figure 3-17

Source: CCSF 1996e

would be about the same on both Yerba Buena Island and Treasure Island, because the seismic response of fill is not linear (USGS 1994).

In addition to ground shaking, several types of ground failure can be triggered by earthquakes. These secondary seismic effects include liquefaction, settlement, and lateral spreading, and in areas with steep slopes, earthquakes may trigger landslides.

Liquefaction Potential

A major cause of damage to structures during earthquakes is soil liquefaction, which occurs when loose, water-saturated soils (generally fine-grained sand) are subjected to strong seismic ground motions of significant duration.

Treasure Island has been designated a Seismic Hazards Studies Zone (SHSZ) by CDMG because of its high liquefaction potential (CDMG 1997). The San Francisco General Plan Community Safety Element, Map 4, indicates Treasure Island, along with portions of the San Francisco shoreline perimeter, as an area of liquefaction potential (see Figure 3-18) (San Francisco 1996b). Liquefaction was observed in the Marina and South of Market districts (San Francisco 1996b), as well as throughout Treasure Island, during the Loma Prieta earthquake (DON 1990d).

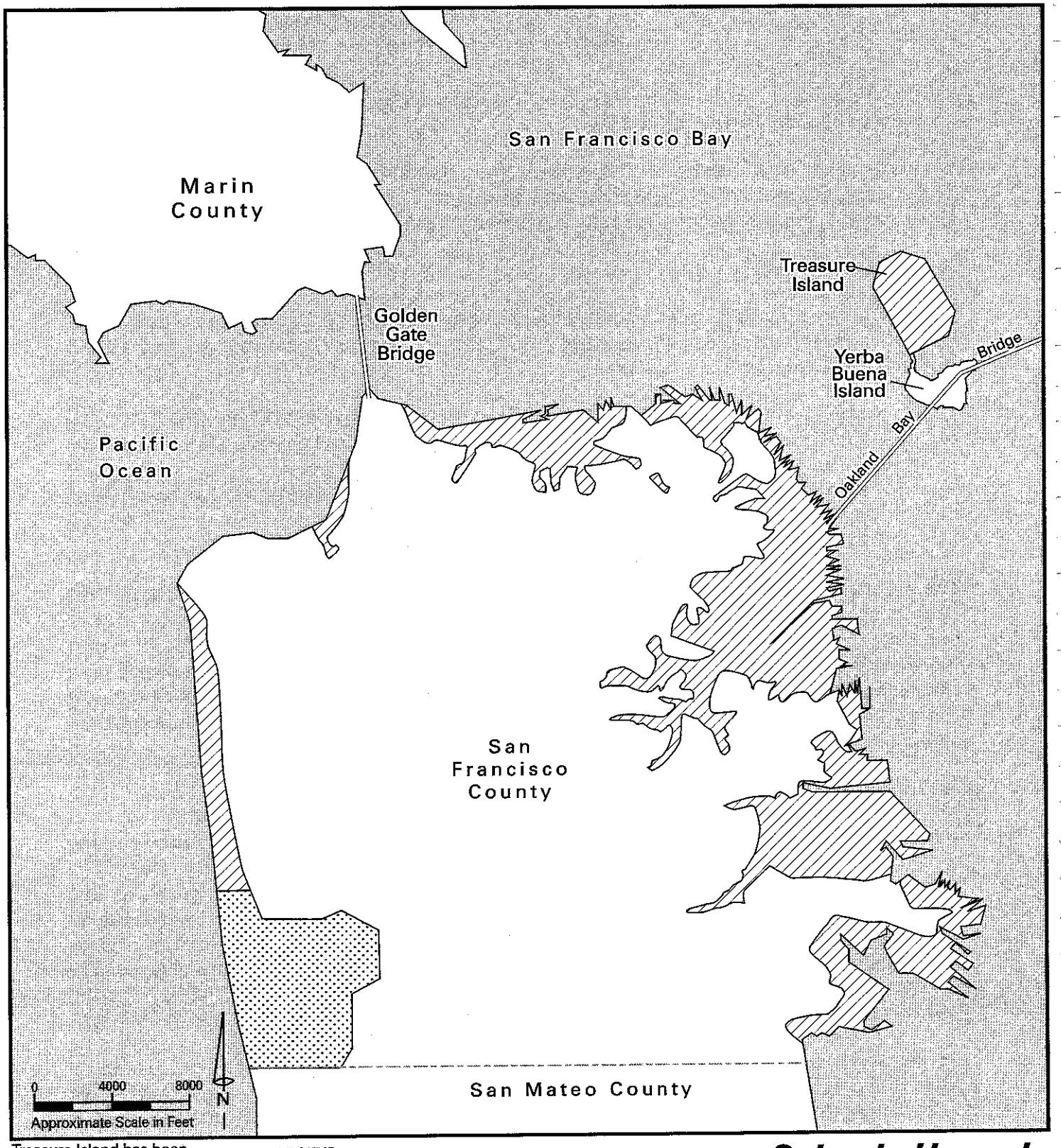
The materials most susceptible to liquefaction are the sand fill below the water table and the underlying shoal sands. The Treasure Island water table typically occurs at a depth of about 5 to 8 feet (1.5 to 2.5 m) below the ground surface. No damage was observed during the Loma Prieta earthquake in an area on the southeast corner of Treasure Island that previously had been compacted to reduce liquefaction hazards (by a method called "vibroflotation"). This suggests that the liquefaction potential of sediments underlying Treasure Island could be reduced by this method or other appropriate site preparation.

Settlement

Settlement is the gradual downward movement of an engineered structure due to compaction of the unconsolidated material below the foundation (USGS 1979). Bay Mud frequently is associated with settlement problems in the San Francisco Bay Area because of its extremely low shear strength (CDMG 1969b). It has been estimated that for an underlying Bay Mud thickness of greater than 60 feet (18 m), about 35 percent of the ultimate settlement would take place during the first 10 years (CDMG 1969a). Due to the relatively old age of the fill across much of Treasure Island, most of the settlement for the current loading already has occurred. Adding new fill or substantially modifying the current loading would initiate a new cycle of settlement.

Seismic shaking can accelerate the rate of settlement, allowing liquefied sediments to reach a greater degree of compaction than before the shaking. In 1990, after the Loma Prieta earthquake, a Navy study to evaluate the seismic stability of NSTI's perimeter dikes estimated that a relatively uniform seismically induced settlement of 1 to 2 feet (0.3 to 0.6 m) would occur across Treasure Island after a large earthquake (DON 1990c).

Differential or uneven settlement results from spatial variations in the uniformity or thickness of the fill and underlying uncompacted sediments. Differential settlement is of particular



Treasure Island has been designated a seismic hazard zone by the California Division of Mines and Geology because of its high liquefaction potential.

LEGEND:

- Area of liquefaction potential
- Area of probable liquefaction potential

Seismic Hazards Study Zones - Areas of Liquefaction Potential

Bay Area, California

Figure 3-18

Source: CCSF 1996b

concern to structures because of the potential for floors, foundations, pavement, or other distributed loads to break or buckle rather than to settle uniformly.

Lateral Spreading

Lateral spreading is the horizontal component of soil movement in the direction of an open (i.e., unsupported) slope face that typically results from liquefaction of a supporting soil layer due to an earthquake. Lateral spreading also occurs due to slope failure that is not caused by earthquakes. Cracks in a nearly horizontal or gently sloping ground surface are a common visual indicator of lateral spreading.

Lateral spreading accompanying liquefaction is a major seismic hazard for Treasure Island (DON 1990e). It has been estimated that lateral displacements in the vicinity of the Treasure Island perimeter dikes may be more than 10 feet (3 m) within the first 500 feet (152 m) from the perimeter for a magnitude 8.0 earthquake on the San Andreas Fault and on the order of 4 feet (1 m) for a magnitude 7.0 earthquake on the Hayward Fault (DON 1990e; San Francisco 1995b). The displacements would extend inland, probably significantly more than the 500 feet (152 m) observed in the Loma Prieta earthquake, and would be exposed as horizontal cracks ranging in size from less than an inch (2.5 cm) to a few feet (0.6 m). Vertical sliding of a fourth to a half the magnitude of the horizontal movements also would occur. Vertical sliding is considered more damaging to structures than the more uniform liquefaction-induced settlement.

Slope Stability

Slope stability depends on a combination of factors, including rainfall, geology, slope steepness, orientation, vegetation cover, seismicity, and development. Slope failure could occur from landslides, debris flows and avalanches, creep, earthflow, or erosion. Catastrophic slope failure in susceptible areas may be triggered by seismic events, rainfall, undercutting of slopes by construction activities, and overloading of unstable deposits.

Figure 3-19 shows the locations of landslide deposits on Yerba Buena Island (USGS 1975a). In addition, the San Francisco General Plan Community Safety Element (Map 5) shows areas of potential landslide hazard on Yerba Buena Island. Landslide deposits are susceptible to continuing failure. Landslide deposits occur at the base of steep slopes around the margin of Yerba Buena Island, mostly on the south side. There is one landslide area on the north side. The island interior is underlain by bedrock with thin soil, which is less susceptible to slope failure.

Dike Stability

Treasure Island contains approximately 15,800 feet (4,816 m) of perimeter stone dike that varies in elevation from 7.7 to 13.8 feet (2.3 to 4.2 m) NGVD. The perimeter dike performs several essential functions—it protects the island interior from flooding, it resists shore erosion, and it retains the fill material that composes the island. The island and the dike were constructed concurrently in 1936 and 1937. Portions of the dike were repaired between 1983 and 1985. This increased the height of the slope north of the entry gate to 54 feet (16.5 m). Repairs consisted of placing rock in this area.

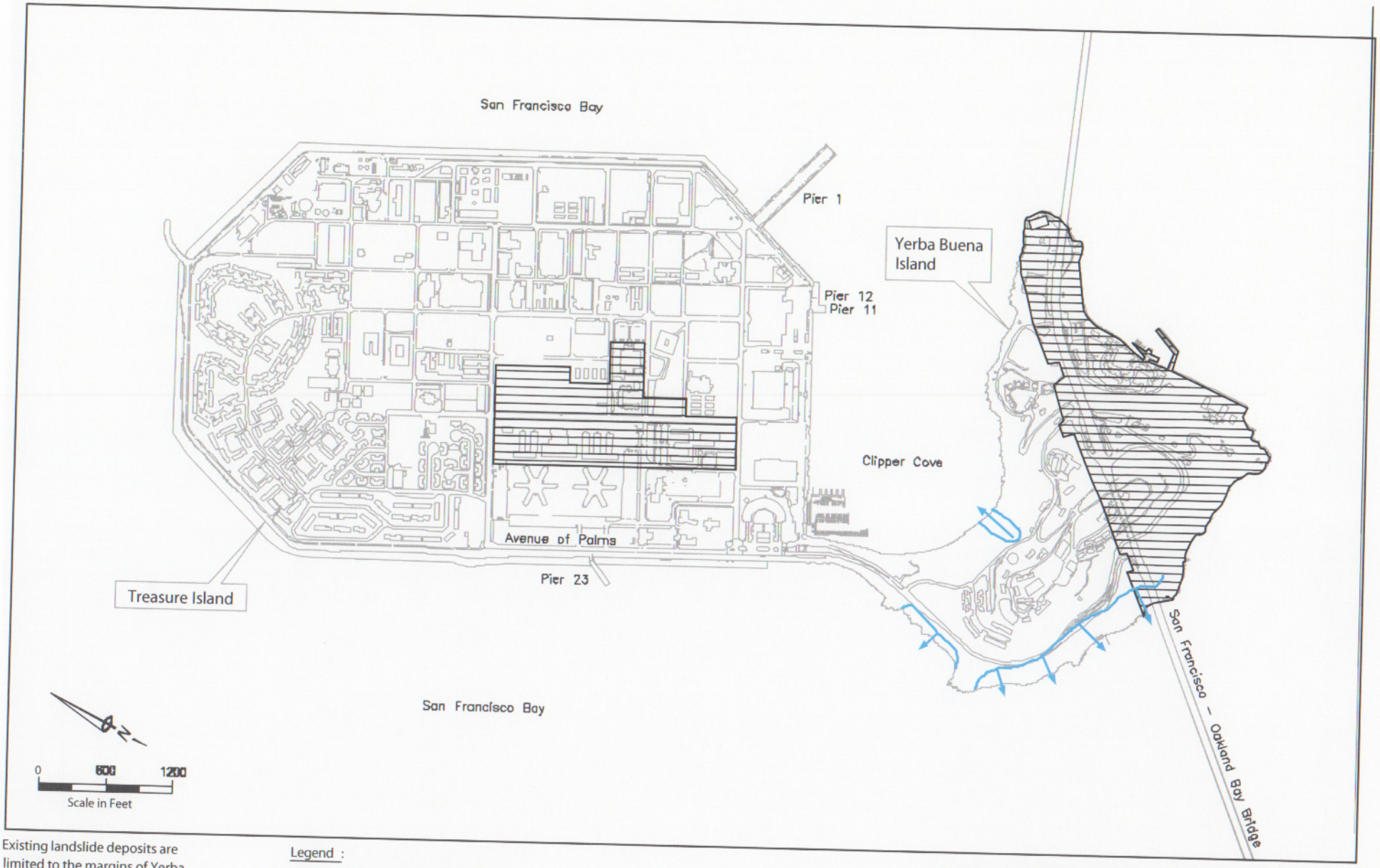
The stability of the perimeter dike at Treasure Island was evaluated by the Navy following the 1989 Loma Prieta earthquake (DON 1990c). It was found that in most locations around the island perimeter, less than 6 inches (15 cm) of lateral (bayward) movement occurred in response to this earthquake. Settlements near the dike were generally less than 12 inches (30.5 cm). Small lateral spreading cracks were observed more than 500 feet (152 m) inland from the perimeter dike on the east side of the island (DON 1990c).

Figure 3-20 shows four cross sections of the perimeter dike (DON 1990c). Cross sections F-F' and I-I', which are the most typical, show that the dikes are constructed on potentially liquefiable material. Cross section C-C' shows where offshore material was removed by dredging or erosion and was repaired with rock. Section D-D' is the location where the retaining dike was reconstructed on 70 feet (21 m) of sand after the slope failed during the initial construction.

The Navy's 1990 study, incorporated into the 1995 Treadwell and Rollo report, indicated that during a design-level earthquake (Richter magnitude 8.0 on the San Andreas Fault or magnitude 7.0 on the north East Bay segment of the Hayward Fault), the sand fill and shoal materials below the water table would be expected to liquefy, and the existing perimeter dikes and causeway shoreline would be expected to spread laterally toward the Bay. Within 500 feet (152 m) inland of the perimeter dike and along portions of the causeway underlain by sand fill and shoal materials, lateral spread displacements were estimated to be greater than 10 feet (3 m). Movements of this magnitude would cause dike failure. Even if improvements are made to mitigate the hazards associated with liquefaction and lateral spreading, rotational slope failures may still occur through the underlying weak layer of recent Bay sediments. During a design-level earthquake, deep failures that could occur through recent Bay sediments could result in up to 5 feet (1.5 m) of slope movement. The study further concluded that if improvements were performed to increase the stability of the slope against deep failures, lateral displacements could be reduced to less than one foot (DON 1990c; San Francisco 1995b).

3.9.5 Improving Ground Stability

Five foundation soil modification techniques have been used at Treasure Island to reduce soil susceptibility to liquefaction and differential settlement (DON 1990c). These techniques involved some form of densifying the underlying soil, such as installing sand compaction piles, installing nonstructural timber piles, vibro-compaction, and stone columns. Mixing the soil with portland cement to form a foundation of "soilcrete" also has been attempted. Figure 3-21 shows the locations of the 12 buildings and one area at the base of Pier 1 with improved foundations. All structures founded on improved ground or piles reportedly performed reasonably well during the Loma Prieta earthquake, with the exception of Building 461 (San Francisco 1995b).



Existing landslide deposits are limited to the margins of Yerba Buena Island.

Legend :

Landslide deposit showing direction of movement

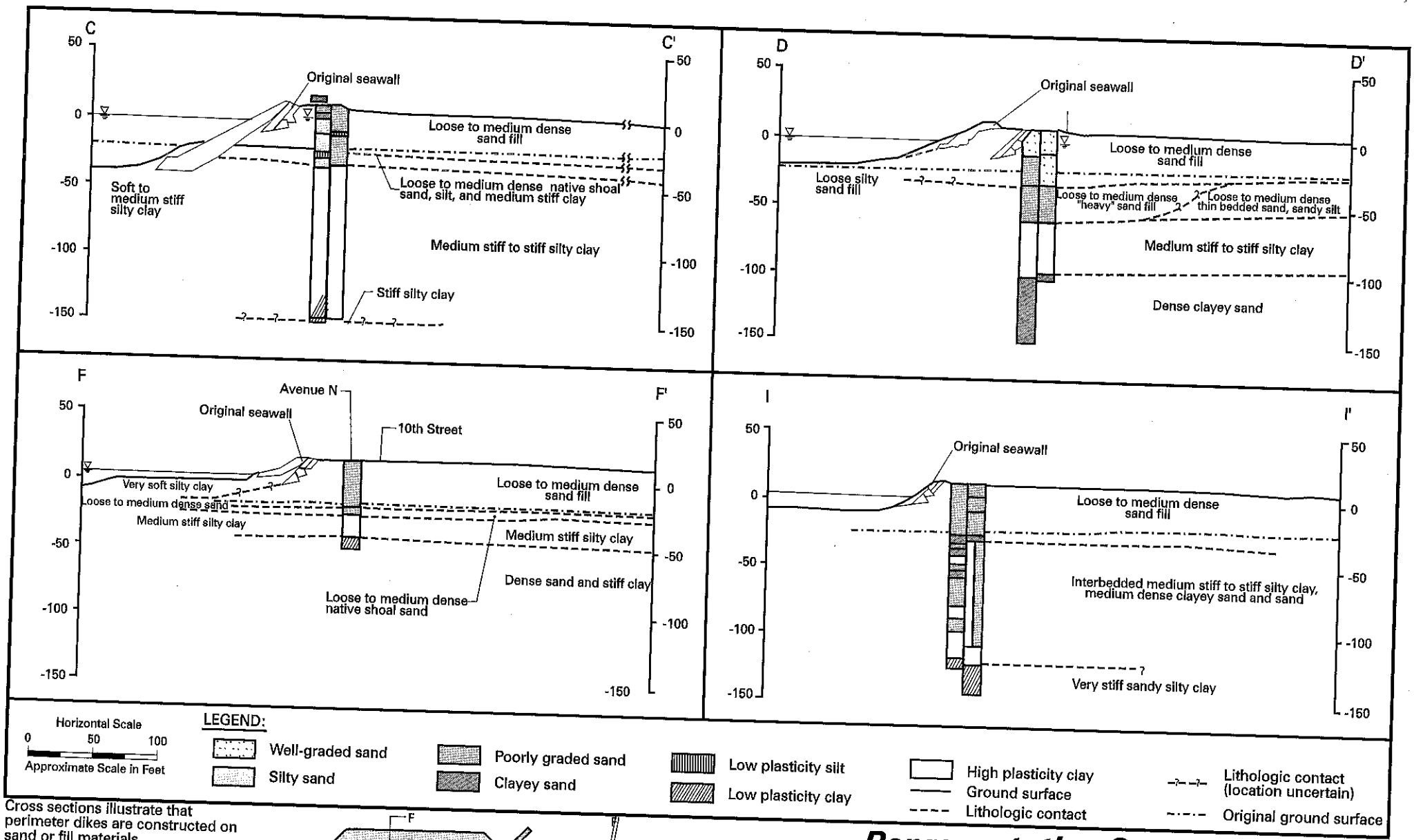
Areas Excluded from Proposed Navy Disposal

Landslide Deposits at NSTI

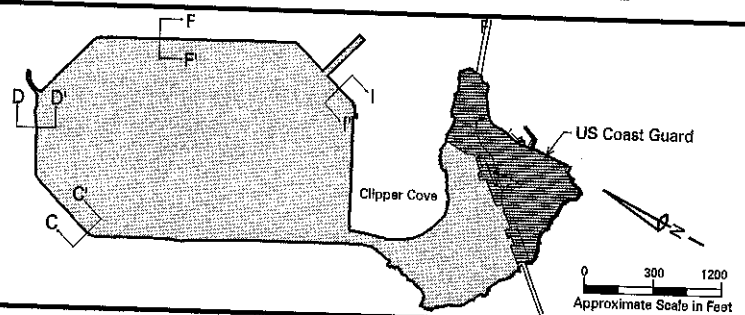
Naval Station Treasure Island, California

Source: Nilsen 1975

Figure 3-19



Cross sections illustrate that perimeter dikes are constructed on sand or fill materials.



Representative Cross Sections on Perimeter Dikes at Treasure Island

Treasure Island, California

Source: DON 1990d

Figure 3-20

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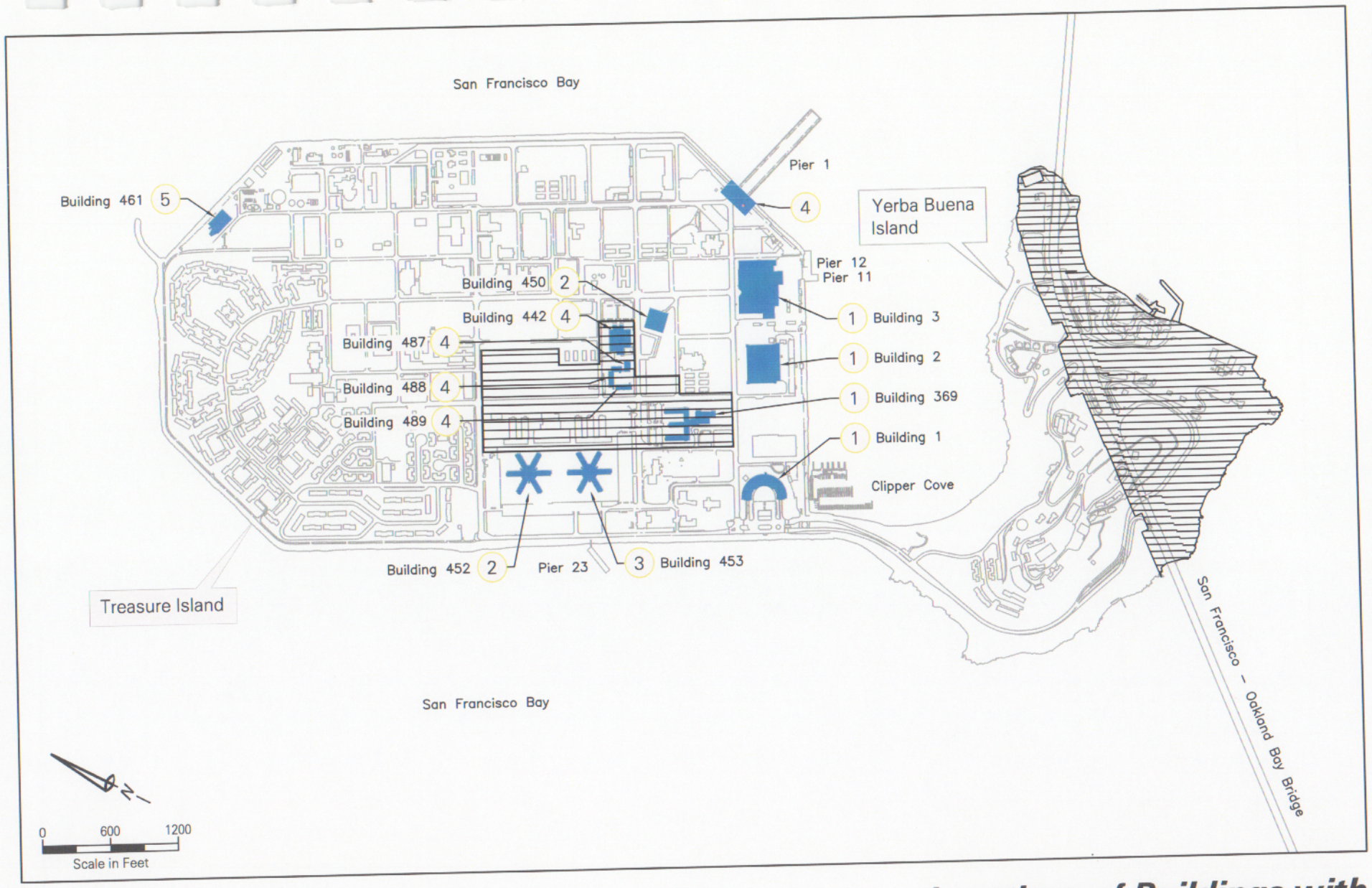

Some of the building sites have been compacted or otherwise prepared to prevent settlement.

Legend:

1. Structure supported by pile foundation
2. Ground improvement by sand compaction piles
3. Ground improvement by nonstructural timber piles
4. Ground improvement by stone columns
5. Structure constructed on pad of soilcrete

Areas Excluded from Proposed Navy Disposal

Buildings with Improved Foundations

Locations of Buildings with Improved Foundations

Naval Station Treasure Island, California

Figure 3-21

Source: DON 1990e

3.10 WATER RESOURCES

This section describes regulatory considerations, surface water resources on NSTI (including flood hazards and water quality), the ground water underlying the islands, and past dredging activities. Other water-related issues, such as stormwater runoff and contamination, are discussed in Utilities (sections 3.11 and 4.11) and Hazardous Materials and Waste (sections 3.13 and 4.13).

3.10.1 Regulatory Considerations

San Francisco Bay Regional Water Quality Control Board

The San Francisco Regional Water Quality Control Board (RWQCB) operates under authority delegated to it by the EPA and the State Water Resources Control Board (SWRCB). The RWQCB is the local enforcement agency for the federal Clean Water Act (Pub. L. 92-500, as amended, 33 U.S.C. §§ 1251-1387) and the State Porter-Cologne Water Quality Act (Cal. Water Code §§ 13000-13999.19). The RWQCB participates in the regionwide long-term management strategy (LTMS) program for dredging and disposing of material dredged from the Bay. The RWQCB also regulates urban runoff discharges under the National Pollutant Discharge Elimination System (NPDES) permit regulations. NPDES permitting requirements cover runoff discharged from point (e.g., industrial outfall discharges) and nonpoint (e.g., stormwater runoff) sources. The RWQCB implements the NPDES program by issuing construction and industrial discharge permits.

Construction projects of one or more acre are subject to NPDES Phase II permit regulations, which require the development of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP is designed to minimize water quality degradation through storm water monitoring, establishment of Best Management Practices (BMPs) (e.g., bioswales), implementation of erosion control measures, and implementation of spill prevention and containment measures. Separate SWPPPs are required for construction and post-construction operations.

All of the stormwater runoff from mainland San Francisco is directed to the city's sewage treatment plants for pretreatment prior to discharge into the Bay or ocean. The treatment plants operate under individual NPDES industrial discharge permits. However, unlike mainland San Francisco, Treasure Island has separate stormwater and wastewater systems.

The wastewater treatment plant at NSTI operates under an NPDES permit. The permit specifies discharge prohibitions, effluent limitations, receiving water limitations, and sludge requirements for the plant. Navy has a self-monitoring arrangement for effluent with RWQCB (DON 1996g). Under this arrangement, effluent constituents are continuously analyzed at one-minute intervals (San Francisco 1995b).

NSTI complies with the statewide General Permit for Stormwater Discharges Associated with Industrial Activities through a notice of intent that covers the entire base as a single industrial site. The permit includes a SWPPP and existing and proposed BMPs. The SWPPP includes a representative stormwater sampling program that evaluates stormwater quality from the most active industrial areas (DON 1998g). Under the three reuse alternatives, anyone conducting

specific industrial operations at the site would be required to comply with requirements of the statewide General Permit for Stormwater Discharges Associated with Industrial Activities.

The RWQCB also regulates water quality in accordance with state laws and policies identified in the San Francisco Basin Plan. The plan identifies beneficial uses of surface and ground waters, wetlands, and marshes, and sets forth water quality objectives to protect the beneficial uses. Beneficial uses for San Francisco Bay include industrial uses, processing, navigation, contact and noncontact recreation, fishing, commercial uses, wildlife habitat, species preservation, and fisheries habitat (RWQCB 1995). The San Francisco Bay RWQCB has determined that groundwater beneath Treasure Island is not a potential source of drinking water and is therefore not considered to be a beneficial use. Groundwater is not used for any beneficial use at NSTI. Stormwater discharges would need to be consistent with beneficial uses identified for San Francisco Bay as part of the basin plan. NPDES permit effluent discharge limitations are structured to achieve regional compliance with basin plan beneficial uses.

Long-term Management Strategy

The LTMS study is intended to identify long-term solutions to the problem of regional dredge material disposal for a 50-year planning period. An estimated average of approximately 300 million cubic yards (229 million m^3) per year of dredge materials will require disposal through the planning period (1995 to 2045). The LTMS includes provisions for disposing of, rehandling, and reusing dredge material in both construction and fill activities. Under the proposed reuse alternatives, dredged materials would be required to be disposed of in compliance with the LTMS Plan.

U.S. Army Corps of Engineers

The San Francisco Bay and shoreline is within the jurisdiction of the COE. The COE's regulatory authorities and responsibilities are based on the following laws:

- Sections 9 and 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. §§ 401, 403), which regulate diking, filling, or placing structures or work in or affecting navigable waters of the US;
- Section 404 of the Clean Water Act of 1972 (33 U.S.C. § 1344), which regulates disposal of dredged or fill material into the waters of the US; and
- Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. § 1413), which regulates the transportation of dredged material for purposes of disposing of it in ocean waters.

The COE also participates in the regionwide LTMS program for dredging and disposing of material dredged from the Bay. For a proposed project within its jurisdiction, the COE conducts a public interest review by soliciting comments on permit applications through a public notice process. The BCDC, RWQCB, CDFG, EPA, USFWS, and NMFS have specific review and comment responsibility for COE-permitted projects. The COE will review developments proposed under the reuse plan that involves structures or dredging within the Bay shoreline or proposed discharges of dredged material into U.S. waters.

3.10.2 Surface Water Resources

Surface Drainage

Surface drainage is the flow or runoff of rainfall from the site. This runoff can be over the ground surface in open drains or through a system of storm drainpipes. Area precipitation is mostly rainfall and averages about 20 inches (51 cm) annually between October through April. The two islands have very different topography; Treasure Island is relatively flat, with shoreline areas protected by a perimeter dike, while Yerba Buena Island has steep slopes and a natural bedrock shoreline. Storm drainage systems of the two islands are separate, but runoff from both systems flows to San Francisco Bay.

Treasure Island

Runoff from Treasure Island collects in a series of storm drain systems and is directed to the Bay via gravity outfalls and pump stations. The Treasure Island storm drainage system includes six storm drain lift stations, each with high capacity pumps for winter storms and lower capacity pumps for summer duty, primarily irrigation runoff. Twenty-five major outfalls serve Treasure Island, primarily steel or concrete pipes, ranging from 12 to 42 inches (31 to 107 cm) in diameter. Approximately 24 smaller outfalls supplement this system, ranging from 4-inch (10-cm) to 10-inch (25-cm) pipes of varied composition (San Francisco 1995a). The Treasure Island storm drain system is adequate in terms of capacity. It performed well in heavy rains during 1995-1996 and 1996-1997, and no ponding or other problems were noted during these events. The Treasure Island storm drain system was inspected in 1991-1992 and was repaired in 1993 (DON 1996i).

Localized ponding occurs on low-lying areas of Treasure Island, particularly on its northern side, from tidal seepage through the perimeter dikes during extreme high tides. This has not affected structures or foundations, which are above the seepage level, but has resulted in ponding in yard and open space areas.

Yerba Buena Island

Runoff from the generally undeveloped portions of Yerba Buena Island flows to the Bay via natural ravines and overland sheetflow; this runoff has caused erosion and slope failures (San Francisco 1998a). Runoff from developed areas flows to the Bay via a gravity stormwater drainage system that discharges at various points along the shoreline.

Flood Hazards

Treasure Island is protected from tidal flooding by a perimeter dike. The dike provides adequate protection from wind- and wake-generated waves (San Francisco 1995b). Tsunamis (also known as seismic sea waves or tidal waves) can be generated by offshore or distant seismic activity or by submarine landslides. Seiches are waves generated in an enclosed body of water caused by seismic shaking, climatic forces, or landslides into the water body. Although seiches are possible in San Francisco Bay, the largest ever measured in the Bay was 4 inches (10 cm) in the 1906 earthquake (Alameda Reuse and Redevelopment Authority 1995).

The site has not been mapped for flood hazards by the Federal Emergency Management Agency (FEMA) (DON 1988b).

Tide heights range from approximately zero to about 6 feet (2 m) NGVD, with 100-year highest estimated tides of 6.4 feet (2 m) NGVD (COE 1984). Waves generated by 60 mph (97 km/hour) storm winds may reach heights of approximately 7.5 feet (2 m) (DON 1985). Therefore, in a worst-case scenario, a maximum high tide, in combination with 60 mph (97 km/hour) storm winds, could result in waves reaching 13 to 14 feet (4 to 4.3 m) above sea level NGVD.

Predictions of future accelerated sea level rise due to global warming vary widely. The EPA projects a 50 percent likelihood that sea levels will rise approximately 4 inches (10 cm) (an average of 0.14 inches [0.36 cm]/year) by 2025 and approximately 8 inches (20 cm) (an average of 0.16 inches [0.39 cm]/year) by 2050 (EPA 1995).

Water Quality

NSTI surface runoff contains relatively low levels of urban pollutants, such as oil and grease, heavy metals, rubber, fertilizers, and pesticides (DON 1998e). Localized ground water contamination from spills and leaks of hazardous materials have been identified in areas of NSTI, and exceedances of the EPA's ambient water quality criteria for various organic compounds and metals have been measured. Areas of contamination are in proximity to the shoreline, and contaminants may reach the Bay via tidal influence (for further discussion, see section 3.13, Hazardous Materials and Waste).

San Francisco Bay in its entirety has water quality problems resulting from past and present practices, including urban waste disposal, runoff from agricultural areas into the Bay, contaminants entrained in urban street runoff, ship repair, and accidental spills or deliberate discharges from ships. The SWRCB has listed Central San Francisco Bay as impaired on the basis of field surveys of the water column, sediments, sediment toxicity, bivalve bioaccumulation, and water toxicity. This determination related to levels of copper, mercury, selenium, diazinon, and PCBs (SWRCB 1997; San Francisco 1998d). Regarding discharge of sewage from vessels at Treasure Island, since 1981, most military vessels have been equipped with holding tanks for both sewage and grey water, and there are adequate pump-out facilities at NSTI docks. However, the marina does not have a pump-out station for recreation boats (San Francisco 1998a).

The sewage treatment plant at NSTI provides for secondary treatment of sanitary sewage and discharge to the Bay via an outfall near the plant. Baseline (pre-closure) discharge volumes equaled approximately 600,000 gallons per day (2,271,000 liters per day) dry-weather flow in 1994 (DON 1994b). This quantity and the quality of discharge is permitted by the RWQCB, which has regulatory authority over Bay discharges. The quality of sediments in near-shore waters is addressed in section 3.13.

3.10.3 Ground Water

NSTI influences on regional ground water hydrology are considered minimal because the islands are isolated from water-bearing aquifers in the Oakland area. Ground water at Treasure Island is recharged by direct infiltration of precipitation, landscape irrigation, and leaking storm

drains (DON 1990b; RWQCB 1996). Ground water occurs at shallow depths throughout Treasure Island but is limited on Yerba Buena Island. The Treasure Island subsurface, whether fill, Bay Mud, or shoal deposits, is saturated at elevations of 0 to 6 feet (0 to 2 m) NGVD, depending on tidal influence. Average ground water elevations in the central part of the island were measured at 3 feet (0.9 m) NGVD in 1990 (DON 1990c) and at 4 feet (1 m) NGVD in 1995 (San Francisco 1995b).

The shallow ground water in fills and Bay Mud is hydrologically connected with the saline waters of San Francisco Bay; this connection is greatest at the edges of the island. Tidally influenced ground water table fluctuations have been observed at distances ranging from 90 to 250 feet (27 to 76 m) inland. Ground water at Treasure Island generally flows from the island center towards the shoreline. Tidal mixing with ground water has been noted up to about 100 feet (30.5 m) inland from the shoreline (DON 1995e), resulting in brackish ground water.

The San Francisco Groundwater Master Plan (San Francisco Public Utilities Commission 1996) does not consider ground water at Treasure Island to be an important water supply aquifer. The San Francisco Bay RWQCB conducted a Pilot Beneficial Use Project (RWQCB 1996), which considered Treasure Island to be of limited value as a water supply aquifer and recommended deleting water supply as a beneficial use for the island's ground water. The San Francisco Bay RWQCB determined that ground water beneath Treasure Island is not a potential source of drinking water, pursuant to SWRCB Resolution no. 88-63 and RWQCB Resolution No. 89-39, because of the quality and hydrologic conditions of the groundwater. Localized ground water contamination from spills and leaks of hazardous materials are discussed in the hazardous materials and waste section of this document (section 3.13).

3.10.4 Past Navy Dredging

Treasure Island and Yerba Buena Island form a cove east of the causeway, open to the northeast. A large shoal area from -3 to -5 feet (-0.9 to -1.5 m) mean lower low waterline (MLLW), which is about 3.1 feet (0.9 m) below NGVD, has formed across the cove, extending to within 150 yards (137 m) of Pier 1. Other depths in the cove, including the marina area, range to -20 feet (-6 m) MLLW. Berth soundings at Pier 1 are -28 feet (-8.5 m) MLLW on the north side and -15 to -28 feet (-4.5 to -8.5 m) MLLW on the south side.

Between 1970 and 1985, Navy dredged a 3-mile (5-km) long, 1,000- to 1,500-foot (305- to 457-m) wide channel to a depth of -35 feet (-11 m) MLLW adjacent to the northern and eastern shores of Treasure Island. This channel continues around the east side of Yerba Buena Island, extending about 3,000 feet (914 m) beyond its southern edge. Three contiguous berthing zones on the northern and eastern side of Treasure Island were dredged to a depth of -45 feet (-14 m) MLLW in 1970 and 1985. The dredging from these projects extracted approximately 763,000 cubic yards (583,355 cubic m) of material, averaging about 51,000 cubic yards (38,992 cubic m) per year from 1970 to 1985. In 1970, approximately 272,000 cubic yards (207,958 cubic m) of material was disposed of at open water sites. In 1985, about 35,000 cubic yards (26,759 cubic m) was disposed of on Treasure Island, and approximately 457,000 cubic yards (349,401 cubic m) was disposed of at the Alcatraz Island disposal site (COE 1996). Navy has maintenance dredged the marina and pier areas of NSTI. The last dredging in the marina area occurred in 1990.

Pursuant to Section 404 of the Clean Water Act (33 U.S.C. § 1344), dredge material is tested routinely for dissolved metals and other contaminants. Sediment quality in the southeast corner of Treasure Island was evaluated in 1984 for the potential homeport of the USS Missouri Battle Group, and no contaminants were detected (DON 1984b). .Navy's Treasure Island Dredging Project reported no history of sediment contamination in the navigation channel (COE 1996). Few data are available to establish sediment quality in Clipper Cove, although data from nearby locations suggest that sediments at other locations in the Central Bay, including nearby at Yerba Buena Island, are contaminated by metals. In one study that compared the toxicities of sediments from various sites in the Bay, sediments from Clipper Cove were found to be toxic to sea urchin, mussel, and amphipod species. However, the source of the toxicity was thought to be high concentrations of ammonia and sulfides, rather than heavy metals. The concentration of copper, nickel, cadmium, zinc, and lead in the Clipper Cove sediments was found to be relatively low (Anderson et al. 1995).

3.11 UTILITIES

This section describes the utility delivery system and quantities of utility use under baseline conditions, including potable water and fire protection distribution, wastewater collection and treatment, stormwater collection, electrical and natural gas, telecommunications, and solid waste systems. The utility infrastructure is still owned by Navy, unless otherwise noted. Portions of the utility infrastructure cross the property that was appropriated by FHWA and transferred to Caltrans; under the terms of the appropriation, that infrastructure is owned by Caltrans. San Francisco personnel are granted periodic access to the property to maintain the infrastructure. While this section describes the current condition of utility systems, levels of use or consumption represent baseline conditions (1993 units). Most buildings at NSTI, including housing units, were not individually metered for utilities.

3.11.1 Potable Water and Fire Protection Water

NSTI has a combined potable water and fire protection distribution system. The San Francisco Water Department supplies water to NSTI through its 10-inch (25.5-cm) diameter steel main attached to the SFOBB. According to the San Francisco Water Department (San Francisco Water Department 1998), the maximum pump rate for that line is 1,750 gallons per minute (6,624 liters per minute).

Emergency backup water service has been provided by the East Bay Municipal Utilities District (EBMUD) through a Navy-owned, 12-inch (30.5-cm), cement-lined steel pipe attached to the SFOBB. This pipe is connected to a Navy-owned pump station in Pier E-23 of the SFOBB and connects at the east end of the SFOBB with approximately 13,000 feet (3,962-m) of Navy-owned land-based pipeline of 12-inch (30.5-cm) and 14-inch (35.6-cm) diameter that originates at a connection to an EBMUD water main in Emeryville. The water is treated with chloramines before delivery to NSTI. The line is used to supply water to SFOBB fire hydrants; however, it has not been used for hydrants since 1999. Total capacity of the system is about 2 million gallons per day (MGD) (7.5 million liters per day).

Water from the San Francisco main is routed into four concrete reservoirs on Yerba Buena Island, which have a total storage capacity of approximately 6.5 million gallons (24.5 million liters) (DON 1994b). The capacity and use of each reservoir is summarized in Table 3.11-1. Use of Reservoir 242 is reserved for fire protection purposes, with a capacity adequate for five hours of firefighting demand (San Francisco 1995b). Reservoir 242 has been drained and repaired; Reservoir 168 is currently out of service but has not been drained; Reservoir 227 was inspected by a dive team, was drained in 1998, and remains out of service since its three million gallon capacity is not required for the current operation of the islands (DON 2001; San Francisco 1998a). With some maintenance and repair, all of the reservoirs are serviceable.

The original potable water distribution system, constructed in 1939, was separate from the fire protection system. This separate system was replaced in 1989-1990 with a combined system. All areas are supplied by gravity except for one housing area on Yerba Buena Island that is supplied from Reservoir 168 by a booster pump. Water from Reservoir 227 is supplied to Treasure Island through an 18-inch (46-cm) main with a maximum flow rate of approximately 7,900 gallons (29,905 liters) per minute. A 22-inch (56-cm) backup main runs parallel to the 18-inch (46-cm) main.

Table 3.11-1
Water Storage Capacity at NSTI (Yerba Buena Island)

Reservoir	*Capacity (million gallons)*	*Water Elevation Range (feet above mean sea level)*	*Use*
227	3.0	252.5 to 255.5	Primary potable water supply to Treasure Island
162	2.0	322.0 to 327.0	Supplies potable water to Yerba Buena Island
242	1.0	247.0 to 251.0	Reserved for fighting fires
168	0.5	356.0 to 359.0	Supplies potable water to Yerba Buena Island
(Total capacity)	6.5	-	-

Source: DON 1994b.

The present system is equipped with sectioning valves that allow sectors to be isolated for maintenance and repair. The distribution system, which includes a chlorinization unit, is in good condition and received regular preventive maintenance. The polyvinyl chloride (PVC) piping in the distribution system, which is present in limited sections, does not conform to San Francisco Water Department standards (San Francisco 1996e). The fire hydrants do not possess backflow regulators. The total capacity of the system is approximately 2 MGD (7.5 million liters per day) (San Francisco 1995b). Baseline domestic water use was 0.96 MGD (3.6 million liters per day) (DON 1997c).

3.11.2 Wastewater Collection and Treatment

The wastewater collection system was constructed in 1939 and was upgraded in 1984 (DON 1994b). Approximately 52,600 linear feet (16,032 linear m) of 4-inch (10-cm) to 16-inch (40.5-cm) diameter pipes collect the wastewater. Wastewater flows through collection piping from gravity and pumping. The system includes 24 lift stations of varying configurations and equipment. The collection system at Yerba Buena Island is linked to Treasure Island by an underwater 6-inch (15-cm) force main. There is also a sewer line connecting the two islands along the causeway.

The current condition of the collection system is fair (DON 2001). Some elements of the plant are in need of repair (San Francisco 1995b). About a third of this system was cleaned and inspected in 1997; repairs were made to the most critical deficiencies (San Francisco 1998a). The wastewater collection system does not conform to San Francisco standards (San Francisco Public Utilities Commission 1998). The plant is constructed on unreinforced ground adjacent to the shoreline, where lateral spreading of 10 feet (3 m) or greater during a severe earthquake is considered a possibility (San Francisco 1995b).

Wastewater flows to the wastewater treatment plant in the northeast corner of Treasure Island. The plant, constructed in 1990, provides secondary treatment and has a design capacity of approximately 2 MGD (7.5 million liters per day), wet weather capacity of approximately 8 MGD (30 million liters per day), and storage tanks that provide 200,000 gallons (757,082 liters) of pre-treatment storage. The plant has a minimum treatment requirement of approximately 200,000 MGD (757,082 million liters per day) and is capable of providing service to a residential

population of about 22,000 people. Under a RWQCB permit, the wastewater treatment plant is permitted to discharge up to approximately 2 MGD (7.5 million liters per day) of treated effluent to San Francisco Bay. Following treatment, residual solids are disposed of at Redwood Landfill in Marin County. Baseline sewage generation was 0.04 MGD (0.15 million liters per day)(DON 1997c).

3.11.3 Stormwater Collection

Storm drains throughout NSTI collect stormwater and convey it via 4-inch (10-cm) to 42-inch (107-cm) pipelines to outfalls. There are 49 outfalls at the perimeter of Treasure Island and 26 at Yerba Buena Island. San Francisco's assessment of the collection system indicated potential problems, including crushed pipe, redwood pipe, asbestos cement pipe, and cross connections, which may be contributing to petroleum contamination of the Bay (San Francisco Department of Public Works 1996). The problem with cross connections has been resolved, and problems related to the nonstandard materials and age of the system require repair and replacement actions (DON 2001). The stormwater collection system does not conform to San Francisco standards (San Francisco Public Utilities Commission 1998). The system operates under a NPDES statewide General Permit for Stormwater Discharges Associated with Industrial Activities. Stormwater quality with respect to urban pollutants is discussed in section 3.10, Water Resources. Stormwater contamination due to hazardous materials, spills, and leaks is discussed in section 3.13, Hazardous Materials and Waste.

3.11.4 Electrical and Natural Gas Systems

Electricity Distribution

Electricity is supplied to NSTI through a Navy-owned 12.5-kilovolt (kV) underwater cable, which originates at a connection at the eastern end of the SFOBB. At that point, the underwater cable connects to a Navy-owned 12.5-kV overheard line originating at the Navy's Davis Substation, located at the former Fleet and Industrial Supply Center (FISC) in Oakland (DON 1996d; DON 2001). Western Area Power Administration (WAPA) power (115 kV) supplied to the substation is stepped down to 12.5 kV for transmission to NSTI. WAPA electricity is generated by 55 hydroelectric plants with a combined capacity of 10,600 megawatts. The Pacific Gas and Electric Company (PG&E) provides secondary electrical power to NSTI via a 12.5-kV underwater cable originating at PG&E Substation J in San Francisco.

The main electrical substation is in Building 3 on Treasure Island. From here, four underground 12.5-kV feeders extend to the NSTI distribution system. In addition, two 4.16-kV feeders supply power to Yerba Buena Island (DON 1985). The electrical distribution system at NSTI was upgraded in the early 1980s. The system is in good condition and is capable of providing service to existing load demands (San Francisco 1995b; DON 2001). The Yerba Buena Island distribution system is aging and in need of replacement. Individual buildings at NSTI are not metered, and most meters serve multiple buildings or customers.

Natural Gas Distribution

PG&E provides natural gas transmission service to the NSTI main metering station, located near the steam plant (Building 455), via a 10-inch (25.5-cm) 120-pounds per square inch (psi)

(8.4 kilograms [kg] per square cm [cm^2]) underwater main from the East Bay. This main has a capacity of 700,000 cubic feet (178,360 m^3) per hour, which is 130 percent of the current load.

Four distribution systems (referred to as A, B, C, and D) supplied both Treasure Island and Yerba Buena Island with natural gas. The Existing Conditions Report (San Francisco 1995b) determined that the distribution system is in adequate condition for current needs. Buildings and customers on the islands are not individually metered. System A, installed in 1965, delivers service (mostly via steel pipe) at 10 psi (0.7 kg per cm^2). System B was installed in 1965 to provide natural gas to steam plants. The steel lines provide gas at 10 psi (0.7 kg per cm^2) to steam plants located in Buildings 455 and 540. System C was installed in 1970 to provide service to the fire fighting school and the steam generation plant at Building 550. Gas is provided through an 8-inch (20-cm) diameter steel pipe at 20 psi (1.4 kg per cm^2). System D was installed in 1985 to provide service to the steam plants at Buildings 520 and 530. Gas is provided at 20 psi (1.4 kg per cm^2) through a 4-inch (10-cm) diameter PVC pipe.

3.11.5 Telecommunications

A conduit on the SFOBB provides telecommunications connections to NSTI from San Francisco through trunk lines installed in 1989. The system consists of basic T-1 trunks (24 voice channels per T-1, over 2 twisted pairs) grouped in cables of 100 to 1,200 copper pairs. The copper cable, consisting of 9,375 cable pairs, is in excellent condition (DON 1996l).

The NSTI telecommunications system was designed for the specific requirements of Navy and tenant organizations. The telephone component of the telecommunications infrastructure was installed in 1989 using both new and used equipment (DON undated). Telecommunications at NSTI were divided into three independent systems: the residential system, the Consolidated Area Telephone System (CATS), and a classified system. The residential system is operated by Pacific Bell, and CATS and the classified system were owned and operated by Navy (DON 1996d). CATS and the classified system are no longer in operation.

The residential system owned and operated by Pacific Bell provides standard "1+" service to meet private needs at family residences, bachelor officers quarters, and bachelor enlisted quarters. The service is connected to a cable hut at Yerba Buena Island from Pacific Bell's central office switch at 611 Folsom Street in San Francisco. From the hut, the cable extends to Building 1 via the causeway. The Pacific Bell system appears to be at capacity. The bachelor officers quarters and bachelor enlisted quarters are underserved. In addition, the cable lines have degraded to the point where only 25 percent are operable.

3.11.6 Solid Waste

Solid waste was collected either by Navy or a private contractor. The solid waste is delivered to the Davis Street Transfer Station, and then it is transported to the Altamont Landfill (DON 1996e). The landfill receives an average of 6,000 tons (5,444 metric tons) per day from all customers and can accept a maximum of approximately 11,150 tons (10,117 metric tons) per day (Waste Management of Alameda County 1997). The landfill was recently expanded and will reach capacity in approximately 30 years.

Weights are not routinely measured, as Navy's agreement with the contractor is based on the number of containers by volume removed, as shown in Table 3.11-2. Assuming that each emptied container was full, NSTI would have generated approximately 113,623 cubic yards (86,871 m^3) or 14,203 tons (12,882 metric tons) of solid waste in fiscal year 1993 (FY93). In addition, Navy removed approximately 8,291 cubic yards (6,339 m^3) or 1,037 tons (941 metric tons) of construction debris in FY93. Combining these two waste streams, the total amount of solid waste generated at NSTI in FY93 is estimated to be 15,240 tons (13,829 metric tons), an average of approximately 42 tons (38 metric tons) per day. The recycling program at NSTI is outlined in the solid waste management plan.

Table 3.11-2
Solid Waste Removed from NSTI (Fiscal Year 1993)

Container Type	*Volume of Container*	*Number of Containers Removed, FY93*
Waste container	50 cubic yards	312
Waste container	20 cubic yards	728
Waste container	5 cubic yards	13,156
Waste container	2 cubic yards	364
Can	32 gallons	105,144
Bag	variable	12,108
TOTAL	77 cubic yards/32 gallons	131,812

Source: DON 1994b.

3.11.7 Steam Distribution

Five boiler plants supplied various areas of NSTI with steam for building space heating, domestic water heating, and galleys (DON 1994b). Steam was the primary source of heat for most nonresidential buildings at NSTI. Approximately 14,000 feet (4,267 m) of distribution pipe and approximately 14,000 feet (4,267 m) of condensate return pipe make up the distribution system. Over 70 buildings received steam at a pressure of 55 psi (3.9 kg per cm^2) through insulated underground piping. The entire system was upgraded in 1983 and closed in 1997; the pipes remain in place.

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3.12 PUBLIC SERVICES

This section describes public services both at NSTI and in San Francisco. Fire protection, police protection, and emergency medical services are addressed. San Francisco public service providers would be responsible for serving NSTI following property disposal. The baseline for conditions at NSTI is pre-closure (1993) conditions. For San Francisco public service providers, baseline conditions are presented to reflect the conditions present at the time the EIS was initiated (1996-1997).

3.12.1 Fire Protection

NSTI

Prior to October 1, 1997, Navy NSTI Fire Department provided services to the islands, including fire suppression, emergency medical services, fire prevention, public education, and hazardous materials mitigation response. A mutual aid agreement was in place with San Francisco. Historically, Navy operated two fire stations, one on Treasure Island (Building 157) and one on Yerba Buena Island (Building 213). The 1988 Master Plan Update (DON 1988b) indicated that the Treasure Island station was in substandard condition and recommended constructing a new facility. This project was not completed.

In 1993, the department employed 41 fire fighters and 18 emergency medical personnel (DON 1996t). In 1993, the department's jurisdiction included the Hunters Point Annex in San Francisco. Approximately 51 fire suppression calls and 224 emergency medical calls were dispatched to both sites in 1993.

In 1992, a fire fighter training complex was completed at NSTI. The complex is a computer-controlled facility with six fire-simulator sites, four classrooms, and training grounds (San Francisco 1995a). Located at the northeast edge of Treasure Island, the complex covers approximately 8 acres (3 ha). The complex was used in 1993 to train Navy firefighters and in 1997 by the California Maritime Academy to train its personnel (San Francisco Fire Department 1997b). The San Francisco Fire Department began using the complex to train department personnel at the end of 1997. San Francisco's planned expansion of the complex would accommodate aircraft crash rescue training facilities.

San Francisco

The San Francisco Fire Department is responsible for providing fire suppression, fire prevention, and emergency medical assistance in San Francisco. On October 1, 1997, the department began providing these services to NSTI from Building 157.

The department is trained and equipped to meet the unique public safety requirements that San Francisco presents, including surf, water, and cliff rescues. The department employs 1,510 fire fighters, 719 of whom are cross-trained as emergency medical technicians (EMTs) (San Francisco Fire Department 1996). Approximately 294 personnel are on duty during an average shift, distributed among 41 fire stations throughout San Francisco.

The department's response time goal is three minutes for the first engine company, and the department is currently achieving that goal (San Francisco Fire Department 1996). The department received 57,112 emergency calls during fiscal year 1996 (San Francisco Fire Department 1997a). Of that number, 29,940 were fire suppression calls, a decrease of 6.6 percent over fiscal year 1995. The remaining calls were emergency medical-related and totaled 27,712, a decrease of 7.5 percent from fiscal year 1995.

Landward, the station nearest NSTI is at 36 Bluxome Street in San Francisco, approximately 4.5 miles (7 km) from NSTI. This station has an 11 person staff, and the vehicles include one fire engine, one fire truck, and one chief's sedan.

Laws and ordinances governing building structure design and equipment requirements for detecting, restraining, and extinguishing fires are in Cal. Code. Regs. Title 24, § 13000 et seq., and the Life Safety Provisions of the San Francisco Uniform Building Code, 1991, as amended in 1992. Under these laws, fire stations and other critical facilities (e.g., police) are required to remain operational after an earthquake. Enforcing these laws and ordinances is the responsibility of the Bureau of Fire Prevention (San Francisco 1996d).

3.12.2 Police Protection

NSTI

Prior to October 1, 1997, police protection services were provided by Navy NSTI Security Department. The Security Department's primary mission was to enforce Navy/military, federal, state, and local laws; to provide security to NSTI; and to maintain evidence for possible use in criminal cases (DON 1996j). A mutual aid agreement was in place with the San Francisco Police Department. In the event of large-scale emergency situations, the department would assist or would be assisted by the San Francisco Police Department and the California Highway Patrol. The department also provided initial response and assistance to emergency situations on the SFOBB.

Police protection facilities at NSTI included a police station (Building 107), a dispatch center (within Building 157), and a military brig (Building 670). The police station was in the middle of Treasure Island and housed the administrative offices of the department. The brig remains on a 3-acre (1-ha) site in the northwest corner of the island. It housed ten single-person cells and 5 prisoner dormitories. The 1988 Master Plan Update (DON 1988b) indicated that Building 107 was in substandard condition and recommended constructing a new facility. This project was not completed.

In 1993, the department employed 65 police and security personnel. Of those, an average of eight officers were on duty at any one time. Approximately 9,400 emergency calls were dispatched in 1993 (DON 1996j).

San Francisco

The San Francisco Police Department is the agency responsible for providing police protection and security services to San Francisco. On October 1, 1997, the department began providing these services to NSTI.

The department currently employs 2,043 sworn officers and 398 nonsworn administration and support personnel (San Francisco Police Department 1996). A minimum of 200 patrol officers are on duty during daytime shifts. This number increases during nighttime shifts, due to an increase in criminal activity. Patrol officers are deployed at ten district stations throughout San Francisco. The patrol force is fully staffed, although newly hired personnel have not all completed the field training program. In 1996, the department received 776,678 calls and filed 139,425 reports, an increase of 25.1 percent and 0.7 percent over 1995 levels, respectively (San Francisco Police Department 1997).

3.12.3 Emergency Medical Services

NSTI

The fire department at Treasure Island has first response duties for emergency medical calls. If a situation requires transporting injured persons, an ambulance unit is requested. The medical clinic employed approximately 12 EMTs trained in basic life support (DON 1996k). A minimum of two EMTs were on duty at all times. The San Francisco fire department is now the emergency response organization for NSTI.

San Francisco

The San Francisco Department of Public Health provides paramedic services to San Francisco. The Paramedic Division of the Department of Public Health currently employs 189 paramedics, an average of 32 of whom are on duty at any one time (San Francisco Department of Public Health 1996, 1997). The division dispatches approximately 65,000 calls per year, approximately 54,000 of which require ambulance transportation to San Francisco hospitals. Of the 1,510 San Francisco Fire Department personnel, 719 are dual-trained as EMTs. Fire department emergency medical personnel are dispatched when a call involves a potentially life-threatening situation.

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3.13 HAZARDOUS MATERIALS AND WASTE

Military activities on NSTI have included operations and training, administration, general engineering support and mission operations, medical and dental activities, materials maintenance, and supply operations. Fuels, lubricants, paints, solvents, and other industrial chemicals have been used throughout much of the history of the station.

3.13.1 Hazardous Materials Management

Under the requirements of the BRAC process, NSTI completed a basewide environmental baseline survey (EBS) in May 1995 (DON 1995c) and a BRAC cleanup plan (BCP) in March 1997 (DON 1997b). The EBS is a broad evaluation and summary of all known and suspected areas where hazardous materials or petroleum products have been handled, stored, disposed of, or released within the boundaries of NSTI and adjacent areas. It also identifies clean properties on Treasure Island under the Community Environmental Response Facilitation Act (CERFA) (Pub. L. 102-426, 42 U.S.C. § 9620). The BCP provides an overview of the environmental restoration and associated compliance programs.

At the time of NSTI closure, hazardous materials that were not required for the environmental site restoration process or caretaker maintenance activities were collected from all designated storage areas and transferred to the Defense Reutilization and Marketing Office (DRMO) off-site. Materials that were not redistributed or sold were removed and disposed of off-site in accordance with the Resource Conservation and Recovery Act of 1976 (RCRA) (Pub. L. 94-580, 42 U.S.C. § 6901-6992k) and state requirements.

Small quantities of hazardous materials will continue to be used at NSTI during the caretaker period. These materials will consist predominantly of lubricants, degreasers, and cleaners used for general maintenance.

3.13.2 Hazardous Waste Management

NSTI has a hazardous waste management plan (DON 1992b). NSTI generated approximately 9,921 pounds (4,500 kg) of hazardous waste per month (based on 1991 records) and is classified as a fully regulated generator, subject to all laws and regulations governing the generation and handling of hazardous waste. Navy hazardous waste management plan for NSTI (DON 1992b) remains in effect for Navy generated waste until NSTI is transferred to a new owner.

Twelve facilities at NSTI generated or stored hazardous wastes or recyclable petroleum products. Waste solvents, cleaners, adhesives, and other hazardous wastes, as well as recyclable oil and antifreeze, were generated by various NSTI work centers. Hazardous wastes were stored in designated hazardous waste accumulation areas for up to 90 days before removal by the hazardous waste handler. The hazardous waste handler notified the NSTI hazardous waste manager of container types, volume, and the waste profile.

Navy has a one-time compliance closure program for closing operational light industrial and hazardous waste and material accumulation facilities. All hazardous wastes and hazardous materials other than structural materials such as asbestos and lead-based paint (LBP) will be

removed in accordance with the NSTI hazardous waste management plan before properties are transferred or conveyed. For discussion of asbestos and LBP, see sections 3.13.4 and 3.12.7.

3.13.3 Installation Restoration (IRP)

The IRP is an ongoing DoD-administered program for identifying, evaluating, and remediating contaminated sites on federal lands under DoD control. The inventory of the full administrative record for the NSTI IRP is at:

U.S. Navy, Southwest Division
Naval Facilities Engineering Command
1230 Columbia Street, Suite 1100
BRAC Operations Office
San Diego, California 92101-8517

Public information repositories are at two locations:

San Francisco Public Library
Main Branch, Government Division
100 Larkin Street
San Francisco, CA 94102

Caretaker Site Office
410 Palm Avenue, Room 123
San Francisco, CA 94130

In January 1995, the Department of Justice (DOJ) determined that a federal agency is not required to independently implement NEPA at CERCLA clean-up sites. The DOJ decision stated that the CERCLA process incorporates many of the NEPA values of public participation including public review, and collection of environmental and human health impacts that could result from a federal action, thus making the clean-up decision process under CERCLA the functional equivalent of NEPA. Clean up of Navy property under CERCLA is independent of, and not a part of, the NEPA decision-making process.

On September 29, 1992, Navy and California Environmental Protection Agency (Cal EPA) (including the Department of Toxic Substances Control [DTSC] and the RWQCB) signed a federal facility site remediation agreement (FFSRA) (DON 1992c). The NSTI FFSRA provides a means for Navy and the State of California to cooperate in accelerating and streamlining the remediation process at NSTI consistent and in compliance with applicable federal and state laws and to use consensus problem-solving to achieve the goal of environmental restoration. It is designed to ensure that environmental impacts associated with past and present activities at NSTI are investigated and remediated to protect public health and welfare and the environment. The agreement specifies and outlines review and approval procedures and stipulates primary and secondary documents to be prepared, meetings to be conducted, and deadlines and extensions to meet. It also takes into consideration emergencies and removals, dispute resolution procedures, enforceability, public participation criteria, real property transfer, statutory compliance and corrective action, quality assurance, funding, and

exemptions. Appendix D of the NSTI FFSRA, which provides the submittal schedule for draft primary and secondary documents, was last updated in 2002.

The following tasks are required under Section 6.2 of the agreement:

- Investigating and sampling all sites to establish the nature and extent of contamination at each site;
- Conducting feasibility studies to determine the most effective method of cleaning up each site;
- Preparing all response actions for the sites, such as removing contaminants and installing treatment systems;
- Conducting operation and maintenance response actions at the sites, including maintaining treatment systems and monitoring to assess the effectiveness of remediation; and
- Notifying and coordinating federal and state natural resource trustees.

CERCLA Remediation Process

CERCLA (Pub. L. 96-510, 42 U.S.C. §§ 9601 – 9675) requires that all federal facilities comply with federal and state laws with regard to the remediation process. The NSTI IRP follows this process. Phases of the process are described below.

Site Discovery (SD). A site is an area that has had or has the potential for a hazardous substance release. A single facility may contain several sites to be studied under the IRP. Occasionally, potential sites are discovered by searching through records or during construction projects.

Preliminary Assessment (PA). This assessment identifies areas of potential contamination and evaluates each area to determine if there is a threat to human health or the environment. A PA report is developed from readily available information, such as past inventory records, aerial photographs, employee interviews, existing analytical data, and an activity visit. A PA may recommend no further action, additional work under the IRP, or a removal action.

Site Inspection (SI). This inspection is conducted after the PA when additional information is needed to evaluate a site. Collecting and analyzing soil, sediment, surface, and ground water samples may help to determine the need for further study. Information needed for hazard ranking also is collected. An SI may recommend a site for no action, further study, or an immediate removal action. The PA and SI often are performed concurrently.

Removal Actions. A removal action is any action that may be necessary to monitor, evaluate, prevent, minimize, or mitigate a threat or potential threat to public health or welfare or the environment, A removal action may include cleanup or removal of a hazardous materials release or hazardous material threat. Usually, removal actions do not completely clean up a site and additional remediation steps are required.

Remedial Investigation (RI). This investigation is performed to more fully define the nature and extent of the contamination at a site and to evaluate possible methods of cleaning up the site. During the investigation, ground water, surface water, soil, sediment, and biological samples

are collected and analyzed to determine the type and concentration of each contaminant. Samples are collected at different areas and depths to help determine the spread of the contamination. The RI process at NSTI typically is done in two phases; phase I is site characterization, and phase II is characterization of the constituents of concern, the migration pathways, and the potential hazards to human health and the environment.

Feasibility Study (FS). The FS identifies and evaluates all applicable site cleanup alternatives. As part of the study, a risk assessment is performed to quantify the level of risk posed by the site. Each alternative is evaluated for effectiveness in protecting human health and the environment, ease of implementation, and overall cost. Remedial Action Objectives (RAOs), specific goals for protecting human health and the environment, are developed. The RI and FS may be performed concurrently.

Remedial Action Plans (RAP)/Record of Decision (ROD). These two documents are essentially the same. RAP is the state term, while ROD is the federal term. The RAP/ROD documents the reasoning behind selecting a particular cleanup alternative. A RAP/ROD is required even if the most feasible alternative is no action.

Remedial Design (RD). After a RAP/ROD is signed, the remedial design phase can begin. In the RD, specific construction parameters or equipment specifications are presented for the selected cleanup alternative.

Remedial Action (RA). During the remedial action phase, the selected cleanup technology is implemented. An RA can be as simple as soil excavation or as complicated as a complete ground water treatment system, which may operate for many years. Remedial action work plans for long-term remediation include operation and maintenance (O&M) plans, which continue until the cleanup is complete.

Long-term Monitoring. After completion of the RA, federal, state, or local regulatory agencies may require subsequent monitoring of the site.

Petroleum Hydrocarbons

The CERCLA definitions of hazardous substances (42 U.S.C. § 9601[14]) and pollutants or contaminants (42 U.S.C. § 9601[33]) specifically exclude petroleum unless specifically listed. The EPA interprets the term petroleum to include hazardous substances found naturally in crude oil and crude oil fractions, such as benzene, and hazardous substances normally added to crude oil during refining. Petroleum additives or contaminants that increase in concentration in petroleum during use are not excluded from CERCLA regulations. Petroleum hydrocarbons in ground water that are not commingled with CERCLA-regulated substances are addressed under a corrective action plan (CAP) administered by the RWQCB. The RWQCB, whose mandate is to protect ground water quality, requires that potential petroleum contamination in ground water be evaluated and, if necessary, a petroleum CAP be developed.

The CAP for NSTI covers nine major sites. These sites are described in more detail below. Several of these sites were initially part of the NSTI Installation Restoration Program (IRP) but following initial site investigation under the IRP, the sites were excluded from the IRP under the CERCLA petroleum exclusion. A Draft Fuel Line CAP has been developed. Closure

documentation is also being prepared for underground storage tank (UST) sites. Cleanup levels for these petroleum-contaminated sites have been determined by the Navy, in coordination with the RWQCB. Final cleanup methods have not been determined but could range from no action to bioventing.

Site 04 (Hydraulic Training School) and Site 19 (Refuse Transfer Area). Sites 04 and 19 (formerly IR 04 and IR 19, respectively) are along the northeastern side of Treasure Island. The Hydraulic Training School operated from the 1970s to 1997, and the Refuse Transfer Area operated until 1997. These two sites were investigated together, since they have similar contaminants and are in close proximity. Petroleum-contaminated soils were identified at these sites, which were investigated during the phase I and II RIs under the IRP and were found to qualify for CERCLA's petroleum exclusion clause. Navy transferred the sites into the petroleum program based on data indicating contamination limited to petroleum products. A site closure report is expected to be submitted to the RWQCB in May 2003.

Site 06 (Fire Training Area). Site 06 (formerly IR 06) is along the northern side of Treasure Island. This site was an active fire training area from 1946 to 1992. During the phase I and II RIs under the IRP, this site was found to qualify for CERCLA's petroleum exclusion. Navy transferred the site into the petroleum program based on data indicating contamination limited to petroleum products. However, in June 1997, the RWQCB requested that Navy continue ground water monitoring for potential CERCLA substances at the site, including, but not limited to, metals and chlorinated solvents (RWQCB 1997b). The CAP was finalized on June 28, 2002. Remediation measures recommended in the Final CAP includes in-situ treatment of groundwater and deep soil (soil vapor extraction) and bioremediation. Dioxins have also been detected and will be further investigated in the CERCLA program. Field activity was completed in January 2003. The Post Construction Summary Report (PCSR) will be submitted in May 2003. The report will include a request for no further action for petroleum in shallow soil. Ground water monitoring will continue for one year. The PCSR includes analysis of dioxins at Site 06. Navy and the regulatory agencies will review the dioxin data to determine if there is a need for additional dioxin investigation. The estimated site closeout date is late 2004.

Site 14 (New Fuel Farm) and Site 22 (Navy Exchange Services Station). Site 14 and Site 22 (formerly IR 14 and IR 22, respectively) are north of 11th Street, between Avenue N and the Bay on the northeast corner of Treasure Island. The sites were investigated together because of their close proximity and similar contaminants. IR 14 operated as a fuel farm between 1943 and 1997. IR 22 operated as Navy Exchange Service Station between 1946 and 1997. Contaminants of concern include VOCs, petroleum, and polynuclear aromatic hydrocarbons (PAHs) in soil. IR 14/IR 22 were investigated during the phase I and phase II RIs and later found to qualify for CERCLA's petroleum exclusion. Based on data indicating contamination limited to petroleum products, Navy evaluated this site as part of the petroleum program. The CAP was finalized on June 28, 2002. Final CAP recommendations included excavation and treatment for surface soil and bioventing for subsurface soil. Soil vapor extraction began operation in June 2002. Navy is currently performing ongoing groundwater monitoring. The estimated site closeout date is late 2004.

Site 15 (Old Fuel Farm). Site 15 (formerly IR 15) is on the southeastern portion of Treasure Island, at the intersection of California Avenue and Avenue M. The site operated as a fuel farm during the 1940s. Petroleum and SVOC contamination in soil were identified as the

contaminants of concern during phase I and phase II RIs. Based on data indicating contamination is limited to petroleum products, the Navy evaluated this site as part of the petroleum program. A Final CAP, dated June 28, 2002, recommended excavation and treatment for surface soil and six months of continued groundwater monitoring. Additional monitoring is required through May 2004 and site closure is anticipated in August 2004.

Site 16 (Clipper Cove Tank Farm). Site 16 (formerly IR 16) is located on the northwestern corner of Yerba Buena Island, at the intersection of Macalla Road and Treasure Island Road. The site operated as a tank farm between the 1940s and the 1960s. Phase I and phase II RIs identified petroleum-contaminated soil. Based on data indicating contamination limited to petroleum products, Navy evaluated this site as part of the petroleum program. Draft CAP recommendations included excavation and treatment for surface soil. The Navy was preparing a construction summary report and a closure summary report when it was discovered that the aboveground tank farm appears to lie south and east of the initial RI investigation area. An additional site investigation was initiated in March 2003. The site closure date depends on the results of the investigation.

Site 20 (Auto Hobby Shop and Transportation Center). Site 20 (formerly IR 20) is in the western portion of Treasure Island. The site is bordered by 12th Street to the north and Avenue B to the west. From 1943 to 1997, the site operated as an auto hobby shop and a transportation center. RI activities identified petroleum-contaminated soil, and excavation and treatment of surface soils was completed. The construction summary report and closure summary report have been completed, and the groundwater monitoring is ongoing. The estimated site closeout date is late 2003.

Site 25 (Seaplane Maintenance). Site 25 (formerly IR 25) is located on the southern portion of Treasure Island, between Avenue D and F. The site operated as a seaplane maintenance facility between 1938 and 1946. Petroleum-contaminated soil was identified during RI activities. Based on data indicating contamination limited to petroleum products, Navy evaluated this site as part of the petroleum program. Regulatory agency concerns at this site are limited to releases at the shoreline and their potential environmental risks. The Final CAP, dated 28, 2002, recommended soil vapor extraction in deep soil and groundwater, which began operation in June 2002. Navy is also currently performing a groundwater monitoring program. The estimated site closeout date is late 2004.

NSTI Installation Restoration Program

Twenty-nine IR sites were originally identified for investigation. Based on the recommendations of a PA/SI conducted in 1988 (DON 1997b), 25 sites remained in the IRP for further study; four sites (02, 18, 23, 26) were removed from the IRP. The three sites requiring no further action under CERCLA are sites 02, 18, and 23. Site 26 was composed of underground storage tanks (USTs); therefore, it was deactivated as an IR site and the individual tank sites are being investigated under a separate petroleum program. As discussed above, nine sites that were initially part of the IRP were removed from the program following the determination under the Draft RI that the petroleum products were the only concern and therefore qualified for the petroleum exclusion under CERCLA. An additional site (IR 30) was added on September 6, 2002. The 17 remaining IRP sites are described below.

Localized ground water contamination from hazardous materials has been noted on both Treasure Island and Yerba Buena Island. Contamination is from various petroleum hydrocarbons and chlorinated solvents that have spilled or leaked into the soil and entered the high ground water table. This contamination has resulted in limited exceedances of the US EPA's ambient water quality criteria for various organic compounds and metals commonly associated with fuel leaks and spills and, at one site, solvents associated with dry cleaning activities (DON 1996n). Most of the known contaminated areas are on the perimeter of Treasure Island within approximately 50 to 600 feet (15 to 183 m) from the shore. Given the proximity of many of these contaminated sites to San Francisco Bay and tidal influences, some contaminated materials may have entered the Bay in concentrations exceeding the US EPA criteria. Specific sites are discussed below.

A draft baseline human health risk assessment and a draft ecological risk assessment report were prepared in conjunction with the draft phase I RI report for the IR sites in 1993. A phase II RI was conducted during 1994, 1995, and 1996 to further characterize the extent of contamination and to collect data necessary for evaluating remedial alternatives.

As IR sites are identified as candidates for removal actions, and after removal actions are completed, some of the IR sites are expected to require no further action.

IR 01 (Medical Clinic). IR 01 is in the central portion of Treasure Island at the intersection of 9th Street and Avenue F. From the 1940s to the late 1970s, the site operated as a medical clinic for NSTI personnel. The clinic occupied Building 257, and the X-ray department was operated at the south end of the middle wing in Building 257 until the early 1970s. During this period of operation, developer and corrosive fixer solutions leaked from the X-ray equipment through the wooden floor of the building into the soil (DON 1997i). Residual silver from the X-ray film was identified as the contaminant of concern at the site. The removal of silver-contaminated soil was completed at the site. At the time of the soil removal, it was determined that the building was constructed over a concrete sub-floor. All contaminated soil was located on top of this concrete sub-floor. No further action under CERCLA is recommended since contamination was limited to the concrete sub-floor and there was no release to the environment. Navy received the site closure approval from DTSC on March 20, 2002.

IR 03 (Polychlorinated Biphenyls [PCB] Equipment Storage Area). IR 03 is along the southeastern side of Treasure Island, approximately 150 feet (46 m) from the shore. The site was used to store and repair transformers used to supply electricity to the various facilities at NSTI from before 1953 to the present. Some of the transformers were known to have contained PCBs. PCB-containing transformer fluid may have been spilled at the site as recently as the mid-1980s (DON 1997i). Based on sampling results from the PA/SI, IR 03 was recommended for further study in an RI. Based on the results of the draft RI, baseline human health risk assessment, and ecological risk assessment, the site has been recommended for no further action under CERCLA. Navy received the site closure approval from DTSC on March 20, 2002.

IR 05 (Old Boiler Plant). IR 05 is on the southeastern portion of Treasure Island. The old boiler plant operated from the 1940s to 1968. Asbestos was used as an insulating material for the boilers and pipes in the building, and mercuric nitrate may have been used during boiler plant operations to inhibit scaling. In 1968, the building was demolished and the debris reportedly buried in place. Underground fuel pipelines that may have been damaged in the 1989 Loma

Prieta earthquake run beneath the site in an east-west direction along 5th Street. A 1988 PA/SI identified that building debris possibly containing asbestos had been buried at the site; therefore, an RI was recommended. Asbestos was not detected in the soil samples taken from the site; however, petroleum and volatile organic compound (VOC) contamination were discovered during Navy's RI. Petroleum contamination will be addressed under the petroleum program. The site will be subject to deed restrictions due to VOC-contaminated ground water. Any additional investigation of ground water at the site will be investigated as part of the dry cleaning facility at Site 24. The Navy will prepare a letter documenting no action at the site. Navy received closure approval from DTSC on January 17, 2001.

IR 07 (Pesticide Storage). IR 07 is located north of 13th Street, between Avenue M and the Bay, in the northeast corner of Treasure Island. Between 1943 and the 1960s, the site was used for storage and handling of a variety of liquid substances, including pesticides, chlorinated herbicides, and paint. Pesticide- and herbicide-contaminated soil and ground water were identified at the site during the phase I and phase II RIs. Additional sampling for contaminants of concern was completed in April 2002 and a Final Supplemental Site Inspection report was completed in October 2002. The Navy has recommended No Further Action at this site. The DTSC is postponing closure of this site until additional investigations at adjacent areas are complete.

IR 08 (Army Point Sludge Disposal Area, Yerba Buena Island). IR 08 is on Army Point at the extreme eastern end of Yerba Buena Island. The site was used as a disposal area for sludge from the wastewater treatment facility on Treasure Island between 1968 and 1976. Waste sludge was transported from the wastewater treatment facility and spread on the ground between the foundations of former buildings at IR 08 to dewater the sludge. Pesticides and metals, including elevated lead concentrations, were identified as the contaminants of concern at the site. DTSC requested that additional effort be made to explain elevated lead concentrations in four borings collected from the site. The Navy is currently reviewing responses to DTSC and CDFG's comments on the Draft Final Onshore RI and will follow up with their findings. This site was transferred to FHWA/Caltrans on October 26, 2000. A validation study for ecological risk has been completed and further evaluation of Caltrans environmental data performed. The final RI will be prepared with Sites 28 and 29. The estimated site closeout date is late 2005.

IR 09 (Foundry). IR 09 is in the central portion of the southern end of Treasure Island. The site has been used for multiple operations since the early 1940s, including a forge and foundry between 1943 and 1947 and a paint shop between 1952 and 1981. Metals are the most likely contaminants from the foundry and the paints used at this facility were known to have contained lead and zinc-chromium based pigments. Two concrete trenches, the remnants of a hydraulic lifting system, indicate that vehicle maintenance also may have been performed at this site. From 1981 to 1987, the foundry building was used as a welding training school by Navy Technical Training Center, and in 1994, it was the site of a small boat maintenance shop. A 1988 PA/SI recommended further investigation because of potential soil and ground water contamination from previous site activities (DON 1997i).

Petroleum and metal contamination was discovered in both soil and ground water during RI activities. The site was recommended for further evaluation and inclusion in the RI because of ecological risks associated with the potential impacts to the Bay. A request was made in March

2000 by DTSC and RWQCB to analyze soil samples collected near a 30-gallon (114-liter) hydraulic hoist tank for VOCs and PCBs. RWQCB also requested adding VOCs to the ground water monitoring program for well 09-MW01. Analytic results indicated no major VOC contamination in ground water. PCB concentrations were below detection limits. Trench oil soil samples were collected and were non detect for PCBs (< 10 mg/kg). Navy completed additional investigation in January 2003 and is currently preparing an RI report in anticipation of a No Action ROD. Site closure is anticipated in late 2004.

IR 10 (Bus Painting Shop). IR 10 is north of 13th Street, between Avenue M and the Bay, in the northeast corner of Treasure Island. It was constructed during the mid-1940s and operated as a bus painting shop through the 1950s. For an unspecified period of time, the building also may have been used for paint mixing. Pesticides, petroleum, and semi-volatile organic compounds (SVOCs) have been identified as the contaminants of concern in both ground water and soil. Additional research was conducted regarding the catch basins located within the building. Elevated TPH extractable concentrations were detected in sediment samples collected from the catch basins. Navy completed additional investigation in January 2003 and is currently preparing an RI report in anticipation of a No Action ROD. Site closure is anticipated in late 2004.

IR 11 (Yerba Buena Island Landfill). IR 11 is a 200- by 600-foot (66- by 197-m) former marsh area on the southern side of the eastern tip of Yerba Buena Island. The site operated as a landfill for an unspecified period of time beginning in 1935. The exact nature of materials disposed at this site is unknown but is thought to include solid wastes from Yerba Buena Island and Treasure Island operations. Former USTs and a fuel pipeline also may have been sources of contamination at the landfill site. The 1988 PA/SI concluded that the site warranted further investigation in an RI due to potential soil and ground water contamination from past site operations (DON 1997i). Metals, petroleum, pesticides, VOCs, and SVOCs in soil and ground water were identified as the contaminants of concern during RI activities. A validation study for ecological risk was finalized and an additional investigation for landfill delineation and lead concentrations in surface soils was completed. Additional sampling of intertidal sediments offshore of Site 11 has been completed. No PCBs or petroleum hydrocarbons were detected above screening criteria, which were presented in the Sampling and Analysis Plan (SAP). Therefore, this sampling data will be incorporated into the No Action ROD being prepared for the Basewide Offshore Sediments (Site 13).

Although this site is on land that was transferred to either the US Coast Guard or FHWA/Caltrans, Navy is continuing with the remedial activities pursuant to CERCLA.

IR 12 (Old Bunker Area). IR 12 comprises about 90 acres (36 ha) at the northwestern end of Treasure Island. Ammunition, electronics, tear gas, and film were stored in bunkers throughout the site from the early 1940s until about 1969 when the site was converted to military housing. Soil trenching and boring activities performed prior to housing foundation excavations in 1965 indicated that debris, including rubbish, bottles, wire rope, paper, and steel drums, had been disposed of in the areas between and around the bunkers. Incinerator ash was also suspected to have been disposed in this area. A UST, a former landing strip, and a former storage yard (FSY) in the area also may have contributed to potential contamination at this site (DON 1997i).

A PA/SI was conducted in 1988 to review past activities. A preliminary risk assessment, including a geophysical survey to locate utilities and buried items, and soil sampling for metals, TPHs, VOCs, and SVOCs, was conducted in 1990. Following the preliminary risk assessment, an RI was performed to assess the nature and extent of the identified TPH and metals contamination, to determine whether the bunker areas and buried oil tank continued to be sources of contamination, to assess the extent of soil and ground water contamination, and to characterize ground water hydraulic parameters for modeling purposes. Petroleum, metals, and SVOCs were identified as contaminants of concern during RI activities. Additional soil and ground water sampling to characterize the portions of the site beyond the boundaries of known or suspected contamination began in October 1997. Further evaluation of the site in an FS was recommended due to potential human health and ecological risks. A removal action at the site is scheduled to be completed in 2004 and will be followed by a Final RI.

Analysis of soil and groundwater samples from the FSY area indicated that PAHs and PCBs were the chemicals of concern. In 2000, all soil in the FSY area containing PCBs at levels in excess of the screening level (1 mg/kg) was excavated to 4 feet (1 m) bgs, except where buildings or other structures such as transformer pads impeded access. Indoor air monitoring to evaluate the potential risk posed by vapor intrusion from volatilization of PCBs into buildings is ongoing. Initial conservative estimates from this investigation indicate that PCB volatilization may pose a risk to human health in Building 1100 Unit C.

This site is currently residential and is expected to remain residential under reuse. Numerous housing units on this site are currently occupied under interim leases with San Francisco and TIHDI for market rate rentals and homeless housing. All CERCLA response actions will be conducted to ensure continued protection of human health and the environment. The Remedial Action Objective under CERCLA will be for residential or unrestricted use, consistent with the current configuration of housing on NSTI. Any subsequent redevelopment of the area that would involve demolition of existing structures and the grading and reconfiguring of the soil would be subject to land use controls on the property, including a City-administered soil management plan that would ensure proper characterization and management of soil and groundwater disturbance. In addition, deeds conveying the affected property will contain a notice that portions of the property not accessible to remediation efforts (such as areas beneath existing foundations) may require additional characterization and possible response actions subject to appropriate regulatory oversight. Navy is currently in remedial investigation and performing ongoing groundwater monitoring with supplemental investigations. The estimated site closeout date is mid-2006.

IR 13 (Stormwater Outfalls, Treasure Island and Yerba Buena Island, Offshore Sediments). IR 13 comprises six stormwater outfall areas (A through G) surrounding Treasure Island and the northeastern end of Yerba Buena Island. Historically at IR 13, petroleum leaks were suspected to have entered Treasure Island storm drains and flowed to the Bay. Navy has a stormwater pollution prevention plan (SWPPP) that monitors the outfalls for petroleum and other potential contaminants on an annual basis.

During the 1993 Phase I ecological risk assessment for NSTI, chemicals of potential ecological concern (CPOECs) were identified using data collected during the stormwater investigation, in which drainage areas served by each stormwater outfall were investigated. The onshore RI focused on human health issues, and the offshore RI primarily addressed ecological risks based

on the CPOECs identified in the 1993 data. The final offshore RI report was completed in December 2001 (DON 2001a). Based on chemical concentration screening of offshore sediment and pore water, the following were identified as chemicals of concern at the IR 13 outfall areas: arsenic, barium, cobalt, copper, lead manganese, mercury, nickel, selenium, vanadium, zinc, and organics, including dichlorodiphenyltrichloroethane (DDT), PCBs, and polychlorinated aromatic hydrocarbons (PAHs). The draft offshore RI addresses the risk these chemicals present to benthic receptors and birds. The Final RI has been completed, a No Action ROD is currently being prepared, and the estimated site closeout date is late-2003. The Navy has recommended No Further Action at this site.

IR 17 (Tanks 103/104). IR 17 is near the center of Treasure Island, approximately 1,400 feet (460 m) west of the eastern edge of the island. The site is bordered by Avenue H, Avenue I, 5th Street, and an unnamed street to the south. The site contains two 200,000-gallon (757,000-liter) diesel fuel aboveground storage tanks (ASTs). The ASTs were installed before 1943 and decommissioned in 1993. An estimated 20,000 gallons (75,700 liters) of diesel fuel was reportedly released from the ASTs in 1983. The 1983 fuel spill, other unrecorded minor spills, and tank or pipeline leaks are thought to be the primary sources of contamination at the site (DON 2001a). Petroleum, metals, and SVOCs were detected in soil and ground water during RI activities. No VOCs have been detected in preliminary well and soil samples collected at the site. The Navy will prepare a letter documenting no action at the site. IR 17 could be the subject of deed restrictions due to solvent-contaminated ground water, depending on the success of remediation actions. Petroleum will be addressed under the petroleum program (Uribe and Associates 2000). Any additional investigations of soil and ground water at the site will be investigated as part of the dry cleaning facility at Site 24. Navy received closure approval from DTSC on January 17, 2001.

IR 21 (Vessel Waste Oil Recovery). IR 21 is along the southeastern edge of Treasure Island, directly adjacent to the Bay and Clipper Cove. Asphalt and buildings cover this site. IR 21 operated as a waste oil transfer and separation facility from 1946 to 1995. Waste oil unloaded from ships was transferred to an onshore oil/water separation facility at IR 21, consisting of five 2,000-gallon (7,570-liter) capacity ASTs. The ASTs were removed in 1995. Several of the buildings at this site were reportedly used for chemical storage. For example, Building 3 stored sulfuric acid for batteries, paint, paint thinner, lubricating oil, and hydraulic fluid. A fuel line also was on the site and was abandoned in place after the 1989 Loma Prieta earthquake damaged it (DON 1997i).

In 1988, a PA/SI was conducted for IR 21, and in 1994 the soil and ground water in the vicinity of the abandoned pipeline were sampled for VOCs, including chlorinated solvents. Chlorinated solvents were detected in ground water samples but not in soil samples (DON 1997i). An RI was conducted to determine the nature and extent of TPH contamination near the oil recovery system and chlorinated solvent contamination near the abandoned pipeline. Petroleum and VOCs (chlorinated solvents from an unknown source) were identified in ground water and soil during RI activities. No further action is planned for soils. For this site, human health risks are within the US EPA target risk range considered protective of human health. Further investigations will lead to decisions regarding remedial action through the IRP. Additional investigation of VOC contamination has been performed and groundwater monitoring/investigation is ongoing. A final RI is being prepared. The estimated site closeout date is mid-2006.

IR 24 (Fifth Street Fuel Releases and Dry Cleaning Facility). IR 24 is on the southeastern part of Treasure Island and extends from the central portion of the island east towards the Bay. The site is rectangular and is bounded by Avenue H on the west, Avenue N on the east, 6th Street on the north, and 4th Street on the south. Building 99, on the site, operated as a laundry and dry cleaning facility from the 1940s through the 1950s. Trench drains in the building's floor may have been used to dispose of dry-cleaning waste solvents. The site also contains an underground pipeline that was formerly used to transport oil and fuel on Treasure Island between 1943 and 1977. In 1986, leaks were discovered at several locations along 5th Street. A PA/SI was conducted in 1988 to determine the extent of soil contamination from the abandoned fuel lines along 5th Street. The highest concentrations of TPHs were detected in soil samples from a stockpile excavated in 1986 and 1987 near the intersection of Avenue M and 5th Street. An RI was conducted to determine the extent of chlorinated solvent contamination in soil and ground water. To further characterize contamination at IR 24, additional ground water sampling was conducted in July 1997. The RI recommended continued ground water monitoring for VOCs.

In March 2000, the RWQCB recommended that additional investigation be conducted to identify the source of VOCs at the site. The site is recommended for further evaluation and inclusion in an FS because of ecological risks associated with the potential impacts to the Bay. For this site, human health risks are within the US EPA target risk range considered protective of human health. Petroleum contamination in the soil and any associated remedial actions will be conducted under the petroleum program (DON 1997i). As with Site 17, a remedial action is planned. The site could be subject to deed restrictions, depending on the success of remedial actions. Navy is currently performing an additional investigation for delineation of VOCs and TPH in addition to ongoing groundwater monitoring/investigation. Workplans are currently being drafted for a source area pilot study, which will include in-situ bioremediation of chlorinated solvents utilizing lactic acid. If the pilot study proves effective on remediating the source area and downgradient plume, the estimated site closeout date could be in 2006.

IR 27 (Clipper Cove Skeet Range). IR 27 is a separate operable unit off the southern shore of Treasure Island. The site operated as a skeet range between 1979 and 1989. IR 27 was investigated in 1996 during the Phase II ecological risk assessment. Sampling to define the vertical and horizontal extent of lead and PAHs in offshore sediments and overlying surface water was conducted during this investigation. This site is included in the December 2001 final offshore RI report (DON 2001a), which was conducted to characterize the sources, extent, and potential toxicity of chemicals in offshore sediments at NSTI. Based on the screening of chemical concentrations in offshore sediment and pore water, lead and PAHs were identified as chemicals of concern. The Clipper Cove Skeet Range was under a Regional Board Cleanup and Abatement Order, and Navy worked with the RWQCB under a Compliance Plan. A feasibility study is being prepared for this site and the estimated site closeout date is mid-2005.

IR 28 (West Side On- and Off-Ramps). IR 28 consists of the northwestern slopes of Yerba Buena Island and the SFOBB's west side on- and off-ramps, along Treasure Island Road. The west side on- and off-ramps on Yerba Buena Island have been in operation since the SFOBB was opened to traffic in 1936. A 1993 investigation indicated lead and zinc concentrations in soil near the west side on- and off-ramps. An RI was conducted to determine the extent of metals contamination, which was found to be present in soils throughout the site. No action for soil has been proposed based on the site's industrial use only categorization. A validation study for

ecological risk was finalized and no additional investigation is required. A final RI will be prepared with Sites 8 and 29. The estimated site closeout date is mid-2004.

IR 29 (East Side On- and Off-Ramps). IR 29 consists of the eastern slopes of Yerba Buena Island directly underneath the SFOBB, and its east side on- and off-ramps along Treasure Island Road, near the guard shack, which is no longer active. The east side on- and off-ramps have been in operation since the SFOBB was opened to traffic in 1936. Similar to IR 28, IR 29 was suspected to be subject to lead and other metals contamination as a result of vehicle emissions and ramp painting and maintenance. Lead contamination in soil was identified during RI activities. Further investigations were requested by RWQCB in March 2000 to evaluate lead concentration levels at the site. Because of the uncertainty associated with the pending SFOBB work, any remedial action would most likely be delayed until all bridge-work is complete. This site was transferred to FHWA/Caltrans on October 26, 2000. A validation study for ecological risk was finalized and further evaluation of Caltrans environmental data performed. An additional investigation of lead concentrations in the surface soils was performed. A final RI will be prepared with Sites 8 and 28. The estimated site closeout date is late 2005.

IR 30 (Building 502). This site was added to the IRP on September 6, 2002. IR 30 currently consists of a Day Care Center (Building 502) and outside play area constructed in 1987. Prior to construction of the building, burn ash was deposited on the site and subsequently spread through grading. Lead, copper, and dioxin have been identified as soil contaminants at this site. Based on the results from the first phase of the site investigation, a time-critical removal action was instituted in the northwestern portion of the site to remove soils contaminated with elevated levels of lead and copper. Additional subsurface characterization at IR 30 detected elevated dioxin levels from various sample locations. An investigation was subsequently conducted to determine the extent of contamination and assist in assessing site options. The site was capped with an agency-approved concrete/asphalt covering over areas where elevated dioxin levels were reported below 2 feet below ground surface. The site closure agreement included deed restriction requirements prohibiting/limiting any future subsurface excavations in the area. The Day Care opened on March 17, 2003. An RI/FS will be completed for this site.

3.13.4 Asbestos

Several surveys to determine the presence of asbestos-containing material (ACM) have been conducted at NSTI. Between 1995 and 1997, the Mare Island Naval Shipyard conducted an ACM survey of some of the nonresidential buildings at NSTI, and Radian conducted surveys of the remaining major nonresidential structures. Abatement of asbestos in all residential and nonresidential buildings has been completed, and the results have been compiled into a report of ACM type, location, and status (Uribe and Associates 2000).

Navy began and partially completed an asbestos survey of the Job Corps buildings. However, this Navy survey was not completed because the Department of Labor began their own asbestos survey and took over remediation responsibility for any hazards. This property has been transferred by DoD to the Department of Labor, and there are no further Navy actions for asbestos.

DoD policy is that any ACM at NSTI found to be a threat to human health will be abated prior to property transfer. ACM considered a threat to human health is defined as any damaged

ACM that is accessible. Any undamaged friable ACM and any damaged friable ACM that is inaccessible may remain (U.S. DoD 1994).

ACM is regulated both as a hazardous material under the Toxic Substances Control Act (TSCA) (15 U.S.C. §§ 2601-2692) and a hazardous air pollutant under the Clean Air Act (42 U.S.C. §§ 7401–7671q). It is a potential worker safety hazard under the authority of California's Occupational Safety and Health Administration (Cal OSHA). These regulations limit emissions of asbestos from asbestos-related manufacturing, demolition, or construction activities and require notice to federal and local government agencies prior to beginning renovation or demolition that could disturb asbestos. BAAQMD requires asbestos removal pursuant to state regulations.

All available information on ACM will be provided to the transferee. The information must include the following:

- Available information on the type, location, and condition of asbestos in any building or improvement on the property;
- Results of testing for asbestos;
- A description of asbestos control measures taken for the property;
- Available information on costs or time necessary to remove all or any portion of the remaining ACM; and
- Results of a site-specific update of the asbestos inventory performed to revalidate the condition of the ACM.

3.13.5 Polychlorinated Biphenyls (PCBs)

PCBs are considered a hazardous substance under the TSCA (15 U.S.C. §§ 2601-2692). A basewide remedial program began in the mid-1980s to update electrical equipment, including primary transformers and capacitors. Investigation of potential releases of PCBs from this equipment was not conducted at the time of replacement. In 1995, Navy completed a survey to determine whether any primary electrical equipment containing PCBs remained at NSTI. Naval Operations Instruction (OPNAVINST) 5090.1B specifies eliminating all transformers containing 500 ppm or more PCBs by October 1998 and eliminating all transformers containing 50 ppm or more PCBs by October 2003. Approximately five pieces of equipment were removed, since PCBs were detected in them at over 500 ppm.

Navy has investigated IR sites 03, 12, and 17 for potential PCB contamination. No further action relative to PCBs has been recommended at either site 03 or 17. A removal action for soils containing PCBs at levels in excess of the screening level (1 mg/kg) was conducted in 2000 at IR 12. The EBS also identified parcels that may have contained PCB equipment. Additional research and investigation into soils for PCBs at IR site 09 has been recommended by DTSC and RWQCB. Two transformers are being investigated as part of EBS data gaps sampling. Results will be presented in a technical memorandum.

3.13.6 Storage Tanks and Oil/Water Separators

Underground Storage Tanks (USTs)

Eighty-six sites with suspected USTs were investigated at NSTI. Of these, 41 were removed, 15 were closed in place, and investigation of 16 USTs indicated that the tanks did not exist (DON 1997b). Recently, two USTs were found near the entrance to the US Coast Guard Station.

Fuel lines also are subject to UST regulations requiring upgrade or removal. Navy has completed removing or closing approximately 11,000 linear feet (3,353 m) of abandoned fuel lines at NSTI. These areas were investigated in 1998 and 1999.

The SWRCB has a draft policy regarding the cleanup of low-risk petroleum sites. The intent of the policy for low-risk sites is to remove floating product and the contaminant source, followed by ground water monitoring to assess whether bioremediation has occurred. Navy has identified approximately 10 sites that appear to qualify as low risk under this guidance. Approval of these sites is pending further negotiations with the RWQCB (DON 1998b).

Aboveground Storage Tanks (ASTs)

Fifty-three ASTs are or were located at NSTI. Of these, 27 have been removed (DON 1997b). Twenty-six ASTs are at NSTI, and seven are included in IR sites (section 3.13.3). Any contamination associated with these ASTs will be addressed under the IRP. Only eight of the remaining ASTs are active. They are being used by the gasoline station (one), fire training school (five), sewer treatment boiler plant (one), and brig (one). Remaining ASTs will be or have been drained and cleaned and will remain in place unless demolition is needed for remedial action (TtEMI 2000b).

Oil/Water Separators (OWS)

There were two underground oil/water separators at the former fire training school location, IR Site 06; however, these tanks were removed in 2002. The status of this site is addressed under section 3.13.3.

3.13.7 Lead

Lead-Based Paint (LBP)

Lead was a major ingredient in the house paint used throughout the country for many years. In 1978, the maximum lead content was reduced to 0.06 percent of newly applied dry paint. LBP use was discontinued in 1980.

Navy, in accordance with HUD guidelines, will abate any hazardous LBP found in residential use structures constructed before 1960. The inspection and abatement will not be performed for buildings scheduled for demolition or nonresidential use.

DTSC has considered a release to soil of LBP from DoD buildings or structures to be a CERCLA hazardous substance release. DoD and EPA have developed a Field Guide for Lead-Based Paint guidelines for disposal of DoD residential real property. Navy's policy for LBP

remediation in nonresidential areas has been to comply with CERCLA in the same manner and to the same extent, both procedurally and substantively, as any non-governmental entity.

Lead in Drinking Water

NSTI tested for lead and copper in drinking water in 1993, 1994, and 1995, but no copper or lead was detected above the federal maximum contaminant levels (MCLs). The City and County of San Francisco, under Navy Cooperative Agreement, will continue to monitor lead and copper in drinking water, as required by the Safe Drinking Water Act of 1974 (Pub. L. 93-523, as amended, 42 U.S.C. §§ 300f–300j-26).

3.13.8 Radon

Radon screening for six locations was conducted by Navy at NSTI (March 1991) as part of Navy Radon Assessment and Mitigation Program. Concentrations ranged from none detected above the detection limit of 0.5 picocuries per liter (pCi/L) (4 locations) to 0.6 pCi/L. No buildings were identified as having radon gas levels above 4 pCi/L, which is the US EPA recommended action level (US EPA 1988).

CHAPTER 4.0
Environmental Consequences

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4.0 ENVIRONMENTAL CONSEQUENCES

Chapter 4 of this EIS addresses the environmental consequences of the proposed disposal and reuse of NSTI with respect to 13 environmental issue areas. Each issue is addressed in its own section, numbered as follows:

4.1 Land Use
4.2 Visual Resources
4.3 Socioeconomics
4.4 Cultural Resources
4.5 Transportation
4.6 Air Quality
4.7 Noise
4.8 Biological Resources
4.9 Geology and Soils
4.10 Water Resources
4.11 Utilities
4.12 Public Services
4.13 Hazardous Materials and Waste

Each of the disposal/reuse alternatives is analyzed from the viewpoint of these 13 environmental issues. Navy disposal is assumed as part of each reuse alternative. Each discussion is organized as follows:

- Alternative 1—This subsection addresses the environmental consequences of the LRA's Draft Reuse Plan for NSTI (San Francisco 1996e). The Draft Reuse Plan can be characterized by a combination of publicly oriented development, open space and recreation, and extensive residential development at full build-out.
- Alternative 2—This subsection analyzes the environmental consequences of a reuse alternative based on development of the site with a land use plan characterized by an emphasis on open space and recreation and publicly oriented uses with low residential use.
- Alternative 3—This subsection analyzes the environmental consequences of a reuse alternative based on development of the site with a land use plan characterized by little new development and extensive reuse of existing facilities.
- No Action Alternative—This subsection addresses the environmental consequences of retaining NSTI in caretaker status in Navy ownership.

Measures that can be taken to reduce impacts to a level below significant are suggested for each alternative, as appropriate. Navy would be responsible for mitigation measures identified in its ROD for the proposed disposal action. As reuse would occur after the property is transferred from federal ownership, mitigation measures identified for impacts associated with reuse are the responsibility of the acquiring entity, under the direction of federal, state, and local agencies with regulatory authority over and responsibility for such resources. Mitigation for impacts associated with reuse is not the responsibility of the Navy.

As discussed in Chapter 3, the environmental baseline year for the EIS is 1993, the year that NSTI was designated for closure. Because data from 1993 was not available for some resource areas, baseline data from the most recent year that represents 1993 conditions was used. The impacts presented in this chapter have been evaluated against the baseline environmental conditions presented in Chapter 3. The Navy recognizes that changes in the environmental

conditions may have occurred in the period between the baseline years and the present and that these changes may result in different, and in many cases, lesser impacts to certain resources. Since baseline environmental conditions are used as the benchmark for analysis, it would be inappropriate to alter the impact analysis based on any interim change in resource conditions.

4.1 LAND USE

The following discussion focuses on compatibility of proposed actions with land uses on the site, compatibility with existing uses adjacent to the reuse plan area (e.g., non-Navy land uses, such as the US Coast Guard Station and FHWA/Caltrans land for the SFOBB on Yerba Buena Island, and Job Corps on Treasure Island), and consistency with the City and County of San Francisco General Plan and zoning ordinance.

Factors considered in determining whether an alternative would have a significant land use impact included the extent or degree to which implementation of the alternative would:

1. Result in non-attainment of policies of applicable plans of the City and County of San Francisco or BCDC; or

2. Result in proposed uses that are incompatible with existing or adjacent land uses.

4.1.1 Alternative 1

Significant and Mitigable Impact

Impact: Land use policy (Factor 1). The City and County of San Francisco General Plan land use designation for NSTI is Military. The zone classifications that would be required for Alternative 1 (i.e., Public, Residential, Mixed Use) would be inconsistent with the existing general plan designation and zoning classification.

Mitigation. To achieve consistency between the selected reuse alternative and city policies, it will be necessary to amend the San Francisco General Plan to include land use designations for surplus property on Treasure Island and Yerba Buena Island prior to approving future land use actions. NSTI would not be rezoned until the final reuse plan is adopted, at which time the City and County of San Francisco should amend its Planning Code to be consistent with planned land uses. Upon receiving a zoning designation, the area would be subject to the land use and height and bulk regulations established by the zoning. These controls would be subject to the Redevelopment Plan and its design for development standards and would likely include site design measures, such as buffering, landscaping, screening, and setbacks, to ensure high quality development and compatibility between land uses.

Not Significant Impacts

Land use policy (Factor 1). Implementing Alternative 1 would increase public access to existing open space areas, including the San Francisco Bay shoreline, and would allow development of recreational facilities, which would be substantially consistent with the anticipated priority use designations for NSTI in the San Francisco Bay Plan. Specific development plans for reuse of NSTI would be subject to BCDC permit authority, which would ensure consistency with the

Bay Plan. Implementation of Alternative 1, in accordance with the Draft Reuse Plan, would not conflict with Sustainability Plan objectives.

Land use compatibility–Treasure Island (Factor 2). As a result of implementing this alternative, proposed reuse of Treasure Island would change the intensity of use and develop publicly oriented land uses in place of former military uses. Introduced and expanded uses would require demolishing some buildings and constructing others.

At full build-out, implementing this alternative would result in a higher development density than existed before the closure decision. However, proposed reuse of Treasure Island would provide additional opportunities for public access to open space and recreational resources, publicly oriented attractions, and access to the Bay. These land use changes would be consistent with the Draft Reuse Plan guiding policies to ensure land use compatibility under reuse and therefore would not be a significant land use impact. No mitigation is proposed.

At the time of the closure decision, there were no non-Navy land uses on Treasure Island. However, after the federal agency screening process, approximately 36 acres and 12 buildings were provided to the US Department of Labor for developing a Job Corps facility. Proposed publicly oriented land uses, including the themed attraction, hotels, retail and specialty stores, and film production, would provide a compatible land use relationship with the Job Corps facility and would provide employment opportunities for the resident population. Proposed reuse of Treasure Island would therefore not result in a significant land use impact to the Job Corps facility. No mitigation is proposed.

Land use compatibility–Yerba Buena Island (Factor 2). Proposed reuse of Yerba Buena Island would represent a change in the intensity of some uses and would introduce publicly oriented use of the island. Proposed land use changes would convert the senior officers quarters (Quarters 1-7), an NRHP listed historic district, to publicly oriented facilities, would develop new residential areas and infill existing residential areas, and would develop a bed and breakfast and restaurant in place of existing residential units on the Yerba Buena hilltop. Introduced and expanded uses would require demolishing some buildings and constructing others. If Quarters 1-7 were to continue in residential use, then fewer dwelling units would be included elsewhere at NSTI so that the total number of units available would remain the same.

At full build-out, implementing Alternative 1 would result in a higher development density than existed at the time of the closure. However, the proposed reuse of Yerba Buena Island would provide additional opportunities for public access to open space, recreational resources, publicly oriented attractions, and access to the Bay. These land use changes would be consistent with applicable Draft Reuse Plan policies guiding future development and would not be considered a significant land use impact. No mitigation is proposed.

Existing non-Navy land uses on Yerba Buena Island include an active US Coast Guard Station and the SFOBB and tunnel structures. The approximately 30-acre (12-ha) US Coast Guard Station is physically separated from land proposed for community reuse, and consequently the physical arrangement of the station would not be disrupted or divided by proposed land use changes. As a result of the federal agency screening process, the US Coast Guard was provided an additional 11 acres (5 ha) of dry land and associated facilities on the southeastern Yerba Buena Island hilltop. This property is physically separated from the land proposed for

community reuse, and the physical arrangement of either would not be disrupted or divided by proposed land use changes.

The existing SFOBB or the proposed realignment would not be affected by changes in land use that are part of community reuse. Land on Yerba Buena Island permanently conveyed in fee to Caltrans to accommodate the SFOBB realignment is no longer available for transfer and reuse and consequently no land use conflict exists. Cumulative impacts from community reuse and the SFOBB are discussed in Chapter 5. Please refer to the EIS for the east spans realignment for discussion of impacts of that project (see http://www.dot.ca.gov/dist4/sfobb/sfobbfeis.htm). There would be no significant land use impact, and no mitigation is proposed.

4.1.2 Alternative 2

Significant and Mitigable Impact

Impact: Land use policy (Factor 1). The City and County of San Francisco General Plan land use designation for NSTI is Military. The zone classifications that would be required for Alternative 2 (i.e., Public, Residential, Mixed Use) would be inconsistent with the existing general plan designation and zoning classification.

Mitigation. To achieve consistency between the selected reuse alternative and city policies, it will be necessary to amend the San Francisco General Plan to include land use designations for surplus property on Treasure Island and Yerba Buena Island prior to approving future land use actions. NSTI would not be rezoned until the final reuse plan is adopted, at which time the City and County of San Francisco should amend its Planning Code to be consistent with planned land uses. Upon receiving a zoning designation, the area would be subject to the land use and height and bulk regulations established by the zoning. These controls would be subject to the Redevelopment Plan and its design for development standards and would likely include site design measures, such as buffering, landscaping, screening, and setbacks, to ensure high quality development and compatibility between land uses.

Not Significant Impacts

Land use policy (Factor 1). Implementing Alternative 2 would increase public access to existing open space areas, including the San Francisco Bay shoreline, and would allow development of recreational facilities, which would be substantially consistent with the anticipated priority use designations for NSTI in the San Francisco Bay Plan. Specific development plans for reuse of NSTI would be subject to BCDC permit authority, which would ensure consistency with the Bay Plan. Alternative 2 would be in accordance with the Draft Reuse Plan guidelines and would not conflict with Sustainability Plan objectives.

Land use compatibility–Treasure Island (Factor 2). This alternative would affect the vicinity character by increasing the amount of land devoted to open space and recreation, decreasing the amount of land used for institutional purposes, eliminating former military housing, and introducing new publicly oriented uses. Land use changes would include constructing an approximately 150-acre (61-ha) golf course, approximately 20-acre (8-ha) wildlife habitat and observation area or possible wetlands, amphitheater, entertainment center, 2 hotels, a

conference center, and an expanded marina. This alternative would involve more demolition than Alternative 1.

With the exception of Building 1, the wedding chapel, firefighter training school, brig, fitness center, and gym, the buildings on Treasure Island would be demolished to accommodate proposed reuses. Implementing this alternative would involve more building demolition and, with the proposed golf course and wildlife area, would create more open space and recreation areas than Alternative 1. As with Alternative 1, proposed reuse of Treasure Island would provide additional opportunities for public access to open space and recreational resources, publicly oriented attractions, and access to the Bay. These land use changes would be consistent with applicable Draft Reuse Plan policies, which guide future development to ensure land use compatibility under reuse, and therefore would not be considered a significant land use impact. No mitigation is proposed.

As with Alternative 1, proposed land uses would provide a compatible land use relationship with the Job Corps facility and would provide trainees with employment opportunities. Proposed reuse of Treasure Island would therefore not result in a significant land use impact to the Job Corps facility. No mitigation is proposed.

Land use compatibility–Yerba Buena Island (Factor 2). As a result of implementing this alternative, proposed reuse of Yerba Buena Island would affect the vicinity character by converting the senior officers quarters to publicly oriented facilities, by developing new residential areas and infilling existing residential areas, and by developing a bed and breakfast in place of existing residential units on the Yerba Buena Island hilltop.

Proposed Yerba Buena Island development would be similar to Alternative 1, but more land would be set aside for publicly oriented uses (i.e., hotel or bed and breakfast, conference center, or restaurant facilities), and less would be devoted to residential uses. This development would involve more demolition and construction than under Alternative 1. As with Alternative 1, the proposed reuse of Yerba Buena Island would provide additional opportunities for public access to open space and recreational resources, publicly oriented attractions, and access to the Bay. These land use changes would be consistent with applicable Draft Reuse Plan policies, which guide future development to ensure land use compatibility under reuse, and therefore would not be considered a significant land use impact. No mitigation is proposed.

As with Alternative 1, proposed land use changes on Yerba Buena Island would be separate and distinct from existing uses, and as such, implementing this alternative would not disrupt or divide the physical arrangement of existing uses. The existing SFOBB or the proposed realignment would not be affected by changes in land use that are part of community reuse. Land on Yerba Buena Island permanently conveyed in fee to Caltrans to accommodate the SFOBB realignment is no longer available for transfer and reuse and consequently no land use conflict exists. Cumulative impacts from community reuse and the SFOBB are discussed in Chapter 5. Please refer to the EIS for the east spans realignment for discussion of impacts of that project (see http://www.dot.ca.gov/dist4/sfobb/sfobbfeis.htm). Therefore, there would be no significant land use impact, and no mitigation is proposed.

4.1.3 Alternative 3

Significant and Mitigable Impact

Impact: Land use policy (Factor 1). The City and County of San Francisco General Plan land use designation for NSTI is Military. The zone classifications that would be required for Alternative 3 (i.e., Public, Residential, Mixed Use) would be inconsistent with the existing general plan designation and zoning classification.

Mitigation. To achieve consistency between the selected reuse alternative and city policies, it will be necessary to amend the San Francisco General Plan to include land use designations for surplus property on Treasure Island and Yerba Buena Island prior to approving future land use actions. NSTI would not be rezoned until the final reuse plan is adopted, at which time the City and County of San Francisco should amend its Planning Code to be consistent with planned land uses. Upon receiving a zoning designation, the area would be subject to the land use and height and bulk regulations established by the zoning. These controls would be subject to the Redevelopment Plan and its design for development standards and would likely include site design measures, such as buffering, landscaping, screening, and setbacks, to ensure high quality development and compatibility between land uses.

Not Significant Impacts

Land use policy (Factor 1). Implementing Alternative 3 would increase public access to existing open space areas, including the San Francisco Bay shoreline, and would allow development of recreational facilities, which would be substantially consistent with the anticipated priority use designations for NSTI in the San Francisco Bay Plan. Specific development plans for reuse of NSTI would be subject to BCDC permit authority, which would ensure consistency with the Bay Plan. Alternative 3 would be in accordance with the Draft Reuse Plan guidelines and would not conflict with Sustainability Plan objectives.

Land use compatibility–Treasure Island (Factor 2). With the exception of the themed attraction and sports complex, proposed reuse of Treasure Island under Alternative 3 would be accommodated within existing facilities. Existing city leases on Treasure Island, including leases for film production, a firefighting school, brig, marina, and elementary school, would continue through 2015 under this alternative. Implementing this alternative would require minimal demolition and construction. As with Alternative 1, proposed reuse of Treasure Island would provide additional opportunities for public access to open space and recreational resources, publicly oriented attractions, and access to the Bay. Proposed land uses under Alternative 3 would be less responsive to the objectives of the Draft Reuse Plan than those of Alternatives 1 and 2; however, land use changes would be consistent with applicable Draft Reuse Plan policies, which guide future development to ensure land use compatibility under reuse, and therefore would not be considered a significant land use impact on the vicinity character of Treasure Island. No mitigation is proposed.

As with Alternatives 1 and 2, proposed land uses would provide a compatible land use relationship with the Job Corps facility and would provide trainees with employment opportunities. Proposed reuse of Treasure Island would therefore not result in a significant land use impact to the Job Corps facility. No mitigation is proposed.

Land use compatibility–Yerba Buena Island (Factor 2). As a result of implementing this alternative, proposed reuse of Yerba Buena Island would represent a change in the intensity of some land uses and would introduce publicly oriented use of the island. Proposed land use changes would affect the vicinity character by converting the senior officer quarters to publicly oriented facilities, by developing new residential areas and infilling existing residential areas, and by developing a bed and breakfast in place of existing residential units on the Yerba Buena hilltop. New uses would require expanding some existing buildings, demolition, and new construction. Using the Nimitz House (Quarters 1), a NRHP listed property, as a conference center would continue through 2015 under this alternative.

At full buildout, overall land uses would be similar to Alternative 1 at a reduced scale. Fewer residential units would be constructed, and only the senior officers quarters would be developed as a conference facility. As with Alternative 1, proposed reuse of Yerba Buena Island would provide additional opportunities for public access to open space and recreational resources, publicly oriented attractions, and access to the Bay. These land use changes would be consistent with applicable Draft Reuse Plan policies, which guide future development to ensure land use compatibility under reuse, and therefore would not be considered a significant land use impact on the vicinity character of Yerba Buena Island. No mitigation is proposed.

As with Alternatives 1 and 2, proposed land use changes on Yerba Buena Island would be separate and distinct from existing uses, and as such, implementing this alternative would not disrupt or divide the physical arrangement of existing uses. The existing SFOBB or the proposed realignment would not be affected by changes in land use that are part of community reuse. Land on Yerba Buena Island permanently conveyed in fee to Caltrans to accommodate the SFOBB realignment is no longer available for transfer and reuse and consequently no land use conflict exists. Cumulative impacts from community reuse and the SFOBB are discussed in Chapter 5. Please refer to the EIS for the east spans realignment for discussion of impacts of that project (see http://www.dot.ca.gov/dist4/sfobb/sfobbfeis.htm). There would be no significant land use impact, and no mitigation is proposed.

4.1.4 No Action Alternative

The No Action Alternative would retain NSTI in a caretaker status under Navy control. No disposal action would occur. Existing structures and grounds would be maintained to minimize deterioration. Environmental cleanup would continue in conformance with federal requirements and ongoing military programs, but cleanup would occur over a longer period of time than Alternatives 1 through 3, as no reuse requirements would need to be met.

Land use policy (Factor 1). The No Action Alternative would be consistent with the existing General Plan and zoning designation (Military). There would be no need for the City and County of San Francisco to amend its General Plan. There would be no land use impact.

Land use compatibility–Treasure Island (Factor 2). Continuing use of Treasure Island would be accommodated within existing facilities. Existing city leases on Treasure Island, including leases for film production, a firefighting school, brig, marina, and elementary school, would continue through 2015 under this alternative. These leases would continue until expired or terminated. Implementing this alternative would require minimal demolition and construction

by Navy to comply with safety standards. There are no proposed land use changes, and there would be no impact on the vicinity character of Treasure Island.

As there are no proposed land use changes, this alternative would provide a compatible land use relationship with the Job Corps. There would be no land use impact.

Land use compatibility–Yerba Buena Island (Factor 2). Continuing use of Yerba Buena Island would be accommodated within existing facilities. Existing leases on Yerba Buena Island would continue until expired or terminated. Implementing this alternative would require minimal demolition and construction by Navy to comply with safety standards. There are no proposed land use changes, and there would be no impact on the vicinity character of Yerba Buena Island.

4.2 VISUAL RESOURCES

Visual resources impacts may be associated with changes in either the built or natural environment and can be short-term or long-term. The presence of heavy machinery during construction of buildings and infrastructure is considered a short-term impact. Large trucks, bulldozers, and other construction equipment would be visible within the construction/demolition zone. Long-term visual changes are associated with demolishing existing buildings and structures and constructing new buildings and structures. The significance of visual effects is very subjective and depends upon the degree of alteration, the scenic quality of the area disturbed, the sensitivity of the viewers, and the viewer perception of features in the viewshed.

Visual resources impacts have been qualitatively evaluated by assessing the nature and extent of change in landscape character that would occur under each disposal and reuse alternative. The visual analysis addresses landscape modifications as seen from notable public viewpoints within the viewshed.

Factors considered in determining whether an alternative would have a significant impact on visual resources included the extent or degree to which its implementation would:

1. Degrade scenic quality within the region of influence (defined as Treasure Island, as seen from any public view or viewpoint);

2. Damage scenic resources, including, but not limited to trees, rock outcroppings, and historic buildings; or

3. Create a new source of substantial light or glare that might adversely affect day or nighttime views in the area.

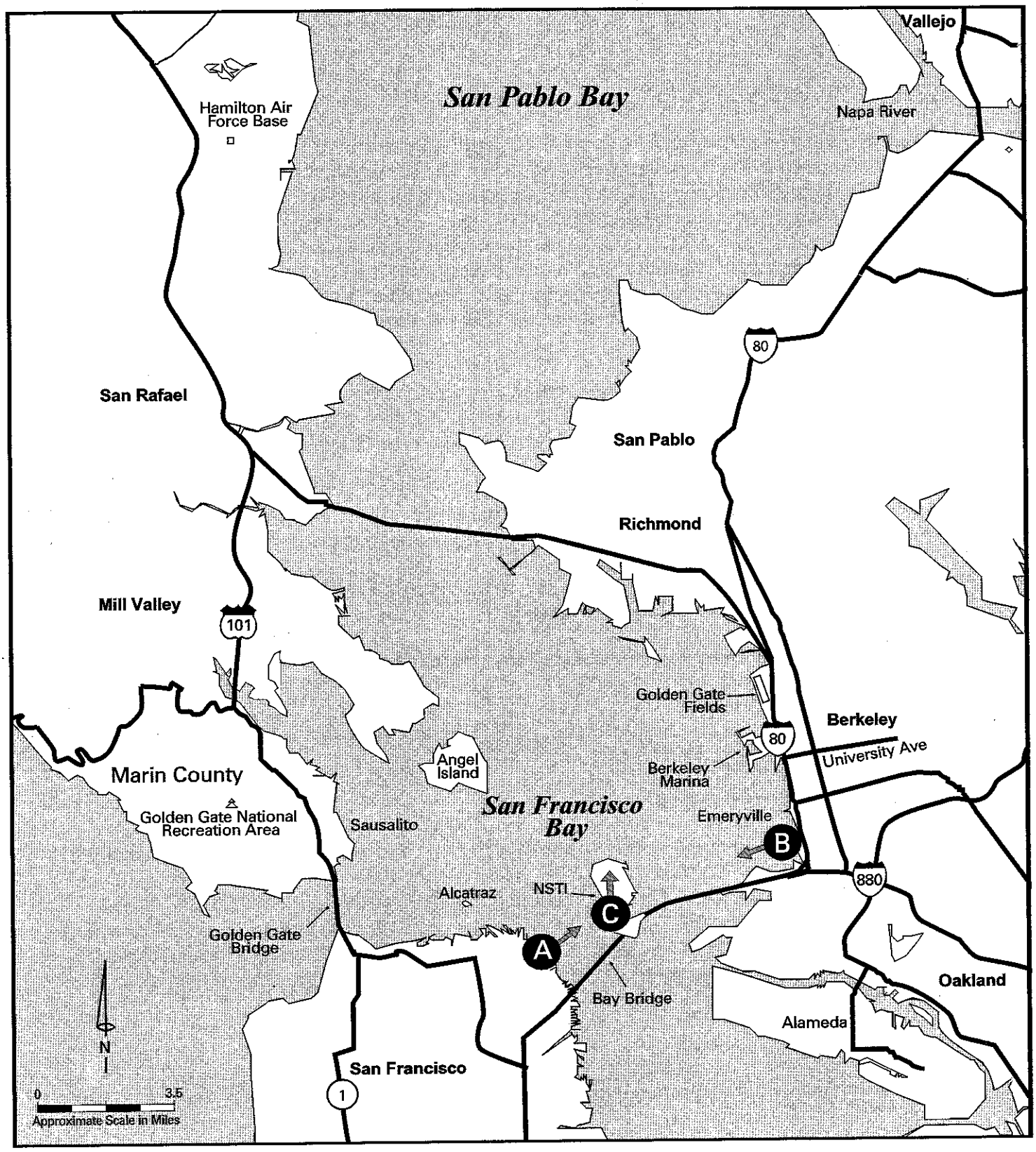
Assumptions for Visual Analysis

The building or development components analyzed are derived from the alternative descriptions in Chapter 2, with additional assumptions based on descriptions of similar components in the Draft Reuse Plan and consultation with city staff and the EIS team. Based on information contained in the Draft Reuse Plan, the analysis assumed building heights for proposed hotels to be 65 to 75 feet (20 to 23 m), for residential buildings to be 40 feet (12 m), for at least one landmark structure to be up to 100 feet (30.5 m), and for other buildings in the Treasure Island core area to be 60 feet (18 m).

Methodology

The descriptions of major proposed development components and their resulting potential visual impacts are generalized. Computer-based photosimulations, taken from three viewpoints identified in Figure 4-1, have been used to supplement the analysis.

These three viewpoints were selected because they are representative public viewpoints from the East Bay, West Bay, and NSTI that are used intensively and that could be affected by the reuse alternatives. The simulations are based on three dimensional (3D) computer-aided



A, B, and C show the vantage point for the visual simulations in this

Legend

- A End of Pier 7, San Francisco (Figure 4-2)
- B Emeryville Shoreline Park (Figure 4-3)
- C Public Parking at the Gate to Treasure Island (Figure 4-4)

Map Viewpoint Used in Photosimulations

Bay Area, California

Figure 4-1

design (CAD) data provided by Navy from photogrammetry of the site, with limited digitizing and 3D modeling of proposed building heights based on the data sources and assumptions discussed above. The simulations show the maximum volume, or extent, of possible development. Because the alternatives are conceptual at this time, the simulations do not show design detail. However, the simulations do provide a conservative estimate of the extent of development.

Major reuse alternative development components considered in this analysis include new buildings (at least two stories high), new larger structures, loss of visually prominent buildings or large areas of buildings by demolition, creation or loss of large areas of open space, and establishment or loss of major tree groups/canopy. The proposed reuse of buildings and facilities without substantial modification would not be identified as having an effect on visual resources or urban design.

4.2.1 Alternative 1

This alternative would alter visual resources in primary views from the San Francisco waterfront, East Bay shore, SFOBB, and in more background views from other locations around San Francisco Bay. Significant adverse impacts are not anticipated, and some of the potential anticipated effects could be beneficial. Beneficial effects could result from aesthetic enhancements of Treasure Island areas and increased opportunities for public access to panoramic views of the San Francisco Bay Area.

Not Significant Impacts

Views from Surrounding Viewshed

San Francisco waterfront and open space (Factors 1 and 2). The principal development components of this alternative visible from the San Francisco waterfront area would include the proposed hotels on Treasure Island, a landmark structure, the themed attraction and other mid-rise buildings, and development on the top and west-facing slopes of Yerba Buena Island. Figure 4-2 shows the view from Pier 7 on The Embarcadero, which is a conservative-case representation of other Embarcadero and waterfront views; at locations to the south (e.g., the Ferry Building area and its nearby promenade), similar but slightly more distant views would be obtained. These are considered highly sensitive viewing locations, where the most viewers come to sightsee or to enjoy the scenic views during breaks in their workday.

The proposed hotel development and a landmark structure in particular would alter the profile of Treasure Island and Yerba Buena Island from this viewpoint, with the potential for visual contrast to be similar in prominence to other landscape features in the panoramic field of view. The hotels, if extending up to approximately 75 feet (23 m) tall along much of their frontage, would introduce a visual mass nearly 2 times that of the existing 40-foot (12-m) prominent Building 1. The landmark structure, assumed to be up to 100 feet (30.5 m), would also create a higher profile but may not have the visual mass of the hotels. However, the existing landscape is dominated by nearby Buildings 2 and 3, originally constructed as aircraft hangers, because their scale and mass exceed that of any other existing or proposed buildings on the island.

The hotels and the landmark structure, in combination with these other large buildings, would, therefore, be prominent above existing and newly established landscaping, especially if painted in pale colors. From The Embarcadero between the SFOBB and approximately Pier 39, the proposed hotel buildings and landmark structure would partially block views of the East Bay hills, although the hotels would be low in comparison with Yerba Buena Island. From more elevated viewpoints such as Coit Tower in San Francisco, the taller buildings would partially block views of the water beyond Treasure Island.

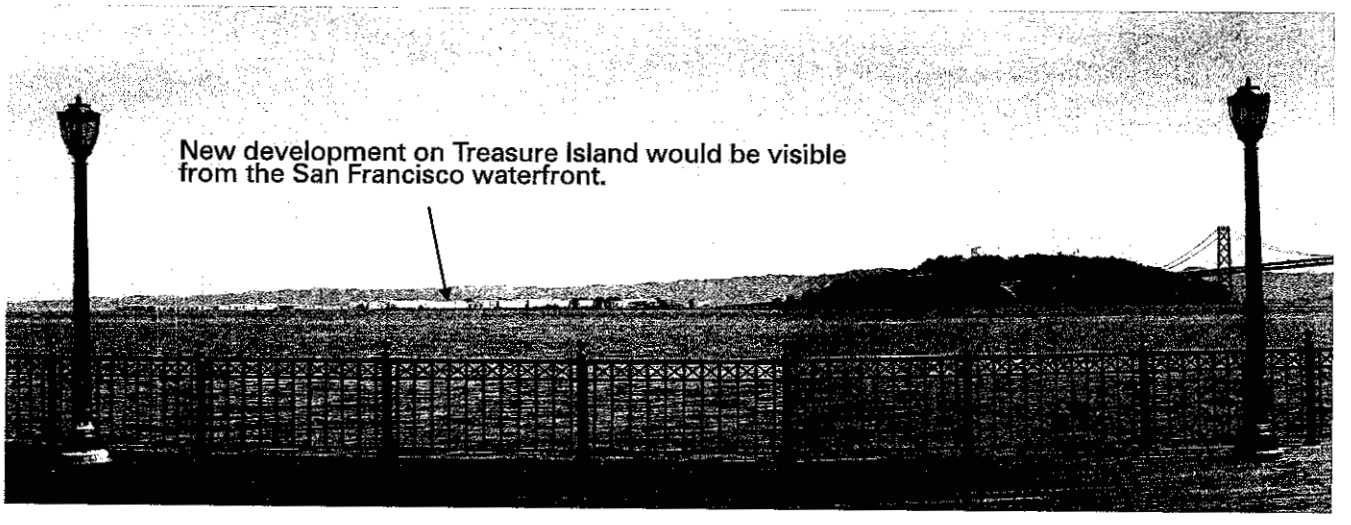
A small hotel (up to approximately 60 feet [18 m] high) on Yerba Buena Island would be clearly visible if located in a prominent location, but it would be visually subordinate to the rest of the island in most viewing conditions, assuming that it is designed with a tapering profile (setbacks at higher stories), as proposed in the Reuse Plan Urban Design policies for the hillside at Yerba Buena Island. Furthermore, the elevation at the proposed hotel location would be below the summit of Yerba Buena Island.

These visual effects are identified as not significant because, although there could be new visual contrasts, the scale and urban design of the development, as proposed in the Reuse Plan Urban Design policies, such as protecting natural character and stepping of buildings following the slope, would not be expected to substantially degrade existing scenic quality. In terms of view blockage, similar views of the East Bay hills could still be obtained elsewhere in the same panorama and from other locations along the waterfront. No mitigation is proposed.

Views from Bay Islands and Marin County (Factors 1 and 2). In views from Alcatraz, Angel Island, and background locations, such as the Golden Gate Bridge and Sausalito, the same components as described for the San Francisco waterfront views would be the most prominent. However, greater viewing distances between Treasure Island and these Bay islands and Marin County would reduce the visual effects of proposed development compared to other landscape features in view. At these long viewing distances, the development would not substantially block views of the East Bay hills or SFOBB. Visual impacts also would not be significant from these viewpoints. No mitigation is proposed.

Views from East Bay shoreline (Factors 1 and 2). The principal components of Alternative 1 that would be visible from the East Bay shoreline parks and open space include the proposed hotels on Treasure Island, landmark structure, themed attraction, and other mid-rise buildings (Figure 4-3). Some screening of new buildings provided by mature trees and lower buildings on the east side of Treasure Island would reduce the degree of change. The higher buildings on Treasure Island would introduce a visual mass approximately seven times that of the existing hangars seen from this location. Because the island is seen against the taller backdrop of the San Francisco skyline from most viewpoints, such as the Emeryville and Watergate shoreline, Berkeley Marina, and Golden Gate Fields on the Berkeley and Albany border, the resulting visual contrast would remain subordinate to other landscape features in the panoramic field of view. The proposed buildings would not block views of the Golden Gate and would only partially block views of lower elevations of San Francisco without interrupting the skyline. A somewhat different situation would occur at the publicly accessible open space near the radio station facilities near the eastern landfall of the SFOBB. From here, partial blockage of views of the Golden Gate Bridge would be increased by the taller buildings and themed attraction, in

Existing View



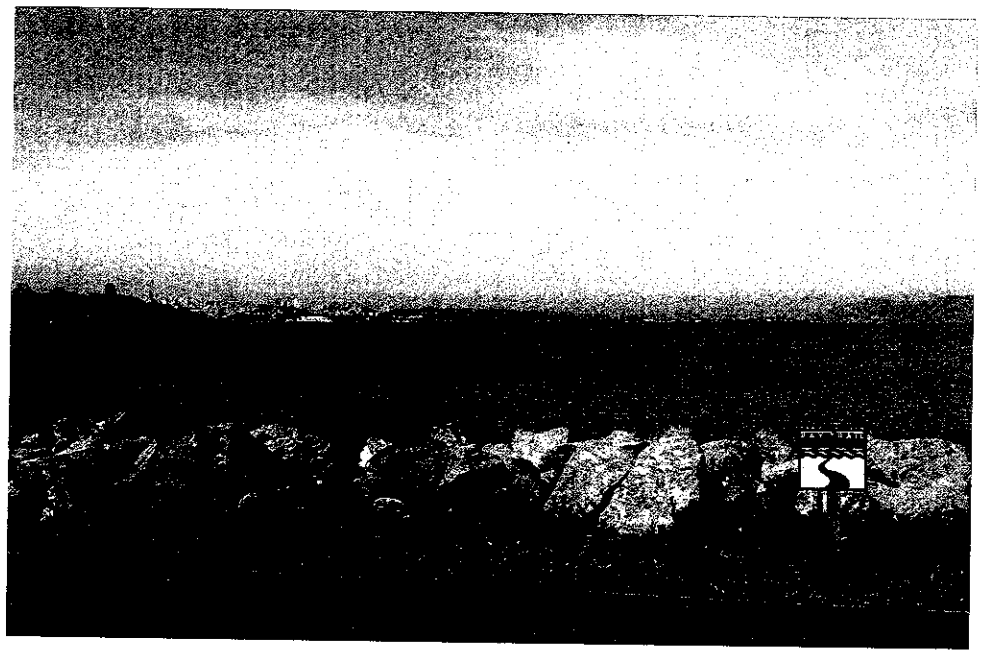
Simulated View

Pier 7, a public open space pier, is a popular spot for pedestrians along Herb Caen Way, and is closer to Treasure Island than other San Francisco waterfront points.

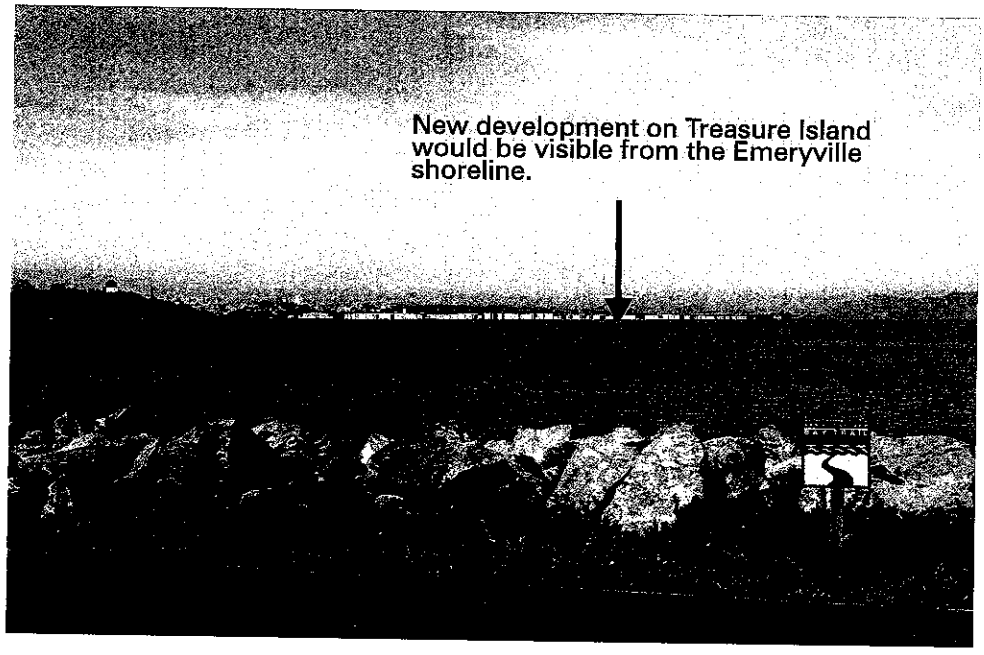
Existing View/Simulated View of Alternative 1, Seen from the End of Pier 7, San Francisco

San Francisco, California

Figure 4-2



Existing View



Simulated View

The point of Emeryville Shoreline Park is closest to Treasure Island of the East Bay vantage points.

Existing View/Simulated View of Alternative 1, Seen from the Emeryville Shoreline Park

Emeryville, California

Figure 4-3

addition to some existing view obstruction of the Golden Gate Bridge deck from this angle by vegetation on Treasure Island. The impact is not significant because of the relatively low levels of use experienced at this location in comparison with the major eastshore parks and the availability of other unobstructed views from similar locations northward along the shoreline. However, should the Bay Trail bring substantially increased levels of use to the area, this partial view blockage from this alternative could be experienced by more people. No mitigation is proposed.

Views from vessels on San Francisco Bay (Factors 1 and 2). In views from ferries and recreational vessels on the Bay, the main components that would be visible include the taller buildings (primarily hotels), development on Yerba Buena Island, and shoreline open space. Visual contrasts of proposed development would be similar in prominence to other existing features (notably Yerba Buena Island, the SFOBB, and hangar buildings) in most views. Some beneficial effects could occur with improved landscaping and new nonindustrial development. View blockage is not a major concern because of the mobility of the viewing position and the free access to views over open water. No mitigation is proposed.

Views from eastshore highway and SFOBB (Factors 1 and 2). In views from the eastshore highway and SFOBB, the buildings at the heights proposed in the Draft Reuse Plan would not project substantially above the San Francisco skyline and therefore would not block the skyline from view. Further, because the viewer would be in vehicles moving in traffic and because the views are either partially blocked by SFOBB railings, other highway structures, or trees on Yerba Buena Island, or are at almost a 90 degree angle from the direction of travel (on the eastshore highway), the views are considered less sensitive and the impacts less significant than the pedestrian views from open space. It is estimated that the proposed hotel buildings would be visible and would at least partially block the views of the Golden Gate Bridge for up to two minutes for passengers of vehicles traveling westward on the SFOBB, but this would occur only from more distant portions of the bridge nearer sea level. Some views of Alcatraz Island from the SFOBB also could be blocked. No mitigation is proposed.

Views from urban and residential areas (Factors 1 and 2). Off-site urban and residential areas with views to Treasure Island are principally at background viewing distances from both the East Bay hills (8 miles) and from higher elevations in San Francisco (under 2 miles). View blockage is not considered a major issue at this viewing distance, and scenic qualities would not be reduced by the proposed hotel and mid-rise buildings. Depending on the design of the themed attraction and the landmark structure, there is the potential for either beneficial or adverse visual impacts because of the introduction of a new visual structure in the center of the Bay. Design of any themed attraction or landmark structure would undergo further public review. No mitigation is proposed.

Views from Within the Reuse Plan Area

On-site views and visual access (Factors 1 and 2). Development on Treasure Island would replace aging industrial and military facilities with urban design elements intended to be more attractive and in closer character with the rest of the San Francisco waterfront. Scenic quality could be enhanced through additional landscaping and attention to aesthetic design in developing new buildings, the themed attraction, and other visitor-serving facilities, according to design guidelines in the Reuse Plan and Urban Design policies of the General Plan.

It is assumed that existing view corridors to the Bay would be kept open, with additional open space perimeter opportunities and public access opportunities provided along the waterfront open space. The hotel complex would block some existing view corridors. In scenic views at public locations, such as the gateway area, and in views around Clipper Cove, most existing scenic features would be retained. The expanded marina with approximately 300 slips and 100 tie-up buoys, compared to the existing 100 slips, would add new visual elements to what is now a relatively undisturbed cove with primarily open water, although the expanded marina would be to some extent visually consistent with the existing marina and pier features along Clipper Cove. The proposed hotels and themed attraction buildings would alter the setting for the older buildings (Figure 4-4), but are intended to be compatible with the existing features. Assuming compatibility in design with the older structures in on-site views, this reuse alternative would not result in significant visual impacts. No mitigation is proposed.

Light and Glare

Night lighting and glare (Factor 3). The proposed development under Alternative 1 would include placement of light sources for safety, identification, and security. Proposed development, including the hotels, lighting along the Treasure Island waterfront, themed attraction lighting, and lighting of other buildings or features would be prominent at night from closer views, such as the San Francisco waterfront and SFOBB. Themed attraction lighting also may be visible from more distant viewpoints, such as from the East Bay. However, assuming lighting levels are similar to urban lighting at the San Francisco waterfront, with shielding to prevent upward glare visible to SFOBB drivers, this alternative is not expected to introduce light and glare at nuisance levels. Lighting could visually enhance the island at night.

Glare, a condition where light is uncomfortably harsh, could impact effective vision or even temporarily blind an individual and is therefore a safety concern. Glare could be generated from new buildings that are composed of reflective materials, such as glass or polished metal. Glare can be controlled through design controls and building material restrictions as part of the standard design review and approval processes of the City and County of San Francisco. For example, City Planning Commission Resolution 9212 generally prohibits use of mirrored or reflective glass in new buildings. Compliance with this resolution would avoid related glare impacts. No mitigation is proposed.

4.2.2 Alternative 2

Under this alternative a mix of land uses would be established, with emphasis on publicly oriented development and open space and recreation. It mainly differs from Alternative 1 by including more open space, especially by replacing residential uses on the northern half of Treasure Island with a golf course and wildlife observation or potential wetlands area. It also would provide for a wider open space strip along the southern and eastern waterfront of Treasure Island, more marina development in Clipper Cove, and an expanded hotel and bed and breakfast area on the western end of Yerba Buena Island.

This alternative would in many respects be visually similar to Alternative 1. The most prominent development components (hotels and themed attraction structures) would alter visual resources in views from the San Francisco waterfront, East Bay shoreline, SFOBB, and in

Existing View

Simulated View

s view would greet the motorist
proaching Treasure Island from
causeway and arriving ferryboat
passengers.

Existing View/Simulated View of Alternative 1 Seen from Public Parking at the Gate to Treasure Island

Treasure Island, California

Figure 4-4

more background views from other locations around San Francisco Bay. These impacts would not be significant. Beneficial effects could include those that result from aesthetic enhancement of existing areas with strong industrial or utilitarian character on Treasure Island and increased opportunities for the public to experience panoramic views of the San Francisco Bay Area.

Not Significant Impacts

Not significant impacts would be similar to those described for Alternative 1 because of the similarity in major visual development components. Specific visual effects that would be similar to or less than those described for Alternative 1 include views from Bay islands and Marin County, views from the East Bay shoreline, views from vessels on San Francisco Bay, views from urban and residential areas, and night lighting and glare. The greater open space and wildlife habitat on Treasure Island in this alternative would not alter its current appearance from most viewpoints in the surrounding Bay Area since the existing housing is of low profile and not conspicuous at greater viewing distances; this impact would, therefore, be less than with Alternative 1. Those visual effects that would be different from Alternative 1 are described below.

Views from San Francisco waterfront and open space (Factors 1 and 2). The proposed hotel complex on Yerba Buena Island would be of lower height than in Alternative 1 and therefore would be less visible and more similar to existing conditions. In other respects, this alternative would have similar not significant impacts to those described for Alternative 1. No mitigation is proposed.

Views from eastshore highway and SFOBB (Factors 1 and 2). The expanse of open space at the north end of Treasure Island would be apparent to passengers of buses and other vehicles with seating raised above the level of the bridge railing. The extent of green space would be conspicuous from this elevated vantage point and would represent a change in comparison with the existing military and industrial character of NSTI. In other respects, this alternative would have similar not significant impacts to those described for Alternative 1. No mitigation is proposed.

On-site views and visual access (Factors 1 and 2). Development on Treasure Island under this alternative would replace aging industrial and military facilities with elements and open space intended to be in character with the rest of the Bay Area shoreline. Effects compared to Alternative 1 would include greater extent and visibility of open space on Treasure Island. The wider open space corridor along the waterfront around the themed attraction also would enhance views to and from the shoreline. Compared to the existing 100-slip marina, the expanded marina would accommodate between 500 to 675 slips and tie-up buoys and would add new visual elements to what is now a relatively undisturbed cove with primarily open water. However, these additional boat slips would not result in a significant visual impact because they would not substantially degrade or obstruct views to and from NSTI and would be to some extent visually consistent with the existing marina and pier features along Clipper Cove.

Light and glare (Factor 3). Urban Design policies in the Reuse Plan and General Plan, and City Planning Commission Resolution 9212 regarding use of mirrored or reflective glass, also would

apply to this alternative. Less development under this alternative would result in even less glare than under Alternative 1. No mitigation is proposed.

4.2.3 Alternative 3

Under Alternative 3, a mix of land uses would be established, but with many of the structures remaining. Compared to Alternative 1, Alternative 3 would have slightly more designated open space (approximately 157 acres [64 ha] versus approximately 135 acres [55 ha]) and would be more similar to existing conditions. Other differences from Alternative 1 include no new hotel buildings, no marina expansion in Clipper Cove, and a greatly reduced area for the themed attraction (approximately 39 acres [16 ha] compared with approximately 59 acres [24 ha] for Alternative 1).

This alternative generally would have less visual impact than Alternatives 1 and 2. This alternative would not include the taller and most prominent project components of the other two reuse alternatives. Views of Treasure Island under this alternative would not appear very different from the island's existing appearance, except for the prominent themed attraction structure and some visible development on Yerba Buena Island. The latter features would appear as described in Alternative 1.

Although the proposed themed attraction structures may still be visible in closer-range and background views, this alternative would have more limited effects on visual resources in views from the San Francisco waterfront, East Bay shoreline, SFOBB, and in more background views from other locations around San Francisco Bay because of its reduced development scale. Other effects could be beneficial, such as those that would result from limited aesthetic enhancement of existing areas on Treasure Island and increased opportunities for the public to experience panoramic views of the San Francisco Bay Area.

Not Significant Impacts

Specific visual effects that would be less than those described for Alternative 1 include views from Bay islands and Marin County, views from vessels on San Francisco Bay, views from the eastshore highway and the SFOBB, views from urban and residential areas, and night lighting and glare. Those visual effects that would be different than Alternatives 1 and 2 are described below.

Views from San Francisco waterfront and open space (Factors 1 and 2). The profile of development on Treasure Island would not appear very different from its existing appearance, with the exception of the prominent themed attraction structure and the hotel on Yerba Buena Island. The latter features would appear as described in Alternative 1. No mitigation is proposed.

Views from East Bay shoreline (Factors 1 and 2). Treasure Island would not appear very different from its existing appearance, except for the prominent themed attraction structure and some visible development at the east end of Yerba Buena Island. The latter features would appear as described in Alternative 1. No mitigation is proposed.

On-site views and visual access (Factors 1 and 2). New development in the themed attraction area would replace aging industrial and military facilities with elements and open space intended to

be in character with the rest of the public Bay Area shoreline. Clipper Cove would remain in its existing condition and therefore would retain the scenic features of this undisturbed open water area compared to the other reuse alternatives that propose expansion of this facility. It is assumed that public access would be provided around the entire perimeter of Treasure Island, offering some of the same beneficial effects of increased visual access as the other alternatives.

Light and glare (Factor 3). Urban Design policies in the Reuse Plan and General Plan, and City Planning Commission Resolution 9212 regarding use of mirrored or reflective glass, also would apply to this alternative. No mitigation is proposed.

4.2.4 No Action Alternative

The No Action Alternative would be a continuation of the caretaker status of NSTI surplus property. Existing interim leases would be allowed to expire. No existing buildings would be rehabilitated or demolished, and no new buildings would be constructed. The only activity on the site would be from maintenance personnel and security staff. Although modification of appearance due to boarding up of some windows and doors may occur, the general physical character of the property would remain the same. This change in appearance would not be visible from off-site views in San Francisco and the East Bay and therefore would be no impact. In addition, access to NSTI under caretaker status would be limited; therefore, no on-site visual impacts would occur. Reduced staffing and the lower level of activity could affect the character of the site; however, the visual contrast would be weak, and impacts would be less than significant. Existing views would not be disrupted or blocked. There would be no substantial visual changes to the site as a result of the No Action Alternative; therefore, no visual impacts would occur.

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4.3 SOCIOECONOMICS

Potential direct and indirect impacts on employment, population, housing, and schools resulting from disposal and reuse of NSTI are discussed in this section. Factors considered in determining whether an alternative would have significant socioeconomic impacts include the extent or degree to which its implementation would:

1. Cause a decrease in local or region of influence employment;
2. Induce growth or concentrations of population;
3. Create a demand for additional housing in San Francisco, Oakland, or the surrounding communities; or
4. Generate student enrollment that exceeds the capability of responsible authorities to accommodate.

The significance of socioeconomic impacts is related to the social and economic characteristics of the region. In general, the more jobs generated, the more beneficial the socioeconomic effects that may occur. Population and housing growth may have ramifications for other environmental issues, such as potential traffic increases and the need for additional infrastructure improvements. The significance of these other impacts is defined in pertinent sections of this document.

Table 4.3-1 summarizes the estimated number of jobs, housing units, and residents that would be associated with each reuse alternative. Assumptions used to generate the population and employment estimates are provided in Appendix F, Socioeconomics.

The impacts presented in this section have been evaluated against the baseline environmental conditions presented in Chapter 3. Navy recognizes that changes in the environmental conditions may have occurred in the period between the baseline years and the present. Although these changes may result in different, and in many cases, lesser impacts to certain resources, changes to the impact analysis based on any interim change in resource conditions is not appropriate.

4.3.1 Alternative 1

Not Significant Impacts

Employment (Factor 1). Alternative 1 would create approximately 4,920 full-time equivalent jobs (information on employment generation factors is provided in Appendix F). Generation of this employment would occur over a period of 15 or more years, dependent on market conditions, land availability, and other factors.

Most of the jobs associated with this alternative would be created through reuse of parts of Treasure Island for a themed attraction, hotel and conference facilities, restaurants, film studios, community services, and a variety of recreational facilities. The largest employment generator would be the themed attraction, which would employ approximately 3,500 persons, although some of these jobs would be seasonal. Of the approximately 4,920 full-time equivalent jobs created, full-time equivalent employment associated with the themed attraction is estimated to

be approximately 1,750. After the themed attraction, the next largest employment generators would be hotel facilities, the film industry, and restaurants.

Table 4.3-1. Estimated Jobs, Population, and Housing Units for Baseline Conditions and Reuse Alternatives

	Baseline Conditions (Year)	*Alternative 1*	*Alternative 2*	*Alternative 3*
EMPLOYMENT[1]				
Treasure Island	-	4,740	2,640	2,015
Yerba Buena Island	-	180	180	180
Total employment	3,635[3,4] (1988)	4,920	2,820	2,195
RESIDENT POPULATION				
Treasure Island[2]	-	6,020	90	3,060
Yerba Buena Island	-	875	620	450
Total population	4,500[3,4] (1990)	6,895	710	3,510
HOUSING UNITS				
Treasure Island	-	2,500	0	905
Yerba Buena Island	-	350	250	160
Total housing units	1,045[3,4] (1990)	2,850	250	1,065

1 Jobs are reported as full-time equivalent jobs; seasonal jobs would increase the total number of jobs.
2 Treasure Island resident population includes brig inmates in all scenarios.
3 Numbers represent totals for 1988 (military employment) and 1990 (civilian employment, population, and housing); data were not available for Treasure Island and Yerba Buena Island separately.
4 Data are reported for Census Tract 179.02, which encompasses both Treasure Island and Yerba Buena Island, and therefore includes US Coast Guard data, but are representative of NSTI baseline conditions.
Note: A "-" indicates that information was not available.
Sources: DON 1988b; US Department of Commerce 1990; DON 1997l.

The number of civilian jobs created under Alternative 1 would offset the 750 jobs lost to closure and would result in a net gain of 4,170 jobs. Therefore, the projected increase in employment under Alternative 1 would be a beneficial impact. No mitigation is proposed.

Population (Factor 2). The development of the reuse plan area would result in an increase in San Francisco's population through the provision of new housing units. As shown in Table 4-1, development under Alternative 1 would result in an estimated total population of about 6,895 people. This estimate is based on the assumption that the average household size for existing and newly constructed housing units is 3.2 and 2.3 persons, respectively (see Appendix F.2, Socioeconomics). Subtracting the baseline residential population of approximately 4,500 in 1990, the net population increase would be approximately 2,395 persons. This increase of 2,395 persons represents 0.3 percent of the projected population in San Francisco by 2015 and is accounted for in ABAG's projected population increases; therefore, this is not considered a significant impact (ABAG 2001). No mitigation is proposed.

Housing (Factor 3). Alternative 1 would provide up to 2,850 housing units on the site at buildout (Table 4-1). Approximately 290 units (200 on Treasure Island and 90 on Yerba Buena Island) are existing military housing that would be converted to civilian use. Because none of the NSTI housing units were previously available to the general public, the total contribution to the City and County of San Francisco housing market would be 2,850 units.

Alternative 1 also addresses housing needs of the homeless. TIHDI initially would manage the leasing of 375 units (285 units on Treasure Island and 90 units on Yerba Buena Island) from the existing housing stock on the two islands, with promise of additional land for TIHDI housing if new housing is developed. As stated in the Draft Reuse Plan, TIHDI would be provided one acre for every 1,000 new residential units developed (San Francisco 1996e). The buildout housing mix would range from affordable to market-rate under this agreement.

Given San Francisco's lack of affordable housing and its lack of housing for those employed in San Francisco, Alternative 1 would have a beneficial impact on housing by providing housing for all income levels and by increasing the number of housing units within the San Francisco housing market (ABAG 1995b). No mitigation is proposed.

Jobs-housing balance (Factor 3). In regional terms, Alternative 1 would add both housing (2,850 units) and jobs (4,920 employees) to the City and County of San Francisco. Assuming that 55 percent of people working in San Francisco are expected to live in the city in 2015, and given that the average number of San Francisco workers in households with workers is 1.6 (MTC undated in San Francisco 1998b; Keyser Marston Associates and Gabriel Roche 1997 in San Francisco 1998b), projected employment growth under Alternative 1 translates to about 1,690 San Francisco households. The housing units provided under Alternative 1 can easily accommodate this demand. Because Alternative 1 provides housing units in excess of the demand generated by employment under this alternative, Alternative 1 would not create a demand for additional housing in San Francisco. Alternative 1 would not result in an adverse jobs-housing balance or a significant impact. No mitigation is proposed.

Schools (Factor 4). As described in section 3.3, enrollment at elementary schools throughout the SFUSD is at or near capacity; at the middle school and high school levels, some schools are at capacity, while others are underenrolled. Enrollment in the district has remained constant since 1990, averaging approximately 63,000 to 64,000 students.

Under Alternative 1, the Treasure Island Elementary School would continue to operate. The middle school and high school students at NSTI would be bussed to San Francisco schools. As demonstrated by US Census data, San Francisco households have fewer children compared to Navy households on NSTI. In 1990, there were 1,134 school-aged children (5 to 19 years of age) at NSTI, representing 25 percent of the total NSTI population. In comparison, 96,173 school-aged children lived in San Francisco in 1990, only 13 percent of the total citywide population (US Department of Commerce 1990). Given the population figure of 6,895 derived in the previous section, the number of school-aged children living at NSTI under this alternative is estimated to be approximately 896 in 2015, or about 80 percent of the number of school-aged children who resided there in 1990. This would lead to an overall decrease in enrollment for the San Francisco school system. This is not considered a significant impact. No mitigation is proposed.

4.3.2 Alternative 2

Not Significant Impacts

Employment (Factor 1). Alternative 2 would create approximately 2,820 full-time equivalent jobs (information on employment generation factors is provided in Appendix F). This alternative would generate this level of employment over a period of roughly 15 or more years, dependent on market conditions, land availability, and other factors.

As in Alternative 1, many new jobs would be associated with a themed attraction or similar visitor attraction. This facility would create about 1,400 seasonal and permanent jobs, or approximately 700 full-time equivalent jobs. The remaining new jobs would be created through the development of a major hotel and conference facility on Treasure Island, as well as smaller scale bed-and-breakfast and reception facilities on Yerba Buena Island.

The number of civilian jobs created under Alternative 2 would offset the 750 jobs lost to closure and would result in a net gain of 2,070 jobs. Therefore, the projected increase in employment under Alternative 2 would be a beneficial impact, and no mitigation is proposed.

Population (Factor 2). The development of the reuse plan area would result in an increase in San Francisco's population through the provision of new housing units. As shown in Table 4-1, development under Alternative 2 would result in an estimated total population of about 710 people; this is because no housing other than the brig is proposed on Treasure Island. Subtracting the baseline residential population of approximately 4,500 in 1990, there would be a net population decrease of approximately 3,790 persons. This decrease represents 0.5 percent of the projected citywide population of 810,500 residents by 2015 and would not be a significant impact. No mitigation is proposed.

Housing (Factor 3). Alternative 2 would provide up to 250 housing units on Yerba Buena Island at build-out (Table 4-1); no housing other than the brig is proposed on Treasure Island. Approximately 50 units on Yerba Buena Island are existing military housing that would be converted to civilian use. Because none of the NSTI housing units were previously available to the general public, the total gain would be 250 units. There may be replacement homeless housing for TIHDI to manage and lease elsewhere off-island. By increasing the number of housing units, Alternative 2 would provide a beneficial impact. No mitigation is proposed.

Jobs-housing balance (Factor 3). In regional terms, Alternative 2 would add both housing and jobs to the City and County of San Francisco. However, only 250 housing units would be provided for 2,820 full-time equivalent jobs. Assuming that 55 percent of people working in San Francisco are expected to live in the city in 2015, and given that the average number of San Francisco workers in households with workers is 1.6 (MTC undated in San Francisco 1998b; Keyser Marston Associates and Gabriel Roche 1997 in San Francisco 1998b), projected employment growth under Alternative 2 translates to about 970 San Francisco households. Therefore, implementing Alternative 2 would create a demand for additional housing in San Francisco. Based on current vacancy rates, this increased housing demand could be accommodated by existing vacant housing units in San Francisco.

An imbalance of housing to jobs is not a physical environmental effect but rather a regional economic and social issue. Certain indirect project and cumulative effects caused by the imbalances in local employment and housing opportunities would be physical environmental impacts, primarily transportation and related air quality impacts created by increased commuting distances for employees living farther from their place of employment. The physical impacts of NSTI's housing supply shortfall under Alternative 2 relate primarily to project-induced and cumulative traffic and air quality effects. These impacts can be reduced through proposed transportation demand management measures (see section 4.5, Transportation and Chapter 5, Cumulative Projects and Impacts).

It is expected that demands for new employees on Treasure Island and Yerba Buena Island under Alternative 2 would be met by the local Bay Area population. Outside of San Francisco, it would be reasonable to presume that any additional housing demand not met locally would be dispersed over the regional housing market and would not be concentrated in any particular location. This additional demand would therefore not have a significant impact on regional housing conditions and land development. No mitigation is proposed.

Schools (Factor 4). Under Alternative 2, the Treasure Island Elementary School would be closed. Based on a residential population of 710, the population of school-aged children associated with Alternative 2 would be approximately 92 children in 2015, or less than a tenth the number who resided at NSTI in 1990. These children would be bussed to San Francisco elementary, middle, and high schools. The 80 children represent about 13 percent of the population projected to be living in the 250 units on Yerba Buena Island. Because the 1,042-person decrease in the population of school-aged children at NSTI would more than offset the loss of the 852-student capacity elementary school, there would be an overall decrease in enrollment for San Francisco schools. The impact on schools would be less than significant. No mitigation is proposed.

4.3.3 Alternative 3

Not Significant Impacts

Employment (Factor 1). Alternative 3 would create approximately 2,195 full-time equivalent jobs (information on employment generation factors is provided in Appendix F). Generation of this employment would occur over a period of 15 or more years, dependent on market conditions, land availability, and other factors.

The majority of new jobs would be associated with mixed use/office space and film production on Treasure Island. The themed attraction would create about 700 seasonal and permanent jobs, or approximately 350 full-time equivalent jobs. The remaining new jobs would be created through the development of smaller scale bed-and-breakfast and reception facilities on Yerba Buena Island.

The number of civilian jobs created under Alternative 3 would offset the 750 jobs lost to closure and would result in a net gain of 1,445 jobs. Therefore, the projected increase in employment under Alternative 3 would be a beneficial impact, and no mitigation is proposed.

Population (Factor 2). The development of the reuse plan area would result in an increase in San Francisco's population through the provision of new housing units. As shown in Table 4-1,

development under Alternative 3 would result in an estimated total population of about 3,510 people. Subtracting the baseline residential population of approximately 4,500 in 1990, there would be a net population decrease of approximately 990 persons. This decrease represents 0.1 percent of the projected citywide population of 810,500 residents by 2015 and would not be a significant impact. No mitigation is proposed.

Housing (Factor 3). Alternative 3 would provide up to 1,065 housing units on the site at buildout (Table 4-1). Approximately 995 units (905 on Treasure Island and 90 on Yerba Buena Island) are existing military housing that would be converted to civilian use. Since the military housing units were not previously available to the civilian market, the total gain would be 1,065 units.

Alternative 3 also addresses housing needs of the homeless. The 200 units of the existing housing units on Treasure Island would be made available to TIHDI for leasing. The buildout housing mix would range from affordable to market-rate under this agreement. Through provision of housing for all income levels and by increasing the number of housing units, Alternative 3 would provide a beneficial impact. No mitigation is proposed.

Jobs-housing balance (Factor 3). In regional terms, Alternative 3 would add both housing (1,065 units) and jobs (2,195 employees) to the City and County of San Francisco. Assuming that 55 percent of people working in San Francisco are expected to live in the city in 2015, and given that the average number of San Francisco workers in households with workers is 1.6 (MTC undated in San Francisco 1998b; Keyser Marston Associates and Gabriel Roche 1997 in San Francisco 1998b), projected employment growth under Alternative 1 translates to about 755 San Francisco households. The housing units provided under Alternative 3 can easily accommodate this demand. Because Alternative 3 provides housing units in excess of the demand generated by employment under this alternative, Alternative 3 would not create a demand for additional housing in San Francisco. Alternative 3 would not result in an adverse jobs-housing balance or a significant impact. No mitigation is proposed.

Schools (Factor 4). Under Alternative 3, the Treasure Island Elementary School would continue to operate. The projected 2015 population described above would include approximately 456 school-aged children, or about 40 percent of the school-aged children who resided on NSTI in 1990. The middle school and high school students at NSTI would be bussed to San Francisco schools. Because the number of school-aged children at NSTI, and also in San Francisco, would decline, the schools impact would be less than significant. No mitigation is proposed.

4.3.4 No Action Alternative

Employment (Factor 1). Under this alternative, property available for disposal at NSTI would continue under federal ownership in an inactive caretaker status, and existing interim leases would be allowed to expire. There would be minimal use of the property and facilities under this alternative. Ongoing activities would include maintenance, to minimize deterioration, and essential security operations.

The caretaker program would provide employment for approximately 50 personnel on the site. This basewide level of employment represents a decrease of 700 jobs from the operational baseline. Employment generated by existing leases to nonfederal agencies would cease,

because these leases would be allowed to expire and would not be renewed or extended. Given the number of jobs available in the region, this would be a less than significant impact.

Population, housing, jobs-housing balance, and schools (Factors 2, 3, and 4). Under the No Action Alternative, the population would decrease to zero once the interim leases expire and the existing military housing would no longer be used. In addition, the No Action Alternative would mean no additional school children enrolling in the SFUSD. No impacts would occur under the No Action Alternative.

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4.4 CULTURAL RESOURCES

Potential impacts to cultural resources, including historical and archaeological resources, resulting from disposal and reuse of NSTI are discussed in this section. Factors considered in determining whether an alternative would have a significant impact on cultural resources include the extent or degree to which implementation would cause either of the following:

- a substantial and adverse change in the characteristics that qualify a historic resource for listing on the NRHP; or
- a substantial and adverse change in the characteristics that qualify an archaeological resource for listing on the NRHP.

Under Section 106 of the NHPA, an undertaking has an effect on a historic property when it alters characteristics of the property that may qualify it for inclusion in the NRHP. The regulations implementing the NHPA define the term "adverse effect" to include the transfer, lease, or sale of the property out of federal ownership, in the absence of adequate and legally enforceable restrictions or conditions, to ensure the long-term preservation of the property.

As discussed in section 3.4, the Navy's analysis of the impacts to cultural resources of disposal and reuse of federal property is limited to the Navy property that is suitable for transfer. Treatment, preservation, and compliance with applicable federal legislation for the properties determined to be historically significant and potentially affected by the undertaking will be accomplished through the agreement and consultation with the SHPO, and through specific measures contained in the MOA discussed below.

Identified Cultural Resources

Yerba Buena Island. On Yerba Buena Island, Navy property suitable for transfer contains the following Navy structures that are listed in or eligible for listing in the NRHP: the Torpedo Building (Building 262), the Senior Officers Quarters Historic District, which consists of Quarters 1 through 7, three garages (Buildings 83, 205, and 230), and the associated landscaping elements. Quarters 1, the Nimitz House, was listed in the NRHP in 1991. Landscaping elements and the setting of the properties are considered qualities that contribute to the significance of the structures. In addition to these properties, there are areas on the island that have been identified as archaeologically sensitive zones. These areas could contain unrecorded sites below the ground surface or underwater adjacent to the island. Sites in these areas may be discovered during construction or some other activity requiring deep excavations (see Figure 3-3 in section 3.4).

Treasure Island. On Treasure Island, the following Navy structures are listed in or eligible for listing in the NRHP: Building 1 (Administration Building), Building 2 (Hall of Transportation), and Building 3 with Building 111 as a structural element (the former Palace of Fine and Decorative Arts).

The Memorandum of Agreement

Navy must comply with Section 106 of the NHPA, which requires consultation among federal agencies, the SHPO, the ACHP, and other interested parties. Navy and the SHPO have prepared an MOA in order to ensure Section 106 compliance with regard to historic properties (a copy of the signed MOA is included as Appendix H). Compliance with the MOA is intended to ensure that project effects are not significant and that preservation measures are implemented. The MOA includes preservation provisions concerning Navy actions prior to disposal and long-term preservation plans following Navy disposal. For example, upon conveyance all historic properties identified in the MOA shall be subject to the City of San Francisco Planning Code, Article 10, Preservation of Historical, Architectural, and Aesthetic Landmarks. Signatories to the MOA include Navy and the SHPO. Following an invitation to participate, the ACHP has declined their opportunity to comment. The City and County of San Francisco is included as an invited signatory. The Bay Band of Miwok Indians, the California Preservation Foundation, and the San Francisco Historic Architecture Heritage (society) are included as concurring parties.

4.4.1 Alternative 1

The proposed reuse for the NRHP-listed and NRHP-eligible buildings under Alternatives 1-3 is summarized in Table 4.4-1.

Table 4.4-1. Reuse Plans for NRHP-listed and NRHP-eligible Buildings on NSTI

Property	*Alternative 1*	*Alternative 2*	*Alternative 3*
Senior Officers Quarters Historic District, Yerba Buena Island	Conference/reception/ restaurant, possible residential	Conference/reception/ restaurant, possible residential	Conference/reception/ restaurant, possible residential
Torpedo Building (Building 262), Yerba Buena Island	Residential live/work units	Restaurant	Restaurant
Building 1, Treasure Island	Mixed use, including museum, office, retail	Mixed use, including museum	Mixed use, including museum
Building 2, Treasure Island	Film production	Demolition for construction of themed attraction	Film production
Building 3 (including related Building 111), Treasure Island	Film production	Demolition for construction of themed attraction	Film production

Source: San Francisco 1996e

Not Significant Impacts

Loss of potentially significant historic resources (Factor 1). To accommodate planned reuse of historic properties, as described in Table 4.4-1, the buildings would likely need to be rehabilitated. Alternative 1 would include a substantial level of rehabilitation and construction on Treasure Island. Construction in the vicinity of the historic properties at NSTI, particularly Building 1, Building 2, and Building 3/111, may be out of character with the historic buildings

and their setting and could have an adverse effect on these properties. Although the proposed themed attraction may restore Building 1, Building 2, and Building 3/111, such construction could alter the character-defining features of Treasure Island (i.e., the setting in which these historic properties are located).

The prepared MOA requires that any rehabilitation work performed prior to final Navy disposal conform to the Secretary of the Interior's *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings* (US Department of the Interior 1996). Following Navy disposal, the MOA stipulates that the properties would be subject to San Francisco Planning Code, Article 10, Preservation of Historical and Aesthetic Landmarks, to insure long-term protection of the properties and their setting. The impact, therefore, would not be significant.

Loss of potentially significant archaeological resources (Factor 2). Implementing Alternative 1 could result in the repair, relocation, or construction of supporting infrastructure on Yerba Buena Island in archaeologically sensitive zones (Figure 3-3). The MOA identifies required measures to guard against the potential loss of important information about the prehistoric or historic occupation of the island and for the unexpected discovery of archaeological remains. Implementing the MOA would insure that archaeological resources would not be significantly affected.

4.4.2 Alternative 2

A summary of the proposed reuse for the NRHP-listed and NRHP-eligible buildings under Alternative 2 appears in Table 4.4-1.

Significant and Not Mitigable Impact

Impact: Demolition of historic resources (Factor 1). Alternative 2 involves the demolition of Building 2 and Building 3 on Treasure Island, both of which are eligible for listing on the NRHP. This demolition would result in the loss of significant historic resources.

Mitigation. This adverse effect can be lessened by recording the affected resources to the standards of either the Historic American Buildings Survey (HABS) or the Historic American Engineering Record (HAER). HABS/HAER recordation would reduce but would not eliminate the adverse effect caused by demolishing NRHP-eligible resources. Available mitigation measures, short of preservation, would not reduce impacts of demolition below the threshold of significance. This mitigation measure is consistent with recordation requirements stipulated by the MOA.

Not Significant Impacts

Loss of potentially significant historic resources (Factor 1). Alternative 2 proposes alteration of historic properties for reuse, as described in Table 4.4-1, construction in the vicinity of the historic properties, or deterioration of vacant buildings after transfer. As described above for Alternative 1, the MOA requires that any rehabilitation work performed or any construction in the vicinity of historic structures prior to Navy disposal conform to the Secretary of the Interior's *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings* (US Department of the Interior 1996).

Following Navy disposal, the MOA stipulates that the properties would be subject to San Francisco Planning Code, Article 10, Preservation of Historical and Aesthetic Landmarks, to insure long-term protection and historically appropriate rehabilitation of the structures and their setting. Following provisions in the MOA, rehabilitation of historic properties would not constitute a significant impact.

Loss of potentially significant archaeological resources (Factor 2). Implementing Alternative 2 could result in the repair, relocation, or construction of supporting infrastructure on Yerba Buena Island in archaeologically sensitive zones (Figure 3-3). The MOA identifies measures that guard against the potential loss of important information about the prehistoric or historic occupation of the island and for the unexpected discovery of archaeological remains. Implementing the MOA would insure that archaeological resources would not be significantly affected.

4.4.3 Alternative 3

A summary of the proposed reuse for the NRHP-listed and NRHP-eligible buildings under Alternative 3 appears in Table 4.4-1. The projected reuse of NRHP-listed or NRHP-eligible buildings would be identical to that of Alternative 1, although on a smaller scale.

Not Significant Impacts

Loss of potentially significant historic resources (Factor 1). Similar to Alternative 1, Alternative 3 proposes alteration of historic properties for reuse, as described in Table 4.4-1, construction in the vicinity of the historic properties that affects the character of those properties, or deterioration of vacant buildings after transfer. As described above for Alternative 1, the prepared MOA requires that any rehabilitation work performed or any construction in the vicinity of historic structures prior to Navy disposal conform to the Secretary of the Interior's *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings* (US Department of the Interior 1996).

Following Navy disposal, the MOA stipulates that the properties would be subject to San Francisco Planning Code, Article 10, Preservation of Historical and Aesthetic Landmarks. Article 10, which includes preservation measures that protect the character of historic districts. The MOA ensures that potential reuse activities would not result in construction that diminishes the character of historic resources.

Loss of potentially significant archaeological resources (Factor 2). Similar to Alternative 1, implementing Alternative 3 could result in the repair, relocation, or construction of supporting infrastructure on Yerba Buena Island in archaeologically sensitive zones (Figure 3-3). The MOA identifies measures that guard against the potential loss of important information about the prehistoric or historic occupation of the island and for the unexpected discovery of archaeological remains. Following the measures within the MOA would eliminate any potential significant impacts.

4.4.4 No Action Alternative

Deterioration of historic property and archaeologically sensitive areas (Factors 1 and 2). The No Action Alternative would be a continuation of the caretaker status of NSTI surplus property.

There would be minimal use of the property and facilities under this alternative. Ongoing activities would include maintenance to minimize deterioration and essential security operations. No structures would be demolished or reused, and NRHP-listed and NRHP-eligible buildings would not be affected. Archaeologically sensitive areas would remain under the control and jurisdiction of Navy and would be afforded the protection of federal historic and archaeological preservation laws and regulations.

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4.5 TRANSPORTATION

Potential transportation impacts resulting from disposal and reuse of NSTI are discussed in this section. Potential impacts are characterized by the changes in the movement of vehicles on freeways, ramps, and intersections, changes in demand for transit services, changes in delivery and loading operations (truck traffic), parking availability, and emergency access on and off the site. A summary of the transportation features assumed for the reuse alternatives is included in Appendix F.3-B. Factors considered in determining whether an alternative would have a significant transportation, traffic, and circulation impact included the extent or degree to which its implementation would:

1. Exceed the capacity of on- and off-ramps, cause LOS at intersections and freeway mainline segments to deteriorate from LOS A through D to LOS E or F, cause LOS to deteriorate from LOS E to LOS F, or increase congestion at intersections currently operating at (or anticipated to operate at) LOS F (San Francisco 2000);
2. Increase demand on public transportation in excess of planned or anticipated capacity at time of increase;
3. Increase demand for bicycle and pedestrian facilities in excess of planned or anticipated capacity at time of increase;
4. Increase truck traffic;
5. Result in parking demand exceeding the supply; or
6. Impede emergency access on or off the site.

Traffic Analysis Methodology

Traffic impacts of the reuse alternatives are described for 2010, which is representative of year 2015 conditions (the assumed build out year for all the reuse alternatives). The year 2010 was selected since it is a common benchmark for long-range planning by regional agencies such as ABAG and MTC, including planning for regional transportation improvements. The MTC has developed forecasts of year 2010 travel demand based on anticipated land use and demographic patterns developed by ABAG (Projections '94), and the planned and funded transportation improvements identified by the nine Bay Area counties, Caltrans and MTC. An update of the year 2025 conditions is presented in Appendix F.3-A.

NSTI is connected to the region by only one route—the SFOBB/I-80. SFOBB/I-80 traffic volumes are controlled by metering lights in the westbound approach and are constrained by the number of traffic lanes on the SFOBB in the eastbound approach. Further, as described in section 3.5.2, the SFOBB has operated and is expected to continue to operate at capacity during peak periods. (The SFOBB replacement alternative may improve traffic operations but congestion is unlikely to be affected [Caltrans and FHWA 2000]). Therefore, traffic at NSTI would not be substantially affected by changes in the regional growth or transportation systems and so, the established regional growth and transportation projections for 2010 are therefore taken to be an accurate representation of year 2015 conditions (see Appendix F.3-B, Future Travel Forecasts).

Typical traffic conditions were evaluated for weekday A.M. and P.M. peak hours (during the morning and evening commute periods). In addition, because some of the reuse alternatives would generate a large amount of weekend traffic and because the SFOBB has high traffic volumes during the weekend midday period, the weekend midday peak hour also was evaluated.

Impacts from each reuse alternative to SFOBB/I-80 freeway operations and local intersections on Treasure Island were determined by the increase in delay caused by the addition of reuse-generated traffic. Impacts on SFOBB/I-80 operations were evaluated using the FREQ11 freeway travel operations model. Impacts at local intersections were evaluated using the TRAFFIX software program, which incorporates methodologies from the 1994 update to the Highway Capacity Manual (Transportation Research Board 1994). Traffic impacts at the SFOBB ramps were evaluated by comparing projected demand under the reuse alternatives (expressed in number of vph) to existing ramp capacity and queuing. The SFOBB East Span is currently under construction. As a part of this project, the eastbound on-ramp on the east side of the tunnel will be reconstructed with standard merging distance, and the traffic impact analysis for this ramp incorporates this change.

Traffic impact analyses for closing military installations typically compare traffic conditions for each reuse alternative to baseline traffic conditions (traffic levels at or just prior to the decision to close NSTI [1993]) under projected build out time frames (year 2010). However, because the SFOBB has operated, does operate, and will continue to operate at or above capacity, comparing peak period traffic generated by the reuse alternatives to a traffic condition that combines baseline trip generation for the reuse plan area with projected year 2010 traffic generation in the region would not change either the SFOBB/I-80 mainline or ramp impact analysis or conclusions. The following analysis presents average daily trip (ADT) traffic and peak-hour vehicle-trip volumes for each of the three reuse alternatives and compares these volumes to future (year 2010) background conditions without the project (No Action Alternative). Reuse traffic volumes also are compared to a fully operational baseline (representing conditions at the time of or prior to closure [1993]) for informational purposes. Table 4.5-1 identifies vehicle-trips generated by the three reuse alternatives and a fully operational baseline; these trips form the basis of the transportation impact analysis on the SFOBB/I-80 corridor and its associated ramps.

Future Travel Forecasts

The development of year 2010 travel forecasts used the regional MTC model to identify traffic growth in the region and the land use components of the reuse alternatives to determine travel demand to and from NSTI. A detailed description of the methodology and assumptions is presented in Appendix F.3-B. This approach includes a cumulative impacts assessment for 2010, taking into account both the growth expected at NSTI and the growth forecasts for San Francisco and the Bay Area.

Table 4.5-1. Estimated NSTI Vehicle-trip Generation[1] Weekday Daily, A.M. and P.M. Peak Hour (2010)[2]

	1993 Existing (Operational Baseline)[4]			Alternative 1			Alternative 2			Alternative 3		
	Weekday Daily	*A.M. Peak Hour*	*P.M. Peak Hour*	*Weekday Daily*	*A.M. Peak Hour*	*P.M. Peak Hour*	*Weekday Daily*	*A.M. Peak Hour*	*P.M. Peak Hour*	*Weekday Daily*	*A.M. Peak Hour*	*P.M. Peak Hour*
Total Vehicle Trips[3]	6,480	442	475	10,525	960	1,555	6,140	385	775	5,390	610	800

1 Includes inbound and outbound trips. Does not include vehicle-trips for persons arriving at ferry terminals in San Francisco and the East Bay by auto (see Tables 4.5-2 and 4.5-3 for total vehicle-trip numbers).

2 The A.M. peak hour of 8:00 to 9:00 A.M. occurs within the A.M. peak period of 6:00 to 9:00 A.M. The P.M. peak hour of 5:00 to 6:00 P.M. occurs within the P.M. peak period of 3:00 to 7:00 P.M.

3 Total vehicle-trips do not include any internal trips since they would be walking, bicycle, or shuttle trips.

4 Trips are presented for 6:00 A.M. to 6:00 P.M. period.

Source: DON 1997d; DON 1986.

4.5.1 Alternative 1

Vehicle Trips

Weekday and weekend vehicle-trips projected to be generated in 2010 under Alternative 1 are shown in Tables 4.5-2 and 4.5-3, respectively. This alternative is estimated to generate approximately 960 vehicle-trips during the weekday A.M. peak hour, 1,555 vehicle-trips during the weekday P.M. peak hour, and 1,440 vehicle-trips during the weekend midday peak hour. Vehicle-trips would be by private auto, carpool vehicles, taxis, limousines, vanpools, and buses, including tour buses and public transit buses. In comparison, there were approximately 442 vehicle-trips during the weekday A.M. peak hour and 475 vehicle-trips during the weekday P.M. peak hour under fully operational baseline conditions (Table 4.5-2).

Significant and Mitigable Impacts

Impact: Increased volumes and queuing on two SFOBB/I-80 Yerba Buena Island ramps (Factor 1). Alternative 1 would result in traffic volumes that exceed the capacities of two ramps: the SFOBB/I-80 Yerba Buena Island westbound on-ramp on the west side of Yerba Buena Island, and the eastbound off-ramp on the west side of Yerba Buena Island. The remainder of the on- and off-ramps would operate within their given capacities, as discussed below under Not Significant Impacts. Figure 3-5 in section 3.5 shows on- and off-ramp locations, while Table 4.5-4 summarizes ramp volumes and queuing. The ramps are discussed separately below.

SFOBB/I-80 Yerba Buena Island westbound on-ramp (west side). The projected traffic demands during the A.M., P.M., and weekend midday peak hours would exceed the current ramp capacity of 330 vph. The projected demands on the westbound on-ramp

Table 4.5-2
Estimated Vehicle-trip Generation by Travel Mode[1]
Weekday Daily, A.M. and P.M. Peak Hour (2010)[2]

Mode	*Alternative 1*			*Alternative 2*			*Alternative 3*		
	Daily	**A.M.**	**P.M.**	**Daily**	**A.M.**	**P.M.**	**Daily**	**A.M.**	**P.M.**
Auto	9,210	875	1,390	5,200	330	660	4,790	545	715
Vanpool/Other	995	60	120	700	45	85	470	50	65
Bus	320	25	45	240	10	30	130	15	20
Total NSTI Vehicle-trips	***10,525***	***960***	***1,555***	***6,140***	***385***	***775***	***5,390***	***610***	***800***
Auto trips to Ferry Terminals[3]	7,575	450	975	6,945	150	900	1,310	100	175
Total Vehicle-trips [4]	***18,100***	***1,140***	***2,530***	***13,085***	***535***	***1,675***	***6,700***	***710***	***975***

[1] Includes inbound and outbound trips.

[2] The A.M. peak hour of 8:00 to 9:00 A.M. occurs within the A.M. peak period of 6:00 to 9:00 A.M. The P.M. peak hour of 5:00 to 6:00 P.M. occurs within the P.M. peak period of 3:00 to 7:00 P.M.

[3] Ferry vehicle-trips include persons arriving at ferry terminals in San Francisco and the East Bay by auto.

[4] Total vehicle-trips do not include any internal trips since they would be walking, bicycle, or shuttle trips.

Source: DON 1997d.

Table 4.5-3
Estimated Vehicle-trip Generation by Travel Mode[1]
Weekend Daily and Midday Peak Hour (2010)[2]

Mode	*Alternative 1*		*Alternative 2*		*Alternative 3*	
	Daily	**Midday**	**Daily**	**Midday**	**Daily**	**Midday**
Auto	7,795	1,300	6,210	670	5,340	695
Vanpool/Other	980	100	1,020	85	745	55
Bus	295	40	275	30	155	20
Total NSTI Vehicle-trips	***9,070***	***1,440***	***7,505***	***785***	***6,240***	***770***
Auto trips to Ferry Terminals[3]	6,465	780	6,830	820	1,210	130
Total Vehicle-trips[4]	***15,535***	***2,220***	***14,335***	***1,605***	***7,450***	***900***

[1] Includes inbound and outbound trips.

[2] The midday peak hour of 12:00 to 1:00 P.M. occurs within the midday peak period of 10:00 A.M. to 1:00 P.M..

[3] Ferry vehicle-trips include persons arriving at ferry terminals in San Francisco and the East Bay by auto.

[4] Total vehicle-trips do not include any internal trips since they would be walking, bicycle or shuttle trips.

Source: DON 1997d.

Table 4.5-4
SFOBB/I-80 Yerba Buena Island Ramp Demand Volumes and Maximum Queue
Existing and Year 2010 Weekday and Weekend Peak Hour Conditions

Peak Hour/Ramp[3]	*1993 Existing (Operational Baseline)*		*2010 Background Conditions (No Action)*		*2010 Alternative 1*		*2010 Alternative 2*		*2010 Alternative 3*	
	Volume	**Queue**[4]	**Volume**	**Queue**[4]	**Volume**	**Queue**[4]	**Volume**	**Queue**[4]	**Volume**	**Queue**[4]
Weekday A.M. Peak Hour										
westbound on-ramp[1] (east side)	40	--	15	--	145	--	40	--	75	--
westbound on-ramp[2] (west side)	90	--	35	--	335	7	90	--	170	--
westbound off-ramp (east side)	190	--	45	--	160	--	145	--	160	--
eastbound on-ramp (east side)	215	--	80	--	300	--	135	--	190	--
eastbound off-ramp (west side)	120	--	95	--	235	--	205	--	235	--
eastbound off-ramp (east side)	20	--	5	--	145	--	135	--	145	--
Total ramp volumes	***675***		***275***		***1,320***		***750***		***975***	
Weekday P.M. Peak Hour										
westbound on-ramp (east side)	25	--	15	--	85	--	70	--	65	--
westbound on-ramp (west side)	135	--	60	--	355	22	295	--	270	--
westbound off-ramp (east side)	240	--	35	--	375	--	145	--	160	--
eastbound on-ramp (east side)	250	--	80	--	300	--	275	--	250	--

Table 4.5-4
SFOBB/I-80 Yerba Buena Island Ramp Demand Volumes and Maximum Queue
Existing and Year 2010 Weekday and Weekend Peak Hour Conditions
(continued)

Peak Hour/Ramp[3]	*1993 Existing (Operational Baseline)*		*2010 Background Conditions (No Action)*		*2010 Alternative 1*		*2010 Alternative 2*		*2010 Alternative 3*	
	Volume	**Queue**[4]	**Volume**	**Queue**[4]	**Volume**	**Queue**[4]	**Volume**	**Queue**[4]	**Volume**	**Queue**[4]
Weekday P.M. Peak Hour (continued)										
eastbound off-ramp (west side)	60	--	55	--	535	36	190	--	240	--
eastbound off-ramp (east side)	20	--	5	--	145	--	45	--	60	--
Total ramp volumes	***730***		***250***		***1,795***		***1,020***		***1,045***	
Weekend Midday Peak Hour										
westbound on-ramp (east side)	20	--	15	--	195	--	90	--	110	--
westbound on-ramp (west side)	125	--	35	--	570	239	260	--	320	--
westbound off-ramp (east side)	130	--	45	--	175	--	150	--	100	--
eastbound on-ramp (east side)	155	--	80	--	480	--	295	--	320	--
eastbound off-ramp (west side)	75	--	95	--	230	--	210	--	160	--
eastbound off-ramp (east side)	20	--	5	--	60	--	50	--	30	--
Total ramp volumes	***525***		***275***		***1,710***		***1,055***		***1,040***	

[1] Ramp located east of Yerba Buena Island tunnel.

[2] Ramp located west of Yerba Buena Island tunnel.

[3] Maximum on-ramp capacity = 330 vehicles per hour per ramp; Maximum off-ramp capacity = 500 vehicles per hour per ramp. Total on-ramp capacity = 990 vehicles per hour and total off-ramp capacity = 1,500 vehicles per hour.

[4] Number of vehicles.

Source: DON 1997d.

west of the Yerba Buena Island tunnel would result in a queue of 7 vehicles during the A.M. peak hour, 22 vehicles during the P.M. peak hour, and 239 vehicles during the weekend midday peak hour. A queue of 239 vehicles would be approximately 4,800 feet (1,463 m) in length and would constrain vehicular and bus movements throughout Yerba Buena Island and onto Treasure Island. The wait time for vehicles in a queue of this length would be substantial. This would be a significant and mitigable impact.

Mitigation. The following mitigation measures are recommended:

- As described in section 3.5, the SFOBB/I-80 Yerba Buena Island on-ramps are substandard by current Caltrans standards, primarily in acceleration/deceleration lengths, ramp radii, and sight distances. Upgrading the on-ramps would increase ramp capacity and level of operation and decrease queuing impacts. However, upgrades to the on-ramps may be constrained by the geology of the site (elevation change and bedrock) and structural limitations due to the viaduct. Implement measures, including signage and notices to residents, to encourage residents and visitors to use the second westbound on-ramp east of the Yerba Buena Island tunnel. These measures would reduce the queue at most times of the day and week except for the weekend midday peak hour.
- Redirecting traffic during the weekend midday peak hour to the second on-ramp east of the Yerba Buena Island tunnel could reduce the queue at the first westbound on-ramp from 4,800 feet to approximately 3,225 feet (977 m). A queue of this length still would extend beyond the Treasure Island Road southbound "Y" split and the intersection of Macalla Road and Treasure Island Road but would not extend to the Treasure Island Main Gate. Mitigation measures to reduce the volume of ramp traffic and thus further reduce the queue length are described below.
- Implement a Travel Demand Management (TDM) program to further reduce traffic generation during peak hours, especially during weekend peak hours. TDM measures encourage individuals to travel during off-peak times or to use alternative means of transportation to reduce the number of vehicles on area roadways during high-volume periods. TDM measures may include flextime, employer-provided shuttles, subsidy of transit services, limiting available visitor parking, and implementing tolls (see TDM assumptions described in Appendix F.3-B). Based on nationwide averages, aggressively implemented TDM measures are anticipated to reduce traffic volumes on these on-ramps by between 6 and 12 percent during the weekday A.M. and P.M. peak hour commute times.
- Implement additional or enhanced TDM measures, such as discounted ferry passes, flex-time, public relations campaigns, and giving employees working on Treasure Island or Yerba Buena Island preferential access to housing on NSTI, to encourage ferry use or to encourage vehicle-trips during the nonpeak period to reduce queues on both westbound on-ramps to tolerable levels.
- Monitor NSTI ramp traffic volumes to ensure that the transportation goals and objectives established by the Draft Reuse Plan are successfully implemented. Monitoring traffic volumes would inform San Francisco whether westbound on-ramp traffic demand would reach capacity at each phase of development. If at some point it is

determined that demand on the westbound on-ramps would approach capacity, either more aggressive TDM and transit improvements must be implemented or additional developments should be delayed until such improvements are implemented.

- Monitor NSTI bus transit demand on an annual basis (or at each phase of development) and ensure that planned services are implemented to meet or exceed demand. If the results of this monitoring program indicate that there is an imbalance between transit service and demand, the planned land use development on NSTI could be limited by San Francisco (which has permit approval authority) until required services are funded and implemented. Limiting land use development at NSTI would ensure that major development would not occur until adequate transit service is provided. Implement a similar monitoring program for ferry demand.
- Restripe the portion of Treasure Island Road between the Main Gate and the westbound on-ramp on the west side of the Yerba Buena Island tunnel from two lanes to accommodate three traffic lanes. The narrowest segment of the roadway is approximately 32.5 feet (9.9 m) wide and could accommodate three 10-foot (3-m) lanes, one in the northbound direction (inbound to Treasure Island) and two in the southbound direction (outbound from Treasure Island). Reconfiguring this portion of Treasure Island Road to accommodate two southbound lanes would ensure that southbound vehicles traveling to the southern half of Yerba Buena Island would not be impeded by vehicles queuing to enter the westbound on-ramp on the west side of the tunnel.

Implementing all of these measures would reduce this impact to a not significant level.

SFOBB/I-80 Yerba Buena Island eastbound off-ramp (west side). The projected traffic increase during the P.M. peak hour would exceed the current ramp capacity of 500 vph. The projected demand of 535 vph would result in a maximum queue of 36 vehicles, or about 720 feet (219 m) on the SFOBB. This could result in a significant impact if vehicles destined to exit the SFOBB/I-80 were to queue along the left (fast-moving) lane of the freeway. This would be a significant and mitigable impact.

Mitigation. The following mitigation measures are recommended:

- Use traffic control measures, such as signage, to encourage eastbound motorists to use the second Yerba Buena off-ramp (the off-ramp on the east side of Yerba Buena Island). By shifting demand to the off-ramp on the east side of Yerba Buena Island, projected traffic volumes on each off-ramp could be reduced to approximately 340 vph, well below the off-ramp capacities of 500 and 560 vph for the west side and east side off-ramps, respectively.
- Implement TDM and monitoring measures to reduce traffic volumes on this off-ramp by between 6 and 12 percent, as described above for increased volumes on the westbound on-ramp on the west side of Yerba Buena Island. Even without shifting demand to the eastbound off-ramp on the east side of Yerba Buena Island, this level of decrease by TDM measures would lower traffic volumes on the eastbound off-ramp on the west side of the tunnel to between approximately 503 and 471 vph. These reduced traffic volumes would slightly exceed or be below the off-ramp capacity of 500 vph and would not substantially constrain access to NSTI or substantially affect SFOBB traffic operations.

Implementing both of these measures would reduce this impact to a not significant level.

Impact: Increased volume on SFOBB/I-80 Yerba Buena Island eastbound on-ramp (east side) (Factor 1). The eastbound on-ramp on the east side of the tunnel will be upgraded as part of the SFOBB East Span project. This ramp upgrade would significantly increase the ramp capacity from the current 330 vph to approximately 900 vph, and, therefore, could accommodate the projected demand in number of vehicles getting onto SFOBB East Span. While this ramp upgrade could significantly reduce queuing impacts, it could potentially cause a secondary impact in terms of potential impacts on SFOBB mainline operation.

Mitigation. Caltrans should consider the installation of a ramp metering devise on this ramp in the future. A ramp metering devise would restrict the number of vehicles getting on the SFOBB for the benefits of maintaining free flow conditions on the SFOBB.

Impact: Increased peak spreading on SFOBB/I-80 (Factor 1). Under Alternative 1, increased traffic onto and off of the SFOBB during the A.M. peak period (6:30 to 9:30) and P.M. peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS F during the last hour of the A.M. peak period (8:30 to 9:30) and to deteriorate from LOS B to LOS E or LOS F during the first hour of the P.M. peak period (3:30 to 4:30) (Table F-22). The increase in other connecting regional freeways would likely be less.

Mitigation. Monitor traffic volumes to ensure that the transportation goals and objectives established by the Draft Reuse Plan are successfully implemented. Monitoring traffic volumes would inform San Francisco whether traffic onto or off of the SFOBB at each phase of development is resulting in deterioration of traffic conditions on the SFOBB. If at some point it is determined that traffic from NSTI is constraining the capacity of the SFOBB, either more aggressive TDM and transit improvements must be implemented or additional developments should be delayed until such improvements are implemented. Implementing this mitigation measure would reduce this impact to a not significant level.

Impact: Transit operations – bus service to East Bay (Factor 2). Lack of direct bus service between NSTI and the East Bay is a significant and mitigable impact (bus service between San Francisco and Treasure Island is provided by MUNI). Approximately 4,290 weekday daily and approximately 4,000 weekend daily bus transit patrons are estimated between NSTI and the East Bay (Table 4.5-5). Without direct service, bus patrons would be required to travel to San Francisco using the MUNI service, and transfer at the Transbay Terminal to AC Transit service to the East Bay or to drive, which would add to the vehicular demand and congestion at the Yerba Buena Island ramps and would be a significant and mitigable impact.

Mitigation. The following mitigation measures are recommended:

- Establishing direct transit service between NSTI and the East Bay would mitigate this impact to a not significant level. To meet the estimated demand, bus service for Alternative 1 would need to be at 10-minute headways (the interval between the trips of

Table 4.5-5
Estimated Bus Transit Person-Trips
Weekday and Weekend Conditions

Origin/Destination	*Alternative 1*			*Alternative 2*			*Alternative 3*		
Weekday Conditions	**Daily**	**A.M.**	**P.M.**	**Daily**	**A.M.**	**P.M.**	**Daily**	**A.M.**	**P.M.**
San Francisco[1]	5,310	440	750	3,620	135	460	2,140	240	325
East Bay	4,290	260	530	3,480	150	450	1,785	190	260
Total	***9,600***	***700***	***1,280***	***7,100***	***285***	***910***	***3,925***	***430***	***585***
Weekend Conditions	**Daily**		**Midday**	**Daily**		**Midday**	**Daily**		**Midday**
San Francisco[1]	4,760		670	3,960		455	2,255		300
East Bay	4,000		440	4,210		420	2,395		210
Total	***8,760***		***1,110***	***8,170***		***875***	***4,650***		***510***

[1]Transit trips from the South Bay and North Bay included with San Francisco.

Source: DON 1997d.

2 successive vehicles) throughout the day during the weekday and at 15-minute headways throughout the day during the weekend.

- Monitor NSTI bus transit demand on an annual basis (or at each phase of development) and ensure that planned services are implemented to meet or exceed demand. If the results of this monitoring program indicate that there is an imbalance between transit service and demand, the planned land use development on NSTI could be limited by San Francisco (which has permit approval authority) until required services are funded and implemented. Limiting land use development at NSTI would ensure that major development would not occur until adequate transit service is provided. Implement a similar monitoring program for ferry demand.
- Implement TDM measures to encourage transit rather than auto use. Such measures include placing limits on parking and tolls (see TDM assumptions described in Appendix F.3-B). Additional TDM measures, such as discounted ferry passes, public relations campaigns, and housing preferences for NSTI employees, are described under the mitigation for increased volumes on the SFOBB/I-80 westbound on-ramp and eastbound off-ramp west of Yerba Buena Island.

Implementing all of these measures would reduce this impact to a not significant level.

Not Significant Impacts

SFOBB/I-80 operations (Factor 1). Access to the SFOBB/I-80 from the East Bay at the toll plaza metering lights and from San Francisco at the approach to the SFOBB would remain constrained. Traffic volumes and operating conditions in 2010 are anticipated to be similar to both fully operational base conditions and future year 2010 background conditions (No Action Alternative) and are therefore considered not significant (Table 4.5-6). Since the SFOBB westbound traffic volumes are controlled by signal lights west of the toll booth, westbound traffic volumes on the bridge structure would not change (the metering lights only allow a sufficient number of vehicles on the bridge to have a free flow operation) regardless of what level of development occurs at Treasure Island.

Other ramp operations (Factor 1). The vehicle-trips generated by Alternative 1 would increase ramp volumes (Table 4.5-4). Except for the westbound on-ramp (west of Yerba Buena Island) and eastbound off-ramp (west of Yerba Buena Island), all other on- and off-ramps would operate with the ramp demand less than the capacity during the weekday peak hour conditions and would therefore not result in any significant queuing impacts.

Delivery/goods movement/loading (Factor 4). A guiding policy of the Draft Reuse Plan is to limit truck service and freight delivery to off-peak hours (generally between 10:00 A.M. and 3:00 P.M. and after 7:00 P.M. on weekdays). It is estimated that Alternative 1 typically would generate approximately 57 service and freight delivery trips (18 inbound and 39 outbound) during the A.M. peak hour and 39 service and freight delivery trips (24 inbound and 15 outbound) during the P.M. peak hour. Since service and delivery vehicles would occur during the off-peak hours to reduce potential conflicts with peak period SFOBB/I-80 traffic, increases in truck traffic would not result in a significant impact.

Table 4.5-6
SFOBB/I-80 Operations
Existing and Year 2010 Weekday and Weekend Peak Hour Conditions

Peak Hour/Direction	*Existing (Operational Base)*		*2010 Background Conditions (No Action)*		*2010 Alternative 1*		*2010 Alternative 2*		*2010 Alternative 3*	
	Speed[3]	**LOS[4]**	**Speed[3]**	**LOS[4]**	**Speed[3]**	**LOS[4]**	**Speed[3]**	**LOS[4]**	**Speed[3]**	**LOS[4]**
Weekday A.M. peak hour[5]										
Eastbound[1]	57	B	57	B	57	B	57	B	57	B
Westbound[2]	45	D	23	F	22	F	23	F	23	F
Weekday P.M. peak hour[6]										
Eastbound[1]	46	D	46	D	46	D	46	D	46	D
Westbound[2]	56	B	18	F	17	F	17	F	17	F
Weekend midday peak hour[7]										
Eastbound[1]	57	B	57	B	56	B	57	B	56	B
Westbound[2]	57	B	57	B	57	B	57	B	57	B

[1]Eastbound SFOBB/I-80 east of Yerba Buena Island tunnel.

[2]Westbound SFOBB/I-80 west of Yerba Buena Island tunnel.

[3]Speed is expressed in miles per hour.

[4]LOS is based on mainline travel speeds, consistent with San Francisco Congestion Management LOS designations.

[5]The A.M. peak hour of 8:00 to 9:00 A.M. occurs within the A.M. peak period of 6:00 to 9:00 A.M..

[6]The P.M. peak hour of 5:00 to 6:00 P.M. occurs within the P.M. peak period of 3:00 to 7:00 P.M..

[7]The midday peak hour of 12:00 to 1:00 P.M. occurs within the midday peak period of 10:00 A.M. to 1:00 P.M..

Note: Degraded operating conditions on the SFOBB/I-80 in 2010 (without reuse) would be attributable to regional growth. The additional vehicle-trips associated with each reuse alternative would contribute to increases in queues at the SFOBB toll plaza, congestion and queues in downtown San Francisco, and in the duration of the peak periods.

Source: DON 1997d.

The eastbound off-ramp at the east side of the Yerba Buena Island tunnel has a 12-foot (3.5-m) height restriction, thereby limiting larger trucks to the off-ramp on the west side of the Yerba Buena Island tunnel. The existing ramp geometry can accommodate any California highway-legal trucks. However, due to the constrained ramp geometries and slower acceleration capabilities of trucks, trucks would take longer to enter the traffic stream than autos. During peak periods, trucks merging with mainline traffic could cause short-term disruptions in traffic flow. Water transportation of goods delivery to NSTI also would be an option. However, unless truck access to NSTI from the SFOBB/I-80 is limited to late night/early morning hours, truckers would likely find ferry access to be inconvenient and expensive. No mitigation is proposed.

Construction activities (Factors 1 and 4). Construction impacts are generally short-term in nature. They usually can be managed through proper phasing, sequencing, and scheduling of the construction activities. However, construction would cause a temporary inconvenience to motorists. Due to the short-term nature of construction-related impacts, they are usually not considered significant. Construction activities on NSTI would include existing roadway work, buildings, the causeway, dike improvements and other seismic work, utility lines, and piers. For each, the following phases generally would or could be included—demolition, excavation, foundation, and for buildings, construction of building structure, and finishing. Construction vehicles would include trucks removing demolition debris and delivering materials and supplies, as well as construction worker vehicles. The volume of construction vehicles accessing NSTI would vary, depending on the specific construction activity and construction schedules for the various components of the alternatives.

Existing ramp geometry would allow all size construction vehicles to enter or exit the SFOBB/I-80 ramps. However, due to the slower acceleration capabilities and larger turning radii, large construction trucks would take longer to enter the SFOBB traffic stream. The additional construction-related traffic would add to traffic at East Bay and San Francisco approaches to the SFOBB and could conflict with SFOBB/I-80 and NSTI traffic; this effect could be reduced by shuttling workers to NSTI from parking areas off of NSTI, such as in San Francisco or the East Bay.

Water transportation of demolition and construction materials could avoid transporting materials on the SFOBB/I-80. There are two possible approaches include a roll-on, roll-off vehicular ferry or a barge. No mitigation is proposed.

Transit operations—ferry and bus service (Factors 2 and 5). This alternative includes a comprehensive transportation program that relies on passenger ferries and buses to transport most residents and visitors between NSTI, San Francisco, and the East Bay. The ferry plan identified for phase three of the Draft Reuse Plan would adequately serve the ferry trip daily demand of approximately 34,635 person-trips on weekdays (Table 4.5-7) and approximately 32,120 person-trips on weekends (Table 4.5-8). The Draft Reuse Plan includes two new ferry terminals (at Candlestick Point in San Francisco and at Golden Gate Fields on the Berkeley/Albany border). The new terminals would provide sufficient capacity to accommodate the ferry demand and would include parking for those ferry patrons arriving by auto. Under Alternative 1, a new ferry terminal would be built on the west side of Treasure Island. Pier 1 would be retrofitted to serve as a ferry landing on the east side of the island.

Table 4.5-7
Estimated Ferry Person-Trips by Mode of Access
Weekday Daily, A.M. and P.M. Peak Hour

Ferry Terminal Location	Alternative 1			Alternative 2			Alternative 3		
	Daily	*A.M.*	*P.M.*	*Daily*	*A.M.*	*P.M.*	*Daily*	*A.M.*	*P.M.*
Transit/Pedestrian Access to Terminal									
Downtown San Francisco/ Ferry Building									
Transit	5,615	535	905	3,955	135	535	3,390	440	595
Pedestrian	6,940	170	635	7,785	95	955	2,545	115	255
Marin County	550	20	60	550	10	70	165	10	20
Candlestick Point	1,450	80	180	1,345	30	170	0	0	0
Jack London Square/Alameda/ Golden Gate Fields	3,020	70	285	3,495	30	435	685	25	70
Total	***17,575***	***875***	***2,065***	***17,130***	***300***	***2,165***	***6,735***	***590***	***940***
Vehicular Access to Terminal									
Downtown San Francisco/ Ferry Building	1,395	80	170	1,305	25	165	655	60	95
Marin County	450	15	50	450	10	60	135	10	15
Candlestick Point	6,150	350	765	5,665	125	715	0	0	0
Jack London Square/Alameda/ Golden Gate Fields	9,065	210	850	10,490	95	1,305	2,055	75	210
Total	***17,060***	***655***	***1,835***	***17,910***	***255***	***2,245***	***2,845***	***145***	***320***
Total Ferry Person-Trips									
Downtown San Francisco/ Ferry Building	13,950	785	1,710	13,045	255	1,655	6,540	615	945
Marin County	1,000	35	110	1,000	20	130	300	20	35
Candlestick Point	7,600	430	945	7,010	155	885	0	0	0
Jack London Square/Alameda/ Golden Gate Fields	12,085	280	1,135	13,985	125	1,740	2,740	100	280
Total	***34,635***	***1,530***	***3,900***	***35,040***	***555***	***4,410***	***9,580***	***735***	***1,260***

Source: DON 1997d.

Table 4.5-8
Estimated Ferry Person-trips by Mode of Access
Weekend Daily and Midday Peak Hour

FERRY TERMINAL LOCATION	ALTERNATIVE 1		ALTERNATIVE 2		ALTERNATIVE 3	
	Daily	*Midday*	*Daily*	*Midday*	*Daily*	*Midday*
TRANSIT/PEDESTRIAN ACCESS TO TERMINAL						
Downtown San Francisco/Ferry Building						
Transit	4,070	770	3,795	475	2,550	465
Pedestrian	7,140	505	8,505	955	155	15
Marin County	525	45	525	65	3,375	225
Candlestick Point	1,285	145	1,395	160	0	0
Jack London Square/Alameda/Golden Gate Fields	3,000	215	3,580	425	730	55
Total	***16,020***	***1,680***	***17,800***	***2,080***	***6,810***	***760***
VEHICULAR ACCESS TO TERMINAL						
Downtown San Francisco/Ferry Building	1,245	140	1,365	160	645	75
Marin County	430	35	430	50	125	10
Candlestick Point	5,430	620	5,835	675	0	0
Jack London Square/Alameda/Golden Gate Fields	8,995	640	10,740	1,270	2,195	160
Total	***16,100***	***1,435***	***18,370***	***2,155***	***2,965***	***245***
TOTAL FERRY PERSON-TRIPS						
Downtown San Francisco/Ferry Building	12,455	1,415	13,665	1,590	6,470	765
Marin County	955	80	955	115	280	25
Candlestick Point	6,715	765	7,230	835	0	0
Jack London Square/Alameda/Golden Gate Fields	11,995	855	14,320	1,695	2,925	215
Total	***32,120***	***3,115***	***36,170***	***4,235***	***9,675***	***1,005***

Source: DON 1997d.

Ferry service also would be provided between NSTI and the Ferry Building in San Francisco and between NSTI and Jack London Square area in Oakland. The ferry terminal at the Ferry Building in downtown San Francisco does not provide dedicated parking for ferry patrons. Under Alternative 1, a daily demand of approximately 540 spaces is estimated (Table 4.5-9). This demand represents daily pick-up/drop-off activities in front of the Ferry Building; it translates into about two to three on-street pick-up and drop-off spaces. Although a substantial supply of parking is available within half a mile (0.8 km) of the Ferry Building (approximately 16,500 off-street spaces on weekdays and approximately 11,500 spaces on weekends within a 7-block radius), these spaces are generally occupied during the weekday. NSTI visitors who would drive to the Ferry Building may not find readily available parking in the vicinity or may not be willing to pay the cost of parking in downtown San Francisco. However, in San Francisco, with its "Transit First" policy, parking shortfalls are not considered significant impacts because ferry patrons could park farther away or could switch travel modes. In practice, existing ferry patrons regularly use public transit from their homes or places of business to access the ferry terminal because parking in San Francisco is scarce and often costly. No mitigation is proposed.

The Jack London Square area in Oakland has approximately 1,110 parking spaces, the Alameda Main Street terminal has approximately 250 parking spaces, and Golden Gate Fields has approximately 5,000 parking spaces (the existing racetrack operates 110 days a year, and parking lots are not completely filled during typical events). If sufficient parking could not be provided at the Jack London Square or Alameda Main Street terminals, the terminal at Golden Gate Fields would need to serve a greater portion of the East Bay demand. Ferry riders driving to the ferry terminals would add to cumulative traffic volumes and congestion in the vicinity of these East Bay terminals (see Chapter 5, Cumulative Projects and Impacts).

The number of transit-trips on bus lines connecting with the ferry terminals would increase. Public transit access to the Ferry Building is via MUNI, Golden Gate Transit, San Mateo County Transit District (SamTrans), BART, and California Train (Caltrain). During the peak periods, the greatest number of additional transit riders destined to the San Francisco Ferry Building would be during the weekday P.M. peak-hour condition, when approximately 905 new trips would be made (Table 4.5-7). Transit access to Candlestick Point would be via MUNI and shuttle buses, with a shuttle between the transit stations and ferry terminals. The weekday P.M. peak-hour trips would be approximately 180 transit-trips to the ferry at Candlestick Point. Access to Jack London Square/Alameda and Golden Gate Fields would be via AC Transit (BART access with an AC Transit connection is also possible to the Jack London Square terminal), with a total of approximately 285 weekday P.M. trips destined to and from both these terminals. In general, the additional transit demand destined to the ferry terminals would be spread over a number of lines and would include inbound and outbound trips.

Approximately 700 bus transit-trips during the weekday A.M. peak, approximately 1,280 trips during the weekday P.M. peak, and about 1,110 trips during the weekend midday peak are estimated for this alternative (Table 4.5-5). Headways (the wait time between two scheduled bus runs) of 10 minutes would be required throughout the day for weekday service to both San Francisco and the East Bay, and 15-minute headways would be required throughout the day during the weekends.

Table 4.5-9
Estimated Parking Demand at Ferry Terminals
Weekday and Weekend Conditions

Ferry Terminal Location	*Alternative 1*	*Alternative 2*	*Alternative 3*
WEEKDAY CONDITIONS (DAILY)			
Downtown SF/Ferry Building[1]	540	345	340
Marin County	190	165	75
Candlestick Point[2]	2,640	1,745	0
Jack London Sq./Alameda/Albany/ Berkeley [3,4]	1,835	1,950	510
Total	***5,205***	***4,205***	***925***
WEEKEND CONDITIONS (DAILY)			
Downtown SF/Ferry Building[1]	365	315	230
Marin County	160	140	65
Candlestick Point [2]	1,815	1,550	0
Jack London Sq./ Alameda/Albany/ Berkeley[3, 4]	1,715	1,940	475
Total	***4,055***	***3,945***	***770***

1 This demand represents needs for pick-up/drop-off activities in front of the Ferry Building. In the San Francisco downtown (bounded by Bryant Street, Second/Sansome, and Broadway) there is a supply of approximately 16,500 off-street parking spaces during the weekday and 11,500 off-street spaces during the weekend. Most of these spaces are occupied by workers and visitors to the area.

2 Candlestick Point currently has approximately 18,000 parking spaces in paved and dirt lots that could be used throughout the week. During twelve days during football games, these parking spaces would not be available for ferry parking.

3 The Jack London Square area has approximately 1,110 parking spaces, and the Alameda Main Street terminal has approximately 250 spaces.

4 Golden Gate Fields on the Albany/Berkeley border has approximately 5,000 parking spaces. The existing horsetrack operates 110 days per year. The parking lots are not completely filled during typical event operations.

Source: DON 1997d.

A condition of the Draft Reuse Plan is that transit service would be provided to accommodate the demand; therefore, transit requirements would not result in a significant impact. Traditionally MUNI has provided services to areas where warranted. Increasing frequency on MUNI line 108, which serves Treasure Island, would require additional funding. MUNI has been subject to increasingly severe funding constraints and thus has limited ability to expand. Without additional funding to pay for further needed service expansion, service may need to be reduced elsewhere in San Francisco or additional funding sources found. The City and County of San Francisco Transportation Commission holds regular public hearings on service modifications. MUNI also prepares short-range transit plans to assess the need for changes in service deployment. Mitigation for transit operations to the East Bay would ensure that major development would not occur until adequate transit service is provided.

Intersection LOS (Factors 1 and 3). Tables 4.5-10 and 4.5-11 present the results of the intersection level of service analysis at the five study intersections within Treasure Island for weekday and weekend conditions, respectively. Under Alternative 1, all five study intersections, except Avenue of Palms/California Street, would operate at LOS A and B during the weekday A.M. and P.M. peak and weekend midday peak hours. Traffic analysis intersections are shown in Figure 4-5. The intersection of Avenue of Palms/California Street would operate at LOS D during the weekday P.M. peak and weekend midday peak hours; LOS D and better are considered acceptable service levels. All intersections would operate as unsignalized intersections.

The intersection of Avenue of Palms/California Street serves as the gateway to Treasure Island; therefore, heavy pedestrian traffic is anticipated at this location. However, projected traffic volumes are not at levels to warrant a traffic signal. This alternative would include sidewalks, crosswalks, and a system of pedestrian and bicycle paths, lanes, and routes. These facilities would allow for convenient and safe travel among the various uses and travel modes on NSTI. A shuttle service, operating between Treasure Island and Yerba Buena Island, would further facilitate internal trips. No mitigation is required.

Parking (Factor 5). Table 4.5-12 presents the parking demand calculations for NSTI. It is estimated that there would be a daily parking demand of approximately 6,820 spaces during the weekday, including about 2,560 nonresidential spaces and 4,260 residential spaces. During the weekend, the total parking demand would be approximately 6,660 spaces (2,300 nonresidential spaces and 4,360 residential spaces). As these estimates show, a substantial portion of the demand would be attributed to the residential component of this alternative.

Alternative 1 would include parking facilities to accommodate the vehicular demand, and approximately 2,560 spaces would need to be provided to accommodate the nonresidential demand during the weekday. Residential parking would be provided, and nonresidential parking would be provided in parking lots.

In San Francisco, which has a "Transit First" policy, parking shortfalls are not considered a significant impact. However, an implementing ordinance would limit the parking demand by encouraging use of transit and discouraging use of private autos. No mitigation is proposed.

Table 4.5-10
Intersection Level of Service—Weekday A.M. and P.M. Peak Hours
2010 Conditions

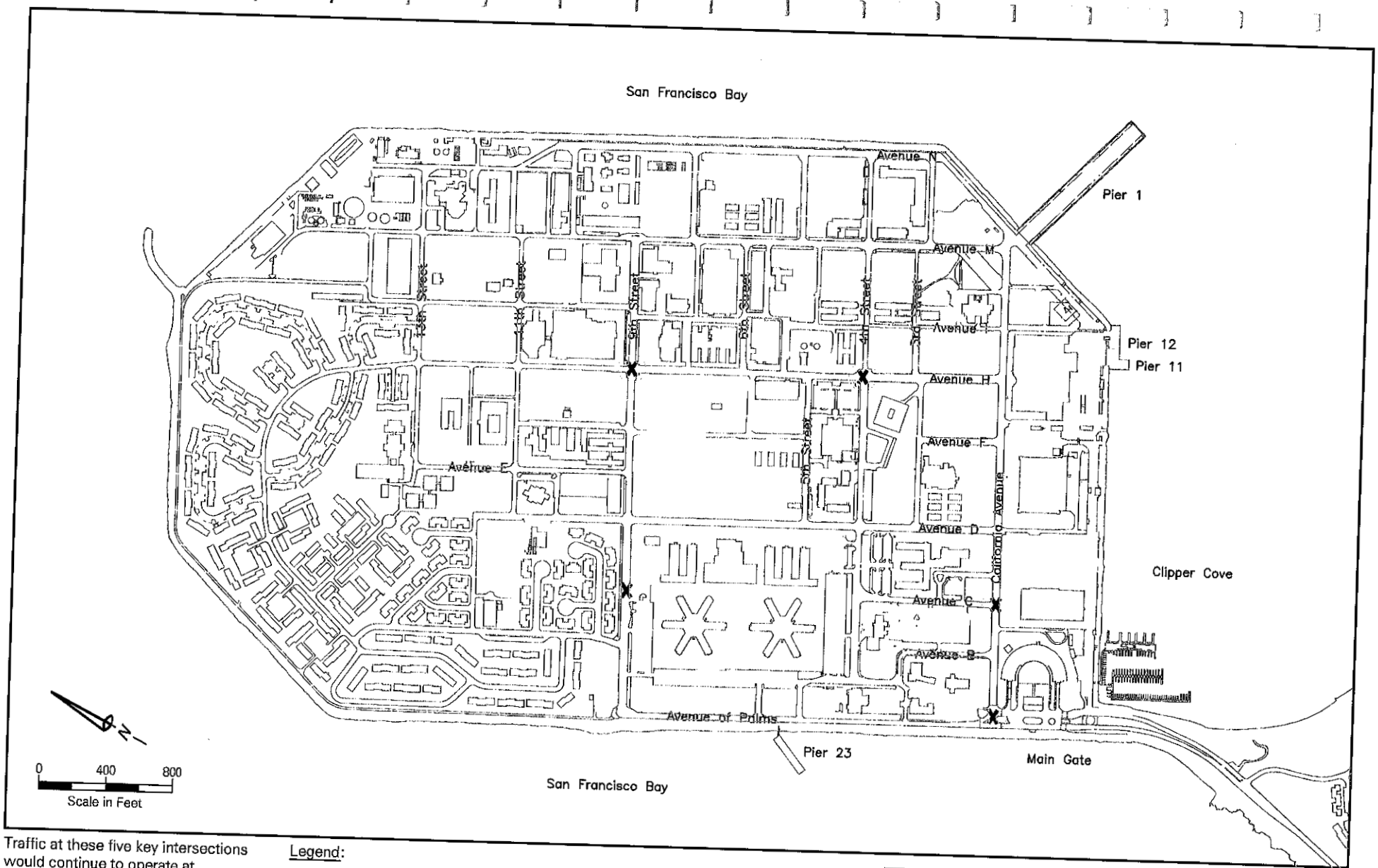
	ALTERNATIVE 1				ALTERNATIVE 2				ALTERNATIVE 3			
	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.	
Study Intersection	***Delay[1]***	***LOS***	***Delay***	***LOS***	***Delay[1]***	***LOS***	***Delay***	***LOS***	***Delay[1]***	***LOS***	***Delay***	***LOS***
Avenue of Palms/ California	6.2	B	28.9	D	0.7	A	3.4	A	2.8	B	3.8	A
Avenue C/California Street	0.1	A	0.9	A	0.1	A	0.0	A	0.1	A	1.2	A
Avenue C/9th Street	0.2	A	2.4	B	0.2	A	0.1	A	0.3	A	2.5	A
Avenue H/4th Street	0.3	A	0.3	B	0.4	A	0.6	A	0.5	A	0.4	A
Avenue H/9th Street	2.5	A	4.5	A	1.1	A	1.3	A	1.2	A	1.2	A

[1] Delay is expressed in seconds per vehicle.
Source: DON 1997d.

Table 4.5-11
Intersection Level of Service—Weekend Midday Peak Hour
2010 Conditions

	ALTERNATIVE 1		ALTERNATIVE 2		ALTERNATIVE 3	
Intersection	*Delay[1]*	*LOS*	*Delay[1]*	*LOS*	*Delay[1]*	*LOS*
Avenue of Palms/California Street	21.9	D	3.4	A	3.5	A
Avenue C/California Street	0.1	A	0.0	A	0.1	A
Avenue C/9th Street	0.2	A	0.2	A	0.5	A
Avenue H/4th Street	0.0	A	0.2	A	0.1	A
Avenue H/9th Street	4.1	A	1.1	A	1.1	A

[1] Delay is expressed in seconds per vehicle.
Source: DON 1997D.



Traffic at these five key intersections would continue to operate at acceptable service levels under Alternative 1.

Legend:

✘ Analysis Intersections

Traffic Analysis Intersections

Treasure Island, California

Figure 4-5

Table 4.5-12
Estimated Parking Demand at NSTI
Weekday and Weekend Conditions

Origin/Destination	*Alternative 1*			*Alternative 2*			*Alternative 3*		
	NONRESIDENTIAL	RESIDENTIAL	TOTAL	NONRESIDENTIAL	RESIDENTIAL	TOTAL	NONRESIDENTIAL	RESIDENTIAL	TOTAL
Weekday Conditions									
Short-term[1]	845	0	845	590	0	590	390	0	390
Long-term	1,715	4,260	5,975	1,355	375	1,730	945	1,710	2,655
Total	*2,560*	*4,260*	*6,820*	*1,945*	*375*	*2,320*	*1,335*	*1,710*	*3,045*
Weekend Conditions									
Short-term[1]	930	0	930	1,045	0	1,045	800	0	800
Long-term	1,370	4,260	5,630	1,025	375	1,400	710	1,710	2,420
Total	*2,300*	*4,260*	*6,560*	*2,070*	*375*	*2,445*	*1,510*	*1,710*	*3,220*

[1] Residential assumes that no short-term parking would be required.

Source: DON 1997d.

Emergency access (Factor 6). A guiding policy of the Draft Reuse Plan is to prepare an emergency response plan for all reuse alternatives to identify critical facilities, roles and responsibilities, and procedures during emergencies. Also, in accordance with the Draft Reuse Plan, an updated emergency response plan (including alternative emergency evacuation scenarios) would be required prior to approving new development. Alternative 1 includes fire stations and medical facilities at NSTI that would handle day-to-day emergencies and participate in larger emergency responses. If emergency evacuation from NSTI could not be made via the SFOBB/I-80, emergency access would be possible by ferry or helicopter. Implementing this plan would assure that there are no significant impacts impeding emergency access to NSTI. No mitigation is proposed.

4.5.2 Alternative 2

Traffic generated on NSTI by Alternative 2 would be 6,140 weekday ADT compared to 10,525 weekday ADT under Alternative 1 (Table 4.5-1). Under Alternative 2, approximately 385 vehicle-trips would be generated during the weekday A.M. peak hour, 775 vehicle-trips during the P.M. peak hour (Table 4.5-2), and 785 vehicle-trips during the weekend midday peak hour (Table 4.5-3). In comparison, there were approximately 442 vehicle-trips during the weekday A.M. peak hour and 475 vehicle-trips during the weekday P.M. peak hour under fully operational base conditions (Table 4.5-1). There would be more trips during the P.M. peak hour and fewer trips during the A.M. peak hour, compared to fully operational base conditions, because the type of reuse land uses (i.e., fewer housing units and jobs and more recreational land use) would generate fewer trips. The number of daily and peak-hour vehicle-trips generated by Alternative 2 would be less than the number generated by Alternative 1.

Significant and Mitigable Impact

Impact: Increased peak spreading on SFOBB/I-80 (Factor 1). Under Alternative 2, increased traffic onto and off of the SFOBB during the A.M. peak period (6:30 to 9:30) and P.M. peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS E or LOS F during the last hour of the A.M. peak period (8:30 to 9:30) and to deteriorate from LOS B to LOS E or LOS F during the first hour of the P.M. peak period (3:30 to 4:30) (Table F-22). The increase in other connecting regional freeways would likely be less.

Mitigation. Monitor traffic volumes to ensure that the transportation goals and objectives established by the Draft Reuse Plan are successfully implemented. Monitoring traffic volumes would inform San Francisco whether traffic onto or off of the SFOBB at each phase of development is resulting in deterioration of traffic conditions on the SFOBB. If at some point it is determined that traffic from NSTI is constraining the capacity of the SFOBB, either more aggressive TDM and transit improvements must be implemented or additional developments should be delayed until such improvements are implemented. Implementing this mitigation measure would reduce this impact to a not significant level.

Impact: Transit operations – bus service to East Bay (Factor 2). Approximately 3,480 weekday daily and approximately 4,210 weekend daily bus transit patrons are estimated between NSTI and the East Bay under Alternative 2 (Table 4.5-5). The impact associated with increased demand for bus service to the East Bay would be similar to that described under Alternative 1 and would be significant and mitigable.

Mitigation. Mitigation measures would be the same as those described for Alternative 1. However, at build-out, bus service for Alternative 2 would need to be at 15-minute headways (rather than 10-minute headways for weekdays under Alternative 1) throughout the day during the weekdays and weekends. Implementing these mitigation measures would reduce the impact to a not significant level.

Not Significant Impacts

Traffic operations (Factor 1). Similar to Alternative 1, traffic volumes on SFOBB would not have a significant change due to the metering lights at the toll plaza. In addition, there would be no significant traffic impacts at the six on-ramps and off-ramps that serve NSTI and NSTI internal intersections during both weekday and weekend conditions because estimated demand on these ramps would be less than capacity during these periods (Table 4.5-4), and no intersection would operate at LOS E and F conditions (Tables 4.5-10 and 4.5-11). Under Alternative 2, traffic volumes would be greater than fully operational baseline (1993) traffic volumes and 2010 background conditions (No Action Alternative). Under Alternative 2, total ramp volumes for the weekday A.M. peak hour would be 750 vph, the weekday P.M. peak hour would be 1,020 vph, and the weekend midday peak hour would be 1,055 vph (Table 4.5-4).

Delivery/goods movement/loading (Factor 4). The estimated delivery vehicle trips would be less than those identified under Alternative 1; similarly, Alternative 2 would not generate significant delivery vehicle-related impacts.

Transit operations – ferry and bus service (Factor 2). Under Alternative 2, a new ferry terminal would be built on the west side of Treasure Island, and Pier 1 would be retrofitted to serve as a ferry landing on the east side of the island. Alternative 2 would generate marginally higher ferry ridership than Alternative 1 on a typical weekday (approximately 1.2 percent), but modestly higher ferry ridership than Alternative 1 on a typical weekend (approximately 13 percent) due to the differences in land use mixes. These changes would not increase the impacts on ferry services (Tables 4.5-7 and 4.5-8). Alternative 2 would generate less bus ridership than Alternative 1 (Table 4.5-5); therefore, it would have less impacts than Alternative 1.

Parking (Factor 5). Parking demand would be approximately 35 percent of Alternative 1; therefore, no significant parking-related impacts would occur.

Construction impacts (Factors 1 and 4). Impacts associated with construction activities would be similar to those identified under Alternative 1. Construction activities would cause inconvenience to motorists, but they can be managed by proper phasing and sequencing to reduce the short-term impacts.

Emergency vehicle impacts (Factor 6). Impacts associated with emergency vehicle access would be similar to those identified under Alternative 1. Day-to-day emergency needs would be accommodated by the on-site fire and medical facilities. Major evacuation would be accommodated by the SFOBB or ferry and helicopters.

4.5.3 Alternative 3

Traffic generated on NSTI by Alternative 3 would be 5,390 weekday ADT compared to 10,525 weekday ADT under Alternative 1 (Table 4.5-1). Alternative 3 would generate about 610 vehicle-trips during the weekday A.M. peak hour, 800 vehicle-trips during the weekday P.M. peak hour (Table 4.5-2), and 770 vehicle-trips during the weekend midday peak hour (Table 4.5-3). In comparison, there were approximately 442 vehicle-trips during the weekday A.M. peak hour and 475 vehicle-trips during the weekday P.M. peak hour under fully operational baseline conditions (Table 4.5-1). In general, this alternative would generate fewer daily and peak hour vehicle-trips than the other reuse alternatives. However, during the weekday A.M. peak hour, the number of vehicle-trips would be greater than Alternative 2, reflecting this alternative's greater number of residential dwelling units.

Significant and Mitigable Impact

Impact: Increased peak spreading on SFOBB/I-80 (Factor 1). Under Alternative 3, increased traffic onto and off of the SFOBB during the A.M. peak period (6:30 to 9:30) and P.M. peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS F during the last hour of the A.M. peak period (8:30 to 9:30) and to deteriorate from LOS B to LOS E or LOS F during the first hour of the P.M. peak period (3:30 to 4:30) (Table F-22). The increase in other connecting regional freeways would likely be less.

Mitigation. Monitor traffic volumes to ensure that the transportation goals and objectives established by the Draft Reuse Plan are successfully implemented. Monitoring traffic volumes would inform San Francisco whether traffic onto or off of the SFOBB at each phase of development is resulting in deterioration of traffic conditions on the SFOBB. If at some point it is determined that traffic from NSTI is constraining the capacity of the SFOBB, either more aggressive TDM and transit improvements must be implemented or additional developments should be delayed until such improvements are implemented. Implementing this mitigation measure would reduce this impact to a not significant level.

Impact: Transit operations – bus service to East Bay (Factor 2). Approximately 1,785 weekday daily and approximately 2,395 weekend daily bus transit patrons are estimated between NSTI and the East Bay under Alternative 3 (Table 4.5-5). The impact associated with increased demand for bus service to the East Bay would be similar to but less than that described under Alternative 1 and would be significant and mitigable.

Mitigation. Mitigation measures would be the same as those described for Alternative 1. However, at build-out, service for Alternative 3 would need to be at 20-minute headways throughout the day during weekdays (rather than 10-minute headways) and 15-minute headways throughout the day during weekends. Implementing these mitigation measures would reduce the impact to a not significant level.

Not Significant Impacts

Traffic operations (Factor 1). Similar to Alternative 1, traffic volumes on SFOBB as a result of this alternative would not change significantly due to the metering lights at the toll plaza. In addition, there would be no significant traffic impacts at the six on-ramps and off-ramps that

serve NSTI and NSTI internal intersections during both weekday and weekend conditions because estimated demand on these ramps would be less than capacity during these periods (Table 4.5-4), and no intersection would operate at LOS E and F conditions (Tables 4.5-10 and 4.5-11). Under Alternative 3, traffic volumes would be greater than fully operational baseline (1993) traffic volumes and year 2010 background conditions (No Action Alternative). Under Alternative 3, total ramp volumes for the weekday A.M. peak hour would be 975 vph, the weekday P.M. peak hour would be 1,045 vph, and the weekend midday peak hour would be 1,040 vph.

Delivery/goods movement/loading (Factor 4). The estimated delivery vehicle trips would be less than those identified under Alternative 1; therefore, Alternative 3 would not generate significant delivery vehicle-related impacts.

Transit operations – ferry and bus service (Factor 2). Under Alternative 3, piers 1 and 12 would be adapted to accommodate ferry service. Alternative 3 would generate substantially lower ferry ridership than Alternative 1 on a typical weekday (approximately 28 percent) and a typical weekend (approximately 30 percent) (Tables 4.5-7 and 4.5-8); therefore, Alternative 3 would not generate significant impacts. Alternative 3 would generate substantially less bus ridership (more than 50 percent lower) than Alternative 1 (Table 4.5-5) and subsequently would have less impact than Alternative 1.

Parking (Factor 5). Parking demand under Alternative 3 would be approximately 50 percent of Alternative 1; therefore, there would be no parking-related impacts.

Construction impacts (Factors 1 and 4). Impacts associated with construction activities would be similar to those identified under Alternative 1. Construction activities would cause inconvenience to motorists, but construction can be managed by proper phasing and sequencing to reduce the short-term impacts.

Emergency vehicle impacts (Factor 6). Impacts associated with emergency vehicle access would be similar to those identified under Alternative 1. Day-to-day emergency needs would be accommodated by the on-site fire and medical facilities. Major evacuation would be accommodated by the SFOBB or ferry and helicopters.

4.5.4 No Action Alternative

Under this alternative, property available for disposal at NSTI would continue under federal ownership in caretaker status, and existing interim leases would be allowed to expire. There would be minimal use of the property and facilities under this alternative. The year 2010 background conditions shown on Table 4.5-4 represent the No Action conditions. A minimal number of trips would be directly generated by this alternative, and these trips would not affect the local or regional transportation system. The SFOBB/I-80 ramps would remain open, providing access to the US Coast Guard facilities and occasional sightseers. Traffic conditions under the No Action Alternative on the SFOBB/I-80 are briefly described below.

SFOBB/I-80 Operations

Degraded operating conditions on the SFOBB/I-80 in 2010 (without reuse) would be attributable to regional growth from projected development assumed to occur under the No Action Alternative (but not caused by the No Action Alternative); therefore, no impact to traffic would occur under this alternative.

During peak periods of operation, traffic demand projected for year 2010 conditions is expected to exceed the current maximum volumes on the SFOBB of approximately 10,500 vph. However, existing metering practices in the westbound direction at the toll plaza would limit the number of vehicles that could access the SFOBB/I-80. Westbound traffic accessing the SFOBB/I-80 is restricted to approximately 10,500 vehicles during the A.M. peak hour and approximately 9,000 vehicles during the P.M. peak hour. More vehicles are controlled with toll plaza metering lights during the P.M. peak to prevent congestion and backups caused by traffic entering westbound I-80.

As traffic increases, the peak period of delay and congestion would be extended over a longer period. By 2010, during both the A.M. and P.M. peak hours, the westbound traffic on the SFOBB/I-80 is projected to operate at capacity for more than 3 hours, compared to 2.5 hours under existing conditions (MTC 1991; BCDC 1994).

In the eastbound direction, the capacity and congestion in downtown San Francisco segments of I-80 restrict the number of vehicles accessing the SFOBB/I-80 to approximately 9,500 vph during both A.M. and P.M. peaks. This condition is anticipated to continue under the No Action Alternative, as there are no planned improvements on the San Francisco approach of the SFOBB/I-80. As in the westbound direction, an increase in eastbound demand could extend the duration of the peak period and could exacerbate queuing. The projected increase in traffic congestion on the SFOBB during the weekday A.M. and P.M. peaks is attributable to regional growth, not from trips generated under the No Action Alternative.

Weekday A.M. peak. During the A.M. peak period, year 2010 traffic demand on the SFOBB/I-80 is anticipated to increase over 1994 conditions by approximately 6 percent (from 10,535 vph in 1994 to 11,135 vph in 2010) in the westbound direction and approximately 14 percent (from 8,320 vph in 1994 to 9,470 vph in 2010) in the eastbound direction. In the morning, the peak direction of travel is westbound into San Francisco. In this direction, travel speeds would drop (from about 45 mph to 23 mph [72 km/hour to 37 km/hour]) east of the Yerba Buena Island tunnel (from LOS E to LOS F). More aggressive metering at the toll plaza would be required to maintain travel speeds at about 45 mph (72 km/hour). Additional metering would result in longer queues at the toll plaza. In the eastbound direction, travel speeds would generally remain the same as under existing conditions (57 mph [92 km/hour], LOS B).

Weekday P.M. peak. By 2010, overall increases in traffic demand over existing conditions during the P.M. peak period are anticipated to be approximately 13 percent in the westbound direction (8,235 vph in 1994 to 9,310 vph in 2010) and 13 percent in the eastbound direction (8,235 vph in 1994 to 9,310 vph in 2010). During the P.M. peak hour, travel speed in the westbound direction would drop east of the Yerba Buena Island tunnel from about 56 mph to 18 mph (90 km/hour to 29 km/hour), and thus operating conditions on the SFOBB/I-80 would drop from LOS B to LOS F. This decrease is due to the extension of the duration of congestion from San Francisco

across the SFOBB/I-80. While this change is significant, it would be caused by future traffic conditions in 2010; it would not be generated by the No Action Alternative.

As identified for the A.M. peak conditions, more aggressive metering at the toll plaza would be required to maintain operating conditions at 1994 levels. More aggressive metering would result in longer queues at the toll plaza. In the eastbound (nonpeak) direction, travel speeds generally would remain the same (about 46 mph [74 km/hour]) as existing 1994 levels (LOS D). The existing constraint to traffic accessing the SFOBB/I-80 at the downtown San Francisco approach would continue to restrict traffic accessing the SFOBB/I-80, would extend the peak period, and would exacerbate queuing at SFOBB/I-80 ramps and connecting arterial roads in San Francisco.

Weekend midday. During the weekend midday peak hour, the anticipated growth in traffic volumes would be similar to the weekday A.M. peak hour (approximately 6 percent in the westbound direction and approximately 14 percent in the eastbound direction). Since the SFOBB/I-80 has available capacity on weekends under existing conditions, the increase in traffic volumes during the weekend due to regional growth could be accommodated without substantially affecting traffic operating conditions. Under No Action Alternative conditions, travel speeds on the SFOBB/I-80 would remain similar to 1994 conditions in both eastbound and westbound directions (about 57 mph [92 km/hour], LOS B).

Other ramp operations. As a result of the closure of NSTI, traffic volume on the ramps connecting the SFOBB/I-80 with Yerba Buena Island has decreased. During both the weekday A.M. and P.M. peak hours, the ramp volumes are anticipated to be approximately a third of the 1993/1994 levels and would not have a significant impact on ramp operations. Under No Action Alternative conditions, total traffic entering and exiting NSTI in both the eastbound and westbound directions would decrease from about 675 vph under 1993/1994 conditions to approximately 275 vph during the A.M. peak hour and from approximately 730 vph to 250 vph during the P.M. peak hour. During the weekend midday peak hour, total ramp volumes are estimated to be similar to weekday A.M. conditions (approximately 275 vph). These vehicles would include trips to and from the US Coast Guard Station.

1 **This page intentionally left blank.**

4.6 AIR QUALITY

Potential air quality impacts resulting from disposal and reuse of NSTI are discussed in this section. Factors considered in determining whether an alternative would have significant air quality impacts included the extent or degree to which its implementation would:

1. Conflict with or obstruct implementation of the applicable air quality attainment plan;
2. Exceed an ambient air quality standard or substantially contribute to an existing or projected air quality violation;
3. Create or contribute to a non-stationary source "hot spot;" or
4. Expose sensitive receptors (e.g., children, elderly, or persons with respiratory conditions) to substantial pollutant concentrations.

Dispersion modeling analyses have been performed and are documented in Appendix F.

General Conformity

On November 30, 1993, EPA published the federal General Conformity Rule (40 C.F.R. §§ 51.850-51.860 and 40 C.F.R. Part 93). The US Navy document *Chief of Naval Operations Interim Guidance on Compliance with the Clean Air Act General Conformity Rule* (DON 1994c) provides policies and procedures for conformity evaluations.

As specified in 40 C.F.R. § 51.853 and 40 C.F.R. § 93.153, certain actions are exempt from general conformity determinations, including the action to dispose of NSTI. This finding is based on the following exemption as stated in 40 C.F.R. § 51.853(c)(2)(xix) and 40 C.F.R. § 93.153(c)(2)(xix): "Actions (or portions thereof) associated with transfers of land, facilities, title, and real properties through an enforceable contract or lease agreement where the delivery of the deed is required to occur promptly after a specific, reasonable condition is met, such as promptly after the land is certified as meeting the requirements of CERCLA, and where the federal agency does not retain continuing authority to control emissions associated with the land, facilities, title, or real properties." This is further explained in Volume 58 Number 228 of the Federal Register, "Supplementary Information on the Final Rule." Subsection III.J(3)(e) states that "Federal land transfers are included in the regulatory list of actions...exempt from the final conformity rules." The Navy's Record of Non-Applicability (RONA) is included in Appendix F.

4.6.1 Alternative 1

Buildout of Alternative 1 would result in short-term air pollutant emissions from construction activities, long-term emissions from operation of new uses, and potential long-term emissions from hazardous air pollutants.

Not Significant Impacts

Construction and demolition (Factors 1 and 2). Clearing and grading of sites and construction, demolition, and remodeling activities within the reuse plan area would generate fugitive dust (PM_{10}) and combustive emissions from equipment and from workers' vehicles. Building demolition, site preparation for new building construction, and roadway reconstruction would

be the primary emission-generating activities. Construction-related emissions would be temporary and limited to the construction period.

Development is expected to occur in phases (see section 2.4). Each phase would include some demolition and construction activities and would lead to additional employment and housing development. In this way, construction and demolition activities at NSTI are expected to occur incrementally, and the inconveniences and impacts associated with construction would be spread out in terms of time and location.

The impact of combustive emissions from proposed construction sources would be insignificant, as construction emissions from land use development projects have been included in the regional air quality attainment plans and they are not expected to delay attainment or maintenance of the O_3 and CO standards within the SFBAAB (BAAQMD 1996). Therefore, fugitive dust is the pollutant of greatest concern with respect to construction activities. The BAAQMD's approach to CEQA analyses of construction impacts is to emphasize implementation effective and comprehensive fugitive dust control measures rather than on detailed emissions quantification. Implementation of feasible control measures would ensure that emissions from construction activities would produce less than significant impacts to air quality (BAAQMD 1996).

Since the proposed reuse construction activities would disturb more then 4 acres of ground, implementation of the following BAAQMD "basic" and "enhanced" PM_{10} control measures would ensure that proposed construction would produce less than significant impacts to air quality:

- Minimize the area disturbed by clearing, earthmoving, or excavation activities at all times;
- Sufficiently water all areas to be excavated or graded to prevent excessive dust generation;
- Seed and water all unpaved, inactive portions of the construction site to maintain a grass cover if they are to remain inactive for a long period during building construction;
- Water or treat all unpaved active portions of the construction site with dust control solutions, twice daily, to minimize windblown dust and dust generation by vehicle traffic;
- Sweep paved portions of the construction site daily or as necessary to control wind-blown dust and dust generation by vehicle traffic;
- Limit on-site vehicle speeds on unpaved areas on the construction site to 15 mph (24 km/hour) or less;
- Sweep streets adjacent to the construction site as necessary to remove accumulated dust and soil;
- Halt all clearing, grading, earthmoving, and excavating activities during periods of sustained strong winds (hourly average wind speeds of 25 mph [40 km/hour] or greater);
- Use tarpaulins or other effective covers for piles stored onsite and for haul trucks that travel on streets; and

- On haul trucks, maintain at least 6 inches (15 centimeters [cm]) of freeboard between the top of the load and the top of the trailer.

Transportation-related air pollutant emissions (Factors 1 and 2). By providing for increased employment and housing, Alternative 1 would result in increased travel, including personal vehicle travel, travel to and from off-site ferry terminals, bus travel, and ferry vessel travel. Travel associated with buildout under Alternative 1 would result in an increase in ozone precursor emissions (reactive organic compounds and nitrogen oxides) and PM_{10} (direct PM_{10} emissions plus organic compounds and nitrogen oxides, which are precursors of the portion of PM_{10} formed through chemical reactions). However, the increase in these emissions would not contribute to an exceedance of any ambient air quality standard for ozone or PM_{10}.

The 2000 Clean Air Plan for the San Francisco Bay Area estimates that regional emissions in 2006 (the last year for which a projection is available) would be approximately 460 tons (383 metric tons) per day for reactive organic compounds and nitrogen oxides and 185 tons (154 metric tons) per day for PM_{10} (BAAQMD 2000). Compared to operational (baseline) activity levels, the net addition of less than 0.2 tons (0.18 metric tons) per day of either ozone precursor or PM_{10} emissions by 2010 under Alternative 1 (Table 4.6-1) would not cause a measurable change in the location, magnitude, or frequency of high ozone or PM_{10} concentrations. Consequently, the change in land use and vehicle travel patterns resulting from buildout of Alternative 1 would not lead to additional violations of ambient air quality standards for ozone or PM_{10}. No mitigation is proposed.

Potential carbon monoxide hot spots (Factors 1 and 2). Implementation of Alternative 1 would add vehicular trips to the local roadways. Therefore, the potential exists for localized carbon monoxide hot spots. A carbon monoxide hot spot is created when sensitive receptors are exposed to carbon monoxide levels that exceed either federal or state ambient carbon monoxide standards. The federal standards for carbon monoxide are an average of 9.0 ppm (parts per million) over an 8-hour period, and an average of 35 ppm over a 1-hour period. The state standards for carbon monoxide are an average of 9.0 ppm over an 8-hour period, and an average of 20 ppm over a 1-hour period.

Areas on Yerba Buena Island in the vicinity of the SFOBB corridor, which would support the highest peak hour traffic volumes, were chosen for analysis. The CALINE4 dispersion model (Caltrans 1989) was used to estimate the carbon monoxide concentrations from vehicular exhaust at three locations: near Macalla Road at the eastern end of Yerba Buena Island, about 300 feet (91 m) east of the eastern SFOBB tunnel opening, and about 160 feet (49 m) west of the western SFOBB tunnel opening. Receptor locations were established at 50, 75, 100, 200, and 300 feet (15, 23, 30.5. 61, and 91 m) from the centerline of the SFOBB. Vehicle emission rates were estimated for 2010 conditions using the California Air Resources Board's EMFAC7F model (California Air Resources Board 1993). Emission rates produced by the EMFAC7F model were adjusted to account for vehicle idling during peak period traffic periods.

As shown in Table 4.6-2, the CALINE4 model demonstrates that carbon monoxide levels would not be expected to exceed federal or state standards at 50 feet (15 m) from the centerline of the SFOBB. Carbon monoxide concentrations would be less at distances greater than 50 feet (15 m). Because no sensitive receptor would be located closer than 50 feet (15 m) from the center of the SFOBB, no sensitive receptors in this area would be exposed to carbon monoxide hot spots in

2010. Therefore, carbon monoxide impacts would be less than significant. No mitigation is proposed.

Table 4.6-1
Summary of Transportation-Related Air Pollutant Emissions for the Reuse Alternatives
(page 1 of 2)

Alternative	*Component*	*Amount*		Estimated 2010 Emissions (Tons per Year)				
				ROG	*NO_x*	*CO*	*SO_x*	*PM_{10}*
NSTI Operational Activity	Vehicle Traffic	21,677,000	annual VMT	7.6	14.5	61.0	0.7	22.3
	Mobile Equipment			1.6	0.5	6.6	0.01	0.04
	Ships			0.2	1.4	0.7	0.5	0.1
	Small Craft			17.7	87.1	19.8	12.3	3.0
	Totals			**27.1**	**103.4**	**88.0**	**13.5**	**25.4**
Alternative 1	Vehicle Traffic	72,800,428	annual VMT	32.8	58.7	316.9	2.4	74.8
	Bus System Travel	1,059,503	annual VMT	4.6	20.4	19.5	0.7	4.0
	To/From Terminals	15,476,203	annual VMT	6.1	8.5	67.9	0.5	15.6
	Ferry Vessel Trips	41,170	annual trips	1.5	18.4	3.7	7.7	1.0
	Totals			**45.0**	**105.9**	**408.1**	**11.3**	**95.5**
Alternative 2	Vehicle Traffic	36,413,204	annual VMT	15.0	31.7	138.5	1.2	37.8
	Bus System Travel	852,113	annual VMT	3.7	16.4	15.7	0.6	3.2
	To/From Terminals	14,813,005	Annual VMT	5.8	8.1	65.0	0.5	14.9
	Ferry Vessel Trips	42,800	Annual trips	1.5	19.1	3.9	8.0	1.1
	Totals			**26.0**	**75.3**	**223.1**	**10.3**	**57.0**
Alternative 3	Vehicle Traffic	35,725,521	Annual VMT	16.8	29.3	149.6	1.2	36.8
	Bus System Travel	468,023	Annual VMT	2.1	9.0	8.6	0.3	1.8
	To/From Terminals	2,741,663	Annual VMT	1.1	1.5	12.0	0.1	2.8
	Ferry Vessel Trips	17,520	Annual trips	0.4	6.7	1.7	2.9	0.4
	Totals			**20.4**	**46.6**	**172.0**	**4.5**	**41.7**

Table 4.6-1
Summary of Transportation-related Air Pollutant Emissions for the Reuse Alternatives
(page 2 of 2)

Alternative	*Component*		Net Change Compared to the Operational Activity Scenario (Tons per Year)[1]				
			ROG	*NO_x*	*CO*	*SO_x*	*PM_{10}*
Alternative 1	Total mobile source emissions		17.9	2.5	320.1	-2.2	70.0
Alternative 2	Total mobile source emissions		-1.1	-28.2	135.1	-3.3	31.6
Alternative 3	Total mobile source emissions		-6.7	-56.9	84.0	-9.0	16.3

Notes: [1] All values rounded independently after calculation.
VMT = vehicle miles traveled

ROG = reactive organic compounds NO_x = nitrogen oxides

CO = carbon monoxide SO_x = sulfur oxides

PM10 = inhalable particulate matter

Annual carbon monoxide emissions from motor vehicle traffic assume 8 months of summer temperature patterns and 4 months of winter temperature patterns.

SO_x emissions for vehicle traffic based on an average emission rate of 0.3 grams/vmt (BAAQMD 1996).

PM_{10} emission estimates for motor vehicle and bus traffic include a resuspended dust component based on the BAAQMD recommended factor of 0.69 grams per vmt (BAAQMD 1996).

Emissions associated with the NSTI operational activity scenario based on Radian International (1997), with adjustment of motor vehicle emissions for emission rate changes between 2001 and 2010.

Mobile equipment under the operational activity scenario include forklifts, pile drivers, and mobile generators.

The operational activity scenario assumes 250 work days per year. The reuse alternatives assume 365 work days per year.

Motor vehicle and bus traffic emissions for reuse alternatives calculated for 2010 using emission factors from the California Air Resources Board's EMFAC7F vehicle emission rate program.

Ferry trip estimates assume average passenger loads of 200 per trip for Alternative 3 and 300 per trip for Alternatives 1 and 2.

Ferry vessel emissions based on data in California Air Resources Board 1991a assuming diesel-fueled ferry vessels and an average run time of 15 minutes per trip.

The maximum CO impact from project and future traffic in the year 2010 was estimated to occur just north of I-80 near the vicinity of Macalla Road at eastern end of Yerba Buena Island. In the year 2025, traffic volumes/speeds within this portion of I-80 would be about 6 percent greater/less then those considered in the CALINE4 dispersion modeling analysis for year 2010. A comparison of applicable emission factors for years 2010 and 2025 shows that CO emissions would decrease by approximately 69 percent during this time period within this portion of I-80 (California Air Resources Board 2002). As a result, the project CO impacts analyzed for year 2010 would be greater then those analyzed for year 2025 conditions. Therefore, the current analysis represents a worst-case analysis compared to conditions beyond year 2010.

Potential toxic air emissions (Factors 3 and 4). Some land uses that may be developed in Alternative 1 may generate air contaminants (other than the criteria pollutants discussed above) that have the potential to harm human health and the environment. Toxic air contaminants

1
2

Table 4.6-2
Summary of Dispersion Modeling Results For Yerba Buena Island
(page 1 of 2)

Location and Distance From the Centerline of the SFOBB	Modeled Peak Hour CO Value (ppm)	1-hour Background CO Value ppm)	Total Peak Hour CO Value (ppm)	Estimated 8-hour CO Value (ppm) By Reuse Alternative		
				ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
NEAR MACALLA ROAD AT EASTERN END OF YERBA BUENA ISLAND						
50 ft N of I-80	5.0	1.0	6.0	5.1	5.0	4.8
75 ft N of I-80	3.4	1.0	4.4	3.7	3.7	3.5
100 ft N of I-80	3.0	1.0	4.0	3.4	3.3	3.2
200 ft N of I-80	2.0	1.0	3.0	2.6	2.5	2.4
300 ft N of I-80	1.6	1.0	2.6	2.2	2.2	2.1
50 ft S of I-80	2.5	1.0	3.5	3.0	2.9	2.8
75 ft S of I-80	2.1	1.0	3.1	2.6	2.6	2.5
100 ft S of I-80	1.8	1.0	2.8	2.4	2.3	2.2
200 ft S of I-80	1.5	1.0	2.5	2.1	2.1	2.0
300 ft S of I-80	1.3	1.0	2.3	2.0	1.9	1.8
ABOUT 300 FEET EAST OF EASTERN TUNNEL OPENING, YERBA BUENA ISLAND						
50 ft N of I-80	4.3	1.0	5.3	4.5	4.4	4.2
75 ft N of I-80	3.4	1.0	4.4	3.7	3.7	3.5
100 ft N of I-80	2.8	1.0	3.8	3.2	3.2	3.0
200 ft N of I-80	1.9	1.0	2.9	2.5	2.4	2.3
300 ft N of I-80	1.8	1.0	2.8	2.4	2.3	2.2
50 ft S of I-80	3.6	1.0	4.6	3.9	3.8	3.7
75 ft S of I-80	2.7	1.0	3.7	3.1	3.1	3.0
100 ft S of I-80	2.2	1.0	3.2	2.7	2.7	2.6
200 ft S of I-80	1.5	1.0	2.5	2.1	2.1	2.0

Table 4.6-2
Summary of Dispersion Modeling Results For Yerba Buena Island
(page 2 of 2)

Location and Distance From the Centerline of the SFOBB	Modeled Peak Hour CO Value (ppm)	1-hour Background CO Value ppm)	Total Peak Hour CO Value (ppm)	Estimated 8-hour CO Value (ppm) By Reuse Alternative		
				ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
300 ft S of I-80	1.2	1.0	2.2	1.9	1.8	1.8
ABOUT 160 FEET WEST OF WESTERN TUNNEL OPENING, YERBA BUENA ISLAND						
50 ft N of I-80	4.1	1.0	5.1	4.3	4.2	4.1
75 ft N of I-80	3.1	1.0	4.1	3.5	3.4	3.3
100 ft N of I-80	2.6	1.0	3.6	3.1	3.0	2.9
200 ft N of I-80	1.9	1.0	2.9	2.5	2.4	2.3
300 ft N of I-80	1.6	1.0	2.6	2.2	2.2	2.1
50 ft S of I-80	3.5	1.0	4.5	3.8	3.7	3.6
75 ft S of I-80	2.6	1.0	3.6	3.1	3.0	2.9
100 ft S of I-80	2.2	1.0	3.2	2.7	2.7	2.6
200 ft S of I-80	1.5	1.0	2.5	2.1	2.1	2.0
300 ft S of I-80	1.0	1.0	2.0	1.7	1.7	1.6

Notes: CO = carbon monoxide.
ppm = parts per million by volume.

Modeling analyses were performed with the CALINE4 dispersion model, assuming poor dispersion conditions (1 meter per second wind speeds, mild inversion conditions [Class E stability], a 50-meter mixing height limit, and a horizontal wind fluctuation parameter of 10 degrees. Wind directions were varied in 10-degree increments. This table presents only the highest modeled CO concentration for each receptor location.

Emission rates were calculated for 2010 using the EMFAC7F vehicle emission rate program, with additional idling emissions added to account for peak period congestion conditions.

Due to SFOBB capacity limitations, peak hour traffic volumes are nearly identical for each alternative, resulting in identical peak 1-hour CO levels. Background CO values represent contributions from unmodeled sources (minor roadways, parking facilities, etc.).

Potential 8-hour CO values are estimated by applying a persistence (extrapolation) factor to the total peak hour CO value. The duration of near capacity traffic flows varies among reuse alternatives, resulting in somewhat larger persistence factors for higher intensity reuse alternatives.

Persistence factors assumed for this analysis are: 78% for the No Action Alternative, 85% for Alternative 1, 83% for Alternative 2, and 80% for Alternative 3.

The federal 1-hour CO standard is 35 ppm. The state 1-hour CO standard is 20 ppm. The federal and state 8-hour CO standards are 9 ppm.

(TACs) could be generated from stationary sources. Although no industrial land use is proposed on NSTI, certain retail establishments could be potential sources of TACs. However, the actual amount of these air contaminants cannot be quantified due to a lack of information about specific business uses that may be located in the reuse plan area.

The BAAQMD limits emissions of and public exposure to TACs through a number of programs. TAC emissions from new and modified stationary sources are limited through an air toxics new source review program, which implements the district's Risk Management Policy via the district's permitting process for stationary sources. These analyses help to establish buffer zones around proposed new uses, preventing the exposure of sensitive receptors to TACs.

Evaluation of potential impacts attributable to TAC emissions from stationary sources would be speculative because no specific types or sizes of stationary sources have been proposed. Therefore, at this time, there is not sufficient information to evaluate the significance of stationary source emissions from future individual projects. Future air permit review (for both construction and operation) required by the BAAQMD would determine the significance of these potential impacts and could require new stationary sources to adopt specific mitigations as a condition for new permits.

In addition to stationary sources, vehicle trips generated under Alternative 1 would cause motor vehicle exhaust and evaporative emissions, known mobile sources of TACs. Exposure of TAC emissions from mobile sources would be roughly proportional to traffic volumes on the area roadway network. The further away from high-volume traffic arteries, the lower the exposure to all mobile source emissions. Reuse of NSTI would not result in traffic volumes on the local roadway network that would be unusually high in comparison to traffic volumes on comparable types of roadways elsewhere in the urbanized portions of the Bay Area. Furthermore, the BAAQMD's Impact Assessment Guidelines (BAAQMD 1996) do not include a requirement for including mobile sources of TACs when evaluating impacts. Therefore, exposure to TAC emissions from mobile sources is considered not significant. No mitigation is proposed.

4.6.2 Alternative 2

Not Significant Impacts

Construction and demolition (Factors 1 and 2). Construction emissions from the development of Alternative 2 would be less than but similar in nature to those that would result from the development of Alternative 1. These activities would occur incrementally over an extended build-out period, making it impossible to estimate specific numbers for any particular year. Construction-generated dust would be reduced to a less than significant level by implementing dust control measures as required by the BAAQMD. No mitigation is proposed.

Transportation-related air pollutant emissions (Factors 1 and 2). Development of Alternative 2 would generate air pollutants from transportation-related emissions (Table 4.6-1). Under this alternative, reactive organic compound emissions in 2010 (26 tons/year [23.5 metric tons/year]) would be a little more than half of those projected under Alternative 1 (45 tons/year [41 metric tons/year]).

The 2000 Clean Air Plan for the San Francisco Bay Area estimates that regional emissions in 2006 (the last year for which a projection is available) would be approximately 460 tons (383 metric tons) per day for reactive organic compounds and nitrogen oxides and 185 tons (154 metric tons) per day for PM_{10} (BAAQMD 2000). Compared to operational (baseline) activity levels, the net decrease of approximately 0.07 tons per day (0.06 metric tons per day) of ozone precursor emissions and the net increase of about 0.08 tons per day (0.07 metric tons per day) of PM_{10} emissions by 2010 under Alternative 2 would not cause a measurable change in the location, magnitude, or frequency of high ozone or PM_{10} concentrations. Consequently, the change in land use and vehicle travel patterns resulting from buildout of Alternative 2 would not lead to additional violations of ambient air quality standards for ozone or PM_{10}. No mitigation is proposed.

Potential carbon monoxide hot spots (Factors 1 and 2). Traffic associated with Alternative 2 would produce carbon monoxide concentrations that are well within the limits of the federal and state air quality standards (Table 4.6-2). Consequently, this impact is considered not significant. No mitigation is proposed.

Potential toxic air emissions (Factors 3 and 4). Unlike Alternative 1, Alternative 2 does not propose to develop any land uses that are anticipated to be major generators of TAC emissions. However, weekday daily vehicle trips generated under Alternative 2, although fewer than under Alternative 1, would cause motor vehicle exhaust and evaporative emissions, known mobile sources of toxic air contaminants. This potential impact is similar to, but less than, the not significant impact described for Alternative 1. No mitigation is proposed.

4.6.3 Alternative 3

Not Significant Impacts

Construction and demolition (Factors 1 and 2). Construction emissions from the development of Alternative 3 would be substantially less than but similar in nature to those that would result for Alternative 1. Lower emissions are expected because several existing buildings would be reused and there would be limited new construction. These activities would occur incrementally over an extended build-out period, making it impossible to estimate specific numbers for any particular year. Construction-generated dust would be reduced to a not significant level by implementing dust control measures as required by the BAAQMD. No mitigation is proposed.

Transportation-related air pollutant emissions (Factors 1 and 2). Development of Alternative 3 would generate air pollutants from transportation-related emissions (Table 4.6-1). Under this alternative, ozone precursor and PM_{10} emissions in 2010 would be less than half of those projected under Alternative 1.

The 2000 Clean Air Plan for the San Francisco Bay Area estimates that regional emissions in 2006 (the last year for which a projection is available) would be approximately 460 tons (383 metric tons) per day for reactive organic compounds and nitrogen oxides and 185 tons (154 metric tons) per day for PM_{10} (BAAQMD 2000). Compared to operational (baseline) activity levels, the net decrease of approximately 0.2 tons per day (0.18 metric tons per day) of ozone precursor emissions and the net increase of about 0.04 tons per day (0.04 metric tons per day) of

PM10 emissions by 2010 under Alternative 3 would not cause a measurable change in the location, magnitude, or frequency of high ozone or PM10 concentrations. Consequently, the change in land use and vehicle travel patterns resulting from buildout of Alternative 3 would not lead to additional violations of ambient air quality standards for ozone or PM10. No mitigation is proposed.

Potential carbon monoxide hot spots (Factors 1 and 2). Traffic associated with Alternative 3 would produce carbon monoxide concentrations that are well within the limits of the federal and state air quality standards (Table 4.6-2). Consequently, this impact is considered not significant. No mitigation is proposed.

Potential toxic air emissions (Factors 3 and 4). Similar to Alternative 2, Alternative 3 does not propose to develop any land uses that are anticipated to be major generators of TAC emissions. However, weekday daily vehicle trips generated under Alternative 3, although fewer than under both Alternatives 1 and 2, would cause motor vehicle exhaust and evaporative emissions, known mobile sources of toxic air contaminants. This potential impact is similar to, but less than, the impact described for Alternative 1. No mitigation is proposed.

4.6.4 No Action Alternative

The No Action Alternative would not result in an increase in air pollutant emissions. The site would be retained under federal ownership under a caretaker maintenance program. No operations other than minimal maintenance and security would occur. Existing interim leases would be allowed to expire. As a result, this alternative would have a beneficial impact on air quality because it would eliminate the majority of existing air pollutant emissions associated with the site and would not generate new emissions.

4.7 NOISE

Potential noise impacts from disposal and reuse of NSTI are discussed in this section. Existing and future noise levels along roadways in the reuse plan area were projected using data from the traffic analysis (see section 4.5). Noise impacts were analyzed considering a full build-out condition for each reuse alternative. Technical terms used in this section are defined in section 3.7. Noise level calculations are indicated in tables to tenths of a dB; noise levels in the text are rounded to the nearest whole dB.

Factors considered in determining whether an alternative would have significant noise impacts included the extent or degree to which its implementation would:

1. Expose sensitive receptors to noise above standards or guidelines;
2. Permanently and noticeably increase ambient noise in a manner that could affect the use and enjoyment of adjacent areas or facilities;
3. Locate a noise sensitive reuse such that it is negatively affected by existing or projected noise levels; or
4. Result in temporary noise levels in excess of limits set by San Francisco's Noise Ordinance.

Residences, schools, libraries, hospitals, and recreational areas generally are considered to be noise sensitive receptors. New development within the reuse plan area would include noise sensitive receptors, such as residences, schools, and recreation areas.

4.7.1 Alternative 1

Not Significant Impacts

Noise generated by traffic associated with reuse (Factors 1 and 2). Implementation of Alternative 1 would result in minor additional vehicular noise from traffic generated by new development. Projected vehicle noise levels along major roadways on Yerba Buena Island are summarized in Table 4.7-1 and assume the existing SFOBB configuration.

As indicated in Table 4.7-1, traffic added to the SFOBB by Alternative 1 would not cause a noticeable change in freeway noise levels; compared to future baseline conditions without the project, noise levels would increase by less than one-tenth of an A-weighted decibel. Predicted traffic volumes on most Treasure Island and Yerba Buena Island roadways would not generate CNEL levels above 60 dB for locations approximately 50 feet (15 m) from the edge of the road because traffic speeds generally would be low (25 mph [40 km/hour]). Even along major collector road segments where traffic speeds would be about 35 mph (56 km/hour) with substantial shuttle bus traffic, CNEL levels generally would be less than 61 dB at a distance of approximately 50 feet (15 m) from the edge of the road. Predicted noise levels do not exceed any adopted land use compatibility thresholds (see Table 3.7-1); therefore, the noise impact from on-site traffic would be less than significant, and no mitigation is proposed.

Ferry service to and from Treasure Island would not be a significant noise source. Boat engines and boat horns would be a minor localized noise source. Based on observations at the San

Table 4-7-1. Summary of Traffic Noise Modeling 24-hour Results for Yerba Buena Island (page 1 of 2)

Location and Distance From SFOBB	Modeled CNEL Levels (dBA) for Weekday Conditions								
	Existing Baseline	*Future Baseline Without Project*	*Baseline Change from Existing*	*Alternative 1*	*Change due to Project*	*Alternative 2*	*Change due to Project*	*Alternative 3*	*Change due to Project*
Near Macalla Road at eastern end of Yerba Buena Island									
100 ft N of I-80	81.1	81.4	+0.3	81.5	+0.1	81.5	+0.1	81.3	-0.1
200 ft N of I-80	75.9	76.2	+0.3	76.3	+0.1	76.3	+0.1	76.1	-0.1
300 ft N of I-80	72.9	73.3	+0.3	73.3	+0.1	73.3	+0.1	73.1	-0.1
500 ft N of I-80	69.1	69.5	+0.3	69.5	+0.1	69.5	+0.1	69.3	-0.1
750 ft N of I-80	66.0	66.3	+0.3	66.4	+0.1	66.4	+0.1	66.2	-0.1
1000 ft N of I-80	63.7	64.1	+0.3	64.1	+0.1	64.1	+0.1	63.9	-0.1
100 ft S of I-80	81.1	81.4	+0.3	81.5	+0.1	81.5	+0.1	81.3	-0.1
200 ft S of I-80	76.3	76.6	+0.3	76.7	+0.1	76.7	+0.1	76.5	-0.1
300 ft S of I-80	73.5	73.9	+0.3	73.9	+0.1	73.9	+0.1	73.7	-0.1
500 ft S of I-80	70.0	70.4	+0.3	70.4	+0.1	70.4	+0.1	70.2	-0.1
750 ft S of I-80	67.1	67.5	+0.3	67.5	+0.1	67.5	+0.1	67.3	-9.1
1,000 ft S of I-80	65.0	65.3	+0.3	65.3	+0.1	65.3	+0.1	65.1	-0.1
About 300 feet east of eastern tunnel opening, Yerba Buena Island									
100 ft N of I-80	80.9	81.2	+0.3	81.3	+0.1	81.3	+0.1	81.1	-0.1
200 ft N of I-80	75.8	76.2	+0.3	76.2	+0.1	76.2	+0.1	76.0	-0.1
300 ft N of I-80	72.8	73.2	+0.3	73.2	+0.1	73.2	+0.1	73.0	-0.1
500 ft N of I-80	69.1	69.4	+0.3	69.5	+0.1	69.4	+0.1	69.2	-0.1
750 ft N of I-80	66.0	66.3	+0.3	66.4	+0.1	66.4	+0.1	66.2	-0.1
1,000 ft N of I-80	63.8	64.1	+0.3	64.2	+0.1	64.2	+0.1	64.0	-0.1
100 ft S of I-80	80.9	81.2	+0.3	81.3	+0.1	81.3	+0.1	81.1	-0.1
200 ft S of I-80	75.9	76.2	+0.3	76.2	+0.1	76.2	+0.1	76.0	-0.1
300 ft S of I-80	72.8	73.2	+0.3	73.2	+0.1	73.2	+0.1	73.0	-0.1
500 ft S of I-80	69.1	69.4	+0.3	69.5	+0.1	69.5	+0.1	69.3	-0.1
750 ft S of I-80	66.1	66.4	+0.3	66.5	+0.1	66.5	+0.1	66.3	-0.1
1,000 ft S of I-80	64.0	64.3	+0.3	64.4	+0.1	64.4	+0.1	64.2	-0.1

Table 4.7-1. Summary of Traffic Noise Modeling 24-hour Results for Yerba Buena Island (Page 2 of 2)

Location and Distance From SFOBB	Modeled CNEL Levels (dBA) for Weekday Conditions								
	Existing Baseline	*Future Baseline Without Project*	*Baseline Change from Existing*	*Alternative 1*	*Change due to Project*	*Alternative 2*	*Change due to Project*	*Alternative 3*	*Change due to Project*
About 160 feet west of western tunnel opening, Yerba Buena Island									
100 ft N of I-80	80.5	80.9	+0.3	81.0	+0.1	81.0	+0.1	80.7	-0.1
200 ft N of I-80	75.1	75.5	+0.3	75.6	+0.1	75.5	+0.1	75.3	-0.1
300 ft N of I-80	72.1	72.4	+0.3	72.5	+0.1	72.4	+0.1	72.2	-0.1
500 ft N of I-80	68.3	68.6	+0.3	68.7	+0.1	68.7	+0.1	68.5	-0.1
750 ft N of I-80	65.5	65.8	+0.3	65.8	+0.1	65.8	+0.1	65.6	-0.1
1,000 ft N of I-80	63.4	63.7	+0.3	63.8	+0.1	63.8	+0.1	63.6	-0.1
100 ft S of I-80	80.6	80.9	+0.3	81.0	+0.1	81.0	+0.1	80.7	-0.1
200 ft S of I-80	75.1	75.5	+0.3	75.5	+0.1	75.5	+0.1	75.3	-0.1
300 ft S of I-80	72.0	72.4	+0.3	72.4	+0.1	72.4	+0.1	72.2	-0.1
500 ft S of I-80	68.3	68.6	+0.3	68.7	+0.1	68.7	+0.1	68.5	-0.1
750 ft S of I-80	65.4	65.8	+0.3	65.8	+0.1	65.8	+0.1	65.6	-0.1
1,000 ft S of I-80	63.4	63.7	+0.3	63.8	+0.1	63.8	+0.1	63.6	-0.1

Notes: dBA = A-weighted decibels.

CNEL = Community noise equivalent level (a 24-hour weighted average noise level, with evening noise weighted by 5 dBA and nighttime noise weighted by 10 dBA).

Noise modeling performed using a spreadsheet version of the Federal Highway Administration Traffic Noise Prediction Model (FHWA 1978) to model a full 24-hour pattern of traffic volumes. Noise contributions from trucks modeled using Caltrans data (Caltrans 1984).

Modeled CNEL values are about 3.3 dBA greater than the maximum 1-hour dBA value.

Upper and lower decks of the SFOBB modeled as separate roadways; tunnel sections were treated as being completely shielded.

Hourly traffic volumes were extrapolated from 1994 patterns, making adjustments to match traffic analysis predictions of peak period volumes, and total daily traffic based on future No Action volumes plus weekday vehicle traffic added by reuse alternatives.

Modeled vehicle speeds adjusted according to estimated hourly volume/capacity ratios. Truck volumes set as fractions of the hourly total volume. Daily medium truck volume averages about 2%; daily heavy truck volume averages about 2.4%.

Noise drop-off rate for the lower deck modeled as 4.5 dBA per doubling of distance; noise drop-off rate for the upper deck modeled as 5 dBA per doubling of distance.

Francisco Ferry Building, boat engine noise is about 70 to 75 dBA at approximately 50 feet (15 m) when boats are maneuvering away from the dock during ferry departures (Tetra Tech 2001). Boat engine noise levels are lower while arriving ferry boats dock. Boat horn noise is about 85 dBA at approximately 50 feet (15 m), but this is a brief noise event. The ferry dock area on Treasure Island would not contain noise-sensitive land uses, and these noise conditions would not be a significant impact. No mitigation is proposed.

Noise-related land use compatibility on Treasure Island (Factor 3). The proposed themed attraction would be a potential source of locally high noise levels. Potential impacts on nearby noise-sensitive land uses, such as persons engaged in recreational activities, would be avoided by appropriate site design. Reasonable attention to site planning and building design would minimize the potential for noise problems in mixed-use zones. Future noise-sensitive uses on Treasure Island would be developed in accordance with applicable regulations and would have adequate noise protection. For example, the San Francisco Building Code includes standards for noise insulation that would be met by new residential construction. In addition, the San Francisco Noise Ordinance is an enforcement mechanism that would limit noise impacts from construction activities and stationary sources. Existing on-site housing units planned for reuse are separated from proposed uses that would be sources of high noise levels by approximately 0.25 mile and, therefore, are not anticipated to experience noise levels greater than 60 dBA. Because predicted noise levels do not exceed any adopted land use compatibility thresholds (see Table 3.7-1), no significant noise-related land use compatibility conflicts are anticipated on Treasure Island. No mitigation is proposed.

Noise-related land use compatibility on Yerba Buena Island (Factor 3). Alternative 1 would include noise-sensitive residential and commercial uses on portions of Yerba Buena Island that are currently subject to high levels of noise from existing traffic on the SFOBB. Existing CNEL noise levels of up to 81 dBA were found during computer modeling (see Table 4.7-1). Locations within approximately 800 feet (244 m) of the freeway would be subject to CNEL levels above 65 dBA except where intervening topography provides noise shielding. Locations within approximately 500 feet (152 m) of the freeway may be exposed to CNEL levels above 70 dBA. These noise levels could pose land use compatibility problems for residential land uses and some commercial land uses (such as restaurants, hotels, and conference centers) if they are not addressed through building design and construction to minimize indoor noise levels. It is difficult to mitigate outdoor noise levels for low-density residential development, especially when noise sources are elevated with respect to residential areas. For residential and commercial developments using tall buildings, the building structures can be used to mitigate outdoor noise levels in relatively modest, largely enclosed outdoor spaces. Since precise site design and building design plans are not known, it is speculative to draw conclusions regarding the significance of outdoor noise impacts for locations relatively close to the SFOBB.

For development on the northern portion of Yerba Buena Island, the Draft Reuse Plan design guidelines identify methods to reduce bridge noise effects (including arranging proposed buildings to open away from the bridge and designing buildings with a "U" or courtyard shape). In addition, state requirements for building insulation would reduce interior noise levels to acceptable levels. If feasible, existing buildings that would be retained in areas of high ambient noise levels (e.g., historic structures on Yerba Buena Island) could be retrofitted with noise insulation features such as fixed windows and climate controls. These building insulation

requirements and the associated noise reduction benefits apply to all structures regardless of interior noise levels. Land use compatibility conflicts, therefore, would be not significant, and no mitigation is proposed.

Construction and demolition noise (Factor 4). Construction, demolition, and pile-driving activities have the potential for causing temporary disturbance to adjacent land uses. Construction and demolition activities would occur intermittently over an extended period; economic conditions would influence the amount, duration, and location of construction activities.

Noise levels from typical construction and demolition activities are summarized in Table 4.7-2. Most construction and demolition activity would result in CNEL levels above 70 dBA within approximately 200 feet (61 m) of construction sites. Pile-driving equipment generates a highly disturbing impulsive noise; over an 8-hour work day, CNEL increments would exceed 70 dBA for locations within approximately 600 feet (183 m) of pile-driving sites. Most pile-driving activity would occur on Treasure Island. Construction noise would become objectionable when areas close to noise-sensitive land uses are developed. Under Alternative 1, proposed noise-sensitive land uses include new residences, as well as parks, plazas, and other open space and recreational areas.

Construction noise impacts would be reduced to acceptable levels by restricting construction activities to normal daytime periods, by providing temporary noise barriers, such as heavy plywood fencing where necessary, and by sequencing development, to the extent feasible and practicable, such that noise-sensitive land uses are constructed last. Conditions would be imposed through San Francisco's building permit process and would result in controlled and reduced noise emissions. If pile driving during nighttime hours is required, it would be necessary to obtain a work permit from the San Francisco Director of Public Works, pursuant to San Francisco Noise Ordinance Section 2908. Construction noise, therefore, would not result in a significant impact. No mitigation is proposed.

4.7.2 Alternative 2

Not Significant Impacts

Noise generated by traffic associated with reuse (Factors 1 and 2). Noise levels on NSTI roadways and from ferry service to and from Treasure Island would not be significant, as described above for Alternative 1.

Noise levels on Yerba Buena Island are dominated by existing freeway noise from the SFOBB. Similar to Alternative 1, traffic added to the SFOBB by Alternative 2 would not cause a noticeable change in freeway noise levels; compared to future baseline conditions without the project, noise levels would increase by less than one-tenth of an A-weighted decibel (see Table 4.7-1). Consequently, Alternative 2 would not generate significant traffic noise impacts. No mitigation is proposed.

Noise-related land use compatibility on Treasure Island (Factor 3). Similar to Alternative 1, the proposed themed attraction would be a potential source of locally high noise levels from traffic, visitors, and rides and attractions, but potential impacts would be avoided by appropriate site design. In addition, noise-sensitive land uses such as residences or schools would not be

developed on Treasure Island. Consequently, no significant noise-related land use conflicts are anticipated on Treasure Island. No mitigation is proposed.

Table 4.7-2. Typical Construction Noise Impacts

Distance from Site (feet)	CNEL INCREMENTS (dBA) FROM TYPICAL CONSTRUCTION PHASES			
	Building Demolition	*Site Preparation*	*Excavation*	*Pile Driving*
50	85.1	84.7	85.7	92.0
100	79.0	78.6	79.6	85.9
200	72.8	72.5	73.5	79.7
400	66.5	66.2	67.2	73.4
600	62.7	62.3	63.4	69.6
800	59.9	59.6	60.6	66.8
1,000	57.6	57.3	58.4	64.5
1,500	53.3	53.1	54.1	60.2
2,000	50.1	49.9	50.9	56.9
2,500	47.4	47.3	48.3	54.2
3,000	45.1	45.1	46.1	51.8
4,000	41.3	41.3	42.3	47.7
5,280	37.2	37.3	38.3	43.3
7,500	31.5	31.6	32.7	36.8
9,000	28.3	28.4	29.5	32.9
10,560	25.2	25.3	26.5	29.1

Notes: dB = decibel. Decibel scales are a logarithmic index based on ratios between a measured value and reference value.
dBA = A-weighted decibels.

CNEL = Community noise equivalent level. Noise calculations incorporate both distance attenuation and atmospheric absorption effect. Noise estimates assume variable equipment use over a 10-hour work day with no nighttime construction activity. Building demolition assumed to be through use of heavy equipment rather than explosives. Building demolition assumed to require two bulldozers, one front end loader, two heavy trucks, and a water truck. Site preparation assumed to require one bulldozer, one backhoe, one front end loader, two heavy trucks, and one water truck. Foundation excavation assumed to require one power shovel, one front end loader, two heavy trucks, and one water truck. Pile driving assumed to require one heavy truck, one crane, one forklift, and one pile driver.

Sources: EPA 1971; Gharabegian, et al. 1985; Acoustical Society of America 1978.

Noise-related land use compatibility on Yerba Buena Island (Factor 3). Potential noise-related land use compatibility impacts and their remedies on Yerba Buena Island under Alternative 2 would be similar to those described for Alternative 1 and would be not significant. If feasible, existing buildings that would be retained in areas of high ambient noise levels (e.g., historic structures on Yerba Buena Island) could be retrofitted with noise insulation features, such as fixed windows and climate controls. No mitigation is proposed.

Construction and demolition noise (Factor 4). Noise impacts from construction, demolition, and pile driving would be similar for Alternative 2 to those discussed for Alternative 1. While the

amount of construction activity would be less than for Alternative 1, the nature and scale of individual construction projects would probably be similar.

As indicated in Table 4.7-2, most construction and demolition activity would result in CNEL levels above 70 dBA within approximately 200 feet (61 m) of construction sites. Pile driving would result in CNEL levels above 70 dBA within approximately 600 feet (183 m) of the construction site. Most pile-driving activity would occur on Treasure Island. Construction noise would become objectionable if areas close to noise-sensitive land uses are developed. For Alternative 2, noise-sensitive land uses include a golf course and other open space and recreational areas. Construction noise impacts would be temporary, limited to the construction period, and minimized by restricting construction activities to daytime periods, by providing temporary noise barriers, by muffling and shielding construction equipment, where necessary, and by sequencing development. No mitigation is proposed.

4.7.3 Alternative 3

Not Significant Impacts

Noise generated by traffic associated with reuse (Factors 1 and 2). Traffic generated by buildout of Alternative 3 would not cause significant noise impacts on Treasure Island or Yerba Buena Island.

Noise levels on Yerba Buena Island are dominated by existing freeway noise on the SFOBB. Traffic added to the SFOBB by Alternative 3 would not cause a noticeable change in freeway noise levels; compared to future baseline conditions without the project, noise levels would actually decrease by approximately one-tenth of an A-weighted decibel (see Table 4.7-1). Consequently, Alternative 3 would not generate traffic noise impacts and would provide a beneficial impact. No mitigation is proposed.

Noise-related land use compatibility on Treasure Island (Factor 3). The proposed themed attraction would be a potential source of locally high noise levels, but potential impacts would be avoided by appropriate site design. Reasonable attention to site planning and building design would minimize the potential for noise problems in mixed-use zones; consequently, no significant noise-related land use conflicts are anticipated on Treasure Island. No mitigation is proposed.

Noise-related land use compatibility on Yerba Buena Island (Factor 3). Potential noise-related land use compatibility impacts and their remedies on Yerba Buena Island under Alternative 3 would be similar to those described for Alternative 1 and would not be significant. However, because Alternative 3 calls for extensive reuse of existing buildings, the Draft Reuse Plan design guidelines to reduce bridge noise effects in new construction and building design would not apply. If feasible, existing buildings that would be retained in areas of high ambient noise levels (e.g., historic structures on Yerba Buena Island) could be retrofitted with noise insulation features, such as fixed windows and climate controls. No mitigation is proposed.

Construction and demolition noise (Factor 4). Although new construction under this alternative would be substantially less than for the other reuse alternatives, the nature and scale of some individual construction projects would be similar to those of the other reuse alternatives. Construction noise would become objectionable if areas close to noise-sensitive land uses were

developed, such as residential and recreation uses. Construction noise impacts generally can be reduced by restricting construction activities to daytime periods, by providing temporary noise barriers, by muffling and shielding equipment, where necessary, and by sequencing development. Noise impacts from construction and demolition activities, therefore, would not be significant. No mitigation is proposed.

4.7.4 No Action Alternative

Under the No Action Alternative, NSTI would remain in federal government ownership under a caretaker maintenance program, and existing interim leases would be allowed to expire. Minimal use of the property and facilities would occur under this alternative, and no noise-sensitive land uses would be introduced on NSTI. No new activity would occur on NSTI, resulting in the elimination of traffic noise generated by vehicles traveling to and from the islands. As a result, the No Action Alternative would have a beneficial impact of reducing traffic noise.

4.8 BIOLOGICAL RESOURCES

Biological resources addressed in this section include sensitive species, sensitive habitats, and wetlands. Factors considered in determining whether an alternative would have significant impacts on biological resources included the extent or degree to which its implementation would:

1. Damage wetlands or other special aquatic sites afforded protection under the CWA, Section 404 (16 U.S.C. §1344) and the § 404(b)(1) guidelines (40 C.F.R. Part 230) or other sensitive habitats;
2. Adversely affect sensitive species, including those listed or proposed for listing as endangered or threatened under the ESA (16 U.S.C. §§ 1531-1544), marine mammals afforded protection under the MMPA (16 U.S.C. §§ 1361-1421h), migratory birds afforded protection by the MBTA (16 U.S.C. §§ 703-712) and Executive Order 13186, or other species of concern; and,
3. Degrade or destroy designated critical habitat, as defined by the ESA, or Essential Fish Habitat (EFH), as defined by the MSA.

4.8.1 Alternative 1

Under this alternative, the planned actions most affecting biological resources would be dredging, increased boat traffic, and increased human presence. The biological resources of concern are the mudflat/eelgrass habitat, shallow water marine habitat, and salmonids (and associated critical habitat and EFH). There would be no significant impacts to ESA protected marine mammal, bird or sea turtle species.

Significant and Mitigable Impacts

Impacts to Sensitive Habitats

Impact: Mudflat habitat disturbance (Factor 1). Significant impacts to mudflat habitat, including eelgrass beds, may occur as a result of increased pedestrian and boating activity around Clipper Cove (Figure 3-14). These impacts are not a direct consequence of the property transfer, but could result from subsequent development. The eelgrass beds are the most sensitive habitats of the designated EFH within the project area. Under Alternative 1, the proposed themed attractions would attract approximately 13,700 daily visitors, which combined with residential development on Treasure Island, would result in increased pedestrian activity in the area adjacent to Clipper Cove. This is likely to result in more people exploring the mudflats during low tide, which could disturb this sensitive habitat.

The enlarged marina under this alternative would add approximately 200 new boat slips and 100 new tie-up buoys to the existing 100 slips and would quadruple boat traffic in Clipper Cove. This would increase the potential for mudflat habitat disturbance, especially during low tides when recreational boating traffic could erode nearshore sediment, which could directly affect invertebrate prey species in shallow water.

Although the project area is not under BCDC jurisdiction as a Navy facility, conversion to a nonfederal facility would place it within the jurisdiction of this agency. Expanding the marina or constructing a yacht harbor, new docks, or other structures that would cover the surface of the water would Waters of the United States and would require permits from the BCDC and the COE.

Mitigation. Construction would require a permit from the COE under Section 404 of the CWA or Section 10 of the Rivers and Harbors Act, as well as a permit from the BCDC. In conjunction with the permitting process, the permittee (property recipient or developer) would be required to minimize disturbance to mudflats and eelgrass beds during construction, and, in the long term, to develop and implement a plan to minimize disturbance of these sensitive habitats from recreational activity. Subject to COE and BCDC review and approval, the permittee could be required to post signs along the shore adjacent to the mudflats and at the marina to inform pedestrians and recreational boaters that the mudflats are a protected sensitive area and that trespassing is not permitted. In addition, buoys could be placed in the bay to identify the restricted mudflat area. A 5-mph (8 kph) zone could be established in Clipper Cove to minimize shoreline and mudflat erosion from high-speed recreational boats in shallow near-shore areas. Placing buoys to mark the channel and establishing a 5-mph (8 kph) zone to regulate impacts from recreational boats would require a US Coast Guard aid to navigation permit. Posting the shoreline with information signs and establishing a 5-mph (8 kph) zone could minimize impacts from recreational boats to sensitive mudflats and eelgrass beds.

Complying with these mitigation procedures would eliminate or reduce impacts to less than significant.

Impacts to Sensitive Bird Species

Impact: Pedestrian and boating impacts on migratory birds (Factors 1 and 2). Increased pedestrian and boating activity around Clipper Cove could have a significant impact on shore- and water-birds (migratory birds protected by the MBTA and Executive Order 13186) by affecting mudflats and eelgrass beds where shorebirds forage. An increase in pedestrian activity near Clipper Cove from new residents and visitors to the themed attractions would be expected result in more people exploring the mudflats during low tide, which could disturb avian species and sensitive habitat zones. In addition, the enlarged marina would quadruple boat traffic in Clipper Cove, increasing the potential for disturbing mudflat habitat and for eroding nearshore sediments, especially during low tides, which could affect invertebrate and fish populations in shallow water. This could affect food resources for migratory birds, and could result in a decrease in foraging success and thus an increase to the birds' energy expenditure. Breeding areas of shorebirds and other resident and migratory species are not likely to be affected. The federally listed western snowy plover is not expected to occur at the project area and therefore would not be affected. Any individual plovers that may be present would be protected by the measures described below.

Mitigation. In conjunction with permitting by the BCDC and COE, the property recipient or developer could be required to post signs along the shore adjacent to the mudflats and at the marina, informing pedestrians and boaters that the mudflats are a protected and sensitive area. Placing buoys in the bay, identifying the mudflat area as restricted, and establishing a 5-mph (8 kph) zone in Clipper Cove could reduce impacts by decreasing both numbers of people and

boats in the area. Placing buoys and establishing a 5-mph (8 kph) zone would require a US Coast Guard aid to navigation permit.

Implementing these mitigation measures would reduce the impacts on identified avian species to a less than significant level.

The acquiring entity or entities would be responsible for implementing these mitigation measures, which would reduce the impacts on migratory bird species to less than significant. It is noted that the regional office of the USFWS, in a letter to the Navy (see Appendix C) recommended that a covenant for the protection of birds protected under the Migratory Bird Treaty Act be included in the deed transferring ownership of the property. The Navy, in the absence of statutory authority, is without legal authority to impose such restrictions.

Impacts to Mudflat and Eelgrass Habitat (EFH)

Impact: Pedestrian and boating impacts on EFH (Factor 1). Increased boat and pedestrian activity around Clipper Cove could have an indirect significant impact on EFH by degrading eelgrass vegetated areas and shallow water and mudflat areas. These areas provide important fish spawning, rearing, and foraging habitat. Impacts to EFH from pedestrian and boating activities are the same as those described under the impact to sensitive habitats, described above.

Mitigation. Proposed mitigation measures are the same as those discussed under impacts to sensitive habitat above. Complying with these mitigation procedures would eliminate impacts or reduce impacts to less than significant.

Not Significant Impacts

Dredging and construction impacts to mudflat and eelgrass habitat (EFH) (Factor 1). Due to their function as cover and feeding habitat for a number of species, eelgrass vegetated areas on the southeastern side of Clipper Cove are considered the most sensitive aspect of EFH in the project area. Herring are known to spawn and deposit their eggs in the eelgrass beds of the surrounding shallow water. A decrease in the quantity of eelgrass around the islands could result in a decrease in egg deposits and a subsequent decrease in the local population of herring, thereby reducing available forage for harbor seals. Any reduction in eelgrass habitat also would affect shorebirds, such as dowitchers and sandpipers, by reducing foraging opportunities.

The lower limit of eelgrass growth is determined by the amount of available light, and plants at the lower limits of growth areas may not have sufficient carbon reserves to withstand periods of high turbidity (Zimmerman et al. 1991). Turbidity generated by dredging could significantly lower the amount of light available to eelgrass at the lower limits and could make such areas unsuitable as habitat for the species. If daily, monthly, and seasonal light requirements of the species are not met, a die-off and reduction in the extent of eelgrass may occur (Zimmerman et al. 1991). Dredging is not proposed in or near eelgrass beds.

Some dredging and construction is proposed on the northwestern side of Clipper Cove for expanding and maintaining the marina. This dredging would occur at a significant distance, approximately 1,200 feet, from eelgrass beds on the southeastern side of Clipper Cove (Figure 3-

14). Dredging, inserting pilings, or installing the seismic wall on the northwestern side of Clipper Cove is unlikely to affect these eelgrass beds due to the distance between construction areas and eelgrass beds.

The property recipient or developer would have to obtain required permits from the COE under section 404 of the CWA and Section 10 of the Rivers and Harbors Act. Also, the ESA and CEQA would require the property recipient or developer to consult and coordinate with the NMFS and CDFG before beginning any activities that may adversely affect sensitive habitats or species. The various permits and conditions resulting from consultations with state and federal resource agencies would address mitigation, avoidance, or minimization of potential adverse impacts. Required permits and consultations also would address impacts associated with disposal of dredge material.

Impacts to other sensitive habitats (Factor 1). Impacts to jurisdictional wetlands, open water habitats, and terrestrial habitats would be less than significant because most development would occur on lands previously developed or disturbed and would not affect any lands currently used or occupied by any sensitive species (Figure 3-14). Marsh gumplant, the only plant species of concern known to occur on or near the project area, occurs to the east of the main project area and would not be affected by project activities. Dredging could result in short-term localized impacts to water quality in open water habitats. These activities are unlikely to cause significant impacts to sensitive habitats because of the distance between these habitats and the dredging activities. No mitigation is proposed.

Under Alternative 1, the number of boat slips in the proposed marina would quadruple, increasing the risk of accidental oil or gas spills. Section 1321 of the CWA (33 U.S.C. § 1321) prohibits the discharge of oil or hazardous substances into or upon the navigable waters of the U.S. Very small quantities of oil or gasoline spilled on surface waters can adversely affect sensitive habitat, although in practice it is difficult to prevent the discharge of small quantities of oil from the many possible sources. Two types of discharges are recognized by the EPA: point discharges attributable to a single source, such as from a pipe or a vent, and nonpoint discharges, which include the many small, accidental, and difficult to account for sources of pollutants. Point discharges are prohibited except under an NPDES permit issued by the RWRQB. NPDES permitting requirements cover runoff discharged from point sources and would minimize potential impacts to sensitive habitats.

The EPA or the state implementing agencies also require that certain classes of industrial facilities and activities, including marinas, obtain permits to allow them to discharge stormwater, provided that they conduct monitoring and adopt best management practices designed to identify and reduce the potential for nonpoint pollution. Certain shoreline facilities that store oil or hazardous substances are required to prepare and implement spill prevention, control, and countermeasures (SPCC) plans, which address the training and readiness to prevent and respond to spills. Finally, accidental spills must be reported to the appropriate regulatory agencies with jurisdiction over the affected waterbody, such as the US Coast Guard and the RWQCB. The possibility of an accidental spill is unknown, as is the potential intensity, which would depend on the volume released, wind patterns, tides, and other physical features. While the potential for spills cannot be eliminated entirely, existing regulatory requirements minimize the potential for spills to occur, require timely response to accidental spills, and reduce the potential for nonpoint sources to cause significant adverse impacts on surface water

quality. The US Coast Guard would have a quick response time, given its proximity to the site; any spills would be contained and would have less than significant impacts on biological resources. Therefore, increased boat traffic, including from proposed ferry service, is not expected to result in significant impacts to sensitive species.

Impacts to critical habitat (Factor 3). The project area is within designated critical habitat for two fish species, the Sacramento River winter-run chinook salmon and the central California coast coho salmon. Other listed salmonids can occur in the project area. However, the actual project area is constitutes a very small portion of the specified habitat, and provides very limited food or other habitat resources for these species. Potential impacts under this alternative would be localized and would not adversely affect critical habitat in the area. No mitigation is proposed. The Navy has initiated and concluded informal consultation with NOAA Fisheries (NMFS) on this project. On August 8, 2002 NOAA Fisheries concurred that the proposed action is not likely to adversely affect listed species or their critical habitats (Appendix C).

The project area falls within designated critical habitat for the endangered Steller sea lion, but this critical habitat zone covers almost all of the west coast of the US, including Alaska. Because the project area makes up such a small portion of that critical habitat and the species is rarely seen in the bay, impacts from project activities would be less than significant. No mitigation is proposed.

Impacts to sensitive marine mammal species (Factor 2). Increased boating activity from ferry service or from expanding the marina would increase boat traffic and human presence in the project vicinity and in the vicinity of the harbor seal haulout areas. Most impacts would come from recreational boats because large vessels would not be found near the haulout area. The level of boat traffic is the single strongest predictor of harbor seal haulout numbers; the more boat traffic, the fewer seals at the haulout site (Lelli and Harris 2001). Wild animals must maintain a balance between intake of nutrients and expenditure of energy to stay healthy. For example, stress can be caused by too little food, or, conversely, too much energy expenditure. If the harbor seals are overly disturbed while hauled out, which is generally a time of rest and recovery, this could increase their energetic expenditure. Although this area is used as a primary haulout site for seals in the bay, they are reasonably adaptable to disturbance from noise and can tolerate some degree of continuous exposure to human-made sounds. Seals can show short-term behavioral reactions to noise (Phillips 1999), especially at low tides or when pups are present (Green 2001). An accurate prediction of the number of boaters in the vicinity of the haulout area is not available; however, the level of potentially disturbing boat activity is not expected to differ substantially from present conditions, in which there are more sailboats than power boats, and in which boats have difficulty accessing the rocky shoreline in the vicinity of the haulout. Additionally, there are signs posted presently warning boaters to keep their distance from the harbor seal haulout site. Impacts to seals at the primary haulout and the secondary haulout west of this site would not be significant.

Dredging could have an indirect impact on harbor seals by affecting herring, a preferred harbor seal prey species that is a significant portion of their diet. Dredging also could have a direct impact on harbor seals from noise associated with dredging to establish and maintain minimum depths for the proposed marina and other boating activities. Dredging noise would be comparable to the noise associated with ongoing vessel traffic in the vicinity and would not be expected to increase the level of disturbance to harbor seals. These activities would occur on the

opposite side of the island from the haulout, affect a relatively small area temporarily, and are unlikely to significantly affect the food resources or normal activities of harbor seals, and no mitigation is proposed. . The property recipient or developer would have to obtain required permits from the COE under sections 404 and 401 of the CWA and Section 10 of the Rivers and Harbors Act. Also, the ESA and CEQA would require the property recipient or developer to consult and coordinate with the NMFS and CDFG before beginning any activities that may adversely affect sensitive habitats or species. The various permits and conditions resulting from consultations with state and federal resource agencies would address mitigation, avoidance, or minimization of potential adverse impacts. Required permits and consultations also would address impacts associated with disposal of dredge material.

Impacts to all other marine mammals from dredging or increased boating and pedestrian activity also would be less than significant. Other marine mammals species in the ROI occur on an intermittent to rare basis and therefore are unlikely to be affected by dredging, increased boating or pedestrian activities. No mitigation is proposed.

Impacts to benthic organisms (Factor 3). Dredging in Clipper Cove would have a short-term adverse impact on benthic organisms and bottom-dwelling invertebrates found within the shallow water habitat of the cove. This impact would affect local populations and is not expected to affect the overall population of these species within the bay. Impacts to these species would lead to impacts to fish and bird species that prey on them, in that the amount of available prey in this area would be reduced temporarily. There are no sensitive aquatic species within this area, except for eelgrass, described in the previous section. Invertebrates affected by dredging are expected to reestablish themselves in the dredged zone over time. No mitigation is proposed.

Impacts to sensitive bird species (Factors 1 and 2). Except for the pedestrian and boating impacts on MBTA-protected shorebirds described previously, there would be no significant impacts to sensitive bird species. Habitat degradation, human presence, and expansion of the marina, including dredging, under this alternative would not have a significant impact on bird species protected under ESA.

American peregrine falcons, a federally delisted but state-listed threatened species, forage in the Central Bay and nest on the SFOBB and Golden Gate Bridge. As noted in section 3.8, two pairs nest on SFOBB—one on the support structure east of Yerba Buena Island and one on the central support structure between the island and San Francisco. This species may hunt over the water and land portions of the site and is unlikely to be adversely affected by development proposed under this alternative because the habitat of the falcon's common prey species (small birds) would remain similar to existing conditions. The peregrine falcon has adapted to an urban setting that includes SFOBB traffic noise and lights; therefore project-related noise and lighting would not be expected to adversely affect this species. No mitigation is proposed.

The California brown pelican and California least tern, federally listed endangered species, occasionally forage for fish in areas off NSTI. The California least tern generally forages in shallow waters and mudflat areas; the California brown pelican generally forages in deeper water on anchovies and sardines, both of which are abundant in the ROI and would not be affected by project activities. Increased boat traffic is likely to be dispersed throughout deep water surrounding NSTI and would not significantly affect foraging habitat or activities for the

California brown pelican. There would be no significant impacts to prey species of these birds from boating or from dredging, as described previously. No mitigation is proposed.

The Alameda song sparrow is considered unlikely to be affected due to its low numbers and the lack of preferred habitat (salt marsh with marsh gumplant) in the main project area. This species would most likely not be affected and there would be no significant impacts to their prey species from boating activity or human presence, as described above. No mitigation is proposed.

There would be no impacts to the California clapper rail because this species is not found in the project area. There also would be no impacts to the double-crested cormorant because no nesting sites are within the project area.

Impacts to sensitive fish species (Factors 1 and 2). The Central California coast steelhead is the only ESA species that occurs in moderate numbers in the project area. Adults of this steelhead ESU are most likely to be in the area during their migration to South Bay spawning grounds. Juveniles are likely to be found in the proximity of the Central Bay, as they move from upstream habitats to the deeper waters of the bay and eventually the Pacific Ocean. Fish are sensitive to high noise levels. Juvenile steelhead would be especially sensitive to noise and elevated turbidity from dredging and in-water construction. Operational noise levels are recommended to remain below 150 dB; noise levels above 200 dB are lethal to fish (Woodbury 2001). Dredging sounds are not expected to reach these levels, and would be comparable to noise associated with ongoing vessel traffic. Dredging and in-water construction would require permitting from the COE and consultation with the NMFS regarding potential effects on listed fishes. Conditions agreed on in these consultations would be implemented as part of project activities, ensuring that project activities would not adversely affect ESA species such as the Central California coast steelhead. Navy has initiated and concluded informal consultation with NMFS on this project, with the conclusion that the proposal disposal of NSTI would not adversely affect listed species or their critical habitats (Appendix C).

In addition, four salmon ESUs, including the Sacramento River winter-run, fall/late fall-run, and spring-run chinook salmon and the Central Valley steelhead, may occur in the Central Bay in low numbers (Woodbury 2001). The project area is not along main migration routes used by these ESUs, therefore these species are not likely to be affected by project activities. These species have been observed in the Central Bay (Woodbury 2001; Hieb 2001) but are likely to occur in the area in low numbers due to the distance between the project area and their known migratory route. Of the low numbers of individuals that occur in the project area, the majority are likely to be juveniles (Woodbury 2001).

Delta smelt are found in the South Bay, although in much smaller numbers in comparison to North Bay populations (Ganssle 1966; Messersmith 1969). Movement of delta smelt and the contiguous nature of these sections of the San Francisco Bay make it likely that individual smelt would be found in the Central Bay. The delta smelt does not spawn in the area and is not expected to be affected by proposed project activities.

Longfin smelt migrate from the ocean to the delta to spawn but are known to enter the Central Bay. Longfin smelt are found in their largest numbers in San Francisco Bay during the spring

and summer, when they are juveniles (Messersmith 1969; Aplin 1967). The longfin smelt does not spawn in the area and would not be expected to be affected by proposed project activities.

Green sturgeon are anadromous and may be found in low numbers in the Central Bay before or after spawning in the Delta. The green sturgeon does not spawn in the area and would not be expected to be affected by proposed project activities.

Fish that are managed under the West Coast Groundfish FMP and the Coastal Pelagics FMP could inhabit the Central Bay. While groundfish, such as the Pacific sand dab, and coastal pelagics, such as the northern anchovy, are found in the project area, they are mobile and can move into other portions of the bay; therefore, their populations would not be expected to be affected by proposed project activities.

Impacts to EFH (Factor 3). Dredging, constructing a seismic wall, expanding the marina, and implementing other in-water activities proposed under Alternative 1 would result in not significant impacts to EFH. All of the bay waters surrounding NSTI are designated as EFH for fish managed under the three FMPs—the Pacific Groundfish FMP, the Coastal Pelagics FMP, and the Pacific Coast Salmon FMP (NMFS 2000). The most delicate component of the Central Bay EFH is the eelgrass vegetated areas. These areas are sensitive to high turbidity and are an important resource to fish, which use eelgrass for depositing eggs, for foraging, and for seeking shelter. The closest eelgrass vegetated area to potential dredging and in-water activities is on the southeastern side of Clipper Cover. It is approximately 1,200 feet away from the proposed dredging area in Clipper Cove (Figure 3-14). This distance is great enough to prevent dredging from disturbing eelgrass.

The property recipient or developer would have to obtain permits from the COE under Sections 404 and 401 of the CWA and Section 10 of the Rivers and Harbors Act, and from BCDC. Also, the ESA and CEQA require the property recipient or developer to consult and coordinate with the NMFS and CDFG before beginning any activities that may adversely affect sensitive habitats or species. The various permits and conditions resulting from consultations with state and federal resource agencies would address mitigation, avoidance, or minimization of potential adverse impacts. Required permits and consultations also would address impacts associated with disposing of dredge material and would incorporate measures consistent with the LTMS.

4.8.2 Alternative 2

Under this alternative, the proposed actions most affecting biological resources would be dredging, expanding the marina, and increasing boat traffic.

Significant and Mitigable Impacts

Impacts to Sensitive Habitat

Impact: Mudflat habitat disturbance (Factor 1). There could be significant impacts to mudflat habitat, including eelgrass beds, because of increased pedestrian and boating activity around Clipper Cove. Eelgrass beds are the most sensitive habitats of the designated EFH in the project area. Treasure Island development under Alternative 2 would attract an estimated 5,000 daily

visitors, or approximately half the increase in pedestrian activity anticipated under Alternative 1. As a result, the impacts in the area of the themed attraction adjacent to Clipper Cove would be less than half of that under Alternative 1. Unlike Alternative 1, Alternative 2 does not include extensive residential development.

Expanding the marina to between approximately 500 and 675 slips and buoys would result in at least a 500 percent increase in boat traffic in Clipper Cove over existing conditions and a 20 percent increase over that proposed under Alternative 1. This increases the potential for recreational boating traffic to disturb the sensitive mudflat habitat, including eelgrass beds. Most impacts would come from recreational boats because large vessels other than ferries would not be found in the project area.

Mitigation. Mitigation measures related to disturbance of mudflat/eelgrass habitats would be the same as those described for Alternative 1. Implementing these mitigation measures would reduce the impact to a less than significant level.

Impacts to Sensitive Bird Species

Impact: Pedestrian and boating impacts on wading shorebirds (Factors 1 and 2). As described for Alternative 1, increased pedestrian and boating activity around Clipper Cove could have a significant impact on shorebirds by affecting mudflats and eelgrass beds where shorebirds forage. Habitat degradation, human presence, and an enlarged marina under Alternative 2 could result in significant impacts to sensitive bird habitat and species. Although none of the bird species are listed as endangered or threatened under the ESA, they are all protected under the MBTA.

Development at Treasure Island under Alternative 2 would attract approximately half the number of daily visitors proposed under Alternative 1. As a result, the impacts in the area of the themed attraction adjacent to Clipper Cove also would be approximately half of those described under Alternative 1. Expanding the marina to between 500 and 675 slips and buoys would result in an approximately 500 percent increase in boat traffic in Clipper Cove over existing conditions and a 20 percent increase over that proposed under Alternative 1. This increases the potential for increased recreational boating to disturb the sensitive mudflat habitat, including eelgrass beds.

Mitigation. Mitigation measures for disturbing mudflat habitat would be the same as those described for Alternative 1. Implementing these mitigation measures would reduce the impact to a less than significant level.

Impacts to Mudflat and Eelgrass Habitat (EFH)

Impact: Pedestrian and boating impacts on EFH (Factor 1). Increased pedestrian and boating activity around Clipper Cove and along the perimeter of the islands could have a significant impact on EFH in shallow water and mudflat areas, as described for sensitive habitats under Alternative 1.

Mitigation. Mitigation measures for disturbing EFH would be the same as those described for sensitive habitats under Alternative 1. Implementing these mitigation measures would reduce the impact to a less than significant level.

Not Significant Impacts

Dredging Impacts to mudflat and eelgrass habitat (Factor 1). Eelgrass vegetated areas on the southeastern side of Clipper Cove are considered the most sensitive aspect of EFH in the project area, due to their function as cover and feeding habitat for a number of species. As for Alternative 1, impacts to eelgrass and mudflat habitat resulting from dredging would be not significant. Dredging and other activities for maintaining Pier 1 for ferry service are not likely to adversely affect any protected bird species. Dredging and disposal activities would require permitting and related agency coordination in compliance with Section 404 of the Clean Water Act, as described in Alternative 1.

Impacts to other sensitive habitats (Factor 1). Impacts to jurisdictional wetlands, open water habitats, and terrestrial habitats would be less than significant. Most development would occur on lands previously developed or disturbed and would not affect any lands currently used or occupied by any sensitive species. Marsh gumplant, the only plant species of concern known to occur on or near the project area, occurs to the east of the main project area and would not be affected by project activities.

Any dredging would require a Section 404 permit. Placing pilings or expanding docks in aquatic habitat would require a Section 10 permit from the COE. Impacts from these activities would be addressed during the permitting process.

Short-term impacts to water quality in open water habitats near dredging areas could occur as a result of dredging but are unlikely to cause significant impacts to sensitive habitats.

As described in Alternative 1, it is unlikely that increased boat traffic would affect sensitive habitats, with the exception of eelgrass, discussed above. No mitigation is proposed.

Impacts to eelgrass beds from accidental oil releases from boats could have short-term impacts on these habitats. Impacts of and prevention measures for accidental oil releases are discussed under Impacts to Other Sensitive Habitats, Alternative 1.

Similar to Alternative 1, any shore-based spills that reach the bay via the stormwater system would be regulated and monitored through the application of best management practices and an SPCC Plan. These measures would reduce this impact to less than significant. Impacts related to dredging to establish and maintain minimum depths for the proposed marina and other boating activities would be the same as those described for Alternative 1 and would be similarly less than significant.

Impacts to critical habitat (Factor 3). As for Alternative 1, the project area overlaps a small area of designated critical habitat for the Sacramento River winter-run chinook salmon and central California coast coho salmon, but the affected area is unlikely to provide important food or habitat resources for these species. As such, there would be no significant impacts to critical habitat.

The project area falls within designated critical habitat for the endangered Steller sea lion, but this critical habitat zone covers almost all of the west coast of the US, including Alaska. Because the project area makes up such a small portion of that critical habitat and the species is rarely seen in the bay, impacts from project activities would be less than significant. No mitigation is proposed.

Impacts to sensitive marine mammal species (Factor 2). Similar to Alternative 1, Alternative 2 would have less than significant impacts on the harbor seals at the basking and haulout area. While expanding the marina to between approximately 500 and 675 slips and buoys would substantially increase in boat traffic in Clipper Cove and would mean a 20 percent increase over that proposed under Alternative 1, this increase would not be expected to affect conditions at the seal haulout sites or the sensitive mudflat habitat (including eelgrass beds), which support harbor seal prey. Dredging and other activities for maintaining Pier 1 for ferry service would also have impacts on seals similar to those discussed for Alternative 1, which would be less than significant and addressed through permit conditions and requirements identified by state and federal resource agencies.

Impacts to benthic organisms (Factor 2). Dredging in Clipper Cove to accommodate a yacht harbor would have a short-term adverse impact on benthic organisms and bottom-dwelling invertebrates found within the shallow water habitat of the cove. This impact would be to local populations and is not expected to affect the overall population of these species within the bay. There are no sensitive species within this habitat type except for eelgrass, described in the previous section, and invertebrates affected by dredging are expected to reestablish themselves in the dredged zone over time. No mitigation is proposed.

Impacts to sensitive bird species (Factors 1 and 2). Impacts to the American peregrine falcon, California brown pelican, California least tern, and Alameda song sparrow are expected to be similar to, but proportionally less than, those described under Alternative 1. These not significant impacts include those to special status species and prey and avian foraging habitat and would be from dredging, in-water or near-shore construction, and increased vessel traffic. No mitigation is proposed.

Impacts to sensitive fish species (Factor 2). Dredging, constructing a seismic wall, expanding the marina, and engaging in other in-water activities proposed under Alternative 2 would result in not significant impacts to sensitive fish species, similar to that described under Alternative 1. No mitigation is proposed.

Impacts to EFH (Factor 3). Dredging, constructing a seismic wall, expanding the marina, and engaging in other in-water activities proposed under Alternative 2 would result in not significant impacts to EFH, similar to that described under Alternative 1. No mitigation is proposed.

4.8.3 Alternative 3

Under Alternative 3, many buildings and facilities at NSTI would be reused. Building upgrades for seismic safety would be limited to minor rehabilitation to meet life safety requirements recommended by FEMA-178 evaluations. Most new development would be on sites already occupied by buildings or parking lots, or on mostly landscaped areas, and therefore would not

significantly affect natural habitat areas. Dredging would be required to maintain the marina and for constructing a new ferry terminal. The planned actions that would affect biological resources would be increasing boat traffic, constructing a ferry terminal at Pier 12 and a yacht harbor, and humans using sensitive mudflat habitat.

Significant and Mitigable Impacts

Impacts to Sensitive Habitat

Impact: Mudflat habitat disturbance (Factor 1). Significant impacts to mudflat habitat, including eelgrass beds, may occur as a result of increased pedestrian and boating activity around Clipper Cove. Due to their function as cover and feeding habitat for a number of species, the eelgrass vegetated areas on the southeastern side of Clipper Cove are considered the most sensitive aspect of EFH. Development at Treasure Island under Alternative 3 would attract an estimated 2,740 daily visitors. Although this represents an 80 percent reduction in pedestrian activity compared to Alternative 1, it is still significantly higher than under current conditions. There would be a small increase in boat traffic from visitors to the island. This slightly increases the potential for disturbing the sensitive mudflat habitat, including eelgrass beds, from increased recreational boating.

Mitigation. Mitigation measures for disturbing mudflat habitat would be the same as those described for Alternatives 1 and 2. Implementing these mitigation measures would reduce the impacts to a less than significant level.

Impacts to Sensitive Bird Species

Impact: Pedestrian and boating impacts on shorebirds (Factors 1 and 2). Alternative 3 would result in impacts to protected bird species from human disturbance similar to those under Alternative 2, though at a reduced level. Although none of the bird species are listed as endangered or threatened under the ESA, they are all protected under the MBTA. Development at Treasure Island under Alternative 3 would attract an estimated 2,740 daily visitors. Although this represents an 80 percent reduction compared to Alternative 1, it is still significantly higher than under current conditions. There would be a small increase in boat traffic from visitors to the island. This slightly increases the potential for disturbing the sensitive mudflat habitat, including eelgrass beds, which may have an indirect effect on protected birds.

Mitigation. Mitigation measures for disturbing shorebirds would be the same as those described for Alternatives 1 and 2. Implementing these mitigation measures would reduce the impact to a less than significant level.

Impacts to Mudflat and Eelgrass Habitat (EFH)

Impact: Pedestrian and boating impacts on EFH (Factor 1). Increased pedestrian and boat activity around Clipper Cove and along the perimeter of the islands would affect EFH in shallow water and mudflat areas, as described for sensitive habitats under Alternative 1.

Mitigation. Mitigation measures for disturbing EFH would be the same as those described for sensitive habitats under Alternatives 1 and 2. Implementing these mitigation measures would reduce the impact to a less than significant level.

Not Significant Impacts

Dredging impacts to mudflat and eelgrass habitat (Factor 1). Impacts to eelgrass and mudflat habitat resulting from dredging would be less than significant. Potential adverse effects would be the same as those listed under Alternative 1.

Impacts to other sensitive habitats (Factor 1). Impacts to jurisdictional wetlands and waters of the US would occur as a result of constructing a yacht harbor in Clipper Cove. Impacts related to dredging to establish and maintain minimum depths for the proposed marina and other boating activities would be the same as those described for Alternative 1. Dredging could result in short-term localized impacts to water quality in open water habitats. These activities are unlikely to cause significant impacts to sensitive habitats because of the distance between these habitats and the dredging activities. Any dredging or construction in these waters would require a Section 404 permit. Placing pilings in aquatic habitat would require a Section 10 permit from the COE. Impacts would be less than significant because these activities would be conducted under Section 404 and coordinated with CDFG and NMFS, as described in Alternative 1. Construction in Clipper Cove by a nonfederal agency would constitute fill, according to BCDC, and would be regulated by that agency.

As described in Alternative 1, it is unlikely that increased boat traffic would cause an impact to sensitive habitats, with the exception of eelgrass, discussed above. No mitigation is proposed.

Impacts to eelgrass beds from accidental oil releases from boats could have short-term impacts on these habitats. Impacts of and prevention measures for oil releases are discussed under Impacts to Other Sensitive Habitats, Alternative 1. Similar to Alternative 1, any shore-based spills that reach the bay via the stormwater system would be regulated and monitored through the application of best management practices and an SPCC Plan. These measures would reduce this impact to not significant.

Impacts to critical habitat (Factor 3). The project area overlaps critical habitat for two fish species, but critical habitat would not be significantly affected. The project area constitutes a very small portion of fish species critical habitat. Potential impacts under this alternative would be localized and would pose no threat to the viability of critical habitat in the area.

The project area falls within designated critical habitat for the endangered Steller sea lion; however, this critical habitat zone covers almost all of the west coast of the US, including Alaska. Because the project area makes up such a small portion of that critical habitat and because the species is rarely seen in the bay, impacts from project activities would be less than significant. No mitigation is proposed.

Impacts to sensitive marine mammals (Factor 2). Impacts to MMPA-protected species from habitat degradation and human presence under this alternative would be similar to, but less than, impacts from Alternative 1. There would be a small increase in boat traffic from visitors to the island. This slightly increases the potential for disturbing the sensitive seal habitat, including haulout and basking sites, from recreational boating. Impacts would be less than significant, and no mitigation is proposed. Dredging and other activities for building and maintaining a ferry terminal at Pier 1 would also have impacts on seals similar to those discussed for

Alternative 1, which would be addressed through adherence to permit conditions and requirements identified by state and federal resource agencies.

Impacts to benthic organisms (Factor 2). Dredging in Clipper Cove to accommodate a yacht harbor would have a short-term, adverse impact on benthic organisms and bottom-dwelling invertebrates found within the shallow water habitat of the cove. This impact would be to local populations and is not expected to affect the overall population of these species within the bay. There are no sensitive species within this habitat type except for eelgrass, described in the previous section, and invertebrates affected by dredging are expected to reestablish themselves in the dredged zone over time. No mitigation is proposed.

Impacts to sensitive bird species (Factors 1 and 2). Impacts to the American peregrine falcon, California brown pelican, California least tern, and Alameda song sparrow are expected to be similar to, but proportionally less than, those described under Alternative 1. These less than significant impacts include impacts to special status species and prey and avian foraging habitat, impacts from dredging and in-water and near-shore construction, and impacts from increased vessel traffic. No mitigation is proposed.

Impacts to sensitive fish species (Factor 2). Dredging, constructing a seismic wall, expanding the marina, and other in-water activities proposed under Alternative 3 would result in not significant impacts to sensitive fish species similar to, but less than, that described for Alternative 1. No mitigation is proposed.

Impacts to EFH (Factor 3). Dredging, constructing a seismic wall, expanding the marina, and other in-water activities proposed under Alternative 3 would result in not significant impacts to EFH similar to, but less than, that described for Alternative 1. No mitigation is proposed.

4.8.4 No Action Alternative

Under the No Action Alternative, property available for disposal at NSTI would continue under federal ownership in an inactive caretaker status, and existing interim leases would be allowed to expire. There would be minimal use of NSTI property and facilities under this alternative. Ongoing activities would include maintenance to minimize deterioration and essential security operations.

Maintaining NSTI in caretaker status would result in no impacts to biological resources. Because no reuse would occur, there would be no impacts to sensitive species, sensitive habitat, marine mammal species, or essential fish habitat. No impacts to the mudflat habitat would occur because no new docks or facilities for recreational boats would be constructed.

4.9 GEOLOGY AND SOILS

The primary geotechnical hazards that may affect the reuse plan area, along with engineering techniques that could avoid or reduce the risk from these hazards, are discussed in this section as related to either seismic events or nonseismic events. The effects of earthquake-induced tsunamis are addressed in Section 4.10, Water Resources.

Factors considered in determining whether an alternative would have a significant impact on geology and soils included the extent or degree to which its implementation would:

1. Cause soil erosion, sedimentation, or land subsidence;
2. Adversely affect unique geologic or topographic features; or
3. Increase exposure of people, structures, or infrastructure to risk of catastrophic loss, injury, or death from rupture of a known earthquake fault, strong seismic ground shaking; or seismic-related ground failure, including liquefaction.

4.9.1 Alternative 1

Significant and Mitigable Impacts

Liquefaction, lateral spreading, and differential settlement (Factor 3). As discussed in Section 3.9, Treasure Island has a high probability of liquefaction and associated lateral spreading and differential settlement in the event of a major earthquake, due to the presence of sand fill below the water table and the underlying shoal sands. Treasure Island is designated a Seismic Hazards Studies Zone (SHSZ) by the California Division of Mines and Geology (CDMG). During a strong earthquake, liquefaction and differential settlement would likely occur throughout Treasure Island and the causeway and lateral spreading would likely occur within 500 feet of the perimeter dike (see Figure 3-19). In addition, approximately 6,700 linear feet of shoreline, in the northwest and southeast portions of the island, is subject to rotational dike failure (see Figure 2-2).

Low-lying areas of Yerba Buena Island underlain by heterogeneous artificial fill also are potentially subject to liquefaction, lateral spreading, and differential settlement hazards. The severity of the damage would vary, depending on the nature of the structure and site-specific geologic conditions.

The potential for damage to structures and infrastructure due to liquefaction-induced ground failure is considered a potentially significant but mitigable impact. Alterative 1 includes seismic stabilization improvements around the entire perimeter of Treasure Island, including the causeway. Under this alternative, a 50-foot wide band of rows of stone columns would be constructed along the shoreline to create an "improved zone" that is capable of confining and retaining liquefied soil inland of the zone. In addition, 6,700 linear feet of cement columns would be constructed in the areas prone to rotational dike failure (see Figure 2-2).

In addition to these proposed seismic stabilization improvements, the following mitigation measures shall be implemented during perimeter stabilization and new construction:

Mitigation. Interior island areas shall be improved to reduce large differential settlement caused by liquefaction, using methods such as stone columns, dynamic compaction, chemical and compaction grouting, dewatering the groundwater below the level of liquefiable soils, and surcharge fill with wick drains (San Francisco 1995b).

All sensitive structures (e.g., buildings greater than three stories, buildings intended for public occupancy, structures supporting essential services, and buildings housing schools, medical, police, and fire facilities) shall be supported on pile systems or other specially designed foundations. Smaller structures shall use mat foundations to distribute loads over a larger area and to increase foundation flexibility. Essential utilities shall be fit with flexible connections designed to withstand rupture (San Francisco 1995b).

Detailed geotechnical studies shall be completed in accordance with San Francisco requirements for individual development sites to identify which specific engineering techniques should be used to reduce liquefaction, lateral spreading, and differential settlement hazards to an acceptable level of risk. Such geotechnical studies shall incorporate recommendations of a California-licensed engineering geologist into future site preparation, foundation, and building design.

Complying with these mitigation measures would eliminate or reduce impacts to less than significant.

Not Significant Impacts

Non-Seismic Hazards

Geotechnical hazards not specifically related to earthquake activity include local settlement, slope instability, and erosion.

Local settlement (Factor 1). Settlement is the localized lowering of the ground surface due to a decrease in the volume of the underlying soil. Development under Alternative 1 could result in settlement hazards associated with construction on the on-site fill sediments or the underlying Bay muds as these materials adjust to new loading from heavy buildings, mat foundations, or other new fills and drains. Although most of the potential settlement at existing loadings at Treasure Island has already occurred, gradual area-wide settlement could be accelerated and could continue for many more years, resulting in increased local ponding, increased flooding potential, or water-logged soils.

Standard engineering techniques to remove and recompact loose, unconsolidated fill to relatively noncompressible materials would be applied in those areas proposed for development under Alternative 1. Geotechnical evaluations of proposed specific reuse development projects would be required. Engineering techniques to remove and recompact near-surface soils would be used to reduce hazards of local settlement. Because established engineering techniques would be applied, as appropriate, the potential for settlement would be minimized, and this impact would be not significant. No mitigation is proposed.

Slope instability (Factor 1). Due to the steep slopes and landslide deposits around the margin of Yerba Buena Island, development under Alternative 1 could result in increased exposure to

hazards associated with slope instability. However, impacts on development would not be significant because of requirements for construction. San Francisco's standard code requirements for slope design and drainage would apply to new developments. San Francisco would routinely check existing landslides and steep slope areas for slope movements. If slope movement is detected, appropriate repairs would be initiated as soon as possible. Specific requirements would be evaluated on a project-by-project basis. Therefore, this impact would not be significant under Alternative 1. No mitigation is proposed.

Erosion (Factor 1). Demolition and construction activities within the reuse plan area could result in increased potential for wind erosion of soils, especially if grading is conducted in dry, but windy, summer weather. Once an individual site is graded and landscaping vegetation is established, the erosion potential of the soils would diminish.

Soil erosion from Treasure Island is not expected to be significant due to the relatively level topography of the island. Construction on Yerba Buena Island could result in substantial erosion due to its steep slopes, which in turn could affect slope stability. Temporary erosion control measures would be provided during the construction phases of the project, as required by the local grading code and NPDES permits, to minimize these effects. A post-development erosion-control program also would be implemented. This program could include regular inspection and maintenance of drainage control devices, proper irrigation to minimize runoff, and landscaping to reduce wind and water erosion. Implementation of these required measures would ensure that erosion impacts are reduced to a not significant level. No mitigation is proposed.

Ferry wakes also could erode the perimeter dike, but it is in good repair and subject to regular wave and wake action daily from local and international shipping vessels. Therefore, it is unlikely that ferry wakes would substantially affect the dike.

Seismic Hazards

As discussed in Section 3.9, the reuse plan area lies within a region of northern California that is seismically active and is subject to earthquake-related hazards, as discussed below.

Surface fault displacement (Factor 3). The reuse plan area is not located within an Alquist-Priolo Earthquake Fault Zone and no active or potentially active fault is known to exist at the ground surface on or immediately adjacent (i.e., within 5 miles [8 km]) to the site. Therefore, the potential risk of loss, injury, or death due to surface fault rupture would be minimal. There would be no impact from hazards to reuse development associated with surface fault displacement.

Seismic shaking (Factor 3). As discussed in Section 3.9, the reuse plan area would be subject to strong seismic ground shaking during major earthquakes. A maximum credible earthquake centered on the northern segment of the Hayward Fault (Mercalli scale intensity IX at NSTI, ABAG 1995a) would cause major damage to NSTI structures and utilities. A major earthquake could severely limit or even prevent vehicular access to the site if the SFOBB is damaged, impeding basic and emergency services to the site, even with the proposed dike improvements, causeway reinforcement, and the proposed SFOBB east span replacement and west span strengthening.

It is likely that emergency response systems, in San Francisco in particular and in the Bay Area as a whole, would be overloaded in the immediate aftermath of a large earthquake. Because of the large population that probably would be present at NSTI in an earthquake under this alternative, it likely would be necessary for offices, hotels, recreational facilities, and residents to be self-sufficient for several days until basic systems could be restored or until occupants could be evacuated.

All new structures in California must be designed and constructed in compliance with seismic safety standards and requirements of the State Uniform Building Code (UBC). San Francisco requires all new development of existing structures to comply with the most current UBC requirements and standards. The San Francisco Department of Building Inspection (DBI) will use the *National Earthquake Hazards Reduction Program Handbook for the Seismic Evaluation of Existing Building* (FEMA-17) to assess seismic hazards in existing buildings; this is the federal standard by which federal buildings are evaluated (San Francisco 1998c). Seismic upgrades of existing structures designated for reuse would be performed to minimize life safety risks from failures in a large earthquake. Structures that cannot feasibly be retrofitted to meet a life safety objective would be demolished. Compliance with these regulations by each individual development within the reuse plan area would reduce impacts related to seismic shaking to the most current safety levels.

Several measures and policies to minimize the effects of seismic shaking are included as part of the Draft Reuse Plan. These measures include investigating structural and geotechnical conditions with appropriate upgrades prior to reuse of existing structures, preparing geotechnical site investigations and conducting appropriate structural design for all new development, and preparing emergency response plans. Therefore, the potential risk of loss, injury, or death would be minimal and impacts would not be significant. No mitigation is proposed.

Dike failure (Factor 3). As discussed in mitigation measures provided above, placing stone columns, soil-cement columns, and rock berms around the island perimeter would minimize risks associated with perimeter dike failure from lateral spreading or slumping in an earthquake or from wave action associated with large storms. Still, localized failures may occur because of the thickness of the unconsolidated sediments underlying the dikes. In the event of a failure, or as a precautionary measure in areas deemed to be less resistant to failure, the rock berm that forms the perimeter dike could be replaced or reinforced with a larger, exterior rock berm. The larger rock berm would buttress the dike and would resist the forces imposed by liquefied soil and fill behind the dike, as well as ground shaking. The San Francisco Department of Building Inspection will require peer review of permits for perimeter dike improvements by structural and geotechnical engineers for the purpose of ensuring that appropriate geotechnical data are collected and properly evaluated, and for ensuring that appropriate corrective measures are proposed. Implementing these measures is expected to reduce the hazards related to dike failure to acceptable levels. Localized dike failure, which has occurred in the past, is not expected to result in an unacceptable risk of loss, injury, or death. No mitigation is proposed.

Seismically induced slope failure (Factor 3). As described in Section 3.9, slope failure can be triggered by an earthquake. Slopes subject to earthquake-induced failure exist on steep slopes of Yerba Buena Island. Existing landslide deposits are concentrated around the margins of

Yerba Buena Island, particularly on the south shore of the island (see Figure 3-21). There is no new habitable development planned for these areas; however, existing roads may continue to be undercut by slope failures and earthquake-induced failures could threaten existing or proposed development in other areas in which landslides have not been mapped. Alternative 1 would not increase the potential for earthquake-induced slope failure; however, it could increase the number of people exposed to the hazards of slope failure to the extent that there would be more traffic on existing roads on Yerba Buena Island. Major slope failure could result in road closures, and this could impede transportation between NSTI and the mainland. Landslides onto the roadway would endanger people using the road. As discussed above with regard to seismic shaking, existing structures, including roadways, would be evaluated and retrofitted or abandoned, if necessary, to reduce risks to acceptable levels. Therefore, the impacts of earthquake-induced slope failure are not considered significant.

No Impacts

Unique geologic and topographic features (Factor 2). The reuse plan area does not contain any unique geologic or topographic features. Yerba Buena Island is a prominent topographic feature, but it is not unique and would not be substantially altered under Alternative 1. Therefore, there is no impact. No mitigation is proposed.

4.9.2 Alternative 2

Significant and Mitigable Impacts

The potential impacts under Alternative 2 would be comparable to those of Alternative 1 because the geotechnical hazards are associated with existing physical features of the reuse plan area itself. However, the type, nature, and magnitude of development under Alternative 2 differ from those proposed under Alternative 1. Alternative 2 includes creating a golf course instead of housing on the northwest portion of Treasure Island, eliminating the proposed perimeter stabilization of that portion of the island, and building fewer residential units on Yerba Buena Island. Less residential development under Alternative 2 would reduce the magnitude of the geologic impacts described for Alternative 1 because a smaller permanent population would be exposed to seismic hazards.

Greater impacts to unprotected recreational land uses would be created in the golf course area due to lack of perimeter stabilization in that area. For example, substantial lateral spreading in a major earthquake would result in a localized loss of recreational land near the point of a dike failure and within 500 feet (152 m) or more inland. If not promptly repaired, such a failure would reduce the buffer area provided by the golf course and possibly subject any unsupported structures and infrastructure inland of the failure to the secondary effects of future seismically induced lateral spreading.

Similar to Alternative 1, impacts are considered potentially significant but mitigable. With the exception of the area adjacent to the proposed golf course, Alterative 2 includes seismic stabilization improvements around the perimeter of Treasure Island, including the causeway (see Figure 2-2). Similar to Alternative 1, an "improved zone" would be created that is capable of confining and retaining liquefied soil inland of the zone.

In addition to these proposed seismic stabilization improvements, the following mitigation measures shall be implemented during perimeter stabilization and new construction:

Mitigation. Proposed mitigation measures are the same as those discussed for Alternative 1. Complying with these mitigation measures would reduce impacts to less than significant.

Not Significant Impacts

As discussed for significant and mitigable impacts above, the potential for less than significant impacts under Alternative 2 would be comparable to those of Alternative 1. Compliance with San Francisco requirements for site-specific geotechnical investigations would be required for each individual development. Requirements identified for Alternative 1 to reduce local settlement, slope instability, and erosion also would be required for development under Alternative 2. No mitigation is proposed.

4.9.3 Alternative 3

Significant and Mitigable Impacts

The potentially significant and mitigable impacts under Alternative 3 would be roughly comparable to those of Alternative 1 because the geotechnical hazards are associated with existing physical features of the reuse plan area itself. However, the type, nature, and magnitude of development-related impacts under Alternative 3 differ from those proposed under Alternative 1. Alternative 3 would involve extensive reuse of existing facilities, including continuation of existing leases, and less intensive new development than the other two reuse alternatives, and there may be more potential difficulty in retrofitting existing structures to resist seismic hazards. Compared to Alternative 2, more residential development would increase the magnitude of the impacts described because a larger resident population would be exposed to seismic hazards, including greater nighttime exposure to these hazards. Perimeter dike improvements would be limited to the northwest and southeast corners of Treasure Island in the areas subject to rotational dike failures (see Figure 2-2). Therefore, greater impacts to unprotected shoreline recreational land uses and some areas proposed for institutional and community uses would be created due to the lack of perimeter stabilization in these areas. Impacts are considered potentially significant but mitigable.

Similar to Alternative 1, an "improved zone" would be created in the northwest and southeast portions of the island that is capable of confining and retaining liquefied soil inland of the zone. The following mitigation measures shall be implemented during perimeter stabilization and new construction:

Mitigation. Proposed mitigation measures are the same as those discussed for Alternative 1. Complying with these mitigation measures would reduce impacts to less than significant.

Not Significant Impacts

As discussed above for potentially significant and mitigable impacts above, the potential for less than significant impacts under Alternative 3 would be comparable to those of Alternative 1. Compliance with San Francisco requirements for site-specific geotechnical investigations would be required for each individual development. Requirements identified for Alternative 1 to

reduce local settlement, slope instability, and erosion also would be required for development under Alternative 3. No mitigation is proposed.

4.9.4 No Action Alternative

The No Action Alternative would not result in new or additional geotechnical impacts. Existing structures would continue to be subject to existing seismic and nonseismic hazards, and no increase over existing seismic hazards would occur.

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4.10 WATER RESOURCES

Potential water resources impacts resulting from disposal and reuse of NSTI are discussed in this section. This section is closely related to section 4.11 (Utilities), which discusses water supply and infrastructure for domestic use. Factors considered in determining whether an alternative has significant impacts to water resources included the extent or degree to which its implementation would:

1. Adversely affect drainage patterns to the extent that the physical, chemical, or biological character of nearby bodies of surface water would be substantially altered;
2. Degrade water quality below levels established by regulatory agencies; or
3. Increase risk to human health and safety, or for economic damage, by siting incompatible land uses and facilities within areas susceptible to flooding or ponding.

4.10.1 Alternative 1

Alternative 1 would require dredging to develop and maintain the marina (including periodic shoal dredging), for maintaining and using Pier 1 for ferry service, and possibly for developing the new ferry terminal pier proposed for the west side of Treasure Island.

The overall area of paved surfaces at NSTI would increase under this alternative. Assuming that approximately 75 percent of open space areas on NSTI are developed, Alternative 1 would generate an additional 37 acres (15 ha) of paved surfaces; therefore, the volume of stormwater discharges also would increase.

The volume of wastewater discharged as treated effluent would remain below the permitted capacity of the sewage treatment plant (see section 4.11.3).

Significant and Mitigable Impacts

Impact: Exposure of individuals and property to ponding from high tides (Factor 3). The installation of residential development in low-lying areas on Treasure Island would result in increased exposure of occupants, visitors, and property to ponding hazards due to seepage through the dike and underlying sediments during some high tide events. The rate of flow from the bay to the interior of the island is proportional to the difference in elevation between the bay and the water table on the island, so the rate of seepage increases with higher tidal stands. This seepage sometimes leads to water ponding in low-lying areas of the island. Compared to baseline conditions, there would be a net increase of about 2,395 residents, plus approximately 13,700 daily visitors. The exposure of people and structures to this type of flooding is considered a potential significant and mitigable impact.

Mitigation. Filling low-lying portions of the residential area to at least 9 feet (3 m) NGVD prior to development would mitigate this impact by ensuring that the ground surface is above the maximum average daily elevation of the bay. In addition, other low-lying areas within 500 feet (152 m) of the Treasure Island perimeter should be similarly filled before development is allowed.

Implementing this mitigation would reduce the impact to a not significant level.

Impact: Exposure of individuals and property to flooding (Factor 3). Developing and reusing Treasure Island under Alternative 1 could expose occupants, visitors, and property to flooding hazards caused by dike overtopping during storms, which could be a significant impact. In a worst-case scenario, a maximum high tide of 6.4 feet (2 m) NGVD, in combination with 60 mph (97 km/hour) storm winds, could result in waves reaching 13 to 14 feet (4 to 4.3 m) above sea level NGVD. As the existing perimeter dike is at elevations ranging from about 7.7 to 13.8 feet (2.3 to 4.2 m) NGVD, events of this magnitude would result in waves overtopping the dike in some areas.

Sea level rise also could increase potential flooding problems at NSTI. Predictions of future accelerated sea level rise due to global warming vary widely. The effect of sea level rise is increased on a land mass that is concurrently subsiding. The EPA projects a 50 percent likelihood that sea levels will rise about 4 inches (10 cm) (an average of 0.14 inches [0.36 cm]/year) by 2025 and about 8 inches (20 cm) (an average of 0.16 inches [0.39 cm]/year) by 2050. Such increases are the middle range of sea level rise estimates, which range from zero to over 18 inches (46 cm) (an average of 0.03 feet [0.009 m]/year) by 2050 (EPA 1995).

When the highest current tide (approximately 6.4 feet [2 m]) is superimposed on the EPA's estimates for rise in sea level (approximately 8 inches [20 cm]), high tides could reach approximately 7 feet (2 m) and 1 inch (2.5 cm) NGVD. Such estimates do not include compounding caused by high storm waves of approximately 7.5 feet (2 m) occurring simultaneously with high tides. They also do not include the effects of continued settlement of the island, which has been estimated to be on the order of approximately 1 foot (0.3 m) over the next 50 years (San Francisco 1995b). Therefore, significant flooding could still occur, even with raised dikes. This is considered a significant and mitigable impact.

Mitigation. Set back development inboard of the perimeter dike to allow room for periodic dike raising without substantially increasing bay fill. Raise the dike as necessary to account for site settlement, changes in maximum tidal heights, and rises in sea levels. In addition, inspect the dike after each major storm to identify repair needs, and repair the dike promptly.

Implementing this mitigation measure would reduce the impacts to a not significant level.

Not Significant Impacts

Dredging and dredge material disposal (Factors 1 and 2). Dredging associated with this alternative could disturb and disperse sediments, including any contaminated sediments, into the water column, reducing dissolved oxygen and increasing suspended particulates (COE 1992). Dredging also would cause temporary increases in water column sediment and turbidity as the sediments are raised through the water column. Contaminants released by dredging activities could significantly degrade water quality at or near the dredge sites, unless precautionary measures are taken.

Sediments will be tested in place prior to dredging. If contaminants are identified at concentrations capable of causing adverse water quality effects, appropriate measures will be evaluated and adopted prior to undertaking dredging. Dredging contaminated sediments

requires use of special dredging equipment, such as an environmental or closed bucket, high solids slurry pumps, marine excavators, and silt curtains. The site will be dredged using appropriate dredging technology suitable to the site-specific conditions and in accordance with future permit requirements placed by the appropriate regulatory agencies.

Sediment sampling conducted in late January through early February 1996 at the former Clipper Cove Skeet Range indicated that there are contaminated sediments in the marina area with elevated levels of lead and polychlorinated aromatic hydrocarbons (PAHs) (DON 1997q). Dredging operations typically do not cause significant short- or long-term fluctuations in salinity, temperature, or pH. However, temporary turbidity increases occur when the scow receiving the dredged materials is allowed to overflow with sediment-laden water so that it can be filled to capacity.

Dredging would require permits and approvals from BCDC, San Francisco Bay RWQCB, and the COE. Prior to dredging, and in compliance with the CWA (Section 404, EPA's 404[b][1] Guidelines of 1980 [40 C.F.R. Part 230]), all materials proposed for excavation and dredging must be tested for heavy metals, hydrocarbons, PCBs, tributyltin, pesticides, and any other contaminants of concern to the RWQCB. Careful delineation and segregation of any contaminated material would minimize the volume of contaminated sediments generated. Compliance with all applicable regulatory requirements would ensure that potential impacts would not continually violate water quality standards or requirements and therefore would be not significant. No mitigation is proposed.

Marine disposal of contaminated dredged sediments also could contaminate receiving waters. Uncontaminated dredge sediments could increase turbidity and suspended sediments at marine disposal sites. Runoff from drying and dewatering dredge materials also could adversely affect adjacent bay waters. However, similar to dredging, the dredge material disposal process is strictly regulated by federal and state agencies. Any contaminated dredging material must be disposed of in approved upland facilities. All sediment disposal programs and methods would need to comply with applicable LTMS sediment disposal priorities, which favor reusing sediments on land instead of disposing of them in the bay or ocean. Complying with the LTMS Implementation Plan for dredge material disposal and all other applicable regulatory requirements would ensure that dredging activities would not violate water quality standards or requirements; therefore, impacts would be not significant. No mitigation is proposed.

Construction impacts (Factors 1 and 2). Alternative 1 would result in construction of buildings, other structures, and infrastructure within the reuse plan area. Construction operations would lead to silt-laden runoff from construction sites due to storm events and watering to reduce PM_{10} emissions. Dewatering of construction sites also could be employed if extensive ground excavation, such as for deep foundations, were required. This runoff, which could contain relatively high levels of petroleum hydrocarbons, would contribute to degrading local and regional surface water quality. Construction would not impact groundwater in the regional aquifer because NSTI is isolated from the water-bearing aquifers in the Oakland area. Groundwater in the shallow aquifer beneath the islands might be locally lowered during construction. However, this impact would be temporary and would not impact water operations elsewhere in the Bay Area.

A stormwater management plan would be developed for NSTI consistent with Clean Water Act requirements for the Stormwater Pollution Prevention Program (SWPPP). The stormwater management plan would address monitoring, source reduction, BMPs, and treatment strategies. Examples of some general actions required by BMPs include the following:

- Schedule excavation and grading work for dry weather;
- Use as little water as possible for dust control;
- Use revegetation, if feasible, for erosion control after clearing, grading, or excavating; and
- Follow other BMPs required by general construction NPDES permits.

Therefore, construction impacts would not violate water quality standards or requirements and would be not significant. No mitigation is proposed.

Water quality (Factors 1 and 2). Alternative 1 would result in a small increase in impervious surface area (see below, for Factor 3), resulting in the potential for an increased rate of discharge of stormwater to the bay. Higher flow velocities or increased ponding in low areas could cause slightly increased loading of urban pollutants (e.g., sediments, oil and grease, etc.). Since the percentage increase in the volume of stormwater runoff would be small, it is unlikely to result in a significant increase in the amount of pollutants that flow into the bay.

Contaminants commonly associated with urban development include leaking motor oils, fuel, and other vehicular fluids, fertilizers and pesticides from landscaping, and trash. These contaminants can be washed by rain and carried with runoff into the bay. Ferry service to and from Treasure Island also could contribute to pollutants in the bay. Similar to construction, an SWPPP and BMPs may be required to limit the introduction of these contaminants into the bay.

As recommended in the Draft Reuse Plan, Alternative 1 would include implementation of BMPs to improve water quality prior to discharging to the bay. BMPs for stormwater runoff include limiting oil and grease runoff from parking areas, limiting contaminants in wash-down of the themed attraction, and managing herbicides and pesticides for open space areas and yards. Wherever possible, grassy swales and detention ponds should be used to provide on-site treatment of urban pollutants prior to water discharges to the bay.

Alternative 1 also could lead to dewatering of the high groundwater table beneath Treasure Island if deep foundations or utilities were to be built. Since groundwater beneath Treasure Island contains petroleum hydrocarbons, metals, and other contaminants, and this project would contribute runoff to the bay, this dewatering would need to comply with BMPs contained in the state's NPDES permit and local RWQCB permits. It is anticipated that most groundwater removed during dewatering activities would be discharged to the on-site wastewater treatment plant. Any contaminated water not treatable by the plant would be disposed of in an appropriately permitted facility. Discharge of the removed groundwater into the on-site drainage system would be allowed only after obtaining a San Francisco discharge permit. In reviewing the permit for discharge, the city would ensure that contaminant levels would be reduced to the extent required to be protective of the bay and in compliance with applicable permits from the RWQCB. If direct discharge to surface water is determined as the appropriate method for disposal of groundwater removed during dewatering, permits issued

by the RWQCB under the NPDES program would be required. Therefore, the impact of dewatering would not be significant.

Exposure of individuals and property to flooding (Factor 3). Although nearly all stormwater (except that which evaporates) must be discharged to the bay to prevent flooding, Alternative 1 would increase the amount of impervious surfaces, particularly in the residential area in the northwest portion of the site, and therefore could increase the average volume and speed of stormwater runoff. Developing sports fields on the central portion of Treasure Island, on the other hand, would reduce the area of impervious surface, and slow the rate of runoff. Because much of the island is already covered with impervious surfaces, the proposed net increase would not be substantial. It is estimated that Alternative 1 would generate an additional 37 acres (15 ha) of impervious surfaces. The small increase in the runoff rate is not expected to substantially increase the potential for flooding.

Tsunami and seiche wave heights are expected to be less than about 3 feet (0.9 m) (San Francisco 1995b). For flooding to occur, tsunamis would need to coincide with combined tide and wave heights of over 7.5 feet (2 m). The likelihood of a major tsunami (e.g., a 100- or 500-year event) occurring simultaneously with a high tide is highly remote. For example, if we estimate that over the next 100 years bay water levels (accounting for tidal levels, base swell, wind-driven waves, rise in sea level, and settlement of the dikes) will exceed the equivalent of 7.5 feet (2 m) NGVD about 20 percent of the time, then the probability of a 100-year tsunami or seiche occurring simultaneously with such a high tide would only be about 0.2 percent per year, or equivalent to about a once in 500 years event. This is not sufficiently probable to be considered a significant impact.

4.10.2 Alternative 2

Under Alternative 2, a golf course would be developed on the northern portion of Treasure Island, and development would occur on the southern half of the island. Similar to Alternative 1, dredging would be required for expanding and maintaining the marina, maintaining and using Pier 1, and constructing a ferry terminal on the west side of Treasure Island. Although stormwater runoff in the northwest portion of Treasure Island (where the golf course is proposed) would decrease, the overall amount of paved surfaces at NSTI would increase under this alternative.

Golf course development is estimated to result in a net loss of approximately 25 acres (10.1 ha) of paved surfaces. However, assuming that approximately 75 percent of open space areas on Treasure Island is developed, Alternative 2 would generate an additional 37 acres (15 ha) of paved surfaces, for a net increase of 12 acres (4.9 ha) of paved area. Therefore, the volume of stormwater discharges also would increase. The volume of wastewater discharged as treated effluent would remain below the permitted capacity of the sewage treatment plant.

Significant and Mitigable Impacts

Impact: Exposure of individuals and property to flooding (Factor 3). Compared to baseline conditions, this alternative would subject fewer residents (a net decrease of approximately 3,790) but more daily visitors (a net increase of 5,500) on the northern half of Treasure Island, where a golf course is proposed, to existing flood hazards. Flood hazards on the southern

portion of the site would be similar to those described for Alternative 1. This is considered a *significant and mitigable impact.*

Mitigation. Mitigation measures for flooding from dike overtopping would be the same as those described for Alternative 1.

Implementing these mitigation measures would reduce the impact to a not significant level. As described for Alternative 1, flooding due to tsunamis or seiches is not considered a significant impact.

Not Significant Impacts

Not significant impacts related to dredging and dredge material disposal, and construction impacts are the same as those described for Alternative 1. Ponding from high tides also would be considered a not significant impact because only minimal structures (e.g., golf club house, golf shop) are planned in the northern portion of the island where existing ponding occurs.

Water Quality (Factors 1 and 2). Not significant impacts to water quality would be similar to those described for Alternative 1 with the exception that Alternative 2 would have a slightly greater potential impact to water quality as a result of the development of a golf course. Chemicals associated with the golf course could adversely affect water quality if not adequately managed. Hazardous materials management would be subject to all regulatory controls. In addition, a chemical application and management plan would be required to address the management of these materials.

4.10.3 Alternative 3

Under Alternative 3, most existing facilities would be reused and existing interim uses, such as the firefighting training facility, would continue. Dredging would be required only for maintaining the existing marina. Dike improvements are proposed along the northwest and southeast portions of Treasure Island in the areas subject to rotational dike failure. It is anticipated that the overall amount of paved surfaces at NSTI would remain roughly the same under this alternative because minimal new development is proposed, so the volume of stormwater discharges would remain roughly the same. The volume of wastewater discharged as treated effluent would remain below the permitted capacity of the sewage treatment plant.

Significant and Mitigable Impacts

Impact: Exposure of individuals and property to flooding (Factor 3). Alternative 3 could subject occupants, visitors, and property to substantial flood hazards throughout Treasure Island. Compared to operational baseline conditions, there would be fewer residents (a net decrease of 990) but more daily visitors (an increase of 2,740) throughout NSTI exposed to these existing hazards. This is considered a significant and mitigable impact.

Mitigation. Mitigation measures for flooding from dike overtopping would be the same as those described for Alternative 1.

Implementing these mitigation measures would reduce the impact to a not significant level. As described for Alternative 1, potential flooding due to tsunamis or seiches is not considered a significant impact.

Impact: Exposure of individuals and property to ponding from high tides (Factor 3). Occupants of structures in the low-lying areas of the residential portion of Treasure Island would be susceptible to substantial ponding hazards. This is considered a significant and mitigable impact.

Mitigation. Mitigation measures for ponding during high tides would be the same as those described for Alternative 1.

Implementing these mitigation measures would reduce the impact to a not significant level.

Not Significant Impacts

Dredging and dredge material disposal (Factors 1 and 2). The only dredging activity proposed under this alternative is maintenance dredging at the existing marina. This level of dredging would be commensurate with historic maintenance dredging activities at NSTI and would not be considered a significant effect. No mitigation is proposed.

Construction impact (Factors 1 and 2). Construction-generated stormwater runoff from the development of Alternative 3 would be substantially less than but similar in nature to what would result for Alternative 1. Lower levels of runoff are expected because several existing buildings would be reused and there would be limited new construction. Impacts would not continually violate water quality standards or requirements and would be not significant. No mitigation is proposed.

Water quality (Factors 1 and 2). Compared to baseline conditions, Alternative 3 would generate about 17 percent fewer daily vehicle trips, and there would be no expected increase in boating activity. Therefore, potential water quality impacts associated with urban pollutants in stormwater runoff and boat discharges would not be significant. The existing firefighting training school is a contained facility, and all runoff is discharged directly to the sanitary sewer for treatment. No materials are burned, and no fire suppression chemicals are used during training exercises; therefore, there would be no significant impacts on runoff water quality generated at this facility. No mitigation is proposed.

4.10.4 No Action Alternative

Under the No Action Alternative, property available for disposal at NSTI would continue under federal ownership in an inactive caretaker status, and existing interim leases would be allowed to expire. There would be minimal use of the property and facilities under this alternative. Dike maintenance would provide continued flood protection under most conditions, although in large storm events it is expected that waves would overtop the dikes occasionally, resulting in flooding of low-lying areas unless the dike elevation is raised or sufficient pumping capacity is installed to drain off the water. Cleanup of hazardous materials, petroleum products, or waste sites also would be continued by the Navy. There would be no additional impervious surfaces; therefore, there would not be an increase in runoff into the stormwater system relative

to current conditions (except if the dikes were overtopped). Ponding of stormwater in low-lying areas would continue, as would settling of the sediments underlying the island, resulting in the potential for continued and possibly increased localized flooding. These impacts would be controlled through maintenance, such as by installing additional pumping capacity as needed, and would be not significant. Existing residual urban pollutants would continue to be discharged to the bay in stormwater runoff, resulting in not significant impacts on water quality. No dredging would be required. No impacts to water resources would occur under this alternative.

4.11 UTILITIES

Utility services addressed in this section are potable water and fire protection distribution, wastewater collection and treatment, stormwater collection, electrical and natural gas, telecommunications, and solid waste systems. Factors considered in determining whether an alternative would have significant impacts on utilities included the extent or degree to which its implementation would:

1. Increase utility demand to a level in excess of current or planned capacity for major utility system components, such as reservoirs, wastewater treatment plants, or landfills; or
2. Would cause the utility provider to violate applicable legal or regulatory environmental standards and requirements.

The impacts presented in this section have been evaluated against the baseline environmental conditions presented in Chapter 3. Navy recognizes that changes in the environmental conditions may have occurred in the period between the baseline years and the present. Although these changes may result in different, and in many cases, lesser impacts to certain resources, changes to the impact analysis based on any interim change in resource conditions is not appropriate.

Resolving utility issues related to ownership of certain portions of NSTI property and the utility infrastructure that crosses that property owned by Caltrans would be the responsibility of San Francisco.

4.11.1 Alternative 1

Under Alternative 1, a new wastewater treatment plant would be constructed, and a new utility corridor would be constructed around the perimeter of Treasure Island and under an east-west roadway in the center of the island. This utility corridor would carry storm and sanitary sewer mains, water mains, reclaimed water mains, and electricity, gas, and telecommunications lines. Because construction of these facilities is part of Alternative 1 reuse, impacts related to air quality, noise, and other environmental issues are described within various sections of chapters 4 and 5.

Not Significant Impacts

Impacts to utility systems, including potable water and fire protection distribution, wastewater collection and treatment, stormwater collection, electrical and natural gas, telecommunications, and solid waste, are considered not significant because they would not increase demand in excess of current or planned capacity nor would they cause utility providers to violate applicable regulations and standards or require unplanned construction of major additional infrastructure. These impacts are discussed in the sections below.

Potable water and fire protection distribution (Factors 1 and 2). Baseline domestic water usage was 0.96 MGD (3.6 million liters per day) (see Table 4.11-1). The average daily domestic water demand was estimated by applying per capita average water demands to the number of employees, residents, theme park visitors, hotel guests, and acres of sports fields anticipated

under this alternative. The projected average daily domestic water demand for the reuse plan area at buildout is estimated to be 2.1 MGD (7.9 million liters per day). Thus, the total change from baseline consumption under Alternative 1 would be an increase of approximately 1.04 MGD (3.9 million liters per day). Under this alternative, and in accordance with the Draft Reuse Plan, the water supply system would be replaced with new pipes that could accommodate the increase. With implementation of water conservation measures and a new recycled wastewater system described in the Draft Reuse Plan (San Francisco 1996e), the potable water demand would be reduced by an unknown amount.

Table 4.11-1. Estimated Water and Wastewater Demand by Alternative

	Estimated Demand (MGD)	
	Potable Water	*Wastewater*
NSTI Capacity	2.0	2.0
Baseline Conditions[1]	0.96	0.77[2]
Alternative 1	2.1	1.5
Alternative 2	1.6	0.49
Alternative 3	0.92	0.55

1 *Source*: DON 1997c
2 Baseline wastewater demand was estimated by assuming that 80 percent of potable water consumed is discharged as wastewater.

The existing transmission pipeline attached to the SFOBB, with a capacity of approximately 2.5 MGD (9.5 million liters per day) (based on a pump rate of about 1,750 gallons [6,624 liters] per minute), and water supply from the San Francisco Water Department are adequate to accommodate the increase in demand (San Francisco Water Department 1998). This impact would not be significant because it would not require the construction of major additional infrastructure and all necessary infrastructure improvements would be implemented as part of this alternative. No mitigation is proposed.

Wastewater collection and treatment (Factors 1 and 2). Assuming that 80 percent of potable water consumed (not including sports field irrigation) is discharged as wastewater, sewage generation with development of Alternative 1 would be approximately 1.5 MGD (5.7 million liters per day). This amount of wastewater would be within the capacity of the existing wastewater treatment plant on Treasure Island (approximately 2 MGD [9.5 million liters per day]) and also would be within the capacity of the new wastewater treatment plant. The wastewater collection system experiences inflow and infiltration problems (DON 1994b), and the increase may periodically exceed the capacity of the existing collection system. A replacement sewer system is planned under this alternative that could accommodate the new uses and would be required to meet applicable discharge standards. Therefore, the increase in sewage generation would not be significant, and no mitigation is proposed.

Stormwater collection (Factor 1). Development of the reuse plan area would replace undeveloped areas and undeveloped parcels with urban-type development. While sports fields and other open spaces would provide some pervious surfaces to absorb rainwater, the overall amount of

impervious surface would increase by 37 acres, thereby increasing the amount of surface water runoff.

In accordance with the Draft Reuse Plan, new stormwater collection infrastructure would be designed to accommodate projected increases in stormwater flow. Other systemwide improvements could include implementing alternative technologies, including use of wetlands to capture stormwater discharges. On-site storm drainage improvements would be required as part of development approvals. This impact would not be considered significant because infrastructure improvements implemented as part of this alternative would provide adequate capacity for the increased stormwater flow. No mitigation is proposed.

Electricity and natural gas (Factor 1). The steam system supplying heat to a number of buildings is dismantled, and buildings proposed for reuse that were previously heated by steam would require either the installation of individual boilers or connection to the natural gas infrastructure. Most of the electrical distribution system at NSTI was upgraded in the early 1980s. With some exceptions, the system is in adequate condition and is capable of providing service to existing load demands (San Francisco 1995b). The natural gas distribution system is in adequate condition for current needs.

The electrical and natural gas infrastructure would be modified or expanded to serve the individual needs of the future users of NSTI. As of October 1, 1998, the San Francisco PUC is purchasing natural gas through California consolidated purchase. Replacement of the steam plant with individual building heating systems would result in a more efficient use of natural gas. The capacity of the existing transmission line is adequate to supply future uses of the property. No mitigation is proposed.

Telecommunications (Factor 1). This alternative would require expanding telecommunication switch capacity to serve those portions of NSTI that were served by Navy telecommunications systems and expanding service to the residential areas. The switch would be designed with adequate capacity, or with the capability to expand, to serve future demands at NSTI. These actions would be phased in with reuse and individual developments. This impact would be considered not significant because all necessary infrastructure improvements would be implemented as part of this alternative. No mitigation is proposed.

Solid waste (Factor 1). It is estimated that proposed development under Alternative 1 would generate approximately 9,549 tons (8,665 metric tons) of solid waste per year, an average of 26 tons (29 metric tons) per day. This generation would be a decrease of about 5,691 tons (5,164 metric tons) per year of solid waste from the baseline generation of 15,240 tons (13,829 metric tons) per year presented in section 3.11, which is equivalent to a decrease of 16 tons (18 metric tons) per day.

Solid waste from development under Alternative 1 would be delivered to the Davis Street Transfer Station and then transported to the Altamont Landfill. This landfill can accept a maximum of approximately 11,150 tons (10,117 metric tons) per day and will reach capacity in approximately 30 years. Based on an excess of approximately 5,000 tons in daily capacity, this solid waste disposal facility has ample capacity to accommodate the solid waste generated daily under Alternative 1. No new facilities would be required; therefore, the impact under Alternative 1 would not be significant. No mitigation is proposed.

Construction and demolition activities would increase the amount of solid waste generated at NSTI. This alternative would involve demolishing approximately 3,059,959 square feet (284,279 m^2) of NSTI structures, or about 70.5 percent of the built space. Such demolition would generate approximately 801,097 cubic yards (612,482 m^3) of solid waste, equivalent to approximately 657 percent of the solid waste generated at NSTI in 1993. Assuming that all the projected demolition occurs within two years after Navy disposal and that no reuse or recycling occurs, the increase in the average amount of demolition solid waste transported daily to the Altamont Landfill would be approximately 151 tons (137 metric tons). This amount would not significantly contribute to the daily tonnage received by the landfill. As development proceeds, the daily tonnage would decrease, due to the cessation of demolition activities and the lower waste generation rates for constructing buildings. No new solid waste disposal facilities would be required; therefore, the impact under Alternative 1 would not be significant, and no mitigation is proposed.

The solid waste generated under this alternative would need to be accommodated within San Francisco's effort to divert 50 percent of solid waste from landfills, as required by the California Integrated Waste Management Act, Cal. Pub. Res. Code § 40000 et seq. San Francisco would remain in compliance with this act by developing a solid waste management plan. This plan would contain programs and procedures to meet the requirements of this regulation and would emphasize reusing and recycling solid waste, particularly construction and demolition debris. At a minimum, the plan would include San Francisco's solid waste recycling and reuse programs. Construction and demolition contractors could be required to submit individual solid waste management plans consistent with the overall plan, detailing the types of waste to be generated, material handling procedures, and the methods of disposal. This is not considered a significant impact, and no mitigation is proposed.

4.11.2 Alternative 2

Under Alternative 2, a new wastewater treatment plant would be constructed. A new utility corridor would be constructed around the perimeter of Treasure Island under Alternative 2, but it would not extend to the perimeter adjacent to the proposed golf course. Because construction of these facilities is part of Alternative 2 reuse, impacts related to air quality, noise, and other environmental issues are described within various sections of chapters 4 and 5.

Not Significant Impacts

Potable water and fire protection distribution (Factor 1). The average daily demand for water under this alternative reuse development would be approximately 1.6 MGD (6.1 million liters per day), which would be an increase of approximately 0.64 MGD (2.4 million liters per day) over baseline demand at NSTI (Table 4.11-1). More than half of the projected potable water demand would be attributable to golf course development. As with Alternative 1, the water supply system would be replaced with new pipes that could accommodate the increased demand. Water supply capacity is available to meet demand for potable water and fire protection; therefore, the impact under Alternative 2 is not significant, and no mitigation is proposed.

Wastewater collection and treatment (Factor 1). The average daily wastewater flow generated by Alternative 2 would be approximately 0.49 MGD (1.8 million liters per day). This average daily flow would result in an increase of approximately 0.45 MGD (1.7 million liters per day) over

baseline average daily flows. As with Alternative 1, a new wastewater treatment plant would be designed to accommodate reuse development. The wastewater collection system experiences inflow and infiltration problems. However, a replacement sewer system is planned under this alternative that could accommodate the new uses, and it would be required to meet applicable discharge standards. This impact would not be significant because all necessary infrastructure improvements would be implemented as part of this alternative. No mitigation is proposed.

Stormwater collection (Factor 1). Although stormwater runoff in the northwest portion of Treasure Island (where the golf course is proposed) would decrease, the overall amount of paved surfaces at NSTI could increase by 12 acres under this alternative, so the volume of stormwater discharges also would increase. On-site storm drainage improvements would be required as part of development approvals, and the new stormwater collection infrastructure would be designed to accommodate projected increases in stormwater flow. This impact would not be considered significant, and no mitigation is proposed.

Electricity and natural gas (Factor 1). Under Alternative 2, the electrical and natural gas infrastructure would be modified or expanded to serve the individual needs of the future users of NSTI. Therefore, this would not be a significant impact. No mitigation is proposed.

Telecommunications (Factor 1). Alternative 2 would require expanding telecommunication switch capacity to serve those portions of NSTI that were served by Navy telecommunications systems and expanding service to the residential areas. As described under Alternative 1, these actions would be phased in with reuse and individual developments. This would not be a significant impact. No mitigation is proposed.

Solid waste (Factor 1). Alternative 2 would generate approximately 4,062 tons (3,686 metric tons) of solid waste per year, which is 11,178 tons (10,142 metric tons) per year less than baseline. These rates represent an average of 11 tons (10 metric tons) of solid waste generated per day, a decrease of 31 tons (28 metric tons) per day. This waste would be disposed of at the Altamont Landfill. This landfill could adequately accommodate solid waste generated under Alternative 2. No additional solid waste facilities would be required to be constructed. Impacts would not be significant, and no mitigation is proposed.

This alternative would have a greater impact on demolition waste management than Alternative 1 due to greater demolition of existing residential units on the northern part of Treasure Island. Demolition would create approximately 939,598 cubic yards (718,374 m^3) of solid waste, equal to about 771 percent of baseline generation. This alternative envisions the demolition of approximately 3,588,991 square feet (333,428 square m) of existing facilities, or about 82.7 percent of the built space. Under this alternative, there would be fewer facilities constructed than under Alternative 1 and less construction debris. As described for Alternative 1, San Francisco would remain in compliance with the California Integrated Waste Management Act by developing a solid waste management plan. No mitigation is proposed.

4.11.3 Alternative 3

Under Alternative 3, the new utility corridor would be limited to the south end of Treasure Island. Because construction of the corridor is part of Alternative 3 reuse, impacts related to air

quality, noise, and other environmental issues are described within various sections of chapters 4 and 5. Where significant impact would occur, mitigation measures are identified.

Not Significant Impacts

Potable water and fire protection distribution (Factor 1). The average daily demand for water under this alternative reuse development would be approximately 0.92 MGD (3.5 million liters per day), which would be a decrease of approximately 0.04 MGD (0.15 million liters per day) over baseline demand at NSTI (Table 4.11-1). As with Alternative 1, system capacity could accommodate reuse development under Alternative 3; therefore, the impact under Alternative 3 would not be significant, and no mitigation is proposed.

Wastewater collection and treatment (Factor 1). The average daily wastewater flow generated by Alternative 3 would be approximately 0.55 MGD (2.1 million liters per day). This average daily flow would result in an increase of approximately 0.51 MGD (1.9 million liters per day) over baseline average daily flows. As with Alternative 1, system capacity could accommodate reuse development under Alternative 3. The wastewater collection system experiences inflow and infiltration problems. However, under this alternative a replacement sewer system is planned that could accommodate the new uses and would be required to meet applicable discharge standards. This impact would not be significant, and no mitigation is proposed.

Stormwater collection (Factor 1). The overall amount of paved surfaces at NSTI would remain roughly the same under this alternative because minimal new development is proposed, so the volume of stormwater discharges would remain roughly the same. San Francisco's assessment of the capacity and condition of the stormwater system found several potential problems. However, on-site storm drainage improvements would be required as part of development approvals, and any new stormwater collection infrastructure would be designed to accommodate projected stormwater flows. This impact would not be considered significant, and no mitigation is proposed.

Electricity and natural gas (Factor 1). Under Alternative 3, the increase in development and increase in energy efficiency likely would result in an increase in the annual amount of energy consumed. The electrical and natural gas infrastructure would be modified or expanded to serve the individual needs of the future users of NSTI. This would not be considered a significant impact. No mitigation is proposed.

Telecommunications (Factor 1). Alternative 3 would require expanding telecommunication switch capacity to serve those portions of NSTI that were served by Navy telecommunications systems and expanding service to the residential areas. As described under Alternative 1, these actions would be phased in with reuse and individual developments. This would not be considered a significant impact. No mitigation is proposed.

Solid waste (Factor 1). Solid waste generation under Alternative 3 would be approximately 4,050 tons (3,675 metric tons) of solid waste per year, or approximately 11 tons (10 metric tons) per day. This amount of solid waste would be about 11,190 tons (10,154 metric tons) of solid waste per year less than baseline generation, an average daily decrease of 31 tons (28 metric tons). Solid waste generated under Alternative 3 would be disposed of at the Altamont Landfill. Landfill space at the Altamont Landfill could adequately accommodate solid waste generated

under this alternative. No additional solid waste facilities would be required to be constructed. Impacts would not be significant, and no mitigation is proposed.

Under Alternative 3, approximately 1,359,874 square feet (126,336 square m), or about 31 percent, of facilities would be demolished, yielding approximately 356,015 cubic yards (272,193 m^3) of solid waste. Such an amount would be equivalent to almost three times the amount of solid waste generated under baseline conditions. However, as described for under Alternative 1, San Francisco would remain in compliance with the California Integrated Waste Management Act by developing a solid waste management plan. This would not be a significant impact, and no mitigation is proposed.

4.11.4 No Action Alternative

Under the No Action Alternative, the utility systems would continue to be operated and maintained by the San Francisco PUC. Due to the reduction in employment and activity, the No Action Alternative would result in reduction in demand for all utilities over baseline conditions. Demand for potable water, sewage, electricity, telecommunications, and solid waste disposal would be reduced to levels necessary for caretaker status. Storm drain conditions would not change. The No Action Alternative would have no impact on either the capacity or function of on-site utility systems. No construction of any on-site utility systems would be required.

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4.12 PUBLIC SERVICES

Public services addressed in this section are police protection, fire protection, and emergency services. The analysis of the need for additional police and emergency service facilities is based on the number of people to be served, whereas the need for additional fire protection facilities is based on the amount of development. Factors considered in determining whether an alternative would have significant impacts on public services included the extent or degree to which its implementation would:

1. Require or result in unplanned construction of new facilities that would cause changes or alterations to the physical environment; or
2. Result in a demand for public services or facilities that would exceed the available or planned capacity of those services.

The impacts presented in this section have been evaluated against the baseline environmental conditions presented in Chapter 3. Navy recognizes that changes in the environmental conditions may have occurred in the period between the baseline years and the present. Although these changes may result in different, and in many cases, lesser impacts to certain resources, changes to the impact analysis based on any interim change in resource conditions is not appropriate.

4.12.1 Alternative 1

Not Significant Impacts

As discussed below, impacts to fire protection, police protection, and emergency medical services are considered not significant. There is land available on NSTI to accommodate any new public service facilities, such as an ambulance company. In addition, funding for new facilities or services could be made available through a variety of mechanisms, such as development impact fees, special taxes, and other public revenues. Developing NSTI property would provide an expanded funding base for San Francisco. The method of funding for expanded public services would be determined during the permitting process for specific development projects, development agreements entered into between San Francisco and developers, or city development policy enactments.

Fire protection (Factors 1 and 2). Alternative 1 would increase demand on San Francisco Fire Department fire prevention and protection services because the amount of development on the site would increase. Individual development projects within the site would be required to meet existing San Francisco Fire Department regulations codified in the 1998 San Francisco Fire Code regarding construction materials and methods, emergency access, water mains, fire flow, fire hydrants, sprinkler systems, building setbacks, and other relevant regulations. Adherence to the San Francisco Fire Department regulations would reduce the risk of uncontrollable fire and increase the ability to efficiently provide fire protection services to the reuse plan area.

As discussed in section 2.4.2, under this alternative, two fire stations would be operated, a new station on Treasure Island and an existing station on Yerba Buena Island. Both stations would be necessary to maintain the department's response time goal of three minutes because the San

Francisco Fire Department's nearest station (36 Bluxome Street) is approximately 4.5 miles (7 km) from NSTI (San Francisco Fire Department 1996). Both stations would be required for one engine company to respond to calls on-site if the other were occupied with an incident on the SFOBB. Because the two stations would meet the demands created by the new development on the site, there would be no significant impact related to provision of new or expanded facilities. Each station would require a staff of one officer and three fire fighters per shift, so that approximately eight officers and 30 fire fighters would be needed altogether. This would represent an approximate 2.5 percent increase in total department staff. The themed attraction developer would be responsible for contracting with the San Francisco Fire Department or another provider for services requiring additional personnel, if required; no new fire department facilities are anticipated for the themed attraction. No mitigation is proposed.

Police protection (Factors 1 and 2). Development of the site under Alternative 1 would increase the need for police emergency protection services. The need for police protection services in San Francisco is assessed on the basis of the number of people to be served. At buildout of Alternative 1, the San Francisco Police Department would need to add about 21 officers, three sergeants, and two patrol cars to cover the additional responsibility (San Francisco Police Department 1998). The added officers would represent an approximate 1.2 percent increase in departmental personnel. Increased police services would be provided to meet projected needs. Under this alternative, the provision of this personnel and equipment would be accommodated at existing facilities and at the new police station that would be constructed on Treasure Island. Because these planned facilities would meet the demands created by the new development on the site, there would be no significant impact related to the provision of police protection services.

The San Francisco Police Department would review future development plans for projects to evaluate visibility, lighting, circulation patterns, emergency access, building design, and other security issues. This would maximize their ability to respond to emergencies.

The themed attraction developer would be responsible for contracting with the San Francisco Police Department or another provider for services requiring additional personnel, if required. Impacts would be not significant, and no mitigation is proposed.

Emergency medical services (Factors 1 and 2). Alternative 1 would increase demand on local emergency medical services because the number of people living and working on the site and the amount of urban development on the site would increase. Under this alternative, the San Francisco Paramedic Division would locate one ambulance company at the new fire station on Treasure Island to serve the site. To meet this increased demand, the division would need to add eight paramedics to its staff (San Francisco Department of Public Health 1996, 1997). The themed attraction developer would be responsible for contracting with the paramedic division or another provider for services requiring additional personnel, if required; no new paramedic facilities are anticipated for the themed attraction. This impact is not significant, and no mitigation is proposed.

4.12.2 Alternative 2

Not Significant Impacts

Fire protection (Factors 1 and 2). Similar to Alternative 1, Alternative 2 would require operating two fire stations, a new station on Treasure Island and an existing station on Yerba Buena Island. Fire protection impacts would be the same as those described for Alternative 1. This impact would not be significant, and no mitigation is proposed.

Police protection (Factors 1 and 2). Similar to Alternative 1, Alternative 2 would construct a new police station on Treasure Island. Police protection impacts would be the same as those described for Alternative 1. This impact would not be significant, and no mitigation is proposed.

Emergency medical services (Factors 1 and 2). Similar to Alternative 1, Alternative 2 would involve the San Francisco Paramedic Division locating one ambulance company on Treasure Island to serve the site. Emergency medical service impacts would be the same as those described for Alternative 1. This impact would not be significant, and no mitigation is proposed.

4.12.3 Alternative 3

Not Significant Impacts

Fire protection (Factors 1 and 2). Under this alternative, San Francisco would not build a new fire station; the San Francisco Fire Department would operate the existing fire stations on Treasure Island and Yerba Buena Island. Although there would be less overall development, fire protection impacts would be similar to those described for Alternative 1. This impact would not be significant, and no mitigation is proposed.

Police protection (Factors 1 and 2). Under this alternative, a new police station would be constructed on Treasure Island to replace existing facilities, similar to Alternative 1. Although there would be fewer residents, employees, and visitors, police protection impacts would be similar to those described for Alternative 1. This impact would not be significant, and no mitigation is proposed.

Emergency medical services (Factors 1 and 2). Similar to Alternative 1, Alternative 3 would involve the San Francisco Paramedic Division locating one ambulance company on Treasure Island to serve the site. Although there would be less overall development, emergency medical service impacts would be similar to those described for Alternative 1. This impact would not be significant, and no mitigation is proposed.

4.12.4 No Action Alternative

The No Action Alternative would not result in additional demand for public services and would have no impact. Public services provided by San Francisco and private contractors under current Navy agreements and contracts would be expected to continue under caretaker status.

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4.13 HAZARDOUS MATERIALS AND WASTE

Factors considered in determining whether an impact would have a significant impact related to hazardous materials and wastes included the extent or degree to which an alternative would:

1. Create a hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials, substances, or wastes; and

2. Create a hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the likely release of hazardous materials into the environment.

4.13.1 Alternative 1

Development of this alternative would result in a variety of residential, commercial, and recreation uses that, depending on the specific type of operation, could use hazardous materials or could generate hazardous wastes. Use and maintenance of residential landscaping might involve pesticides, fertilizers, and other household chemicals. Commercial land uses, such as activities associated with offices, film production, and retail and service industries, could require use of hazardous substances, such as fuels, solvents, corrosives, and flammables. Recreation uses likely would use pesticides and fertilizers in their operations.

Significant and Mitigable Impacts

Impact: Installation Restoration Program (IRP) (Factor 1). Construction activities at NSTI associated with future development of the housing unit area, including demolition of existing structures, may interfere with remedial actions under CERCLA.

Mitigation. The Navy is in the process of implementing various remedial actions at NSTI pursuant to and in accordance with the requirements of CERCLA and the NCP that will remove, manage, or isolate any potentially hazardous substances present on the property prior to conveyance. These remedial actions will ensure that human health and the environment will be protected based on the land uses specified in the Draft Reuse Plan. If the CERCLA remedy for a particular site includes land use controls, the acquiring entity or entities will be required to comply with the land use controls during construction or operations to ensure continued protection of human health and the environment. No CERCLA ROD has been signed for NSTI and therefore discussion of the specifics of possible land use controls would be premature. However, based on the approach used for closure of other nearby military installations, it is expected that land use controls would be managed according to a tiered process. The first tier would be a permitting process administered by San Francisco for disturbance of soil and groundwater. If necessary, a second tier would follow that would include further characterization and potentially a response action.

Subsequent redevelopment of the housing area which would involve demolition of existing structures and the grading and reconfiguring of the soil would likely be subject to land use controls on the property, including compliance with a City-administered soil management plan that would require soil and groundwater disturbance be permitted subject to proper characterization and management. In addition, deeds conveying the affected property will

contain a notice that areas of the property not subject to remediation efforts (such as areas beneath existing foundations) may require additional characterization and possible response actions subject to appropriate regulatory oversight. Adherence to land use controls and regulatory requirements would mitigate potentially significant impacts to an acceptable level.

Not Significant Impacts

Construction

Asbestos Containing Material (ACM) (Factor 1). Demolition and/or renovation of existing structures would occur under Alternative 1. The exact number of structures to be demolished or renovated is not known. These activities have the potential to generate air emissions of asbestos from ACM. Any renovation or demolition would be subject to federal, state, and local requirements designed to minimize the potential for asbestos fiber releases and associated health risks. In order to be issued a permit to demolish or renovate (Cal. Health and Safety Code § 19827.5), the acquiring entity would be required to comply with applicable OSHA regulations and the Asbestos NESHAP, 40 C.F.R. Part 61, Subpart M (1998). The BAAQMD, which regulates airborne pollutants, would be notified 10 days prior to any demolition or abatement work. The acquiring entity would be required to employ a contractor trained and certified in the proper handling of ACM during demolition and renovation work. The acquiring entity also would be required to notify the local office of Cal OSHA prior to the start of work and would be required to register with the Office of the California Department of Health Services in Sacramento to obtain a Hazardous Waste Generation number. Adherence to these regulatory requirements would reduce potential impacts to a not significant level. No mitigation is proposed.

Lead Based Paint (LBP) (Factor 1). Demolition and/or renovation of existing structures would occur under Alternative 1. These activities have the potential to generate air emissions of lead-contaminated dust from LBP. LBP was in common use at NSTI and elsewhere prior to 1978. In accordance with DoD policy and the Residential Lead-based Paint Hazard Reduction Act of 1992 (42 U.S.C. § 4851 et seq.), housing at NSTI constructed prior to 1978 will be inspected for LBP hazards. The 200 housing units on Treasure Island proposed for reuse under this alternative were constructed in 1989 and therefore would not be subject to inspection. Of the 90 existing units on Yerba Buena Island proposed for residential reuse, 36 were constructed before 1960 and 54 were constructed in 1966. The units constructed in 1966 would be subject to inspection, and the units constructed before 1960 would be subject to inspection and abatement.

Any LBP hazards discovered in housing constructed prior to 1960 will be abated before the housing is conveyed out of federal ownership, unless the transferee intends to demolish the housing and assumes responsibility for the proper handling of and disposal of LBP waste during demolition. Results of LBP surveys and lead warning statements will be included in any contract for transfer or lease, and the acquiring entity or entities will assume responsibility for properly managing LBP on buildings, in accordance with all applicable federal, state, and local laws and regulations. Adherence to these regulatory requirements would reduce potential impacts to a not significant level. No mitigation is proposed.

Polychlorinated Biphenyls (PCBs) (Factor 1). PCB-containing equipment and PCB release sites have been identified at NSTI. PCB surveys by Navy at NSTI are ongoing, and all PCB release

sites will be remediated prior to property conveyance. Navy will comply with the restrictions on the distribution of PCBs in commerce found in Section 6 of the TSCA (15 U.S.C. § 2605), and implementing EPA regulations, including the requirement that it disclose the existence of known PCB-containing electrical equipment at the time of lease, transfer, or conveyance. The acquiring entities would be required to comply with all applicable provisions of TSCA and other applicable laws and regulations designed to minimize the risks posed by PCBs. Any new releases of PCBs to the environment would be subject to the cleanup requirements of TSCA, CERCLA, and state law. Adherence to these regulatory requirements would reduce potential impacts to a not significant level. No mitigation is proposed.

Storage tanks (Factor 1). All current tanks will be closed per approved closure plans. No significant impacts to construction or operation would result. Reuse activities associated with this alternative might require removing ASTs or USTs. Reused and new tanks installed by the acquiring entities would be subject to all applicable federal, state, and local regulations, including San Francisco's tank operation and removal ordinance, Chapter 21 of the San Francisco Municipal Code. These regulations include acceptable leak detection methods, spill and overfill protection, cathodic protection, secondary containment for hazardous waste tank systems and piping, liability insurance, and removal regulations. Adherence to these regulatory requirements would reduce potential impacts to a not significant level. No mitigation is proposed.

Installation Restoration Program (IRP) (Factor 1). Construction activities at NSTI that may interfere with remediation would be subject to institutional controls identified in CERCLA RODs, including a Soil Management Plan. For any future project, the property owner must be informed of the past use so that remediation sites can be considered in the more detailed designs of future projects. Contractors would be informed of the past use and would be required to implement health and safety plans for work around remediation sites. Contractors would develop contingency plans to address contaminated soil and groundwater. If contaminated soil or groundwater is encountered, work could proceed following the applicable provisions of the contingency plan. Adherence to these institutional controls and regulatory requirements would reduce potential impacts to a not significant level. No mitigation is proposed.

Operation

Hazardous materials use and hazardous waste generation (Factors 1 and 2). Land use under Alternative 1 could use and generate small amounts of hazardous substances in commercial and recreation areas. The presence of these materials would create the potential for incidents of uncontrolled releases of hazardous materials to the environment through accidental spills, equipment failure, and other unanticipated events. However, no significant impacts related to hazardous materials use or hazardous waste generation are anticipated under Alternative 1 because federal, state, and local laws require procedures and practices to ensure that hazardous materials are properly used, stored, and disposed of to prevent or minimize injury to human health and the environment.

Hazardous wastes generated by reuse operations would be handled and disposed of according to current regulatory guidelines. The acquiring entity and any tenants and business operators with which the acquiring entity establishes property usage agreements would be responsible for

hazardous materials and waste management under federal, state, and local laws and regulations. Depending on the types and quantities of hazardous materials used, each acquiring entity would be subject to the requirements of the Emergency Planning and Community Right-to-Know Act (EPCRA) (42 U.S.C. § 11001 et seq.), the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. § 6901 et seq.), and state hazardous materials business plans and risk management prevention programs for emergency planning review and community right-to-know inventory reporting. Adherence to these strict regulatory requirements would reduce potential impacts to a not significant level. No mitigation is proposed.

Radioactive materials (Factors 1 and 2). Under this alternative, small quantities of radioactive materials could be used for medical diagnosis and treatment in medical offices. Use and storage of such materials are tightly regulated under federal and state regulations. Adherence to these regulatory requirements would reduce potential impacts to a not significant level. No mitigation is proposed.

Medical/biohazardous wastes (Factors 1 and 2). Under this alternative, medical office tenants may produce small quantities of medical or biohazardous wastes. Handling, storing, and disposing of such wastes is strictly regulated by federal and state law, which also requires the establishment of medical or biohazardous material business plans and risk management prevention programs. Adherence to these regulatory requirements would reduce potential impacts to a not significant level. No mitigation is proposed.

Pesticides (Factors 1 and 2). Pesticide use may vary under this alternative but is expected to be minimal. All household and commercial use of pesticides would be controlled and regulated by the City Pesticide Management Program, Chapter 39 of the San Francisco Administrative Code, and applicable federal, state, and local regulations. Adherence to these regulatory requirements would reduce potential impacts to a not significant level. No mitigation is proposed.

4.13.2 Alternative 2

The total built area under this alternative would be somewhat less than that for Alternative 1, and combined employee and resident populations would be about two-thirds less than Alternative 1. Overall hazardous materials use and hazardous waste generation would be lower for this alternative than for Alternative 1 due to the lesser amount of planned residential, commercial, and other uses that may require the use of hazardous materials and that may generate hazardous wastes.

Significant and Mitigable Impacts

Impact: Installation Restoration Program (IRP) (Factor 1). Development of a golf course in the northern part of the island would involve demolition of existing structures and the grading and reconfiguring of the soil, which may interfere with remedial actions under CERCLA.

Mitigation. The Navy is in the process of implementing various remedial actions at NSTI pursuant to and in accordance with the requirements of CERCLA and the NCP that will remove, manage, or isolate any potentially hazardous substances present on the property prior

to conveyance. If a remedy for a particular site includes land use controls, the acquiring entity or entities will be required to comply with the land use controls during construction or operations to ensure continued protection of human health and the environment. Similar to Alternative 1, any work impacting the property under land use controls would comply with a City-administered soil management plan. Deeds conveying the affected areas will contain a notice that the property not subject to remediation efforts (such as areas beneath existing foundations) may require additional characterization and possible response actions subject to appropriate regulatory oversight. Therefore, compliance with all applicable federal, state, and local regulations in the handling and use of hazardous substances and adherence to land use controls would mitigate potentially significant impacts to an acceptable level.

Not Significant Impacts

Pesticides (Factors 1 and 2). Creating a golf course instead of housing in the northern part of NSTI would increase pesticide use in that location, as compared to other alternatives. Pesticide use is controlled by federal, state, and local regulations, including the San Francisco Pest Management Program. Moreover, the City and County of San Francisco would develop and implement a pesticide, herbicide, and fertilizer management plan. For example, golf course design and operation could include BMPs for the storage, handling, and use of pesticides or fertilizers, including a chemical application and management plan. Golf course operation also could include integrated pest management to limit pesticide use. The use of BMPs and integrated pest management would be based on factors such as topography, proximity to water resources, mowing, and irrigation. BMPs would help to limit soil and water contamination from daily operations. Compliance with these regulations would minimize pesticide impacts to a not significant level, and no mitigation is proposed.

4.13.3 Alternative 3

The construction and operational impacts under this alternative would be similar to, but less than, those identified for Alternative 1. The total built area and combined employee and resident populations would be about half that of Alternative 1. Because the existing facilities would be used and no new housing would be constructed, impacts associated with this alternative would be less extensive than those anticipated for Alternatives 1 and 2. Overall hazardous materials use and hazardous waste generation would be lower for this alternative than for Alternative 1 due to the lesser amount of planned residential and other uses that may require the use of hazardous materials and that may generate hazardous wastes.

Significant and Mitigable Impacts

Impact: Installation Restoration Program (IRP) (Factor 1). If subsequent redevelopment of the housing area involving demolition of existing structures and the grading and reconfiguring of the soil were to occur, it may interfere with remedial actions conducted under CERCLA.

Mitigation. The Navy is in the process of implementing various remedial actions at NSTI pursuant to and in accordance with the requirements of CERCLA and the NCP that will remove, manage, or isolate any potentially hazardous substances present on the property prior to conveyance. If a remedy for a particular site includes land use controls, the acquiring entity or entities will be required to comply with the land use controls during construction or

operations to ensure continued protection of human health and the environment. Similar to Alternatives 1 and 2, any work impacting the property under land use controls would comply with a City-administered soil management plan. Deeds conveying the affected areas will contain a notice that the property not subject to remediation efforts (such as areas beneath existing foundations) may require additional characterization and possible response actions subject to appropriate regulatory oversight. Therefore, compliance with all applicable federal, state, and local regulations in the handling and use of hazardous substances and adherence to land use controls would mitigate potentially significant impacts to an acceptable level.

4.13.4 No Action Alternative

Under the No Action Alternative, Navy would retain ownership of NSTI property. Except for the existing leases, which would be allowed to expire, buildings would be vacated. The property would be under caretaker status, the area fenced off, buildings would be sealed and decommissioned, and no new construction would occur. Ongoing remediation efforts would continue at all restoration sites, which would be cleaned to standards consistent with the current program requirements.

All remediation efforts would be conducted in compliance with federal, state, and local regulations. However, under this alternative, NSTI would not be transferred for reuse, and therefore cleanup efforts would not be accelerated pursuant to the President's fast-track cleanup directive. The scope and timing of investigations and cleanup would reflect the caretaker status of the property and would proceed in accordance with the IRP. However, cleanup may slow without the possibility of reuse.

ACM left in existing buildings would not be impacted under caretaker status. Normal maintenance operation in buildings would not release ACM.

The No Action Alternative would have no impact to hazardous materials and environmental contamination on NSTI. Maintenance would be undertaken so that human health and the environment would be protected.

CHAPTER 5.0

Cumulative Projects and Impacts

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5.0 CUMULATIVE PROJECTS AND IMPACTS

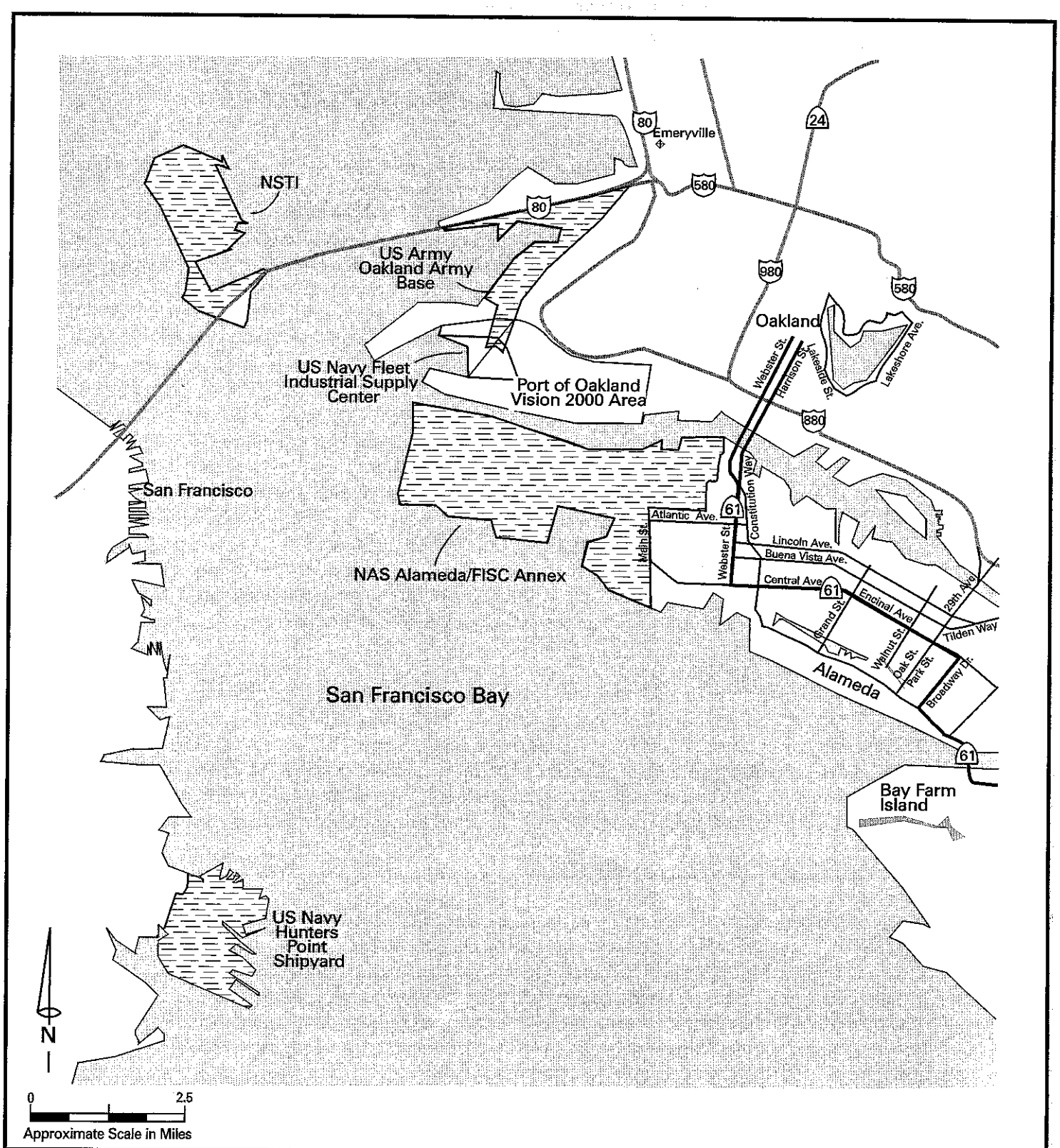
CEQ regulations implementing NEPA require that the cumulative impacts of a proposed action be assessed (40 C.F.R. Parts 1500-1508). A cumulative impact is an "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions" (40 C.F.R. § 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 C.F.R. § 1508.7).

CEQ's guidance for considering cumulative effects, states that NEPA documents "should compare the cumulative effects of multiple actions with appropriate national, regional, state, or community goals to determine whether the total effect is significant" (CEQ 1997). In this section, the region of influence for each resource is the same as described in Chapter 4. The area from which potential cumulative projects was drawn is the East and West bays of the San Francisco Bay Area, including Alameda and San Francisco counties. Because NSTI is an island and not immediately adjacent to lands where other projects are likely to occur, the area from which cumulative projects can reasonably be drawn is fairly limited (Alameda County and San Francisco). While it is likely that many other projects may occur in this area (i.e., construction projects, roadway modifications, dredging activities), most such projects would be either too small or too remote to have a meaningful interaction with the proposed action. Cumulative projects considered below are either similar to the proposed action, large enough to have far reaching effects, or in proximity to the proposed action.

Other base disposal and reuse activities in Alameda and San Francisco counties are within this area and would be implemented concurrent with the NSTI reuse alternatives. Military bases near NSTI undergoing reuse activities and contributing to the cumulative analysis are shown on Figure 5-1. Other major nonmilitary projects in the more immediate vicinity of the project that could contribute to local cumulative impacts are considered. These nonmilitary projects include replacement of the SFOBB east span and waterfront development in San Francisco.

5.1 CUMULATIVE ASSUMPTIONS

CEQ's cumulative effects guidance sets out several different methods to determine the significance of cumulative effects, such as checklists, modeling, forecasting, and economic impact assessment where changes in employment, income and population are assessed (CEQ 1997). This EIS uses a checklist methodology of resource areas and regional projects within the region of influence to determine cumulative effects on ecosystems and it uses economic analysis and forecasting for determining socioeconomic and infrastructure impacts. ABAG *Projections 2002* has been used for this cumulative analysis in addition to cumulative impacts analyses reported for other projects in close proximity to NSTI listed in Figure 5-1. ABAG *Projections 2002* data is presented in section 3.3, Socioeconomics. The cumulative traffic impact analysis was based on the regional MTC transportation model, which included land use forecasts developed by ABAG for year 2010. Year 2010 is a frequently used benchmark established by regional transportation agencies such as the MTC for long-range planning of regional transportation improvements.



In addition to NSTI, there are four other Navy bases in the East and West Bay undergoing closure and reuse: NAS Alameda/FISC Annex, Fleet and Industrial Supply Center, Oakland, Oakland Army Base, and Hunters Point Naval Shipyard.

LEGEND:

Military Sites Undergoing Civilian Reuse

Regional Base Closures and Reuse in the San Francisco Bay Area

Bay Area, California

Figure 5-1

5.2 BAY AREA BASE CLOSURES

Concurrent ongoing and proposed specific base closures and reuse relatively near NSTI could reasonably contribute to cumulative impacts; these projects are identified in Table 5-1 and their locations are shown on Figure 5-1. A joint Final NEPA/CEQA EIS/EIR was completed for the Fleet and Industrial Supply Center, Oakland (FISCO) in August 1997. A Final EIS/EIR for the Disposal and Reuse of Hunters Point Shipyard in San Francisco was issued in March 2000. A Final EIS for the Naval Air Station (NAS) Alameda/Fleet and Industrial Supply Center (FISC) Annex in Alameda was issued in October 1999. The Draft EIS for the Oakland Army Base was issued in September 1999. Several additional projects have occurred as a result of Bay Area base closure decisions and subsequent property transfer requests. Two of these projects—the Job Corps facility and the US Coast Guard Station expansion—are on Treasure Island and Yerba Buena Island, respectively.

Job Corps

US Department of Labor uses Buildings 363, 364, 365, and 368 on Treasure Island for its federal Job Corps training facility. US Department of Labor was granted approximately 36 acres (14 ha) of Treasure Island, with improvements thereon, for the continued use of this training facility. The Job Corps trains underprivileged youth to serve local communities. The Job Corps at Treasure Island would provide approximately 300 new jobs and maintain a student enrollment of approximately 850 new students. Approximately 750 new students would reside on Treasure Island but approximately 100 students and all staff are expected to commute (US Department of Labor 1997). Job Corps trainees could provide restaurant service, medical, and technical support services to island uses, employees, visitors, and residents.

US Coast Guard

The US Coast Guard has been granted approximately 11 acres of dry land (4 ha) on Yerba Buena Island, with improvements thereon, to support its continuing operations. No additional employees or residents are expected as a result of the expansion of the station area. An additional 11 acres (4 ha) of submerged lands was transferred to US Coast Guard in 2002.

USFWS Wildlife Refuge

As part of the closure of NAS Alameda/FISC Annex, the USFWS was granted 900 acres (362 ha) of dry and submerged land for use as part of the San Francisco Bay National Wildlife Refuge Complex. The refuge provides habitat and nesting for the only substantial colony of California least tern in the San Francisco Bay.

5.3 NONMILITARY PROJECTS

Two concurrent local nonmilitary developments or plans are considered in this analysis. The first is the seismic upgrade of the SFOBB, including replacing the east span. The second development is implementing the San Francisco Waterfront Land Use Plan. A Final EIR for the Waterfront Land Use Plan was certified in 1996.

Table 5-1. Regional Base Closure and Reuse

Project	*Proximity to NSTI*	*Project Size*	*Historical Uses*	*Project Description*	*Completion Date of Planning Document*	*Projected Project Completion Date*	*Historical Population*	*Projected Future Population*	*Net Population Change*
NAS Alameda/FISC Annex	3 to 5 miles	2,842 acres	Military	Reuse property for civilian residential and nonresidential purposes.	October 1999 (Final EIS)	2020	5,736	21,939-28,097	22,361-16,203
FISCO/Port of Oakland, Vision 2000 Program	3 to 5 miles	541 acres of FISC Oakland; additional acres for joint intermodal terminal facility	Port and rail facilities-military and civilian	Change to civilian use and provide major port and rail expansion. Site will become one of the 3 largest port facilities in the western United States.	August 1997 (Final EIS/EIR)	2010	0	0	0
Oakland Army Base	3 to 3.5 miles	422 acres	Military	Currently unknown civilian reuse of base.	September 1999 (Draft EIS)	2010	0	0	0
Hunters Point Naval Shipyard	6 miles	936 acres	Military	Mixed-use	October 1998 (Revised Draft EIS/EIR); March 2000 (Final EIS)	2025	39	1,050-3,900	1,011-3,861

SFOBB

The SFOBB East Spans Seismic Safety Project involves construction of a new east span and dismantling of the existing east span of the SFOBB. A Final EIS for the SFOBB east span project was published in May 2001 and a ROD was issued on July 11, 2001. Replacement Alternative N-6 with the self-anchored suspension bridge design option was selected as the final replacement alternative (FHWA 2001). The replacement bridge would be located north of the existing east span (see Figure 5-2). This alternative involves constructing a new bridge with two side-by-side decks, each consisting of five lanes. Approximately 1,968 feet (600 m) east of the tunnel on Yerba Buena Island, the alignment would transition from a double-deck viaduct to two parallel structures. The western limit of construction for the selected replacement alternative is the eastern portal of the Yerba Buena Island tunnel; however, the limits of work may extend to the western approach of the west span in San Francisco due to project-related traffic controls and signage. Parts of the Yerba Buena Island east viaduct would be retrofitted, modified, partially demolished, and reconstructed. SFOBB construction is scheduled to be completed in 2007. Most of the reuse improvements on Yerba Buena Island, according to the initial Draft Reuse Plan phasing schedule, is to occur between 2007 and 2011, after the new SFOBB east span is completed. While little or no concurrent construction between the two projects is expected, the effects of constructing the two projects sequentially on Yerba Buena Island may still result in cumulatively significant impacts. Please refer to the EIS for the east spans realignment for discussion of impacts of that project (see http://www.dot.ca.gov/dist4/sfobb/sfobbfeis.htm). It is estimated that the project will begin by 2004 and be completed within seven years.

San Francisco Waterfront Land Use Plan

The San Francisco Waterfront Plan (Waterfront Plan) covers a project area of about 730 acres (296 ha) along approximately 7.5 miles (12 km) of waterfront (April 1996). The overarching goal of the Waterfront Plan is "reuniting the City with its waterfront" through implementation of the Waterfront Plan. Implementing the Waterfront Plan could add as many as 460 persons to the population of San Francisco or less than one percent of the projected city population growth of 50,700 in the period 1995 to 2010. As many as 230 new housing units and as many as 6,850 new jobs could be added in the Waterfront Plan project area (San Francisco 1997b). The Waterfront Plan takes into account a number of other projects that are in various stages of development. These projects include:

- *Mid-Embarcadero Roadway/Terminal Separator Structure:* This project entailed replacing the Embarcadero Freeway with a surface roadway. It was completed in 2000.
- *Hyde Street Harbor and Pier 45:* This project involved adding berths and constructing support facilities for the fishing community.
- *Ferry Building Renovation:* The Port is currently restoring the historic Ferry Building, adding retail and offices space.
- *Downtown Ferry Terminal Improvements:* These improvements would renovate the ferry landings/terminals at Pier ½ and Pier 1.

- *Cogeneration Facility:* The California Energy Commission has recommended construction of a cogeneration plant.
- *Rincon Hill Area:* A 450,000 square foot sports and recreation and entertainment facility is being considered for the base of Rincon Hill, South of Market Street.
- *China Basin Mixed Use Opportunity Area:* The development of the Pacific Bell baseball park for the San Francisco Giants has been completed.
- *China Basin Channel/Mission Bay:* Development in the Mission Bay and China Basin Channel areas contemplates potential construction of 2000 multi-family residences and up to 400,000 square feet of an urban entertainment retail area. This project is out of the Waterfront Plan area.

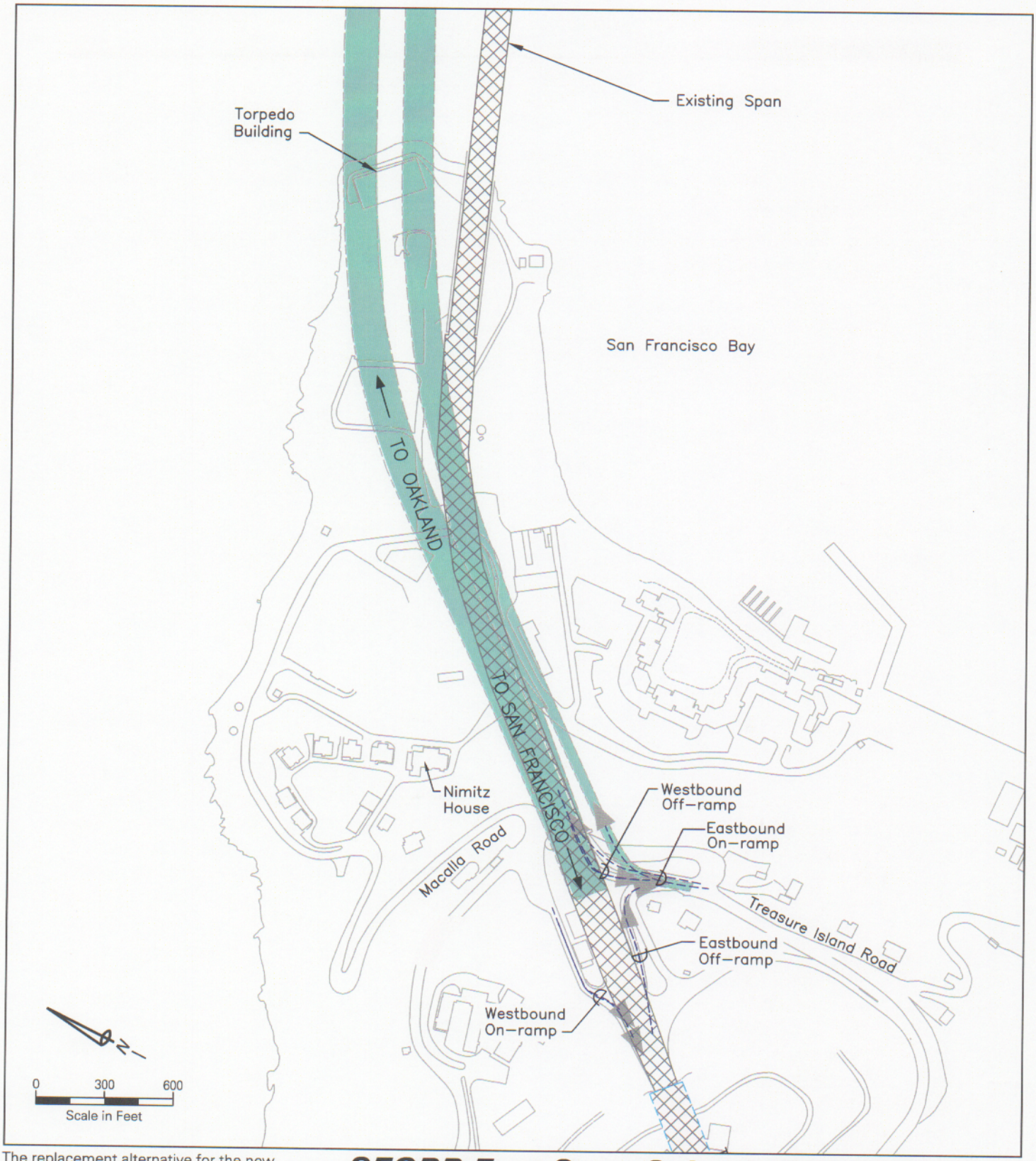
5.4 ANALYSIS OF CUMULATIVE IMPACTS

The cumulative impacts of these concurrent developments and the Waterfront Plan, as well as the military base closure and reuse projects presented in Table 5-1, are discussed by resource area below. Implementing Navy disposal action, as essentially a transfer of title, would not contribute to any direct cumulative impacts to any of the resources analyzed in this document. Therefore, the discussion of cumulative impacts for each resource does not include further analysis of Navy disposal. Relevant significant and not mitigable, significant and mitigable, and not significant cumulative impacts associated with NSTI reuse are described below.

Land Use

All three reuse alternatives would result in developing additional urban uses, and all three would entail a significant change in the historic land use of NSTI. The most basic impact is the change from military use to combined residential, public and light industrial. The change in land use is similar in nature to the other base closures in the area, although the reuse alternatives for NSTI have a smaller percentage industrial component. Combined with future regional development, each reuse alternative would contribute to a cumulative increase in urbanization of the area and the region. The increased urbanization process within the region would be required to proceed in accordance with land use plans of the local communities, as each community's General Plan governs all future development within its jurisdictional boundaries. These plans contain policies, implementation measures, and programs designed to ensure that future development would be compatible with existing and planned land uses, would proceed in an orderly fashion, and would contribute to community goals and objectives for land use. After implementation of mitigation to amend the general plans and zoning codes of San Francisco, the inconsistency with local land use plans would be eliminated. Each of the three reuse alternatives would be a component of this region-wide process, and would be implemented in a manner that would not create land use conflicts with existing or future land uses in the area. Therefore, the reuse alternatives' incremental contribution to regional cumulative land use impacts would not be significant.

The incremental contribution of implementing the reuse alternatives in combination with reconstructing the SFOBB east span could result in cumulatively significant land use impacts. The selected SFOBB replacement alternative would result in planned land uses for



The replacement alternative for the new east span of the SFOBB is north of the existing span. Existing Yerba Buena Island on- and off-ramps are also shown. The redesign of new ramps on Yerba Buena Island is the subject of continuing discussion between Caltrans and the City and County of San Francisco.

Source: Caltrans 1993, 1994

SFOBB East Span Seismic Safety Project - Replacment Alternative for New East Span

Planned Replacement

Existing

Figure 5-2

redevelopment of Yerba Buena Island, in accordance with the Draft Reuse Plan. This is a conceptual plan for NSTI reuse; therefore, the assumption is that the SFOBB construction would not significantly affect implementation of the overall reuse concept on Yerba Buena Island.

Construction-generated traffic and noise impacts as a result of reuse activities and SFOBB construction could have adverse localized effects on both the physical desirability and economic viability of land uses on Yerba Buena Island and Treasure Island. For example, construction activities could adversely affect noise-sensitive film industry activities on Treasure Island in Buildings 2 and 3. Planned reuse of Yerba Buena Island would be affected, particularly the planned residential and public development proposed in areas near the new SFOBB alignment and subject to noise and traffic of construction. (Please see the SFOBB east spans realignment EIS at http://www.dot.ca.gov/dist4/sfobb/sfobbfeis.htm for a discussion of impacts of the SFOBB project.) These localized cumulative land use impacts, however, would be temporary. In addition, the magnitude of cumulative impact is difficult to predict since it would depend on the timing of construction for reuse and the SFOBB. Separate construction periods for reuse and the SFOBB, as currently planned, would result in a lesser impact at any one time but extended over a longer period, while concurrent construction would result in a greater impact at any one time.

Visual Resources

The viewsheds of San Francisco Bay consist of a diverse combination of urban development, industrial, military, and natural landscape. In combination with other similar projects, the cumulative visual effect would result in a movement away from a military and industrial theme and toward a mixed use development. Each of the reuse alternatives would result in a change from a military base and associated structures to a mixed-use development. The development would be similar in character to the surrounding development in San Francisco, including reuse of regional Navy bases, converted wharves and warehouses, Ferry terminals and marinas, and would not contribute to significant cumulative effects on visual resources.

Development under each of the NSTI reuse alternatives would not substantially alter existing views; however, these changes, in conjunction with replacing the SFOBB, could result in cumulative impacts to the visual character of Yerba Buena Island. The proposed parallel roadway alignment for the SFOBB would result in a much wider bridge footprint and a greater number of support piers (Caltrans and FHWA 2001). The effect of physical changes from reuse and SFOBB construction, as well as changes in shadow and lighting, may substantially alter the visual character of the eastern side of the island from viewpoints on both Treasure and Yerba Buena islands over time.

Realignment of the SFOBB east span would also require removing woodland vegetation from Yerba Buena Island, including oak woodland habitat near Macalla Road and eucalyptus groves on the east side of Yerba Buena Island. Future reuse of Yerba Buena Island, which includes reuse in previously developed portions of the island, combined with a new east span structure, could cumulatively alter the visual character of NSTI. According to the SFOBB east spans project EIS, all vegetation removed on Yerba Buena Island would be replanted with native or drought tolerant species (Caltrans and FHWA 2001).

Visual impacts from construction activities, such as from construction staging or lighting, would be short-term. These impacts, combined with potential construction impacts from reuse construction, would not be cumulatively significant, following mitigation by project construction requirements.

Socioeconomics

The three reuse alternatives would contribute to regional employment and population growth. However, housing at NSTI under Alternatives 1 and 3 would be comparable to the projected increase in jobs and therefore would be consistent with San Francisco population and housing growth forecasts. Population and employment increases projected under the three reuse alternatives would be in addition to those provided by the Job Corps (which will add approximately 1,150 trainees and teaching and administrative employees to the local population on Treasure Island). The incremental contribution of NSTI jobs would not have a significant effect on regional housing demand under these two reuse alternatives and would therefore not be cumulatively considerable. While SFOBB construction could temporarily displace occupants of NSTI housing, this impact would be short-term and would not cumulatively add to effects from reuse activities on Yerba Buena Island because these two projects would not be expected to be constructed simultaneously.

Under Alternative 2, Treasure Island housing would be eliminated over time. As a result, any employment growth could result in increased long-term housing demand. The need for affordable housing to Bay Area workers is a region-wide policy issue of great importance. However, an imbalance of housing to jobs is not a physical environmental effect, but rather an economic and social issue. The physical impacts of NSTI's housing supply shortfall under Alternative 2 relate primarily to project-induced and cumulative traffic and air quality effects, discussed below.

There is a possibility that the uses contemplated for Treasure Island reuse will overlap or compete with proposed developments in the San Francisco waterfront area, such as the Rincon Hill Arena project and proposals for an entertainment retail center in the China Basin/Mission Bay Plan area. However, planning of these entertainment areas will be coordinated by San Francisco and such similar developments are not expected to cause adverse socioeconomic impacts. Similar projects may provide additional jobs to San Francisco residents and any additional housing demand created by Rincon Hill and China Basin entertainment complexes would be covered by potential development of 2,000 multi-family residences in the China Basin project (San Francisco 1997b).

Cultural Resources

The demolition of historic military properties as part of disposal and reuse of Bay Area Navy installations, including Point Molate, NAS Alameda, Mare Island Naval Shipyard, and Hunters Point Naval Shipyard, could result in a significant cumulative impact to cultural resources. Although transfer of each of these installations has been or will be accompanied by a MOA between Navy and SHPO, as well as other invited signatories, to ensure protection of historic resources, demolition of historic properties may occur at some installations (i.e., Mare Island Naval Shipyard) under certain reuse alternatives. While Alternatives 1 and 3 would preserve historic structures on NSTI and would not contribute to a cumulative impact, Alternative 2

would add to the significant cumulative impact through demolition of historic buildings and structures at NSTI.

The selected alignment for the SFOBB east span could also adversely affect significant cultural resources on both Navy and non-Navy land on Yerba Buena Island. For example, noise and vibration generated by driving piles and other construction activities, as well as potential interruptions in access and construction staging, could affect historic Yerba Buena Island buildings, such as the Senior Officers Quarters Historic District (see Figure 3-4 in section 3.4). The area east of Quarters 1 may be used for construction staging as part of the SFOBB east span project. Construction activities for the SFOBB would substantially reduce Navy and the reuse entity's ability to maintain these historic properties. Permanent visual, shadow, noise, and vibration effects resulting from construction of the SFOBB alignment also could result in deterioration of historic characteristics of structures on Yerba Buena Island. In addition, physical disturbances, such as possible demolition and adaptation of cultural resources in the area, could result in an irreversible loss of finite resources.

Known prehistoric archeological resources are confined to non-Navy land on Yerba Buena Island. Cumulative significant impacts to these resources could occur under all three reuse alternatives in conjunction with the proposed SFOBB east span project if subsurface archeological remains are discovered during reuse implementation (see Figure 3-3 in section 3.4).

Mitigation for these cumulative impacts would involve prohibiting demolition of significant historic buildings and structures, the adaptive reuse of these properties following the Secretary of the Interior's *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings*, and the appropriate treatment of historic and prehistoric archeology, should such resources be uncovered. In addition, resources should be documented before destruction in accordance with HABS/HAER standards.

Transportation

The traffic analysis presented in section 4.5 calculated traffic to be generated by each of the reuse alternatives for NSTI, added it to projected traffic from probable future development, distributed the trips to the transportation network, and then determined the impact. The analysis assumed full build out of the alternatives in year 2010 and 2025. The future conditions in the traffic analysis takes into account both the growth expected at NSTI and the growth forecast for San Francisco and the Bay Area, and is therefore inherently cumulative.

Cumulative impacts would occur under the three reuse alternatives related to traffic congestion and an increased demand for parking at ferry terminals that would provide service to and from NSTI. Jack London Square/Alameda Main Street and Golden Gate Fields are outside the San Francisco's jurisdiction. The significance of this cumulative impact at these locations is not known with certainty; it would be a localized impact. Potential specific mitigation measures also cannot be known at this time. Given the lack of specific development projections and the high degree of uncertainty concerning possible effects on the environment, potential cumulative impacts attributable to increased traffic congestion and parking demand at East Bay ferry terminals are considered too speculative to evaluate.

Caltrans has begun construction of a new east span of the SFOBB. The new east span of SFOBB provides for the bridge to use structures separating the double-decked lanes into two parallel structures. The eastbound on-ramp on the east side of the YBI tunnel would be rebuilt to current standards under the SFOBB project; however, the reconstruction and funding for other new ramps on Yerba Buena Island was not included as part of the SFOBB project. Future improvements to the other ramps are possible under a separate project because MTC has made them eligible for future funding in the Regional Transportation Plan. The replacement alternative would maintain existing vehicular capacity and may improve traffic operations, but congestion is unlikely to be effected (Caltrans and FHWA 2001). The SFOBB is projected to be at capacity during peak hours in the future, whether or not reuse occurs. The three reuse alternatives would contribute a small increment to projected traffic volumes, which would be considered cumulatively significant. The contribution to cumulative congestion attributable to the reuse alternatives could be reduced by implementing the TDM measures, proposed ferry services, and transit services identified in section 4.5, Transportation. In addition, a traffic monitoring program was included in the mitigation measure to ensure that additional traffic generated by the proposed action would not negatively impact SFOBB.

Construction-related traffic would be noticeable on island roadways and could contribute to localized congestion. Construction of the SFOBB would also require temporary closure of roadways on Yerba Buena Island such as Macalla Road and Southgate Road. The area east of Quarters 1 may be used for construction staging as part of the SFOBB east span project. Cumulative impacts would be reduced to the extent that, as initially planned, the scheduled SFOBB construction and reuse construction activities on Yerba Buena Island would occur at different times. Additional mitigation for this cumulative impact would involve providing alternate routes and regulating on-island roadways with flaggers, particularly along Macalla Road, to ensure there are no conflicts with oversized construction vehicles using these roads. Other measures that could be undertaken include requiring that construction contractors limit the number of vehicles on the islands, provide alternative means of transportation for construction workers, and use car ferries to transport construction workers and materials. Project-specific proposals also should include temporary replacement parking, as necessary.

Air Quality

The geographic scope of impacts on air quality is the San Francisco Bay Area Air Basin. Falling within the boundaries of the San Francisco Bay Area Air Basin are stationary source emissions within the project boundaries, mobile source emission from people travelling to and from the project site, and power plant emissions from facilities providing power to the project area. All of these affect the concentration of pollutants at locations distant from the site within the basin. Cumulative air quality concerns include potential local carbon monoxide effects due to cumulative traffic congestion and cumulative regional emissions of ozone and PM_{10} precursors. As indicated in the modeling analysis presented in section 4.6, there is little potential for cumulatively adverse carbon monoxide impacts along the SFOBB, even when traffic volumes reach that facility's capacity limits.

Ozone precursor and PM_{10} precursor emissions associated with NSTI reuse (see Table 4.6-1 in section 4.6) would be added to similar emissions from other sources of regional growth and would contribute to cumulative air pollutant emissions in the Bay Area. Cumulative air quality issues in the San Francisco Bay Area are being addressed through regional air quality plans

such as the BAAQMD *Bay Area 2001 Ozone Attainment Plan*. The projected changes in land use and vehicle travel patterns from the reuse alternatives would not have significant cumulative air quality impacts because projected reuse-generated emissions would not alter existing air quality conditions. Implementing TDM measures discussed in section 4.5, Transportation, can reduce cumulative air quality impacts.

NSTI reuse, if undertaken concurrently with the proposed SFOBB east span project, could contribute to significant cumulative construction and demolition air quality impacts from dust and vehicle emissions. The primary emission-generating activities would be new construction, roadway reconstruction, and demolition. This cumulative impact can be mitigated by implementing the dust control measures during construction and demolition activities described in section 4.6, Air Quality.

Noise

Noise conditions are inherently localized, because noise levels decrease quickly with increasing distance from the noise source. Very few noise sources are audible at distances beyond 2 miles. Cumulative noise effects are limited primarily to local effects of cumulative traffic conditions or combined effects of adjacent development. Isolation from other urban development in the Bay Area limits cumulative noise issues to traffic noise along the SFOBB corridor. The contribution of traffic associated with reuse to this cumulative traffic noise would be inconsequential. The reuse alternatives could, however, introduce new uses to areas near the SFOBB, which could be affected by noise associated with the proposed SFOBB east span project.

The EIS for the SFOBB east span project estimates that peak noise levels generated by that project would exceed noise abatement criteria for sensitive land uses but would generally be less than existing traffic noise levels due to use of steel-reinforced concrete and a side-by-side roadway design (rather than stacked decks). Reuse activities in combination with SFOBB construction activities may result in temporary cumulative noise impacts. Reuse construction on Yerba Buena Island is planned to occur following SFOBB construction, which would minimize concurrent cumulative impacts. Cumulative impacts may nevertheless occur as a result of sequential construction noise events. Reuse construction noise would be minimized through limitations on activities, as described in section 4.7. Caltrans will work with the property recipient regarding appropriate noise abatement approaches on Yerba Buena Island to mitigate noise impacts from SFOBB construction (Caltrans and FHWA 2001).

Biological Resources

NSTI reuse would not combine with other projects to result in cumulatively significant effects on biological resources. Effects on biological resources from reuse of NSTI are limited to disturbance to mudflats and eelgrass habitat at NSTI, dredging for the proposed marina, and potential effects on harbor seals. These NSTI project effects, however, would not incrementally add to effects of other projects to cause significant impacts to wetlands, shoreline, or other marine biological resources.

In regard to long-term population growth and secondary impacts on land use and wetlands, the proposed NSTI reuse would not substantially increase urbanization or population pressure in the region of influence and therefore would not contribute to such increases that could cause

alterations of wetland or other sensitive habitats. In regard to the cumulative effects of the reuse of NSTI and those of other Bay Area base closures identified in the region of influence, the disposal and reuse of NAS Alameda/FISC Alameda or the reuse of the Presidio Army Base in San Francisco are expected to have beneficial impacts on marine and biological resources and therefore there would be no significant cumulative adverse effects from the base closures.

Implementing either Alternative 1 or 2, in combination with replacing the SFOBB east span, could result in cumulative impacts to mudflat habitat along Yerba Buena Island, including potential impacts to eelgrass beds. Mitigation identified for the reuse alternatives would minimize disturbance to these mudflats. SFOBB replacement would be expected to result in the loss of a small area of eelgrass at the Oakland touchdown. Mitigation proposed for this loss includes a conceptual mitigation plan to replace affected mudflat habitat and eelgrass beds (Caltrans and FHWA 2001). Therefore cumulative impacts from the proposed reuse of NSTI and construction of SFOBB would be minimized and would not be significant.

Proposed dredging activity under NSTI reuse could incrementally add to cumulative impacts to marine species and habitats both locally, as a result of the SFOBB east span project, and in other portions of the Bay proposed for dredging, such as the Oakland Inner Harbor as part of the reuse of FISCO. Dredging impacts include the physical modification of benthic habitats and the removal or disturbance of local populations of bottom-dwelling organisms; increased turbidity and the release of contaminants that are contained in the sediments into the water column; and the noise and disturbance caused by dredging operations. Dredged material disposal can have analogous impacts at disposal sites. However, impacts of dredging are generally short-term, limited in area, and mitigable at the source on a project-specific basis through compliance with stringent federal and state regulatory requirements. In addition, cumulative Bay-wide dredging and dredged material disposal impacts, including the small amount of potential dredging at NSTI, are being mitigated through the Bay Area Long Term Management Strategy (LTMS) (COE 2000b). Therefore, the contributions of the reuse alternatives to cumulative impacts to marine species and habitats from dredging would not be significant.

Increased boat traffic under Alternatives 1 or 2, in combination with the SFOBB east span replacement (scheduled for completion by 2005) and work at the Richmond-San Rafael Bridge (scheduled for completion by 2004) could result in cumulative impacts to harbor seals at Yerba Buena Island. However, because none of these projects would directly use the haul-out sites during construction activities, the construction phases of these projects would not overlap, and the project activities would be intermittent, cumulative impacts from these projects are not considered to be cumulatively adverse or significant.

Geology and Soils

NSTI is in an active seismic area subject to periodic earthquakes. Each of the three reuse alternatives, in conjunction with future development at closing Navy bases in the Bay Area and in the region, would expose more persons to earthquake hazards. Other geotechnical constraints, such as liquefaction and lateral spreading, might present hazards in specific areas. In addition, vegetation removal would present potential erosion conditions. Adherence to recommendations contained in site-specific geotechnical reports, building codes, and grading ordinances, and implementation of region-wise erosion control plans would avoid significant

cumulative impacts because exposure would not result in risks higher than commonly accepted in northern California.

Water Resources

Possible cumulative impacts from development of structures in coastal areas include impacts to changes in flooding patterns, loss of sand, and loss of near shore areas. Land use and drainage patterns would not be substantially altered and no impacts are expected in these areas. The possible cumulative water resources impacts of NSTI reuse and other projects in the region of influence would be the impacts of dredging and dredge material disposal on the water quality of central San Francisco Bay. Significant cumulative impacts could occur as a result of concurrent dredging activities for NSTI reuse, SFOBB replacement, FISCO reuse, and the Vision 2000 program for deepening Oakland Inner Harbor; however, impacts of dredging are generally short-term, limited in area, and mitigable at the source on a project-by-project basis through compliance with applicable regulatory requirements, including the LTMS. The impacts of dredging at NSTI are expected to be consistent with the federal and state established plan for dredged spoils in the San Francisco Bay. Depending on the selected disposal option, dredge material disposal may have cumulatively significant water quality impacts. Compliance with applicable dredge disposal priorities, which favor reusing sediments on land, would minimize this impact to a not significant level.

Utilities

Each of the three reuse alternatives in combination with cumulative regional development would result in increased demand for utilities in San Francisco (potable water and fire protection distribution, wastewater collection and treatment, stormwater collection, electrical and natural gas, telecommunications, and solid waste systems). The increased regional demand could require construction of new and enlarged utility systems and upgrading of existing utility infrastructure. Construction of utility systems and facilities to serve regional growth and development would proceed under the direction of the utility providers. Each of the reuse alternatives would include development of utility systems and facilities that would adequately serve the reuse development without impacting services in the region and therefore would not conflict with general plans of San Francisco or neighboring municipalities. Therefore, there would be no cumulative impact.

Realignment of the SFOBB east span, in accordance with the east spans realignment alternative selected by FHWA in its July 11, 2001 ROD, would require demolishing the old east span and would remove a Navy potable water line through which EBMUD provides emergency backup service to NSTI. If this line were not replaced, the site would lose this emergency backup service. This is a significant and mitigable cumulative impact resulting from the SFOBB project. Mitigation would involve replacing the potable water pipeline along the new east span of the SFOBB to provide emergency backup service to Treasure Island and Yerba Buena Island.

Public Services

The three reuse alternatives, in conjunction with other area development on Treasure and Yerba Buena Islands and in the region, would result in a cumulative increase in demand for public services. However, development restrictions would not allow for construction of a reuse

alternative until all public services can be provided. Further, reuse of NSTI would not result in the realignment or development of other projects in the region of influence, which may further increase the demand for public services. Therefore, NSTI reuse development under any of the three reuse alternatives would not have an incremental cumulative impact on the ability to provide these services.

Hazardous Materials and Waste

Similar reuse of contaminated properties (i.e., military base closures) could result in a greater potential for exposure of the public to hazardous substances. Implementing various remedial actions pursuant to CERCLA at each of these sites to remove, manage, or isolate any potentially hazardous substances prior to conveyance would minimize the potential for a significant cumulative impact. Acquiring entities at these installations have been required to comply with Land Use Controls during construction or operations to ensure continued protection of human health and the environment; deeds conveying these properties have, in some cases, contained notices that areas not subject to remediation efforts (such as under foundations) may require additional characterization and possible response actions to appropriate regulatory oversight.

Implementation of the three reuse alternatives would result in the use of hazardous materials and the generation of hazardous wastes. Such waste would also be generated by other Navy bases in the Bay Area that are closing, the Job Corps facility on Treasure Island, and possible waterfront development in San Francisco. Future development at NSTI and other installations would be required to comply with all applicable federal, state, and local regulations governing the use, storage, transfer, and disposal of hazardous materials, as well as the measures stated above. Therefore, development at NSTI under any of the three reuse alternatives would not incrementally contribute to a cumulative impact from hazardous materials or waste. In addition, while remediation at NSTI and other Bay Area Navy bases being conducted in accordance with CERCLA is not subject to NEPA, it would nevertheless have a beneficial impact on the region's environment.

CHAPTER 6.0

Other Considerations Required by NEPA

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6.0 OTHER CONSIDERATIONS REQUIRED BY NEPA

This section addresses other topics required by NEPA in an EIS. These include: an analysis of significant unavoidable adverse impacts to the environment; the relationship between local short-term uses of the environment and long-term productivity; the identification of any irreversible and irretrievable commitments of resources; a discussion of Executive Order 12898 (Environmental Justice, 59 Fed. Reg. 7629 [Feb. 11, 1994]); and a discussion of Executive Order 13045 (Environmental Health and Safety Risks to Children, 62 Fed. Reg. 19885 [April 21, 1997]).

6.1 SIGNIFICANT UNAVOIDABLE ADVERSE EFFECTS

An EIS must describe any significant unavoidable impacts for which either no mitigation or only partial mitigation is feasible. The impact analysis presented in Chapters 4 and 5 of this EIS indicates that significant unavoidable adverse effects would occur only under Alternative 2.

Implementation of Alternative 2 would require demolition of Building 2 and Building 3 on Treasure Island, buildings eligible for listing on the NRHP. This would result in the loss of significant historic resources. This adverse effect can be lessened or reduced by recording the affected resources to the standards of HABS/HAER, but recordation would not eliminate the adverse effect caused by the demolition of NRHP-eligible resources.

6.2 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

NEPA requires that an EIS consider the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. The analysis covers the extent to which both disposal and reuse involve tradeoffs between short-term environmental gains at the expense of long-term losses, or vice versa.

Because most of NSTI has been developed, redevelopment under any of the three reuse alternatives would do little to negatively affect the short or long-term productivity of the area. Disposal and subsequent reuse of NSTI could however result in both short- and long-term environmental gains that would enhance productivity of the site. Improved vehicle access and increased public recreation opportunities along the San Francisco Bay shoreline under reuse would be both a short- and long-term gain. Long-term gains would also include increases in jobs and housing and generation of sufficient revenue to support the investment necessary to upgrade the Treasure Island perimeter dike and undertake other facility ground improvements that would improve the seismic safety of the site.

Disposal and reuse of NSTI could result in potential environmental impacts, as identified in Chapters 4 and 5 of this EIS, such as those to transportation, biological resources, and water resources. If not mitigated, these impacts could result in decreases in the long-term productivity of the environment on NSTI.

6.3 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

NEPA requires that an EIS analyze the extent to which the proposed alternatives' primary and secondary effects would commit nonrenewable resources to uses that future generations

probably would be unable to reverse. Disposal and subsequent reuse of Navy property and structures would constitute an irreversible or irretrievable commitment of military resources and land uses.

Reuse of the property would provide for responsible long-term resource management and, except for Alternative 2, makes no irreversible resource commitments. Alternative 2 would include the planned removal of historic Building 2 and Building 3 on Treasure Island, which would be a permanent loss of these resources.

Implementing any of the reuse alternatives would require short-term commitments of both renewable and nonrenewable energy and material resources for demolition, and commitments for construction of the structures and infrastructure improvements required for implementation. These developments would represent a very large commitment of financial resources but would not represent an irreversible commitment of NSTI surplus property to the proposed uses.

Equipment used during construction and demolition activities at NSTI would consume petroleum fuels, such as gasoline and diesel. This temporary energy expenditure would occur over the short term and would not substantially increase the overall demand for electricity or natural gas. Implementing the reuse alternatives would consume large volumes of nonrenewable fossil fuel as a result of increased trips generated by automobile, bus, and ferry trips. Additional energy would also be expended at the wastewater treatment plant. The increase in development likely would result in an increase in the annual amount of energy consumed in heating, air conditioning, and other operational uses of energy. Infrastructure improvements would be provided corresponding to each new phase of development to meet increased demand.

6.4 ENVIRONMENTAL JUSTICE

This section summarizes potential impacts from disposal and reuse of the site on issues of environmental justice, as mandated by Executive Order 12898. The Executive Order on "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations," issued on February, 11, 1994, requires that the impacts of federal actions on minority and low-income populations be addressed to avoid disproportionate adverse impacts to these groups.

On April 21, 1995, the Secretary of Defense submitted a formal environmental justice strategy and implementation plan to the EPA. To comply with the executive order, this EIS included the following actions:

- Gathering economic, racial, and demographic information generated from the 1990 census to identify areas of low-income and high minority populations in San Francisco and Alameda counties that would potentially be exposed to project impacts;

- Assessing the disposal and reuse alternatives for disproportionate impacts resulting from on-site activities associated with reuse of project site facilities; and

- Encouraging community participation and input through public hearings and meetings and extensive public notification, which are described in Chapter 1 and Chapter 7 of this document.

6.4.1 Criteria and Methodology

Under the provisions of Executive Order 12898, "[m]itigation measures outlined or analyzed in an environmental assessment, environmental impact statement, or record of decision, whenever feasible, should address significant and adverse environmental effects of proposed federal actions on minority communities and low-income communities." Relative to environmental justice, a significant impact would occur if the proposed action, including the consideration of all resource issues, would result in disproportionate negative effects on minority populations or low-income populations. To determine whether low-income or minority populations could be disproportionately affected by the disposal and reuse of NSTI, low-income and minority populations were first identified. Potential effects in areas where these populations live were next identified and these effects were further evaluated to determine if there would be any disproportionate effect. The area considered in this analysis includes NSTI, San Francisco, and Alameda County.

6.4.2 Minority Population and Low-income Population Overview

As presented in Table 6-1, the population of NSTI in 1990 was predominately White (65 percent), as it was in the Bay Area region (69 percent), in San Francisco (54 percent), and in Alameda County (60 percent). The residential population of NSTI in 1990 was entirely composed of military personnel and their dependents. The non-white (i.e., racial minority) population at NSTI was roughly proportional to the region and in the surrounding communities of San Francisco and Alameda counties.

Median income of NSTI households in 1990 was about 16 percent lower than the San Francisco median income and 25 percent lower than Alameda County's (see Table 3.3-4 in section 3.3, Socioeconomics). At the time of the 1990 census approximately nine percent of all households in the Bay Area, 13 percent of San Francisco households, and 11 percent of Alameda County households were below the poverty level.

6.4.3 Potential Disproportionate Impacts to Minority Populations or Low-income Populations

The potentially affected area adjacent to NSTI does not include disproportionately high minority populations or low-income populations compared to adjacent communities. In addition, impacts under any of the three reuse alternatives would either not be significant or, if significant, would be adequately mitigated such that no disproportionate impact would be expected to occur. As a result, none of the reuse alternatives appear likely to have a disproportionate impact on minority populations or low-income populations to warrant further analysis beyond that conducted in each of the environmental issue areas.

Table 6-1
Racial Composition of NSTI, Bay Area, San Francisco, and Alameda County Population, 1980 and 1990

Location		*White*		*Black*		*American Indian*		*Asian Pacific Islander*		*Other*		*Hispanic*	
		1980	**1990**	**1980**	**1990**	**1980**	**1990**	**1980**	**1990**	**1980**	**1990**	**1980**	**1990**
NSTI	#	2,565	2,911	321	718	44	38	794	702	211	140	293	389
	%	65.2	64.6	8.2	1.6	1.1	0.8	20.2	15.5	5.4	3.1	7.4	8.6
Bay Area	#	3,940,084	4,147,971	466,274	533,188	37,187	39,035	462,890	919,279	273,349	384,104	632,640	899,243
	%	76.0	68.9	9.0	8.9	0.7	0.6	8.9	15.3	5.3	6.4	12.2	14.9
San Francisco	#	395,081	388,341	86,414	78,931	3,548	3,354	147,426	211,000	46,505	42,333	83,373	96,640
	%	58.2	53.6	12.7	10.9	0.5	0.5	21.7	29.1	6.8	5.8	12.3	13.3
Alameda County	#	740,612	762,557	203,612	229,316	7,446	8,354	85,899	193,282	67,810	85,673	129,962	176,017
	%	67.0	59.6	18.4	17.9	0.6	0.7	7.8	15.1	6.1	6.8	11.8	13.8

Note: Percentages may not add to 100 due to rounding. Hispanic origin is for information only and is not considered a separate race. Persons of Hispanic origin are also counted under one of the other race columns.

Source: U.S. Department of Commerce 1980, 1990.

Socioeconomic impacts under any of the reuse alternatives would not occur or would not be considered significant if they were to occur, and would not be expected to disproportionately affect minority or low-income populations (see section 4.3). Each of the reuse alternatives would create a net gain in employment, and jobs that would be provided at the theme park should offer opportunities for minority populations and low-income populations. In addition, TIHDI's Notice of Interest for NSTI includes homeless housing, support services, employment, and economic development programs and services for the homeless, which would benefit low-income populations.

Under the No Action Alternative, the caretaker program would provide employment for approximately 50 personnel on the site, which would represent a decrease of 700 jobs from the operational baseline. While most of the lost jobs would be from relocation of military personnel to other installations, some would be local, civilian support jobs. Given the number of jobs available in the region, this would be a less than significant impact. There is no indication that the workers in these jobs would be predominantly minority or low-income and therefore would be disproportionately affected.

The significant and not mitigable environmental impact of reuse Alternative 2 identified in this EIS would affect cultural resources, as summarized in section 6.1. Under Alternative 2, the loss of Buildings 2 and 3 on Treasure Island, which meet the criteria for listing in the National Register, would have localized impacts at the individual sites and potential cumulative regional impacts throughout the Bay Area, but would not have a disproportionate adverse impact on minority populations or low-income populations.

There may be potentially significant but mitigable on-site health and safety implications resulting from exposure to environmental contamination/hazardous materials on the site during reuse (as discussed in section 4.13), but there is no indication that any such potential impacts would disproportionately accrue to minority populations or low-income populations. Health and safety impact concerns could also extend off-site under the reuse alternatives. Air quality is one such issue, but given that any such impacts would be experienced on a regional basis, no disproportionate impacts to minority populations or low-income populations are anticipated.

Some unauthorized fishing has historically taken place at Pier 23 and other areas on NSTI; it is possible that under the reuse plan public access for fishing would be broadened. Under these circumstances, therefore, minority or low-income populations that conduct subsistence fishing might gain increased access to fishing opportunities. It should be noted that California EPA has identified possible health consequences from eating fish caught in San Francisco Bay, due to high levels of the following chemicals: mercury, dioxins, PCBs, DDT, dieldrin, and chlordane (California EPA 2001). It is recommended that under the selected alternative, warning signs in a variety of languages be posted in areas that provide public access for fishing to warn of possible health risks from consuming fish caught in San Francisco Bay.

6.5 PROTECTION OF CHILDREN FROM ENVIRONMENTAL HEALTH RISKS AND SAFETY RISKS

On April 17, 1997 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, was signed by President Clinton. The policy of the Executive Order states that:

> A growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because: children's neurological, immunological, digestive, and other bodily systems are still developing; children eat more food, drink more fluids, and breathe more air in proportion to their body weights than adults; children's size and weight may diminish their protection from standard safety features; and children's behavior patterns may make them more susceptible to accidents because they are less able to protect themselves. Therefore, to the extent permitted by law and appropriate, and consistent with the agency's mission, each federal agency:
>
> - shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and
>
> - ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.
>
> Under the definitions provided in Executive Order 13045, covered regulatory actions included those that may be "economically significant" (under Executive Order 12866) and "concern an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children." Further, Executive Order 13045 defines "environmental health risks and safety risks" [to] "mean risks to health and safety that are attributable to products or substances that the child is likely to come in contact with or ingest (such as the air we breathe, the food we eat, the water we drink or use for recreation, the soil we live on, and the products we use or are exposed to).

Environmental health risks and safety risks mean risks to health or to safety that are attributable to products or substances that the child is likely to come into contact with or to ingest. To comply with Executive Order 13045, this section of the EIS discusses child-specific environmental health risk and safety risk issues.

Areas on NSTI where there may be potentially high concentrations of children include schools, day care centers, and residential areas. The only school on NSTI is the Treasure Island Elementary School, leased to the SFUSD by Navy. This school has a capacity of up to a total of 1,000 students, kindergarten through 5th grade. The former child development center in Building 502 closed in mid-1997, but was re-opened in March 2003.

Under Alternatives 1 and 3, the existing school would be retained and a child development center would re-occupy Building 502. Residential development is also proposed under the

three reuse alternatives. The largest amount of residential development would occur under Alternatives 1 and 3, where new residences would be developed in the northern half of Treasure Island and on Yerba Buena Island. Under Alternative 2, residences would only be developed on Yerba Buena Island.

There may be potentially significant, but mitigable on-site health and safety impacts resulting from exposure to environmental contamination/hazardous materials on the site during reuse (as discussed in section 4.13), but there is no indication that any such potential impacts would disproportionately accrue to children. Areas of contamination are scheduled for cleanup prior to reuse, with restoration to levels appropriate to subsequent reuse categories. Children would not be expected to be exposed during the cleanup process.

Health and safety impact concerns could also extend off-site with the reuse alternatives. Air quality impacts (as discussed in section 4.6) are a potential concern, but given that any such impacts would be of a small incremental level and would be experienced on a regional basis rather than a localized basis, no disproportionate impacts to children are anticipated.

As explained for environmental justice, a significant and not mitigable impact to historic resources under Alternative 2 would not disproportionately affect children. For all significant and mitigable environmental impacts identified in this EIS, implementing identified mitigation measures as described would ensure that no disproportionate impacts to environmental health risks and/or safety risks to children would occur under any of the reuse alternatives.

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CHAPTER 7.0

Consultation and Coordination

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7.0 CONSULTATION AND COORDINATION

7.1 AGENCY COORDINATION

The federal, state, and local agencies were consulted prior to and during the preparation of this EIS. Agencies were notified of plans for closure and disposal activities by mail; by scheduled public meetings associated with the reuse planning process; by publication of an NOI announcing preparation of a Draft EIS; by a public scoping meeting; by publication of an NOA announcing the availability of the Draft EIS, and by a public hearing on the Draft EIS. The agencies' viewpoints were solicited with regard to activities and issues within their jurisdiction. Agency correspondence with US Fish and Wildlife Service, NOAA Fisheries, US Department of Housing and Urban Development, and SHPO, is provided in Appendix C. The agencies contacted are listed below.

7.1.1 Federal Agencies

Department of Defense

- US Navy, Naval Station Treasure Island
- US Navy, Engineering Field Activity West
- US Navy, Public Works Center San Francisco Bay

Department of the Interior

- US Fish and Wildlife Service

Department of Labor

Department of Transportation

- US Coast Guard
- Federal Highways Administration

7.1.2 State Agencies

State Department of Transportation

- Caltrans – District 4

State Lands Commission

State Office of Historic Preservation

7.1.3 Regional Agencies

San Francisco Bay Conservation and Development Commission

East Bay Municipal Utilities District

San Francisco Bay Regional Water Quality Control Board

7.1.4 City and County of San Francisco

California Academy of Science

Department of Public Health

Department of Public Works

Fire Department

Hetch Hetchy Water and Power

Municipal Railway (Muni)

Office of Emergency Services

Planning Department

Police Department

Public Utilities Commission

Solid Waste Management Program

Treasure Island Homeless Development Initiative

Unified School District

Water Department

7.1.5 Public Service Agencies

Altamont Landfill and Resource Recovery Facility

7.2 PUBLIC COORDINATION

Extensive public coordination has occurred, and will continue to occur, as part of this proposed action. Public involvement opportunities to date include the reuse planning process and the EIS notification process, including the NOI and one scoping meeting. Sections 7.2.1 through 7.2.5 provide more information on the outreach activities and responses associated with the reuse planning process, NOI process, public scoping meeting, public review of the Draft EIS, and release of the Final EIS.

7.2.1 Reuse Planning Process

The process to convert NSTI to civilian use involved an extensive reuse planning and community outreach process San Francisco, acting as the LRA, prepared the reuse plan for NSTI. During the reuse planning process, efforts were made to encourage and incorporate public participation and communication into the reuse planning process. Community outreach and involvement were critical components in the reuse plan development. This process provided several opportunities to inform agencies and the public of the availability of NSTI assets and to identify potential commercial interests in surplus military property.

A major portion of the outreach process involved conducting community workshops to define issues and to discuss reuse opportunities. In addition to the community workshops, all meetings of the Treasure Island Citizens Reuse Committee (CRC) were open to the public.

Based on the community outreach program and public interest, the LRA Draft Reuse Plan was prepared. Section 2.2 of this EIS summarizes the alternatives development and screening process leading to the final selection of a reuse plan.

7.2.2 Notice of Intent to Prepare the Draft EIS/EIR

The scoping process was conducted jointly with San Francisco. In conformance with the requirements of NEPA, an NOI to prepare an EIS for the Disposal and Reuse of NSTI was published by Navy in the Federal Register and distributed to potentially interested parties, including regulatory agencies, local jurisdictions, service providers, and others. A copy of the NOI is provided in Appendix D.

7.2.3 Public Scoping Meeting

An additional effort to inform the public and to solicit input on the scope of the EIS from affected jurisdictions, interested members of the public, and organized groups was afforded through a public scoping meeting held by Navy and San Francisco. The NSTI public scoping meeting was held on October 9, 1996 at the San Francisco Ferry Building. Presentations were given by representatives of Navy and San Francisco. An opportunity for oral comments followed. Six oral comments were received; no written comments were received at the meeting. Twelve written comments on the NOI were received via mail.

A complete transcript of the public scoping meeting is available from:

Timarie Seneca
US Navy, Southwest Division
BRAC Operations Office
1230 Columbia Street, Suite 1100
San Diego, California 92101-8517
(619) 532-0955

The environmental issues raised in the six oral and twelve written comments were considered during the course of the impact assessment process, and are briefly summarized below.

Oral Comment Summary

Public Involvement Process

A commentor expressed concern about the public comment period and notice for the reuse plan, as well as inadequate discussion of alternatives in the reuse plan.

Land Use

A request was made for analysis of different land use intensities. It was suggested that a new alternative that reuses housing without the addition of any new housing be analyzed. Expanding the marina facilities and increasing parking areas with the marina were proposed.

Socioeconomics

Issues were raised regarding the inclusion of the concerns of veterans, as well as inclusion of economic, educational, and technical programs in the reuse plan.

Biological Resources

It was recommended that wildlife habitat and wildlife viewing opportunities be included on Treasure Island and Yerba Buena Island. The addition of wetlands was a suggested alternative. A point was made that such opportunities also had economic, recreational, and sewage treatment benefits.

Public Plans, Policies, and Regulatory Agencies

Concerns were expressed for the consistency of development with the Tidelands Trust and the Sustainable San Francisco Plan.

Written Comment Summary

Alternatives

- Navy was encouraged to examine a full range of alternatives that maximize environmental quality and that incorporate pollution prevention and conservation measures.
- A clear definition of the region of influence and an unambiguous statement of purpose and need must be provided.
- Navy is required to identify both a Preferred Alternative and an Environmentally Preferable Alternative.
- The public should be able to participate in the refinement of the reuse alternatives during the EIS process beyond the minimum requirements of NEPA.
- The reuse plan developed by the Urban Lands Institute should be considered as an alternative.
- The Reduced Impact Alternative should include reuse of the existing housing on Treasure Island, as well as 300 units on Yerba Buena Island for affordable housing.

Land Use

- The US Coast Guard's current and future land use on Yerba Buena Island should be considered in the EIS.

- Existing and projected land use conflicts should be identified, and the EIS should offer opportunities that would reduce them.

- A portion of the lands comprising NSTI remains subject to the common law tidelands trust. Upon the cessation of military use, the State Lands Commission has agreed to allow San Francisco the continued use of existing buildings located on public trust lands (submerged and tidal lands) for their intended use for an appropriate period, even where the uses do not fall within the range of public trust uses.

- Designate the shoreline promenade, referred to in the Draft Reuse Plan, as part of the planned 400-mile recreational Bay Trail system.

- It appears that the reuse alternatives involve land uses that are not permitted on public trust land; the impacts of non-compliance with the Tidelands Trust Doctrine must be fully detailed and mitigated.

Visual Resources and Urban Design

- The EIS should identify potential aesthetic effects particularly on the Bay shoreline.

Socioeconomics and Population

- Nearby residential areas should be documented and the potential effects on these areas fully analyzed.

- The effects on minority communities should be analyzed in accordance with Executive Order 12898, and opportunities for minority input should be presented in the EIS process.

- The potential for providing affordable housing on Treasure Island and parts of Yerba Buena Island by reusing existing housing should be considered.

Cultural Resources

- In accordance with the NHPA, the EIS should identify all historic, prehistoric and archeological resources at Treasure Island and provisions should be made to protect any cultural resources encountered during project implementation.

- The reuse plan should incorporate systematic inventory and recording of historic resources, protection of historic resources, and cultural resource reviews.

Transportation

- Transportation across the Bay Bridge and over the Bay by ferry should be given particular consideration.

- Transportation effects should be taken in context with other transit changes in the region.

- Direct and indirect effects of reuse, which should be fully documented in the EIS, might result in increased transit if additional employment is generated.

- A complete traffic study was recommended to identify the impacts to State Route 80. A request was made that the impact of additional traffic on the Bay Bridge, the inadequate design of the existing on/off ramps, and the need for restricted accessibility to pedestrians be addressed.

- Give consideration to safe pedestrian and bicycle access to Treasure Island, particularly shoreline areas.

Air Quality

- Information regarding the current air quality attainment status and the generation of criteria pollutants under the proposed alternatives should be analyzed with respect to attainment status.

Noise

- Noise contours should be used to show existing and proposed noise levels. These should be overlain by known sensitive areas to indicate potential impacts.

Biological Resources

- It is important that the project's effects on protected and endangered species and critical fisheries habitat be addressed.

- A wildlife habitat component should be included in the alternatives.

- Consideration should be given to the preservation of remnant indigenous biological communities on Yerba Buena Island in land use planning.

- The current reuse options should be more ecologically sustainable; the current options use large amounts of natural resources and generate waste.

- Seabird nesting sites for MBTA-protected species at NSTI, such as the western gull, the Brandt's cormorant, pelagic cormorant, and the black oystercatcher, should be protected from development or other disturbance.

Water Resources

- The proposed development and reuse should not hinder the Department of Defense's obligation to meet water quality standards.

- The EIS should address NPDES requirements, effects on Waters of the United States, baseline conditions, and dredging.

Public Services and Utilities

- The EIS should discuss and encourage pollution prevention and energy conservation opportunities.

- The net effect on regional water supplies and demand as a result of the project's actions should be surveyed.

- Water conservation measures should be encouraged.

Hazardous Materials and Waste

- Areas of existing and historical hazardous waste storage, disposal, and contamination should be identified and any plans to disturb these areas discussed. Of particular concern was the potential for adverse health effects on people who consume fish caught in the bay.

- The EIS should ensure that the reuse alternatives do not expose people to contaminated soils on Treasure Island. Petroleum pollution on Treasure Island poses a threat to both surface and ground water, and the stormwater conveyance system conducts the contaminants throughout the island and into the Bay. It was suggested as mitigation that stormwater be treated prior to its return to the Bay.

Public Plans, Policies, and Regulatory Agencies

- The regional planning efforts of the City, County, and Port of San Francisco and the City and Port of Oakland should be taken into account to avoid potential future conflicts.

Cumulative Effects

- The EIS should contain a discussion of the cumulative effects of the project on its region of influence. The discussion should describe the incremental impact of an alternative in conjunction with past, current, and future projects. Special consideration should be given to disposal and reuse of Hunter's Point Naval Shipyard, Mare Island, Alameda NAS, the Fleet and Industrial Supply Center, the Oakland Naval Medical Center, and the Oakland Army Base, as well as long term plans for the San Francisco waterfront.

Impacts

- Significance criteria and baseline conditions should be clearly defined.

- There are more environmental effects to consider than those identified on the Initial Study checklist.

Mitigation

- Potential mitigation measures should be identified in the Draft EIS that would provide the basis for specific commitments that would be carried forward through the rest of the environmental process.

7.2.4 Public Review of the Draft EIS

The public was invited to review and comment on the Draft EIS. An NOA was published in the Federal Register on May 10, 2002 and notices were published in the *San Francisco Chronicle* and *Oakland Tribune* on May 25 and 26, 2002. Copies of the Draft EIS and NOA were mailed to those

on the mailing list (Chapter 10 of the Draft EIS), beginning a 45-day public comment period. A public hearing on the Draft EIS was also held at Building 140 on Treasure Island on June 11, 2002.

During the public comment period, 22 comment letters on the Draft EIS were received from agencies or individuals. In addition, four persons provided oral comments on the Draft EIS at the public hearing. Comments on the Draft EIS and responses to those comments are provided in Chapter 11, Responses to Comments. The Final EIS has been revised, as appropriate, in response to public comments.

7.2.5 Final EIS

The Final EIS incorporates and responds to comments received on the Draft EIS and has been provided to all agencies or individuals that officially commented on the document or otherwise requested a copy (see Chapter 10, EIS Distribution List). An NOA of the Final EIS was published in the Federal Register on June 27, 2003.

As required under NEPA, there will be a 30-day review period after publication of the Final EIS. During this period, the public may comment on the adequacy of responses to comments and the Final EIS. After the 30-day review period, Navy can issue a NEPA ROD.

CHAPTER 8.0

List of Preparers and Contributors

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CHAPTER 9.0
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CHAPTER 10.0

EIS Distribution and Notification List

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10.0 EIS DISTRIBUTION LIST

A copy of the EIS has been distributed to the following:

FEDERAL AGENCIES

Advisory Council on Historic Preservation

US Army Corps of Engineers

US Department of Commerce, National Marine Fisheries Service

US Department of Commerce, National Oceanic and Atmospheric Administration

US Department of Defense, Office of Economic Adjustment

US Department of Education

US Department of Energy

US Department of Homeland Security

- US Coast Guard
- Federal Emergency Management Agency, Region 9

US Department of Housing and Urban Development

US Department of the Interior

- Office of Environmental Policy and Compliance
- Bureau of Indian Affairs
- Fish and Wildlife Service Realty Division
- National Park Service
- US Geological Survey

US Department of Labor

US Department of State

US Department of Transportation

- Federal Aviation Administration
- Federal Highway Administration

Federal Transit Administration

US Environmental Protection Agency, Region 9

US General Services Administration

US Navy

Naval Facilities Engineering Command, SOUTHWESTDIV

Naval Facilities Engineering Command, Washington Navy Yard

STATE AGENCIES

California Air Resources Board

California Assembly Office of Research

California Department of Conservation

California Department of Fish & Game

California Department of Forestry

California Department of Health Services

California Department of Highway Patrol

California Department of Parks & Recreation

California Department of Toxic Substance Control

California Department of Transportation, District 4

California Department of Water Resources

California Economic Development Department

California Labor Foundation

California Native American Heritage Commission

California Office of Economic Adjustment

California Office of Emergency Services

California Public Utilities Commission

California State Coastal Conservancy

California State Historic Preservation Office

California State Lands Commission

California Trade and Commerce Agency

California Water Resources Control Board

Northwest Information Center

San Francisco Bay Conservation and Development Commission

State of California, Clearinghouse

The Resources Agency

University of California, Berkeley and at San Francisco

ELECTED OFFICIALS

Senator Barbara Boxer

Senator Dianne Feinstein

Congresswoman Barbara Lee

Congressman George Miller

Congresswoman Nancy Pelosi

Congressman Peter Stark

Senator John Burton

Assemblywoman Dion Aronor

Assemblywoman Helen Thompson

Mayor, Willie Brown, City and County of San Francisco

Mayor, Jerry Brown, City of Oakland

Honorable, Tom Ammiano, President, San Francisco Board of Supervisors

Honorable Chris Daly, San Francisco Board of Supervisors

Honorable, Matt Gonzalez, San Francisco Board of Supervisors

Honorable, Tony Hall, San Francisco Board of Supervisors

Honorable, Mark Leno, San Francisco Board of Supervisors

Honorable, Jake McGoldrick, San Francisco Board of Supervisors

Honorable, Sophie Maxwell, San Francisco Board of Supervisors

Honorable, Gavin Newsom, San Francisco Board of Supervisors

Honorable, Aaron Peskin, San Francisco Board of Supervisors

Honorable, Gerardo Sandoval, San Francisco Board of Supervisors

Honorable, Leland Yee, San Francisco Board of Supervisors

REGIONAL AGENCIES/SPECIAL PURPOSE AGENCIES

AC Transit

Association of Bay Area Governments, San Francisco Bay Trail Project

Bay Area Air Quality Management District

Bay Area Rapid Transit District Planning

California Regional Water Quality Control Board

East Bay Municipal Utility District

Metropolitan Transportation Commission

Port of Oakland

San Francisco Municipal Railway

LOCAL AGENCIES

City and County of San Francisco

- City Attorney's Office
- Department of Building Inspection
- Department of City Planning
- Department of Public Health
- Department of Public Works
- Division of General Engineering Services

Fire Department Regional Training Center

Fire Department, Division of Planning & Research

Planning Commission

Planning Department

Police Department

Public Utilities Commission

Real Estate Department

Recreation & Park Department

Redevelopment Agency, Office of Base Conversion

San Francisco Landmarks Preservation Advisory Board

San Francisco Port Commission

City of Alameda, Planning Department

City of Berkeley, Planning Department

City of Brisbane, Planning Department

City of Daly City, Planning Department

City of Emeryville, Planning Department

City of Larkspur, Planning Department

City of Oakland, Planning Department

City of San Mateo, Planning Department

City of Sausalito, Community Development Planning Department

City of South San Francisco, Planning Department

City of Tiburon, Planning Department

City of Vallejo, Planning Department

County of Alameda, Planning Department

County of Marin, Planning Department

County of San Mateo, Planning Department

County of Solano, Planning Department

OTHER INTEREST GROUPS

Arc Ecology

Bay Area Council

Coalition for San Francisco Neighborhoods

Golden Gate Audubon Society

Natural Resources Defense Council

Nature Conservancy

San Franciscans for Reasonable Growth

San Francisco Bay Chapter of the Sierra Club

San Francisco Planning & Urban Research Association

San Francisco Tomorrow

Social Economic Environmental Justice Advocates

Treasure Island Development Authority

Treasure Island Homeless Development Initiative

Treasure Island Firefighters

Treasure Island Yacht Club

LIBRARIES

Oakland Public Library, Eastmont Branch

Oakland Public Library, Main Library

San Francisco Public Library, Main Library

San Francisco Public Library, Bayview/Waden Branch

San Francisco Public Library, Portrero Branch

San Francisco Public Library, Chinatown Branch

San Francisco Public Library, North Beach Branch

San Francisco Public Library, Bernal Heights Branch

UTILITIES/PUBLIC SERVICES

Pacific Gas and Electric

TI Utilities Manager

San Francisco Unified School District

Water Department Distribution Division

NATIVE AMERICANS

Ione Band of Mission Indians

INTERESTED INDIVIDUALS

Woody Baker-Cohn

Eugene Brodsky

Normal de Vall

Susan DeVico

Katherine Erolinda Perez

Karen Frick

John Geddie

Mr. Gerberding

Kathleen Gilbert

Ruth Gravanis

Richard Hansen

Emeric Kalman

Karen Knowles-Pearce

Lew Schalit

Dale Smith

1 Warwick Tompkins

2 Joel Ventresca

3 Lisa Vorderbrueggen

4 Bill Wong

CHAPTER 11.0

Responses to Comments

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11.0 RESPONSES TO COMMENTS

The Draft EIS for the Disposal and Reuse of NSTI was circulated for public and agency review from May 10 to June 24, 2002. The lead agency, the Navy, held a public hearing on June 11, 2002, at Treasure Island to provide the public with an opportunity to comment on the content and accuracy of the Draft EIS. In addition, written comments were accepted throughout the review period.

In accordance with NEPA regulations, the Final EIS provides responses to comments on the Draft EIS (40 CFR § 1503.4). In compliance with those regulations, this section of the Final EIS includes a list of agencies, organizations, and individuals commenting on the Draft EIS, comment letters, and responses to the substantive environmental issues raised in the comments. Responses to comments received at the public hearing also are included. If a comment did not relate to an environmental issue or was worded more as a statement to be entered into the record, it is indicated by the response "comment noted."

Agencies or Individuals Commenting on the Draft EIS

Letter Reference	*Commentor*
FEDERAL AGENCIES	
A	US Coast Guard
B	US Department of Transportation, Federal Highway Administration
C	US EPA
STATE AGENCIES	
D	State Clearinghouse
E	State Clearinghouse
F	Department of California Highway Patrol
G	Department of Toxic Substances Control
H	California Department of Transportation
I	Office of Historic Preservation
J	San Francisco Bay Conservation and Development Commission
K	California Regional Water Quality Control Board, San Francisco Bay Region
L	California State Land Commission
LOCAL AND REGIONAL AGENCIES	
M	San Francisco Bay Trail Project
N	City and County of San Francisco
O	San Francisco Municipal Railway

Letter Reference	*Commentor*
ORGANIZATION	
P	Arc Ecology
INDIVIDUALS	
Q	Michael Dziadek
R	Norman L. de Vall
S	Ruth Gravanis
T	Richard Hansen
U	Emeric Kalman
V	Warwick Tompkins
W	Warwick Tompkins
PUBLIC HEARING COMMENTS	
PH-1 and 2	Warwick Tompkins
PH-3	Richard Hansen
PH-4	Susan DeVico
PH-5	Dale Smith

LETTER A

U.S. Department of Transportation
United States Coast Guard

Commander
Maintenance & Logistics
Command Pacific

Coast Guard Island, Bldg 54D
Alameda, CA 94501-5100
Staff Symbol: se-1
Phone: (510) 437-3511
FAX: (510) 437-5753

16475
June 24, 2002

Ms. Timarie Seneca
BRAC Operations Office
U.S. Navy, Southwest Division
Naval Facilities Engineering Command, Code 06CM.TS
1230 Columbia Street, Suite 1100
San Diego, CA 92101-8517

Subject: *Draft Environmental Impact Statement for the Disposal and Reuse of Naval Station Treasure Island, San Francisco, California.* May 2002.

Dear Ms. Seneca:

Thank you for providing copies of the subject draft environmental impact statement (DEIS) to the Coast Guard. We have noted that Coast Guard property was excluded from this DEIS that only addresses development proposals on 920 acres to be disposed of by the Navy, i.e., Naval Station Treasure Island (NSTI) lands as delineated in the DEIS as "Reuse Plan Area". The Coast Guard has some concerns about matters that may directly or indirectly affect Coast Guard operations, property, and personnel related to the proposed alternative development plans.

The DEIS discussion of future utilities related primarily to development proposed on Treasure Island, e.g., installation of a perimeter utility corridor around Treasure Island for Alternatives 1 and 2. The DEIS did not address provision of utility services to entities outside the NSTI planning area, i.e., the U.S. Department of Labor, Coast Guard, or Caltrans. The Navy currently owns and operates the utilities, and provides utilities services to the Coast Guard. The Coast Guard wants the responsibility to be transferred to San Francisco. A-1

Coast Guard has some concerns regarding its access road, i.e., Macalla Road, and the capacity of the road to accommodate additional traffic from new development proposed in the DEIS. The relocation of Macalla Road by Caltrans, as part of its east span replacement construction activity for the San Francisco Oakland Bay Bridge, should afford an opportunity to work out a new design that will provide a satisfactory solution for all users. A-2

As mentioned in the DEIS, the on and off ramps to the bridge need upgrading, and it was noted that the ramps are owned by the Navy. The Coast Guard is concerned about accessibility to Yerba Buena Island (YBI) and the bridge, and the need to upgrade the ramps to have the capacity to handle additional traffic that will be generated by the alternative development proposals. A-3

Coast Guard has some concerns about potential contamination from past practices. Installation Restoration Site 11 (IR 11), is contiguous to Coast Guard property. As mentioned in the DEIS, it was transferred to the FHWA, but additional investigation is planned to determine the extent of the landfill and the need for remedial action. The Coast Guard is concerned about possible migration of contamination from IR 11 onto or under its property. This is an issue that Coast A-4

Guard needs to have resolved before Caltrans starts construction activity on IR 11. The Coast Guard is pleased with a statement that two underground storage tanks (UST) at the entrance to Coast Guard property will be removed. A-4

References in the DEIS to Quarters 8 and 9, which are both eligible for the National Register of Historic Places, are somewhat confusing. They were transferred by the Navy to the Coast Guard, but this was not stated anywhere in the DEIS. The depiction of Quarters 8 and 9 on Figure 3-4 is inconsistent with the title of this figure, i.e., "National Register Listed Buildings and Eligible Properties on NSTI" since Quarters 8 and 9 are outside of NSTI. A-5

If you have any questions regarding the above comments, please call my environmental reviewer, Ms. Carol Meyer, at (510) 437-3511. Thank you for your consideration.

Sincerely,

J. P. Milkey

J. MILKEY
Lieutenant Commander, U. S. Coast Guard
Chief, Planning Branch
By Direction of the Commander

Copy: Commanding Officer, Coast Guard Group San Francisco

RESPONSE TO COMMENTS

Response to Comment A-1. The Navy intends to convey all utilities associated with NSTI to the designated property recipient. The Navy has retained all utility easements that are within lands transferred to FHWA. Easements that are assignable will be transferred to the designated property recipient in conjunction with the associated utilities. The US Coast Guard would be required to reach agreement with the property recipient for providing or sharing operation of any utility services in the future.

Response to Comment A-2. The design of the San Francisco-Oakland Bay Bridge (SFOBB) east span retrofit project has been completed and construction has begun. The project will include improved eastbound ramp access from Yerba Buena Island to the Bay Bridge East Span for vehicular traffic, as well as new pedestrian and bicycle access to and from the East Bay on the south side of the SFOBB East Span. Neither Caltrans nor the Treasure Island Development Authority (TIDA) has plans to make further improvements to Macalla Road and connecting ramps. Macalla Road currently has very low traffic volumes. While it is not a high capacity road, it has the capacity to handle 300-400 vehicles per hour. The May 2000 EIR estimated that the on-ramp on the east side of the SFOBB tunnel would carry approximately 195 vehicles during the weekend midday peak hour (worst case condition under Alternative 1), of which only a portion came from Treasure Island using Macalla Road. The remaining came from Yerba Buena Island. Macalla has capacity for an additional 200 vehicles.

Response to Comment A-3. As stated in response to comment A-2, the design of the SFOBB east span retrofit project has been completed and construction has begun. The project will include improved ramp access from Yerba Buena Island to the Bay Bridge East Span for vehicular traffic, as well as new pedestrian and bicycle access to and from the East Bay on the south side of the SFOBB East Span. Neither Caltrans nor the TIDA has plans to make further improvements to the connecting ramps.

Response to Comment A-4. IR Site 11 is in the remedial investigation (RI) stage. The full extent of contamination will be assessed, and, upon completion of the RI, the appropriate course of action to address contamination at the site will be made. The remedial action selected will ensure that contamination issues at the site will be adequately addressed and that no contamination would migrate onto US Coast Guard property. As the commentor notes, the Navy intends to remove two underground storage tanks at IR Site 11. The date of removal of these tanks will be determined based on the timing of SFOBB construction activities in the area. All remedial work is expected to be completed in 2006.

Response to Comment A-5. Section 3.4 has been revised to clarify that quarters 8 and 9 have been transferred to the US Coast Guard. Quarters 8 and 9 have been removed from Figure 3-4.

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CALIFORNIA DIVISION
980 Ninth Street, Suite 400
Sacramento, CA. 95814-2724

June 11, 2002

IN REPLY REFER TO
HDA-CA
File #: 04-SF-80
Document #: P 40532

Ms. Timarie Seneca
BRAC Operations Office, Southwest Division
Naval Facilities Engineering Command, Code 06CM.TS
1230 Columbia Street, Suite 1100
San Diego, CA 92101-8517

Dear Ms. Seneca:

SUBJECT: **DEIS for Disposal and Reuse of Naval Station Treasure Island.**

Thank you for the May 7, 2002, notice along with a copy of the Draft Environment Impact Statement (DEIS) for the Disposal and Reuse of Naval Station Treasure Island (NSTI).

The DEIS purpose and need as stated is to dispose of surplus federal property at NSTI for subsequent reuse. Furthermore, it states "Navy considered the Local Redevelopment Authority's (LRA) stated purpose and need in developing reasonable reuse alternatives." Since the scoping meeting, the DEIS shows that the City and County of San Francisco have decided to proceed with the state process under a separate environmental impact report (EIR) to analyze the impacts from the reuse of NSTI. It is our understanding that the proposed EIR is currently being prepared. As such the DEIS is deficient in addressing the impact related to the developments that have not yet been determined by the city. B-1

The DEIS states that on October 26, 2000, the Federal Highway Administration (FHWA) transferred 97 acres of Navy dry and submerged land on Yerba Buena Island (YBI) to the California Department of Transportation (Caltrans). It further states that the FHWA conveyed this land in fee and this land is no longer available for transfer by the Navy to the city. Most of the acreage noted in the federal land transfer to Caltrans is under a "Temporary Construction Easement (TCE)," please note that the TCE acreage is not a fee transfer and the land will be returned to the United States when the construction of the San Francisco – Oakland Bay Bridge, East Span Seismic Safety Project is completed. The DEIS needs to clarify and identify the area as fee transfer and other areas as TCE. We have enclosed a map showing the limits of the federal land transfer for your use. B-2

Section 3.5, Transportation, discusses the transportation system and the deficiencies. Table 3-9 on page 3-47 is using accident data from January '92 to April '95. More recent information should be used to assess the accidents to date as well as the safety concerns associated with the increased traffic by future city developments. B-3

Chapter 4, Environmental Consequences are deficient in addressing land use on YBI and the ramps to and from I-80. As noted above, the TCE will return to the Navy/United States when it is no longer needed for the SFOBB. The impact associated with the city's development should be evaluated and mitigated. The document uses 2010 for traffic analysis and certain mitigation measures identified was based on 2010 forecast and demand. It would be appropriate to use 2015 or built out year forecast to assess mitigation for future planned developments. Section 4.5.1 shows impact to SFOBB/I-80 YBI westbound on-ramp (west side) and (east side) to be significant. One of the mitigation measures for the west side on-ramp is to route traffic to the east side on-ramp. The DEIS also discusses the planned ramp upgrade as a part of the SFOBB project. This statement is incorrect. The existing eastside westbound on-ramp will be closed during the construction of the SFOBB, East Span. After construction, the existing on – ramp will be similar to what it is today. It is our understanding that the City is working with Caltrans to improve or modify this ramp but this is being proposed outside the scope of the SFOBB, East Span project. Unless the proposed upgrade by the City is completed, both of these on-ramps will be deficient and have insufficient capacity to handle the increased traffic from the city's development.

B-4

If you have any questions regarding these comments please contact Bill Wong, Bay Bridge Project Manager, at (916) 498-5042.

Sincerely,

For
Michael G. Ritchie
Division Administrator

Enclosure

Response to Comments

Response to Comment B-1. As the commentor notes, the federal action evaluated in this EIS is the disposal of surplus federal property at NSTI. NEPA requires federal agencies to evaluate the reasonably foreseeable effects of the federal action. The EIS needs only to assess the potential for impacts based on the reasonably foreseeable reuse of the property and need not address future site development plans that are beyond the Navy's ability to reasonably estimate.

Because a final development plan was not available at the time it was prepared, the EIS relies on alternatives that reflect a range of development concepts, including the City and County of San Francisco's Draft Reuse Plan (San Francisco 1996e). Alternative 1 represents the City's draft reuse plan concept and is a high level of development. Alternative 2 is based on recommendations by the Urban Land Institute and the public on the Draft Reuse Plan and is a medium level of development. Alternative 3 is a limited development alternative that focuses on reuse of existing facilities.

A developer submitted a proposal for NSTI to TIDA on July 2, 2002, and TIDA is currently reviewing it. TIDA or private reuse entities will be required to prepare separate environmental documentation to address the potential impacts of the development plan once it has been finalized.

Response to Comment B-2. The May 2002 draft EIS was prepared with the understanding that all property in the temporary construction easements (TCEs) and aerial easements were encumbered to such a degree that it eliminated the ability for development, per the Draft Reuse Plan. In earlier negotiations, TIDA and the Navy concluded that the property need not be conveyed until the easements had been relinquished. Further, the prospective completion date for the new SFOBB east span was beyond the period in which the Navy could convey the property under the BRAC authority. Therefore, all of the approximately 98 acres (40 ha) of land transferred to FHWA, including the TCEs and aerial easements, were excluded from evaluation in the Draft EIS. Due to a new understanding between Navy and TIDA, Navy has determined that the TCEs and aerial easements are available for disposal and are included in the transfer and reuse analysis presented in the Final EIS.

The Final EIS has been revised to reflect that land on Yerba Buena Island transferred to FHWA, and subsequently conveyed to Caltrans, via permanent aerial easements of approximately 0.6 acre (0.2 ha) of dry land and TCE's approximately 77 acres (32 ha) of dry and submerged land, are available for disposal and are evaluated in the EIS. Lands permanently conveyed in fee to Caltrans (approximately 20 acres [8 ha] of dry land) for construction and operation of the SFOBB are permanently transferred out of Navy ownership and are not evaluated in the EIS. In addition, Figure 1-2 and other figures throughout the Final EIS have been revised to reflect the inclusion of these areas.

With the exception of the cultural resources analysis, inclusion of the TCEs and aerial easements was not found to measurably alter the analysis or conclusions presented in the Final EIS. The TCE and aerial easements make up only approximately 8.5 acres [3.5 ha], or 0.02 percent of the dry land proposed for disposal. The analysis of such resources as socioeconomics, traffic, air

quality, and noise is partly based on the approximate acreage of each land use type. Nevertheless, the designated land uses for these lands (residential, publicly oriented, and open space/recreation), which were developed before being transferred to FHWA, are less intensive and, as such, loss of this land does not substantially alter the assumptions of the analysis in the EIS.

The TCEs and aerial easements contain structures that are eligible for listing on the National Register of Historic Places and areas of cultural sensitivity. These areas were not considered as part of the proposed transfer and were identified but not analyzed in the Draft EIS. The Final EIS has been revised to address these resources. The MOA for cultural resources has also been revised to include these areas; as a result of inclusion of these resources in the MOA, no new significant impacts were identified as a result of inclusion of these areas.

Response to Comment B-3. The accident data in Table 3-9 of the Draft EIS (now Table 3.5-1 of the Final EIS) has been updated based on information provided by Caltrans.

Response to Comment B-4. Please see response to comment B-2 regarding inclusion of the FHWA/Caltrans easements in the EIS analysis.

A technical memorandum has been included as Appendix F.3-A with year 2025 freeway mainline and ramp analyses. This technical memorandum concluded that there is no change in the findings of additional significant traffic impacts on SFOBB and its connecting ramps at NSTI. The year 2025 vehicle trip generation estimates for the proposed action is the same as that of year 2010 because the year 2010 vehicle trip generation analysis presented in the Draft EIS is for the full build of the proposed action. While traffic demand on the Bay Bridge would be greater in 2025 than in 2010, the actual number of vehicles that can get onto the SFOBB in both eastbound and westbound directions are restricted by the metering lights on the eastern end and by the I-80 lane configuration and congestion in San Francisco downtown.

The EIS states that the level of service on the SFOBB is assumed to continue to operate at capacity with or without reuse of NSTI. The EIS does state that there would be significant but mitigable impacts from the increased volumes and queuing on three SFOBB ramps on Yerba Buena Island and from a reduced level of service on the westbound SFOBB during the peak traffic periods and the only feasible mitigation (transportation demand management [TDM]) is provided. The metering lights at the SFOBB toll plaza control westbound traffic to ensure smooth operation of the SFOBB. Additional traffic under reuse of NSTI would not slow the metering lights and, as a result, regardless of the number of vehicles approaching the SFOBB, the operation of the SFOBB would remain the same and, therefore, impacts as evaluated in the EIS would not change.

It is noted that the eastbound on-ramp on the west side of Yerba Buena Island is expected to be closed for approximately three years during construction of the SFOBB, which may result in traffic impacts that Caltrans would need to mitigate as part of that project. Nevertheless, the closure of the eastbound on-ramp during SFOBB construction would not be expected to measurably affect or interact with reuse construction for several reasons. First, the traffic analysis presented in the EIS is for full build out at NSTI. It is unlikely that the first phase of

reuse construction would generate such high levels of traffic. Second, SFOBB construction is scheduled to be completed in 2005 and is unlikely to substantially overlap with the first phase of reuse construction, which was projected in the Draft Reuse Plan to occur between 2002 and 2006. Finally, the EIS does not refer to any planned upgrade of the westbound on-ramp on the eastside of Yerba Buena Island. The Navy concurs that the eastside westbound on-ramp would be deficient to address reuse traffic and proposes mitigation to address this potential impact.

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LETTER C

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

Timarie Seneca
BRAC Operations Office
Naval Facilities Engineering Command
U.S. Navy, Southwest Division
1230 Columbia Street, Suite 1100
San Diego, CA 92101

June 20, 2002

Dear Ms. Seneca:

The U.S. Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (DEIS) for the ***DISPOSAL AND REUSE OF NAVAL STATION TREASURE ISLAND (NSTI), City and County of San Francisco, California*** (CEQ # 020174. # D-USN-K11107-CA). Our comments are provided pursuant to the National Environmental Policy Act (NEPA), the Council on Environmental Quality's NEPA Implementing Regulations (40 CFR 1500-1508), and Section 309 of the Clean Air Act. EPA attended the Navy's public hearing for this DEIS, held on Treasure Island on the evening of June 11, 2002.

The proposed action is disposal of Navy property for subsequent reuse and redevelopment. Operationally closed in 1997, NSTI is on two islands in San Francisco Bay midway between the shores of the San Francisco and Oakland. Treasure Island, the larger island, consists of 402 acres of dry land created with fill in the 1930s. Approximately 681 acres of dry and submerged land are available for disposal on Treasure Island. Yerba Buena Island is a natural island connected to Treasure Island by a causeway. Approximately 239 acres of dry and submerged land are available for disposal on Yerba Buena Island (a total acreage of approximately 920 acres is thus proposed for disposal and reuse). Approximately 36 acres of land on Treasure Island were previously transferred to the U.S. Department of Labor, while approximately 97 acres on Yerba Buena Island were transferred to the Federal Highway Administration (with a subsequent transfer to the California Department of Transportation), and 22 acres are scheduled for transfer to the U.S. Coast Guard (the acreage already transferred to the U.S. Department of Labor and the Federal Highway Administration, and scheduled for transfer to the U.S. Coast Guard, is outside the scope of the current disposal and reuse action assessed in this DEIS).

The DEIS evaluates three reuse alternatives. Navy disposal of 920 acres of dry and submerged land on the two islands is assumed for each reuse alternative. Alternative 1 represents full implementation of the development scenario described in the Naval Station Treasure Island Draft Reuse Plan developed by the Treasure Island Development Authority (TIDA). Alternative 2 is based on comments received during the scoping process, including recommendations by an advisory panel of the Urban Land Institute. Alternative 3 represents a lower level of

redevelopment than proposed in the Draft Reuse Plan. A fourth alternative, No Action, assumes no property disposal, but retention of the property by the Navy in an inactive or caretaker status. Under No Action, existing leases would continue until they expire or are terminated, no new leases would be implemented, and all buildings and other facilities would remain vacant and unused. Alternative 1 (the Navy's Preferred Alternative) features a combination of publicly-oriented development, open space and recreation, and extensive residential development at full build out. Under Alternative 1, publicly-oriented development on Treasure Island would include a theme attraction park, a 300-room hotel, and a 1,000-room hotel with three restaurants and offices. Publicly-oriented uses on Yerba Buena Island would include a 150-room hotel, conference facilities, and restaurant. Clipper Cove Marina would be expanded and a new yacht club developed. Community uses on both islands would include parks and open space, schools, a bikeway and pedestrian path. Industrial uses and infrastructure include a new wastewater treatment plant, a new police station and a new fire station on Treasure Island. Other facilities would include an elementary school, child development center, fire training school and brig. Residential housing includes a reuse of existing housing and construction of new housing on both islands. Alternative 1 proposes 2,840 dwelling units (290 existing residential units + 2,550 new residential units).

The DEIS sufficiently addresses the environmental impacts associated with the proposed disposal and reuse action. However, EPA has environmental concerns that mitigation is not addressed where impacts are identified, and information which is necessary to assess impacts is not provided. Specifically, EPA has environmental concerns with the proposed action because air quality impacts are identified, however, no mitigation is proposed. These include emissions from construction and demolition activities; transportation-related emissions; potential carbon monoxide (CO) hot spots; and potential air toxic emissions (see pp. 4-60 to 4-64). In each case, the Navy asserts that no air quality-related mitigation is proposed because the emissions are not considered to be significant. However, NEPA requires that an Environmental Impact Statement discuss steps that could be taken to mitigate adverse environmental consequences (e.g., potential CO hot spots, emissions of air toxics) even if such mitigation would not be implemented by the lead Federal agency (as in this case, since TIDA and/or the City and County of San Francisco would require or implement mitigation associated with NSTI's reuse).

EPA also has environmental concerns because the DEIS does not present relevant information on the location and amount of dredging associated with reuse activities, i.e., a new ferry terminal and marina maintenance. Because NSTI was an active Federal facility for more than 60 years, and the Navy was historically involved in a number of dredging and dredged material disposal projects in the San Francisco Bay Area, we assume that the Navy has information on file regarding dredging activities at NSTI, including historic data on sediment quality and characteristics. However, the Navy has deferred an analysis of impacts associated with dredging for this project, with page 2-14 stating, "this EIS must necessarily evaluate potential impacts from dredging on a programmatic level." There is, however, no corresponding commitment by the Navy to prepare a tiered NEPA document analyzing the environmental effects of dredging associated with NSTI reuse activities.

We have environmental concerns regarding several issues involving hazardous materials and hazardous substances contamination at NSTI. EPA believes that the manner in which the Navy presents information on hazardous materials and hazardous substances contamination at NSTI can be presented more clearly, resulting in an improved NEPA document and an informed decision-making process. For example, although the DEIS presents a useful discussion of hazardous substances contamination at NSTI, no map is provided that depicts contamination at NSTI, although such maps are available as part of the environmental restoration process. Additionally, no information is provided regarding the Navy's schedule for its investigation and remediation activities at NSTI. We are concerned by remarks made by the Navy at the June 11, 2002 hearing that environmental restoration activities and this NEPA process are separate processes, and that information developed as part of the environmental restoration process will not be presented in this NEPA analysis (e.g., maps depicting contamination at NSTI, and information regarding the Navy's schedule for investigation and remediation of hazardous substances at NSTI). Although we recognize that the NEPA process and the environmental restoration process are separate statutory requirements, current information developed in the course of the Navy's environmental restoration process at NSTI should be appropriately reflected in a concise manner in this EIS.

Based upon our review, EPA rates this DEIS as EC-2, Environmental Concerns - Insufficient Information. Please refer to the attached "Summary of Rating Definitions" for a detailed explanation of EPA's rating system. Please refer to our detailed comments (attached) for further discussion of EPA's concerns and other issues requiring clarification or more discussion in the Final Environmental Impact Statement (FEIS). We appreciate the opportunity to comment on the DEIS. Please send two copies of the FEIS to me at the letterhead address (mailcode: CMD-2) when it is filed with EPA's Washington, D.C. office. If you have any questions, please contact my staff reviewer for this document, David Tomsovic, at 415-972-3858.

Sincerely,

Lisa B. Hanf, Manager
Federal Activities Office

Enclosures: 4
"Summary of Rating Definitions"
EPA's Detailed Comments on DEIS
Site Location Map (contaminated sites)
Site Summary (list of contaminated sites)
Pollution Prevention Checklists

LETTER C

SUMMARY OF EPA RATING DEFINITIONS

This rating system was developed as a means to summarize EPA's level of concern with a proposed action. The ratings are a combination of alphabetical categories for evaluation of the environmental impacts of the proposal and numerical categories for evaluation of the adequacy of the EIS.

ENVIRONMENTAL IMPACT OF THE ACTION

"LO" (Lack of Objections)

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

"EC" (Environmental Concerns)

The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

"EO" (Environmental Objections)

The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

"EU" (Environmentally Unsatisfactory)

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potentially unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

ADEQUACY OF THE IMPACT STATEMENT

Category 1" (Adequate)

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

"Category 2" (Insufficient Information)

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analysed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

"Category 3" (Inadequate)

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analysed in the draft EIS, which should be analysed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

*From EPA Manual 1640, "Policy and Procedures for the Review of Federal Actions Impacting the Environment."

U.S. EPA Comments on the Navy's Draft Environmental Impact Statement (DEIS) - Disposal and Reuse of Naval Station Treasure Island (NSTI), City and County of San Francisco, California - June 20, 2002.

AIR QUALITY

Air Quality Impacts and Air Quality Mitigation

The DEIS (p. 4-59) states, "Buildout of Alternative 1 would result in short-term air pollutant emissions from construction activities, long-term emissions from operation of new sources, and potential long-term emissions from hazardous air pollutants." For Alternative 1, pages 4-60 to 4-64 state that no mitigation is proposed for the air quality effects of construction and demolition activities; transportation-related air pollutant emissions; potential carbon monoxide (CO) hot spots; or potential air toxic emissions. In each instance, the DEIS asserts that such impacts are 'not significant,' thus not warranting mitigation. Similarly, no air quality mitigation is proposed for Alternatives 2 and 3. Dust control measures recommended by the Bay Area Air Quality Management District (BAAQMD) are listed (p. 4-60).

In order to facilitate effective NEPA public disclosure, we strongly recommend that the Navy discuss its rationale for determining that impacts related to potential CO hot spots, emissions of air toxics, and other air quality-related issues were found to be 'not significant.' For example, page 4-64 states that for Alternative 1, air toxics could be generated by retail establishments, but the DEIS acknowledges that "the actual amount of these air contaminants cannot be quantified due to a lack of information about specific business uses...in the reuse plan area." It thus appears premature to assert that air toxic emissions would not be significant if actual pollutant types and emission levels are not known. It also seems premature to indicate that no mitigation is proposed without knowing the types and volumes of air toxics that would be emitted.

C-1

EPA believes that the Navy's approach (i.e., no mitigation proposed for air quality effects) is not consistent with the Council on Environmental Quality's (CEQ) pollution prevention memorandum to Federal agencies ("Memorandum to Heads of Federal Departments and Agencies Regarding Pollution Prevention and the National Environmental Policy Act," CEQ, January 12, 1993). Concerning the responsibilities of Federal agencies, CEQ's memorandum indicates that "federal departments and agencies should take every opportunity to include pollution prevention considerations in the early planning and decision making processes for their actions...and...document those considerations in any EISs...."

It does not appear that the Navy has taken "every opportunity" to integrate air quality mitigation to the "fullest extent practicable." Because of the role played by the BAAQMD in protecting the airshed, we encourage the Navy to work closely with that office to identify appropriate air quality mitigation measures, which should be presented in the Final Environmental Impact Statement (FEIS).

C-2

Recommended Mitigation for Air Toxic Emissions

Page 4-64 states that no mitigation is proposed for potential air toxic emissions. The FEIS should recognize that construction machinery is a source of air toxic emissions. A discussion of appropriate mitigation to reduce air toxics from construction machinery should be presented in the FEIS. Such mitigation would prove useful to the Treasure Island Development Authority (TIDA), and the City and County of San Francisco, as they proceed with NSTI's reuse. Below are suggested mitigation measures to reduce construction-related diesel emissions that EPA recommends be presented in the Navy's FEIS:

- Require that diesel-powered equipment be properly maintained;
- Minimize idling of diesel equipment to the fullest extent feasible;
- Lease or buy newer, "cleaner" equipment, 1996 or newer model year and use a minimum of 75 percent of the total horsepower of the equipment;
- Prohibit engine tampering to increase horsepower (engines should be tuned to meet the engine manufacturer's specifications);
- Use low sulfur diesel fuel (with a sulfur content of 15 ppm or less);
- Reduce diesel emissions using control technologies like traps that capture about 80% of diesel particulates, and specialized catalytic converters (oxidation catalysts) which control approximately 20% of diesel particulates, 40% of carbon monoxide, and 50% of hydrocarbons. These control technologies can be used together to maximize reductions in diesel emissions;
- Evaluate the use of other available engine types such as electric, liquified or compressed natural gas (CNG), hydrogen fuel cells, or alternative diesel formulations [Note: CNG may have a drawback since there is research data indicating that formaldehyde is emitted during combustion];
- Reduce construction-related traffic trips; and,
- Develop a 'Construction Emissions Mitigation Plan' describing measures to reduce the project's diesel emissions.

The Navy should know that the National Aeronautics and Space Administration (NASA) has agreed to adopt similar recommendations as part of their NASA Ames Programmatic Development Plan, including adoption of a 'Construction Emissions Mitigation Plan.'

C-3

Coordination with the Federal Highway Administration on Traffic-Related Issues, Including Air Quality

Page 7-1 identifies agencies contacted during the development of the DEIS. The Federal Highway Administration (FHWA) was not contacted. Since access to, and egress from, NSTI connects to the National Highway System (Interstate 80, I-80), the FHWA may have concerns regarding potential impacts to I-80 from future reuse activities at NSTI, including air quality impacts and an appropriate level of air quality mitigation. We recommend that the Navy contact FHWA to determine potential issues of concern to FHWA, including the EIS's presentation of

C-4

project-related impacts, and mitigation that should be presented in the FEIS. We note that a number of potential transportation-related mitigation measures are recommended in 4.5 (Transportation). Lastly, since FHWA may have jurisdiction by law and/or special expertise regarding access or potential impacts to I-80, the FEIS should address whether FHWA was asked to be a cooperating agency. C-4

DREDGING AND DREDGED MATERIAL DISPOSAL

Page 2-14 states, "[t]he exact location and amount of potential dredging is not known at present and therefore, this EIS must necessarily evaluate potential impacts from dredging on a programmatic level." Because the Navy does not specifically identify this DEIS as a 'programmatic' NEPA document, it may be inappropriate to defer analyzing such impacts by indicating that they will be evaluated on a 'programmatic level' at some future point. Should the Navy use a programmatic approach for dredging-related issues at NSTI, the FEIS and NEPA Record of Decision should contain a commitment that a future 'tiered' NEPA document would be prepared by the Navy to assess dredging-related activities at NSTI, consistent with CEQ's NEPA Implementing Regulations on programmatic analyses. Absent that, dredging-related issues should be fully discussed in the current NEPA document, and addressed as part of the Navy's NEPA decision-making process for this project. As indicated in our cover letter, EPA assumes the Navy has information on file regarding dredging-related issues at NSTI, including historic data on sediment quality and characteristics. As a matter of NEPA public disclosure, such information should be presented in the FEIS. The FEIS should also address if the party seeking authorization for dredging and/or dredged material disposal would be TIDA, the City and County of San Francisco, and/or a private party. C-5

HAZARDOUS SUBSTANCES CONTAMINATION AND HAZARDOUS MATERIALS

Polychlorinated Biphenyls (PCBs)

Page 3-137 addresses the spillage or release of PCB-contaminated transformer fluids at the PCB equipment storage area (Installation Restoration [IR] site 03). Page 3-143 states, "Surveys continue to be conducted for PCBs in secondary electrical equipment and hydraulic equipment." The FEIS should clarify the most current information regarding PCBs which may remain in use or in storage at NSTI, as well as the most current information regarding the known or suspected release of PCBs into the environment at NSTI areas proposed for reuse. The Navy should update the text discussion on page 3-137 to indicate that the Navy has requested permission from the State of California to eliminate site 03 as an IR site. The FEIS should clarify the phrase "the site was used to store and repair transformers," (p. 3-137) as the Navy's Base Realignment and Closure (BRAC) staff indicated to regulatory agencies that the site served only as an electrical substation. C-6

The DEIS discusses other NSTI facilities where PCBs may have been potentially used C-7

(e.g., the old boiler plant and medical clinic, see p. 3-137; and the foundry, see p. 3-138). Page 3-143 indicates that the State of California has recommended further investigation of PCB contamination at IR site 09 (foundry). The FEIS should address if PCBs may have been used at the old boiler plant or other facilities using equipment containing PCBs, and, if so, whether PCB contamination may be an issue of concern. We note that page 3-137 states that the old boiler plant building was demolished in 1968, and its debris "reportedly buried in place." Should PCBs have been used at the old boiler plant, the FEIS should address if PCB contamination at the boiler plant site is an issue of concern. C-7

The discussion in the DEIS on IR site 12 (old bunker) (p. 3-139) should be expanded to provide a more detailed description of the site contamination and investigation history under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). For example, please update the FEIS to describe a former Chemical Storage Yard in the vicinity of Halyburton and Bigelow Courts that was the subject of a large-scale removal action (approximately two acres) conducted in 2000-2001 to remove PCB-contaminated soils, and describe the numerous indoor air and subsurface soil sampling activities to assess PCBs at this area. C-8

Impacts from Potential Methane Gas Concentrations

The FEIS should address if concentrations of methane gas may be an issue of concern at any areas of NSTI proposed for reuse. One potential area could be IR site 11 (Yerba Buena landfill), for which additional investigation is planned "to determine the extent of the landfill." (p. 3-139). Should methane gas concentrations be an issue of concern, the FEIS should address the Navy's coordination with regulatory agencies, including applicable requirements or mitigation to avoid or reduce potential impacts related to methane gas. C-9

Radon and Radiological Contamination

Page 3-145 briefly addresses radon screening at six locations conducted under the Navy's Radon Assessment and Mitigation Program. In order to facilitate effective public disclosure under NEPA, the FEIS should discuss what activities involving potential radiological contamination occurred at these sites. Additionally, the FEIS should discuss the location of any sites screened for radon, and whether the Navy intends to survey other sites at NSTI for potential radiological contamination. C-10

The FEIS should also briefly discuss if military vessels used in U.S. atmospheric testing of atomic and hydrogen weapons at Bikini and Enewetak (present-day Republic of the Marshall Islands) were brought to NSTI for damage assessment and radiological decontamination, or whether such activities took place only at the (former) Hunters Point Naval Shipyard. It is unclear if damage assessment and radiological decontamination took place at NSTI. The FEIS should briefly discuss if vessels involved in the weapons testing program were berthed at NSTI and, if so, whether radiological contaminants may have entered adjacent waters. This issue is C-11

relevant to addressing potential impacts associated with dredging and dredged material disposal for the marina and ferry service. C-11

Map Depicting Known or Suspected Hazardous Waste, Toxic Substances or Hazardous Substances Contamination

The DEIS does not provide a map or maps depicting known or suspected hazardous waste, toxic substances or hazardous substances contamination at NSTI. In order to facilitate effective NEPA public disclosure, the FEIS should provide a map or maps depicting:

- Installation Restoration (IR) sites, including 29 sites identified for investigation (p. 3-136) which includes the 16 remaining IR sites described on pp. 3-136 to 3-142. We suggest that the FEIS present the Site Location Map and Site Summary Table from "Naval Station Treasure Island, Environmental Closeout Strategy/Schedules" (December 2001);
- Petroleum hydrocarbon contamination, including the nine major petroleum hydrocarbon sites identified on pp. 3-135 and 3-136 (e.g., hydraulic training school, fire training area, etc);
- Fuel storage tanks and oil/water separators;
- Polychlorinated biphenyls (both as releases or discharges into the environment, and in electrical and hydraulic equipment still at NSTI); C-12
- Metals;
- Pesticides and herbicides;
- Solvents;
- Asbestos-containing materials;
- Lead-based paint;
- Radon and any other radiological contamination; and,
- Other areas or contaminants of concern to the Navy.

A Navy map (attached) found in "Island Times: Environmental Investigation and Cleanup News" (summer 2001) is a useful reference that should be presented in the FEIS; this map depicts IR and petroleum sites, underground storage tanks, pipelines requiring possible investigation and remediation, and buildings at NSTI. In many respects the "Island Times" map is similar to the December 2001 map noted above, although the "Island Times" map does not specifically depict IR site 13 (stormwater outfalls), instead indicating that site 13 "includes all offshore areas."

Investigation and Remediation of Contaminated Areas

Pages 3-131 to 3-145 provide a useful discussion of hazardous materials, hazardous waste, and hazardous substances contamination at NSTI. The DEIS does not, however, present the Navy's schedule for when each contaminated area would be investigated and, as necessary, remediated prior to reuse. Current information on when the Navy's investigation and remediation efforts would be completed is integral to effective NEPA public disclosure for C-13

NSTI's reuse, and should be presented to agencies and the public as part of this NEPA document. The FEIS should provide the Navy's most current assessment for each area having known or suspected contamination or other releases into the environment; as well as for environmental restoration efforts involving units such as the survey of PCBs in secondary electrical equipment and hydraulic equipment, remediation of asbestos-containing materials, and other efforts. We recommend that such information be presented in a matrix format so readers can understand the Navy's schedule for completing its investigation and remediation of areas at NSTI with known or suspected contamination, or other toxic materials still in use. For reference, we have attached a "Site Summary: Naval Station Treasure Island" (Draft, 12/11/2001) that the FEIS could use as a model to portray the schedule for NSTI environmental restoration efforts. C-13

POLLUTION PREVENTION AND MITIGATION FOR THIS PROJECT

EPA commends the U.S. Department of Defense and the Navy for environmental leadership in the Federal sector, including an exemplary leadership role in pollution prevention, energy and water conservation, recycling, waste reduction, and waste minimization. However, despite the Navy's leadership role, the DEIS does not specifically reference how the proposed reuse can meet the intent of guidance issued in 1993 by the Council on Environmental Quality (CEQ) to integrate pollution prevention in NEPA planning, NEPA documents, and NEPA decisions. Please note that CEQ does not require that a particular impact or emission level be considered "significant" before a Federal agency is able to discuss mitigation that avoids, prevents or reduces environmental impacts, including health impacts (e.g., the health effects of air toxics). CEQ instructs Federal agencies to include pollution prevention to the extent practicable in the proposed action and in the reasonable alternatives. For your reference, we have attached several pollution prevention checklists (for building/housing construction; dredging; energy management; landscaping; and military base closure and reutilization) presenting strategies to reduce potentially adverse impacts associated with a facility's reuse. C-14

The Council on Environmental Quality's "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations" is instructive (CEQ, March 16, 1981, see 46 Fed. Reg. 18026). Question 19a raises the question, "What is the scope of mitigation measures that must be discussed?" In reply, CEQ states,

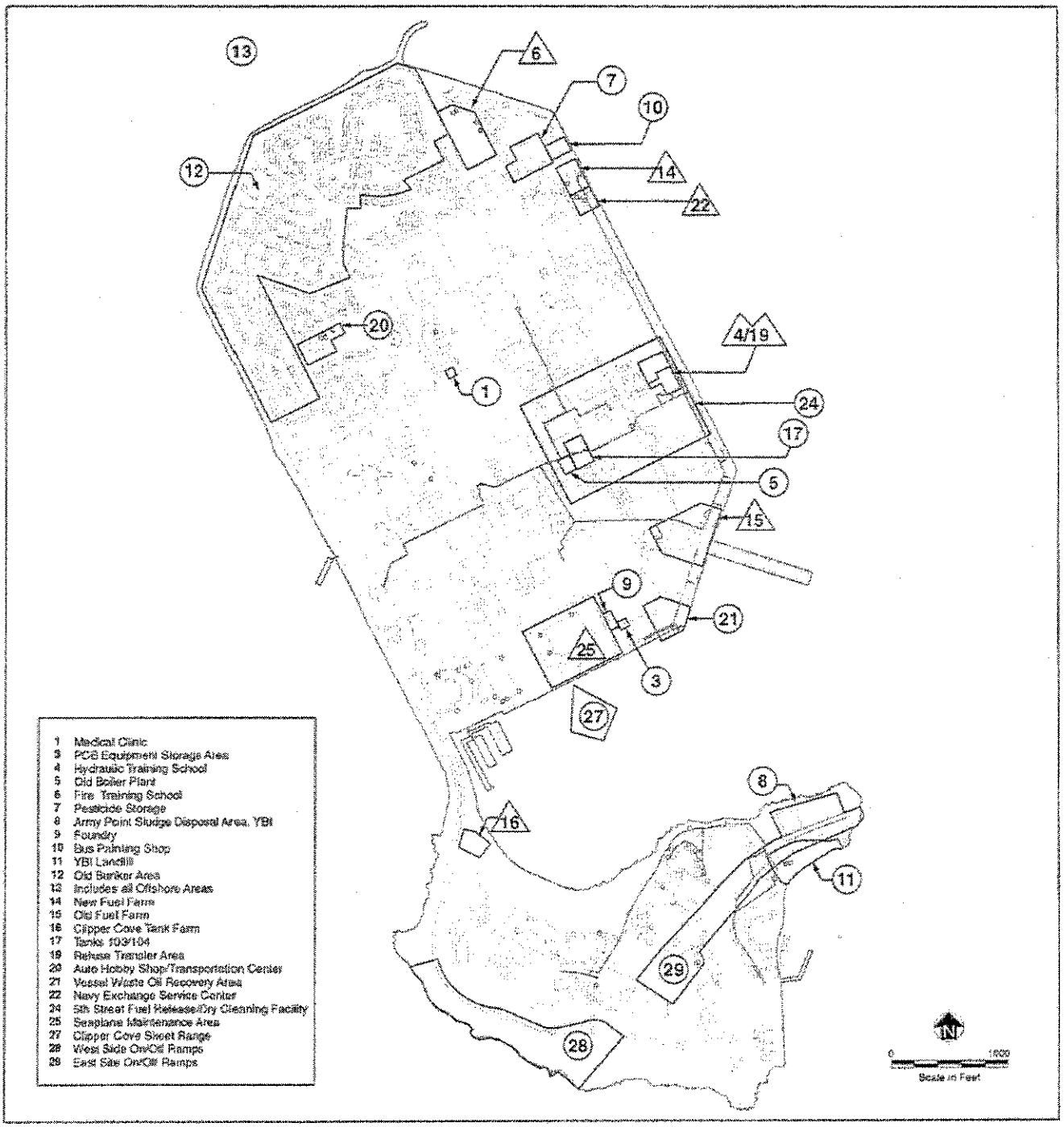
> "The mitigation measures discussed in an EIS must cover the range of impacts of the proposal....Mitigation measures must be considered even for impacts that by themselves would not be considered 'significant.' Once the proposal itself is considered as a whole to have significant effects, all of its specific effects on the environment (whether or not "significant") must be considered, and mitigation measures must be developed where it is feasible to do so."

Question 19b asks, "How should an EIS treat the subject of available mitigation measures that are (1) outside the jurisdiction of the lead or cooperating agencies, or (2) unlikely to be adopted or enforced by the responsible agency?" CEQ indicates that,

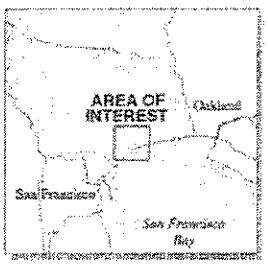
> "All relevant, reasonable mitigation measures that could improve the project are to be identified, even if they are outside the jurisdiction of the lead agency or the cooperating agencies, and thus would not be committed as part of the RODs of these agencies.... This will serve to alert agencies or officials who can implement these extra measures, and will encourage them to do so. Because the EIS is the most comprehensive environmental document, it is an ideal vehicle in which to lay out not only the full range of environmental impacts but also the full spectrum of appropriate mitigation."

C-14

For NSTI's reuse, TIDA is the primary entity to implement such measures, while the Navy's EIS should be the primary vehicle to identify such measures, even if impacts are 'not significant.' Lastly, the Navy should address the applicability of two Executive Orders: 13101 ("Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition," 9/14/1998); and 13148 ("Greening the Government Through Leadership in Environmental Management," 4/21/ 2000). The FEIS should discuss measures for acquisition of environmentally preferable materials for facility construction (which could be Federally-funded), waste prevention, waste recycling, energy and water conservation, and other feasible pollution prevention measures.



1 Medical Clinic
3 PCB Equipment Storage Area
4 Hydraulic Training School
5 Old Boiler Plant
6 Fire Training School
7 Pesticide Storage
8 Army Point Sludge Disposal Area, YBI
9 Foundry
10 Bus Painting Shop
11 YBI Landfill
12 Old Bunker Area
13 Includes all Offshore Areas
14 New Fuel Farm
15 Old Fuel Farm
16 Clipper Cove Tank Farm
17 Tanks 103/104
19 Refuse Transfer Area
20 Auto Hobby Shop/Transportation Center
21 Vessel Waste Oil Recovery Area
22 Navy Exchange Service Center
24 5th Street Fuel Release/Dry Cleaning Facility
25 Seaplane Maintenance Area
27 Clipper Cove Skeet Range
28 West Side On/Off Ramps
29 East Side On/Off Ramps



LEGEND

28 IR Site

16 Petroleum Site

Underground Storage Tanks

Pipeline requiring possible investigation/remediation

Buildings

Roads

Shoreline

SITE SUMMARY
NAVAL STATION TREASURE ISLAND

Site No.	Site Name and Description	Current Status
1	Medical Clinic	Awaiting site closure approval
3	PCB Equipment Storage Area	Awaiting site closure approval
04/19	Hydraulic Training School/Refuse Transfer Center	Corrective action in planning phase
5	Old Boiler Plant	Closed – incorporated into Site 24
06	Fire Training School	Currently being documented in CAP
7	Pesticide Storage Area	Additional investigation being prepared
8	Army Point Sludge Disposal Area	No additional sampling; will be documented into Final RI with Sites 11, 28, and 29
9	Foundry	Additional investigation being prepared for further delineation of TPH and lead
10	Bus Painting Shop	Additional investigation being prepared for further delineation of pesticides and SVOCs
11	YBI Landfill	Additional investigation being prepared for landfill delineation and delineation of lead in surface soil
12	Old Bunker Area	Further investigation and time critical removal actions being performed
13	Stormwater Outfalls	Final RI in preparation
14/22	New Fuel Farm/ Navy Exchange Service Station	Currently being documented in CAP/ Interim Action in progress (SVE pilot)
15	Old Fuel Farm	Currently being documented in CAP
16	Clipper Cove Tank Farm	Construction Summary Report and Closure Summary Report in preparation
17	Tanks 103 and 104	Closed – incorporated into Site 24
20	Auto Hobby Shop and Transportation Center	Construction Summary Report and Closure Summary Report in preparation
21	Vessel Waste Oil Recovery Area	Additional investigation for delineation of VOCs being performed
24	Dry Cleaning Facility	Additional investigation for delineation of VOCs and TPH being performed
25	Seaplane Maintenance Area	Currently being documented in CAP/ Interim Action in progress (SVE pilot)
27	Clipper Cove Skeet Range	Final RI in preparation, FS in preparation
28	West Side On/Off Ramp	No additional sampling; will be documented into Final RI with Sites 8, 11, and 29
29	East Side On/Off Ramp	Additional investigation being prepared for delineation of lead in surface soil

POLLUTION PREVENTION/ENVIRONMENTAL IMPACT REDUCTION CHECKLIST FOR BUILDING/HOUSING CONSTRUCTION

How Can Building/Housing Construction Affect the Environment?

Wastes associated with building/housing construction include unused and excess material generated during site excavation, site clearance, construction, and renovation activities. These wastes may be rubble (concrete, bricks, and asphalt), wood and wood products, plaster, metals, plastics, and insulation. These materials (commonly referred to as C&D debris) comprise approximately 15 to 30 percent of all waste disposed of in landfills. Further, some of these waste products may contain toxic constituents that pose a risk to human health and the environment. Many local governments have passed ordinances that restrict or prohibit the disposal of C&D debris in landfills and require the recycling of many of these materials. In addition, purchasing decisions associated with building/housing construction projects can affect the amounts of waste generated, as well future energy requirements (e.g., from lighting and heating).

Also see checklists on Ecosystem Preservation and Protection, Siting, Landscaping, Pest Management, and Energy Management.

What Questions Should Be Asked To Ensure That These Effects Are Minimized or Eliminated?

Ecosystem Concerns. The clearing of lands for construction can lead to the loss of wildlife habitats, erosion and sedimentation associated with the use of heavy machinery, loss of native plant life, and contamination of soils and surface and groundwater. However, proper design and planning can help reduce these impacts.

- Is the construction project necessary? Is the project over-designed? In some cases, the construction of additional structures is not needed and minor alterations to existing facilities may be sufficient.
- Have attempts been made to avoid construction in environmentally sensitive areas (such as wetlands and threatened or endangered species habitats)? *
- Are specifications for construction practices designed to control and exclude pest entry in contained habitats? *
- Does the construction contract specify that contractors should cause the least possible disturbance to the site's vegetation? For example, under certain circumstances, it may be possible to preserve individual trees or stands of old-growth that would otherwise be destroyed.
- Does the construction plan provide for erosion and sediment control during construction as well as after? Uncontrolled soil erosion can have adverse effects on local waterbodies and aquatic life.
- Will soil excavated from the construction site be reused? Topsoil can be respread in areas to be landscaped to enhance plant health. *
- Does the plan include the revegetation of areas disturbed by construction? *

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* Indicates an environmental impact reduction opportunity.

- Is there a plan to reduce the use of materials containing constituents that can negatively affect the environment?

- Is there a spill control and countermeasure plan to properly address spills of hazardous construction materials?

- Will hazardous materials be stored properly at the construction site? Hazardous materials should be kept in storage buildings (with secondary containment and hard stands) located away from the active construction zone. Examples of hazardous materials typically found at construction sites are petroleum products (lubricating oils and greases), fuels (gasoline, kerosene), solvents, paints, batteries, and miscellaneous equipment maintenance supplies.

Procurement Concerns. Environmentally sound purchasing decisions are an important element of pollution prevention, helping reduce the amount of waste generated by a building/housing construction project. In addition, the purchasing of recycled-content material helps support markets for materials collected for recycling.

Executive Order 12873 directs all Federal agencies to review and revise their specifications, product descriptions, and standards to increase their purchase of environmentally preferable and recycled products.

- Will the project include the use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time?

- Are there provisions for the proper storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements?

- Will perishable construction materials (such as paints) be purchased incrementally to ensure reduced spoilage of unused materials?

- Will the project use building materials that have minimal packaging to avoid the generation of excessive packaging waste?

- Will the project use building materials that are produced locally to avoid energy use and pollution generated from transportation?

- Will the project use construction materials containing recycled content when possible and in accordance with accepted standards? Examples of recycled-content materials include concrete containing fly ash and thermal insulation containing cellulose (i.e., recovered newspaper with fire retardant). *

- Does the construction plan include the use of alternative, environmentally preferable construction materials? Alternative construction materials include lumber products containing recycled plastic and/or wood, lead-free and low-VOC paints and coatings, and recycled steel for use in building frame applications.

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* Indicates an environmental impact reduction opportunity.

- Does the construction plan call for the use of refurbished construction materials? Purchasing and using once-used or recovered construction materials can often save money and reduce the amount of C&D debris disposed of as waste.

Reuse and Recycling. Many of the waste materials generated as a result of building/housing construction can be reused, refurbished, or recycled into usable products. The benefit of these practices is that materials that would otherwise be disposed of from the waste stream are diverted for productive uses.

- Will the construction contract specify that construction materials left over at the end of the project be reused in other projects rather than be disposed of? *
- Will the construction contract specify that construction materials that are damaged or wasted be recovered for refurbishing and use in other construction projects? Such items as cabinets, doors, plumbing and lighting fixtures, tile, carpeting, door hinges, wall paneling, restroom mirrors, and stairway banisters can be recovered and renovated for use. Local community groups or individual homeowners may also be interested in reusing these items. *
- Is there a plan to use or sell trees cut down during construction activities as lumber or compost? *
- Will any metal, wood, or packaging wastes generated as a result of construction activities be collected for reuse or recycling into other usable products? Commonly recycled construction materials include concrete, asphalt roofing material, metals, and structural wood. *
- Will mercury-containing materials recovered in any renovations of existing structures be recycled?

Energy Efficiency. Employing energy efficient technologies and practices can have a significant positive effect on the environment. There are a number of opportunities to include energy efficiency in building/housing construction projects.

Executive Order 12902 calls on Federal agencies and facilities to increase energy conservation efforts and improve energy efficiency.

- Does the construction plan specify the use of "low-embodied energy" construction products whenever possible? The energy required to make a product should be considered in making purchasing decisions.
- Does the construction plan specify the use of energy efficient lighting systems?
- Will preference be given to purchasing energy-efficient electric products and equipment (such as appliances and heating and cooling systems)?
- Does the construction plan call for sufficient insulation to reduce heat loss and conserve energy?
- Will the proposed facility participate in the EPA Energy Star Buildings program?

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* Indicates an environmental impact reduction opportunity.

POLLUTION PREVENTION/ENVIRONMENTAL IMPACT REDUCTION CHECKLIST FOR DREDGING

How Can Dredging Affect the Environment?

Dredging activities in fresh and salt water environments can have a variety of impacts on the environment. These impacts can include benthic disturbances, water quality degradation and impacts on aquatic organisms, and water and soil contamination resulting from marine and upland disposal of dredged materials. Impacts can also result from the potential release of hazardous constituents to marine and terrestrial environments. Dredging activities require the transportation of dredged materials and the use of energy resources.

Also see checklists on Dams, Hydropower, and Water Supply Reservoirs, Ecosystem Preservation and Protection, and Flood Control Projects.

What Questions Should Be Asked To Ensure That These Effects Are Minimized or Eliminated?

Beneficial Use Options. Beneficial use options for dredged materials include beach nourishment and habitat restoration or enhancement. The beneficial use of dredged materials prevents the material from consuming limited upland landfill capacity and from having adverse impacts on the marine environment.

- Have specific beneficial use options been identified for dredged materials to reduce or eliminate the volume of waste that would otherwise be disposed of? "
- Will dredged materials be sampled and analyzed for particle size and evaluated for use as beach nourishment? Dredged materials should be sampled and analyzed for hazardous constituents to ensure that their use will not introduce pollution into the environment? "
- Does the project consider options to "clean" toxic dredged materials, thereby rendering them safe for beneficial use? "

Ecosystem Concerns/Dredging. Two dredging alternatives, mechanical and hydraulic, are practiced to remove sediments from marine environments. Mechanical dredging uses hoppers to dig and remove sediments. Hydraulic dredging uses a great deal of water to create suction to remove sediments and generates a much greater volume of dredged material that must be disposed of or used otherwise. This additional volume becomes a problem particularly when upland disposal is the only option.

- When considering dredging alternatives, has emphasis been placed on reducing or eliminating the amount of disturbance to the marine environment? "
- Will the selection of the dredging alternative (mechanical or hydraulic) be based on factors that will reduce or eliminate the generation of pollution and minimize the impacts on the environment?
- Will the dredging alternative be selected based on pollution prevention criteria that minimize energy consumption?
- Are sediment flushing or pass through alternatives being considered?

" Indicates an environmental impact reduction opportunity.

- Will measures be taken to minimize potential impacts on fisheries and aquatic resources?

- Have alternatives to dredging or alternatives that would reduce the amount of material to be disposed of, habitat destruction, and/or disposal-related impacts been considered? Options might include choosing an alternative site, extending the length of the pier to reach deep water, or reconfiguring dockage space to accommodate vessels into a smaller area.

- Have all environmentally sensitive areas been characterized? Have attempts been made to avoid dredging in environmentally sensitive areas? *

- Are measures considered to reduce or eliminate the pollution generated from dredging equipment and operations? Will sediments containing hazardous constituents be contained during dredging operations?

- Will hazardous materials needed for onsite heavy equipment maintenance and operation (e.g., fuels, solvents, greases) be properly stored and managed?

Ecosystem Concerns/Disposal of Dredged Materials. Dredging and dredged materials disposal in marine environments may have significant effects, including the disturbance of benthic environments, suspension of sediments, plume migration and introduction of potentially hazardous constituents (including heavy metals), and other negative impacts on water quality. By implementing various techniques, however, these impacts may be reduced or eliminated.

- Will measures be taken to minimize the introduction of contaminated dredged materials to benthic and other aquatic environments?

- Will techniques be used to reduce or minimize the suspension of sediments during dredging and or dredge disposal?

- Does the selection of marine disposal sites include criteria to create the least impact on aquatic life, water quality, plume migration, and sediment suspension?

- Has clean material been identified for use as a cap on toxic materials deposited in marine disposal?

Transporting Dredged Materials. Dredged materials must be transported from the original dredge site to the location of beneficial use or to disposal in either upland or marine disposal sites. The transportation of toxic materials presents significant threats to the environment in the event of a spill, accident, or other release. By addressing and utilizing pollution prevention techniques, these threats can be reduced or minimized.

- Has the dredging plan considered the need to transport potentially toxic dredged materials and taken steps to prevent spills during transportation?

- Have the safest and least populated routes of travel been identified for transporting toxic dredged materials that are unsuitable for beneficial use to the ultimate disposal site?

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* Indicates an environmental impact reduction opportunity.

- Does the plan for the transportation of dredged materials to marine disposal sites consider minimizing the disruption of benthic environments and the dispersal of dredged materials in the water column during deposition?

- Will the method for transporting dredged materials minimize energy consumption?

Other References

U.S. Environmental Protection Agency. January 1994. Final EIS for the Designation of a Deepwater Disposal Site.

U.S. Army Corp of Engineers. January 1994. EIS/EIR for the Oakland Harbor Deep-Draft Navigation Improvements.

POLLUTION PREVENTION/ENVIRONMENTAL IMPACT REDUCTION CHECKLIST FOR ENERGY MANAGEMENT

How Can Energy Management Affect the Environment?

The generation of electricity accounts for 35 percent of all U.S. emissions of carbon dioxide, the most prevalent greenhouse gas. Electricity generation also accounts for 75 percent of U.S. sulfur dioxide emissions and 38 percent of nitrogen oxides emissions. These gases can cause smog, acid rain, and global warming. The pollution associated with these greenhouse gases can be reduced by applying energy efficient technologies and practices. These techniques, which include using compact, long-lasting fluorescent lighting as an alternative to incandescent bulbs and using fuel efficient vehicles and alternative transportation methods, can have a significant impact on the environment.

What Questions Should Be Asked To Ensure That These Effects Are Minimized Or Eliminated?

Executive Order 12902, Energy Efficiency and Water Conservation, directs all Federal agencies and facilities to increase efforts to conserve energy and increase energy efficiency. Other Executive Orders, such as 12844 and 12845, call on Federal agencies and facilities to increase their purchasing of alternatively fueled vehicles and energy-efficient computers.

Lighting. Lighting consumes about 20 to 25 percent of the electricity generated in the United States. In commercial buildings, lighting accounts for 40 percent of overall electricity usage. Lighting is one of the easiest areas where energy conservation and efficiency techniques can be applied to save energy.

- Will an assessment be performed to determine the best number, location, and type of lighting fixtures for the facility? A well-designed lighting assessment prevents the installation of excessive lighting fixtures and should incorporate the use of task-specific lighting (e.g., desk lamps) where possible rather than relying on overhead lighting.

- Can motion sensors or timers be used to turn lights off automatically when they are not needed? Motion sensors are widely used in European countries in such areas as hallways, stairwells, and restrooms, as well as work spaces. The use of these sensors is growing in the United States as well.

- Will the most efficient lighting equipment available be used? Optical reflectors and electronic ballasts can improve the efficiency of lower wattage lighting.

- Will the facility take advantage of the lighting provided by natural sunlight through building design, orientation, and internal layout? Other opportunities to maximize the use of natural light include utilizing top-silvered blinds and light colored finishes to reflect light and installing glass skylights or panels on top of office partitions to increase ambient lighting.

- Will the use of external lighting be minimized to reduce impacts to nearby sensitive habitats?

- Will the facility prepare an energy awareness campaign to educate employees about the importance of energy conservation?

Electrical Products and Equipment. A facility's energy consumption can be reduced greatly by purchasing energy-efficient products, such as energy-efficient computers and appliances. Computers alone are believed to account for 5 percent of commercial electricity consumption. The selection of energy efficient products can, then, help reduce a facility's energy consumption.

- Will the facility use energy efficiency as a criterion in purchasing electrical equipment?
- Will commercially available appliances with high energy ratings be selected?
- Will the project make use of high-efficiency, adjustable-speed motors in machinery and equipment applications when possible?
- Can timers be used to turn off computers or equipment automatically when they are not in use?

Heating and Cooling. Improvements in heat, ventilation, and air conditioning (HVAC) systems can lead to significant energy savings.

- Will heat and/or air conditioning thermostat settings be either manually or automatically changed at night, weekends, or at other times when the facility is not in use?
- Will the facility employ a computerized energy management system (EMS) to control heating or cooling systems or lighting?
- Can outside air be intentionally drawn into the facility for cooling purposes during cool weather?
- Can a system to bring warm air down to floor level from the underside of the roof be installed for heating purposes during the winter (e.g., ceiling fans)?
- If the facility will utilize electric chillers, will the chilled water lines be properly insulated?
- If the facility will use a boiler, will the steam/hot water lines be properly insulated?
- Will energy efficient windows or reflective films, such as "low-emissivity" or "low-e" coatings, be installed?
- Could solar panels be integrated into the building design to reduce reliance on electricity or fossil fuels?
- Will the smallest, most-efficient HVAC system possible be used to regulate building temperature properly?
- Will load sharing be used to reduce energy consumption? Shutting down HVAC systems for non-critical uses for short periods can result in significant savings.
- Will the facility use natural shading from trees and shrubbery to reduce heating and air conditioning needs?

- Will appropriate building materials be selected to minimize energy use from heating and air conditioning (e.g., using light colored paint, paving, and roofing materials and not designing a building with large glass facades in hot, sunny areas)?

Insulation Concerns. Insufficient insulation can result in the loss of large amounts of energy. For example, the poor insulation of windows is responsible for approximately 25 percent of all heating and cooling requirements. The insulation of heat-generating equipment also reduces the need for building cooling.

- Will hot or cold equipment surfaces and the building walls and roof be well insulated?
- If this is a manufacturing or industrial environment, will any heat exchangers for heat recovery be installed?
- Will building doors opening to the environment minimize energy losses? Proper weather stripping reduces energy losses, as do revolving and double doors.
- Will insulated windows be used? Such windows employ a gas, such as argon, between two coated panes of glass to minimize energy losses.
- Where appropriate, will energy efficient insulation materials fabricated from recycled materials be used?

Hot Water. Reducing the use of hot water can help conserve energy by decreasing the amount of energy that must be expended to heat water.

- Will water-efficient showerheads be installed?
- Will faucet aerators be installed?
- Will water heaters be sufficiently insulated?
- Will energy-efficient water heaters be purchased?
- In manufacturing facilities, can the heat radiated from hot water pipes be used for other purposes?

Fuel and Gasoline. Increasing fuel efficiency and using alternatively fueled vehicles helps reduce our reliance on fossil fuels, which cause air pollution when burned.

- If the facility requires the use of fleet vehicles, will fuel-efficient, cleaner burning vehicles be purchased?
- Has the use of alternatively fueled (e.g., electric, solar electric, compressed natural gas, ethanol, or methanol) vehicles been considered? Alternatively fueled vehicles have proved successful for short distance purposes. They can be used as fleet vehicles for facility maintenance or for short trips around a large facility.

- Are there provisions to encourage facility employees to reduce motor vehicle use? These provisions can include installing bike racks and showers, providing shuttle service between the facility and public transportation stops, promoting carpooling by maintaining ride boards, and subsidizing public transportation costs.

Energy Production Facilities. The design, construction, and operation of energy production facilities presents a number of opportunities to reduce pollution and environmental impacts.

- In constructing or operating energy production facilities, will rate structures be considered that will reduce peak loads?

- Are co-generation activities included in facility design?

Other References

Northeast Sustainable Energy Association. 23 Ames Street, Greenfield, MA 01301. Telephone No. (413) 774-6051.

Rocky Mountain Institute. 1739 Snowmass Creek Road, Snowmass, CO 81654-9199. Telephone No. (303) 927-3851, Fax No. (303) 927-4178.

U.S. Department of Energy, Federal Energy Management Program. CE-44, 1000 Independence Avenue, SW, Washington, DC 20585. Telephone No. (202) 586-5772.

U.S. EPA, Energy Star Buildings Program. Telephone No. (202) 233-9146.

U.S. EPA, Energy Star Computers Program. Telephone No. (202) 233-9114.

U.S. EPA, Green Lights Program. Telephone No. (202) 233-9065.

POLLUTION PREVENTION/ENVIRONMENTAL IMPACT REDUCTION CHECKLIST FOR LANDSCAPING

How Can Landscaping Affect the Environment?

Landscaping wastes currently account for approximately 20 percent (or 31 million tons) of the municipal solid waste (MSW) generated in the United States each year. This makes landscape trimmings the second largest component (by weight) of the MSW stream. Because of their high bulk and density, landscaping wastes consume a disproportionate amount of landfill space. In addition, these wastes, as well as other organic matter disposed of in the landfill, can generate methane and acidic leachate when they decompose. When incinerated, the high moisture content and high nitrogen levels of these wastes can interfere with the combustion process and contribute to the formation of smog-causing nitrogen oxides.

What Questions Should Be Asked To Ensure That These Effects Are Minimized or Eliminated?

On April 26, 1994, President Clinton signed a Presidential Memorandum calling for the establishment of guidelines for Federal facility managers on how to increase the use of native species, reduce the use of chemical fertilizers and pesticides, implement water conservation techniques, and promote awareness of the environmental and economic benefits of better landscaping techniques. These guidelines will be proposed by a Federal interagency workgroup established by the Federal Environmental Executive. The following questions address the concept delineated in the Presidential Memorandum, as well as additional opportunities to prevent pollution and reduce waste generation associated with landscaping operations.

Ecosystem Concerns. Landscaping activities can affect the environment through the release of toxic pesticides and excess nutrients, as well as the destruction of wildlife habitat and ecologically sensitive areas. However, proper landscape design and maintenance can help reduce these environmental impacts and can help minimize the effects of other activities as well.

- Will landscape development be integrated with existing natural resources? Such integration may include the use of a Geographic Information System (GIS) that incorporates physical and natural features of the area to be developed (e.g., tidal and non-tidal wetlands, steep slopes, and natural riparian buffers). *
- Will the landscape plan incorporate the use of plants that require little water and minimal fertilizer, herbicide, and pesticide use?
- Does the landscape plan encourage the use of Integrated Pest Management (IPM)?
- Will the landscape plan ensure that rare, threatened, and endangered wildflowers and other species are adequately protected? *
- Does the landscape plan consider materials other than asphalt for constructing walkways across lawns (i.e., using wood chips, flag stones, and other materials that have less environmental impact than asphalt)?

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* Indicates an environmental impact reduction opportunity.

- Will the landscape plan include the planting of primarily native trees, shrubs, and perennials? *
- Will the introduction of invasive species be avoided? *
- Will the plantings be arranged in a natural manner and in naturally associated groupings? *
- Does the landscaping plan incorporate features to minimize solar radiation or heat sinks, such as planting shade trees and avoiding overly large areas of asphalt? *
- Will the plant species used in the landscape plan provide food or cover for desirable wildlife? *
- Will the landscape plan call for fertilizing lawns only when grass roots will take up nutrients? These times are late summer-fall for cool season grasses and early summer for warm season grasses.
- Will lawns be watered at the optimal time of day to promote healthy growth and conserve water?
- Does the landscape plan take advantage of vegetation's natural properties? Planting shade trees near building windows can reduce energy consumption associated with air conditioning needs and serve as effective wind barriers.
- Will species of vegetation that support wetlands development be planted on the edges of waterbodies? These species may help break down pollutants carried in non-point source runoff and also can prevent soil and debris from polluting waterbodies.
- Will lawn areas be kept to a minimum with the remainder planted/retained as native meadows and woodlands to minimize air impacts associated with power maintenance equipment and the need for pesticides?
- Does the facility design reduce the impact of lighting on critical habitats and scenic areas?

Reducing Landscape Wastes. A number of steps can be taken during project planning, design, and operation and maintenance to reduce or avoid the generation of landscaping wastes. These techniques include landscape development and alteration, grass-cycling, composting, and mulching. They can be tailored to specific characteristics of a landscape, such as climate and geography, and can be mixed in any number of combinations.

- Will the landscape plan incorporate the planting of native and indigenous trees and plants that require less attention and maintenance? *
- Will trees and shrubs be pruned only on an as needed basis? *
- Will grass-cycling be practiced as part of project landscape maintenance operations? Grass-cycling is a process in which grass clippings are left in place on a lawn after mowing instead of being raked and bagged. Grass-cycling requires that no more than one third of the blade is cut off and that no more a 1-inch total be cut at any one time. This process improves lawn quality by returning

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important nutrients from the decaying clippings to the soil and lawn. When grass-cycling is practiced, less money is spent on fertilizers, disposable collection bags, labor costs, and waste disposal. *

- Will composting be practiced as part of project landscaping maintenance operations? Composting is a process using microorganisms (generally bacteria or fungi) in the presence of oxygen and moisture to break down organic wastes into a humus-like product. Compost is a superior soil conditioner or mulch suitable for most landscaping and gardening uses. Using compost will help reduce reliance on phosphate and nitrogen fertilizers that may be detrimental to the surrounding ecosystems. Compostable materials include grass clippings, seaweed, leaves, sawdust, chipped or shredded brush, cow and horse manure, chipped or shredded logs, weeds, pine needles, hay, straw, shredded newspaper, and wool and cotton rags. Weeds with many seeds, diseased plants, and manure from meat-eating animals should not, however, be composted.

- Will mulching be practiced as part of project landscaping maintenance? Mulching is the practice of spreading or mixing organic material, such as wood chips, leaves, or compost, over soil surfaces. Mulch reduces moisture evaporation from the soil surfaces, reduces soil erosion and compaction from heavy rains, moderates soil temperature, provides optimal conditions for soil enhancing organisms, protects young tree trunks, and provides nutrients as it decays. Furthermore, mulch inhibits weed growth, thereby decreasing the need for constant landscaping care and weed disposal.

Landscape Product Purchasing and Management. Lawn and plant care products, such as fertilizers and pesticides, are also considered as wastes that result from landscape operations. Spoilage of these materials and the packaging left after use should be minimized to reduce an operation's impact on the environment.

- Will landscape products be purchased in bulk or concentrate to reduce packaging waste?

- Will strict inventory control practices be adopted to prevent material expiration and, thus, waste generation?

- Will the use of gas-powered landscape maintenance equipment (which account for 5 percent of our air pollution) be kept to a minimum? Executive Order 12844 calls on Federal facilities to increase their purchase of alternatively fueled motor vehicles.

Other References

"Presidential Memorandum for the Heads of Executive Departments and Agencies on Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds." August 22, 1994. *Federal Register* Vol. 59, No. 161.

U.S. EPA. "Environmental Fact Sheet: Recycling Grass Clippings." July 1992. EPA/530-F-92-012.

U.S. EPA. "Environmental Fact Sheet: Yard Waste Composting." May 1991. EPA/530-SW-91-009.

* Indicates an environmental impact reduction opportunity.

POLLUTION PREVENTION/ENVIRONMENTAL IMPACT REDUCTION CHECKLIST FOR MILITARY BASE CLOSURE AND REUTILIZATION

How Can Military Base Closure and Reutilization Affect the Environment?

Military base closure and reutilization projects can have a variety of effects on the environment. These impacts may include air quality effects from demolition/construction dust and increased vehicle/aircraft emissions, hazardous materials and waste management concerns (including Installation Restoration Program sites, unexploded ordnance, PCBs, asbestos, lead-based paint, and underground storage tanks), noise impacts, pollution of surface water and groundwater sources, impacts to biological resources, and soil erosion and contamination.

Also see checklists on Ecosystem Preservation and Protection, Energy Management, Water Use, Landscaping, Waste Site Investigations and Cleanup Activities, Solid Waste Landfills, Building/Housing Construction, Airports, and Water Use.

What Questions Should Be Asked To Ensure That These Effects Are Minimized or Eliminated?

Air Quality Concerns. Demolition and construction as part of military base closure activities can cause air quality impacts from fugitive dust and construction equipment emissions. In addition, proposed base reuse plans may result in an increase of air pollutants from mobile sources (e.g., vehicles and aircraft) and point sources (e.g., generators, incinerators, and storage tanks).

- Are there opportunities to reduce the adverse effects of air emissions by considering alternative reuse plans for the military base?
- Will fugitive dust reduction measures (such as ground watering and reduced speed limits on unpaved roads) be incorporated into demolition/construction activities?
- Are adequate containment measures specified to avoid the accidental release of friable asbestos during demolition or modification of structures?

Hazardous Material/Waste Management Concerns. Concerns associated with military base closure and reuse projects include the management of hazardous materials and wastes (such as solvents, pesticides, aviation fuels, POL, and heavy metals), remediation of existing Installation Restoration Program (IRP) sites, removal of unexploded ordnance, and management of asbestos, PCBs, lead-based paint, and underground storage tanks.

- Are there provisions for reducing potential spills and uncontrolled releases of hazardous materials? Is there a spill prevention and control plan?
- Will new and reused underground storage tanks be equipped with leak detection mechanisms, secondary containment systems, spill and overfill protection, and cathodic protection?

- Will PCB-contaminated equipment be removed prior to base closure? Will remaining PCB-contaminated equipment be routinely inspected for leaks? Will transformers be retrofilled with non-PCB-containing oils? *

- Are measures specified for the proper removal and disposal of structural material containing toxic lead-based paint associated with demolition activities? *

Noise Concerns. Noise associated with demolition/construction equipment and planned land uses, such as airfields or industrial activities, can affect both humans and wildlife.

- If aircraft operations are planned to continue, are noise buffer zones and a wide range of sound attenuation measures, such as noise barriers and concrete bunkers, included to reduce noise impacts?

Surface Water Concerns. Surface water quality could be affected by spills or leaks of hazardous materials and by contaminated storm water runoff.

- Does the project require the preparation of Spill Prevention Control and Countermeasures Plans, Stormwater Pollution Prevention Plans, and Soil Erosion and Sediment Control Plans?

- Will oil/water separators be installed to prevent fuels, oils, and other residual contaminants in storm water runoff from contaminating any nearby streams or other surface water?

- Do construction designs incorporate provisions to reduce storm water runoff/sediment transport? Such designs include creating landscaped areas that are pervious to surface water, minimizing areas of surface disturbance, and constructing runoff/sediment transport barriers around soil stockpiles.

New Use Concerns. Public utilities, such as wastewater treatment facilities, solid waste landfills, and electricity/natural gas supplies, may be affected by military base closure and reuse projects. Reuse plans may propose new commercial and residential uses that would increase water and electricity/natural gas consumption and increase wastewater and solid waste disposal requirements.

- Does the project require the collection of inert demolition/construction wastes, such as wood, metals, concrete, and asphalt, for reuse or recycling to decrease potential impacts on landfills?

- Will energy efficiency and water conservation devices be incorporated into all new residential and commercial structures?

Biological Resources Concerns. The construction of new or expanded facilities could require the filling of wetlands and could result in habitat loss from the siting of structures and utilities. Potential impacts to wildlife could result from noise and dust during demolition/construction activities.

- Does the siting of any new construction take into consideration avoiding proximity to wetlands, wildlife habitat, and ecologically sensitive areas? *

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- Are measures included to avoid disturbing the habitat of any threatened or endangered species located on or in the vicinity of the military base? *

- Are measures specified to control construction runoff, such as the use of berms, silt curtains, straw bales, and other erosion control techniques?

- Will native trees and vegetation be planted to increase favorable habitat for wildlife and help prevent erosion? *

Geology/Soils Concerns. Demolition/construction activities may cause soil erosion and soil contamination.

- Can existing facilities and paved areas be remodeled and used to minimize soil disturbance caused by extensive new construction?

- Does the project call for preparation of soil erosion and sediment control plans? Are specific control measures suggested, such as seeding exposed soil, watering to prevent fugitive dust, and using sediment basins and fences?

Other References

Army Regulation 200-1, Environmental Protection and Enhancement.

Army Regulation 220-2, Environmental Effects of Army Actions.

U.S. Department of the Interior, Denver Service Center. September 1993. *Guiding Principles of Sustainable Design*. National Park Service (NPS) publication number NPS D-902; GPO publication number GPO 777442.

* Indicates an environmental impact reduction opportunity.

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Response to Comments

Response to Comment C-1. The carbon monoxide (CO) hot spot modeling analysis revealed no potential violations of federal or state CO standards. In addition, no violations of federal or state CO standards have been detected in the San Francisco Bay Area since 1991. Consequently, there is no requirement to propose mitigation measures related to ambient CO conditions. Similarly, there are no indications that normal residential, commercial, or office development would create any unusual sources of hazardous air pollutants requiring special mitigation measures. Furthermore, the Navy will not have any authority over reuse activities and thus is in no position to impose mitigation measures related to the types or intensities or reuse activities. EPA and the California Air Resources Board have sole jurisdiction to regulate vehicle fuel composition and resulting emissions of hazardous air pollutants from vehicle traffic.

Response to Comment C-2. No significant air quality problems have been identified for either closure or reuse of NSTI, so there is no requirement to propose any air quality mitigation measures. As noted previously, the Navy will have no authority or responsibility with respect to reuse of NSTI and is thus not in a position to impose mitigation measures.

Response to Comment C-3. EPA and the California Air Resources Board have sole jurisdiction over the composition of vehicle fuels and the regulation of vehicle emissions. Unlike the NASA example cited in the comment, the Navy is disposing of NSTI property with no operational responsibility. The Navy will have no authority or responsibility over construction contracts or actual reuse activities, so it is not in any position to impose specific mitigation measures on construction associated with reuse activities. The designated property recipient will be required by law to ensure that appropriate construction-related mitigation measures are imposed.

Response to Comment C-4. The Navy has conferred with FHWA regarding the transfer of land for the SFOBB and the relationship of this transfer to the disposal and reuse and NSTI. (FHWA has been added to the list of agencies contacted during preparation of the EIS.) FHWA was not asked to be a cooperating agency for this EIS. The SFOBB realignment and the disposal and reuse of NSTI are separate actions, and neither the Navy nor the FHWA are under obligation to include the other as a cooperating agency in the preparation of their respective EISs. FHWA is not regarded as having special expertise or jurisdiction warranting inclusion as a cooperating agency because the SFOBB is operated by Caltrans and all NSTI lands transferred to FHWA were subsequently conveyed to Caltrans.

Response to Comment C-5. As assumed in the EIS, some dredging will occur as part of reuse, but no specific development proposal has been completed at present, so it is not possible to determine the extent and location of any future dredging or to evaluate specific impacts. Regardless of who seeks authorization for dredging, such operations will be required to comply with the permitting requirements of the US Army Corps of Engineers and to be consistent with the LTMS. The noted text in chapter 2 has been revised to read as follows:

> "[t]he exact location and amount of potential dredging is not known at present and therefore, this EIS can necessarily evaluate potential impacts from dredging in only a ~~programmatic~~ general way."

The Navy completed a remedial investigation of offshore sediments in 2001 and addressed the potential ecological risk from contaminants at the former Clipper Cove skeet range (immediately east of the marina), stormwater outfalls, and an area on the northwestern shoreline of Treasure Island. Under this investigation, no chemicals were found at levels that would pose a risk to aquatic and avian receptors, and no further investigation or action was recommended. The study did note that sediment dredging near the former Clipper Cove skeet range could disrupt and resuspend lead shot on the sediment surface.

Response to Comment C-6. An inventory of all potential sources of PCBs was completed in 1995. Since that time, all potential sources of PCB contamination have been removed for NSTI, including out of service or closed hydraulic equipment. IR Site 03 is an area immediately adjacent to an electrical substation where transformers may have been placed or repaired in the past. IR Site 03 was closed with DTSC approval in 2002.

Response to Comment C-7. Based on the 1995 inventory for PCBs, no PCB sources were identified at IR Site 09, which is in the remedial investigation phase. Following completion of the investigation, the potential contaminants and the appropriate course of action will be determined.

No PCB sources were identified at IR Site 01 during the 1995 inventory, and the DTSC granted closure approval on March 20, 2002.

In the PCB inventory completed in 1995, a potential source of PCBs at the old boiler plant (Site 05) was not identified; thus, Navy has determined that no action is required at IR Site 05. Groundwater contamination at IR Site 05 will be investigated as part of measures taken at IR Site 24, which surrounds IR Site 05.

Response to Comment C-8. The nature of material formerly stored at IR Site 12 is unknown, and no records describe the types of operations in the vicinity. The following text has been added to the description of IR Site 12 in section 3.13 of the Final EIS:

> Analysis of soil and groundwater samples from the FSY area indicated that PAHs and PCBs were the chemicals of concern. In 2000, all soil in the FSY area containing PCBs at levels in excess of the screening level (1 mg/kg) was excavated to 4 feet (1 m) bgs, except where buildings or other structures, such as transformer pads, impeded access. Indoor air monitoring to evaluate the potential risk posed by vapor intrusion from volatilization of PCBs into buildings is ongoing. Initial conservative estimates from this investigation indicate that PCB volatilization may pose a risk to human health in Building 1100 Unit C.

Response to Comment C-9. There is no indication that methane gas is being released at IR Site 11. Although the site is a former landfill, it appears that the debris placed at this location contained little organic material that would produce methane during decomposition.

Response to Comment C-10. Radon is a naturally occurring gas and is not related to human activities. As described in the EIS, radon screening was conducted at NSTI, and all samples were found to be below US EPA recommended action levels; consequently the Navy does not

believe further investigations for radon are warranted. Radiological concerns at NSTI are limited to past decontamination training conducted at IR Site 02. The radiological material used in this training had a short half-life and would no longer be found at the site. Radiological concerns were not part of the remedial investigation at IR Site 02. The Navy has been gathering data on potential radiological concerns as part of its ongoing investigations at NSTI but has found none.

Response to Comment C-11. No radiological decontamination is known to have occurred at NSTI, where radiological concerns are limited to those described above in response to comment C-10. The Navy did conduct radiological decontamination at Hunters Point Naval Shipyard, which is addressed in the CERCLA process for that facility.

Response to Comment C-12. The environmental investigation and remediation at NSTI is being carried out pursuant to and in accordance with the provisions of CERCLA. The CERCLA process is considered to be the functional equivalent of the NEPA process, including extensive opportunities for public involvement. In addition, the remedial process is a rapidly evolving program and subject to frequent changes. As a result, the remedial process under CERCLA is summarized in section 3.13 of the EIS, but details of investigations, results of sampling, and mapping of contamination are not included. Detailed information on environmental investigation and remediation can be obtained through the CERCLA staff in the Navy's BRAC Operations Office, as noted in section 3.13.3 of the EIS. The Navy is committed to cleaning up each site according to applicable laws and regulations and to levels appropriate to the proposed land use to ensure protection of public health and safety.

Response to Comment C-13. Please see response to comment C-12, above, regarding including additional information on CERCLA activities in the EIS.

Response to Comment C-14. Navy agrees that pollution prevention is an important issue. The federal action evaluated in the EIS is the disposal of federal property, and the Draft EIS addresses pollution prevention in the context of fugitive dust control measures for air quality (section 4.6), minimizing impacts to water quality (section 4.10), and proper remediation and disposal of potentially hazardous materials (section 4.13). Navy may require specific mitigations be in place prior to conveying the property but will have no authority or responsibility over actual reuse activities. Consequently, Navy is not in a position to impose mitigation measures for pollution prevention associated with reuse. Considering that the proposed action is the disposal of federal property, additional mitigation measures beyond those included in the Draft EIS do not appear to be warranted. Navy believes that the appropriate vehicle to identify measures associated with reuse would be the City and County of San Francisco's NSTI reuse EIR in compliance with CEQA, not the Navy's EIS.

Executive Orders 13101 ("Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition," 9/14/1998), 13148 ("Greening the Government Through Leadership in Environmental Management," 4/21/2000), and additionally, 13123 ("Greening the Government Through Efficient Energy Management" 6/8/1999) would apply only to the federal action, and not to activities associated with reuse. Navy assumes that state and local regulations would

provide similar pollution prevention regulatory guidance to the City and County of San Francisco for all reuse activities.

LETTER D

STATE OF CALIFORNIA

Governor's Office of Planning and Research

State Clearinghouse

Gray Davis
GOVERNOR

Tal Finney
INTERIM DIRECTOR

June 27, 2002

Timarie Seneca
U.S. Navy
1230 Columbia St. Suite 1100
San Diego, CA 94066-0720

Subject: Disposal and Reuse of Naval Station Treasure Island
SCH#: 2002052061

Dear Timarie Seneca:

The State Clearinghouse submitted the above named Draft EIS to selected state agencies for review. On the enclosed Document Details Report please note that the Clearinghouse has listed the state agencies that reviewed your document. The review period closed on June 26, 2002, and the comments from the responding agency (ies) is (are) enclosed. If this comment package is not in order, please notify the State Clearinghouse immediately. Please refer to the project's ten-digit State Clearinghouse number in future correspondence so that we may respond promptly.

Please note that Section 21104(c) of the California Public Resources Code states that:

> "A responsible or other public agency shall only make substantive comments regarding those activities involved in a project which are within an area of expertise of the agency or which are required to be carried out or approved by the agency. Those comments shall be supported by specific documentation."

These comments are forwarded for use in preparing your final environmental document. Should you need more information or clarification of the enclosed comments, we recommend that you contact the commenting agency directly.

This letter acknowledges that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act. Please contact the State Clearinghouse at (916) 445-0613 if you have any questions regarding the environmental review process.

D-1

Sincerely,

Terry Roberts

Terry Roberts
Director, State Clearinghouse

Enclosures
cc: Resources Agency

1400 TENTH STREET P.O. BOX 3044 SACRAMENTO, CALIFORNIA 95812-3044
916-445-0613 FAX 916-323-3018 www.opr.ca.gov

State Clearinghouse Data Base

LETTER D

SCH#	2002052061
Project Title	Disposal and Reuse of Naval Station Treasure Island
Lead Agency	U.S. Navy

Type	EIS Draft EIS
Description	This environmental impact statement (EIS) evaluates the potential impacts on the natural and human environment that could result from Navy disposal of surplus federal properties within NSTI and subsequent reuse of those federal properties. NSTI is made up of dry and submerged lands of both Treasure Island and portions of Yerba Buena Island in San Francisco, California.

Lead Agency Contact

Name	Timarie Seneca		
Agency	U.S. Navy		
Phone	619-532-0995	**Fax**	
email			
Address	1230 Columbia St. Suite 1100		
City	San Diego	**State** CA	**Zip** 94066-0720

Project Location

County	San Francisco				
City	San Francisco, Oakland				
Region					
Cross Streets					
Parcel No.					
Township	1S	**Range** 5W	**Section**	**Base** . MTDIABLO	

Proximity to:

Highways	101
Airports	
Railways	
Waterways	San Francisco Bay
Schools	San Francisco United School District
Land Use	Military installation

Project Issues	Aesthetic/Visual; Air Quality; Archaeologic-Historic; Coastal Zone; Drainage/Absorption; Economics/Jobs; Flood Plain/Flooding; Geologic/Seismic; Noise; Population/Housing Balance; Public Services; Recreation/Parks; Schools/Universities; Sewer Capacity; Soil Erosion/Compaction/Grading; Solid Waste; Toxic/Hazardous; Traffic/Circulation; Vegetation; Water Quality; Water Supply; Wetland/Riparian; Wildlife; Landuse; Cumulative Effects; Other Issues
Reviewing Agencies	Resources Agency; Department of Boating and Waterways; Department of Fish and Game, Region 3; Office of Historic Preservation; Department of Parks and Recreation; San Francisco Bay Conservation and Development Commission; California Highway Patrol; Caltrans, District 4; Caltrans, Division of Transportation Planning; Air Resources Board, Major Industrial Projects; Integrated Waste Management Board; Regional Water Quality Control Board, Region 2; Department of Toxic Substances Control; State Lands Commission

Date Received 05/13/2002 **Start of Review** 05/13/2002 **End of Review** 06/26/2002

Note: Blanks in data fields result from insufficient information provided by lead agency.

Response to Comments

Response to Comment D-1. Comment noted.

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LETTER E

STATE OF CALIFORNIA

Governor's Office of Planning and Research

State Clearinghouse

Gray Davis
GOVERNOR

Tal Finney
INTERIM DIRECTOR

July 1, 2002

Timarie Seneca
U.S. Navy
1230 Columbia St. Suite 1100
San Diego, CA 94066-0720

Subject: Disposal and Reuse of Naval Station Treasure Island
SCH#: 2002052061

Dear Timarie Seneca:

The enclosed comment (s) on your Draft EIS was (were) received by the State Clearinghouse after the end of the state review period, which closed on June 26, 2002. We are forwarding these comments to you because they provide information or raise issues that should be addressed in your final environmental document. E-1

The California Environmental Quality Act does not require Lead Agencies to respond to late comments. However, we encourage you to incorporate these additional comments into your final environmental document and to consider them prior to taking final action on the proposed project.

Please contact the State Clearinghouse at (916) 445-0613 if you have any questions concerning the environmental review process. If you have a question regarding the above-named project, please refer to the ten-digit State Clearinghouse number (2002052061) when contacting this office.

Sincerely,

Terry Roberts

Terry Roberts
Senior Planner, State Clearinghouse

Enclosures
cc: Resources Agency

1400 TENTH STREET P.O. BOX 3044 SACRAMENTO, CALIFORNIA 95812-3044
916-445-0613 FAX 916-323-3018 www.opr.ca.gov

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Response to Comments

Response to Comment E-1. Comment noted. The Navy has addressed the issues raised in the attached letters.

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Memorandum

Flex your POWER

Date: June 24, 2002

To: State Clearinghouse
1400 Tenth Street, Room 121
Sacramento, CA 95814

Clear 6.26.02

From: **DEPARTMENT OF CALIFORNIA HIGHWAY PATROL**
San Francisco Area

RECEIVED
JUN 26 2002
STATE CLEARING HOUSE

File No.: 335.11425

Subject: ENVIRONMENTAL DOCUMENT REVIEW AND RESPONSE, SCH #2002052061

The Environmental Document Review and Response for the disposal and reuse of Naval Station Treasure Island (NSTI), SCH #2002052061, has been reviewed. NSTI closed on September 30, 1997, and the Navy is in the process of disposing of the property in accordance with applicable laws and regulations. NSTI is on two islands in San Francisco Bay approximately midway between the shores of the cities of San Francisco and Oakland. Vehicular access to NSTI is via the San Francisco/Oakland Bay Bridge (SFOBB) on Yerba Buena Island. The SFOBB is part of the Interstate-80 (I-80) freeway system and provides an east-west link between the cities of San Francisco and Oakland.

At the time of operational closure, NSTI totaled approximately 1,075 acres of dry and submerged land within San Francisco. Approximately 36 acres were transferred from the Navy to the Department of Labor, 22 acres were transferred to Coast Guard, and 97 acres were transferred to Federal Highway Administration (FHWA), leaving 920 acres for disposal. The Navy can either retain NSTI surplus property in federal ownership (No Action Alternative) or dispose of the property for subsequent reuse.

Reuse Alternative 1 proposes 151 acres of publicly oriented uses. The major publicly oriented development on Treasure Island would be a theme attraction with the potential to attract an average of approximately 13,700 daily visitors. Development would include a 300-room and a 1,000-room hotel with three restaurants and offices. The total number of jobs expected to be generated is 4,482. Alternative 1 proposes 131 acres of residential uses. The total number of housing units associated with this reuse alternative would be approximately 2,850. Traffic generated by Alternative 1 is estimated to be approximately 960 vehicle trips during the weekday AM peak hour, 1,555 vehicle trips during the weekday PM hour, and 1,440 vehicle trips during the weekend midday peak hour.

Reuse Alternative 2 is similar to Alternative 1, but less extensive. Alternative 2 proposes 151 acres of publicly oriented uses. A theme attraction would draw up to approximately 5,500 daily visitors. Development would include a 700-room and 500-seat amphitheater, and an entertainment and retail center. The total number of jobs expected to be generated is 2,513. Alternative 2 proposes 19 acres of residential uses. 50 existing housing units would remain and approximately 200 new units would be added. Traffic generated by Alternative 2 is estimated to be 385 vehicle trips during the weekday AM peak hour, 775 vehicle trips during the PM peak hour, and 785 vehicle trips during the weekend midday peak hour.

Reuse Alternative 3 represents minor development and existing facilities would be reused. Alternative 3 proposes 121 acres of publicly oriented uses. A theme attraction would draw up to approximately 2,740 daily visitors. Development would include at least one landmark structure up to 100 feet tall, and other new buildings similar in height to existing conditions. The number of jobs expected to be generated is 1,736. Alternative 3 proposes 150 acres of residential uses. The number of housing units associated with this reuse alternative would be approximately 1,100. Traffic generated by Alternative 3 is estimated to be 610 vehicle trips during weekday AM peak hour, 800 vehicle trips during the weekday PM hour, and 770 vehicle trips during the weekend midday peak hour.

The following comment is offered regarding the reuse alternatives:

> Regardless of the alternative considered, SFOBB will definitely be adversely impacted by traffic. Westbound SFOBB traffic is controlled at the toll plaza by metering lights. The additional traffic resultant of the NSTI reuse would require the slowing of the metering lights, which would adversely impact traffic on Interstates 80, 580, and 880 in Alameda County. In order to properly manage this amount of traffic and adequately provide the public service required in this general location, it would be necessary to increase in-view patrol during weekday AM and PM peak hours and weekend midday peak hours. F-1

If you have any questions regarding this memorandum and our comment, please contact me or Lieutenant Don Morrell at (415) 557-1094.

E. C. CHOI, Lieutenant
Acting Commander

cc: Golden Gate Division
Special Projects Section

Response to Comments

Response to Comment F-1. Please see response to comment B-4 regarding traffic on the SFOBB and at the SFOBB toll plaza. Additional traffic generated by the proposed action would not require the slowing of the SFOBB metering lights; metering lights are designed to restrict the number of vehicles to get onto the SFOBB. However, these additional vehicles may cause longer vehicle queuing on the approach to the toll plaza. As stated in the response to comment B-4, regardless of the number of vehicles approaching the SFOBB, the operation of the SFOBB would remain the same and, therefore, it is not certain that additional in-view patrols would be required.

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LETTER G

Department of Toxic Substances Control

Edwin F. Lowry, Director
700 Heinz Avenue, Suite 200
Berkeley, California 94710-2721

Alinston H. Hickox
gency Secretary
alifornia Environmental
Protection Agency

Gray Davis
Governor

June 24, 2000

Ms. Timarie Seneca
BRAC Operations Office
Southwest Division, Naval Facilities Engineering Command
Code 06CM.TS
1230 Columbia Street, Suite 1100
San Diego, California 92101-8517

DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS), NAVAL STATION TREASURE ISLAND, SAN FRANCISCO, CALIFORNIA

Dear Ms. Seneca:

The Department of Toxic Substances Control (DTSC) has reviewed the DEIS for the disposal and reuse of Naval Station Treasure Island dated May 2002. The DEIS analyzes potential environmental impacts from three reuse alternatives relating to land use, visual resources, socioeconomics, cultural resources, transportation, air quality, noise, biological resources, geology and soils, water resources, utilities, public services and hazardous materials and waste. DTSC's review was limited to sections directly addressing hazardous materials and waste issues. Following are DTSC's comments.

1. Chapter 1, Section 1.2, Overview of NSTI

   A fuel service station and munitions storage bunkers were operated by the Navy and should be added to the list of facilities that were formerly located on Treasure Island. G-1

2. Chapter 1, Section 1.5, Related Studies

   The 1997 BRAC Cleanup Plan mentioned does contain a remediation plan and schedule, however, the plan and schedule are out of date and do not reflect the current understanding of the Installation Restoration sites and associated schedules. G-2

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3. Chapter 3, Section 3.13.1, Hazardous Materials Management

Please see comment number two. G-3

4. Chapter 3, Section 3.13.3, Installation Restoration Program (IRP)

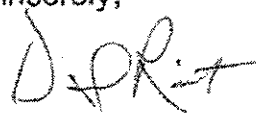
The master schedule for NSTI was last updated in 2001 and will be updated annually. The master schedule will be the Appendix D schedule for the NSTI FFSRA. G-4

5. Chapter 3, Section 3.13.5, Polychlorinated Biphenyls (PCBs)

IR Site 12 should be added to the list of sites known to have had historical releases of PCBs to soils that are in need of further evaluation and eventual remediation. G-5

If you should have any questions regarding this letter, please contact me at (510) 540-3763.

Sincerely,



David Rist
Hazardous Substances Scientist
Office of Military Facilities

cc: Mr. Phillip Ramsey (SFD-8-2)
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, California 94105

Ms. Sarah L. Raker
California Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, California 94612

Ms. Martha Walters
Mayor's Office at Treasure Island
770 Golden Gate Avenue
San Francisco, California 94102

Response to Comments

Response to Comment G-1. The facilities listed in section 1.2 are intended to inform the reader of the general types of uses at NSTI, especially with respect to structures that may be part of reuse. Because of the size and complexity of land uses and facilities on NSTI, this list is not intended to be inclusive of all historic uses of NSTI facilities.

Response to Comment G-2. The BCP has not been updated and, as noted by the commentor, does not reflect the current schedule and remediation plan. As noted in section 3.13.3 of the EIS, current information on remediation plans and schedules are available through the Navy's BRAC Operations Office and in Appendix D of the NSTI FFSRA.

Response to Comment G-3. Please see the response to comment G-2 above.

Response to Comment G-4. The text in section 3.13.3 of the Final EIS has been revised to read as follows:

> Appendix D of the NSTI FFSRA, which provides the submittal schedule for draft primary and secondary documents, was last updated in 2002.

Response to Comment G-5. The text in section 3.13.5 has been revised to read as follows:

> Navy has investigated IR sites 03, 12, and 17 for potential PCB contamination. No further action relative to PCBs has been recommended at either site 03 or 17. A removal action for soils containing PCBs at levels in excess of the screening level (1 mg/kg) was conducted in 2000 at IR 12.

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LETTER H

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY GRAY DAVIS, Governor

DEPARTMENT OF TRANSPORTATION
P. O. BOX 23660
OAKLAND, CA 94623-0660
(510) 286-4444
(510) 286-4454 TDD

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June 24, 2002

SF-80-7.71
File #SF080104
SCH #2002052061

Ms. Timarie Seneca
BRAC Operations Office
Southwest Division
Naval Facilities Engineering Command
Code 06CM.TS
1230 Columbia Street, Suite 1100
San Diego, CA 92101-8517

Dear Ms. Seneca:

Disposal and Reuse of Naval Air Station Treasure Island - Draft Environmental Impact Statement (DEIS)

Thank you for including the California Department of Transportation (Department) in the environmental review process for the above-referenced project. We have reviewed the DEIS dated May 2002, and have the following comments to offer:

1. Executive Summary – Section ES-3, Disposal and Reuse Process, page ES-3:
   The Executive Summary states "The easements impose substantial restrictions on Navy's ability to access and utilize the underlying property. This land is no longer available for transfer by the United States and, as such, is no longer available for community reuse..." It continues, "For that reason, the SFOBB property, including the construction and aerial easements, is not included in the Navy disposal and is therefore, excluded from this EIS."

   The Department questions the meaning of these statements since the deeds transferring the land include the provision for terminating the temporary construction easements of several parcels on Yerba Buena Island. The deeds state that "termination shall occur when the State determines that the easements are no longer required for the construction of the seismic safety projects or when the State gives final acceptance to its contractor for work on the seismic safety projects. If requested, the State will prepare, execute and deliver to the Navy deeds to release and extinguish the temporary construction easements." When construction activities on Yerba Buena Island are completed, the State will then relinquish its rights on the temporary construction easement. Further, the deeds also acquired right of way for all three bridge replacement alternatives under consideration for Department's east span seismic replacement project on the SFOBB and the deed also provides for returning any unnecessary right of way to the Navy. Therefore, excluding the portion of Yerba Buena Island currently within the State's temporary construction easement and all the permanent right of way acquired in October 2000, the DEIS ignores the potential reuse of this land. H-1

2. Section 3.1.3 Surrounding Land Uses, page 3-11:
We suggest that the San Francisco-Oakland Bay Bridge be included in this section, as it is a ve important land use on the island. H-2

3. Section 3.3 Socioeconomics, page 3-18:
The analysis in this section relies heavily on the Association of Bay Area Governments (ABA Projections 1996 series. Three new Projection Series have been released since the 1996 ser (1998, 2000, and 2002). We have found in general that, compared to the more recent Projecti Series, the 1996 Projections (which were released toward the end of an economic recession) te to under-predict future job, population and housing growth in the region. For example, AB/ Projections 2002 estimates a 41% increase in Bay Area jobs between 1990 and 2015 (from million to 4.5 million), rather than the 29% job growth for the same period referenced from 19 on page 3-19 of the DEIS. The most recent Projection Series available, ABAG Projections 20 should be used and all analysis should be revised accordingly. H-3

4. Section 3.5.1 Roadway Network, second paragraph, page 3-39:
The text states that Figure 3-5 shows "the location of the six ramps and the Caltrans easem across Yerba Buena Island." Figure 3-5 on page 3-40 does not show the Department's easem on Yerba Buena Island. H-4

5. Chapter 4, Introduction, Environmental Consequences, last paragraph, page 4-2:
The Department disagrees with the statement that the "Navy is effectively precluded at this ti from taking those actions that are required of it to make temporary construction easements a possible excess property suitable for conveyance." While construction activities on the easem will indeed limit Navy's access to its property, land use planning can proceed. In addition, transfer did not include right of way for roadway and utility purposes across one parcel. T Navy has identified certain hazardous waste sites in portions of the area previously within Temporary Construction Easement and in-fee land, and if the Navy requires access from Department to investigate and/remediate such wastes, it is entitled to such access under provisions of the land transfer. This means that the Navy can in fact take actions necessary prepare the land for conveyance. H-5

6. Section 4.5 Transportation - Traffic Analysis Methodology, page 4-34:
The report provides traffic forecasts to year 2010, stating that this is a common benchmark u by the Metropolitan Transportation Commission (MTC) for long-range planning in the regi MTC currently provides traffic forecasts, based on ABAG Projections 2000, to year 2025. T analysis should take into account the latest planned and programmed transportat improvements assumed in the current MTC travel demand model, and identified by the nine E Area counties, Caltrans, and MTC. Traffic projections should at least be provided for assumed Naval Station Treasure Island build-out year, 2015, and, to be consistent with regio planning efforts, year 2025 traffic forecasts should be developed as well. H-6

7. Section 4.5, Transportation, Significant and Mitigable Impacts, pages 4-36 to 4-58:
Mitigation of the significant traffic impacts identified in the DEIS relies heavily on implementation of the Transportation Demand Management (TDM) measures identified in Chapter 4 & Appendix F. We are skeptical of the ability of these TDM measures to effectively H-7

reduce vehicle demand for the island, particularly since ferry service to and from the island (currently non-existent) appears to play a major role. Since much of the TDM measures depend on adequate funding, it is unrealistic to propose them as mitigation without an established financing plan. H-7

8. Section 4.5, Transportation, Significant and Mitigable Impacts, pages 4-36 to 4-58:
The eastbound on-ramp will be rebuilt with the replacement of the east span. The rebuilt on-ramp will have a significantly improved merge taper, which will increase the on-ramp capacity. We estimate the peak period capacity to be approximately 900-1000 vehicles per hour (vph), which will be able to handle all of the forecasted demands. This additional demand entering the freeway will very likely have a significant adverse impact on freeway operation, particularly during the PM peak period when the freeway operates at capacity. The proposed mitigation should be revised to address the expected impact to the freeway. As part of the mitigation, we recommend implementation of ramp metering which would be operated to maintain capacity flow along the entire length of the bridge. H-8

9. Section 4.5, Transportation, page 4-40:
The DEIS proposes that impacts from the increased traffic for the westside eastbound off-ramp be mitigated with signs directing traffic to the eastside eastbound off-ramp. The analysis estimates that this mitigation would split the demand about evenly between the two off-ramps. We believe that it is unrealistic to expect this amount of traffic shift to occur. It is more likely that most, if not all, of the eastbound traffic destined for Treasure Island will use the westside eastbound off-ramp regardless of the signing. It is more appropriate to assume that no traffic would shift, and develop mitigation measures that would directly address this impact. H-9

10. Section 4.5, Transportation, pages 4-43 to 4-45:
The DEIS describes construction-related impacts as being not significant. However, construction-related vehicles may have a significant impact if they use the bridge during the peak periods due to the currently over-saturated conditions. This should be identified as a potential significant impact with use of water transportation and off-peak vehicle travel as mitigation. H-10

11. Section 4.5, Transportation, Not Significant Impacts, page 4-43:
Under "Other ramp operations (Factor 1)" the DEIS states that there would be no significant queuing impacts because ramp demand would be less than capacity, except for the western westbound on-ramp, the eastern eastbound off-ramp, and the eastbound on-ramp. While this may be true for the ramp operation, it is not a correct assessment of freeway impacts since any increase in on-ramp volume entering the freeway during the peak period in the peak direction would *significantly* impact freeway operation on the bridge and its approaches. This is true because the freeway currently operates at capacity essentially along the entire length of the bridge in the westbound direction during the AM peak period, and in the eastbound direction during the PM peak period. The bridge is the primary bottleneck along this corridor, which means that *any* additional traffic entering the bridge will result in an increase in traffic congestion and delay. H-11

12. Section 4.5, Transportation, Level of Service, page 4-44:
It appears that the level of service (LOS) for the freeway mainline was determined using speed as the criterion. The accepted methodology in the Highway Capacity Manual is to use density as the criteria for freeway LOS. The analysis should be revised accordingly. H-12

13. Appendix F.2 Socioeconomics:
Since 1990 U.S. Census data shows that the average household size at Naval Station Treasure Island was 3.7, it would seem more appropriate to use this value to represent existing household size, rather than the 3.2 figure based on the average family size in San Francisco assumed in the Presidio reuse plan. H-13

14. Appendix F.3 Transportation, Table F-7, page F-17:
How were the number of trips derived for specific land uses in each travel analysis zone? Are these based on Institute of Transportation Engineers (ITE) trip generation rates? H-14

15. Appendix F.3, Travel Demand, page F-23:
What assumptions were made in "adjusting" the trip generation, trip distribution, and mode split estimates for the various land use alternatives, as well as for auto occupancy factors and vehicle trips to ferry terminals? How was the travel demand information derived for land uses not evaluated for the reuse plan? The basis for these assumptions should be clearly defined. H-15

16. Appendix F.3, Trip Generation, page F-23:
It is not clear which ITE Trip Generation Edition was used to derive the number of trips assumed for the various land use categories. The 6th Edition (most recent) is the preferred source of trip generation rates, and should be used in this analysis. H-16

17. Appendix F.3, Trip Generation, page F-24:
On what basis was it concluded that 40% of the daily and peak-hour person trips in Alternative 1 will consist of internal trips? This key assumption in the analysis requires a much more detailed explanation as to how such a seemingly high percentage of internal trips was derived. Similarly, further explanation is needed as to how the other travel mode percentages (for auto, vanpool, bus and ferry) were derived. H-17

18. Appendix F.3, Table F-14, Person Trip Generation, page F-31:
The totals of the Retail/Work trip distribution percentages in Table 14 exceed 100%. This should be corrected, along with any part of the analysis that utilized the errant figure. H-18

19. Appendix F.3, Table F-15, Mode Split, and Tables F-16 & F-17, Average Vehicle Occupancy, page F-32:
What is the justification for assuming that 100% of all internal work and non-work trips, for each land use category, will be made by bus? The mode split percentages assumed here are significantly different than the current average mode split percentages for the region (as is the high vehicle occupancy rate). Detailed justification and documentation supporting such percentages should be provided. H-19

20. Appendix F-3, Transportation Features Assumed, page F-20:
There is no discussion of the accommodation of bicycles and pedestrians in this DEIS. The Appendix indicates that pedestrian and bicycle facilities would be provided. However, there is no mention how this will be done on Yerba Buena Island, and how this will connect to the pedestrian and bicycle path on the new east span of the Bay Bridge. These are significant issues H-20

that should be addressed. This DEIS needs to indicate how pedestrian and bicycle facilities will be accommodated on Yerba Buena Island, and how they will connect to Treasure Island. The DEIS should also indicate whether the proposed bicycle accommodations will be compliant with the Americans with Disabilities Act. H-20

We look forward to your response to our concerns. Should you require further information or have any questions regarding this letter, please call Paul Svedersky of my staff at (510) 622-1639.

Sincerely,

Jean C R Finney

JEAN C. R. FINNEY
District Branch Chief
IGR/CEQA

c: Katie Shulte Joung, State Clearinghouse

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Response to Comments

Response to Comment H-1. Please see response to comment B-2 regarding inclusion of the FHWA/Caltrans easements in the EIS analysis.

Response to Comment H-2. The SFOBB was discussed in the Draft EIS under Yerba Buena Island in section 3.1.2 Reuse Plan Area. This discussion has been moved to section 3.1.3 Surrounding Land Uses in the Final EIS.

Response to Comment H-3. Previous projections (ABAG 1996) indicted a job growth rate of 29 percent for the Bay Area, while more recent projections (ABAG 2002) estimate a job growth rate of 39.9 percent growth between 1990 and 2015, with the largest growth occurring in Santa Clara and Alameda counties. Due to the substantial difference in anticipated population and job growth between Projections '96 and Projections '02, data from the ABAG's Projections 2002 was used to update this section. This data also was used to revise the analysis of socioeconomic effects in section 4.3 and the cumulative socioeconomic effects described in section 5.1 Cumulative Assumptions, and section 5.4 Analysis of Cumulative Impacts. The updated information did not alter the conclusions in these sections.

Response to Comment H-4. Figure 3-5 has been revised to show the FHWA/Caltrans easements.

Response to Comment H-5. Please see response to comment B-2 regarding inclusion of the FHWA/Caltrans easements in the EIS analysis. The referenced text has been removed.

Response to Comment H-6. Please see response to comment B-4 regarding updates of traffic projections to year 2025.

Response to Comment H-7. The only access to NSTI is from the SFOBB. The EIS documented existing ramp constraints and current and future traffic conditions and impacts on these ramps and SFOBB mainline. The current vehicular access to NSTI is highly constrained. T he only feasible modifications to the ramps are those included in the SFOBB east span project. Other major physical improvements, such as a BART Treasure Island Station, were dropped from consideration. Consequently, the only feasible mitigation measures are TDMs, new ferry services, balancing the ramp volumes, and the creation of a monitoring program that would potentially limit the amount of land use development on NSTI. All of these mitigation measures are presented in section 4.5.1 under Alternative 1, Significant and Mitigable Impacts.

The proposed action evaluated in the EIS is the transfer of federal property. Mitigations for potential impacts associated with reuse are identified and agreed to by the City as part of the transfer agreement. Funding for these measures would be undertaken by the City as part of reuse. State legislation has created a regional Water Transit Authority (WTA) to assist in defining a regional ferry system for the future. Treasure Island is one of the key locations for the initial services.

Response to Comment H-8. Comments on the new eastbound on-ramp on the east side of the tunnel is noted and changes were made in the text. A potential mitigation measure of a metering light is also included. Please see response to comment B-4 regarding traffic impacts on the eastbound on-ramp on the east side of the tunnel.

Response to Comment H-9. Section 4.5 states that the proposed TDM program could reduce the peak-hour vehicle trips by 6 to 12 percent. Consequently, traffic volumes on the eastbound off-ramp on the west side of Yerba Buena Island could be reduced from 535 vehicles to 471-503 vehicles. The capacity of this ramp has been observed to be 500 vehicles per hour. Even with a smaller shift in traffic to the off-ramp on the east side of the island, the impact could be reduced to an nonsignificant level, meaning that drivers would not have to queue on the SFOBB during the PM peak hour. Currently there are no signs to direct vehicles to use the off-ramp on the east side of the island, which is underutilized (approximately 21 percent of the total drivers from the eastbound direction use this ramp).

Response to Comment H-10. As stated in the EIS, a guiding policy of the Draft Reuse Plan (San Francisco 1996e) is to limit truck service and freight delivery to off-peak hours (generally between 10:00 AM and 3:00 PM and after 7:00 PM on weekdays). In addition, construction on NSTI would vary depending on the specific construction activity and schedule for the various components of the development. In addition, construction impacts are generally short term in nature and can be managed through proper phasing, sequencing, and scheduling. Truck ferries could potentially be used to transport construction materials and equipment to accommodate construction activities.

Response to Comment H-11. Table 4-8 of the Draft EIS (now Table 4.5-6 of the Final EIS) presents the freeway SFOBB mainline impacts. It shows that there would be no significant impacts on SFOBB both in the eastbound and westbound directions. For the westbound direction, SFOBB will operate at LOS F condition with or without the redevelopment of NSTI. Traffic operation on the SFOBB westbound direction is controlled by the metering lights at the approach to the SFOBB to ensure a free flow condition of SFOBB. If additional traffic from NSTI would cause traffic speed to slow down on the SFOBB, Caltrans could further reduce the number of vehicles getting onto the SFOBB, which could potentially cause secondary impacts.

Response to Comment H-12. The freeway mainline analysis performed in 1996 (using speed to determine level of service instead of density based on the Highway Capacity Manual 1985) was appropriate at the time it was prepared. Since then the Highway Capacity Manual was modified twice and the current version (2000) recommends the use of density as a measure to determine freeway mainline level of service. While the change of analysis may affect the level of service presented in the Final EIS, it would not affect the proposed mitigation measures.

NSTI is an island that can only be accessed by the six freeway on- and off-ramps from SFOBB. Freeway volumes on SFOBB during AM and PM peak hours from both the eastbound and westbound directions are restricted either because of the metering lights (in the westbound direction) or lane geometry (in the eastbound direction). There is no opportunity to modify the ramp geometry (except the eastbound on-ramp on the east side of the tunnel which will be improved as part of the SFOBB East Span project). Feasible measures for the Disposal and

Reuse of Treasure Island project to mitigate impacts are documented under "Significant and Mitigable Impacts for SFOBB/I-80 Yerba Buena Island Ramps". These mitigation measures include a TDM program, increased bus and ferry services, traffic signage to balance ramp usage, and a monitoring program to ensure the established goals and objectives in the Draft Reuse Plan are implemented. If the results of the monitoring program indicate that significant impacts still occur, either more aggressive TDM and transit improvements must be implemented or additional developments should be delayed until such improvements are implemented.

Response to Comment H-13. The average military household size when NSTI was used solely for military purposes was 3.7 persons. It is assumed in the analysis that the units to be reused would have a slightly smaller household size (3.2 persons per unit) because non-military population densities are less than military. The lower household size (3.2 versus 3.7 persons) also is based on the fact that there would be additional constraining factors to non-military families reusing the area that did not exist for military families: children who might have to be shuttled to a variety of after-school activities, medical appointments, shopping, etc. A slightly lower average household size, therefore, was projected for the reuse of the larger units, using the Presidio Planning Socioeconomic Analysis Report as an estimate for consistency. The higher density for reuse of the existing units, as compared to the new ones (3.2 persons in the reused units versus 2.3 persons in the new units), is based on the larger number of bedrooms/square footage than is common in the Bay Area.

Response to Comment H-14. Analysis presented in the EIS used the ITE rates for only part of the trip generation analysis. Whenever possible, trip generation rates developed by the San Francisco Planning Department were used. When the data was not available from the San Francisco Planning Department, ITE rates were used. The San Francisco Planning Department data were obtained from an extensive survey of a wide range of land uses in 1991 and documented in a report, titled San Francisco Citywide Travel Behavior Survey (CTBS). The key differences between the CTBS and ITE data are that ITE data were mostly obtained from suburban sites, typically in a single-use site, where CTBS data are San Francisco specific and they are mostly in a mixed-use setting. CTBS data have been used for all transportation impact analysis both for individual development projects as well as areawide planning projects, such as the Hunters Point Naval Shipyard EIS/EIR. ITE data were used whenever CTBS data are not available. The assumptions for the trip generation rates are presented in Tables F-8 and F-9 of the Draft EIS (now Tables F-10 and F-11 of the Final EIS).

Response to Comment H-15. Trip generation, trip distribution, and modal split ratios for the EIS were developed by the San Francisco Planning Department as part of the Citywide Travel Behavior Survey. They are presented in Tables F-14 and F-15 of the Draft EIS (now Tables F-16 and F-17 of the Final EIS). Both Tables F-8 and F-9 of the Draft EIS (now Tables F-10 and F-11 of the Final EIS) contain extensive documentation of the assumptions in the footnote.

Response to Comment H-16. As stated in Appendix F, trip generation rates were obtained from City and County of San Francisco sources. Where San Francisco trip generation rates were not available, rates were obtained from ITE version 5.

Response to Comment H-17. The internal trip assumptions are presented in Table F-14 of the Draft EIS (now Table F-16 of the Final EIS). This table presents trip distribution pattern for all land use categories by work and non-work related trips, including internal trips. The Draft EIS generally stated that the Island would be developed as a mixed-use district.

Response to Comment H-18. The percentage of internal work trips for retail in Table F-14 of the Draft EIS (now Table F-16 of the Final EIS) has been corrected to read 10 percent rather than 100 percent.

Response to Comment H-19. The modal split ratios presented in Table F-15 of the Draft EIS (now Table F-17 of the Final EIS) were incorrect and have been modified.

Treasure Island is approximately 0.6 miles by 1 mile, and, therefore, most of the land uses would be within reasonable walking distance to each other, except those located on the perimeter of the Island. The majority of the internal trips would be made by transit, pedestrian, and bicycle modes. This assumption is further supported by that fact that Treasure Island would be designed as a mixed-use island with a wide range of land uses, including residential, office, retail, and recreational uses. It would also be designed to include multimodal transportation modes to facilitate pedestrian, bicycle, and transit use. Key transportation policies from the Draft Reuse Plan include:

- Establish transit and pedestrian-based development on Treasure Island, and
- Establish a multimodal internal circulation system that emphasizes non-auto modes.

Response to Comment H-20. The EIS is a program level document based on the description provided by the City and County of San Francisco in its Draft Reuse Plan. The Draft Reuse Plan stated that pedestrian and bicycle facilities would be provided; however, no specific design was presented. This condition was also stated in the SFOBB East Span Seismic Safety Project EIS (page 4-25 under section 4.2.2 Yerba Buena Island).

The SFOBB East Span Seismic Safety Project EIS states that: "the bicycle/pedestrian path proposed for the Preferred Alternative (Replacement Alternative N-6) and Replacement Alternatives N-2 and S-4 would terminate on the eastern side of Yerba Buena Island. In the final design phase for a replacement alternative, Caltrans would work with the Navy and/or the City and County of San Francisco (San Francisco) to design appropriate path connections to the local roadway network. Caltrans would consult with the Navy and/or other property owners on Yerba Buena Island about their interest in having directional signage installed for path users on the bridge. If consultation results in agreement on the nature and placement of the signs, Caltrans would install the signage. To the extent the Navy and San Francisco believe the SFOBB bicycle/pedestrian path would create excessive demand on Navy/ San Francisco facilities on Yerba Buena Island, Caltrans would limit access to Yerba Buena Island at the request of the Navy and/or San Francisco. Should the Navy or the San Francisco desire Yerba Buena Island access to be specifically directed, limited, or prohibited, Caltrans would work with these agencies to design signage or barriers. Caltrans does not have responsibility or authority for areas of Yerba Buena Island and Treasure Island once path users leave the path on the East Span.

"Caltrans and MTC are currently preparing a feasibility study for a possible bicycle/pedestrian/maintenance path from San Francisco across the West Span and a connection around Yerba Buena Island to a path on the replacement East Span. East of the Yerba Buena Island anchorage, the path would continue on elevated structures which would connect to an at-grade path along the south side of Yerba Buena Island, generally along the existing Treasure Island Road, that would then connect to the East Span path. Any future pathway on the West Span and on Yerba Buena Island would be separate project. The East Span path could accommodate connections to a possible path of the West Span."

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LETTER I

STATE OF CALIFORNIA – THE RESOURCES AGENCY GRAY DAVIS, *Governor*

OFFICE OF HISTORIC PRESERVATION
DEPARTMENT OF PARKS AND RECREATION
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June 28, 2002

REPLY TO: USN020508A

Ron Plaseied, Base Closure Manager
Department of the Navy
Southwest Division
Naval Facilities Engineering Command
1220 Pacific Highway
SAN DIEGO CA 92132-5190

Re: Draft Environmental Impact Statement for the Disposal and Reuse of Naval Station Treasure Island, City and County of San Francisco.

Dear Mr. Plaseied:

Thank you for submitting to our office your May 7, 2002 letter and copy of the "Draft Environmental Impact Statement (DEIS) for Disposal and Reuse of Naval Station Treasure Island," a property located in the City and County of San Francisco. The closure of the facility is being done under the direction of the Defense Base Closure and Realignment Act (DBCRA). The 103rd U.S. Congress approved the closure of Naval Station Treasure Island (NSTI) in September 1993. The DEIS seeks to evaluate the potential impacts on cultural resources that could result from Navy disposal of surplus federal properties within NTSI and subsequent reuse of those federal properties. The Navy is considering four alternatives, including a No-Action Alternative, for implementation of the disposal and reuse of the properties on NTSI. The alternatives are detailed in the Executive Summary of the DEIS and in other sections of the document that seek to measure the impacts of the alternatives on the natural and human environment.

The Navy is seeking our comments on its DEIS in accordance with 36 CFR 800, regulations implementing Section 106 of the National Historic Preservation Act. It has been noted in Sections 3.4 and 4.4 of the DEIS that historic properties on Treasure Island and Yerba Buena Island have been identified and evaluated by the Navy in consultation with our office. A number of these properties have been determined, by consensus, to be eligible for inclusion on the National Register of Historic Places (NRHP). The Navy's identification and evaluation of historic properties on NTSI, as described in the DEIS, appears adequate and meets the standards set forth in 36 CFR 800.4. We will provide comments on the proposed closure and reuse of NTSI once the Navy has selected a preferred alternative and has provided documentation regarding its potential impacts on historic resources. I-1

Thank you again for seeking our comments on your project. If you have any questions, please contact staff historian Clarence Caesar at (916) 653-8902.

Sincerely,

Dr. Knox Mellon
State Historic Preservation Officer

Response to Comments

Response to Comment I-1. Comment noted.

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LETTER J

STATE OF CALIFORNIA
GRAY DAVIS, *Governor*

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
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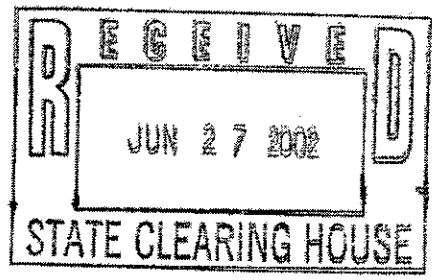
June 26, 2002

clear to proceed date



Southwest Division
Naval Facilities Engineering Command
1230 Columbia Stret, Suite 1100
San Diego, CA 92101-8517

Attn: Ms. Timarie Seneca

and

City and County of San Francisco
Treasure Island Development Authority
Treasure Island
San Francisco, California 94130

Attn: Ms. Ann Marie Conroy

SUBJECT: BCDC Inquiry File No. SF.YB.7120.1, Comments on Draft Environmental Impact Statement For the Disposal and Reuse of Naval Station Treasure Island, State Clearinghouse Number 2002052061

Greetings:

This letter conveys the staff comments on the on Draft Environmental Impact Statement For the Disposal and Reuse of Naval Station Treasure Island (DEIS), State Clearinghouse Number 2002052061, dated May 2002 and received in our office on May 14, 2001. Although the Commission has not had an opportunity to review the DEIS, we trust the following staff comments based on the Commission's law, the McAteer-Petris Act (Act), and the policies of the Commission's *San Francisco Bay Plan* (Bay Plan), will be considered by the United States Navy when preparing the final DEIS for the transfer of Naval Station Treasure Island (NSTI).

The DEIS assesses potential environmental impacts of the disposal and reuse of NSTI from the United States Navy (USN) to the City and County of San Francisco (City) and the potential significant impacts of three proposed reuse alternatives, Draft Reuse Plan Alternative 1, Alternative 2 and Alternative 3. A fourth alternative, no action, assumes no disposal of the property and retention of NSTI by the Navy in caretaker status. The DEIS states that the only significant non-mitigable impact is would occur under alternative 2 and involves the demolition of historic buildings.

Jurisdiction.

On Page 3-4 through 3-6, the DEIS summarizes the Commission's authority under the McAteer-Petris Act, including the *San Francisco Bay Plan* and the *San Francisco Bay Area Seaport Plan* and the federal Coastal Zone Management Act. The discussion of the Commission's jurisdiction and authority is thorough and for the most part accurate with a few minor inaccuracies. The DEIS states, in part that "the the *San Francisco Bay Plan* and the *San Francisco Bay Area Seaport Plan* are the approved local coastal plans for complying with CZMA in San Francisco Bay." This is partially correct. The Commission's approved federal Coastal Management Program does include these plans, among others. The Commission's approved management program includes its laws, the McAteer-Petris Act and the Suisun Marsh Preservation Act, its plans the *San Francisco Bay Plan, Suisun Marsh Preservation Plan , San Francisco Bay Area Seaport Plan, San Francisco Waterfront Special Area Plan,* and other Special Area Plans, and many other documents. The DEIS also states on page

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3-5 that "the *San Francisco Bay Plan,* adopted by BCDC in January 1969 and amended through 1997..." The *San Francisco Bay Plan* has been amended by the Commission 10 times since 1997 and was last amended on April 18, 2002. Nine of the Bay Plan amendments adopted since 1997 are in full force and effect, and the April 18, 2002 amendment is in effect for the Commission's review of permits, but not yet for federal consistency reviews. The Commission submitted a notice of a routine program change to the Office of Coastal Resource Management for its concurrence and for public comment on June 21, 2002. Within 30 days or by July 20, 2002, these new policies will be in force and effect for federal consistency reviews. Therefore, they are quoted below as they will apply to the Commission's federal consistency review of the USN's proposed disposal of NSTI. J-2

The maps in Figures 2-3, 2-4 and 2-5 do not clearly show the location of the proposed land uses in relation to the location of the Commission's jurisdiction. From our review of the DEIS, the elements of the project which appear to be located in the Commission's jurisdiction from the three proposed alternatives include: (1) waterfront trails or promenades; and (2) roadways; (3) conference center uses; (3) new ferry terminals; (4) marina expansion; (5) public open space; (6) film production uses; (7) institutional and community uses; (8) theme park uses; and (9) publicly-oriented uses golf course and wildlife habitat; and (10) shoreline stabilization. The Final DEIS should identify those project elements within the Commission's jurisdiction so that we can more accurately assess their potential effects on the Coastal Zone. Although the DEIS correctly states that NSTI is not currently within the Coastal Zone, development of the uses proposed and evaluated in the DEIS will occur within the Commission's jurisdiction and will require permit authorization from the Commission. Therefore, these proposals will affect the Coastal Zone and should be evaluated pursuant to the Commission's approved federal coastal management program. J-3

Table 2-4 Summary of Significant Environmental Consequences and Mitigation Measures. The Land Use category in this table fails to mention the potential inconsistency of proposed land uses for Yerba Buena Island with the Bay Plan waterfront park priority use designation of the site. The FEIS should evaluate the consistency of the proposed reuse plan with the Bay Plan waterfront park priority use designation and what if any changes to the proposed uses would address this inconsistency. J-4

In addition, under the topic of Biological Resources on page 2-28 in this table, the DEIS states that under all alternatives, "significant impacts to mudflat habitat, including eelgrass beds, may occur as a result of increased pedestrian and boater activity around Clipper Cove. Expanding the marina or constructing a yacht harbor, new docks or other structures that would cover the surface of the water could impact eelgrass beds, but would require a permit from the COE." Section 66605(a) of the McAteer-Petris act provides, in part "that further filling of San Francisco Bay....should be authorized only when the public benefits from the fill clearly exceed the public detriment from the loss of the water areas...." The FEIS should discuss the public benefits that would accrue from the proposed fill and evaluate these benefits against the public detriment from the loss of important habitat values such as eel grass beds. J-5

This analysis should include a cumulative analysis of the proposed impacts in conjunction with the impacts of the SFOBB East Span replacement project which will impact portions of existing eel grass beds in the Bay on the north shore of Yerba Buena Island. J-6

The section on Biological Impacts in this table does not indicate that potential increased impacts on harbor seals from the proposed increase in boating activity would be significant. This may not be an accurate assessment of the impacts to harbor seals. The FEIS should include a more extensive evaluation of the types of impacts that could occur. Increased boating activity would increase the interactions between humans and harbor seals and if an increase is expected, disturbance of harbor seals would occur as a result. The DEIS should provide a more thorough analysis supporting the determination that these impacts would not be significant, including a discussion of the threshold of significance, and a cumulative impact analysis that considers the impacts of the SFOBB East Span Replacement project and the Richmond San Rafael Bridge seismic retrofit project which also have impacts on Harbor Seals. J-7

San Francisco Bay Plan Recreation Policies. Following staff's review of the DEIS, and the proposed reuse alternatives, it appears that certain uses proposed in the alternatives for Yerba Buena Island, including residential and some commercial uses are inconsistent with the Commission's J-8

LETTER J

waterfront park priority use designation and the Bay Plan recreation policies. The Bay Plan policies on recreation identify, among other things, the need to focus shoreline park planning on docking and picnic facilities for boaters, the opportunity to view nature and open space without adversely affecting habitat and access to the Bay through waterfront trails, recreational boating facilities views and fishing facilities. The Bay Plan policies on recreation also state, in part, that "...[l]imited commercial recreation facilities, such as small restaurants, should be permitted within waterfront parks, provided they are clearly incidental to the park use, are in keeping with the basic character of the park, and do not obstruct public access to and enjoyment of the Bay. Limited commercial development may be appropriate (at the option of the park agency responsible) in all parks shown on the Bay Plan maps except where there is a specific note to the contrary." (Recreation Policy 5(a)). The policies also state, in part, that "recreational facilities that do not need a waterfront location, e.g., golf courses, and playing fields should generally be placed inland, but may be permitted in shoreline areas if they are part of park complex that is primarily devoted to water-oriented uses." The Bay Plan designates the entirety of YBI for waterfront park, beach priority use. Bay Plan Map 4, note 19 requires that areas of YBI "released from military use should be developed for recreation uses." The Reuse Plan makes specific provision for recreation uses on YBI by setting aside 30 acres of inaccessible hillside areas for viewing as open space; by preserving the existing picnic area at the western end of Clipper Cove; and by designating Building 262 for commercial recreation use. Thus, commercial uses and active recreation uses that are appropriate to the park at NSTI could be consistent with the Bay Plan. J-8

As outlined in the DEIS, the proposed reuse plan at NSTI considers three alternative land use scenarios, including Alternative 1: full build-out of the communities draft reuse plan, at an accelerated rate (completion in 2015 v. 2030), Alternative 2: the Community Reuse Plan modified by the recommendations made by the Urban Land Institute; and Alternative 3: a lower level of development than that envisioned in the Draft Reuse Plan, in addition to the no action alternative. Figure 2-1 and Table 2-2 on pages 2-10 and 2-12 of the DEIS describe the general acreage of proposed land uses under the three alternatives and summarize the specific uses that might occur under the broad headings of public oriented, Institutional and community, residential, and open space/recreation. The range of uses that could occur under these headings is quite broad. The DEIS also states that recreation uses could include both active and passive recreation uses. From reviewing the maps in the DEIS and the description of the proposed reuse alternatives, it is not possible to tell to what degree land uses that may be inconsistent with the Commission's priority use designation would be located within the waterfront park priority use area. J-9

On page 4-2 through 4-9 of Section 4.1. Land Use, the DEIS fails to mention the San Francisco Bay Plan (BayPlan) designation of Yerba Buena Island for waterfront park priority use. The DEIS states that "Implementing Alternative 1 would increase public access to existing open space areas, including the San Francisco Bay shoreline, and would allow development of recreational facilities, which would be consistent with the San Francisco Bay Plan." The DEIS provides no basis for this conclusion, based on the Commission's Bay Plan waterfront park priority use designation and the recreation policies. The FEIS should evaluate the consistency of the proposed land uses with this priority use designation.

In general, the proposed reuse alternatives raise the following two issues: whether the proposed mix of recreation and non-recreation uses within the Commission's Bay Plan priority use area is consistent with the Bay Plan priority use designation, and whether the alternatives that contemplate non-park uses at NSTI on Yerba Buena Island would be consistent with the Commission's federally approved coastal management plan and whether any of these alternatives would negatively affect the coastal zone. As noted above, the recreation policies state that commercial development should be provided at a shoreside park, only if appropriate for the site and not expressly prohibited in the Bay Plan. Since it is not possible to tell the amount or type of commercial use contemplated in the Waterfront Park Beach priority use area, we are unable to assess the consistency of such use with the Bay Plan policies. Therefore, the blanket statement of consistency with the Bay Plan policies on page 4-3 of the DEIS is premature, and inconsistent with the prior statement that a Bay Plan amendment would be required in order to approve the uses proposed. J-10

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Moreover, it is unclear from the maps and descriptions provided whether residential uses within the priority use area, as proposed would have a negative effect on the coastal zone. It is clear from reviewing the DEIS, alternative 2 most closely conforms to the Bay Plan park priority use designation and recreation policies. The other two alternatives may raise significant issues with regard to the Bay Plan, depending on how these uses are located, and what their affect might be on the public's ability to use the shoreline open space areas. We will need additional information regarding the location and intensity of the proposed non-park uses of the site in order to accurately assess the consistency of the proposed alternatives with the recreation policies in the San Francisco Bay Plan. The Final DEIS should assess whether any proposed active recreational uses within the shoreline areas would be consistent with the Bay Plan recreation policies. J-10

The majority of the shoreline band on Treasure Island is proposed for passive recreation uses. In general, the reuse plan envisions the shoreline edge being developed with the shoreline protection system (riprap or sheet pile or some combination), a shoreline trail in a landscaped corridor inboard of the shoreline protection system, and a perimeter roadway. Buildings are to be set back at least 100-feet from the shoreline. Since the Reuse Plan establishes policy calling for continuous public access to the shoreline, it can be considered generally consistent with the existing Bay Plan recreation policies and Bay Plan Map 4 policy18. However, recent amendments to the San Francisco Bay Plan policies on Map 4 regarding Treasure Island addressing the harbor seal haul out site there may affect the nature of public access that can be allowed there. J-11

Visual Resources. The discussion of impacts on views in Section 4.2 Visual Resources evaluates visual impacts for each of the three alternatives. This section includes an evaluation of the on-site views and visual access for each alternative. In the analysis of the alternatives, the DEIS mentions that beneficial effects would occur because increased public access would provide more opportunities to views. The analysis seems to focus on development on Treasure Island with little or no analysis of the visual impacts or benefits that would occur on Yerba Buena Island. The FEIS should include a discussion of whether the alternatives would modify or remove any existing buildings on Yerba Buena Island to improve views, particularly if the proposed hotel building would block existing view corridors. The FEIS should also discuss in more detail what the opportunities for improving public views are on Yerba Buena Island and how each of the alternatives takes advantage of these opportunities. J-12

Transportation. On page 3-53, the DEIS, in section 3.5.4 Pedestrian and Bicycle Circulation, describes existing conditions on the island, but does not mention the addition of pedestrian and bicycle access to the east and west spans of the San Francisco-Oakland Bay Bridge. The State of California Department of Transportation is constructing a new east span that will include pedestrian and bicycle access to Yerba Buena Island. The Bay Area Toll Authority has prepared an analysis of the design and cost of providing pedestrian and bicycle access to the west span of the SFOBB as required in State legislation. The DEIS should evaluate the proposed project's effects on these two pedestrian and bicycle facilities. The discussion in Section 4.5 Transportation makes no mention of the pedestrian and bicycle access from the new east span of the SFOBB. J-13

Biological Resources. On pages 3-59 through 3-65, the DEIS discusses existing biological resources on the site. The DEIS does not mention Pacific Herring (Clupea pallasi) as a fish species occurring at the site. However, Section 4.8 discusses potential impacts to the herring fishery, and identifies the impacts as not significant. The Commission's Bay Plan fish, other aquatic organisms and wildlife policies state in part that "to assure the benefits of fish, other aquatic organisms and wildlife for future generations, the greatest extent feasible, the Bay's tidal marshes, tidal flats and subtidal habitat, should be conserved, restored and increased." The Bay Plan policies on Subtidal Habitat state, in part that, "Any proposed filling or dredging project in a subtidal areas should be thoroughly evaluated to determined the local and Bay-wide effects of the project on: (a) the possible introduction or spread of invasive species; (b) tidal hydrology; (c) fish, other aquatic organisms and wildlife; (d) aquatic plants; and (e) the Bay's bathymetry. Projects in subtidal areas should be designed to minimize and, if feasible, avoid any harmful effects....Subtidal areas that are scarce in the J-14

LETTER J

Bay or have an abundance and diversity of fish, other aquatic organisms, and wildlife (e.g., eelgrass beds, sandy deep water or underwater pinnacles) should be conserved. Filling, changes in use and dredging projects in these areas should therefore be allowed only if: (a) there is no feasible alternative; and (b) the project provides substantial public benefits. The FEIS should include a supplemental analysis of the impacts to the herring fishery, that considers these Bay Plan policies. It is likely that the Commission would deem any impacts to the eelgrass beds or the herring fishery at NSTI as significant. J-14

On page 4-78, the DEIS states that "under alternative 1, the number of boast slips in the proposed marina would quadruple" and on page 4-79, the DEIS states that "the level of disturbing boat activity is not expected to differ substantially from present conditions." This assessment is inaccurate, both because of the certain increase in boater activity in the area as a result of expanding the marina, and a failure to assess impacts from other craft, particularly kayaks that are ever more frequently plying the waters of San Francisco Bay, especially in the vicinity of Yerba Buena Island. As improvements are made to recreation facilities on NSTI during its reuse, the frequency of small craft use in the area will also likely increase. Citizen efforts are underway to create a "water trail" around San Francisco Bay for kayaks and canoes. This trail would include landing and launching sites on Yerba Buena and Treasure Islands. The FEIS should reevaluate the likely impacts to harbor seals that would occur from the reuse of NSTI, including an analysis of small craft impacts. It is likely that active management and an information program will be necessary to address this potentially significant impact. J-15

Thank you, for the opportunity to comment on the DEIS for the transfer and reuse of Naval Station Treasure Island. If you have any questions regarding these comments or any other matter, please contact me by phone at (4415) 352-3656 or email joel@bcdc.ca.gov

Sincerely,

JOSEPH LaCLAIR
Senior Planner

cc: Katie Shulte Joung, California State Clearinghouse
Ann Marie Conroy, Treasure Island Development Authority

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Response to Comments

Response to Comment J-1. The referenced text in section 3.1 of the Final EIS has been revised to read:

> The Bay Area Seaport Plan and the San Francisco Bay Plan, discussed below, are the approved local coastal plans in the portion of San Francisco Bay around NSTI and, in conjunction with other BCDC laws, Special Area Plans, and other guidance, form BCDCs management program for complying with CZMA.

Response to Comment J-2. The referenced text in section 3.1 of the Final EIS has been revised to read:

> The San Francisco Bay Plan, adopted by BCDC in January 1969 and amended through 2002, includes policies…

It is noted that 2002 Bay Plan amendments may be in effect at the time of NSTI disposal.

Response to Comment J-3. As stated in section 3.1.1, Regulatory Considerations, federal property such as NSTI is not subject to the CZMA and, therefore, is not subject to the priority use designations and policies of the Bay Plan. The expectation is that BCDC would amend the Bay Plan to incorporate priority use designations for Treasure Island and Yerba Buena Island, following transfer of the property out of federal ownership. At that time, all specific reuse development would be subject to these designations through BCDC permitting authority.

The alternatives analyzed in the EIS are based on conceptual plans that delineate the general arrangement of land uses but do not depict the specific locations of development within these areas. It is not possible in the EIS to meaningfully assess the consistency of specific development activities with BCDC policies based on these general development plans, as the commentor has noted. Although priority use designations are not in effect for NSTI, detailed reuse plans are not available, and some specific uses under the alternatives may be inconsistent with the proposed priority use designations, it appears that most of the reuse concept would be substantially consistent with future Bay Plan policies for NSTI. The text in section 4.1 addressing potential impacts to land use policy under each reuse alternative has been revised to reflect this.

Response to Comment J-4. Please see response to comment J-3 above regarding consistency with BCDC policies.

Response to Comment J-5. Eelgrass is not found in the area of marina construction and would not be affected. The text in Table 2-4 of the Final EIS has been corrected to read:

> Expanding the marina or constructing a yacht harbor, new docks, or other structures that would cover the surface of the water would impact Waters of the Untied States ~~could impact eelgrass areas~~ but would require a permit from the BCDC and the COE.

The appropriate text regarding this impact in section 4.8 (Biological Resources) of the Final EIS, has also been revised.

Response to Comment J-6. Please see response to comment J-5 above regarding impacts to eelgrass beds. Potential cumulative impacts to eelgrass beds from reuse alternatives and the SFOBB east span replacement project are discussed in Chapter 5.

Response to Comment J-7. The determination that potential impacts to harbor seals would be less than significant is based on the fact that the harbor seal haul-out site on Yerba Buena Island is on US Coast Guard property and is not part of the reuse plan area, and that no modifications or public access are considered in this area as part of the disposal and reuse of NSTI. Furthermore, the haul-out site is in a remote location with very steep topography that is a natural obstacle to access by land.

The population of approximately 700 harbor seals in the San Francisco Bay and at Yerba Buena Island is robust. The number of seals has remained fairly constant since the early 1970s, even in the midst of increasing development. The local sub-population of harbor seals at Yerba Buena Island has also remained steady, with several hundred harbor seals using Yerba Buena Island as a haul-out site year-round.

While an increase in boat traffic in the area could be expected under each of the reuse alternatives, the haul-out site is far removed from the area where boat traffic would increase. Additional boat traffic that could occur near the haul-out site would be limited by the fact that the site is in a small rocky cove that is difficult to access by boat. Access is further limited by NMFS signage clearly stating that the seals are protected under the MMPA and that the public must stay away. While the routes of proposed ferries are not known, it is unlikely that they would be close enough to the shoreline to affect the haul-out site.

Based on the above factors, the Navy has determined that potential impacts to the harbor seals from the disposal and reuse of NSTI do not meet the criteria for significance stated in the EIS and would not adversely affect any species afforded protection under the MMPA. As part of the disposal action, the Navy has consulted with NMFS about potential impacts from disposing of the property. NMFS has closed consultation and has issued its concurrence with the Navy's assessment of impacts.

Response to Comment J-8. Please see response to comment J-3 above regarding consistency with BCDC policies.

Response to Comment J-9. Please see response to comment J-3 above regarding consistency of with BCDC policies.

Response to Comment J-10. Please see response to comment J-3 above regarding consistency of with BCDC policies.

Response to Comment J-11. Please see response to comment J-3 regarding consistency of with BCDC policies. The seal haulout area is not within NSTI and therefore no development or

public access would occur in the area. Please see response to comment J-7 above regarding potential impacts to harbor seals.

Response to Comment J-12. Specific development plans for Yerba Buena Island, such as the removal, addition, or modification of buildings, including the conference center, have not been finalized. Analysis of potential visual impacts should be conducted by the designated property recipient or private developer as part of the environmental review for specific development plans implemented under reuse. Nevertheless, the perimeter areas on Yerba Buena Island are expected to remain open space, based on the steep topography of these areas and the land use concept illustrated in the Draft Reuse Plan (San Francisco 1996e). This also is stated in section 4.2, Visual Resources: "It is assumed that existing view corridors to the Bay would be kept open, with additional open space perimeter opportunities and public access opportunities provided along the waterfront open space."

Response to Comment J-13. Please see response to comment H-20 regarding bicycle and pedestrian access to Yerba Buena Island from the new SFOBB.

Response to Comment J-14. Please see response to comment J-3 regarding consistency of with BCDC policies.

The potential for impacts to the Pacific herring were evaluated in the Draft EIS and it was determined that potential impacts to this species would not be significant. Pacific herring was discussed on page 3-79 of the Draft EIS. Potential impacts to this species were discussed with regard to dredging impacts mudflat and eelgrass habitat (page 4-77 of the Draft EIS). No other in-water construction was proposed that could potentially impact the species. Pacific herring is not discussed under sensitive resources because it has no listing status and therefore no federal protection.

Response to Comment J-15. Please see response to comment J-7 above regarding potential impacts to harbor seals.

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LETTER K

California Regional Water Quality Control Board

San Francisco Bay Region

Winston H. Hickox
Secretary for Environmental Protection

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1515 Clay Street, Suite 1400, Oakland, California 94612
Phone (510) 622-2300 • FAX (510) 622-2460

Gray Davis
Governor

Date: JUN 2 0 2002
File No. 2169.6013 (SLR)

Ms. Timarie Seneca
BRAC Operations Office,
Southwest Division Naval Facilities Engineering Command, Code 06CM.TS
1230 Columbia Street, Suite 1100
San Diego, CA 92101-8517

Subject: Comments on Draft Environmental Impact Statement, Naval Station Treasure Island, San Francisco

Dear Ms. Seneca:

Regional Water Quality Control Board (RWQCB) staff reviewed the draft report titled *Disposal and Reuse of Naval Station Treasure Island, Draft Environmental Impact Statement (EIS), San Francisco, California*, received on May 10, 2002, and prepared by Southwest Division, Naval Facilities Engineering Command. The EIS was prepared to comply with the National Environmental Policy Act (NEPA). The EIS evaluates three reuse alternatives proposed in the Draft Reuse Plan, dated July 1996, prepared by the Office of Military Base Conversion, Planning Department, City and County of San Francisco and the San Francisco Redevelopment Agency. The EIS also evaluates the No Action Alternative in which the Navy would retain ownership in a caretaker status. The companion Environmental Impact Report (EIR) will be prepared by the City and County of San Francisco and is due later this summer.

The EIS analyzes potential environmental impacts relating to land use; visual resources; socio-economics; cultural resources; transportation; air quality; noise; biological resources; geology and soils; water resources; utilities; public services; and hazardous materials and wastes. The following comments have been prepared for this document.

Section 3.10.1 Regulatory Considerations – (p. 3-119) Please state the beneficial uses of groundwater at Treasure Island and Yerba Buena Island. K-1

Section 3.10.3 Ground Water – (p. 3-122) In addition to the recommendations presented in the pilot beneficial use study (RWQCB, 1996), the RWQCB submitted a letter to the Navy stating that the quality and the hydrogeologic conditions of the groundwater beneath Treasure Island is such that the water is not a potential source of drinking water pursuant to SWRCB Resolution 88-63 and Regional Water Quality Control Board (RWQCB) Resolution No. 89-39. Please add this to the report. K-2

Section 3.13.3 Petroleum Hydrocarbons – (pp. 135-136) Please update the recommendations for the site remediation to reflect the most recent decisions made at each site, as stated in the draft Corrective Action Plan (CAP)(2002). K-3

Section 3.13.3 Site 08 – (p. 138) Please clarify what additional research is planned to evaluate ecological risk from potential surface water runoff at Site 8. K-4

Section 3.13.3 Site 09 – (p. 138) Please update the site summary for Site 09 to state that although no volatile organic compounds (VOCs) were detected in 09-MW01, additional investigation is being conducted to evaluate the extent of contaminants in the hoist area. K-5

Section 3.13.3 Site 10 - (p. 139) Please update the schedule for the additional investigation at Site 10. K-6

Section 3.13.3 Site 21 - (p. 141) The document states " recent data reviewed by the RWQCB suggests that discharges are occurring to the Bay". What is the source of this statement? Current data indicate that VOCs are not migrating to the Bay. K-7

Section 3.13.3 Site 27 – (p. 142) What is the status of the RWQCB Order and the Compliance Plan at the Clipper Cove site? K-8

Section 4.10.2 Alternative 2 (Water Resources) – (p. 4-100) As stated in the text "Under Alternative 2, a golf course would be developed on the northern portion of Treasure Island". Please describe the additional impacts associated with the proposed golf course and the mitigation measures that will be required. For example, a chemical application and management plan (CHAMP) will be required to control chemical applications and discharge to surface water K-9

Section 4.11 Utilities – (p. 4-103) Please include a discussion that all appropriate efforts will be made to maximize use of reclaimed water for landscape irrigation including golf course irrigation, under each of the proposed alternatives. K-10

If you have questions, please feel free to contact me by telephone at (510) 622-2377 or by electronic mail at slr@rb2.swrcb.ca.gov.

Sincerely,

Sarah L. Raker, R.G., C.HG.
Associate Engineering Geologist

EIS comments.doc

cc: Mr. David Rist, Department of Toxic Substances Control
Mr. Phillip Ramsey, U.S. Environmental Protection Agency
Ms. Martha Walters, San Francisco Redevelopment Agency

Response to Comments

Response to Comment K-1. The following text has been added to section 3.10.1 of the Final EIS:

> The San Francisco Bay RWQCB has determined that groundwater beneath Treasure Island is not a potential source of drinking water and is therefore not considered to be a beneficial use. Groundwater is not used for any beneficial use at NSTI.

Response to Comment K-2. The following text has been added to section 3.10.3 of the Final EIS:

> The San Francisco Bay RWQCB determined that ground water beneath Treasure Island is not a potential source of drinking water, pursuant to SWRCB Resolution no. 88-63 and RWQCB Resolution No. 89-39, because of the quality and hydrologic conditions of the ground water.

Response to Comment K-3. The summaries of IR and CAP sites in section 3.13 Hazardous Materials and Waste have been updated to reflect current status. Please note that restoration pursuant to CERCLA is subject to frequent change. Information on any status updates for sites can be obtained from the BRAC Operations Office, as listed in section 3.13.3 of the EIS.

Response to Comment K-4. An RI is currently underway at IR Site 08. A determination as to any additional investigations and possible remedial actions will be made following completion of the RI. Information on any future investigations can be obtained from the BRAC Operations Office, as listed in section 3.13.3 of the EIS.

Response to Comment K-5. An RI is currently underway at IR Site 09. A determination as to any additional investigations and possible remedial actions will be made following completion of the RI. Information on any future investigations can be obtained from the BRAC Operations Office, as listed in section 3.13.3 of the EIS.

The following text has been added to the discussion of IR Site 09 in section 3.13 of the Final EIS:

> Navy completed additional investigation in January 2003 and is currently preparing an RI report in anticipation of a No Action ROD. Site closure is anticipated in late 2004.

Response to Comment K-6. The discussion of IR Site 10 in section 3.13 of the Final EIS has been revised to read:

> Navy completed additional investigation in January 2003 and is currently preparing an RI report in anticipation of a No Action ROD. Site closure is anticipated in late 2004.

Response to Comment K-7. Several rounds of groundwater sampling have been conducted at IR Site 21 and no VOC discharge has been documented. The text regarding migration of VOCs to the Bay has been deleted.

Response to Comment K-8. The RWQCB Order and the Compliance Plan were issued for investigation of the skeet range in Clipper Cove prior to commencement of remedial activities on NSTI pursuant to CERCLA. With the concurrence of RWQCB, investigation of this site was incorporated into the CERCLA process. The FFSRA has superceded the RWQCB Order and Compliance Plan; the schedule for action at the former Clipper Cove skeet range (IR Site 27) is now part of FFSRA.

Response to Comment K-9. Potential significant impacts from hazardous materials use at the golf course under Alternative 2 are addressed in section 4.13 Hazardous Materials and Waste, of the EIS. The text in this section has been revised to read:

> For example, golf course design and operation could include BMPs for the storage, handling, and use of pesticides or fertilizers, including a chemical application and management plan.

The following text has been added to section 4.10 (Water Resources) under the discussion of not significant impacts for Alternative 2:

> *Water Quality* (Factors 1 and 2). Not significant impacts to water quality would be similar to those described for Alternative 1 with the exception that Alternative 2 would have a slightly greater potential impact to water quality as a result of the development of a golf course. Chemicals associated with the golf course could adversely affect water quality if not adequately managed. Hazardous materials management would be subject to all regulatory controls. In addition, a chemical application and management plan would be required to address the management of these materials.

Response to Comment K-10. The Navy will have no authority or responsibility over actual reuse activities and, consequently, the Navy is not in a position to impose specific mitigation measures such as use of reclaimed water. The designated property recipient may encourage or require use of reclaimed water for reuse activities. Although the draft development plan for NSTI submitted to the City and County of San Francisco in July 2002 is not final, the plan does call for use of reclaimed water for irrigation.

STATE OF CALIFORNIA GRAY DAVIS, *Governor*

CALIFORNIA STATE LANDS COMMISSION
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Sacramento, CA 95825-8202

PAUL D. THAYER, *Executive Officer*
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California Relay Service From TDD Phone **1-800-735-2922**
from Voice Phone **1-800-735-2929**

Contact Phone: **916-574-1227**
Contact FAX: **916-574-1955**

June 24, 2002

File Ref: SCH 2002052061

US Navy, Southwest Division
Naval Facilities Engineering command
1230 Columbia Street, Suite 1100
BRAC Operations Office
San Diego, CA 92101-8517
ATTN: Ms. Timarie Seneca

Dear Ms. Seneca:

Thank you for the opportunity to comment on the Draft Environmental Impact Statement (EIS) for the Disposal and reuse of Naval Station Treasure Island, San Francisco, California.

Under the Land Use section (3.1), Page 3-7, the EIS states that the State Lands Commission has allowed existing specialized or single-purposes facilities to continue as nonconforming public trust uses for their useful life. This reuse issue should be further clarified by adding the language in Section 9(a), (b), (c) of Chapter 898, Statutes of 1997.

- **Section 9, Subdivision (a)** "...existing buildings or structures on the Trust Property which are incapable of being devoted to trust purposes may be used for other purposes, consistent with the reuse plan for the Trust Property, for the remaining useful life of such buildings or structures."
- **Section 9, Subdivision (b)** " The Authority and the State Lands Commission shall, by agreement, establish the remaining useful life of the buildings and structures described in subdivision (a), either individually or by category, provided that in no case shall the useful life of any building or structure be deemed to extend less than 25 years or more than 40 years from the effective date of this act."
- **Section 9, Subdivision (c)** "The maintenance and repair of any of the existing buildings or structures described in subdivision (a), and any structural or other alterations necessary to bring such buildings or structures into compliance with applicable federal, state, and local health and safety standards, including, but not limited to, seismic upgrading, shall be permitted, provided such activities will not enlarge the footprint or the size of the shell of such buildings or structures."

L-1

If you have any questions, please do not hesitate to contact me at the number referenced above.

Sincerely,

Grace Kato

Grace Kato
Public Land Management Specialist

cc: Betty Silva

Response to Comments

Response to Comment L-1. It is the Navy's position that the United States acquired full fee simple absolute title to all the property at NSTI, including the tidelands and submerged lands, and that the property would not be subject to the public trust upon disposal by the Navy. However, the State of California believes that all former and existing tidal and submerged lands on Treasure Island would be subject to the public trust in the event of a transfer of the property from the Navy. In 1997, the Treasure Island Conversion Act (TICA) (1997 Cal. Stat. 898, AB 699) authorized the City and County of San Francisco to establish TIDA as the redevelopment agency responsible for redeveloping NSTI. The act also granted TIDA power to administer and control property at NSTI, which the State of California identified as land that will be subject to the public trust upon its release from federal ownership. Thus, the City and County of San Francisco's reuse planning process assumes the public trust applies, despite the Navy's contention that it does not. The text in section 3.1.1 has been revised to more accurately characterize the Navy's position on the public trust at NSTI.

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LETTER M

June 17, 2002

US Navy, Southwest Division
Naval Facilities Engineering Command
1230 Columbia Street, Suite 1100
BRAC Operations Office
San Diego, CA 92101-8517
Attn: Ms. Timarie Seneca

Subject: DEIS for the Disposal and Reuse of Naval Station Treasure Island

Dear Ms. Seneca,

I am writing provide comments for the San Francisco Bay Trail Project on the U. S. Navy's Draft Environmental Impact Statement (DEIS) for the Disposal and Reuse of Naval Station Treasure Island. Below, you will find a general overview of the Bay Trail and its interest in the project, as well as specific comments pertaining to the DEIS.

Bay Trail Overview & Interest in Project
The Bay Trail Project is a nonprofit organization administered by the Association of Bay Area Governments (ABAG) that coordinates the implementation of the Bay Trail. When complete, the Bay Trail will be a continuous 400-mile recreational pathway that will encircle San Francisco and San Pablo bays in their entirety. It will link the shoreline of all nine Bay Area counties, as well as 47 cities. A little more than half the length of the proposed system has been developed to date. Enclosed, you will find an overview map of the Bay Trail, a detailed map of the Bay Trail in the vicinity of Treasure Island, and a Bay Trail fact sheet.

The Bay Trail provides fantastic opportunities for recreation, environmental education, wildlife viewing and alternative transportation throughout the Bay Area. It also serves as a connective pathway between cities and counties as well as between parks and other open spaces. The Bay Trail currently travels across the Golden Gate Bridge and the Dumbarton Bridge, and will soon be implemented on the east span of the Bay Bridge, the Carquinez Bridge and the Benicia-Martinez Bridge. These connections provide trail users with the opportunity for non-motorized travel throughout the region, providing first-hand experience of the Bay and its amazing resources.

As you may know, an 15.5-foot-wide bicycle and pedestrian pathway is planned to run along the south side of the eastbound deck of the new 2-mile long east span of the Bay

Administered by the Association of Bay Area Governments
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Phone: 510-464-7935
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Bridge. The addition of the Bay Trail to this new span of the Bay Bridge creates momentum for providing a continuous link between East Bay trails (including the planned Eastshore State Park) and Treasure Island.

In addition, the reuse of Treasure Island provides an excellent opportunity to extend the Bay Trail along the shoreline of Treasure and Yerba Buena Islands. A continuous pathway around Treasure Island's perimeter would no doubt make it a destination point for recreation and entertainment, and increase the accessibility of the Island.

We would appreciate the opportunity to work with the Navy and the Treasure Island Development Authority on the planning and design of a new Bay Trail spur connecting the planned Bay Trail on the new east span of the Bay Bridge to and around Treasure Island.

Comments Pertaining to the DEIS

Chapter 2, Proposed Action Alternatives

While each of the alternative maps (Figure 2-3 to Figure 2-5) depict a band of shoreline open space around Treasure Island, a bicycle and pedestrian pathway is discussed only in Alternative 1 (page 2-17). The DEIS should clarify whether Alternative 2 and Alternative 3 would also provide for a shoreline pathway around Treasure Island. M-1

General Comment

We are aware of the fact that the City and County of San Francisco and Caltrans are involved in a continuing discussion regarding the design of the Bay Bridge touchdown on Yerba Buena Island (Figure 5-2, page 5-6). It is unclear, however, how the connection between the bicycle and pedestrian pathway on the east span will be planned for and implemented. The DEIS should identify a process for planning a continuous connection between the planned pathway on the new Bay Bridge east span and Yerba Buena and Treasure Islands, including all potential stakeholders and their role in the planning process. M-2

We are grateful for the opportunity to comment of the DEIS and look forward to the completion of the final Disposal and Reuse plan for Treasure Island. Please feel free to call me at 510/464-7919 with any additional questions or comment.

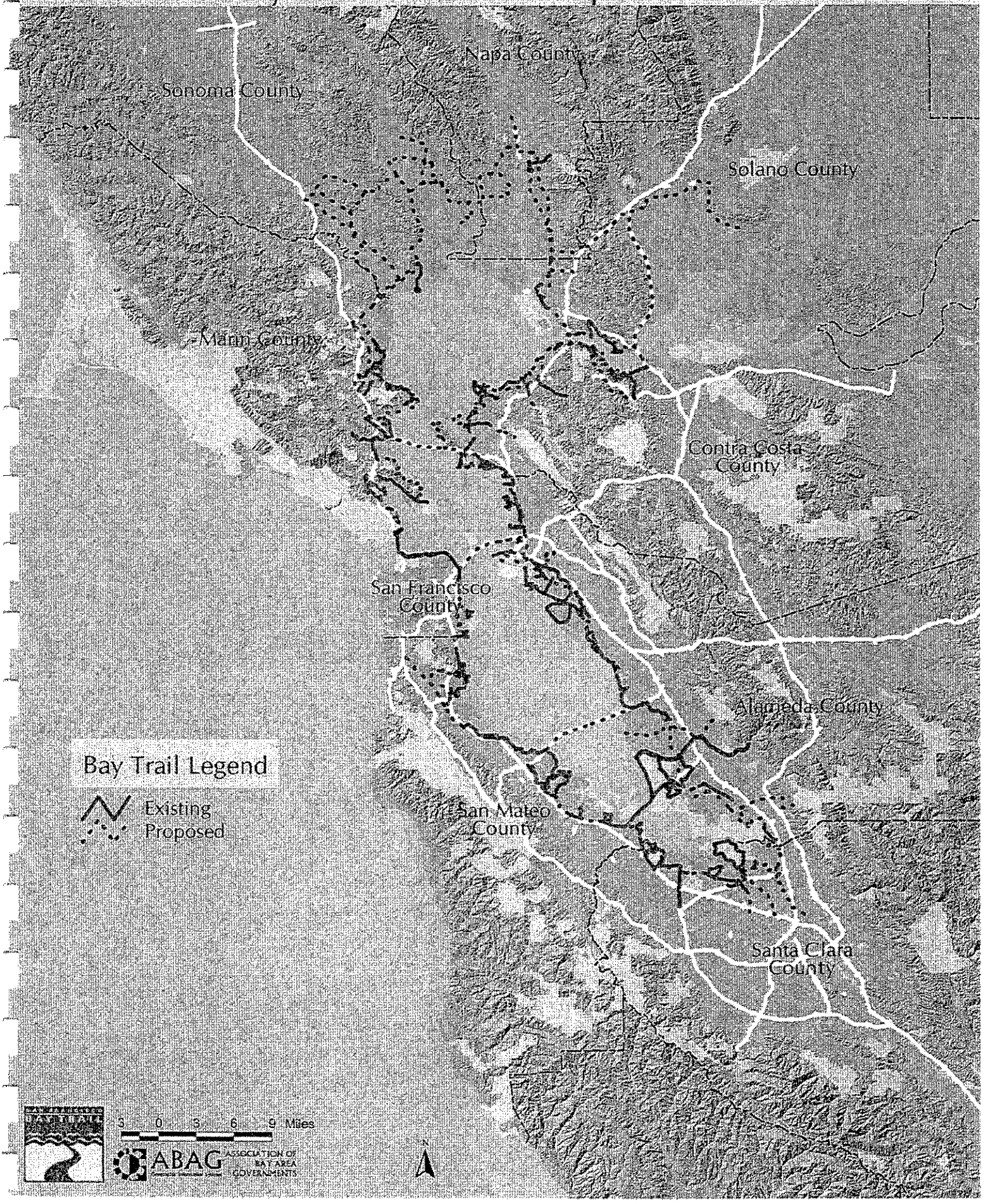
Sincerely,

Melissa Barry
Bay Trail Planner

Enclosures: San Francisco Bay Trail: Overview Map
San Francisco Bay Trail: Treasure Island Connections
Bay Trail Fact Sheet

LETTER M

San Francisco Bay Trail: Overview Map



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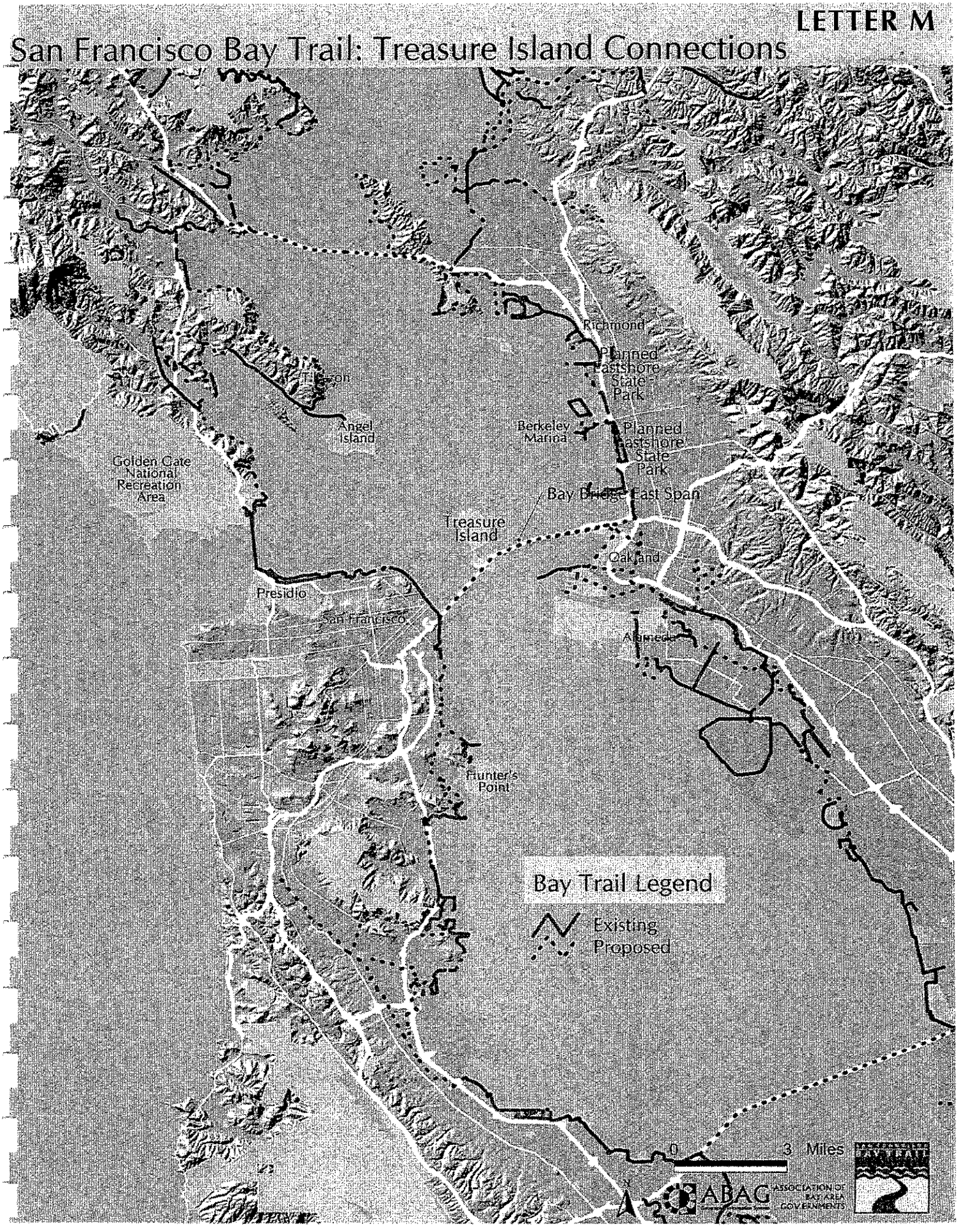
LETTER M

San Francisco Bay Trail: Treasure Island Connections



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A FEW FACTS ABOUT THE SAN FRANCISCO BAY TRAIL

- When complete, the Bay Trail will be a **CONTINUOUS 400-MILE CORRIDOR** that will encircle San Francisco and San Pablo bays, connecting people to each other and to the water. It will link the shorelines of all nine Bay Area counties and pass through 47 cities. To date, slightly over half the Bay Trail's ultimate length has been developed.

- The Bay Trail provides free and easily accessible **RECREATIONAL OPPORTUNITIES** for outdoor enthusiasts, including hikers, joggers, bicyclists and skaters. It also offers a setting for wildlife viewing and environmental education, and it increases public respect and appreciation for the Bay.

- The Bay Trail also has important **TRANSPORTATION BENEFITS**: it provides a commute alternative for cyclists, and connects to numerous public transportation facilities, including ferry terminals, light-rail lines, bus stops, and Caltrain, Amtrak, and BART stations. Also, the Bay Trail will eventually cross the major bridges in the region.

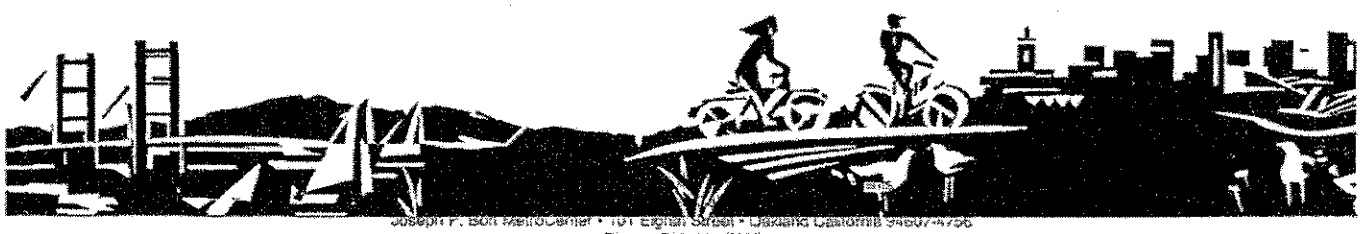
- The Bay Trail **PROVIDES ACCESS** to commercial, industrial and residential neighborhoods; points of historic, natural and cultural interest; recreational areas like beaches, marinas and fishing piers; and over 130 parks totaling 57,000 acres of open space. It passes through highly urbanized areas such as downtown San Francisco as well as remote natural areas such as the San Francisco Bay National Wildlife Refuge. Depending on the location of its segments, the Bay Trail consists of paved multi-use paths, dirt trails, bike lanes, sidewalks or signed bike routes.

- As much as possible, the Bay Trail overlaps with, and connects to, other trails and local bike routes. The Bay Trail should not be confused with the Bay Area Ridge Trail, a separate **REGIONAL TRAIL NETWORK** that travels inland, mostly along the Bay Area's mountain ridges.

- Senate Bill 100, authored by then-state Senator Bill Lockyer and passed into law in 1987 with the endorsement of the entire Bay Area legislative delegation, introduced the concept of a "**RING AROUND THE BAY**." SB 100 directed the Association of Bay Area Governments (ABAG) to develop an alignment for the Bay Trail as well as funding and implementation plans. This plan for the Bay Trail was adopted by ABAG in 1989.

- Implementation of the Bay Trail is coordinated by the Bay Trail Project, a **NONPROFIT ORGANIZATION** created by ABAG and housed at its offices in Oakland. To carry out its mission, the Bay Trail Project raises funds for trail construction and maintenance, ensures consistency with the adopted Bay Trail Plan, provides technical assistance, enlists public participation in trail-related activities, and publicizes the Bay Trail and its benefits to the region.

To learn more about the Bay Trail, visit the Bay Trail Project's web site at http://www.baytrail.org; call us at 510/464.7935 (Janet), .7909 (Laura), .7919 (Melissa); .7915 (David) or e-mail us at BayTrail@abag.ca.gov. (June 2002)



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Response to Comments

Response to Comment M-1. The following text has been added under the heading "Open Space and Recreation Uses" for Alternatives 2 and 3 in section 2.4 of the Final EIS:

> Similar to Alternative 1, the shoreline open space would be widened to approximately 100 feet (30 m) and would feature a bikeway and pedestrian path.

Response to Comment M-2. Please see response to comment H-20 regarding the connection between the bicycle path on the SFOBB and Yerba Buena Island.

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LETTER N

OFFICE OF THE MAYOR
SAN FRANCISCO

WILLIE LEWIS BROWN, JR.

TREASURE ISLAND PROJECT
410 AVENUE OF THE PALMS
BUILDING 1, 2ND FLOOR
TREASURE ISLAND
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(415) 274-0660
FAX (415) 274-0299

June 24, 2002

Ms. Timarie Seneca
US Navy Southwest Division
Naval Facilities Engineering Command
1230 Columbia Street, Suite 1100
BRAC Operations Office
San Diego, CA 92101-8517

Re: Draft Environmental Impact Statement (DEIS) for the Disposal and Reuse of Naval Station Treasure Island, San Francisco, California

Dear Ms. Seneca:

On behalf of the City and County of San Francisco ("City"), the Treasure Island Development Authority ("Authority") has reviewed the Draft Environmental Impact Statement ("DEIS") for the Disposal and Reuse of Naval Station Treasure Island ("Project") with the assistance of technical consultants. The Authority submits the following comments for your consideration. As the Local Redevelopment Authority for Naval Station Treasure Island and the proposed recipient of the land in question, the Authority has an interest in assuring that this document is adequate, accurate, and complete under the National Environmental Protection Act ("NEPA"). The Authority has reviewed the document and believes that the DEIS may be inadequate or inaccurate in several respects. For example, the DEIS contains incomplete or inadequate information; fails to identify all significant environmental effects; and fails to propose adequate mitigation measures.

Our comments are described in detail below. We appreciate your consideration of these comments and hope that you will take them into account in issuing the Final EIS for the Project.

I. General Comments

FHWA Land Transfer: The DEIS does not consider the transfer of certain interests in land to the Federal Highway Administration ("FHWA") to be part of the Navy disposal and has thus excluded it from the DEIS. The Authority does not agree with this approach. The Navy executed a land transfer with the Federal Highway Administration

N-1

("FHWA"), who in turn transferred property to Caltrans for construction of the replacement span for the Bay Bridge. The transfer included property transferred in fee to the agencies as well as the granting of temporary construction easements ("TCE") for the construction period. These transfers, however, may not transfer the entire fee and, even where the fee is transferred, the property may revert to the Navy or its designee, in this case the Authority, when the need for the interest no longer exists.

While this issue has been the source of some debate over the past year and half, the property was included in the Authority's Economic Development Conveyance Application to the Navy, and the Authority's understanding is that the Navy may agree to transfer the fee interest in TCE properties subject to the easement rights. The Authority maintains that such a transfer constitutes part of the Project being considered by the EIS; thus those properties should be included in the project description and analyzed for any potential impacts. Otherwise, because FHWA did not analyze the effects of the transfer in this document or any other, the effects of the transfer would remain unanalyzed. N-1

Baseline Data/Interim Circumstances: The DEIS does not use a consistent baseline. The DEIS purports to (correctly) use a baseline of full operations immediately prior to the closure in 1993 for some resource areas, but then without explanation states that for some resources a 1996-1997 baseline is used. This discrepancy could result in different types of data that are difficult to compare or a skewed perspective of the impacts on some resources. The Authority recommends that the DEIS use a consistent baseline or explain why using two baselines is an acceptable method. N-2

Moreover, while the Authority agrees with the use of a 1993 baseline, the DEIS should take account of events that have transpired since 1993 to give an accurate assessment of the current situation on the Project site. The Authority notes some such events in its specific comments below.

II. Specific Comments

Proposed Action and Alternative: This Section is incomplete. Table 2-3 on page 2-24 should indicate that the Navy must seek a Coastal Zone Management Act consistency determination from the San Francisco Bay Conservation and Development Commission ("BCDC") for the proposed disposal action. N-3

Land Use: Section 3.1 is incomplete and the information on page 3-5 should reflect the fact that BCDC has received approval from their Board to prepare an amendment to the Bay Plan that will address future land uses on Treasure Island and Yerba Buena Island. N-4

Cultural Resources: This section contains several inaccuracies and improperly relies on an unsigned Memorandum of Agreement ("MOA") to mitigate significant effects to both historic and archaeological resources. Please note the following: N-5

- The DEIS notes that "Building 262 is within the area transferred to FHWA and is not part of the disposal and reuse." (Section 3.4.2, Zone 1.) This statement is incorrect. The footprint of Building 262 is specifically excluded from the FHWA transfer. N-5

- Building 111 (associated with Building 3 on Treasure Island) should be added to Table 4-2. N-6

- The DEIS notes that "the area where the reported human remains were found was within the area transferred to FHWA" (Section 3.4.2, Zone 2). This statement may be inaccurate. The deed to FHWA only includes property up to the 270-foot elevation contour on Yerba Buena Island. The Authority is concerned that the area described in the text is above the 270-foot elevation. N-7

- The DEIS describes the Draft MOA between the Navy and the State Historic Preservation Office ("SHPO"). The Authority has provided the Navy with comments on the Draft MOA and these comments have not been incorporated into the version attached as Appendix H. The Authority requests that the Navy incorporate these comments or explain why they are not included. The attached Draft MOA is not acceptable to the Authority. Parts of the Draft MOA are not enforceable and the Draft MOA is extremely confusing as to its applicability. The Draft MOA in Appendix H also does not include any of the Exhibits to the Agreement. The public cannot properly evaluate the document without the proposed exhibits. In addition, the DEIS does not inform the Authority or the public as to the status of the MOA. Most importantly, it does not indicate whether the version included as Appendix H is final or could change before the DEIS becomes final. N-8

- The Navy should provide additional support for its finding that under Alternative 2 (Section 4.4.2), the Loss of Potentially Significant Historic Resources (Factor 1) is not a significant impact. While the DEIS (Section 4.4) notes that "compliance with the MOA is intended to ensure that project effects are not significant" and implementation of the MOA may mitigate the impacts, the MOA contains obligations that require approval by the San Francisco Board of Supervisors, and the City is not a signatory to the MOA. The DEIS cannot rely on future actions of a party who is not a signatory to the MOA to conclude that the MOA will reduce impacts to historic resources to a less-than-significant level. N-9

Furthermore, an adverse effect through modification of an historic resource or a change in setting could constitute a significant effect. The DEIS (and MOA) focus on direct impacts to buildings through rehabilitation or demolition under various alternatives. It is less clear how the setting of historic resources might be changed. For example, development of the marina may have an effect on historic buildings when new features are constructed that will change the N-10

setting. While these may end up being not significant or not adverse, this should be evaluated in the DEIS. N-10

- The Navy should provide additional support for its finding that under Alternative 2 (Section 4.4.2), the Loss of Potentially Significant Archaeological Resources (Factor 2) is not a significant impact. The "archaeologically sensitive zone 2" is not addressed in the MOA, and is afforded no special protection by the MOA. The inadvertent discovery clause within the MOA provides for an expedited consultation process, but does not "eliminate any potential significant impacts." Additional mitigation measures, above and beyond reliance on the MOA, should be proposed to reduce potential adverse significant impacts. N-11

- The DEIS also does not adequately address the existence of underwater archaeological resources. While the underwater survey cited in the DEIS did not reveal the presence of shipwrecks, it did reveal several possible underwater archaeological features and recommend that a diver verify them. This has not been done; thus the survey is incomplete. The possible underwater resources should be identified in the Section 106 process and addressed in the MOA. N-12

Transportation: The DEIS contains several inaccuracies and inconsistencies in this section and should be corrected as follows:

- The information related to Muni service to and from Treasure Island is incorrect (Section 3.5.3, Page 3-48). The 108 line operates at 20-minute frequencies in the morning and afternoon peak periods, there is 24-hour service to the island, and there is service on Saturday, Sunday and holidays. N-13

- The analysis of the alternatives does not consider the fact that Caltrans will be replacing the eastbound on-ramp (east side) as part of the San Francisco Oakland Bay Bridge (SFOBB) seismic replacement project (Section 4.5.). N-14

- The parking availability around the Ferry Building has changed, so the DEIS should reflect present circumstances (Section 4.5, p. 4-45.). N-15

- The DEIS is inconsistent in its discussion of the ferry terminals. On page F-18, the DEIS states that there would be a west-side ferry terminal, but on page F-22 the DEIS states that only the eastern terminals would be updated and used. The DEIS should clarify the plans for ferry terminals on Naval Station Treasure Island. N-16

In addition, the DEIS does not accurately discuss the levels of significance as to Transportation Impacts (Section 4.5). The significance criteria for transportation impacts are vague and do not coincide with the local criteria standard for the City and County of San Francisco. For example, it is stated that if the truck traffic increases or the N-17

parking demand exceeds the supply, the impact would be significant. This implies that any increment in the number of trucks or parking regardless of its size would be significant. The DEIS also reports that the "Implementation of all of these [transportation] measures would reduce this impact to a non significant level." (Section 4.5, page 4-40.) There is no technical documentation, however, to support this statement. The DEIS must support this statement and other statements claiming to reduce transportation impacts. N-17

Water: The DEIS should note recent events in this area. While the DEIS says that the Regional Water Quality Control Board ("RWQCB") "recommends deleting water supply as a beneficial use for the Island's ground water," it is the Authority's understanding that RWQCB has already taken this action. (Section 3.10.3, Page 3-122). N-18

Utilities: This Section contains unsupported conclusions and needs additional information and analysis to meet the standard for adequacy. Note the following:

- It is impossible to evaluate the discussion of the alternatives without the individual utility demand calculation summary sheets. These should be included in the Appendix. The DEIS assumes, but does not analyze, the feasibility of providing adequate utilities under each development scenario. The DEIS should discuss the necessary provision of utilities under each alternative and whether each development scenario could support the necessary upgrades. N-19

- The DEIS should include a better description of the utility "backbone" system, specifically in regard to where utilities are located on the island. N-20

- The DEIS also ignores the fact that the age and condition of the water line across the East Span of the Bay Bridge is in question and may need to be replaced. Moreover, the DEIS should include a discussion of the availability of emergency back up water service system from East Bay MUD. N-21

- The DEIS also concludes that the electrical and natural gas distribution systems are adequate, but does not discuss providing service to plan loads. The DEIS should comment on the capability of undertaking this. N-22

- The DEIS states that the degraded condition of the cable line and PacBell are currently at capacity, but does not analyze or comment on the need for a new master switch for the Naval Station Treasure Island. N-23

Public Service: This Section should note new existing conditions and identify the impacts to public services. For example, current levels of police and fire staffing should be noted as they currently differ significantly from the baseline information provided. (Section 3.12.) In addition, the analysis of the alternatives should identify the fact that each of the three alternatives would have an impact on the provision of public services. (Section 4.12.) Mitigation to this impact should also be discussed. For example, this N-24

impact could be mitigated by the City through the expansion of service to Treasure Island, using facilities and funding sources that could be made available. The financial feasibility of accomplishing this mitigation for the various alternatives would also need to be addressed. N-24

Hazardous Materials: The Authority is concerned that a CERCLA ROD has not been signed for Naval Station Treasure Island. The absence of any specific documentation makes an evaluation of the adequacy of the mitigation measure impossible. The Authority requests a full discussion of the CERCLA process including the preliminary assessment/site inspection, the Hazard Ranking System (HRS) scoring, the NPL site listing process, the Remedial Investigation/Feasibility Study (RI/FS), the remedy selection process and preferred alternative, the public comment phase, the selection of the final remedial action, and the schedule for completion of the ROD. In addition, the Authority requests a discussion of any Applicable or Relevant and Appropriate Requirements (ARARs), standards, criteria or limitations that have been established under federal or more stringent California law. N-25

Specifically for each site, to the extent available, the Authority requests a discussion of the nature and extent of the contamination, the applicable clean-up levels, the remedial alternatives evaluated, the remedial alternative selected and rationale for selection, the schedule of implementation, the long term maintenance or monitoring required, the potential impacts, and the current regulatory status of the site. Please depict the location of each site on maps of each Alternative, with a key describing the type of site and target clean-up levels. N-26

We look forward to additional information and clarification on these issues.

Sincerely,

Stephen Proud
Deputy Director
Treasure Island Development Authority

cc: Ron Plaseied
Laurie Nelson
Annemarie Conroy
Michael Cohen
Kate Stacy
Susan Cleveland
Denise Heick

Response to Comments

Response to Comment N-1. Please see response to comment B-2 regarding inclusion of the FHWA/Caltrans easements in the Final EIS analysis.

Response to Comment N-2. As noted on page 3.1-2 of the Final EIS, 1993 is used as the baseline for analysis since this more accurately reflects environmental conditions during operational status of NSTI. This condition provides a better gauge of potential impacts under reuse than would a comparison to conditions after closure of NSTI. Data was collected for the baseline year of the project whenever possible; however, if accurate data was not available for the baseline year, data from closest available year was presented and used for the analysis. For example, cultural resources investigations conducted in 1996, following closure, are intended to be representative of 1993 conditions. Data from 1993 was not available for other resources, such as water resources, so data from the closest years available (1990 and 1995) were used to represent 1993 conditions. Finally, analysis of post-1993 conditions for certain resources, such as hazardous materials, should be considered in the EIS.

The text on page 3.1-2 of the Final EIS has been revised to read:

> The environmental baseline year for the EIS is 1993, which reflects conditions before NSTI was designated for closure. This follows Navy BRAC policy, which recommends using the last year the installation was in full operational use as the baseline year instead of a baseline year portrayed as the property under caretaker status. Since data from 1993 was not available for some resource areas, the baseline for those resources relies on data from the closest year that is representative of 1993 conditions. The analysis of hazardous materials and waste is unique in that, because hazardous materials remediation is ongoing, it is based on current conditions at NSTI. The physical conditions present in 1993 are the same as the physical conditions present in later years; the entire infrastructure for NSTI is still physically present on the property and has not been significantly altered since 1993.

Response to Comment N-3. As noted in section 3.1, federal property is considered to be outside the state coastal zone, as defined under the CZMA. The Navy has determined that a Coastal Consistency Determination with the BCDC Bay Plan is not necessary for disposal of NSTI. Upon conveyance of the property to a nonfederal entity, Bay Plan policies would be in effect and reuse activities would be subject to BCDC priority use designations. Please see response to comment J-3 regarding consistency with Bay Plan policies.

Response to Comment N-4. Please see response to comment J-3 regarding applicability of BCDC priority use designations to NSTI.

Response to Comment N-5. At the time the Draft EIS was published, the MOA between Navy and SHPO had not been finalized. The MOA that was included in the Draft EIS was incomplete in that suggested changes to the MOA by the City and County of San Francisco and others had

not been resolved and incorporated. As stated in the EIS, NSTI cannot be conveyed to the designated property recipient until a MOA ensuring protection of cultural resources has been executed.

The revised MOA was completed by Navy and resubmitted to SHPO on September 15, 2002. The City and County of San Francisco is included as an invited signatory party. A complete copy of the Final MOA is found in Appendix H of the Final EIS.

Building 262, the Torpedo building, is within an area for which FHWA/Caltrans was granted a permanent aerial easement for the SFOBB retrofit project. All land surrounding this building was conveyed in fee to Caltrans. All areas transferred to FHWA were previously considered to be too encumbered to permit conveyance and were not considered in the Draft EIS. Recent discussion between Navy and TIDA have led to a determination that the TCE and aerial easements are available for disposal. Consequently, Building 262 is now considered part of the project and preservation measures are included in the MOA.

Response to Comment N-6. The text in Table 4-2 of the Draft EIS (now Table 4.4-1 of the Final EIS) has been revised as follows:

Building 3 (including related Building 111), Treasure Island

Response to Comment N-7. The Final MOA includes provisions to accurately delineate portions of the "area where human remains were found" in addition to testing all known sites and sensitive areas prior to disposal.

Response to Comment N-8. The MOA has been revised to reflect City comments and appropriate exhibits have been compiled.

Response to Comment N-9. The EIS states that loss of historic resources under Alternative 2 would be a significant and unmitigable impact. Please see response to comment N-5 regarding the MOA for cultural resources.

Response to Comment N-10. The revised MOA specifically states that construction or other modifications must be evaluated with regard to the potential effects on the integrity of setting for historic properties and historic districts.

Response to Comment N-11. The revised MOA addresses archaeologically sensitive resources in all zones and specifically describes responsibilities of the Navy with regard to testing and mitigating to reduce or eliminate potential adverse effects.

Response to Comment N-12. The potential for submerged cultural resources has been considered in the revised MOA. The stipulation includes all sensitive archaeological zones and requires testing and possibly mitigation of as yet undiscovered resources that are considered potentially significant.

Response to Comment N-13. The text in section 3.5.3 has been revised per your comment.

Response to Comment N-14. The EIS was prepared in 1996 at which time no SFOBB east span retrofit design was available. The technical analysis will not be affected by the new east span because it would not affect trip generation, trip distribution, modal split, and trip assignment analysis. The only potential effect the new east span would have on the EIS analysis is increased merging lane for the eastbound on-ramp onto the SFOBB, which would enhance the safety of vehicle entering the SFOBB from Treasure Island and Yerba Buena Island. This benefit is documented in section 4.5.1. of the EIS.

Response to Comment N-15. Parking supply in the vicinity of the San Francisco Ferry Building has not changed substantially. Most of the parking facilities in the vicinity of the Ferry Building are inside of high-rise office buildings, such as the Embarcadero Center. There has been no major parking garage constructed or major parking facilities removed in the area. Most of the new parking garages constructed as part of new developments in the vicinity were on previous parking lots. Regardless of the change, the conclusion stated in the EIS that NSTI visitors who would drive to the Ferry Building may not find readily available parking in the vicinity or may not be willing to pay the cost of parking in downtown would not change.

Response to Comment N-16. Page F-18 of the Draft EIS (now page F.3-B-6 of the Final EIS) provides the water transit policies presented in the Draft Reuse Plan (San Francisco 1996e), which calls for the update of the existing docking facility on the east side of Treasure Island and the construction of a new docking facility on the west side. As discussed in section 2.4.1, section 4.5, and in the transportation appendix (Appendix F) of the Draft EIS, a new ferry terminal would be built on the west side of Treasure Island under Alternatives 1 and 2, but not under Alternative 3. The reference to only using eastern terminals on page F-22 of the Draft EIS (now page F.3.B-10 of the Final EIS) referred only to assumptions made for Alternative 3.

Response to Comment N-17. The Draft EIS does not conclude that truck and parking impacts would be significant. Both truck impacts and parking impacts are listed in the EIS as "Not Significant Impacts".

Response to Comment N-18. Please see the response to comment K-2 regarding beneficial use of groundwater beneath Treasure Island.

Response to Comment N-19. Utility demand calculation summary sheets have been added to Appendix E of the Final EIS. The utilities impact analysis considered proposed upgrades in its methodology and evaluated the ability of the upgraded utility systems to meet the utility demand requirements estimated for each alternative. Implementation of the proposed upgrades is one of the critical assumptions underlying the analysis in the EIS.

Response to Comment N-20. Maps of the utility infrastructure can be viewed at the office of the San Francisco Public Utilities Commission, Treasure Island Utilities Manager, Treasure Island, Building 264. Most of the project alternatives would abandon the existing utility infrastructure and install new infrastructure throughout NSTI, with utility mains installed in a

perimeter corridor. Because most of it would be abandoned, the location of the existing infrastructure was not an important component of the impact analysis.

Response to Comment N-21. None of the documents or personnel consulted indicated that the existing transmission line was in less than satisfactory condition or was in need of replacement.

Response to Comment N-22. Because projecting specific requirements for natural gas, electricity, and telecommunications would be speculative, the analysis assumed that future loads would be of the same magnitude as baseline loads. Utility providers would be expected to accommodate any increases and any individual utility requirements.

Response to Comment N-23. Section 4.11.1 states that future development would require expanding the capacity of the telecommunication switch. This could be accomplished through replacement of the master switch.

Response to Comment N-24. The Draft Reuse Plan includes the provision of adequate public services for NSTI. This can be accomplished only by establishing adequate police and fire stations at NSTI, including adequate staffing and equipment levels. Therefore, the analysis assumes that these conditions would be present at buildout of each alternative.

Response to Comment N-25. Please see response to comment C-12 regarding inclusion of CERCLA information in the EIS.

Response to Comment N-26. Please see response to comment C-12 regarding inclusion of CERCLA information in the EIS. Information on remediation activities at each site have been updated in section 3.13 of the Final EIS.

LETTER O

SERVICE PLANNING • SAN FRANCISCO MUNICIPAL RAILWAY

1145 Market St, Ste 402. • San Francisco, CA 94103 • (415) 554-3475• Fax: (415) 554 -3408

June 27, 2002

Ms. Timarie Seneca
BRAC Operations Office, SW Division
Naval Facilities Engineering Command, Code 06CM.TS
1230 Columbia Street, Suite 1100
San Diego, CA 92101-8517

Dear Ms. Seneca:

We are in receipt of your request for review and comments on the DEIS for "The Disposal and Reuse of Naval Station Treasure Island". The San Francisco Railway Service Planning staff have the following comments on this primarily land use plan.

We request that Section 4.12 Public Services include the need for public transit services between the island and the main part of the City. We are currently providing extensive bus service to numerous visitors and residents of the island and this demand has grown exponentially over the past two years as the population of the island has increased. O-1

In regards to the land use plan, if any large scale transit facilities, as were originally envisioned for the island, are anticipated in the future, accommodations for them should be made now.

Sincerely,

Peter Straus
Manager of Service Planning

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Response to Comments

Response to Comment O-1. Transit service to NSTI is discussed in the transportation section of the EIS. The Draft Reuse Plan (San Francisco 1996e) outlined proposed transit improvements, including both ferry and bus (MUNI and AC) services. The EIS transportation analysis assumes that these recommended improvements will be provided by MUNI and also acknowledged that additional funding would be required (see page 4-49 of the Draft EIS).

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ARC ECOLOGY COMMENTS
DEIS ON DISPOSAL AND REUSE OF NSTI

EXECUTIVE SUMMARY

ES.3 DISPOSAL AND REUSE PROCESS

The DEIS is unclear which portions of the property Caltrans has acquired in fee and on which portions Cal Trans has been given easements (the temporary construction easement and the permanent aerial easement referred to on page ES-3). It is also unclear why the portions of the property covered by these easements have been excluded from the EIS. The explanation offered, that "This land is no longer available for transfer by the United States and, as such, is no longer available for community reuse in accordance with the NSTI Draft Reuse Plan" does not seem to apply to the land covered by the temporary easement which will become available for transfer when construction on the bridge has been completed, within the buildout period of the Reuse Plan. The Government should not expect that sale of these sites to produce significant revenue, given the constraints on access that traffic imposes on development of Treasure Island and Yerba Buena Island as a whole. P-1

Recommendations:

- Please provide information about the location and number of acres covered by (i)the temporary construction easement and (ii)the permanent aerial easement, and (iii)identify both sites on Figure ES-2.
- Explain when, and under what authority the Navy made the policy decision to exclude the land covered by the easements from the Economic Development Conveyance. Was the public informed of this decision prior to publication of the DEIS?
- Analyze the changes the Reuse Plan needs to make to accommodate the shrinkage of the Project area.

ES.5 PUBLIC INVOLVEMENT PROCESS

We question the adequacy of the scoping process used in the preparation of this EIS because it occurred six years ago. Environmental conditions have changed since 1996. The Project itself has also changed, since 144 acres of dry land (out of a total of 552) have been removed from the Project and transferred to the Department of Labor, the Coast Guard, and the Federal Highways Administration. Rules governing the transfer of BRAC properties, CERCLA, and the use of Public Trust land at Treasure Island have also changed during the interim. P-2

Recommendation:

- Prepare an updated Notice of Intent in order to revise and recirculate the DEIS.

ES.10 OTHER CONSIDERATIONS – ENVIRONMENTAL JUSTICE

The DEIS is too quick to dismiss the potential for disproportionate impacts on minority and low-income populations. The statement that "The potentially affected area adjacent to NSTI does not include disproportionately high minority populations or low-income populations compared to adjacent communities is misleading; NSTI itself includes high concentrations of low income and minority populations. Low income, minority children from the San Francisco Tenderloin attend a school located on Site 12, a former waste disposal area. All of the residents in the TIHDI housing and members of the Job Corps are low income and many are people of color. The significant P-3

impacts identified by the DEIS, associated with hazardous materials and waste, could disproportionately affect these on-site minority and low-income populations, particularly as cleanup proceeds.

In addition, the Reuse Plan has the potential to displace these populations. P-3

Recommendation:

- The EIS needs to evaluate and mitigate any disproportionate impacts of cleanup actions that would occur as a result of disposal and reuse on these minority and poor populations.
- The EIS also needs to evaluate and mitigate disproportionate displacement impacts of disposal and reuse.

CHAPTER 1 PURPOSE AND NEED

1.1 PURPOSE AND NEED

Additional information is needed about the portions of the site with easements given to Caltrans – how big they are, where they are, and changes to the Project that are needed. P-4

Recommendation:
See ES.3.

1.3.2 DISPOSAL PROCESS REQUIREMENTS

The description (including Table 1-1) of the property transferred to FHWA and Caltrans does not distinguish between sites that the Navy has transferred in fee and those for which it has only provided FHWA and Caltrans with easements only. P-5

Recommendation:
See ES.3.

CHAPTER 3 AFFECTED ENVIRONMENT

TABLE 3-1 ENVIRONMENTAL ISSUES AND REGION OF INFLUENCE

The Reuse plan area is identified as the region of influence for hazardous materials and waste. The potential impacts of NSTI hazardous materials and waste issues could extend to the waters of San Francisco Bay. P-6

Recommendation:

- Include the Bay in the ROI for hazardous materials and waste.

PAGES 3-1 –2 DISCUSSION OF BASELINES

Publishing an analysis in 2002 of Project impacts on environmental conditions that existed in 1993 ("for most of the resource areas") is inconsistent with both the letter and the spirit of NEPA. The justification that the "trough [between the decision to close the base and its reuse] is temporary, constantly changing, and a wholly artificial situation that cannot provide a stable and meaningful basis for measuring the environmental impact of subsequent redevelopment" is inaccurate. The trough has lasted for almost a decade – long enough for any unused environmental capacity to be absorbed by subsequent development in the region. If conditions on the base are changing more than elsewhere, relying on an obsolete baseline would undermine the NEPA analysis. Finally there is no evidence that the conditions are artificial or unique. P-7

Nor is there any provision in NEPA for using a baseline so far in the past. Although it is true that CEQA provides that, under certain conditions "the determination of whether the reuse plan may have a significant effect on the environment may, at the discretion of the lead agency, be based upon the physical conditions which were present at the time that the federal decision for the closure or realignment of the base or reservation became final", there is no evidence that *NEPA* allows the use of the earlier baseline. Since this EIS is not combined with the EIR, it is difficult to understand why it relies on CEQA to justify using an obsolete baseline.

In some instances a 1996-97 baseline is used. The mixing of baselines further threatens the integrity of the analysis. When the DEIS evaluates project impacts against more than a single baseline, the public and decision-makers have a much more difficult task sorting out the effects of disposal and reuse from other changes occurring over time. The mixing of baseline also raises the possibility that the document has chosen a baseline for each resource area to minimize impacts.

P-7

Recommendation:

- Revise the analysis based on current conditions.

3.1.1 REGULATORY CONSIDERATIONS

On page 3-7 the document states that "the State Lands Commission has allowed existing specialized or single-purpose facilities to continue as nonconforming public trust uses for their useful life." This is true for Treasure Island, but it is not true for other bases.

P-8

Recommendation:

- Revise the text to refer to the specific provision of the Migden Bill for Treasure Island to avoid creating the impression these provisions apply to other bases.

3.1.2 REUSE PLAN AREA

The statement on page 3-11 that "Caltrans currently possesses 97 acres (39ha) of dry and submerged land on Yerba Buena Island for the SFOBB, including 10 acres of easement property and structures that it previously occupied and maintained in fee" is very confusing.

P-9

Recommendations:

- Clarify whether "10 acres of easement property" refers to property on which Caltrans has easements now or whether this refers to a previous easement.
- What is meant by "occupied and maintained in fee"? Did Caltrans previously own property for which it now has easement rights?

3.5.1 ROADWAY NETWORK

The statement that "Figure 3-5 shows the locations of the six ramps and the Caltrans easement across Yerba Buena Island" is inaccurate. Figure 3-5 does not display any information about the location of easements.

P-10

Recommendation:

- Provide clear, straightforward information about the ownership status of land at NSTI to clarify sites that have been conveyed to Caltrans in fee, and sites for which temporary and permanent easements have been granted. P-10

3.7.2-.3 EXISTING NOISE AT TI AND YERBAN BUENA

Relying on a 1986 baseline, in conjunction with the model used to predict Project impacts, underestimates potential noise conditions. Traffic levels – which drive the noise impacts – were significantly lower sixteen years ago. The model used to project total noise levels adds Project impacts to the baseline. The total is compared to a set standard. An undercounted baseline, therefore, results in an undercount of total noise against which land use compatibility is evaluated. P-11

Recommendation:

- Use current levels of noise to describe existing conditions, and as the baseline for modeling future noise levels.

3.9.4 GEOLOGIC HAZARDS AT NSTI

Recommendation:

- Cite the Treadwell and Rollo report (San Francisco, 1995b) Existing Conditions Report, Volume II: Geotechnical Report prepared by Treadwell and Rollo, August 1995. P-12

3.10.2 SURFACE WATER RESOURCES

It is unclear why 1998 is the baseline year for the analysis of water quality Data is available that can show trends as well as a baseline years consistent with other resources. P-13

Recommendation:

- Use a baseline year that is current and consistent with the baseline used to analyze other resources.

3.11 UTILITIES

Question:

- What are the potential impacts of Caltrans owning the utility infrastructure on the portions of the land it has acquired? P-14

3.13.3 INSTALLATION RESTORATION PROGRAM

No RODs, or even a complete RI, have been approved; therefore the statement, "and no further action under CERCLA is recommended" is inappropriate. P-15

Recommendation:

- Change the phrase to "no further action under CERCLA is anticipated."

3.12 PUBLIC SERVICES

The problem of mixing baselines is demonstrated in this section. It is unclear whether the baseline is the level of fire and police protection provided in 1993 or 1997. P-16

Recommendations:

- Identify a baseline year that is consistent with the baseline used to analyze other resources.
- Include information about the number of firefighters and police officers per person, including supervisory and support personnel.

P-16

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

PAGE 4-2 FHWA PROPERTY

The statement on this page, that "FHWA acquired 97 acres (39 ha) of Navy dry and submerged land on Yerba Buena Island and *conveyed this land in fee* to Caltrans for the SFOBB east spans retrofit project" conflicts with the earlier statements on pages 3-11 and ES.3 that the 97 acres *includes the site for which easements were given.*

P-17

Recommendation:

- Please clarify as we have previously requested.

4.1.1 LAND USE – ALL ALTERNATIVES

The DEIS overlooks the potential for substantial land use conflicts between the Reuse Plan (which was devised prior to plans for bridge realignment) and the bridge project. However, the DEIS dismisses these potential impacts with the following *non sequitur*: "The existing SFOBB or the proposed realignment would not be affected by changes in land use that are part of community reuse. Land on Yerba Buena transferred to FHWA to accommodate the SFOBB realignment is no longer available for transfer and reuse and consequently no land use conflict exists."

P-18

Recommendations:

- Analyze the uses that the Reuse Plan designates for portions of the property that are now under the control of Caltrans.
- To mitigate the conflict between a reuse plan devised before Caltrans obtained its property and subsequent conditions, include modifications of the Reuse Plan that would allow these pre-empted uses to occur elsewhere.

4.2 VISUAL RESOURCES

The DEIS dismisses visual impacts because they are short term. In this case, short term appears to be more than the decade, through buildout in 2015. In any case, NEPA does not allow an agency to ignore impacts simply because they are not permanent.

P-19

Recommendation:

- Analyze and mitigate the impacts the visual impacts of on-going construction that will take place during the long buildout period, especially on existing and early phase residents.

The DEIS dismisses potential visual impacts caused by light and glare based upon undocumented assumptions. The DEIS assumes that lighting levels "are similar to urban lighting at the San Francisco waterfront, with shielding to prevent upward glare visible to SFOBB drivers..." Nothing in this section prevents development from exceeding conditions similar to

P-20

urban lighting at the San Francisco waterfront. Nothing requires appropriate shielding. The DEIS also assumes that City Planning Commission Resolution 9212 will protect against project-related glare impacts. This resolution only addresses glare from mirrored or reflective glass surfaces, not from all shiny surfaces.

P-20

Recommendation:

- Analyze and mitigate potential light and glare impacts.

4.3 SOCIOECONOMICS

TABLE 4-1

Table 4-1 uses baseline data that is 14 years old – even more obsolete than the 1993 data that the DEIS tried to justify earlier. This table mixes data from 1988 with data from 1990. No reason is given for choosing a baseline so far in the past.

Although Table 4-1 provides information (however dated) on three related factors – jobs, resident population, and housing – the DEIS fails to explore the interaction among these variables. The discussion of the issues of employment, housing, and jobs-housing balance is part of an effort to ensure that housing will be available for the people attracted to the Bay Area by the new jobs at Treasure Island. A simple comparison of the number of jobs with the number of housing units does not address the issue.

For example, the 4,920 jobs projected for Alternative 1 would be predominantly low-paying ("Most of the jobs associated with this alternative would be created through reuse of parts of Treasure Island for a themed attraction, hotel and conference facilities, restaurants, film studios, community services, and a variety of recreational facilities."[1]). Given the extraordinarily high cost of housing in San Francisco, the assumption (based on 1997-1998 data) that 55 percent of these mostly service employees would be able to live in San Francisco[2] is unsupported; it is far more likely that most will have to commute from the East (and the North) Bay where affordable housing is more available. As the DEIS point out, however, there is no bus service from the East Bay to Treasure Island. For this Project, the environmental impacts of creating low paying jobs that are inaccessible by public transportation to affordable housing are especially severe.

P-21

Even if the assumption were reasonable that 55% of the Treasure Island workforce will live in San Francisco, the DEIS fails to address the housing impacts generated by the other 45%. The DEIS argues that the Reuse Plan provides more than enough housing (2,850 units) to house the 4,920 employees because only 55% (2,706) are expected to live in San Francisco where there are 1.6 workers per household (requiring 1,690 units to house the 4,920 employees in San Francisco). However, the 45% of the workers (about 2200) who would live elsewhere in the region will also need somewhere to live. Two pages earlier the DEIS states that impacts would result if the Project were to "create a demand for additional housing in San Francisco, Oakland, or the surrounding communities." The DEIS ignores this housing impact.

The problem is not addressed by the argument[3] that the projected population increase generated by the Project of 2,395 people would not have any impacts because thay are "accounted for in

[1] Page 4-24
[2] Ibid.
[3] page 4-23

ABAG's projected population increases." There is nothing in the methodology of ABAG's projections that suggests that the demand for housing of projected growth will be accommodated. There is no implication that the scenario projected by ABAG has mitigated its environmental impacts. ABAG did not prepare an EIR on the projections. The projections are simply projections, not an environmental envelope.

Recommendations:

- Provide baseline information from a single, current, date.
- Analyze housing opportunities for the Treasure Island workforce, taking into account the low incomes that Reuse Plan jobs will produce. Revise assumptions about where the work force will live.
- Adjust trip assumptions in the transportation analysis to reflect that a higher proportion of the workforce will live in the East Bay, which is not linked to Treasure Island by public transit.

P-21

4.5 TRANSPORTATION

PAGE 4-34 DEFINITION OF IMPACTS

The list of potential transportation impacts, by including "parking demand exceeding the supply", in effect precludes mitigating traffic congestion with a substantial reduced parking requirements, yet this mitigation is one of the most effective approaches known.

In addition, the list of potential impacts does not address an important indicator of increased traffic congestion on a roadway (especially one where diversion is not possible) that is already operating at capacity: the spreading of the peak.

P-22

It is surprising that there is not analysis of the potential for the Reuse Plan to cause an increase of accidents on the bridge.

Recommendations:

- Omit shortage of parking from the list of traffic impacts.
- Add to the list of impacts the spread of the peak over an increased number of hours.
- An increase in the number of accidents as vehicles enter and exit bridge traffic should be analyzed as a potential impact.

PAGE 4-34 TRAFFIC ANALYSIS METHODOLOGY

It is not legitimate to substitute projections of traffic in 2010 for traffic in 2015. Acknowledging that the reconstructed bridge will not reduce congestion is not equivalent to evidence that conditions in 2015 will be the same as they were in 2010. There is the potential for substantial growth and increase in traffic during this five year period.

It is also unacceptable to use ABAG 1994 projections of land use and demographic conditions at buildout (2015), no matter which baseline is used. ABAG projections published in 2002 are available and are more likely to present an accurate picture of conditions in 2015.

P-23

It is similarly unclear why the DEIS used the 1994 Highway Capacity Manual instead of the 1998 version.

Recommendations:

- Use traffic projections for 2015.
- Use the most recent projections and methodologies available.

P-23

TABLE 4-3 ESTIMATED NSTI VEHICLE-TRIP GENERATION

The traffic day – 6:00 am to 6:00 pm - is defined to narrowly to capture the true volume of traffic, especially when the DEIS itself states that the peak period extends until 7:00 pm. In addition, there is a substantial amount of traffic between 6:00 pm and 6:00 am.

Relying on a single hour to define the peak (8:00 am – 9:00 am and 5:00 pm – 6:00 pm) undercounts the peak load and is less likely to capture changes in volume. As we suggested earlier, one of the main indications of increased congestion is a spreading of the peak period. This effect is not taken into account if the peak period is arbitrarily reduced to a single hour. Table F-5 shows a westbound peak on I-80 that in 1993 extended from 6:00 am through at least 11:00 am, and an eastbound peak extending from 2:00 pm through 8:00 pm.

P-24

Furthermore, the single hour chosen to represent the peak does not even capture the period of highest traffic volumes.

Recommendations:

- Provide a 24-hour trip count for I-80.
- Analyze Project impacts on traffic volumes over the full peak period.
- Identify any spreading of the peak that will occur at 2015.

4.5.1 ALTERNATIVE 1 SIGNIFICANT AND MITIGABLE IMPACTS

The DEIS is unclear whether the significant impact of increased volume and queuing on the bridge ramps can be mitigated. The document acknowledges that the most effective mitigation proposed – to upgrade substandard ramps – may not be implementable.

Projecting that TDM measures can reduce trips by 6-12% is not justified if the package of TDM programs is not specified. The TDM examples mentioned - to encourage travel during off-peak hours, and flexible work hours – are probably infeasible since the peak extends over most of the day.

The most effective means to curtail trip generation is to limit parking, a mitigation that is missing from the list (except for visitor parking).

P-25

Mitigating transit impacts by monitoring transit demand is not a useful approach since transit demand is strongly determined by the quality of transit services (headways, distance from transit stops, etc.). The analysis of transit impacts should instead evaluate the impacts on transit systems that would caused by meeting goals for transit usage (based on the calculated need to divert trips from automobiles to transit)..

Recommendations:

- Clarify the relative contribution of each mitigation measure to reduction of impacts so that it is possible to determine the package of mitigations needed to fully mitigate impacts.

- Include a drastic reduction of parking as a primary mitigation measure.
- Analyze the impacts on transit providers of providing transit with the routes and headways that would be needed to meet transit goals.

P-25

NOT SIGNIFICANT IMPACTS

The assumption that the Project would create no impacts to Bridge-I-80 operations because metering lights regulate the flow of traffic overlooks increased delays of longer meter cycles and potential for metering lights to be in operation for longer periods of time (another indication of peak spread).

The assumption that the Reuse Plan will limit truck service and freight delivery to off-peak hours is unrealistic when the peak extends over most of the day.

The judgment that construction impacts will be short term for a project that will not achieve buildout until 2015 is unrealistic.

Assuming that the Project includes "two new ferry terminals (at Candlestick Point in San Francisco and at Golden Gate Fields on the Berkeley/Albany border)" substitutes wishful thinking for an analysis of impacts and mitigations.. Similarly *assuming* that transit service will be adequate because the Reuse Plan calls for service that accommodates demand is an evasion of NEPA responsibilities.

P-26

Recommendations:

- Replace mitigations that would divert traffic to off-peak hours with a rigorous analysis of capacity during the entire peak and rely on mitigations that would be effective during peak periods to mitigate peak period impacts.
- Mitigate construction impacts.
- Replace ability to meet transit demand as the standard of transit adequacy with a target of diverting a specific proportion of automobile trips to transit, and analyze the routes and headways that would be needed to achieve this goal.

4.6 AIR QUALITY

It is not clear whether air emission calculations are based on the 12-hour trip numbers or 24-hour numbers.

- Base emission calculations on a 24-hour day.

P-27

4.13 HAZARDOUS MATERIALS AND WASTE

The discussion of the Installation Restoration Program does not provide for the potential conflict between the Reuse Plan and long-term groundwater monitoring and treatment.

- Provide mitigations to ensure that construction will not damage monitoring wells and will not disrupt water flows to the wells.
- Provide mitigations to ensure proper oversight of any institutional controls.

P-28

CHAPTER 5 CUMULATIVE PROJECTS AND IMPACTS

5.1 CUMULATIVE ASSUMPTIONS

- Since this DEIS uses a 1993 baseline (among others), it is necessary for the cumulative analysis to take into account all development that has occurred since then within the region of influence for each resource area.

P-29

CHAPTER 6 OTHER CONSIDERATIONS REQUIRED BY NEPA

6.4 ENVIRONMENTAL JUSTICE

This analysis must address the potential for hazardous materials, displacement, and traffic congestion impacts on the minority and low income residents of Treasure Island.

P-30

Response to Comments

Response to Comment P-1. Please see response to comment B-2 regarding inclusion of the FHWA/Caltrans easements in the EIS analysis.

Response to Comment P-2. The Navy does not concur that scoping and circulation of the Draft EIS be done again. Although portions of NSTI have been transferred to US Department of Labor, US Coast Guard, and FHWA/Caltrans since scoping was conducted in 1996, the project area and the overall reuse concept remains largely the same. All regulations governing transfer of federal property are addressed in the EIS and would not be affected by another round of scoping. Consequently, it is unlikely that reinitiation of scoping would result in the identification of any substantial new issues to be addressed in the EIS. In addition, the public may identify any issues that it believes should be addressed in the EIS during the public review and comment on the Draft EIS.

Finally, another round of scoping and recirculating the Draft EIS would result in extensive delays in the process of transferring the property. Such delays would not be consistent with the BRAC mandate for timely disposal of property for the benefit of the community and would place a burden on the designated property recipient in its efforts to move forward with reuse.

Response to Comment P-3. Clean up and reuse of IR Site 12 would not disproportionately affect minority or low income populations because the areas in which soil disturbance would occur would be subject to land use controls and regulatory requirements that would reduce the potential human health effects and environmental effects to acceptable levels. CERCLA remedial actions will ensure that human health and the environment will be protected based on continued residential use of the area. If the CERCLA remedy for a particular site includes land use controls, the acquiring entity or entities will be required to comply with the land use controls during construction or operations to ensure continued protection of human health and the environment. These requirements apply to all areas requiring CERCLA actions and would affect all populations using these areas of NSTI.

In addition, this EIS evaluates the potential effects of reuse of NSTI. A detailed evaluation of the effects of CERCLA remediation on NSTI is not properly within the scope of this document.

The Treasure Island Homeless Development Initiative (TIHDI) was consulted in the development of the reuse alternatives and in 1995 submitted a comprehensive Notice of Interest for surplus property at NSTI for incorporation into the LRA's Draft Reuse Plan. The alternatives include provision of economic development opportunities and employment for homeless individuals and affordable housing, as described in Chapter 2, Proposed Action and Alternatives. While the reuse alternatives have the potential to displace the current residents of TIHDI housing (and could result in negative effects on these individuals), the reuse alternatives were developed (in consultation with TIHDI and the public) to provide an overall beneficial result for San Francisco's low-income populations.

Response to Comment P-4. Please see response to comment B-2 regarding easements granted to FHWA/Caltrans for the SFOBB.

Response to Comment P-5. Please see response to comment B-2 regarding easements granted to FHWA/Caltrans for the SFOBB.

Response to Comment P-6. The ROI for hazardous materials, as well as other resources, is the reuse plan area. Because the area proposed for disposal includes submerged lands around Treasure and Yerba Buena Island, this area by definition includes waters of the San Francisco Bay. Analysis of potential impacts from hazardous materials and waste includes discussion of migration of contaminants into the surrounding Bay waters.

Response to Comment P-7. Please see response to comment N-2 regarding the baseline for analysis in the EIS.

Response to Comment P-8. Please see response to comment L-1 regarding the public trust at NSTI.

Response to Comment P-9. The text has been moved to beneath the heading *Non-Navy Land Uses* within section 3.1.3 of the Final EIS and has been revised to read:

> The FHWA conveyed 98 acres (40 ha) on Yerba Buena Island held by Navy to Caltrans for right-of-way purposes in connection with the construction, operation, and maintenance of the SFOBB east spans retrofit project. Approximately 20 acres (8 ha) of dry land were permanently conveyed in fee and are not part of the disposal action evaluated in this EIS. The remaining 78 acres (32 ha) comprises TCE or permanent aerial easements of dry and submerged land on Yerba Buena Island. Land within the TCEs and aerial easements are available for disposal and are part of the proposed disposal action evaluated in this EIS.

Response to Comment P-10. Figure 3-5 has been revised to show the FHWA/Caltrans easements.

Response to Comment P-11. The results of the noise monitoring conducted in 1986 on Treasure Island are a reasonable representation of conditions on Treasure Island at the time of closure (1993). Noise levels at present are likely to be similar or lower than conditions in 1986 since there is currently far less activity on Treasure Island. The majority of Treasure Island is too far from the SFOBB to be measurably affected by traffic noise. As noted in the text, additional measurements were taken in 1998 near piers 11 and 12 to model noise levels from SFOBB traffic. Traffic noise is a larger concern on the Yerba Buena Island portion of NSTI. Consequently, additional noise monitoring was conducted by Navy in 1996. Noise monitoring by Caltrans in 1988 is also included in the EIS analysis.

Response to Comment P-12. The existing conditions geotechnical report by Treadwell and Rollo is cited as San Francisco 1996b in the Geologic Resources section.

Response to Comment P-13. Please see response to comment N-2 regarding the baseline year for the analysis.

Response to Comment P-14. Please see response to comment A-1 regarding utility easements and rights-of-way within the lands transferred to Caltrans.

Response to Comment P-15. The decision to proceed or not proceed with an action pursuant to CERCLA is based on a recommendation by Navy, which relies on information gathered thorough the CERCLA process. Concurrence with the recommendation must be provided by DTSC and/or the respective RWQCB. The text has not been revised.

Response to Comment P-16. Please see response to comment N-2 regarding the baseline year for the analysis. Text has been added to the introduction in section 3.12 to explain the use of two baselines for public services. Because the baseline ratio of the number of firefighters and police officers to the number of residents was not used to determine the future demand for service personnel, that ratio was not calculated and presented in the EIS. Instead, the equipment and personnel requirements for each of the service providers under the reuse alternatives were determined through direct consultation with the San Francisco Fire Department, the San Francisco Police Department, and the San Francisco Department of Public Health.

Response to Comment P-17. Please see response to comment B-2 regarding easements to FHWA/Caltrans for the SFOBB. The text on page 3-11 and ES-3 in the Draft EIS, as referenced in the comment, has been revised based on previous comment P-9.

Response to Comment P-18. Although the approximately 20 acres of land transferred to FHWA was designated for publicly oriented, open space, and residential uses in the Draft Reuse Plan (San Francisco 1996e), this represents only a small percentage of the total reuse plan area designated for these uses. Since the Draft Reuse Plan provides only a very general land use development concept, it is assumed that the uses proposed for the FHWA lands can be accommodated elsewhere in the reuse plan area, either by slight changes in the boundaries of the defined use areas or by slight changes in densities. Furthermore, the analysis dependent on acreage of land uses are not measurably affected by the loss of such small areas and the loss of land uses that contribute little in terms of traffic, jobs, etc. Please see response to comment B-2 for further discussion of the FHWA/Caltrans easements.

Response to Comment P-19. Since construction activities and the associated visual impacts would shift during the different phases of redevelopment, no one viewpoint would be significantly affected in the long-term. Further, it is beyond the scope of the analysis in this EIS to attempt to evaluate the visual impact from specific construction activities since the locations, timing, and extent of these activities are not known, nor is it known where all potentially sensitive visual receptors may be found during the different phases of reuse.

Response to Comment P-20. The EIS evaluation of potential impacts from light and glare is based on very conceptual land use development plans, including the Draft Reuse Plan. Consequently, reasonable assumptions about conditions under reuse must be made. It is reasonable to assume that, since the City and County of San Francisco would be the ultimate recipient of the property, conditions on NSTI under reuse would be comparable to those on the

San Francisco waterfront and that San Francisco Resolution 9212 would apply. The designated property recipient will be required to evaluate and, if necessary, mitigate potential impacts from light and glare under the final development plan.

Response to Comment P-21. Please see response to comment N-2 regarding the baseline year for the analysis. Projections of future socioeconomic conditions were derived from the most current data available, since this most accurately reflects future conditions. The assumptions of the analysis are based on the best available information concerning the projected employment opportunities on Treasure Island, future housing availability, commuting patterns, and projected population growth. Although, it is possible that more of the employees who would work in these industries would live outside San Francisco, a more accurate estimate of the future distribution of these employees is not available. Employees live and work in San Francisco in the industries identified in the Draft Reuse Plan. Employment on Treasure Island during reuse also will be composed of people already living in San Francisco (and other parts of the Bay Area), who are unemployed, under-employed, or who would change jobs, as well as new residents that might migrate into the area as a result of the new jobs created by the reuse projects.

Response to Comment P-22. It is reasonable to identify parking shortage as an impact. While not providing a sufficient number of parking spaces could suppress auto ownership, typically this occurs in the center city area, where abundant transit services are available and support retail stores are conveniently located within a short walking distance. Treasure Island is an isolated location, unlike downtown San Francisco. However, a parking shortage is identified as a not significant impact due to the City's "transit first" policy.

A significant and mitigable impact has been added due to peak-hour spreading, as follows:

> *Impact: Increased peak spreading on SFOBB/I-80* (Factor 1). Under Alternative 1, increased traffic onto and off of the SFOBB during the A.M. peak period (6:30 to 9:30) and P.M. peak period (3:30 to 6:30) would cause westbound traffic on certain segments of the SFOBB to deteriorate from LOS D to LOS F during the last hour of the A.M. peak period (8:30 to 9:30) and to deteriorate from LOS B to LOS E or LOS F during the first hour of the P.M. peak period (3:30 to 4:30) (Table F-22). The increase in other connecting regional freeways would likely be less.
>
> *Mitigation.* Monitor traffic volumes to ensure that the transportation goals and objectives established by the Draft Reuse Plan are successfully implemented. Monitoring traffic volumes would inform San Francisco whether traffic onto or off of the SFOBB at each phase of development is resulting in deterioration of traffic conditions on the SFOBB. If at some point it is determined that traffic from NSTI is constraining the capacity of the SFOBB, either more aggressive TDM and transit improvements must be implemented or additional developments should be delayed until such improvements are implemented. Implementing this mitigation measure would reduce this impact to a not significant level.

Similar impact statements have been added for Alternatives 2 and 3 as well.

Traffic on the Bay Bridge is controlled by the metering lights and, therefore, the total SFOBB mainline traffic volumes would not significantly change in the future. In fact, the current number of vehicles allowed by the metering lights may be decreased if the traffic from Treasure Island were to increase. Current traffic accidents on the Treasure Island ramps are generally low, except the westbound off-ramp on the east side of the tunnel and eastbound off-ramp on the west side of the tunnel. Future increases in traffic volumes at these two ramps could increase the number of accidents.

Response to Comment P-23. Please see response to comment H-6 regarding updated projections for the project area.

Response to Comment P-24. The SFOBB 24-hour traffic volumes are presented in Table F-5 of the Draft EIS (now Table F-7 of the Final EIS). SFOBB traffic was analyzed for the peak period, and the results of the analyses are presented in Tables F-21 through F-23 of the Draft EIS (now Tables F-23 and F-25 of the Final EIS). The EIS presents only the AM and PM peak-hour traffic impacts, those hours having been selected to represent the worst-case condition during the day. The shoulders of the two-hour peak period (the hour before and after the peak hour) are likely to have less traffic or, at the most, the same amount of traffic as the peak hour, so impacts to traffic conditions would be less than during the peak hour.

Please see the responses to comments for P-22 regarding spreading peak-hour traffic conditions.

Response to Comment P-25. The EIS for the disposal and reuse of NSTI primarily evaluates the potential impacts of the federal action, disposal of the property. The potential impacts of reuse are necessarily evaluated in a general way because the parameters of reuse have not yet been determined. It is not known at this time which of the three reuse alternatives most accurately represents the full buildout conditions of reuse. Because of the uncertainty of the reuse scenario, the transportation issues and choices under reuse cannot be accurately predicted at this time, so it is not possible to estimate the relative contribution of each mitigation measure to overall traffic reduction. For this reason, two monitoring mitigation measures are included in the mitigation program to provide feedback on the effectiveness of the various traffic mitigations. Both monitoring measures suggest that if significant impact were to occur, either more aggressive TDM and transit improvements must be implemented or additional development should be delayed until such improvements are implemented.

Appendix F3 provides a list of TDM measures that would be implemented, several of which involve limiting parking supply, such as restricting visitor parking, prohibiting parking for certain uses, such as the themed attraction, establishing parking restrictions, and prohibiting free parking.

Potential transit impacts are presented in the EIS and include estimated ridership level and frequency. Detailed analysis would be necessary at a later date, depending on the origin and destination of the residents, workers, and visitors.

Response to Comment P-26. Please see responses to comments P-24 regarding the peak period analysis. As illustrated in Table F-5 of the Draft EIS (now Table F-7 of the Final EIS), it is not correct to state that the peak period extends over most of the day.

At present there is no data available on future construction activity, and construction impacts would be analyzed for each individual project at a later date. Construction activity at Treasure Island would occur in phases, depending on market and availability of financing sources for these projects.

The Water Transit Authority has been established with the responsibility of implementing a regional ferry system in the Bay Area. The Water Transit Authority has identified service to Treasure Island as a tier one project.

Response to Comment P-27. All emission calculations in the EIS were tabulated based on daily activity estimates. Construction emissions assume daytime activity. Vehicle traffic and ferry service emissions assume daily trip patterns.

Response to Comment P-28. The EIS identifies a potentially significant but mitigable impact under each of the alternatives as a result of potential conflicts between construction activities associated with reuse and remedial actions pursuant to CERCLA. As stated in the mitigation for this potential impact, no CERCLA ROD has been signed and therefore it would be highly speculative to attempt to impose measures to mitigate potential impacts at this time. It is assumed that any necessary controls would be developed through the CERCLA process and implemented through land use controls on the specific property or properties.

Response to Comment P-29. Because NSTI is on an island, there is no nexus between the proposed disposal and reuse and many other past, present, and reasonably foreseeable actions throughout the Bay Area. The cumulative analysis accounts for all projects that could reasonably be expected to cumulatively interact with the proposed action. Many other smaller projects have occurred or will occur in the region that will not produce measurable interactions with the proposed action except through incremental changes in traffic conditions on the SFOBB. To account for these changes, the traffic analysis is based on MTC regional transportation model which forecasts land use changes for purposes of estimating traffic conditions.

Response to Comment P-30. Clean up and reuse of NSTI would not disproportionately affect minority or low-income populations, as described under comment P-3. Development at NSTI under any of the three reuse alternatives would not incrementally contribute to a cumulative impact from hazardous materials or waste.

Please see comment P-3 regarding potential for displacement impacts on the minority and low income residents of Treasure Island.

Although low-income populations would be among those affected by cumulative traffic congestion, these populations would not be particularly or disproportionately affected since cumulative traffic congestion would affect all populations parking at ferry terminals that would provide service to and from NSTI. The three reuse alternatives would contribute a small increment to projected traffic volumes on the new SFOBB, which would be considered cumulatively significant. The contribution to cumulative congestion attributable to the reuse alternatives could be reduced by implementing the TDM measures identified in section 4.5, Transportation.

Draft Environmental Impact Statement on Disposal and Reuse of Naval Station Treasure Island San Francisco, California June 11, 2002

SPEAKER REGISTRATION/COMMENT CARD

Please check your affiliation below:

[X] Individual (no affiliation)	[ ] Citizen's Group
[ ] Private Organization	[ ] Elected Representative
[ ] Federal/State/Local Government	[ ] Regulatory Agency

Name: MICHAEL DZIADEK
Organization (*if applicable*):
Street Address (*optional*): 1238 A NORTH POINT
City/State/Zip (*optional*):
Phone number (*optional*):
E-mail (*optional*):

Do you wish to speak this evening? [ ] Yes [ ] No

If you prefer to provide your comments in writing instead of orally, please write your comments below, using the back of the card if necessary.

Is there any corporate involvement behind Alternative 2 if yes who is backing this proposal

Q-1

Submit written comments tonight, or mail by **June 24, 2002** to:
Commander, Southwest Division, Naval Facilities Engineering Command
Attn: Ms. Timarie Seneca (Code 06CM.TS)
1230 Columbia Street, Suite 1100
San Diego, CA, 92101-8517

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Response to Comments

Response to Comment Q-1. The alternatives were developed by the Navy and the City and County of San Francisco to reflect a range of possible development patterns for NSTI. While specific elements of each alternative may have the support of corporate or development interests, such interests were not involved in the development of the alternatives, nor were they involved in the preparation of the EIS.

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LETTER R

Norman L. de Vall
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June 24, 2002

US Navy, Southwest Division
Naval Facilities Engineering Command
1230 Columbia Street, Suite 1100
BRAC Operations Office
San Diego, California 92101-8517
(6129)532-0955 532:0940
transmitted via fax 6.24.02

Attn: Ms. Timarie Seneca

re: Draft Environmental Impact Statement for the Disposal and Reuse of Naval Station Treasure Island, San Francisco, California

Dear Ms. Seneca,

Please accept the following as my Comment Letter relative to the above referenced DEIS.

First and foremost, I wish to protest the lack of availability of the DEIS and the very short comment period allowed. Most upsetting is that after attending the Meeting of the Treasure Island Development Authority on June 12, 2002 in San Francisco, also attended by Mr. Steve Edde of BRAC Operations, Code O6CA.SE, where I was assured that I would receive a copy of the document, none has been received to date, the last day of comment. R-1

Therefore, with such protest having been made, and only having an hour to review a desk reference copy, I wish to state:

1. The DEIS is woefully inadequate relative to the prospective options and opportunities presented by the island as a neighborhood of the City of San Francisco. R-2

2. The DEIS recommends that Alternative 1 and 2 include a marina with mooring buoys. As a sailor with over 45 years of experience on the Bay, I submit that the location of such a facility is adverse to the public interest, poorly located, a cause for further impacting of the traffic on the Oakland-San Francisco Bay Bridge, and would create an environmentally negative impact.

Decision makers must ask "Why would this be a desirable marina? The DEIS does not address the need for on-shore facilities, such as radio repairs shops, a rigging shop, or sailmaker, nor does the marina create a facility of a "critical mass" size; therefore, all boat owners, except for the most simple purchase at the Chandlery, will travel to either Oakland or Sausalito for the necessary repairs and equipment. R-3

The number of motor vehicle moves, relative to the use of boats and their crews is measurable, especially on three day weekends, national holidays and Opening Day. The DEIS does not address traffic patterns of users of the proposed marina.

3. The proposed marina at the Cove would take up and change the use of a very special asset in the Bay of San Francisco. Centrally located it is the ideal place for sail training, not to mention the phenomenal beauty of the Cove. The DEIS does not address the negative impacts to the visual character that such a facility would create. R-4

4. Nor does the DEIS address whether or not the Public will be allowed on the floats of the marina. While there is questionable need for locked gates, the further taking of public assets for private benefit is not in the public interest. The DEIS should address this issue. R-5

5. The DEIS does not address the presence of the existing piers on the east side of the Island, nor does it address the possibility of locating the marina there or anywhere else. Such glaring oversights should be addressed. R-6

In conclusion, the DEIS serves more as an Economic Development Master Plan rather than as a Draft Environmental Impact Statement. It appears to this reader that the Navy is attempting to "polish the apple" well enough for the City and County of San Francisco to buy into a huge redevelopment project with endless problems and limitations. R-7

In fact, the No Option Alternative should not be discarded. Treasure Island can eventually become the most expensive land for the City of San Francisco to provide city and county services.

And lastly, I again protest the lack of availability of the DEIS, which in my mind is grounds enough to seek judicial remediation. R-8

Sincerely,

Norman L. de Vall
Mendocino County Board of Supervisors, 5 Dist., Retired

cc: US. Representative Michael Thompson, CA 1 District
California State Senator Wesley Chesboro
Zan Hensen, Esq.
Latitude 38
President, County of San Francisco, Board of Supervisors
Annamarie Conroy, Exec. Director, TIDA

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Response to Comments

Response to Comment R-1. The Navy has made a diligent effort to make the Draft EIS available for the public to review. A notice of availability of the Draft EIS was published in the Federal Register on May 10, 2002 and notices of the public hearing, including where to get copies of the EIS, were published in the Oakland Tribune and San Francisco Chronicle on May 26 and 27, 2002. The Draft EIS was distributed to 175 individuals and organizations, including libraries in San Francisco and Oakland. Notices were also sent to another 1,300 individuals and organizations. A copy of the Final EIS will be provided to all individuals and agencies who received or who commented on the Draft EIS, including the commentor. The commentor may review the Final EIS and provide comments to the Navy on whether specific issues have been adequately addressed.

Response to Comment R-2. As described in Chapter 2 of the EIS, the alternatives analyzed in the EIS were developed to reflect the extensive public input and planning that took place during the formulation of reuse concepts for NSTI. Alternative 1 was developed to reflect the land use plan presented in the Draft Reuse Plan (San Francisco 1996e). The Draft Reuse Plan itself was prepared under the guidance of the citizen reuse committee and included a number of public meetings and workshops. Alternatives 2 and 3 were developed to reflect other input on the reuse potential of NSTI, including the review of the Draft Reuse Plan by the Urban Land Institute, the City's Alternatives Report, public input on these studies, and public scoping comments on the EIS. Finally, the final development plan is likely to be similar in the general types of land uses proposed to the alternatives presented in the EIS, but it may differ in any number of small ways.

Response to Comment R-3. Although development of a marina is considered under alternatives 1 and 2, details of commercial facilities associated with the marina are not considered at the level of analysis provided in the EIS. Such facilities would be developed by the designated property recipient in the final development plans for NSTI. The potential traffic impact analysis provided in section 3.5 includes assumed vehicle trips generation by the marina for each of the reuse alternatives.

Response to Comment R-4. The EIS acknowledges that the expanded marina under Alternatives 1 and 2 would add new visual elements to Clipper Cove. The impact of the marina expansion is deemed to be less than significant since this development would not substantially affect sensitive views. The text in section 4.2 of the Final EIS has been revised read:

> The expanded marina with approximately 300 slips and 100 tie-up buoys, compared to the existing 100 slips, would add new visual elements to what is now a relatively undisturbed cove with primarily open water, although the expanded marina would be to some extent visually consistent with the existing marina and pier features along Clipper Cove.

Response to Comment R-5. Although development of a marina is considered under alternatives 1 and 2, details of the marina and its operation are not considered at the level of

analysis provided in the EIS. Such details would be developed by the designated property recipient in the final development plans for the property.

Response to Comment R-6. The only pier that currently is on the east side of the Treasure Island is Pier 1, which would be retrofited under all reuse alternatives for use as a ferry terminal. Another pier previously was located on the east side of Treasure Island, north of Pier 1, but this pier was dismantled and is not addressed in the EIS.

Response to Comment R-7. The federal action evaluated in the EIS is the disposal of property at NSTI. The EIS does not propose or advocate any reuse alternatives but analyzes the reasonable reuse alternatives for NSTI that have been developed by through the reuse planning process. The final alternative will be selected in the Navy ROD for the proposed action; however, the ultimate reuse scenario will be developed by the designated property recipient.

Response to Comment R-8. Please see response to comment R-1 regarding the availability of the Draft EIS.

LETTER S

Ruth Gravanis
74 Mizpah Street
San Francisco, CA 94131
(415) 585-5304
gravanis@earthlink.net

June 24, 2002

Attn: Ms. Timarie Seneca
Code 06CM.TS

Commander, Southwest Division
Naval Facilities Engineering Command
1230 Columbia Street, Suite 1100
San Diego, CA 92101-8517

FAX: (619) 532-0940

Re: Draft EIS for Disposal and Reuse of Naval Station Treasure Island
5090 - Ser 06CA.TS/0472

Dear Ms. Seneca:

I appreciate the opportunity to comment on the DEIS for Disposal and Reuse of Naval Station Treasure Island (DEIS-NSTI). My comments are limited to two topics:

Wildlife Habitat

The discussion of Existing Conditions indicates that there are remnants of native wildlife habitat on Yerba Buena Island. Yet Table 2-2 shows zero acres of Wildlife Habitat for Alternatives 1 and 3, and the 18 acres shown for Alternative 2 presumably refers to the new habitat to be created on Treasure Island. The habitat areas on YBI have significant value that should be recognized as such and not referred to merely as open space/recreation. S-1

Traffic and Transportation

The table on page 2-25 implies that constraints to vehicular circulation would be a negative environmental impact. In fact, the limited capacity of the on-ramps should serve as a positive inducement to create a transportation plan that reduces private automobile trips, thereby improving the environment in a number of ways (noise, air quality, runoff, etc.). Upgrading the on- and off-ramps should not be regarded as environmental mitigation. And the constraints to upgrading them are not merely geology and structural limitations, as noted in the DEIS, but also the negative impacts that would result from the associated destruction of open space and habitat. S-2

Table 2-4 (and the discussion in Section 4-5) mentions some useful mitigation measures (encouraging ferry and bus use), but omits or gives short shrift to other mitigation measures that will prevent the problem (too many cars for the conditions) rather than treating the symptom (congestion): encouraging rail transit on the Bay Bridge, with a station stop on YBI; a City Car-Share Program on the islands; convenient bicycle rentals; and limits to parking on the islands, with appropriate pricing for the few spaces that are provided. Monitoring measures are not mitigation. Spreading out the peak periods to cover more hours is not mitigation. S-3

Please feel free to contact me if clarification would be useful.

Yours truly,

Ruth Gravanis

Response to Comments

Response to Comment S-1. Text has been added as a footnote to Table 2-2 to indicate that open space includes areas of native habitat on Yerba Buena Island. Native habitat on Yerba Buena Island is addressed by habitat type in the biological resources section of Chapter 3. While it is true that native habitat does exist on Yerba Buena Island, there is not an impact assessment on these habitat types unless they are designated by the USFWS as being critical habitat, are designated as being rare or sensitive by the CDFG, or otherwise provide habitat for any rare or endangered species. There is no record of these habitat areas supporting any sensitive species. Furthermore, these habitat types are in the open space areas and would not be affected by the closure or reuse plans.

Response to Comment S-2. Comment noted. The adequate flow of traffic on NSTI under the reuse scenarios is regarded as a negative impact; however, the commentor is correct that a reduction in vehicle trips would reduce potential impacts to other resources. Vehicle trip reduction is the objective of the TDM measures identified in the recommended traffic mitigation measures. As noted in the EIS, upgrades to the on- or off-ramps are suggested as possible mitigations measures but such upgrades may be constrained by geology of the site and structural limitations.

Response to Comment S-3. Mitigation measures suggested in the comment, such as car-share or bicycle rentals, may be effective at limiting potential traffic impacts and have been added to the TDM assumptions in Appendix F as additional examples of TDM measures that may be implemented to reduce potential transportation impacts. Measures such as encouraging rail service on the SFOBB is not reasonably within the scope of the potential reuse scenarios evaluated in this EIS. Restriction in the available visitor parking on NSTI is assumed in the EIS as a component of the TDM measures for all alternatives.

Although monitoring measures do not in and of themselves mitigate potential traffic impacts, such measures are recommended as part of TDM and transit service mitigations to ensure that these measures effectively address potential impacts. While measures to shift vehicle trips toward off-peak hours do not reduce the number of vehicle trips, these measures do mitigate potential traffic impacts by reducing vehicle trips during peak hours when the transportation system is at capacity.

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Draft Environmental Impact Statement on Disposal and Reuse of Naval Station Treasure Island San Francisco, California June 11, 2002

SPEAKER REGISTRATION/COMMENT CARD

Please check your affiliation below:

- ☐ Individual (no affiliation)
- ☐ Private Organization
- ☐ Federal/State/Local Government
- ☐ Citizen's Group
- ☐ Elected Representative
- ☐ Regulatory Agency

Name: RICHARD T. HANSEN
Organization (*if applicable*):
Street Address (*optional*): 2531 LOBITOS ST.
City/State/Zip (*optional*): SAN RAFAEL, CA 94121
Phone number (*optional*): (415) 453-9412
E-mail (*optional*):

Do you wish to speak this evening? ☒ **Yes** ☐ **No**

If you prefer to provide your comments in writing instead of orally, please write your comments below, using the back of the card if necessary.

PLEASE EXTEND COMMENT PERIOD TO PERMIT MORE TIME FOR ANALYSIS ANALYSIS, DEADLINE OF JULY 24, 2002 IS PREFERRED.

T-1

Submit written comments tonight, or mail by **June 24, 2002** to:
Commander, Southwest Division, Naval Facilities Engineering Command
Attn: Ms. Timatie Seneca (Code 06CM.TS)
1230 Columbia Street, Suite 1100
San Diego, CA, 92101-8517

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Response to Comments

Response to Comment T-1. The BRAC legislation requires that the Navy complete transfer of property within a specified time frame in order to support efficient reuse of the property. In addition, CEQ guidelines state that a lead agency may grant an extension of the comment period but the guidelines further state that an extension shall not be granted solely because an interested party has not had sufficient time for review of the document.

The Navy has attempted to allow maximum public participation in the review of the Draft EIS, including mailing the EIS to 174 interested agencies and individuals and notices to another 1,300 interested agencies and individuals, as well as publishing notices in local papers and the Federal Register. A total of three requests for an extension of the comment period were received during the review period based on insufficient time for review of the document.

The Navy has determined that these requests did not meet the CEQ recommendations for granting an extension, nor did they represent a substantial public interest an extension. Furthermore, it should be noted that the public will have the opportunity to review and comment on the Final EIS during the 30-day no action period prior to issuance of a ROD on the proposed action. Copies of the Final EIS will be distributed to all parties who commented on the Draft EIS or otherwise requested a copy.

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LETTER U

VIA FAX TO : (619)532-0940

Emeric Kalman
211 Granville Way
San Francisco, CA 94127
(415)665-5777

June 24, 2002

Ms.Timarie Seneca
BRAC Operations Office
Naval Facilities Engineering Command
Code 06CM.TS,
1230 Columbia Street, Suite 1100,
San Diego, CA 92101-8517

Dear Ms. Seneca:

I am pleased to provide you my comments on the DEIS for "The Disposal and Reuse of Naval Station Treasure Island" in the context of the Stewart B. McKinney Homeless Assistance Act; the Base Closure Community Development and Homeless Act of 1994 and the provisions of 10 U.S.C.2687, Armed Forces.

The documentation is incomplete with no information to the size and nature of the homeless population in San Francisco, the availability of existing services to meet the needs of the homeless in San Francisco and the totality of the buildings and property in the Treasure Island complex suitable for maximum use for the needs of the homeless in San Francisco.(10 USC 2687 Sec.2905(b)(7)(H)(i)(I) and subsequent non-conformity to subclauses (II);(III);(IV);(V):). U-1

I do believe that the DEIS for "The Disposal and Reuse of Naval Station Treasure Island", by exclusion without justification of a MAXIMUM HOMELESS USE ALTERNATIVE PLAN is not serving its purpose and mandate. U-2

The Draft Reuse Plan was approved by HUD on November 26, 1996 and commended as a model for base redevelopment and balancing the (homeless) needs of San Francisco.

The tragic reality is that, literally in plain view, human beings are let to die by the hundreds do to the inadequacy of homeless assistance leading agencies approach and oversight by HUD and other federal and state agencies!

Would you amend the "Reuse" plans to save lives? U-3

If you have any questions, or wish to discuss my comments, please call me at (415)665-5777.

Thank you.

Sincerely,

Emeric Kalman

Emeric Kalman

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Response to Comments

Response to Comment U-1. DBRCA legislation calls for surplus federal property, such as NSTI, to be transferred to a local reuse entity for use in a manner that benefits the full needs on the community. As part of the disposal process, the Navy is required under the Stewart B. McKinney Homeless Assistance Act, to consider benefits to the homeless community as a key part of the process. The homeless assistance planning process for NSTI is described in section 2.3 of the EIS. This process resulted in the development of the 1995 Homeless Assistance Plan, which provides economic development opportunities and employment for homeless individuals.

Response to Comment U-2. Comment noted.

Response to Comment U-3. Alternative 1 evaluated in the Draft EIS is based on the Draft Reuse Plan (San Francisco 196e). Upon completion of transfer of the property, TIDA will select a development partner and develop a Final Reuse Plan. As acknowledged in the Draft Reuse Plan, the Plan is by no means reflective of the only way development may occur. The designated property recipient and/or development partner would be required to comply with CEQA and evaluate potential environmental impacts of the specific development plan ultimately chosen for the property.

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LETTER V

Sailing Yacht Service

CONSULTATION - MAINTENANCE
REPAIR - RIGGING - DELIVERY

by WARWICK M. TOMPKINS • 50 PORTOLA LANE • MILL VALLEY • CALIFORNIA 94941 • TEL/FAX (415) 383-0949

24 June 2002

US Navy SW Division
Naval Facilities Engineering Command
1230 Columbia Street, Suite 1106
BRAC Operations Office
San Diego, CA 92101-8517

Attention : Timarie Seneca, FAX # 619 532 0940

Or To Whom It May Concern:

I attended the Tuesday 11 June 02 meeting convened on Treasure Island to hear public comment on the Draft Environmental Impact Statement (DEIS) prepared by the Navy and made public on 09 May 02.

Two other speakers and I requested an extension of the period available for study and comment of the DEIS. I handed, on that occasion, a letter to Ms Timarie Seneca, noting several objections to the DEIS, and formally requesting an extension of the period available for public study and comment. The period I requested was a further forty-five days (45).

On 21 June I received a telephone message from Ms Seneca, informing me that the Navy was "disinclined", I believe were the words used, to extend the period allowed for public study and or comment. Today, 24 June, the final day of the original forty-five day public commentary period, I was informed by Ms Seneca that "informally, the time for public comment was to be extended until the end of this week."

I wish to go on record as objecting strenuously to this brief, informal extension. Firstly, virtually no-one can be aware that the extension has been made, therefore its usefulness is next to non-existent. Secondly, the DEIS is a dense and complicated document, packed with information which cannot be digested quickly. Unless an individual were able to devote himself exclusively to reading and analysis of such a document, the time allowed is insufficient. The ability to focus solely on such a document does not describe any member of the public of whom I am aware.

V-1

LETTER V

I am conscious that the process of transferring title of Treasure Island/Yerba Buena from the Navy to the City of San Francisco is a lengthy and time consuming one, and that as Ms Seneca stated to me there are target dates to be met. Time pressures notwithstanding the public commentary aspect is critical if the ultimate goal of open and aboveboard government and management is to be met.

V-1

Please reconsider and grant those of us in the public domain a further forty-five (45) days to study and comment upon your document. My and the other two requests for extension were the only public comments offered. One of the other speakers made reference to her difficulty in obtaining the DEIS as did I, both orally and in my letter.

Failure to grant this extension makes a mockery of the public commentary process.

Respectfuly submitted,

Warwick d'Oempkins

Cc: Barbara Boxer
John Burton
San Francisco Chronicle

Response to Comments

Response to Comment V-1. Please see response to comment T-1 regarding an extension of the public comment period on the Draft EIS.

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LETTER W

Sailing Yacht Service

CONSULTATION · MAINTENANCE
REPAIR · RIGGING · DELIVERY

by WARWICK M. TOMPKINS · 50 PORTOLA LANE · MILL VALLEY · CALIFORNIA 94941 · TEL/FAX (415) 383-0949

US Navy, Southwest Division
Naval Facilities Engineering Command
1230 Columbia Street, Suite 1100
BRAC Operations Office
San Diego, CA 92101-8517
Attn: Ms. Timarie Seneca

Dear Ms. Seneca:
I am writing with regard to the DRAFT ENVIRONMENTAL IMPACT STATEMENT published by the Navy on 09 May 2002.
I find sections of the Statement incomplete, and others inaccurate.

The incomplete issues relate to the effects that dredging and pile driving are likely to have on the wildlife in the area. The noise level of these activities are discussed and then dismissed. The issue of the toxicity caused by the bottom paints of the vessels in the proposed Marina, or the effect of wastes discharged from these vessels is not mentioned.

My scaling of the area suggests that dredging and pile driving will take place, at its closest, within five hundred feet (500') of the Yerba Buena shoreline, rather than the twelve hundred (1200") mentioned in the Statement. W-1

Further, obtaining copies of this document has been difficult, negatively impacting the time available to study it in its entirety. Three of the seven libraries listed as having copies of the DEIS could not locate it. In addition, the telephone numbers listed in the document are all FAX numbers, which precluded direct contact with you. W-2

Treasure Island and its development are a highly visible and potentially very significant addition to the ambience of this area. It would be shameful if the development of the islands were done hastily or improperly.

In view of the above I officially request an additional forty-five (45) day review period. W-3

Sincerely,

Warwick M. Tompkins 11 June 2002

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Response to Comments

Response to Comment W-1. The potential impacts on wildlife of dredging and noise from pile-driving are discussed in section 4.8 (Biological Resources). The existing marina at Clipper Cove is approximately 500 feet from the eelgrass beds; however, expansion of the marina in Clipper Cove is proposed to occur east of the existing marina, approximately 1,200 feet from the eelgrass beds. As noted in the EIS, any in-water construction activities associated with marina expansion would require a permit from the COE and consultation with CDFG and NMFS. Such a permit would include conditions to reduce potential impacts to this habitat. In addition to permit approvals to address potential sources of contamination from marina construction, as described in section 3.10, the marina would also require an industrial stormwater permit to ensure potential contamination is avoided during operation.

Response to Comment W-2. Please see response to comment R-1 regarding availability of the Draft EIS.

Response to Comment W-3. Please see response to comment T-1 regarding an extension of the public comment period on the Draft EIS. As described in response to comment T-1, the Navy has determined that an extension of the comment period was not warranted. While the Navy made no express commitment to its ability to address comments received after the close of public comment period, in order to try and accommodate requests by members of the public, the Navy did offer to try and incorporate comments received by these individuals after the close of the formal comment period. The Navy has addressed concerns that were submitted after the close of the comment period.

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not references. It's just the way that it is laid out.

RON PLASEIED: If it's just how the text was written, if it's written more CEQA-wise in your mind, rather than NEPA-wise, feel free to throw out a comment on that. We'll gladly get back to you.

Why don't we take a ten minute break. We'll come back and we'll start hearing our comments. Thank you very much.

(A short recess was taken.)

RON PLASEIED: Welcome back. We'd like to start our second phase with the public hearing, which is, of course, the public comment period.

We're having some technical difficulties. It's a simple slide. The goal of this entire public hearing is to hear public comments. It's a very, very important part of this process.

We now turn our attention to that. Speakers will be called in order of the receipt of the cards. I have one. We ask that when you do come up and speak you limit yourself to five minutes so everyone can get a turn. I think we'll have plenty of time. Don't worry, we'll also allow time to following on speakers if you have more questions or want to make a general comment.

I do ask that when you do get up you speak clearly and more slowly than I did during the presentation, so that the court reporter here can accurately capture all the information. Please give your name, community you're with, organization you represent or whatever the pertinent information is. We'll make sure that we get that down.

Written comments are also encouraged whether you give them tonight or whether you get them postmarked to us by the 24th. At the end, we'll put up a slide that will give you the address of where those comments should go.

When you're called if you wouldn't mind just coming up to the podium. We only ask that so that you can get closer to the court reporter so we can accurately transcribe everything that is said. And please forgive me, I have a difficult name myself, so that gives me the purview and right to slaughter other people's names.

Warwick Tompkins?

WARWICK TOMPKINS: That's close. It's an English name. The second "W" doesn't get pronounced.

RON PLASEIED: Ah, Warwick?

WARWICK TOMPKINS: Warwick Tompkins is my

name. I'm a sailor. I represent myself. I'm trying to be a good citizen, and I'm here because I'm concerned about Clipper Cove and it's use in the future.

The environmental impact statement -- the whole political process surrounding this is sort of strange to me, it's new. I'm not an activist, and I'm learning. It's a little painful. I'm meeting a lot of nice people. I know a lot of hard work has gone into all this so far.

My comments are really not so much about your statement as they are about the cove and what might happen. And I will say about the statement that I haven't had enough time to look at it, and I have filed with Timarie a request for more time for me and others like me to study. I found difficulty in getting the statement. When I did get it, I studied it for a couple of hours today, and I found things that I thought were hasty, incomplete, and sometimes I thought inaccurate. Mainly with the cove, and the rest of the island I don't know about. I'm not even sure exactly how the draftee's plan is going to go, but I am a sailor of considerable experience, and I have real positive ideas about the cove, and I will say them tonight.

Am I speaking loudly enough? Slowly enough?

Clipper Cove, in my view, is a very unique sheet of water. It separates the two islands in a very obvious way. Everybody who came here a little earlier than I probably saw a small boat sailing out there.

There is a marina planned for the development, and it is apparently the apple of the development authority's eye. It certainly would be, and I am the first to agree that a marina is very much in order for this part of the bay.

It's a central location. For all the reasons that Clipper Cove is unique, a marina in this area would also be unique. It would be, in my view, a great tragedy to build a marina on such a unique body of water. It's an obvious place to build a marina, but if you think about how the sailing which is presently taking place as we speak on Clipper Cove is going to be eliminated by a marina -- and it will be because of the wind direction -- and the way it's used by sailing boats of all sizes, that sailing will be a thing of the past.

PH-1

I attended a fundraiser for the Treasure

Island Sailing Foundation, and all of their slide presentations showed activity in the water which will be occupied by the marina.

It appears that the San Francisco No Treasure Island Sailing Center Foundation is in league with the developers of the marina, and they are committed to supporting the marina, and they are doing so.

My vision of this area, for the record, is that the southern shore of Treasure Island should be turned into a marina or park, and there should be a good enough looking topography that you'd say, "I want to take my family there and have a picnic. I want to go there with my sweetie and hold hands." If the buildings are kept the way they're said to be kept, building number 1 and 180 were eliminated, you could build an interesting land site there, which would be covered, in my view. PH-2

In any case, if you could build a handsome place there, those people in that park would look across a stretch of water which would be filled with small boat activity for a good share of each day, and they would look at the north shore of Yerba Buena Island, which is just as beautiful as Angel Island, and this could be a jewel of a place.

Presently, when I drive down the causeway, I see breathtaking views to the west across the city across the Golden Gate, the Marin hills, it's a spectacular view. When you look to the right, you see Treasure Island, which is sorely in need of help, and a little lagoon. And the lagoon is a jewel, and I think could be kept that way. And I think if it were, that it would be a real asset to the community. Public access to the water via a park and small boats sailing via something either run by the public park or an independent franchise maintained mainly roughly 40 to 50 boats of different sizes using that water would be a brilliant use of the area, in my view.

PH-2

Additionally, to the east on Treasure Island, I think the parking lot should be made accessible to the water's edge so it would be a launching area for major international activities would come to San Francisco bay.

As a sailor, the uniqueness of this area and the closeness to all wonderful sailing centers is special. It's very special, and it should be preserved in my view.

That concludes my comments. Thank you.

RON PLASEIED: Did we get any more comment

cards?

RICHARD HANSEN: My name is Richard Hansen, and I'd like to request that the deadline be extended by one month, until the 24th of July, to prepare -- to provide people with additional opportunity to read the recommendations and to make a better assessment of what's coming.

I personally am disappointed that the meeting is so poorly attended, and I'm disappointed that the city could not make a more detailed presentation as to what their plans could be, but it seems to me it's an important topic that deserves more time, more attention. So one month would be helpful.

PH-3

RON PLASEIED: Thank you. Any more? One more?

SUSAN DeVICO: It's real quick. I'm Susan DeVico. I'm a resident, and I wanted to echo the sentiment of the gentleman that just spoke. Residents did not have an understanding of the importance of this meeting. I can tell you that as someone who tries to stay abreast of the things going on. I urge you -- this is a very digital community -- to please post this online electronically. You have a beautiful representation

PH-4

with maps and a PDF file, something that could be download. We have a community bulletin board here. I didn't see anything online about it at all. TIDA and the Navy is well aware of that.

RON PLASEIED: Thank you. Any others?

Okay. Would anyone like to have any follow-up questions comments or concerns? Okay.

DALE SMITH: I have one.

When the transfer of land to CalTrans took place to facilitate the expansion of the east extension of the Bay Bridge, does that remove it from clean up?

RON PLASEIED: No.

DALE SMITH: This is kind of an off-the-wall thing.

RON PLASEIED: The clean up responsibilities for the areas which were backed by that conveyance, the property is CalTrans property, state property. The clean up responsibility still rests with the Navy, and it's still a part of our program.

We have to now do a little more coordination with the state contractors, but we will be doing that clean up.

Any more questions?

PH-4

PH-5

Okay. If there's no more questions or comments, again, thank you very much for your attendance tonight. We are still actively seeking any comments. We have until the 24th. Any comments you have will be postmarked by the 24th to that address.

Thank you very much. This concludes the public hearing meeting. Have a great evening.

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Response to Comments

Response to Comment PH-1 (Mr. Warwick Tompkins). Please note that expansion of the marina is considered only under alternatives 1 and 2, with a smaller expansion under Alternative 1. The details of marina expansion and related shoreline development will be determined in the final development plan by the designated property recipient.

Response to Comment PH-2 (Mr. Warwick Tompkins). Please see response to comment PH-1 above regarding changes to Clipper Cove.

Response to Comment PH-3 (Mr. Richard Hansen). Please see response to comment T-1 regarding an extension of the public comment period on the Draft EIS. The purpose of the public meeting held on June 11, 2002, was to receive comments on the Draft EIS prepared by the Navy for disposal of NSTI. Specific development plans for NSTI are part of a separate process being conducted by the designated property recipient. TIDA is currently reviewing a detailed Draft development plan for NSTI. This plan can be reviewed at the TIDA website (www.ci.sf.ca.us/treasureisland).

Response to Comment PH-4 (Ms. Susan DeVico). Although the Draft EIS was not available on-line, it was made available through a number of other means, including direct mailing and area libraries.

Response to Comment PH-5 (Mr. Dale Smith). The Navy is responsible to complete all remedial activities currently being pursued under CERCLA on property that was conveyed to Caltrans for realignment of the SFOBB.

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APPENDICES

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APPENDIX A
Glossary

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APPENDIX A
GLOSSARY

100-year flood zone	Land area having a one percent chance of being flooded during a given year.
Ambient air quality standards	Standards established on a state or federal level that define the limits for airborne concentrations of designated criteria pollutants (nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, lead), to protect public health with an adequate margin of safety (primary standards) and public welfare, including plant and animal life, visibility, and materials (secondary standards) (also see Attainment area, below).
Aquifer	A layer of underground sand, gravel, or spongy rock in which water collects.
Arterial	A roadway from which local routes branch.
Artifact	Any product or human cultural activity; more specifically, any tools, weapons, artworks, etc., found in archeological contexts.
Asbestos	A carcinogenic substance formerly used widely as an insulation material by the construction industry; often found in older buildings.
Assemblage	The complete inventory of artifacts from a single, defined archaeological unit (such as a stratum or component).
Attainment area	An area which meets the National Ambient Air Quality Standards for a criteria pollutant under the Clean Air Act or meets state air quality standards.
A-weighted decibel (dBA)	A number representing the sound level which is frequency weighted according to a prescribed frequency response established by the American National Standards Institute (ANSI-S1.4-1971) and accounts for the response of the human ear.
Best-management practices (BMPs)	Includes schedule of activities, prohibition of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Burial	Human remains disposed of by interment. Burials may be *simple* (containing the remains of one person) or *complex* (containing the remains of two or more individuals), *primary* (including the remains as originally interred), or *secondary* (where a re-internment follows a temporary disposal elsewhere).
Capacity (transportation)	The maximum rate of flow at which vehicles can be reasonably expected to traverse a point or uniform segment of a lane or roadway during a specified time period under prevailing roadway, traffic, and control conditions.
Capacity (utilities)	The maximum load a system is capable of carrying under existing service conditions.
Caretaker	The U.S. Navy process of maintaining a closed facility.
Clean Air Act (CAA)	The CAA legislates that air quality standards set by federal, state, and county regulatory agencies establish maximum allowable emission rates and pollutant concentrations for sources of air pollution on federal and private property. Also regulated under this law is proper removal and safe disposal of asbestos from buildings other than schools.
Clean Water Act (CWA)	The CWA is the major federal legislation concerning improvement of the nations water resources. It provides for development of municipal and industrial wastewater treatment standards and a permitting system to control wastewater discharges to surface waters. The act contains specific provisions for regulation of ships' wastewater and disposal of dredge spoils within navigable waters. Section 404 of the act regulates disposal into waters of the United States, including wetlands.
Climate	The prevalent or characteristic meteorological conditions (and their extremes) of any given location or region.
Community Environmental Response Facilitation Act (CERFA)	A 1992 amendment to CERCLA, CERFA expedites the identification of uncontaminated real property within closing federal military facilities which offer the greatest opportunity for reuse and redevelopment.
Community noise equivalent level (CNEL)	Noise compatibility level established by California Administrative Code, Title 21, Section 5000. The 24-hour average A-weighted sound level with a 5 dB weighting added to levels occurring between 10:00 PM and 7:00 AM.

Comprehensive Environmental Response, Compensation, And Liability Act (CERCLA)	CERCLA, also known as Superfund, was enacted in 1980 to ensure that a source of funds is available to clean up abandoned hazardous waste dumps, compensate victims, address releases of hazardous materials, and establish liability standards for responsible parties. The act also requires creation of a National Priorities List (NPL) which sets forth the sites considered to have the highest priority for cleanup under Superfund.
Contamination	The degradation of naturally occurring water, air, or soil quality either directly or indirectly as a result of human activities.
Council on Environmental Quality (CEQ)	Established by NEPA, the CEQ consists of three members appointed by the President. CEQ regulations (40 CFR 1500-1508, as of July 1, 1986) describe the process for implementing NEPA, including preparation of environmental assessments and environmental impact statements, and timing and extent of public participation.
Cultural	(1) The nonbiological and socially transmitted system of concepts, institutions, behavior, and materials by which a society adapts to its effective natural and human environment; (2) Similar or related assemblages of approximately the same age from a single locality or district, thought to represent the activities of one social group.
Cultural history	The archeological sequence of cultural activity through time, within a defined geographic space or relating to a particular group.
Cultural resource	Prehistoric or historic districts, sites, buildings, objects, or any other physical evidence of human activity considered important to a culture, subculture, or community for scientific, traditional, religious, or any other reason.
Cumulative impacts	The combined impacts resulting from the addition of incremental impact of the proposed action to other past, present, and reasonably foreseeable future actions, regardless of which agency or person undertakes them.
Day-night average sound level (Ldn)	The 24-hour average-energy sound level expressed in decibels, with a 10 decibel penalty added to sound levels between 10:00 PM and 7:00 AM to account for increased annoyance due to noise during the night.
Decibel (dB)	A unit of measurement on a logarithmic scale which describes the magnitude of a particular quantity of sound pressure or power with respect to a standard reference value.
Developed	When land, a lot, a parcel, or an area has been built upon, or where public services have been installed prior to residential or commercial construction.

Disposal	Legal transfer of Navy property to other ownership.
Dredging	Removal of mud from the bottom of water bodies using a scooping machine.
Easement	An interest in land owned by another that entitles its holder to a specific limited use
Effluent	Waste material discharged into the environment.
Endangered species	A species that is threatened with extinction throughout all or a significant portion of its range.
Endangered Species Act (ESA)	The ESA requires federal agencies to determine the effects of their actions on endangered species and their critical habitats.
Environmental impact statement (EIS)	A document required of federal agencies by NEPA for major projects or legislative proposals significantly affecting the environment. A tool for decisionmaking, the EIS describes the positive and negative effects of the undertaking and lists alternative actions.
Equivalent noise levels (Leq)	Equivalent noise levels are used to develop single-value descriptions of average noise exposure over various periods of time.
Fault	Fracture in earth's crust accompanied by a displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.
Feasibility study (FS)	The feasibility study, part of the CERCLA remediation process, identifies and evaluates all applicable site cleanup alternatives. For most sites, a long list of alternatives are possible. A risk assessment is performed as part of the study to quantify the level of risk to the public and environment posed by the site. Often, the risk assessment determines which alternative is selected for final remediation. Each alternative is evaluated for effectiveness in protecting human health and the environment, ease of implementation, and overall cost. Typically, the remedial investigation and FS are performed concurrently.
Feature	A large, complex archeological artifact or part of a site such as a hearth, cairn, housepit, rock alignment, or activity area.
Flora	Plants; organisms of the plant kingdom taken collectively.
Ground water	Water within the earth that supplies wells and springs.

Hazard Ranking System (HRS)	This system provides a uniform method of scoring or ranking of the potential risk of a facility site where a hazardous substance has been present. The EPA developed the HRS to prioritize their cleanup efforts. The EPA evaluates the draft HRS packages and proposes any facilities scoring over 28.5 or higher for inclusion on the National Priorities List (NPL). Facilities which are listed on the NPL receive the highest priority.
Hazardous material	A substance or mixture of substances that poses a substantial present or potential risk to human health or the environment. Any substance designated by the EPA to be reported if a designated quantity of the substance is spilled in the waters of the United States or if it is otherwise released into the environment.
Hazardous waste	A waste or combination of wastes which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may either cause or significantly contribute to an increase in mortality or an increase in serious irreversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Regulated under RCRA.
Historic	A period of time after the advent of written history dating to the time of first Euro-American contact in an area. Also refers to items primarily of Euro-American manufacture.
Historic district	National Register of Historic Places designation of a geographically defined area (urban or rural) possessing a significant concentration, linkage, or continuity of sites, structures, or objects united by past events or aesthetically by plan of physical development.
Impacts	An assessment of the changes in the characteristics of an environmental resource caused by the project; an aggregation of all the adverse effects, usually measured using a qualitative and nominally subjective technique. Impacts analyzed under CEQA must be related to a physical change.
Infrastructure	The basic installations and facilities on which the continuance and growth of a locale depend (roads, schools, power plants, transportation, and communication systems).
Installation Restoration Program (IRP)	A program established by the Department of Defense to meet requirements of CERCLA of 1980 and SARA of 1986 which identifies, assesses, and cleans up or controls contamination from past hazardous waste disposal practices and hazardous material spills.

Level of Service (LOS)	In transportation analysis, a qualitative measure describing operational conditions within a traffic stream and how they are perceived by motorists and/or pedestrians. Usually given a letter grade from A to F, with A being free-flow; E, capacity; and F, forced-flow. Factors considered in LOS analyses include speed, travel time, traffic interruptions, freedom of maneuver, safety, driving comfort, and convenience. In public services, a measure describing the amount of public services available to community residents, generally expressed as the number of personnel providing service per 1,000 population.
Liquefaction	The transformation during an earthquake of unconsolidated, water-saturated sediment into a liquid form.
Long-term	Impacts that would occur over an extended period of time, whether they start during the construction or operations phase. Most impacts from the operations phase are expected to be long term since program operations essentially represent a steady-state condition (i.e., impacts resulting from actions that occur repeatedly over a long period of time). However, long-term impacts could also be caused by construction activities if a resource is destroyed or irreparably damaged or if the recovery rate of the resource is very slow.
Marsh	A type of wetland that does not accumulate appreciable peat deposits and is dominated by herbaceous vegetation. Marshes may be either fresh or salt water and tidal or nontidal.
McKinney Act	The McKinney Act gives recognized providers of assistance to the homeless a high priority in acquiring unneeded land and buildings on federal properties. The property can be used only for the homeless and only for two years. Homeless providers must be able to finance upgrades of facilities, pay a proportionate share of municipal service costs, and fund its program operations.
Migratory Bird Treaty Act	This act prohibits the taking or harming of a migratory bird, its eggs, nests, or young without the appropriate permit.
Mitigation	A method or action to reduce or eliminate project impacts, including application of existing plans, policies, and laws.
Multi-family housing	Townhouse or apartment units that accommodate more than one family though each dwelling unit is only occupied by one household.

National Environmental Policy Act (NEPA)	Public Law 91-190, passed by Congress in 1969, established a national policy designed to encourage consideration of the influence of human activities on the natural environment. NEPA also established the Council on Environmental Quality. NEPA procedures require that environmental information be made available to the public before decisions are made.
National Historic Preservation Act (NHPA)	The NHPA protects cultural resources. Section 106 of the act requires a Federal agency to take into account the potential effect of a proposed action on properties listed on or eligible for listing on the National Register of Historic Places.
National Pollution Discharge Elimination System (NPDES)	The NPDES is a provision of the Clean Water Act which prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the EPA or state.
National Priorities List (NPL)	A list of sites (regulated by either a federal or state agency) where releases of hazardous materials may have occurred and may cause an unreasonable risk to the health and safety of individuals, property, or the environment.
National Register Resources	Properties listed on the National Register of Historic Places, properties formally determined eligible for listing on the National Register, and those properties appearing to qualify for listing on the National Register.
Native American Graves Protection and Repatriation Act (NAGPRA)	NAGPRA defines the ownership and control of Native American human remains and associated funerary objects discovered or recovered from federal or tribal land.
Native Americans	Used in the collective sense to refer to individuals, bands, or tribes who trace their ancestry to indigenous populations of North America prior to Euro-American contacts.
Native vegetation	Plant life that occurs naturally in an area without agricultural or cultivational efforts. It does not include species that have been introduced from other geographical areas and have become naturalized.
Natural gas	A natural fuel containing primarily methane and ethane that occurs in certain geologic formations.
Nonnative species	Species that have invaded or been introduced into an area.
PCB-contaminated equipment	Equipment which contains a concentration of PCBs from 50 to 449 ppm or greater. Disposal and removal are regulated by the EPA.

Peak hour	The hour of highest traffic volume on a given section of roadway between 7:00 A.M. and 9:00 A.M. or between 4:00 P.M. and 6:00 P.M.
Permit	An authorization, license, or equivalent control document to implement the requirements of an environmental regulation.
Polychlorinated biphenyls (PCBs)	Any of a family of industrial compounds produced by chlorination of biphenyl. These compounds are noted chiefly as an environmental pollutant that accumulates in organisms and concentrates in the food chain with resultant pathogenic and teratogenic effects. They also decompose very slowly.
Potable water	Water that is suitable for drinking.
Prehistoric	The period of time before the written record.
Prehistory	The archeological record of nonliterate cultures; the cultural past before the advent of written records.
Preliminary assessment (PA)	The PA, part of the CERCLA remediation process, identifies areas of potential contamination and evaluates each area to determine if a threat to human health or the environment exists. A PA report is developed from readily available information such as past inventory records, aerial photographs, employee interviews, existing analytical data, and a site visit. A PA may recommend no further action, additional work, or a removal action.
Radon	A colorless, naturally occurring, radioactive, inert gaseous element formed by radioactive decay of radium in soil or rocks.
Record of Decision (ROD)	The document prepared under the federal government pursuant to NEPA that documents the reasoning behind the decision.
Recycling	The process of minimizing the generation of waste by recovering usable products that might otherwise become waste.
Region of influence (ROI)	For each resource, the region affected by the proposed action or alternatives and used for analysis in the affected environment and impact discussion.

Remedial action	During the remedial action (RA) phase, part of the CERCLA remediation process, the selected cleanup technology is implemented. RA can be as simple as soil excavation or as complicated as a complete ground water treatment system that operates for many years. Remedial action work plans for long term remediations will include Operation and Maintenance (O&M) plans. O&M efforts continue until the cleanup is complete.
Remedial investigation (RI)	This investigation, part of the CERCLA remediation process, is performed to more fully define the nature and extent of the contamination at a site and evaluate possible methods of cleaning up the site. During the investigation, ground water, surface water, soil, sediment, and biological samples are collected and analyzed to determine the type and concentration of each contaminant. Samples are collected at different areas and depths to help determine the spread of contamination.
Removal actions	In the event of an immediate threat or potential threat to human health or the environment, a short-term mitigating or cleanup action may be implemented. The goal of the removal action is to isolate the contamination hot spot and its source from all biological receptors. Usually, removal actions do not completely clean up a site, and additional remediation steps are required.
Resource Conservation and Recovery Act (RCRA)	RCRA was enacted in 1976 as the first step in regulating the potential health and environmental problems associated with hazardous waste disposal. RCRA and the regulations developed by EPA to implement its provisions provide the general framework of the national hazardous waste management system, including the determination of whether hazardous wastes are being generated, techniques for tracking wastes to eventual disposal, and the design and permitting of hazardous waste management facilities.
Runoff	The noninfiltrating water entering a stream or other conveyance channel shortly after a rainfall event.
Seismicity	Relative frequency and distribution of earthquakes.
Short-term	Transitory effects of the proposed program that are of limited duration and are generally caused by construction activities or operations start-up.

Significance	The importance of a given impact on a specific resource as defined under the Council on Environmental Quality regulations.
Single-family housing	A conventionally built house consisting oaf a single dwelling unit occupied by one household.
Site	The location of past cultural activity; a defined space with more or less continuous archeological evidence.
Site discovery	A site is an area that has or has had the potential for a hazardous substance release. A single facility may contain several sites to be studied. Potential sites are occasionally discovered by searching through records or during construction projects.
Site inspection (SI)	An inspection conducted after a preliminary assessment when additional information is needed to evaluate the site. The collection and analysis of soil, sediment, and surface or ground water samples may help determine the need for further study. The site inspection collects any information needed for hazard ranking. The SI may recommend a site for no action, further study, or an immediate removal action.
Soil	A natural body consisting of layers or horizons of mineral and/or organic constituents of variable thickness and differing from the parent material in their morphological, physical, chemical, and mineralogical properties and biological characteristics.
Soil types	A category or detailed mapping unit used for soil surveys based on phases or changes within a series (e.g.. slope, salinity).
Solid waste management	Supervised handling of waste materials from their source through recovery processes to disposal.
State Historic Preservation Officer (SHPO)	The official within each state, authorized by the state at the request of the Secretary of the Interior, to act as a liaison for purposes of implementing the National Historic Preservation Act.
Stratigraphy	The study of cultural and natural strata or layers in archeological and geological deposits, particularly with the aim of determining the relative age of strata.
Superfund Amendments and Reauthorization Act (SARA)	SARA was enacted in 1986 to increase the Superfund to $8.5 billion, modify contaminated site cleanup criteria scheduling, and revise settlement procedures. It also provides a fund for leaking underground storage tank cleanups and a broad, new emergency planning and community right to know program.

Surface water	All water naturally open to the atmosphere and all wells, springs, or other collectors which are directly influenced by surface water.
Threatened species	Plant and wildlife species likely to become endangered in the foreseeable future.
Toxic	Harmful to living organisms.
Toxic Substances Control Act (TSCA)	TSCA provides authority to test and regulate chemicals to protect human health. Substances regulated under TSCA include asbestos and PCBs.
Traffic, peak hour	The highest number of vehicles observed to traverse a section of roadway during 60 consecutive minutes.
Transfer	Deliver U.S. government property to another federal agency.
U.S. Environmental Protection Agency (USEPA)	The independent federal agency established in 1970 to regulate federal environmental matters and oversees the implementation of federal environmental laws.
Waters of the United States	Waters that are subject to Section 404 of the Clean Water Act. These include both deep water aquatic habitats and special aquatic sites, including wetlands.
Zoning	The division of a municipality into districts for the purpose of regulating land use, types of buildings, required yards, necessary off-street parking, and other prerequisites to development. Zones are generally shown on a map and the text of the zoning ordinance specifies requirement for each zoning category.

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APPENDIX B

Overview of Federal and State Disposal Laws and Regulations

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APPENDIX B
OVERVIEW OF FEDERAL AND STATE DISPOSAL LAWS AND REGULATIONS

FEDERAL REUSE PLANNING PROGRAMS AND PROCEDURES

This section briefly highlights some of the key federal planning programs and procedures that guide the base closure process at NSTI.

Defense Base Closure and Realignment Act of 1990 (10 U.S.C. § 2687)

This act established procedures to minimize the economic hardships on local communities adversely affected by base closures and to facilitate the economic recovery of such communities. In order to maximize the local benefit from the reutilization and redevelopment of the installation, the Secretary of the military department must consider local economic needs and priorities in the disposal process.

For NSTI, the Treasure Island Development Authority (TIDA) is recognized as the local redevelopment authority (LRA). The LRA is the entity recognized by the DoD through its Office of Economic Adjustment to prepare and direct the implementation of the reuse plan. In determining economic needs and priorities, and in preparing the Record of Decision (ROD) for an EIS, the federal lead agency must take into account and give substantial deference to the reuse plan developed by the LRA for the installation. A reuse plan is provided for the reuse or redevelopment of the closed military installation.

President Clinton's Five Point Program

This program was announced by former President Clinton in July 1993 in an effort to offset the negative effects of military base closures on local communities. The program emphasizes expeditious disposal of federal property for uses that will create new jobs for the local community. Job creation and economic development are given the highest priority in the reuse of closed military bases.

National Defense Authorization Act of 1994 (Pub. L. No. 103-160, 107 Star. 1547)

This act is an amendment to the DBCRA of 1990. Under this act, the federal government should attempt to facilitate the economic recovery of communities that experience adverse economic circumstances as a result of base closure or realignment. The federal government works with such communities to identify and implement means of redeveloping and revitalizing closed military installations in a beneficial manner and accelerate the environmental cleanup and restoration of closed military installations. The federal government may also make real property at closed military installations available to local communities at less than fair market value, or without consideration, if appropriate.

Stewart B. McKinney Homeless Assistance Act of 1987, as amended (Public Law No. 100-77)

Under this act, a homeless services provider may prepare and submit an application to acquire surplus federal property for purposes of assisting the homeless. As authorized by the act, DON must report the potential availability of all underutilized, unutilized, excess and/or surplus buildings and land to HUD. The suitability of these properties for use by the homeless is then determined by HUD. Homeless assistance providers have 60 days after the notice of availability is published in the Federal Register to express interest in the property to HHS and 90 days to submit an application. HHS has 25 days from receipt of the application to review and approve/deny it. With extremely limited exceptions, once an application is submitted to and approved by HHS, the holding agency (in this case DON) must assign the property to HHS for conveyance to the approved applicant.

An assignment of real property to another federal agency is categorically excluded under NEPA. However, under the provisions of 45 C.F.R. § 12.10, the other federal agency would be required to complete an environmental evaluation and to otherwise comply with NEPA prior to making a final conveyance of the property.

Base Closure Community Redevelopment and Homeless Assistance Act (42 U.S.C. § 11411)

The provisions of the Base Closure Community Redevelopment and Homeless Assistance Act, passed as part of the National Defense Authorization Act of 1994, support and put into law the intent of the President's efforts to support local communities affected by closure. This act, also referred to as the "Redevelopment Act," creates a locally controlled reuse process for redevelopment of a closing base. The act requires that the DoD recognize a local redevelopment authority for each closing installation in order to develop a reuse plan for each installation. The LRA is responsible for completing the screening and use of the base for state, local government, and homeless uses. The Department of Housing and Urban Development (HUD) reviews the community redevelopment plan to ensure that homeless needs have been adequately considered.

Surplus Property Act of 1994 (50 U.S.C. app. § 1601) and Federal Property and Administrative Services Act of 1949 (40 U.S.C. 471)

These acts established the authority for the transfer of excess real property to other federal agencies and the disposal of surplus property. The acts and implementing regulations provide for public benefit conveyances for health, education, and other purposes to tax exempt, nonprofit organizations, and public entities. The acts and regulations establish the process for the disposal of property through negotiated sales to public entities and through advertised competitive bidding.

STATE AND LOCAL PLANNING PROGRAMS AND PROCEDURES

This section briefly highlights some of the key local planning programs and procedures that guide the reuse process of NSTI.

California Planning and Zoning Law (Government Code Title 7, Division 1, §§ 65000-66037)

This law established regulations for long-term policies for use of property and related improvements, as well as the framework for zoning and subdivision regulations to implement those policies by city, county, and other local government agencies. California State law requires each city to adopt a comprehensive, long-term general plan for its physical development.

California Community Redevelopment Law (Health and Safety Code, § 33000 et. seq.)

This law establishes regulations for use by cities and counties to revitalize deteriorating and blighted urban areas. It authorizes a city or a county to establish a redevelopment agency and one or more redevelopment project areas. The law provides a redevelopment agency with powers that are typical for a local governmental agency and two unique powers: the ability to use the power of eminent domain (condemnation) to acquire property for resale to another private entity or organization; and the power to collect property tax increment in order to finance the redevelopment programs of the community, including the provision of public infrastructure and other improvements. Most of the NSTI reuse planning area is within the boundaries of a proposed redevelopment project area.

California Local Military Base Recovery Area Act (Government Code § 7105-7117)

In order to stimulate business and industrial growth in areas affected by military base closures, the State Legislature established the concept of local military base recovery areas (LAMBRAs) that could provide relaxed regulatory controls, tax credits, and other economic incentives to private sector investors. Local jurisdictions can apply for LAMBRA status for a base, provided it is not already within a state-designated enterprise zone. The act authorizes the California Trade and Commerce Agency (CTCA) to designate no less than one LAMBRA in each of the state's five regions, and limits the Agency to designating no more than eight LAMBRAs.

Governor Wilson's Executive Order W-81-94

This Executive Order by Governor Pete Wilson directs State agencies to pursue successful economic conversion of military bases by implementing State programs, regulatory pursuits, and allocation of resources for State-funded capital outlay projects. It includes provisions to expedite economic assistance and regulatory and resource reviews. It also designates the Director of the Office of Planning and Research (OPR) as the State lead public contact for redevelopment of military bases, and directs OPR to coordinate a comprehensive program to implement recommendations provided by the Governor's Military Base Reuse Task Force through state and federal legislation. All State departments and agencies are directed to cooperate in this effort.

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APPENDIX C

Agency Correspondence

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April 11 '95
"C94-179"

United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 NE. 11th Avenue
Portland, Oregon 97232-4181

IN REPLY REFER TO:
FWS/ARW-RE

1995

Dennis P. Drennan, Jr.
Director, Real Estate Division
Department of the Navy
Naval Facilities Engineering Command
900 Commodore Drive
San Bruno, California 94066-2402

Dear Mr. Drennan:

The U.S. Fish and Wildlife Service (Service) has been informed by Duane Marti of the U.S. Bureau of Land Management that the U.S. Navy will be disposing of Naval Station Treasure Island, which includes Yerba Buena Island.

The Service recognizes Yerba Buena Island as habitat for colonial seabirds. According to a 1990 census, the island supported small nesting colonies of Brandt's cormorants (4 nests), pelagic cormorants (2 nests), western gulls (31 nests), and black oystercatcher (1 breeding bird). The Brandt's cormorant colony and the pelagic cormorant colony are the only ones in San Francisco Bay. The Brandt's and pelagic cormorants are located at site 03 within site SFB-SF-07 as depicted on the enclosed map. Gulls are located at sites 01 through 05. The oystercatcher is located at site 01.

While we recognize that Yerba Buena Island does not warrant incorporation into the National Wildlife Refuge System, the natural resources of the island should be protected. Access to and activities around the nesting birds on Yerba Buena Island should be restricted. We recommend that the following covenant be included in any deed conveying the property to a non-Federal entity:

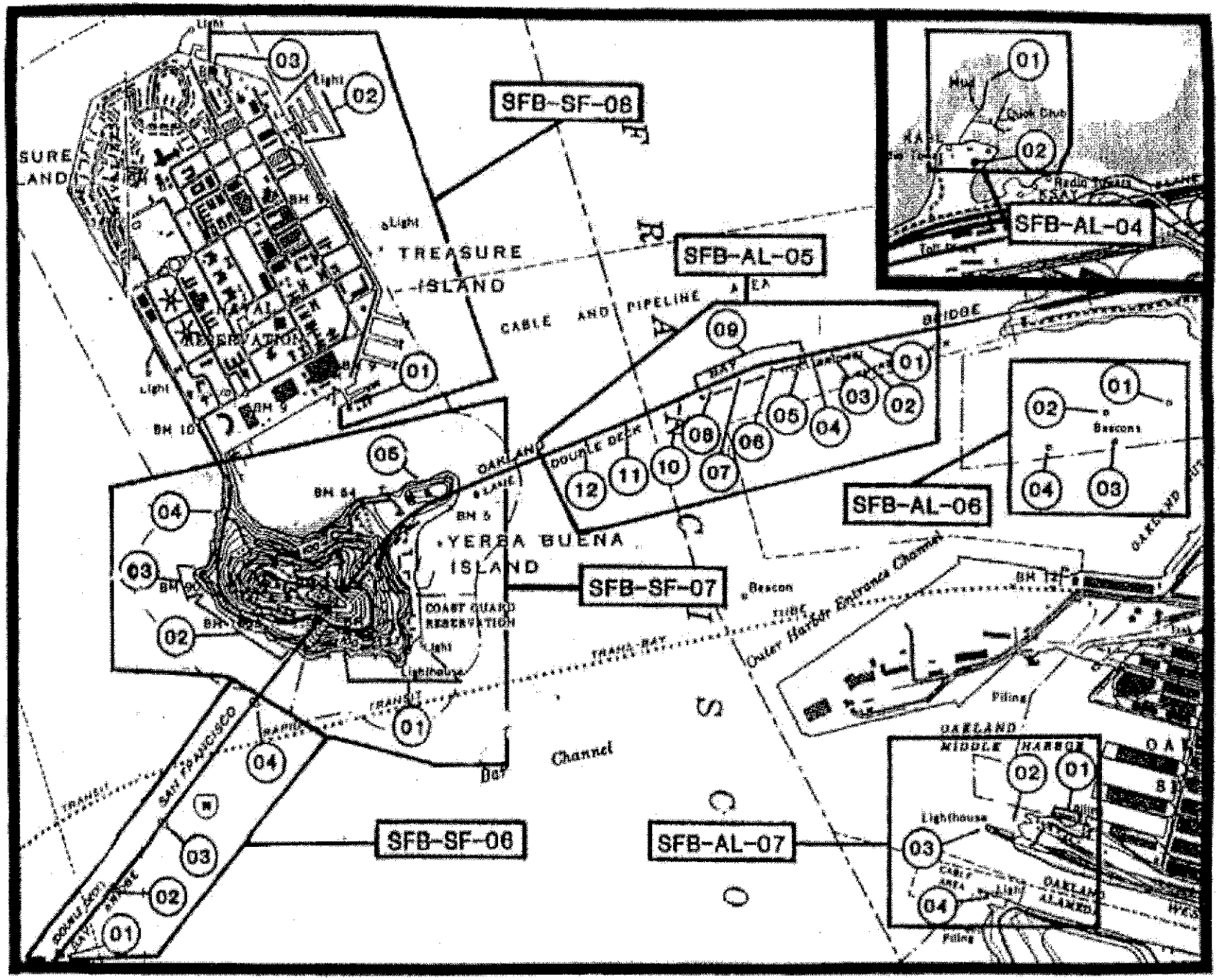
> The owner shall not use, or authorize the land to be used by others specifically during the breeding and nesting period between March 15 through August 30 of each year, for any purpose that would substantially or adversely interfere with its use as a seabird nesting area.

If you have any questions, please contact Richard Moore, Realty Supervisor, at (503) 231-6209 in Portland, Oregon. Thank you for your cooperation.

Sincerely,

Regional Director

Enclosure



C2

Chart 18649 Sections from 11th Edition, 3rd Printing, 5th March 2005 North of San Francisco and Northern Part

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
Sacramento Field Office
3310 El Camino Avenue, Suite 130
Sacramento, California 95821-6340

IN REPLY REFER TO:

1-1-97-I-839

February 27, 1997

Mr. Douglas Pomeroy
Group Leader, Base Conversion/Biology Section
U.S. Department of the Navy
Engineering Field Activity, West
Naval Facilities Engineering Command
900 Commodore Drive
San Bruno, California 94066-5005

Subject: Request for Concurrence for the Proposed Closure of Naval Station Treasure Island, San Francisco County, California, on Federally Listed Plant Species

Dear Mr. Pomeroy:

The U.S. Fish and Wildlife Service (Service) has reviewed the Navy's Special-Status Plant Survey and Habitat Assessment prepared for Yerba Buena Island. The Service concurs that closure of Naval Station Treasure Island, including Yerba Buena Island, is not likely to adversely affect any federally listed plant species.

No further action pursuant to the Endangered Species Act of 1973, as amended, is necessary for listed plants. We have included an attachment of federally listed animal species in the area of Treasure Island for use in developing the draft Environmental Impact Statement (DEIR). Several special-status avian species are known to occur within the project vicinity (i.e. California brown pelican, western snowy plover, California least tern, American peregrine falcon) and should be addressed individually in the DEIR. Please feel free to contact the Service should you require further information or technical assistance. We look forward to reviewing the DEIR upon its completion.

If you have questions regarding this response, please contact Meri Moore of my staff at (916) 979-2752.

Sincerely,

Wayne S. White
Field Supervisor

Attachment

cc: CDFG, Environmental Services, Sacramento, CA
FWS, Habitat Conservation, Sacramento, CA

THREATENED & ENDANGERED ANIMALS IN THE AREA OF OR AFFECTED BY PROJECTS IN THE AREA OF TREASURE ISLAND, CALIFORNIA
JANUARY 27, 1997

OAKLAND WEST

Eagle, bald, Haliaeetus leucocephalus (T)
Falcon, American peregrine, Falco peregrinus anatum (E)
Frog, California red-legged frog, Rana aurora draytonii (T)
Goby, tidewater, Eucyclogobius newberryi (E)
Mouse, salt marsh harvest, Reithrodontomys raviventris (E)
Pelican, California brown, Pelecanus occidentalis californicus (E)
Plover, western snowy, Charadrius alexandrinus nivosus (T)
Rail, California clapper, Rallus longirostris obsoletus (E)
Salamander, California tiger, Ambystoma californiense (C)
Salmon, Coho - central CA coast, Oncorhynchus kisutch (T)
Salmon, winter-run chinook, Oncorhynchus tshawytscha (E)
Salmon, winter-run chinook critical habitat, Oncorhynchus tshawytscha (E)
Smelt, delta, Hypomesus transpacificus (T)
Splittail, Sacramento, Pogonichthys macrolepidotus (PT)
Steelhead, Central California, Oncorhynchus mykiss (PE)
Tern, California least, Sterna antillarum (=albifrons) browni (E)
Whipsnake, Alameda, Masticophis lateralis euryxanthus (PE)

SAN FRANCISCO NORTH

Butterfly, San Bruno elfin, Incisalia mossii bayensis (E)
Butterfly, mission blue, Icaricia icarioides missionensis (E)
Eagle, bald, Haliaeetus leucocephalus (T)
Falcon, American peregrine, Falco peregrinus anatum (E)
Frog, California red-legged frog, Rana aurora draytonii (T)
Mouse, salt marsh harvest, Reithrodontomys raviventris (E)
Pelican, California brown, Pelecanus occidentalis californicus (E)
Plover, western snowy, Charadrius alexandrinus nivosus (T)
Rail, California clapper, Rallus longirostris obsoletus (E)
Salamander, California tiger, Ambystoma californiense (C)
Salmon, Coho - central CA coast, Oncorhynchus kisutch (T)
Salmon, winter-run chinook, Oncorhynchus tshawytscha (E)
Salmon, winter-run chinook critical habitat, Oncorhynchus tshawytscha (E)
Smelt, delta, Hypomesus transpacificus (T)
Splittail, Sacramento, Pogonichthys macrolepidotus (PT)
Steelhead, Central California, Oncorhynchus mykiss (PE)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

IN REPLY REFER TO:
1-1-00-SP-1247

March 21, 2000

Mr. Terry Witherspoon
Project Manager
Tetra Tech, Inc.
180 Howard Street, Suite 250
San Francisco, California 94105-1617

Subject: Species List for EIR/EIS, Disposal and Reuse of Naval Station Treasure Island, San Francisco County, California

Dear Mr. Witherspoon:

We are sending the enclosed list in response to your March 20, 2000, request for information about endangered and threatened species (Enclosure A). The list covers the following U.S. Geological Survey 7½ minute quad or quads: San Francisco South and Oakland West Quads.

Please read *Important Information About Your Species List* (enclosed). It explains how we made the list and describes your responsibilities under the Endangered Species Act. Please contact Harry Mossman, Biological Technician, at (916) 414-6650, if you have any questions about the attached list or your responsibilities under the Endangered Species Act. For the fastest response to species list requests, address them to the attention of Mr. Mossman at this address. You may fax requests to him at 414-6710 or 6711.

Sincerely,

for Karen J. Miller
Chief, Endangered Species Division

Enclosures

ENCLOSURE A

Endangered and Threatened Species that May Occur in or be Affected by

PROJECTS IN SAN FRANCISCO COUNTY

Reference File No. 1-1-00-SP-1247

March 21, 2000

Listed Species

Mammals

sei whale, *Balaenoptera borealis* (E)

blue whale, *Balaenoptera musculus* (E)

finback (=fin) whale, *Balaenoptera physalus* (E)

right whale, *Eubalaena glacialis* (E)

humpback whale, *Megaptera novaeangliae* (E)

sperm whale, *Physeter catodon (=macrocephalus)* (E)

salt marsh harvest mouse, *Reithrodontomys raviventris* (E)

Guadalupe fur seal, *Arctocephalus townsendi* (T)

Critical Habitat, Steller (=northern) sea-lion, *Eumetopias jubatus* (T)

Steller (=northern) sea-lion, *Eumetopias jubatus* (T)

Birds

California brown pelican, *Pelecanus occidentalis californicus* (E)

California clapper rail, *Rallus longirostris obsoletus* (E)

western snowy plover, *Charadrius alexandrinus nivosus* (T)

bald eagle, *Haliaeetus leucocephalus* (T)

Reptiles

leatherback turtle, *Dermochelys coriacea* (E)

loggerhead turtle, *Caretta caretta* (T)

green turtle, *Chelonia mydas (incl. agassizi)* (T)

olive (=Pacific) ridley sea turtle, *Lepidochelys olivacea* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

tidewater goby, *Eucyclogobius newberryi* (E)

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

delta smelt, *Hypomesus transpacificus* (T)

Central California steelhead, *Oncorhynchus mykiss* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

mission blue butterfly, *Icaricia icaroides missionensis* (E)

San Bruno elfin butterfly, *Incisalia mossii bayensis* (E)

Plants

Presidio manzanita, *Arctostaphylos hookeri ssp. ravenii* (E)
Presidio clarkia, *Clarkia franciscana* (E)
San Francisco lessingia, *Lessingia germanorum* (E)
Marin dwarf-flax, *Hesperolinon congestum* (T)
marsh sandwort, *Arenaria paludicola* (E)*
beach layia, *Layia carnosa* (E)*

Proposed Species

Birds

short-tailed albatross, *Diomedea albatrus* (PE)

Candidate Species

Amphibians

California tiger salamander, *Ambystoma californiense* (C)

Species of Concern

Mammals

gray whale, *Eschrichtius robustus* (D)
Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)
greater western mastiff-bat, *Eumops perotis californicus* (SC)
long-eared myotis bat, *Myotis evotis* (SC)
fringed myotis bat, *Myotis thysanodes* (SC)
long-legged myotis bat, *Myotis volans* (SC)
Yuma myotis bat, *Myotis yumanensis* (SC)
San Francisco dusky-footed woodrat, *Neotoma fuscipes annectens* (SC)
salt marsh vagrant shrew, *Sorex vagrans halicoetes* (SC)

Birds

little willow flycatcher, *Empidonax traillii brewsteri* (CA)
black rail, *Laterallus jamaicensis coturniculus* (CA)
bank swallow, *Riparia riparia* (CA)
American peregrine falcon, *Falco peregrinus anatum* (D)
tricolored blackbird, *Agelaius tricolor* (SC)
grasshopper sparrow, *Ammodramus savannarum* (SC)
Bell's sage sparrow, *Amphispiza belli belli* (SC)
American bittern, *Botaurus lentiginosus* (SC)
ferruginous hawk, *Buteo regalis* (SC)
Vaux's swift, *Chaetura vauxi* (SC)
lark sparrow, *Chondestes grammacus* (SC)
olive-sided flycatcher, *Contopus cooperi* (SC)
hermit warbler, *Dendroica occidentalis* (SC)
white-tailed (=black shouldered) kite, *Elanus leucurus* (SC)

Pacific-slope flycatcher, *Empidonax difficilis* (SC)
common loon, *Gavia immer* (SC)
saltmarsh common yellowthroat, *Geothlypis trichas sinuosa* (SC)
loggerhead shrike, *Lanius ludovicianus* (SC)
Alameda (South Bay) song sparrow, *Melospiza melodia pusillula* (SC)
long-billed curlew, *Numenius americanus* (SC)
ashy storm-petrel, *Oceanodroma homochroa* (SC)
rufous hummingbird, *Selasphorus rufus* (SC)
Allen's hummingbird, *Selasphorus sasin* (SC)
red-breasted sapsucker, *Sphyrapicus ruber* (SC)
elegant tern, *Sterna elegans* (SC)
Xantus' murrelet, *Synthliboramphus hypoleucus* (SC)
Bewick's wren, *Thryomanes bewickii* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)
southwestern pond turtle, *Clemmys marmorata pallida* (SC)
California horned lizard, *Phrynosoma coronatum frontale* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)
river lamprey, *Lampetra ayresi* (SC)
Pacific lamprey, *Lampetra tridentata* (SC)
longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Opler's longhorn moth, *Adela oplerella* (SC)
sandy beach tiger beetle, *Cicindela hirticollis gravida* (SC)
globose dune beetle, *Coelus globosus* (SC)
Ricksecker's water scavenger beetle, *Hydrochara ricksecker*i (SC)
bumblebee scarab beetle, *Lichnanthe ursina* (SC)

Plants

San Francisco Bay spineflower, *Chorizanthe cuspidata var. cuspidata* (SC)
San Francisco wallflower, *Erysimum franciscanum* (SC)
fragrant fritillary, *Fritillaria liliacea* (SC)
San Francisco gumplant, *Grindelia hirsutula var. maritima* (SC)
Marin checkermallow, *Sidalcea hickmanii ssp. viridis* (SC)
Mission Delores campion, *Silene verecunda ssp. verecunda* (SC)
San Francisco owl's-clover, *Triphysaria floribunda* (SC)
San Francisco popcornflower, *Plagiobothrys diffusus* (CA)*

alkali milk-vetch, *Astragalus tener var. tener* (SC) *
compact cobweb thistle, *Cirsium occidentale var. compactum* (SC) *
Diablo helianthella (=rock-rose), *Helianthella castanea* (SC) *
Kellogg's (wedge-leaved) horkelia, *Horkelia cuneata ssp. sericea* (SC) *
adobe sanicle, *Sanicula maritima* (SC) *
San Francisco manzanita, *Arctostaphylos hookeri ssp. franciscana* (SC) **
coast lily, *Lilium maritimum* (SC) ?*

KEY:

(E)	*Endangered*	Listed (in the Federal Register) as being in danger of extinction.
(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(PX)	*Proposed Critical Habitat*	Proposed as an area essential to the conservation of the species.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	Other species of concern to the Service.
(D)	*Delisted*	Delisted. Status to be monitored for 5 years.
(CA)	*State-Listed*	Listed as threatened or endangered by the State of California.
*	*Extirpated*	Possibly extirpated from the area.
**	*Extinct*	Possibly extinct
	Critical Habitat	Area essential to the conservation of a species.

ENCLOSURE A

Endangered and Threatened Species that May Occur in
or be Affected by Projects in the Selected Quads Listed Below
Reference File No. 1-1-00-SP-1247
March 21, 2000

QUAD : 466C SAN FRANCISCO NORTH

Listed Species

Mammals

Guadalupe fur seal, *Arctocephalus townsendi* (T)

sei whale, *Balaenoptera borealis* (E)

blue whale, *Balaenoptera musculus* (E)

finback (=fin) whale, *Balaenoptera physalus* (E)

right whale, *Eubalaena glacialis* (E)

Critical Habitat, Steller (=northern) sea-lion, *Eumetopias jubatus* (T)

Steller (=northern) sea-lion, *Eumetopias jubatus* (T)

sperm whale, *Physeter catodon (=macrocephalus)* (E)

salt marsh harvest mouse, *Reithrodontomys raviventris* (E) *

Birds

western snowy plover, *Charadrius alexandrinus nivosus* (T)

bald eagle, *Haliaeetus leucocephalus* (T)

California brown pelican, *Pelecanus occidentalis californicus* (E)

California clapper rail, *Rallus longirostris obsoletus* (E) *

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Critical habitat, coho salmon - central CA coast, *Oncorhynchus kisutch* (T)

coho salmon - central CA coast, *Oncorhynchus kisutch* (T)

Central California steelhead, *Oncorhynchus mykiss* (T)

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

mission blue butterfly, *Icaricia icarioides missionensis* (E)

San Bruno elfin butterfly, *Incisalia mossii bayensis* (E)

Plants

Presidio manzanita, *Arctostaphylos hookeri ssp. ravenii* (E)

marsh sandwort, *Arenaria paludicola* (E) *

Presidio clarkia, *Clarkia franciscana* (E)

Marin dwarf-flax, *Hesperolinon congestum* (T)

beach layia, *Layia carnosa* (E) *

San Francisco lessingia, *Lessingia germanorum* (E)

Proposed Species

Birds

short-tailed albatross, *Diomedea albatrus* (PE)

Fish

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (PX)

Candidate Species

Amphibians

California tiger salamander, *Ambystoma californiense* (C)

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)

gray whale, *Eschrichtius robustus* (D)

greater western mastiff-bat, *Eumops perotis californicus* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

San Francisco dusky-footed woodrat, *Neotoma fuscipes annectens* (SC)

Point Reyes jumping mouse, *Zapus trinotatus orarius* (SC)

Birds

tricolored blackbird, *Agelaius tricolor* (SC)

Bell's sage sparrow, *Amphispiza belli belli* (SC)

ferruginous hawk, *Buteo regalis* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

saltmarsh common yellowthroat, *Geothlypis trichas sinuosa* (SC)

black rail, *Laterallus jamaicensis coturniculus* (CA)

ashy storm-petrel, *Oceanodroma homochroa* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

southwestern pond turtle, *Clemmys marmorata pallida* (SC)

California horned lizard, *Phrynosoma coronatum frontale* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

Fish

longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Opler's longhorn moth, *Adela oplerella* (SC)

sandy beach tiger beetle, *Cicindela hirticollis gravida* (SC)

globose dune beetle, *Coelus globosus* (SC)

Ricksecker's water scavenger beetle, *Hydrochara ricksecker* (SC)

bumblebee scarab beetle, *Lichnanthe ursina* (SC)

Plants

San Francisco manzanita, *Arctostaphylos hookeri ssp. franciscana* (SC) **

alkali milk-vetch, *Astragalus tener var. tener* (SC) *

San Francisco Bay spineflower, *Chorizanthe cuspidata var. cuspidata* (SC)

San Francisco gumplant, *Grindelia hirsutula var. maritima* (SC)

Kellogg's (wedge-leaved) horkelia, *Horkelia cuneata ssp. sericea* (SC) *

San Francisco popcornflower, *Plagiobothrys diffusus* (CA) *

adobe sanicle, *Sanicula maritima* (SC) *

Marin checkermallow, *Sidalcea hickmanii ssp. viridis* (SC)

Mission Delores campion, *Silene verecunda ssp. verecunda* (SC)

San Francisco owl's-clover, *Triphysaria floribunda* (SC)

QUAD : 466D OAKLAND WEST

Listed Species

Mammals

salt marsh harvest mouse, *Reithrodontomys raviventris* (E)

Birds

western snowy plover, *Charadrius alexandrinus nivosus* (T)

bald eagle, *Haliaeetus leucocephalus* (T)

California brown pelican, *Pelecanus occidentalis californicus* (E)

California clapper rail, *Rallus longirostris obsoletus* (E)

California least tern, *Sterna antillarum (=albifrons) browni* (E)

Reptiles

Alameda whipsnake, *Masticophis lateralis euryxanthus* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

tidewater goby, *Eucyclogobius newberryi* (E)

delta smelt, *Hypomesus transpacificus* (T)

coho salmon - central CA coast, *Oncorhynchus kisutch* (T)

Central California steelhead, *Oncorhynchus mykiss* (T)

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Proposed Species

Fish

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (PX)

Plants

Santa Cruz tarplant, *Holocarpha macradenia* (PT) *

Candidate Species

Amphibians

California tiger salamander, *Ambystoma californiense* (C)

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)

Berkeley kangaroo rat, *Dipodomys heermanni berkeleyensis* (SC) *

greater western mastiff-bat, *Eumops perotis californicus* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

San Francisco dusky-footed woodrat, *Neotoma fuscipes annectens* (SC)

Alameda Island mole, *Scapanus latimanus parvus* (SC)

salt marsh vagrant shrew, *Sorex vagrans halicoetes* (SC)

Birds

tricolored blackbird, *Agelaius tricolor* (SC)

Bell's sage sparrow, *Amphispiza belli belli* (SC)

ferruginous hawk, *Buteo regalis* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

saltmarsh common yellowthroat, *Geothlypis trichas sinuosa* (SC)

black rail, *Laterallus jamaicensis coturniculus* (CA)

Alameda (South Bay) song sparrow, *Melospiza melodia pusillula* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

southwestern pond turtle, *Clemmys marmorata pallida* (SC)

California horned lizard, *Phrynosoma coronatum frontale* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

Fish

longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Bridges' Coast Range shoulderband snail, *Helminthoglypta nickliniana bridgesi* (SC)

Ricksecker's water scavenger beetle, *Hydrochara ricksecker* (SC)

San Francisco lacewing, *Nothochrysa californica* (SC)

Plants

alkali milk-vetch, *Astragalus tener var. tener* (SC) *

San Francisco Bay spineflower, *Chorizanthe cuspidata var. cuspidata* (SC) *

northcoast bird's-beak, *Cordylanthus maritimus ssp. palustris* (SC) *

Kellogg's (wedge-leaved) horkelia, *Horkelia cuneata ssp. sericea* (SC) *

adobe sanicle, *Sanicula maritima* (SC) *

KEY:

(E)	*Endangered*	Listed (in the Federal Register) as being in danger of extinction.
(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(PX)	*Proposed Critical Habitat*	Proposed as an area essential to the conservation of the species.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	May be endangered or threatened. Not enough biological information has been gathered to support listing at this time.
(D)	*Delisted*	Delisted. Status to be monitored for 5 years.
(CA)	*State-Listed*	Listed as threatened or endangered by the State of California.
(*)	*Extirpated*	Possibly extirpated from this quad.
(**)	*Extinct*	Possibly extinct.
	Critical Habitat	Area essential to the conservation of a species.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
777 Sonoma Avenue, Ste. 325
Santa Rosa, California 95404

April 12, 2000 F/SWR:4 BMM

Terry Witherspoon
Tetra Tech, Incorporation
180 Howard Street, Suite 250
San Francisco, California 94105-1617

Dear Terry Witherspoon:

Thank you for your letter requesting a list of species of concern from the National Marine Fisheries Service (NMFS) that are found in the project area impacted by the Disposal and Reuse of Naval Station Treasure Island in San Francisco County, California.

The following fish species federally-listed under the Endangered Species Act are located within the project area:

Sacramento River winter-run chinook salmon (Oncorhynchus tshawytscha)- endangered
Central Valley ESU spring-run chinook salmon- (Oncorhynchus tshawytscha) - threatened
Central California Coast ESU steelhead (Oncorhynchus mykiss) - threatened
Central Valley ESU steelhead (Oncorhynchus mykiss) - threatened

The project is located within designated critical habitat for the above listed species.

The project location is also designated as Essential Fish Habitat (EFH) for fish species managed with the following Fishery Management Plans under the Magnuson-Stevens Fishery Conservation and Management Act:

Pacific Groundfish Fishery Management Plan
Coastal Pelagics Fishery Management Plan

Information on EFH and the Fishery Management Plans, as well as species lists for the project area, are located on our website under Habitat Conservation Division (http://swr.ucsd.edu).

Two species of marine mammals are located in the project area: the California sea lion and the Harbor seal. These species are protected by the Marine Mammal Protection Act.

The U. S. Fish and Wildlife Service (USFWS) may also have listed species or critical habitat under its jurisdiction in the project area. Please contact USFWS at 2800 Cottage Way, Sacramento, California 95825, or (916) 414-6600, regarding the presence of listed species or critical habitat under their jurisdiction that may be affected by your project.

If you have any questions concerning these comments, please contact Brian Mulvey at (707) 575-6056.

Sincerely,

James R. Bybee
Habitat Program Manager
Northern California Region

cc: Christina Fahy, NMFS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

IN REPLY REFER TO:
1-1-02-SP-306

November 26, 2001

Ms. Jeannette Weisman
Biologist
Tetra Tech, Inc.
180 Howard Street, Suite 250
San Francisco, California 94105

Subject: Species List for Environmental Impact Statement for Disposal and Reuse of Naval Station Treasure Island, San Francisco County, California

Dear Ms. Weisman:

We are sending the enclosed list in response to your November 19, 2001, request for information about endangered and threatened species (Enclosure A). The list covers the following U.S. Geological Survey 7½ minute quad or quads: San Francisco North and Oakland West Quads.

Please read *Important Information About Your Species List* (enclosed). It explains how we made the list and describes your responsibilities under the Endangered Species Act. Please contact Harry Mossman, Biological Technician, at (916) 414-6674, if you have any questions about the attached list or your responsibilities under the Endangered Species Act. For the fastest response to species list requests, address them to the attention of Mr. Mossman at this address. You may fax requests to him at 414-6712 or 6713.

Sincerely,

Cecilia L. Brown

for Jan C. Knight
Chief, Endangered Species Division

Enclosures

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute *quads*. The United States is divided into these quads, which are about the size of San Francisco. If you requested your list by quad name or number, that is what we used. Otherwise, we used the information you sent us to determine which quad or quads to use.

Animals

The animals on your species list are ones that occur within, *or may be affected by projects within*, the quads covered by the list. Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.

Plants

Any plants on your list are ones *that have actually been observed* in the quad or quads covered by the list. We have also included either a county species list or a list of species in nearby quads. We recommend that you check your project area for these plants. Plants may exist in an area without ever having been detected there.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. For plant surveys, we recommend using the enclosed *Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed and Candidate Species*. The results of your surveys should be published in any environmental documents prepared for your project.

State-Listed Species

If a species has been listed as threatened or endangered by the State of California, but not by us nor by the National Marine Fisheries Service, it will appear on your list as a Species of Concern. *However you should contact the California Department of Fish and Game for official information about these species.* Call (916) 322-2493 or write Marketing Manager, California Department of Fish and Game, Natural Diversity Data Base, 1416 Ninth Street, Sacramento, California 95814.

Your Responsibilities Under the Endangered Species Act

All plants and animals identified as *listed* on Enclosure A are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the *take* of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal. Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

> If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a *formal consultation* with the Service. Such consultation would result in a *biological opinion* addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.
>
> If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an *incidental take permit*. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project. Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that mitigates for the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the mitigation plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as *critical habitat*. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Maps and boundary descriptions of the critical habitat may be found in the *Federal Register*. The information is also reprinted in the *Code of Federal Regulations* (50 **CFR** 17.95).

Candidate Species

We recommend that you address impacts to *candidate* species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Your list may contain a section called *Species of Concern*. This term includes former *category 2 candidate species* and other plants and animals of concern to the Service and other Federal, State and private conservation agencies and organizations. Some of these species may become candidate species in the future.

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6580.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed, candidate and special concern species in your planning, this should not be a problem. We also continually strive to make our information as accurate as possible. Sometimes we learn that a particular species has a different range than we thought. This should not be a problem if you consider the species on the county or surrounding-quad lists that we have enclosed. If you have a long-term project or if your project is delayed, please feel free to contact us about getting a current list. You can also find out the current status of a species by going to the Service's Internet page: *www.fws.gov*

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

In reply please refer to:
151422-SWR-01-SR-937:ME

DEC - 3 2001

Jeanette Weisman, Biologist
Tetra Tech Inc.
180 Howard Street, Suite 250
San Francisco, California 94105

Dear Ms. Weisman:

Thank you for your letter dated November 21, 2001, regarding the presence of Federally listed threatened or endangered species or critical habitat that may be affected by the U.S.Navy's proposed Disposal and Reuse of Naval station Treasure Island, in San Francisco, California.

Available information indicates that the following listed species (Evolutionarily Significant Units) and designated critical habitat may occur in the project areas:

Sacramento River winter-run chinook salmon (*Oncorhynchus tshawytscha*)
endangered (January 4, 1994, 59 FR 440)
critical habitat (June 16, 1993, 58 FR 33212)
Central Valley spring-run chinook salmon (*Oncorhynchus tshawytscha*)
threatened (September 16, 1999, 64 FR 50394)
critical habitat (February 16, 2000, 65 FR 7764)
Central California Coast coho (*Oncorhynchus* kisutch)
threatened (October 31, 1996, 64 FR 56138)
critical habitat (May 5, 1999, 64 FR 24049)
Central California Coast steelhead (*Oncorhynchus mykiss*)
threatened (August 18, 1997, 62 FR 43937)
critical habitat (February 16, 2000, 65 FR 7764)
Central Valley steelhead (*Oncorhynchus mykiss*)
threatened (March 19, 1998, 63 FR 13347)
critical habitat (February 16, 2000, 65 FR 7764)

The project location is also within an area designated as Essential Fish Habitat (EFH) for fish species managed with the following Fishery Management Plans (FMP) under the Magnuson-

Stevens Fishery Conservation and Management Act:

Pacific Groundfish FMP - (English sole, spiny dogfish, big skate, leopard shark, etc.)
Coastal Pelagics FMP - (northern anchovy, Pacific sardine)
Pacific Coast Salmon FMP - (chinook salmon)

If you have questions concerning these comments, please contact Maura Eagan of my staff at (707) 575-6092.

Sincerely,

Patrick J. Rutten
Northern California Supervisor
Protected Resources Division

cc: Jim Lecky, NMFS

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

AUG - 8 2002

In reply please refer to:
151422SWR01SR937: DPW

Michael C. Stroud
U.S. Department of the Navy
Southwest Division
Naval Facilities Engineering Command
1220 Pacific Highway
San Diego, California 92132-5190

Dear Mr. Stroud:

Thank you for your request of April 8, 2002, to initiate Endangered Species Act (ESA) section 7 consultation with the National Marine Fisheries Service (NOAA Fisheries) for the proposed disposal of the Naval Station at Treasure Island (NSTI), located in San Francisco Bay, California. Your letter also requested direction regarding compliance with the Magnuson-Stevens Fishery Conservation and Management Act (MSA). NOAA Fisheries has evaluated potential adverse effects to listed species under the jurisdiction of NOAA Fisheries and Essential Fish Habitat associated with the Navy's disposal of NSTI. NOAA Fisheries did not evaluate potential adverse effects to fisheries and habitat arising from reuse of the project area.

The Navy proposes to close its base on Yerba Buena Island and Treasure Island. A total of 922 acres is proposed for transfer to the City and County of San Francisco (City). The May 2002 draft Environmental Impact Statement (EIS) for this project describes Navy disposal alternatives and subsequent reuse alternatives. Navy disposal of surplus property is the federal action evaluated in the EIS, but the document also evaluates reasonably foreseeable impacts arising from reuse. The City's reuse plans include the expansion of an existing marina, construction of two ferry terminals, construction of housing, and construction of a 30-acre theme park. Several activities associated with the reuse plan, such as dredging, pile driving, and stormwater runoff, may adversely affect species and habitat protected under both the ESA and MSA. However, the Navy expects the Local Reuse Authority for the site to obtain permits for these actions associated with reuse and NOAA Fisheries will consult on these reuse activities in the future, when applications for federal permits are processed. Based on discussions between my staff and Mr. Robert Palmer of your staff, this current consultation is limited solely to the Navy's proposed transfer of surplus property.

On June 5, 2002, representatives from NOAA Fisheries, the Navy, and the Navy's consultation, Tetra Tech, visited NSTI and discussed the proposal disposal and reuse alternatives.

Endangered Species Act
The following listed species (Evolutionarily Significant Units) and designated critical habitat under the jurisdiction of NOAA Fisheries may occur in the project area:

Sacramento River winter-run chinook salmon (*Oncorhynchus tshawytscha*)
endangered (January 4, 1994, 59 FR 440)
critical habitat (June 16, 1993, 58 FR 33212)
Central Valley spring-run chinook salmon (*Oncorhynchus tshawytscha*)
threatened (September 16, 1999, 64 FR 50394)
Central California Coast steelhead (*Oncorhynchus mykiss*)
threatened (August 18, 1997, 62 FR 43937)
Central Valley steelhead (*Oncorhynchus mykiss*)
threatened (March 19, 1998, 63 FR 13347)

Based on the best available information, the transfer of Naval Station Treasure Island property to the City and County of San Francisco is not likely to adversely affect the threatened and endangered species listed above or their designated critical habitat. However, several actions proposed by the City associated with reuse alternatives may adversely affect listed species or designated critical habitat under the jurisdiction of NOAA Fisheries. The City should ensure that there is proper coordination and project-level review by NOAA Fisheries pursuant to the Federal Endangered Species Act (ESA) prior to taking any reuse actions that may effect listed anadromous salmonids.

This concludes consultation in accordance with 50 CFR §402.14(b)(1) for the proposed transfer of NSTI to the City and County of San Francisco. However, further consultation may be required if (1) new information becomes available indicating that listed species or critical habitat may be adversely affected by the project in a manner not previously considered; (2) the project is modified in a manner that affects listed species or critical habitat; or (3)a new species is listed that may be affected by this action.

Magnuson-Stevens Act - Essential Fish Habitat
The aquatic portion of NSTI is an area identified as Essential Fish Habitat (EFH) for various life stages of fish species managed with the following Fishery Management Plans (FMP) under the MSA:

Pacific Groundfish FMP - (English sole, brown rockfish, starry flounder, leopard shark, etc.)
Coastal Pelagics FMP - (northern anchovy, Pacific sardine)
Pacific Coast Salmon FMP - (chinook salmon)

NOAA Fisheries has evaluated the proposed transfer of property for potential adverse effects to EFH pursuant to Section 305(b)(2) of the

MSA. Because the action of transferring property does not alter EFH, Conservation Recommendations are not necessary. However, as stated above for the BSA, the City should ensure that there is proper coordination and project-level review by NOAA Fisheries pursuant to the MSA prior to taking any reuse actions that may adversely affect EFH.

Please contact David Woodbury of my staff at (707) 575-6088 if you have any questions regarding this consultation.

Sincerely,

Rodney McInnis For
Acting Regional Administrator

cc: Jim Lecky, NMFS, Long Beach
Penny Ruvelas, NMFS, Long Beach
Robert Palmer, US Navy, San Diego

WASHINGTON, D.C. 20410-7000

OFFICE OF THE ASSISTANT SECRETARY FOR
COMMUNITY PLANNING AND DEVELOPMENT

November 26, 1996

Larry Florin
Manager of Military Base Conversion
City and County of San Francisco
401 Van Ness Avenue, Room 336
San Francisco, CA 94102

Dear Mr. Florin:

I am pleased to inform you that the Department of Housing and Urban Development (HUD) has approved your base reuse plan for the Naval Station Treasure Island under the Base Closure Community Redevelopment and Homeless Assistance Act of 1994. This means that you can now move forward with implementing your plan.

Specifically, we have determined that the plan meets the requirements under the Act regarding outreach to homeless assistance providers and balancing the economic redevelopment, other development, and homeless needs of your community. We are pleased that the City and County of San Francisco and the Treasure Island Homeless Development Initiative agreed on a mutually acceptable arrangement that is reflected in the enclosed legally binding agreement which provides for participation in housing and economic development opportunities for the clients of fourteen homeless providers.

Congratulations on your success in balancing the diverse needs of your community. The creative combination of interim use of the base housing and funding from part of the proceeds of its future development is a model for base redevelopment.

I wish you continued success in implementing your base reuse plan. HUD stands ready to assist you in your revitalization efforts.

Sincerely,

Andrew Cuomo
Assistant Secretary

Enclosure

STATE OF CALIFORNIA — THE RESOURCES AGENCY

PETE WILSON, Governor

OFFICE OF HISTORIC PRESERVATION
DEPARTMENT OF PARKS AND RECREATION
P.O. BOX 942896
SACRAMENTO 94296-0001
(916) 653-6624
FAX: (916) 653-9824

October 15, 1997

REPLY TO: USN970708A

Louis S. Wall, Cultural Resources Program Coordinator
Environmental Planning Branch
Engineering Field Activity, West
Naval Facilities Engineering Command
900 Commodore Drive
SAN BRUNO CA 94066-24402

Dear Mr. Wall:

RE: CLOSURE OF NAVAL STATION TREASURE ISLAND, SAN FRANCISCO

Thank you for fowarding the above referenced undertaking to my office for review and comment pursuant to Section 106 of the National Historic Preservation Act and its implementing regulations found at 36 CFR Part 800.

The undertaking is the closure of Naval Station Treasure Island, San Francisco pursuant to the Base Realignment and Closure Act. As part of its responsibilities under Section 106 the Navy has evaluated properties at the Naval Station to determine if any are eligible for inclusion in the National Register of Historic Places. The documentation for the Navy's determinations is found in "Cultural Resource Inventory and Evaluation Investigations: Yerba Buena Island and Treasure Island Naval Station Treasure Island, San Francisco, California," prepared by JRP Historical Consulting Services in March 1997, and in "Archeological Inventory and Assessment of Naval Station Treasure Island Disposal and Reuse Project, San Francisco County, California," prepared by PAR Environmental Services in June 1997. As a result of these studies, the Navy has determined that the following properties are eligible for inclusion in the National Register of Historic Places: Senior Officers' Quarters Historic District, Yerba Buena Island; Quarters 8, Quarters 9, and Building 262, Yerba Buena Island; and that archeological sensitivity zones 1 through 4 have the potential to yield important information about the prehistory or history of Yerba Buena Island, and may qualify for listing in the National Register. The Navy has noted that consensus determinations of eligibility between the SHPO and the Navy exist for Buildings 1, 2, and 3 on Treasure Island, and has not asked for my concurrence in their National Register eligibility at this time. The Navy has further determined that the balance of buildings and archeological properties at the Naval Station are not eligible for inclusion in the National Register. My comments on your various determinations appear below.

Senior Officers' Quarters Historic District, Yerba Buena Island: You have determined that this district is eligible for inclusion in the National Register under criteria A and C at the local level of significance. The period of significance for the district extends from 1900-1947. Contributors include Quarters 1-7 (Quarters 1 is individually listed in the National Register), Building 83, Building 205, and Building 230. Boundaries for the district are outlined at Figure 1 of the District Record form. The period of significance extends from 1900-1947. I agree with the concept of the proposed historic

district, but I think it is important to clarify some additional characteristics of the district at this time. While you have acknowledged that landscape elements tie buildings in the district together, you have not identified them as contributors to the district. I recommend that you include the site of the district as an additional contributor including collectively the 1940 tennis court, walkways, terraced gardens, masonry walls, greensward in front of Quarters 1-4, and whatever other elements you believe appropriate. Also, what non-contributors exist within the district boundaries? There is one small building identified by the initials G.H. near Building 205., I am assuming this is a non-contributor, along with Building 200 which you have show inside the boundaries. Is this assumption correct?

Quarters 8, Yerba Buena Island: I concur with your determination that Quarters 8, built in 1905, is individually eligible for inclusion in the National Register under criteria A and C at the local level of significance. Its period of significance extends from 1905-1947.

Quarters 9, Yerba Buena Island: I concur with your determination that Quarters 9, built c. 1916, is individually eligible for inclusion in the National Register under criteria A and C at the local level of significance. Its period of significance extends from 1916-1947.

Building 262, Yerba Buena Island: I concur with your determination that Building 262, constructed in 1891 and known historically as the Torpedo Assembly Building, is individually eligible for inclusion in the National Register under criteria A and C at the state level of significance. Its period of significance extends from 1891-1947.

Archeological Sensitivity Zones 1 through 4: I agree that Sensitivity Zones 1 through 4 appear to have the potential to contain important information in history and prehistory. This information has largely been recovered over the years during construction activities in the various sensitivity areas. Your current submittal, however, documents evidence that each of the sensitivity zones has been sufficiently damaged over the years to possess only limited integrity. Thus far, the Navy has formally identified CA-SFr-4 (sensitivity zone 1), while the three other sensitivity zones (2 through 4) have not been recorded nor have trinomials been assigned. I agree that while lacking definitive information on the sensitivity zone deposits they may still be eligible for the National Register as the Navy asserts. To date, however, there is nothing to support a determination that any of the sensitivity zones or CA-SFr-4 are eligible for the National Register.

Miscellaneous Archeological Properties: The Navy requests that I concur with its determination that none of the other prehistoric sites or historic archeological features are eligible for inclusion in the National Register. Other than CA-SFr-4 and the sensitivity zones discussed above, what other prehistoric sites/features are there? I am also very interested to know how the Navy supports its determination that the historic era features P-35-000135 through P-38-000156 are not eligible. It seems that certain of these features, for example the 1916 Recruit Mess Hall/Kitchen Complex (P-38-000135), might have buried deposit. The Navy should determine whether this a

possibility before formalizing its National Register eligibility determination for the 22 historic era features.

Non-eligible Buildings/Structures: I concur with your determination that the buildings/structures listed in Table 3.2 of JRP Historical Consulting Services "Cultural Resource Inventory and Evaluation Investigations", pp. 4-10 are not eligible for inclusion in the National Register.

Treasure Island: Treasure Island was built in 1936 by the San Francisco District Corps of Engineers on the Yerba Buena Shoals. JRP Historical Consulting Services describe the feat, "filling a 400 acre island with millions of cubic yards of rock and sand—in about 18 months" as a "Herculean task." You have not addressed the eligibility of this property. What are the views of the Navy regarding the National Register eligibility of this structure (excluding later improvements) created by the engineering talents of the Corps of Engineers?

I look forward to hearing from you at your earliest convenience regarding the Senior Officers' Quarters Historic District on Yerba Buena Island, archeological properties outside of the identified sensitivity zones on Yerba Buena Island, and Treasure Island. If you have questions or comments regarding historic buildings or structures, please contact staff historian Lucinda Woodward at (916) 653-9116. Questions or comments regarding prehistoric or historic sites or features should be addressed to staff archeologist Steve Grantham at (916) 653-8920.

Sincerely,

Cherilyn Widell
State Historic Preservation Officer

APPENDIX D

Notice of Intent (NOI) and Availability

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[Federal Register: September 24, 1996 (Volume 61, Number 186)]
[Notices]
[Page 50004]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr24se96-31]

DEPARTMENT OF DEFENSE
Department of the Navy

Notice of Intent To Prepare a Joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Disposal and Proposed Reuse of Naval Station Treasure Island, San Francisco, CA

Summary: Pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969 as implemented by the Council on Environmental Quality regulations (40 CFR Parts 1500-1508), the California Environmental Quality Act (CEQA) Section 15170, the Department of the Navy, in coordination with the City and County of San Francisco, California, announces its intent to prepare a joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the disposal and proposed reuse of the Naval Station Treasure Island (NSTI) property and structures located in the City and County of San Francisco, California. The Navy will be the lead agency for NEPA documentation and the City and County of San Francisco will be the lead agency for CEQA documentation. The Defense Base Closure and Realignment Act (Public Law 101-510) of 1990, as implemented by the base closure process of 1993, directed the Navy to close NSTI. NSTI is scheduled for closure in September, 1997.

NSTI is located in the San Francisco Bay between the cities of Oakland and San Francisco within the boundaries of the City and County of San Francisco. NSTI occupies about 403 acres on Treasure Island, with about 150 military buildings, 908 family housing units, and nine barrack-style housing facilities. NSTI also occupies approximately 115 acres on Yerba Buena Island, with approximately 10 military buildings and 105 housing units. Yerba Buena Island is bisected by the San Francisco-Oakland Bay Bridge.

The EIS/EIR will address Navy disposal of the property, including a Navy ``no action'' alternative, and the potential environmental impacts resulting from community reuse development proposed in the Naval Station Treasure Island Reuse Plan prepared by the City and County of San Francisco. The reuse plan's Land Use Plan, dated July 1996, will serve as the basis for the EIS/EIR reuse alternatives. Three community reuse alternatives are expected to be evaluated in the EIS/EIR: the Maximum Density Alternative, Reduced Density Alternative, and Residential Neighborhood Alternative. The Navy ``no action'' alternative will evaluate NSTI as closed but remaining in federal caretaker status.

The Maximum Density Alternative includes publicly oriented uses such as a theme park, sports field, film production center, hotels, museum, and conference center. It also includes institutional uses, educational and child care facilities, a fire fighting training school, community services, recreational facilities, public open space along the Treasure Island shoreline and Yerba Buena western hillside, and up to 2,800 residential units. The Reduced Density Alternative includes the publicly oriented, institutional uses, and recreational facilities identified above, as well as the public open space along the Treasure Island shoreline and Yerba Buena western hillside. There would be no housing development on Treasure Island under this alternative. Up to 300 housing units would be located on Yerba Buena Island. The Residential Neighborhood Alternative focuses on the creation of new housing opportunities at NSTI, with up to 5,000 dwelling units located on Treasure Island, and an additional 235 units located on Yerba Buena Island. It includes publicly oriented uses such as a film production center and a small hotel, as well as institutional uses, educational and child care

facilities, recreational facilities, and public open space along the Treasure Island shoreline and Yerba Buena western hillside.

ADDRESSES: Federal, state and local agencies, and interested individuals are encouraged to participate in the scoping process to assist the Navy in determining the range of issues and reuse alternatives to be addressed. A public scoping meeting to receive oral and written comments will be held on Wednesday, October 9, 1996, at 7:00 p.m., in the Port Commission Room, Third Floor, Suite 3100, Ferry Building, San Francisco, California. Navy and City and County of San Francisco representatives will briefly summarize the community reuse planning process, the environmental impact analysis processes, and will then solicit public comments. In the interest of allowing everyone a chance to participate, each speaker will be requested to limit oral comments to five minutes. Longer comments should be summarized at the public meeting and/or mailed to the address listed at the end of this announcement.

FOR FURTHER INFORMATION CONTACT: All written comments must be submitted within 30 days of the published date of this notice to Ms. Mary Doyle (Code 185), Engineering Field Activity West, Naval Facilities Engineering Command, 900 Commodore Drive, San Bruno, California 94066-5006, telephone (415) 244-3024, fax (415) 244-3737. For information concerning the EIR, please contact the City and County of San Francisco, Planning Department, Ms. Carol Roos, telephone (415) 558-6378, or fax (415) 558-6426. For further information regarding the Naval Station Treasure Island Reuse Plan, please contact Ms. Alison Kendall, City and County of San Francisco, Planning Department, telephone (415) 558-6290, or fax (415) 558-6426.

Dated: September 19, 1996.
D.E. Koenig,
LCDR, JAGC, USN, Federal Register Liaison Officer.
[FR Doc. 96-24427 Filed 9-23-96; 8:45 am]

[Federal Register: May 10, 2002 (Volume 67, Number 91)]
[Notices]
[Page 31791-31793]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr10my02-43]

DEPARTMENT OF DEFENSE

Department of the Navy

Public Hearing for the Draft Environmental Impact Statement (DEIS) for Disposal and Reuse of Naval Station Treasure Island (NSTI), San Francisco, CA

AGENCY: Department of the Navy, DOD.

ACTION: Notice.

SUMMARY: Pursuant to section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969, as implemented by the Council on Environmental Quality regulations (40 CFR parts 1500-1508), the Department of the Navy (Navy) has prepared and filed with the United States Environmental Protection Agency (EPA) the DEIS for Disposal and Reuse of NSTI. A public hearing will be held to receive oral and written comments on the DEIS. Federal, state, and local agencies and interested individuals are invited to be present or represented at the hearing.

DATES AND ADDRESSES: A public hearing will be held on Tuesday, June 11, 2002, from 7:00 p.m. to 9:30 p.m. at the Nimitz Conference Center, Building 140, corner of ``D'' and ``California'' streets, Treasure Island, San Francisco, CA 94130 for the purpose of receiving oral and written comments on the DEIS.

FOR FURTHER INFORMATION CONTACT: Ms. Timarie Seneca, Community Planner, BRAC Operations Office at (619) 532-0955, by fax at (619) 532-0940 or write to Commander, Southwest Division, Naval Facilities Engineering Command, Attn: Ms. Timarie Seneca, Code 06CM.TS, 1230 Columbia Street, Suite 1100, San Diego, CA 92101-8517.

SUPPLEMENTARY INFORMATION: The DEIS has been prepared in accordance with the Defense Base Closure and Realignment Act of 1990 (10 U.S.C. 2687) and the recommendations of the Defense Base Closure and Realignment Commission approved by the President and accepted by Congress in 1991, 1993, and 1985.

A Notice of Intent (NOI) to prepare the DEIS was published in the Federal Register at 61 FR 50004, Sep. 24, 1996. A public scoping meeting was held on October 9, 1996, at the San Francisco Ferry Building.

The meeting was advertised in the San Francisco Chronicle, Marin Independent Journal, San Jose Mercury News, and Oakland Tribune on Sunday, September 29, 1996, and Tuesday, October 1, 1996.

The proposed action is the disposal of Navy property for subsequent reuse and redevelopment, in accordance with the 1990 Defense Base Closure and Realignment Act, and the 1993 Base Realignment and Closure Commission recommendations. NSTI was operationally closed on September 30, 1997. NSTI is located on two islands in the San Francisco Bay approximately midway between the shores of the cities of San Francisco

and Oakland. The larger island, called Treasure Island, consists of 402 acres (160 hectare (ha)) of dry land created with artificial fill in the 1930s. Approximately 681 acres (276 ha) of dry and submerged land are available for disposal on Treasure Island. Yerba Buena Island is a natural island connected to Treasure Island by a causeway. Approximately 239 acres (97 ha) of dry and submerged land are available for disposal on Yerba Buena Island. Approximately 36 acres (14 ha) of land on Treasure Island have been transferred to the Department of Labor, approximately 97 acres (39 ha) on Yerba Buena Island have been transferred to Caltrans, and a total of 22 acres (9 ha) are ultimately scheduled for transfer to the Coast Guard.

The DEIS evaluates three reuse alternatives. Navy disposal is assumed as part of each of the reuse alternatives. Alternative 1 represents full implementation of the development scenario described in the Naval Station Treasure Island Draft Reuse Plan developed by the Local Redevelopment Authority (LRA). Alternative 2 is based on comments received during the scoping process, including the recommendations of an Urban Land Institute advisory panel. Alternative 3 represents a lower level of redevelopment than proposed in the Draft Reuse Plan. A fourth alternative, No Action, assumes no disposal of property and retention of the property by the Navy in an inactive or caretaker status. Under the No Action Alternative, existing leases would continue until they expire or are terminated, no new leases would be entered into, and all buildings and other facilities would remain vacant and unused.

Alternative 1 (Preferred Alternative) features a combination of publicly oriented development, open space and recreation, and extensive residential development at full build out. Under Alternative 1, publicly oriented development on Treasure Island would include a theme attraction similar to Disneyland; with lighting displays, some tall structures, such as a roller coaster, and at least one landmark structure assumed to be up to 100 feet (305 meters (m)) tall. Development would also include a 300-room hotel and a 1,000-room hotel with three restaurants and offices. Publicly oriented uses on Yerba Buena Island would include a 150-room hotel, conference facilities, and a restaurant. Clipper Cove Marina would also be expanded and a new yacht club would be developed. Community uses on both islands would include public parks and open space, schools, a bikeway and pedestrian path. Industrial uses would include a new wastewater treatment plant, a new police station, and a new fire station on Treasure Island; these facilities and an existing fire station on Yerba Buena Island would be staffed with fire, paramedic, and police personnel. The elementary school, child development center, fire training school, and brig would be retained and reused for their original uses, with some modifications. Residential housing use would include reuse of existing housing as well as construction of new housing on both islands. No decision on the proposed action will be made until the NEPA process has been completed.

Potential impacts evaluated in the DEIS include, but are not limited to: Land use, visual resources, socio-economics, public services, utilities, cultural resources, biological resources, geology and soils, water resources, traffic and circulation, air quality, noise, and hazardous materials and waste. Potentially significant impacts that can be mitigated include: land use impacts related to inconsistencies with the general plan designation and zoning classification; traffic impacts to westbound and eastbound on and off ramps on Yerba Buena Island under Alternative 1; impacts to transit operations due to lack of bus service between NSTI and the East Bay under all alternatives; biological impacts to mudflats, wading shorebirds and essential fish habitat due to increased pedestrian and boating activities under all alternatives; potential exposure of individuals and property to ponding under Alternatives 1 and 3 and flooding hazards under all alternatives; and potential health and safety implications from future development activities interfering with remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act. The one significant impact that cannot be mitigated would be to cultural resources from demolition of two buildings on Treasure Island eligible for listing on the National Register of Historic Places under Alternative 2.

The DEIS has been distributed to affected Federal, state, and local agencies and other interested parties. In addition, copies of the DEIS are available for review at the following public libraries:

- San Francisco Main Library, 100 Larkin St (at Grove), San Francisco, CA 94102, (415) 557-4400

- Bayview/Waden Branch Library, 5075 3rd St (at Revere Ave), San Francisco, CA 94124, (415) 715-4100
- Potrero Branch Library, 1616 20th St (between Arkansas and Connecticut St), San Francisco, CA 94107, (415) 695-6640
- Chinatown Branch Library, 1135 Powell St (near Jackson St), San Francisco, CA 94108, (415) 274-0275
- North Beach Branch Library, 2000 Mason St (at Columbus Ave), San Francisco, CA 94133, (415) 274-0270
- Oakland Public Library (Main Branch), 125 14th St, Oakland, CA 94612, (510) 238-3134
- Oakland Library (Eastmont Branch), Eastmont Mall--2nd Flr, 7200 Bancroft Ave, Ste 211, Oakland, CA 94605, (510) 615-5726

A public hearing will be held to inform the public of the DEIS findings and to solicit and receive oral and written comments. Federal, state, and local agencies and interested parties are invited to be present at the hearing. Oral comments will be heard and transcribed by a court recorder; written comments are also requested to ensure accuracy of the record. Agencies and the public are also invited and encouraged to provide written comments in addition to, or in lieu of, oral comments at the public hearing. All comments, both oral and written, will become part of the official record. Comments should clearly describe specific issues or topics with the DEIS. In the interest of allowing everyone a chance to participate, speakers will be requested to limit their oral comments to five (5) minutes. Longer comments should be summarized at the public hearing and submitted in writing either at the hearing or mailed to: Commander, Southwest Division, Naval Facilities Engineering Command, Attn: Ms. Timarie Seneca, Code 06CM.TS, 1230 Columbia St, Suite 1100, San Diego, CA 92101-8517. Comments must be postmarked by June 24, 2002, to be considered in this environmental review process.

Dated: May 2, 2002.
R.E. Vincent II, Lieutenant Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.
[FR Doc. 02-11773 Filed 5-9-02; 8:45 am]

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APPENDIX E
Reuse Alternative Assumptions

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APPENDIX E
REUSE ALTERNATIVE ASSUMPTIONS

REUSE ALTERNATIVE ASSUMPTIONS

In addition to the assumptions made for each reuse alternative (Tables E-3 to E-5 at the end of this Appendix), certain analyses required further assumptions. These are described below by resource area. Only those resource areas that required further assumptions are listed. The absence of a resource area in this list means that the analysis for that resource area was possible without further assumptions or that assumptions are provided in a separate appendix, as is the case with Transportation and Socioeconomics. Figure E-1, Building Numbers, identifies the location of buildings referenced in Tables E-3 through E-5 and is presented at the end of this appendix.

Although the Draft Reuse Plan presents a possible phasing strategy for reuse development, phasing was not assumed in the analysis in this EIS. As stated in the Reuse Plan, "phasing is illustrative and is expected to vary depending on actual market conditions, funding, and policy decisions" (San Francisco 1996e). The EIS therefore assesses the socioeconomic and environmental conditions at full buildout for each of the alternatives in order to avoid inaccurate impact characterization under a phased reuse implementation.

Subsequent to completion of the federal screening process and Navy determination that the property at Treasure Island was surplus to the needs of the United States on July 6, 1995, FHWA acquired 98 acres (40 ha) on Yerba Buena Island held by Navy. FHWA conveyed this property to Caltrans for construction of the east span of the SFOBB. The deed conveying the right-of-way also granted Caltrans a temporary construction easement (TCE) over approximately 78 acres (32 ha) of dry and submerged land on the Yerba Buena Island, as well as two permanent aerial easements of approximately 0.3 acres each.

Earlier negotiations between TIDA and Navy concluded that the property transferred to FHWA/Caltrans need not be conveyed to the designated property recipient until the easements had been relinquished. Further, the prospective completion date for the new SFOBB east span was beyond the period in which the Navy could convey the property under the BRAC authority. All lands transferred to FHWA, including the TCEs, were therefore excluded from evaluation in the Draft EIS. Due to new understandings between the Navy and TIDA, the Navy has determined that the TCE and aerial easements are available for disposal. These areas, consisting of approximately 78 acres (32 ha) of dry and submerged lands, are considered in the analysis presented in the Final EIS.

The land transferred to FHWA/Caltrans was considered in the 1995 Draft Reuse Plan and was designated for residential, publicly oriented, and open space/recreation uses. While the EIS alternatives are based on the 1995 Draft Reuse Plan and input on the Draft Plan, the development plan presented in the Reuse Plan is intended to be illustrative of the implications of plan policies and guidelines and "is by no means reflective of the only way development may occur" (San Francisco 1996e). For this reason, the analysis in the EIS assumes that uses that were proposed for lands transferred to FHWA are essential to the objectives of the reuse plan and would be accommodated in some manner within the remaining reuse plan area (i.e. other

locations or on reduced acreages). Therefore, while only 20 acres (8 ha), or approximately 4 percent of the developable acreage proposed for disposal, was lost to reuse as a result of the FHWA transfer, the functional loss to reuse would be much less.

While it may feasible to accommodate publicly oriented and residential uses within the remaining reuse area, it may not be feasible to accommodate all open space proposed for the FHWA/Caltrans area elsewhere within the reuse plan area, loss of some open space would not have a measurable effect on the analysis in the EIS. Open space mainly has a beneficial impact under reuse by providing recreational space and visual enhancement, and contributes very little to socioeconomic and environmental impacts (the socioeconomic analysis assumes that open space on Yerba Buena Island would provide only one job [see Appendix F]). Further, much of the open space area transferred to FHWA is steeply sloping and has limited potential for development. Should these areas not be necessary for construction or operation of the SFOBB they may remain as open space and provide similar benefits.

VISUAL RESOURCES ASSUMPTIONS

Alternative 1

Under Alternative 1, a mix of land uses would be established that emphasizes publicly oriented development, open space/recreation, and residential development. Key assumptions about proposed development components that could affect visual resources or shadow include:

Shoreline on Treasure Island. The dike would remain at its present height (14 feet [4 m] NGVD), with modest widening and no highly visible structural strengthening; a 100-foot (30.5-m) wide shoreline open space corridor with landscaping, paths and overlooks (as described in the urban design section of the reuse plan [p. 65]).

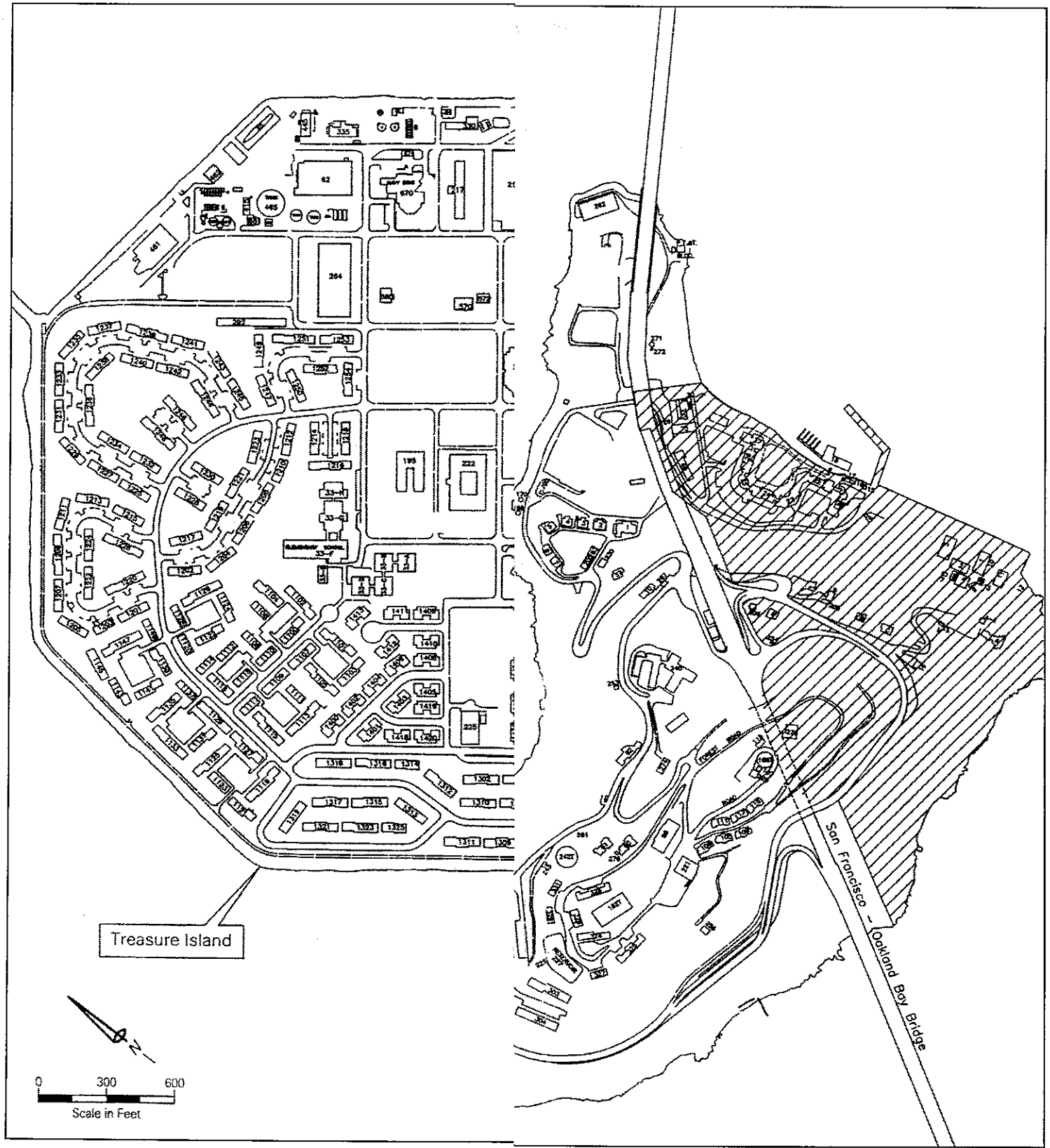
Hotels on Treasure Island. Two building complexes with height up to 75 feet (23 m), as shown in reuse plan Figure 3 (Illustrative Plan); San Francisco would apply some massing restrictions to the design of these buildings; the footprints of the buildings would not exceed 10 percent of the 75-foot (23-m) height-limit area.

Themed attraction. General appearance would be similar to Disneyland or Africa/USA, with lighting displays at night, fountains, elaborate landscaping in places, some tall structure such as a roller coaster, and at least 1 landmark structure for distant visibility in a central location (assumed to be a slender structure up to 100 feet [30.5 m] high); other buildings up to 60 feet (18 m), with building density similar to that of existing conditions.

Offices. 60-foot (18-m) height limit, with densities similar to the existing conditions.

Sports complex. No major landmark structures; building heights up to 60 feet (18 m), with the majority of the area comprising open playing fields for soccer, basketball, tennis courts, etc.

New residential on Treasure Island. 2,300 new units, replacing approximately 700 existing units on 80 acres (32.5 ha) (at an average density of almost 30 units per acre [0.4 ha]) and heights up to 40 feet (12 m) high (4-story multi-family dwellings). Two hundred existing residential units of the 1400 series would remain.



Treasure Island has approximately 150 nonresidential buildings and 905 housing units. The NSTI portion of Yerba Buena Island includes 90 housing units and 10 other buildings for storage, communications, fire safety, and administration.

Building Numbers

Naval Station Treasure Island, California

Source: ULI 1996; Developed by CCSF 1998

Figure E-1

Small hotel/bed and breakfast on Yerba Buena Island. Sited on the hilltop location, with 60-foot (18-m) height limit and building density similar to that shown in the reuse plan, Figure 3 (Illustrative Plan).

New residential on Yerba Buena Island. 250 units, with approximately 170 new units and approximately 80 new infill units within existing residential areas higher on the hill. Buildings are assumed to be multi-family and up to 40 feet (12 m) in height (4-story).

Open space and vegetation. Loss of vegetation and open space would occur on both Treasure Island and Yerba Buena Island, but new development would minimize loss of large trees (including mature Eucalyptus trees on Yerba Buena Island) by rebuilding on current building footprints.

Demolition. Buildings unsuitable for reuse would be demolished at various locations on Treasure Island and at the hilltop (Tower Park area) on Yerba Buena Island; most residential structures elsewhere on Yerba Buena Island would remain or be rebuilt on the same general footprint.

Roads and SFOBB access. No change in the appearance or configuration of the roadways and bridge ramps.

Ferry terminals at Pier 1 and Treasure Island west side. Would include covered terminal buildings of modest scale (not landmark), similar in scale to Jack London Square on Oakland.

Alternative 2

Key assumptions on major development components that could affect visual resources include:

Shoreline area. Similar to that described for Alternative 1, except that the shoreline open space would be wider (assumed 150 feet [46 m]) in most areas.

Themed attraction. As for Alternative 1, with 1 landmark structure for distant visibility but lower overall density and more open space/landscaping.

Urban entertainment center. 300,000 square feet (27,870 square m) on 6 acres (2.5 ha), located behind the museum on Clipper Cove, and up to 3 stories (40 feet [12 m]).

Amphitheater. 91,476 square feet (8,498 square m) on 7 acres (3 ha), assumed to be without a distinctive architectural feature, and approximately 40 feet (12 m) high.

Sports facilities. Similar to existing facilities.

Hotels on Treasure Island. Similar to Alternative 1, with a 700 room hotel (with 100,000 square-foot (9,290 square-m) conference facility) and 500 room resort hotel, assumed to be up to 75 feet (23 m) and configured as described for Alternative 1.

Small hotel/bed and breakfast on Yerba Buena Island. 150 units on 14 acres (6 ha)(i.e., much lower density than Alternative 1); assumes limited razing of existing housing in the area, with mainly

conversion of use; height/mass of hotel assumed to be less than 40 feet (12 m), which is less than Alternative 1 limit of 60 feet (12 m).

Demolition. Several large buildings in northern half of the island would be razed, as well as housing in the hotel/bed and breakfast area on Yerba Buena Island and Buildings 2 and 3.

New residential on Yerba Buena Island. 200 units on 7 acres (3 ha); height/mass/lower density than Alternative 1; 2-story maximum.

Golf course. 147 acres (59.5 ha) on site of present housing, assumed to be regraded and landscaped.

Wildlife area. 18 acres (7 ha), with viewing areas.

Alternative 3

Key assumptions on major development components that could affect visual resources include:

Shoreline area. New seawall and landscaping restricted to the southern perimeter of Treasure Island.

Small themed attraction. 39 acres (16 ha), with much lower intensity of development than in the other alternatives; includes 1 landmark structure for distant visibility (100 feet [30.5]); other new buildings similar in height to existing buildings.

Small hotel/bed and breakfast Yerba Buena Island. As described for Alternative 1.

New residential Yerba Buena Island. 70 new units on 9 acres (3.5 ha), at the lowest density of all alternatives; 2 to 3 stories.

Demolition. Most buildings remain intact (including hangars and barracks buildings); some razing of buildings, particularly in the themed attraction area.

Ferry pier. No new west side ferry pier.

WATER RESOURCES ASSUMPTIONS

All Three Reuse Alternatives

Levee. The height of the levee was assumed to be raised as necessary to 15 feet (4.5 m) NGVD around the entire perimeter of Treasure Island.

Dredging. All ferry piers and marina area 15 to 20 feet (4.5 to 6 m) below MLLW.

UTILITIES ASSUMPTIONS

The assumptions for utility demand under each alternative are presented in Table E-1.

Alternative 1

Under this alternative, a new reinforced utility corridor would be constructed along the perimeter of Treasure Island in conjunction with the geotechnical perimeter improvements. This corridor would contain primary infrastructure for the potable water distribution, wastewater collection, stormwater collection, electrical, natural gas, and telecommunications systems. The utility corridor also might include a recycled wastewater distribution system. Construction of the corridor would occur as a long-term phased development.

For infrastructure improvements not associated with the utility corridor, a long-term phased replacement plan coordinated with reuse and redevelopment likely would be implemented. The plan likely would coordinate upgrades and replacement with development of specific portions of the property. During the initial phases of reuse, existing infrastructure would be used to the extent possible with minor system upgrades, as necessary. Some of the required infrastructure improvements include:

- replacement of potable water pipelines composed of PVC and concrete-lined steel with ductile iron piping;
- replacement or repair of the potable water storage reservoirs;
- replacement of the wastewater collection system with a gravity-fed system composed of vitrified clay pipe; and
- construction of a new tertiary-level wastewater treatment plant.

Alternative 2

The utility corridor constructed under this alternative would not extend to the shoreline perimeter adjacent to the golf course. Infrastructure improvements and repairs not associated with this corridor likely would be implemented as part of a separate long-term phased program coordinated with reuse and redevelopment.

Table E-1
Assumptions for Utility Demand

Utility Type	*Current Demand*	*Projected Per Capita Demand*	*Projected Population*	*Projected Demand*	*Increase in Demand*	*Percentage Increase*
Alternative 1						
Potable Water - Residents (gallons per day)		130	6,895	896,350	896,350	
Potable Water - Hotel Guests (gallons per day)		130	1,450	188,500	188,500	
Potable Water - Employees (gallons per day)		42	4,920	206,640	206,640	
Potable Water - Visitors (gallons per day)		42	13,700	575,400	575,400	
Potable Water - Sports Fields (gallons per day)		6,000	47	282,000	282,000	
Potable Water - Total (gallons per day)	960,000			2,148,890	1,188,890	124
Wastewater - Total (gallons per day)				1,493,512		
Solid Waste - Commercial (tons per year/employee)		1.35	4,920	6,642		
Solid Waste - Residential (tons per year/dwelling unit)		1.02	2,840	2,897		
Total Solid Waste (tons per year)	15,240			9,539	-5,701	-37
Solid Waste - Demolition (tons)	15,240		3,059,959	110,159	94,919	623
Solid Waste - Demolition (cubic yards)	121,914		3,059,959	801,153	679,239	557
Alternative 2						
Potable Water - Residents (gallons per day)		130	710	92,300	92,300	
Potable Water - Hotel Guests (gallons per day)		130	1,200	156,000	156,000	
Potable Water - Employees (gallons per day)		42	2,820	118,440	118,440	
Potable Water - Visitors (gallons per day)		42	5,500	231,000	231,000	
Potable Water - Sports Fields (gallons per day)		6,000	165	990,000	990,000	
Potable Water - Total (gallons per day)	960,000			1,587,740	627,740	65
Wastewater - Total (gallons per day)				478,192		
Solid Waste - Commercial (tons per year/employee)		1.35	2,820	3,807		
Solid Waste - Residential (tons per year/dwelling unit)		1.02	250	255		

Table E-2
Assumptions for Utility Demand
(continued)

Utility Type	*Current Demand*	*Projected Per Capita Demand*	*Projected Population*	*Projected Demand*	*Increase in Demand*	*Percentage Increase*
Total Solid Waste (tons per year)	15,240			4,062	-11,178	-73
Solid Waste - Demolition (tons)	15,240		3,588,991	129,204	113,964	748
Solid Waste - Demolition (cubic yards)	121,914		3,588,991	939,663	817,749	671
Alternative 3						
Potable Water - Residents (gallons per day)		130	3,510	456,300	456,300	
Potable Water - Hotel Guests (gallons per day)		130	0	0	0	
Potable Water - Employees (gallons per day)		42	2,195	92,190	92,190	
Potable Water - Visitors (gallons per day)		42	2,740	115,080	115,080	
Potable Water - Sports Fields (gallons per day)		6,000	40	240,000	240,000	
Potable Water - Total (gallons per day)	960,000			903,570	-56,430	-6
Wastewater - Total (gallons per day)				530,856		
Solid Waste - Commercial (tons per year/employee)		1.35	2,195	2,963		
Solid Waste - Residential (tons per year/dwelling unit)		1.02	1,065	1,086		
Total Solid Waste (tons per year)	15,240			4,050	-11,190	-73
Solid Waste - Demolition (tons)	15,240		1,359,874	48,955	33,715	221
Solid Waste - Demolition (cubic yards)	121,914		1,359,874	356,040	234,126	192

Alternative 3

The new utility corridor would only be built on the southern Treasure Island perimeter. Infrastructure improvements and repairs not associated with this corridor likely would occur as needed to support the program of reuse and redevelopment.

HAZARDOUS MATERIALS AND WASTE ASSUMPTIONS

All Three Reuse Alternatives

The reuse alternatives call for a mix of land uses, most of which could involve the use and storage of hazardous materials. The alternatives include developed recreational and entertainment, institutional, and commercial land uses that, depending on the specific type of operation, could generate hazardous wastes. Hazardous materials likely to be used upon implementation of a reuse alternative based on land use categories are identified in Table E-2.

Table E-2
Hazardous Materials Use by Land Use Category

Land Use	*Operation Process*	*Hazardous Materials*
Entertainment and publicly-oriented uses	Activities associated with themed attraction, hotel, and entertainment, including building and facilities maintenance and boat/ferry service and operations	Petroleum products, solvents, heavy metals, corrosives, catalysts, aerosols, fuels, heating oils, flammables, pesticides
Recreation/open space	Maintenance of existing recreation facilities and development of new facilities, including golf course, bike path, sports complex, swimming pools, and other recreation facilities	Pesticides, fertilizers, chlorine, heating oils, paints, thinners, cleaners, solvents, aerosols
Institutional	Public education, higher education, research labs, training facilities, vocational schools	Laboratory chemicals, corrosives, flammables, solvents, heating oils, solvents, lubricants, cleaners, pesticides, paints, thinners
Commercial	Activities associated with offices, film production, retail, service industries, restaurants	Fuels, heating oils, pesticides, dry cleaning chemicals, solvents, corrosives, flammables
Residential	Use and maintenance of single-family and multi-family units, landscaping	Pesticides, fertilizers, fuels, oils, chlorine, and household chemicals

Source: Developed by San Francisco 1997.

Table E-3
Alternative 1 Assumptions

Treasure Island Land Use	*Acres*	*FAR*[1]	*Buildout (sf)*	*Other*	*Existing Buildings To Be Reused*
Publicly Oriented					
Themed Attraction	59	n/a		13,700 average daily visitors	
Hotel/Conference/Lodging	18	n/a		300 room hotel (unknown buildout sf) and 1,000 room hotel (unknown buildout sf)	
Retail/Specialty/Restaurant	8	n/a	225,000	includes three "landmark" restaurants	1, 227, 271
Entertainment center	0		0		
Amphitheater	0		0		
Movie Theater	0		0		
Wedding Chapel	0		0		
Museum	3	n/a	15,000	museum (see also retail/specialty/restaurant and mixed use/office)	1
Mixed Use/Office	11	n/a	100,000		1, 450, 140
Film Production	31	n/a	501,000	401,000 sf existing; expand by 100,000 sf	2, 3, 180, 111
Marina (land)	2	n/a	20,000	20,000 sf yacht club	
Marina (water)				12 water acres; 103 existing slips; 200 new slips and 100 new buoys	
Other publicly oriented uses	14	0.30	182,952	new development	
Total Publicly Oriented	**146**				
Residential					
Existing Residential	22	n/a		200 units	1400 series
New Residential	80	n/a		2,300 units	
Neighborhood Retail	1	n/a	24,000		
Total Residential	**103**				

Table E-3
Alternative 1 Assumptions
(continued)

Treasure Island Land Use	*Acres*	*FAR*[1]	*Buildout (sf)*	*Other*	*Existing Buildings To Be Reused*
Institutional and Community					
Elementary school	9	n/a		existing facility	existing buildings
Child development center	4	n/a	10,123	existing facility	502
Fire training school	5	n/a	69,887	existing facilities	600-617
Warehouse/Storage	0		0		
WWTP	10	0.20	87,120	new facility	
Brig	5	n/a	26,310	existing facilities	670, 671
Fire station	4	0.20	34,848	new facility	
Police station	3	0.20	26,136	new facility	
Other institutional facilities	0		0		
Total Institutional and Community	40				
Open Space/Recreation					
Golf course	0		0		
Sports fields/complex	47	0.20	409,464	new and existing facilities (square feet calculated from FAR, not sf of existing buildings)	402, 497, 229
Shoreline promenade/open space	30	n/a			
Ferry Terminals/Piers	0		0	new ferry dock and breakwater on west side of NSTI; Pier 1 would provide ferry docking	Pier 1
Wildlife Habitat	0		0		
Total Open Space/Recreation	77				
Total Treasure Island Disposal Acreage	**366**			**402 acres minus federal-to-federal transfer acres**	
Total Treasure Island Building Square Footage			**1,731,840**		

Table E-3
Alternative 1 Assumptions
(continued)

Yerba Buena Island Land Use	*Acres*	*FAR*[1]	*Buildout (sf)*	*Other*	*Existing Buildings To Be Reused*
Publicly Oriented					
Hotel/Bed and Breakfast	3	n/a		150 room hotel (hilltop)	
Conference/Reception	4	n/a	90,241	Quarters 1-7 (30,241 sf) and new 60,000 sf conference facility	Quarters 1-7
Restaurant	2	n/a		restaurant is part of new 60,000 sf conference facility	
Total Publicly Oriented Uses	**9**				
Residential					
Existing Housing	28	n/a		approximately 90 units	100, 200, 300 series, excluding 326, 324, 320 and 162T (tank)
New Housing	5	n/a		approximately 250 units	
Mixed Use	1	n/a	12,000	approximately 10 live-work units	
Total Residential	**34**				
Institutional and Community	**0**				
Open Space/Recreation	**41**	**n/a**			
Total Yerba Buena Island Disposal Acreage	**84**			**115 acres minus federal-to-federal transfers**	
Total Yerba Buena Island Building Square Footage			**102,241**		

[1] A Floor Area Ratio (FAR) of 0.20 was used for community facilities; 0.25 was used for neighborhood commercial facilities; 0.30 was used for visitor serving facilities.

Table E-4
Alternative 2 Assumptions

Treasure Island Land Use	*Acres*	*Far*[1]	*Buildout (sf)*	*Other*	*Existing Buildings To Be Reused*
Publicly Oriented					
Themed Attraction	74	n/a		5,480 average daily visitors	2, 3*
Hotel/Conference/Lodging	26	n/a		700 room hotel (unknown buildout sf) with 100,000 sf conference; 500 room tourist hotel (unknown buildout sf)	
Retail/Specialty/Restaurant	0		0		
Entertainment center	6	n/a	300,000		
Amphitheater	7	0.30	91,476	5,000 seats	
Movie Theater	0		0		
Wedding Chapel	1		9,884	existing facility	187
Museum	4		149,799	existing facility	1
Mixed Use/Office	0		0		
Film Production	0		0		
Marina (land)	0		0		
Marina (water)				65 water acres; between 500 and 675 slips and buoys	
Other publicly oriented uses	14	0.30	182,952	new development	
Total Publicly Oriented	**132**				
Residential					
Existing Residential	0		0		
New Residential	0		0		
Neighborhood Retail	0		0		
Total Residential	**0**				

Table E-4. Alternative 2 Assumptions (continued)

Treasure Island Land Use	*Acres*	*Far*[1]	*Buildout (sf)*	*Other*	*Existing Buildings To Be Reused*
Institutional and Community					
Elementary school	0		0		
Child development center	0		0		
Fire training school	5	n/a	69,887	existing facilities	600-617
Warehouse/Storage	0		0		
WWTP	5	0.20	43,560	new facility	
Brig	4	n/a	26,310	existing facilities	670, 671
Fire station	2	0.20	17,424	new facility	
Police station	2	0.20	17,424	new facility	
Other institutional facilities	0		0		
Total Institutional and Community	18				
Open Space/Recreation					
Golf course	147	n/a	20,000	20,000 sf clubhouse	
Sports fields/complex	18	n/a	36,325	square feet includes only existing facilities	402, 497
Shoreline promenade/open space	33	n/a			
Ferry Terminals/Piers	0		0	new ferry dock and breakwater on west side of NSTI; Pier 1 would provide ferry docking	Pier 1
Wildlife Habitat	18	n/a			
Total Open Space/Recreation	**216**				
Total Treasure Island Disposal Acreage	**366**			**403 acres minus federal-to-federal transfer acres**	
Total Treasure Island Building Square Footage			**965,041**		

Table E-4. Alternative 2 Assumptions (continued)

Yerba Buena Island Land Use	*Acres*	*Far*[1]	*Buildout (sf)*	*Other*	*Existing Buildings To Be Reused*
Publicly Oriented					
Hotel/Bed and Breakfast	14	n/a		150 room hotel/bed and breakfast	
Conference/Reception	5	n/a	30,241	Quarters 1-7	Quarters 1-7
Restaurant	1	n/a	12,000	Torpedo Depot	262
Total Publicly Oriented Uses	**20**				
Residential					
Existing Housing	16	n/a		approximately 50 units	100, 200, 300 series, excluding buildings within the hotel/bed and breakfast area
New Housing	5	n/a		approximately 200 units	
Mixed Use	0		0		
Total Residential	**21**				
Institutional and Community	**0**				
Open Space/Recreation	**43**				
Total Yerba Buena Island Disposal Acreage	**84**			**115 acres minus federal-to-federal transfers**	
Total Yerba Buena Island Building Square Footage			**42,241**		

[1] A Floor Area Ratio (FAR) of 0.20 was used for community facilities; 0.25 was used for neighborhood commercial facilities; 0.30 was used for visitor serving facilities.
*Buildings 2 & 3 may be demolished.

Table E-5
Alternative 3 Assumptions

Treasure Island Land Use	*Acres*	*Far*[1]	*Buildout (sf)*	*Other*	*Existing Buildings To Be Reused*
Publicly Oriented/Visitor Attraction					
Themed Attraction	39	n/a		2,740 average daily visitors	
Hotel/Conference/Lodging	6	n/a	80,000	80,000 sf conference	140
Retail/Specialty/Restaurant	1	n/a	13,200	Fogwatch restaurant	227
Entertainment center	0		0		
Amphitheater	0		0		
Movie Theater	0		0		
Wedding Chapel	2	n/a	9,884	existing facility	187
Museum	4	n/a	15,000	portion of existing facility (see also mixed use/office)	1
Mixed Use/Office	6	n/a	214,605	existing facilities (square feet calculated by using existing building 1 sf minus 15,000 sf, plus the square feet for building 265 and 450)	1, 265, 450
Film Production	33	n/a	501,000	existing facilities	2, 3, 180, 111
Marina (land)	2	n/a	20,000	20,000 sf yacht club	
Marina (water)				6 water acres; 103 existing slips	
Other publicly oriented uses	20	n/a	256,080	existing facility (7,788) plus possible new development (19 acres x 0.30 FAR x 43,560 = 248,292 sf)	271
Total Publicly Oriented	**113**				
Residential					
Existing Residential	110	n/a	360,370	905 units and 75 beds in barracks (360,370 sf)	1100, 1200, 1300, 1400 series; Barracks 452 and 453
New Residential	0		0		
Neighborhood Retail	0		0		

Table E-5. Alternative 3 Assumptions (continued)

Treasure Island Land Use	*Acres*	*Far*[1]	*Buildout (sf)*	*Other*	*Existing Buildings To Be Reused*
Total Residential	**110**				
Institutional and Community					
Elementary school	9	n/a		existing facility	existing buildings
Child development center	4	n/a	10,123	existing facility	502
Fire training school	5	n/a	69,887	existing facility	600-617
Warehouse/Storage	4	0.20	34,848	new facility	
WWTP	3	n/a		existing facility	415, 416, 417, 421, 465, 466, 467, 468
Brig	5	n/a	36,543	existing facilities	670, 671, 217
Fire station	2	n/a	10,215	existing facility	157
Police station	3	n/a	2,836	new facility in existing buildings	462, 463
Other institutional facilities	8	n/a	129,147	existing facilities	**233, 7, 461**
Total Institutional and Community	43				
Open Space/Recreation					
Golf course	0		0		
Sports fields/complex	40	n/a	150,557	existing facilities (150,557 sf) and possible new facilities (unknown sf)	402, 497, 201, 202
Shoreline promenade/open space	60	n/a			
Ferry Terminals/Piers	0		0	Piers 1 and 12 would provide ferry docking	Piers 1 and 12
Wildlife Habitat	0		0		
Total Open Space/Recreation	**100**				
Total Treasure Island Disposal Acreage	**366**			**403 acres minus federal-to-federal transfer acres**	
Total Treasure Island Building Square Footage			**1,914,285**		

Table E-5
Alternative 3 Assumptions (continued)

Yerba Buena Island Land Use	*Acres*	*Far*[1]	*Buildout (sf)*	*Other*	*Existing Buildings To Be Reused*
Publicly Oriented					
Hotel/Bed and Breakfast	3	n/a		150 room hotel (hilltop)	
Conference/Reception	5	n/a	30,241	existing buildings	Quarters 1-7
Restaurant	1	n/a	12,150	Torpedo Depot	262
Total Publicly Oriented Uses	**9**				
Residential					
Existing Housing	28	n/a		approximately 90 units	100, 200, 300 series, excluding 326, 324, 320, 162T (tank)
New Housing	5	n/a		approximately 70 units	
Mixed Use	0		0		
Total Residential	**33**				
Institutional and Community	**0**				
Open Space/Recreation	**42**				
Total Yerba Buena Island Disposal Acreage	**84**			**115 acres minus federal-to-federal transfers**	
Total Yerba Buena Island Building Square Footage			**42,391**		

[1] A Floor Area Ratio (FAR) of 0.20 was used for community facilities; 0.25 was used for neighborhood commercial facilities; 0.30 was used for visitor serving facilities.

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APPENDIX F

Supporting Technical Information

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APPENDIX F-1

Photographic Documentation

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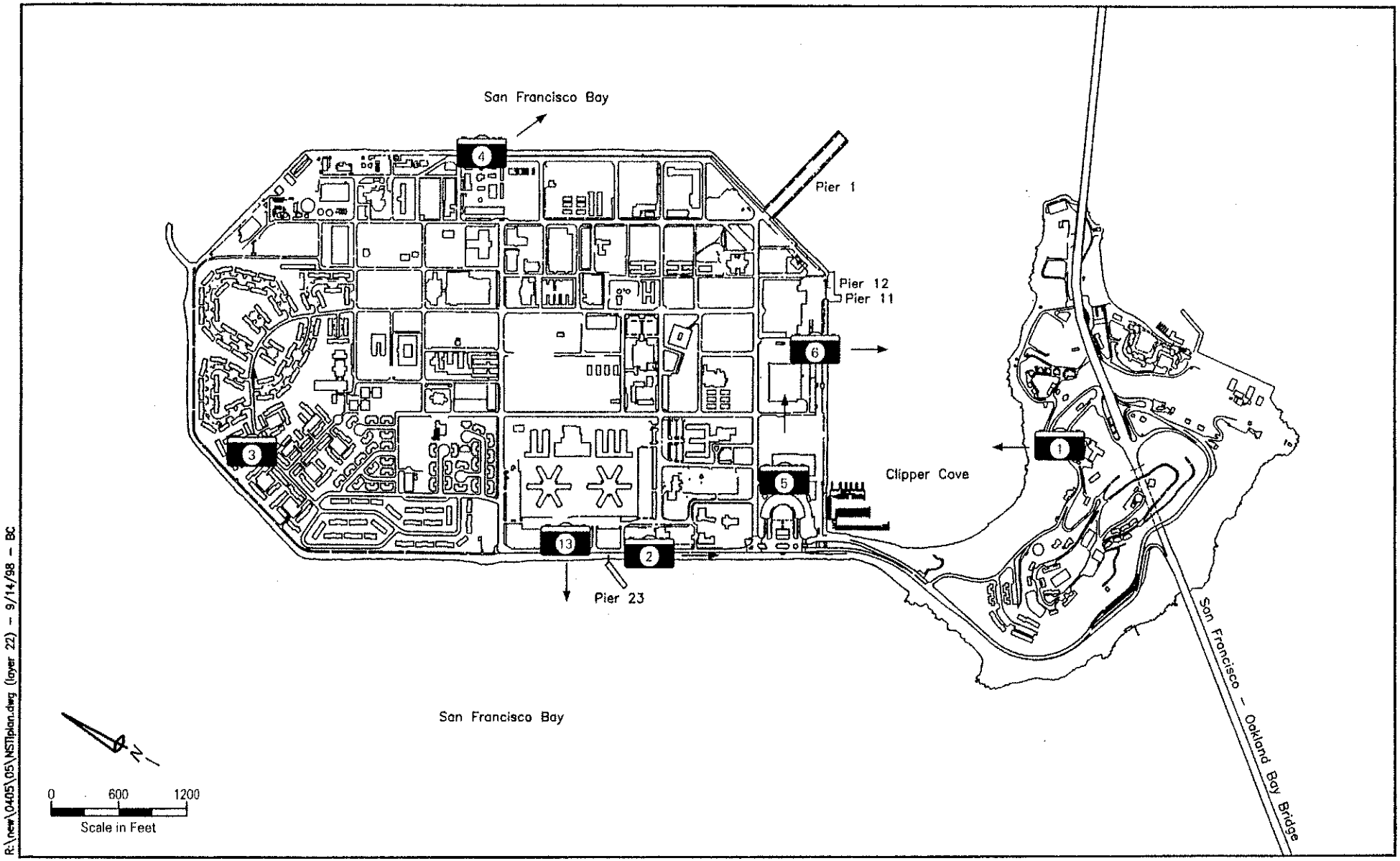

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Upon reuse, Treasure Island and Yerba Buena Island would provide recreational viewing opportunities for the public.

Legend:

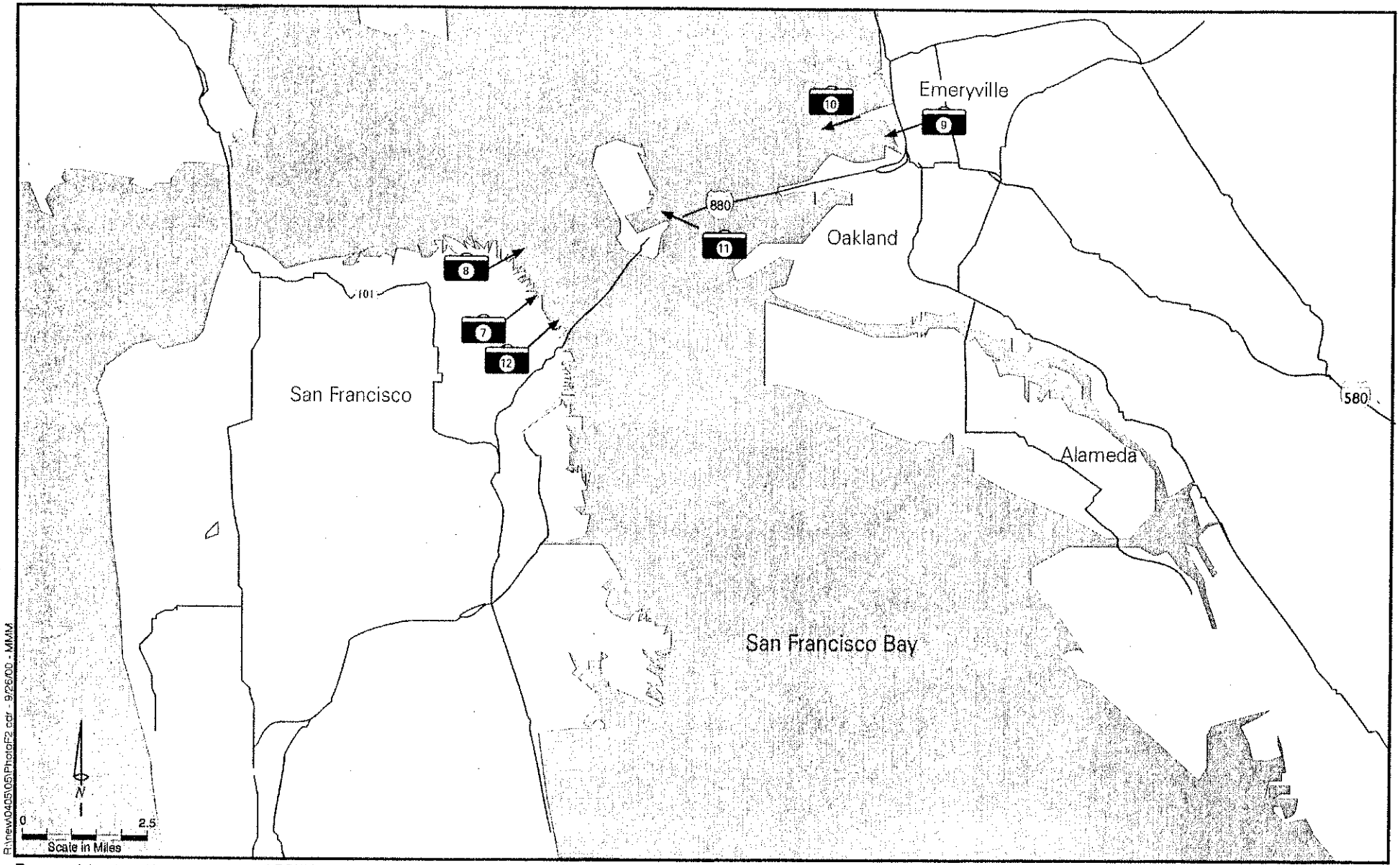
2 Photograph Location

Photograph Direction

Photograph Locations at NSTI

Naval Station Treasure Island, California

Figure F-1



Treasure Island and Yerba Buena Island can be seen from various vantage points throughout the Bay Area.

Photograph Locations in Bay Area

Bay Area, California

Figure F-2

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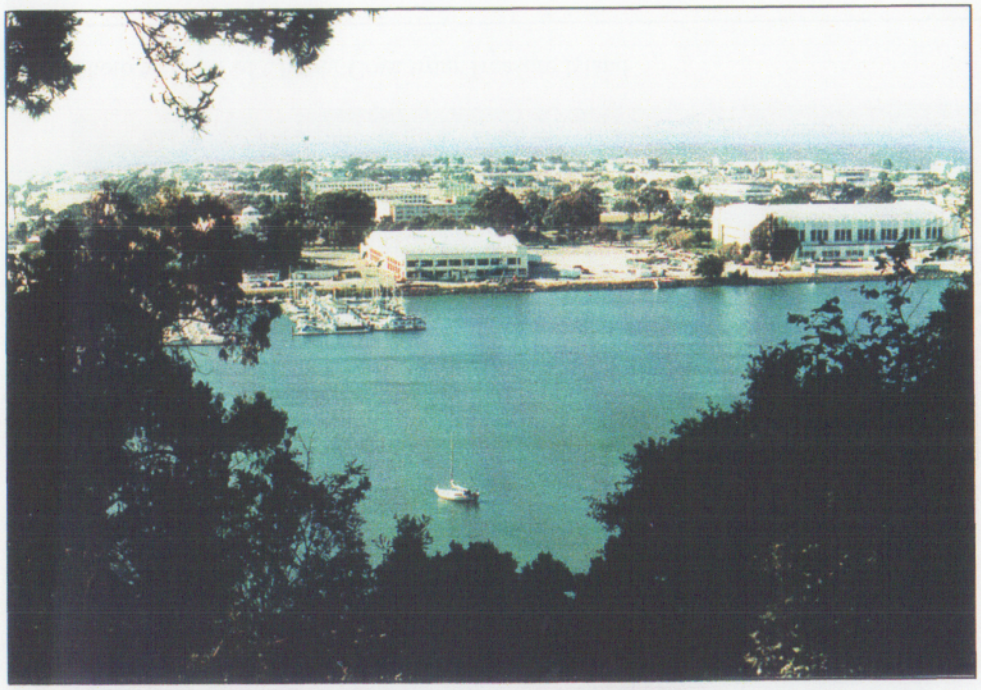

Photo 1: Overview of Treasure Island from Yerba Buena Island

Photo 3: View of the Residential Area

Photo 2: View of the Entry Area, Seen from the Avenue of Palms

Photo 4: View of the East Side of the Waterfront

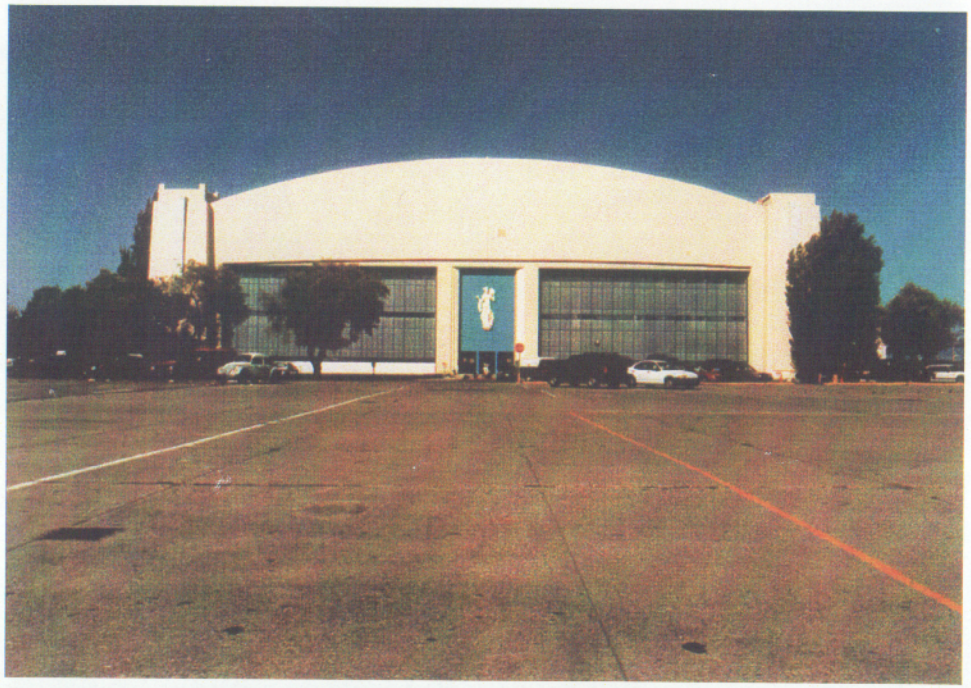

Photo 5: View of the Former Hangar Building (Building 2)

Photo 6: View of Clipper Cove from Treasure Island

Photo 7: View from Recreational Pier 7, San Francisco Embarcadero

Photo 8: View from Coit Tower Vista Point in San Francisco

Photo 9: View from Interstate 80 in Emeryville

Photo 10: View from Emeryville Waterfront

Photo 12: View Along Howard Street View Corridor Near Spear Street

Photo 11: View of Treasure Island from a Bus Traveling West on the Bay Bridge

Photo 13: View from Pier 23 toward San Francisco

APPENDIX F-2
Socioeconomics

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APPENDIX F-2
SOCIOECONOMICS

POPULATION AND EMPLOYMENT ASSUMPTIONS

This appendix describes the assumptions that were used to estimate population and employment impacts associated with the three NSTI reuse alternatives considered in the EIS. Sources are noted throughout the text with full references provided at the end of the appendix.

Population Estimation Assumptions

For the purpose of this analysis, household size for existing housing units at NSTI was estimated to be 3.2 persons, while household size for newly constructed units was estimated to be 2.3 persons (Mara Feeney & Associates estimate). The rationale for these assumptions is presented in the following paragraphs.

Factors that might attract larger households to Treasure Island include the availability of an elementary school and childcare center. However, the access constraints could be a major deterrent to families with children who might have to be shuttled to a variety of after-school activities, medical appointments, shopping, etc.

According to the 1990 U.S. Census, the average household size in San Francisco was 2.3, and at NSTI was 3.7, reflecting the larger size of military families in comparison to typical San Francisco households. At NSTI, existing military family housing units have two to four bedrooms. It seems likely that in the future these units would be allocated to relatively large households (e.g., Coast Guard personnel with larger household sizes as reflected in the census data; or larger San Francisco families having the greatest need for space, and/or TIHDI to provide support services for families or groups of adults).

A variety of assumptions have been made regarding household size in current base closure and reuse studies. The Presidio Planning Socioeconomic Analysis Report assumed an average household size of 3.2 for Presidio reuse, based on San Francisco's average *family* size in 1990, as opposed to average household size (Jones & Jones, Inc. 1994). The NSTI Reuse Plan assumed 1.5 persons per household for new construction at Yerba Buena Island and 1.8 persons per household for new housing construction on Treasure Island (San Francisco 1996). The Mayor's Office currently is assuming an average household size of 2.5 persons per household in its NSTI projections (EPS 1997).

Based on a consideration of the above information, it was decided that using two different household sizes—one for existing units and one for new units (which are likely to be built at higher densities)—would provide the most accurate population estimates. Therefore, for existing units, a household size of 3.2 persons is assumed, while a household size of 2.3 is projected for new units.

Population associated with live-work units was estimated at 1.25 persons per unit (Mara Feeney & Associates estimate). Treasure Island population estimates also include the brig inmate population, which is estimated to be 90 (HMH 1997).

Employment Estimation Assumptions

The employment density factors in Table F-1 were used to estimate employment from land uses proposed under each NSTI reuse scenario (Tables F-2 to F-4).

Table F-1
Employment Multipliers for Each Land Use

Land Use	*Employment Density Factor*	*Source*
Publicly Oriented		
Themed Attraction	0.7 jobs per 1,000 visitors, with FTEs[1] calculated as half of total jobs	EPS 1997a
Hotels	1 employee per room	San Francisco 1996; ROMA 1994; EPS 1997
Conference Facilities	1 employee per 5,000 sf	EPS 1997
Retail and Restaurants	1 employee per 500 sf	Jones & Jones, Inc. 1994; ROMA 1994; EPS 1997
Entertainment Center/ Amphitheater	1 employee per 2,500 sf	Mara Feeney & Associates estimate
Wedding Chapel	1 FTE[1]	Mara Feeney & Associates estimate
Museum	1 employee per 2,500 sf	San Francisco 1996; EPS 1997
Mixed Use/Office	1 employee per 385 sf	Jones & Jones, Inc. 1994
Film Production	1 employee per 1,000 sf	EPS 1997
Marina	3 employees per 100 slips/buoys	Mara Feeney & Associates estimate
Yacht Club	1 employee per 1,000 sf	Mara Feeney & Associates estimate
Other public-oriented Uses	1 employee per 1,000 sf	Mara Feeney & Associates estimate

Table F-1
Employment Multipliers for Each Land Use (continued)

Land Use	*Employment Density Factor*	*Source*
Residential		
New Residential	1 job per live-work unit and 1 employee per 500 sf neighborhood retail	Jones & Jones, Inc. 1994
Institutional and Community		
Elementary School	1 teacher per 30 students (approx.) and 1 staff person per 200 students	San Francisco 1996
Child Development Center	1 staff person per 12 children (approx.) or one employee per 1,000 sf (approx.)	San Francisco 1996
Fire Training School	20 staff year-round	HMH 1997
Warehousing	1 employee per 5,000 sf	Jones & Jones, Inc. 1994
Wastewater Treatment Plant	1 employee per 5,000 sf	Mara Feeney & Associates estimate
Police and Fire Stations	1 employee per 1,000 sf	Mara Feeney & Associates estimate
Other Institutional	1 employee per 1,000 sf	Jones & Jones, Inc. 1994
Open Space/Recreation		
Sports Complex	1 employee per 60,000 sf (ballfields) and 1 employee per 10,000 sf (gymnasium)	EPS 1997

Table F-2
Estimated Population and Employment for Alternative 1

	Estimated Population	*Estimated Employment*[1]
TREASURE ISLAND LAND USE		
Publicly Oriented		
Themed Attraction		1,750
Hotel/Conference/Lodging		1,300
Retail/Specialty/Restaurant		450
Entertainment center		
Amphitheater		
Movie Theater		
Wedding Chapel		
Museum		6
Mixed Use/Office		260
Film Production		501
Marina (land)		20
Marina (water)		12
Other publicly oriented uses		183
Total Publicly Oriented		***4,482***
Residential		
Existing Residential	640	
New Residential	5,290	
Neighborhood Retail		48
Total Residential	***5,930***	***48***

Table F-2
Estimated Population and Employment for Alternative 1
(continued)

	Estimated Population	*Estimated Employment*[1]
Institutional and Community		
Elementary school		32
Child development center		10
Fire training school		20
Warehouse/Storage		
WWTP		17
Brig	90	60
Fire station		35
Police station		26
Other institutional facilities		
Total Institutional and Community	***90***	***200***
Open Space/Recreation		
Golf course		
Sports fields/complex		7
Shoreline promenade/open space		
Ferry Terminals/Piers		2
Wildlife Habitat		
Total Open Space/Recreation		***9***
Total Treasure Island	**6,020**	**4,739**

Table F-2
Estimated Population and Employment for Alternative 1
(continued)

	Estimated Population	*Estimated Employment*[1]
YERBA BUENA ISLAND LAND USE		
Publicly Oriented		
Hotel/Bed and Breakfast		150
Conference/Reception		18
Restaurant		
Total Publicly Oriented Uses		*168*
Residential		
Existing Housing	288	
New Housing	575	
Mixed Use	13	10
Total Residential	*876*	*10*
Institutional and Community	N/A	N/A
Open Space/Recreation		**1**
Total Yerba Buena Island	**876**	**179**
NSTI TOTALS	**6,896**	**4,918**

[1]Full-time equivalent.

Table F-3
Estimated Population and Employment for Alternative 2

	Estimated Population	*Estimated Employment*[1]
TREASURE ISLAND LAND USE		
Publicly Oriented		
Themed Attraction		700
Hotel/Conference/Lodging		1,400
Retail/Specialty/Restaurant		
Entertainment center		150
Amphitheater		4
Movie Theater		
Wedding Chapel		1
Museum		60
Mixed Use/Office		
Film Production		
Marina (land)		
Marina (water)		15
Other publicly oriented uses		183
Total Publicly Oriented		***2,513***
Residential		
Existing Residential		
New Residential		
Neighborhood Retail		
Total Residential		

Table F-3
Estimated Population and Employment for Alternative 2
(continued)

	Estimated Population	*Estimated Employment*[1]
Institutional and Community		
Elementary school		
Child development center		
Fire training school		
Warehouse/Storage		
WWTP		9
Brig	90	60
Fire station		17
Police station		17
Other institutional facilities		
Total Institutional and Community	***90***	***103***
Open Space/Recreation		
Golf course		20
Sports fields/complex		1
Shoreline promenade/open space		
Ferry Terminals/Piers		2
Wildlife Habitat		
Total Open Space/Recreation		***23***
Total Treasure Island	**90**	**2,639**

Table F-3
Estimated Population and Employment for Alternative 2
(continued)

	Estimated Population	*Estimated Employment*[1]
YERBA BUENA ISLAND LAND USE		
Publicly Oriented		
Hotel/Bed and Breakfast		150
Conference/Reception		6
Restaurant		24
Total Publicly Oriented Uses		***180***
Residential		
Existing Housing	160	
New Housing	460	
Mixed Use		
Total Residential	***620***	
Institutional and Community	N/A	N/A
Open Space/Recreation		**1**
Total Yerba Buena Island	**620**	**181**
NSTI TOTALS	**710**	**2,820**

[1]Full-time equivalent.

Table F-4
Estimated Population and Employment for Alternative 3

	Estimated Population	*Estimated Employment*[1]
TREASURE ISLAND LAND USE		
Publicly Oriented/Visitor Attraction		
Themed Attraction		350
Hotel/Conference/Lodging		16
Retail/Specialty/Restaurant		26
Entertainment center		
Amphitheater		
Movie Theater		
Wedding Chapel		1
Museum		6
Mixed Use/Office		557
Film Production		501
Marina (land)		20
Marina (water)		3
Other publicly oriented uses		256
Total Publicly Oriented		***1,736***
Residential		
Existing Residential	2,971	
New Residential		
Neighborhood Retail		
Total Residential	***2,971***	

Table F-4
Estimated Population and Employment for Alternative 3
(continued)

	Estimated Population	*Estimated Employment*[1]
Institutional and Community		
Elementary school		32
Child development center		10
Fire training school		20
Warehouse/Storage		7
WWTP		5
Brig	90	60
Fire station		10
Police station		3
Other institutional facilities		129
Total Institutional and Community	***90***	***276***
Open Space/Recreation		
Golf course		
Sports fields/complex		3
Shoreline promenade/open space		
Ferry Terminals/Piers		
Wildlife Habitat		
Total Open Space/Recreation		***3***
Total Treasure Island	**3,061**	**2,015**

Table F-4
Estimated Population and Employment for Alternative 3
(continued)

	Estimated Population	*Estimated Employment*[1]
YERBA BUENA ISLAND LAND USE		
Publicly Oriented		
Hotel/Bed and Breakfast		150
Conference/Reception		6
Restaurant		24
Total Publicly Oriented Uses		***180***
Residential		
Existing Housing	288	
New Housing	161	
Mixed Use	0	
Total Residential	***449***	
Institutional and Community	N/A	N/A
Open Space/Recreation		**1**
Total Yerba Buena Island	**449**	**181**
NSTI TOTALS	**3,510**	**2,196**

[1]Full-time equivalent.

APPENDIX F-3
Transportation

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F.3-A. TECHNICAL MEMORANDUM

UPDATE OF TREASURE ISLAND EIS TRAFFIC ANALYSIS

Based on public comments provided by several government agencies on the *Draft Environmental Impact Statement for the Disposal and Reuse of Naval Station Treasure Island* (DEIS), this technical memorandum updates the freeway mainline and ramp analyses to year 2025. The DEIS included a future year cumulative analysis for year 2010. Year 2010 was a reasonable future horizon year when the preparation of the initial EIS document began in 1996. As stated above, several government agencies requested that the future cumulative year be updated to 2025. These requests are reasonable since year 2025 is commonly used as the future horizon year for the cumulative analysis now. The following sections describe which assumptions were updated, how the updates were performed, and the findings of the analysis.

Analysis Tool

The DEIS used the FREEQ11 traffic simulation model as the software to perform the freeway mainline and ramp analyses. The FREEQ model was developed by the Institute of Transportation Studies of the University of California, Berkeley. In order to provide consistency between the current analysis methodologies and results with the original analyses, FREEQ11 was used for the updates.

Analysis Assumptions

Reuse Alternative Assumptions

The three reuse alternatives, or land use scenarios, analyzed in the DEIS have not changed. The year 2025 updates analyzed traffic impacts generated by the same three land use scenarios as those used in the DEIS.

Transportation Assumptions

For consistency purposes, most of the transportation assumptions for the year 2025 updates remain the same as those used in the DEIS for the year 2010 (refer to the following transportation technical data section of this Appendix) except for the future year freeway mainline traffic volumes (discussed below in F.3-B).

TRIP GENERATION - Since the year 2010 trip generation analysis was prepared for full build-out of NSTI and the land use scenarios have not changed, person and vehicle trip generation estimates for year 2025 remain the same as those presented in the DEIS for year 2010.

TRIP DISTRIBUTION AND MODAL SPLIT ASSUMPTIONS AND TRAFFIC ASSIGNMENT PATTERNS - For consistency, trip distribution and modal split assumptions and traffic assignment patterns remain the same as those presented in the DEIS for year 2010.

YEAR 2025 RAMP VOLUMES - Since the year 2010 trip generation estimates was prepared for full build-out of NSTI, the year 2025 Treasure Island/Yerba Buena Island ramp volumes remain the same as those presented in the DEIS for year 2010.

FREEWAY SYSTEMS - Assumptions for the freeway mainline, weaving section, and on- and off-ramp capacities and free flow speed remain the same as in the DEIS for the year 2010, except for those relating to the eastbound on-ramp on the east side of the tunnel. This ramp will be reconstructed as part of the SFOBB East Span project. Caltrans has estimated that the capacity for the new ramp would be approximately 900-1000 vehicles per hour, compared to the 330 vehicles per hour used in the DEIS.

FUTURE YEAR FREEWAY MAINLINE VOLUMES - Year 2025 freeway mainline volumes were updated using the same methodology used in the DEIS for the year 2010. MTC model output data were used to calculate the growth rates from 1994 and 2025. The growth rates were then applied to the 1994 observed freeway traffic volumes to estimate the year 2025 traffic volumes.

Results of Freeway Mainline and Ramp Analysis

Freeway Mainline LOS Analysis

Table F-5 presents the observed SFOBB traffic volumes in 1994, associated freeway levels of service, and estimated year 2025 traffic volumes for the baseline and three project reuse alternatives. While the MTC model shows that the year 2025 SFOBB baseline traffic demand would be higher than that of year 2010, the number of vehicles can actually get onto SFOBB during the peak hours would be limited. The number of vehicles traveling westbound from the East Bay to SFOBB is controlled by the metering lights and is restricted to approximately 10,500 vehicles during the AM peak hour and 9,000 vehicles during the PM peak hour. The eastbound traffic volumes would be restricted to 9,500 vehicles during both the AM and PM peak hours due to the capacity and congestion of the downtown segments of I-80.

WEEKDAY AM AND PM PEAK HOURS, EASTBOUND DIRECTION - Due to the projected increase in traffic volumes between the 2010 and 2025 future years in the eastbound direction during AM and PM peak hours, travel speed on SFOBB in 2025 would decrease marginally compared to the 2010 analysis (Table 4.8, DEIS). However, the levels of service on SFOBB would stay the same between the two future years in all development scenarios.

WEEKDAY AM AND PM PEAK HOURS, WESTBOUND DIRECTION - Due to the projected increase in traffic volumes between the 2010 and 2025 future years in the westbound direction during AM and PM peak hours, travel speed on SFOBB in 2025 would decrease marginally compared to the 2010 analysis (Table 4.8, DEIS). However, the levels of service on SFOBB would stay the same between the two future years in all development scenarios.

WEEKEND MIDDAY - Due to the projected increase in traffic volumes between the 2010 and 2025 future years in the both eastbound and westbound directions during typical weekend midday travel, speed on SFOBB would decrease marginally compared to the 2010 analysis (Table 4.8, DEIS). However, the levels of service on SFOBB would stay the same between the two future years in all development scenarios.

Ramp LOS Analysis

Table F-6 presents the observed SFOBB ramp volumes and queue in 1994 and the estimated ramp volumes and queue in year 2025 for the baseline and three project reuse alternatives.

There are only two changes to the Treasure Island/Yerba Buena Island ramp levels of services, both of which would occur during a typical weekend midday condition. The length of the vehicle queue at the westbound on-ramp on the west side of the tunnel would increase from 239 vehicle in year 2010 (Table 4.6, DEIS) to 242 vehicles in year 2025. Vehicle queuing on the eastbound on-ramp on the east side of the tunnel would disappear because of the increased capacity of the new on-ramp on the east side of the tunnel that will be constructed as part of the SFOBB East Span project. The DEIS projected a 150 vehicle queue on this ramp during the weekend midday peak hour in 2010 (Table 4.6, DEIS).

Conclusions

The year 2025 update of the freeway mainline and ramp analyses revealed that no additional significant impacts would occur when compared to the year 2010 analysis presented in Section 4.5 of the DEIS.

Table F-5. SFOBB/I-80 Operations Existing and Year 2025 Weekday and Weekend Peak Hour Conditions

Peak Hour/Direction	*Existing (1994) (Operational Base)*		*2025 Background Conditions (No Action)*		*2025 Alternative 1*		*2025 Alternative 2*		*2025 Alternative 3*	
	Speed[3]	**LOS[4]**	**Speed[3]**	**LOS[4]**	**Speed[3]**	**LOS[4]**	**Speed[3]**	**LOS[4]**	**Speed[3]**	**LOS[4]**
Weekday AM peak hour[5]										
Eastbound[1]	57	B	56	B	56	B	56	B	56	B
Westbound[2]	45	D	20	F	20	F	21	F	21	F
Weekday PM peak hour[6]										
Eastbound[1]	46	D	44	D	43	D	44	D	44	D
Westbound[2]	56	B	16	F	16	F	16	F	17	F
Weekend midday peak hour[7]										
Eastbound[1]	57	B	56	B	56	B	56	B	56	B
Westbound[2]	57	B	57	B	57	B	57	B	57	B

[1] Eastbound SFOBB/I-80 east of Yerba Buena Island tunnel.

[2] Westbound SFOBB/I-80 west of Yerba Buena Island tunnel.

[3] Speed is expressed in miles per hour.

4 LOS is based on mainline travel speeds, consistent with San Francisco Congestion Management LOS designations.

[5] The AM peak hour of 8:00 to 9:00 AM occurs within the AM peak period of 6:00 to 9:00 AM.

[6] The PM peak hour of 5:00 to 6:00 PM occurs within the PM peak period of 3:00 to 7:00 PM.

[7] The midday peak hour of 12:00 to 1:00 PM occurs within the midday peak period of 10:00 AM to 1:00 PM.

Note: Degraded operating conditions on the SFOBB/I-80 in 2010 (without reuse) would be attributable to regional growth. The additional vehicle-trips associated with each reuse alternative would contribute to increases in queues at the SFOBB toll plaza, congestion and queues in downtown San Francisco, and in the duration of the peak periods.

Source: DON 1997d.

Table F-6. SFOBB/I-80 Yerba Buena Island Ramp Volumes and Maximum Queue
Existing and Year 2025 Weekday and Weekend Peak Hour Conditions

Peak Hour/Ramp[3]	*Existing (1994) (Operational Base)*		*2025 Background Conditions (No Action)*		*2025 Alternative 1*		*2025 Alternative 2*		*2025 Alternative 3*	
	Volume	*Queue*[4]	*Volume*	*Queue4*	*Volume*	*Queue4*	*Volume*	*Queue4*	*Volume*	*Queue4*
Weekday AM Peak Hour										
westbound on-ramp1 (east side)	40	--	15	--	145	--	40	--	75	--
westbound on-ramp[2] (west side)	90	--	35	--	335	7	90	--	170	--
westbound off-ramp (east side)	190	--	45	--	160	--	145	--	160	--
eastbound on-ramp (east side)	215	--	80	--	300	--	135	--	190	--
eastbound on-ramp (west side)	120	--	95	--	235	--	205	--	235	--
eastbound on-ramp (east side)	20	--	5	--	145	--	135	--	145	--
Total ramp volumes	675		275		1320		750		975	
Weekday PM Peak Hour										
westbound on-ramp (east side)	25	--	15	--	85	--	70	--	65	--
westbound on-ramp (west side)	135	--	60	--	355	27	295	--	270	--
westbound off-ramp (east side)	240	--	35	--	375	--	145	--	160	--
eastbound on-ramp (east side)	250	--	80	--	300	--	275	--	250	--
eastbound on-ramp (west side)	60	--	55	--	535	36	190	--	240	--
eastbound on-ramp (east side)	20	--	5	--	145	--	45	--	60	--
Total ramp volumes	730		250		1795		1020		1045	

Table F-6. SFOBB/I-80 Yerba Buena Island Ramp Volumes and Maximum Queue Existing and Year 2025 Weekday and Weekend Peak Hour Conditions

(continued)

Peak Hour/Ramp[3]	*Existing (1994) (Operational Base)*		*2025 Background Conditions (No Action)*		*2025 Alternative 1*		*2025 Alternative 2*		*2025 Alternative 3*	
	Volume	*Queue*[4]	*Volume*	*Queue*[4]	*Volume*	*Queue*[4]	*Volume*	*Queue*[4]	*Volume*	*Queue*[4]
Weekend midday Peak Hour										
westbound on-ramp (east side)	20	--	15	--	195	--	90	--	110	--
westbound on-ramp (west side)	125	--	35	--	570	242	260	--	320	--
westbound off-ramp (east side)	130	--	45	--	175	--	150	--	100	--
eastbound on-ramp (east side)	155	--	80	--	480	--	295	--	320	--
eastbound on-ramp (west side)	75	--	95	--	230	--	210	--	160	--
eastbound on-ramp (east side)	20	--	5	--	60	--	50	--	30	--
Total ramp volumes	**525**		**275**		**1710**		**1055**		**1040**	

[1] Ramp located east of Yerba Buena Island tunnel.

[2] Ramp located west of Yerba Buena Island tunnel.

[3] Maximum on-ramp capacity = 330 vehicles per hour per ramp, except the eastbound on-ramp on the east side of the tunnel = 900 vehicle; maximum eastbound off-ramp capacity (west of the tunnel) = 500 vehicles per ramp. Other off-ramps = 560 vehicles per ramp. Total on-ramp capacity = 1,560 vehicles per hour and total off-ramp capacity = 1,620 vehicles per hour.

[4] Number of vehicles

Source: DON 1997d.

F.3-B TRANSPORTATION

Transportation Analysis Methodology and Assumptions

This appendix presents the methodology and assumptions used in the transportation analysis of this EIS.

Existing Freeway Volumes

Table F-7 presents 24-hour volumes and average daily vehicle trips (ADT's) from traffic counts conducted by Caltrans for the Bay Bridge/I-80 during weekday and weekend periods (Caltrans 1993).

Ramp Volumes

Table F-8 presents the westbound and eastbound traffic volumes on the on- and off-ramps between Yerba Buena Island and the Bay Bridge/I-80. 1994 Caltrans traffic count information for 1994 was used for the ramps.

Land Use Program

The reuse alternatives in Chapter 2, Proposed Action and Alternatives, were defined using 26 classifications of land use assigned to approximately 15 delineated areas of the NSTI property. For purposes of the traffic analysis, these 15 areas were aggregated into 8 Traffic Analysis Zones (TAZs), 7 on Treasure Island and 1 on Yerba Buena Island. The 8 TAZs are shown on the Figure F-3 for Alternatives 1, 2, and 3, respectively. Land use classifications were then used to calculate total trips that would be generated from projected reuses.

Table F-9 presents aggregated acreages, units, or trips for the individual land use categories for each of the community reuse alternatives. The EIS developed land use data for the reuse alternatives based on information from the Reuse Plan and the San Francisco Planning Department.

Policy Summary

The following policies from the Draft Reuse Plan address regional access, street systems, transit, and water transportation; these were developed during the community reuse planning process.

- Develop waterborne transportation as the primary means of access to Treasure Island;
- Establish transit and pedestrian-based development on Treasure Island;
- Establish a multimodal internal circulation system that emphasizes non-auto modes; and
- Promote a regional system of ferry landings that are accessible by a diversity of travel modes.

Table F-7
24-hour Mainline Counts and Total Daily Trips

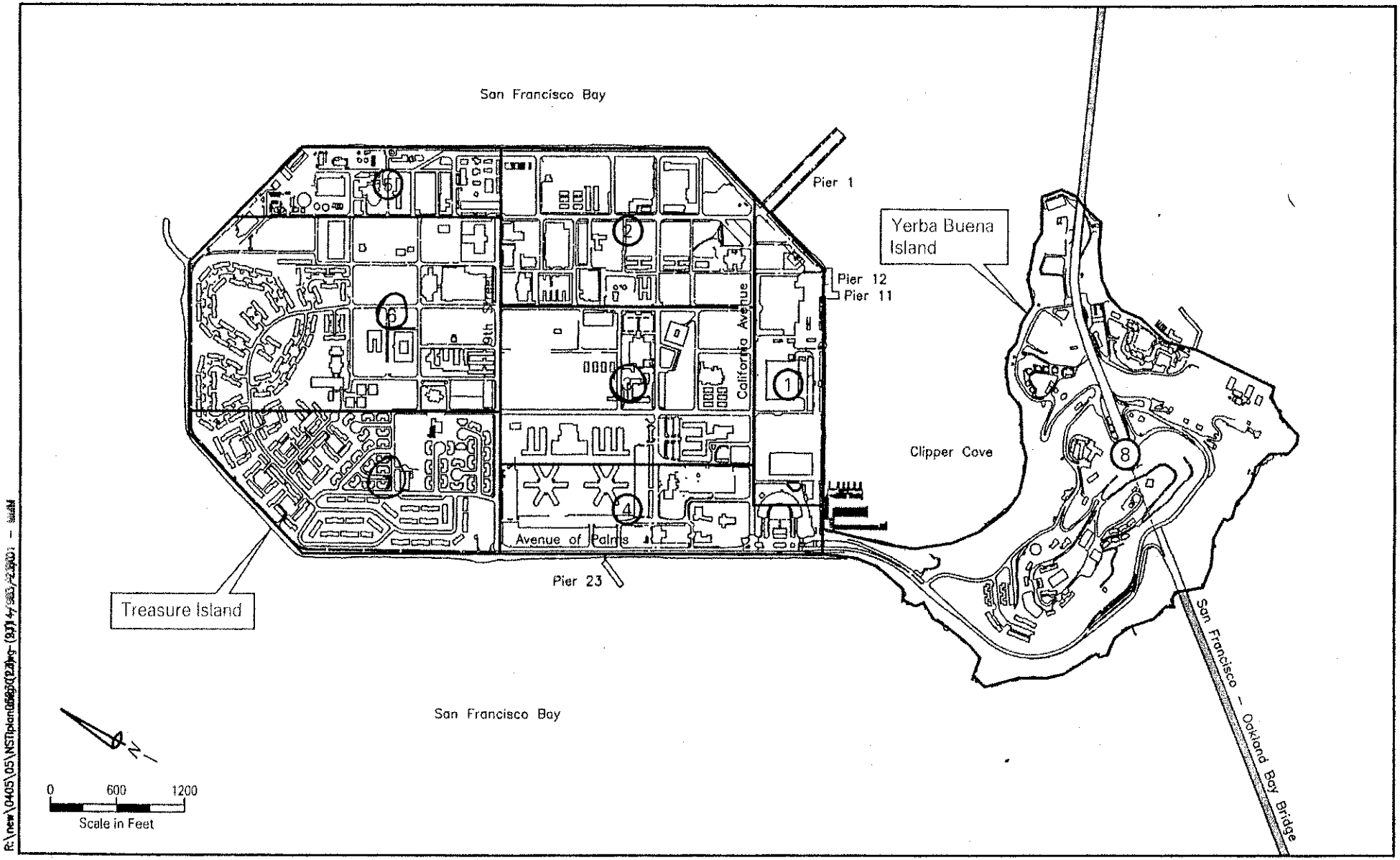
Time	I-80 Westbound Weekday (vph)	Weekend (vph)	Time	I-80 Eastbound Weekday (vph)	Weekend (vph)
12 - 1 AM	1,249	2,080	12 - 1 AM	2,499	4,491
1 - 2	792	1,226	1 - 2	1,442	3,367
2 - 3	597	747	2 - 3	986	2,669
3 - 4	689	727	3 - 4	679	1,368
4 - 5	1,342	812	4 - 5	735	946
5 - 6	4,689	1,886	5 - 6	1,653	1,218
6 - 7	9,798	3,227	6 - 7	4,517	2,293
7 - 8	10,762	4,365	7 - 8	7,925	3,936
8 - 9	10,026	5,865	8 - 9	8,356	5,307
9 - 10	8,461	7,760	9 - 10	6,216	6,281
10 - 11	7,423	8,476	10 - 11	5,900	7,077
11 - 12	6,898	8,940	11 - 12	6,442	7,028
12 - 1 PM	6,435	8,373	12 - 1 PM	6,585	6,937
1 - 2	6,408	8,527	1 - 2	7,056	6,974
2 - 3	6,475	7,534	2 - 3	8,855	8,021
3 - 4	7,554	7,152	3 - 4	10,266	8,792
4 - 5	8,289	7,597	4 - 5	9,156	7,608
5 - 6	8,505	7,804	5 - 6	9,747	9,625
6 - 7	7,528	7,753	6 - 7	9,931	9,193
7 - 8	5,752	7,052	7 - 8	8,505	6,961
8 - 9	4,170	5,280	8 - 9	6,071	5,411
9 - 10	4,064	5,759	9 - 10	6,157	5,585
10 - 11	3,804	5,488	10 - 11	5,458	6,074
11 - 12	2,429	4,083	11 - 12	4,833	6,009
Daily Total	134,139	128,513	Daily Total	139,970	133,171

Source: Caltrans 1993.

Table F-8. Ramp Volumes - 1994 Conditions

	I-80 Westbound (Weekday)				I-80 Eastbound (Weekday)				
		On-Ramp		Off-Ramp		Off-Ramp		On-Ramp	
Time	Macalla Rd. Vph	T.I. Road vph	Total vph	T.I. Road (vph)	Time	T.I. Road vph	T.I. Road vph	Total vph	T.I. Road (vph)
12 - 1 AM	1	24	25	28	12 - 1 AM	10	7	17	27
1 - 2	0	12	12	20	1 - 2	4	3	7	8
2 - 3	0	6	6	15	2 - 3	8	4	12	7
3 - 4	3	3	6	10	3 - 4	3	1	4	7
4 - 5	0	8	8	27	4 - 5	5	1	6	12
5 - 6	2	26	28	178	5 - 6	22	3	25	63
6 - 7	15	53	68	470	6 - 7	118	52	170	344
7 - 8	42	86	128	198	7 - 8	122	16	138	226
8 - 9	32	64	96	98	8 - 9	64	32	96	139
9 - 10	18	62	80	142	9 – 10	73	17	90	127
10 - 11	23	83	106	179	10 - 11	74	23	97	125
11 - 12	25	120	145	150	11 - 12	79	20	99	161
12 - 1 PM	29	93	122	177	12 - 1 PM	74	31	105	149
1 - 2	31	85	116	127	1 - 2	79	29	108	157
2 - 3	21	165	186	183	2 - 3	82	23	105	248
3 - 4	45	179	224	210	3 - 4	85	32	117	313
4 - 5	24	142	166	242	4 - 5	78	33	111	206
5 - 6	22	65	87	183	5 - 6	78	16	94	136
6 - 7	19	62	81	168	6 - 7	64	15	79	148
7 - 8	16	47	63	135	7 - 8	57	45	102	102
8 - 9	12	40	52	122	8 - 9	54	12	66	71
9 - 10	32	84	116	104	9 - 10	50	25	75	79
10 - 11	5	48	53	65	10 - 11	39	15	54	50
11 - 12	3	22	25	46	11 - 12	27	14	41	24
Daily Total	420	1,579	1,999	3,277	Daily Total	1,349	469	1,818	2,929

Source: Caltrans 1994.



For purposes of the traffic analysis, NSTI was divided into eight Traffic Analysis Zones, seven on Treasure Island and one on Yerba Buena Island.

Legend:

Traffic Analysis Zone (TAZ) boundary

(2) TAZ number

Traffic Analysis Zones for Community Reuse Alternatives

Naval Station Treasure Island, California

Source: Developed by KORVE 1997

Figure F-3

Table F-9
Land Use Program for the Community Reuse Alternatives

Alternative One			Alternative Two			Alternative Three		
Land Use	Size	Unit	Land Use	Size	Unit	Land Use	Size	Unit
ZONE 1:						ZONE 1:		
Museum	15	ksf	Themed Attraction	19	acres	Museum	15	ksf
Film Production	501	ksf	Entertainment Center	300	ksf	Film Production	501	ksf
Marina	403	slips	Museum	49,799	ksf	Marina	503	slips
			Marina	500	slips			
ZONE 2:								
Themed Attraction	59	acres	Themed Attraction	41	acres	Themed Attraction	39	acres
Outdoor Recreation	6.1	acres	Amphitheater	5000	seats	Open Space	36	acres
			Outdoor Recreation	10.8	acres	Community / Institutional	89.629	ksf
ZONE 3:								
Office	100	ksf	Themed Attraction	15	acres	Office	178.8375	ksf
Community / Institutional	183	ksf	Community / Institutional	182.952	ksf	Conference	80	ksf
Job Corps	635	trips	Job Corps	635	trips	Job Corps	635	trips
						Community / Institutional	128.04	ksf
ZONE 4:								
Restaurant	225	ksf	Office	100	ksf	Restaurant	13.2	ksf
Retail	24	ksf	Hotel	1200	rooms	Wedding Chapel	9.864	ksf
Open Space	30	acres	Open Space	15.3	acres	Office	35.7675	ksf
Hotel	1300	rooms	Conference	100	ksf	Community / Institutional	12.804	ksf
			Wedding Chapel	9.864	ksf	Open Space	24	acres
						Warehouse	34.848	ksf
ZONE 5:								
Water Treatment Plant	10	acres	Police, Fire & Medical	60.984	ksf	Fire School	244	trips
Brig	109	trips	Fire School	244	people	Community / Institutional	25.608	ksf
Fire School	244	trips	Open Space	15.3	acres	Water Treatment Plant	3	acres
Police, Fire & Medical	61	ksf	Brig	109	trips	Brig	109	trips
			Water Treatment Plant	10	acres	Police, Fire & Medical	2.61	ksf
			Community / Institutional	34.848	ksf			
ZONE 6:								
Outdoor Recreation	40.9	acres	Outdoor Recreation	7.2	acres	Outdoor Recreation	3.5	acres
Residential	1250	units	Open Space	20.4	acres	Police, Fire & Medical	10.441	ksf
Elementary School	152	trips	Golf Course	8	holes	Elementary School	152	trips
Child Development Center	10	ksf				Child Development Center	10.123	ksf
ZONE 7:								
Residential	1250	units	Golf Course	10	holes	Residential	980	units
						Police, Fire & Medical	2.61	ksf
ZONE 8:								
Open Space	58	acres	Open Space	57	acres	Open Space	57	acres
Conference	4	acres	Conference	30,241	ksf	Conference	30,241	ksf
Restaurant	12	ksf	Restaurant	12	ksf	Restaurant	12.15	ksf
Hotel	150	rooms	Hotel	150	rooms	Hotel	150	rooms
Mixed	12000	sq. ft.	Residential	250	units	Residential	160	units
Residential	340	units	Community / Institutional	0	ksf	Community / Institutional	348.48	ksf
Community / Institutional	348	ksf						
TOTALS:								
Amphitheatre			Amphitheatre	5000	seats	Amphitheatre		
Brig	109	trips	Brig	109	trips	Brig	109	trips
Child Development Center	10	ksf	Child Development Center			Child Development Center	10	ksf
Community/Institutional	531	ksf	Community/Institutional	216	ksf	Community/Institutional	605	ksf
Conference	4	acres	Conference	130	ksf	Conference	110	ksf
Elementary School	152	trips	Elementary School			Elementary School	152	trips
Entertainment Center			Entertainment Center	300	ksf	Entertainment Center		
Film Production	501	ksf	Film Production			Film Production	501	ksf
Fire School	244	trips	Fire School	244	trips	Fire School	244	trips
Golf Course			Golf Course	18	holes	Golf Course		
Hotel	1450	rooms	Hotel	1350	rooms	Hotel	150	rooms
Job Corps	635	trips	Job Corps	635	trips	Job Corps	635	trips
Marina	403	slips	Marina	500	slips	Marina	503	slips
Mixed Use	12000	sq. ft.	Mixed Use			Mixed Use		
Museum	15	ksf	Museum	50	ksf	Museum	15	ksf
Office	100	ksf	Office	100	ksf	Office	215	ksf
Open Space	88	acres	Open Space	108	acres	Open Space	117	acres
Outdoor Recreation	47	acres	Outdoor Recreation	18	acres	Outdoor Recreation	3.5	acres
Police Fire Medical	61	ksf	Police Fire Medical	61	ksf	Police Fire Medical	18	ksf
Residential	2840	units	Residential	250	units	Residential	1140	units
Restaurant (Quality)	237	ksf	Restaurant	12	ksf	Restaurant	25	ksf
Retail	24	ksf	Retail			Retail		
Themed Attraction	59	acres	Themed Attraction	75	acres	Themed Attraction	39	acres
Warehouse			Warehouse			Warehouse	35	ksf
Water Treatment Plant	10	acres	Water Treatment Plant	10	acres	Water Treatment Plant	3	acres
Wedding Chapel			Wedding Chapel	10	ksf	Wedding Chapel	10	ksf

Regional Access Policies

- Establish ferry service to Treasure Island in conjunction with publicly oriented uses, and increase service as visitor volumes expand;
- Place a priority on making seismic improvements to the causeway; and
- Encourage Caltrans to consider seismic and geometric improvements to the SFOBB as part of the bridge retrofit.

Street System Policies

- Establish a network of streets that builds upon the existing Treasure Island grid to accommodate travel demand and distribute traffic;
- Emphasize shoreline-to-shoreline connections across the island that provide direct linkages from the destinations within the island to the water's edge, aid in orienting users to the site, and maximize opportunities for public access to the shoreline;
- Develop multimodal streets on Treasure Island that accommodate significant levels of bicycle and pedestrian traffic as well as shuttles, transit buses, and automobiles;
- Promote high visibility and accessibility of the ferry terminals through the design of the street system;
- Incorporate amenities in the design of the street network for pedestrians and bicyclists; and
- Maintain the existing street network on Yerba Buena Island.

Transit System Policies

- Establish bus and shuttle services on the islands; and
- Establish a coordinated transit plan for providing access to Treasure Island that brings together Muni, Alameda-Contra Costa Transit District (AC Transit), and ferry operations.

Water Transportation System Policies

- Upgrade facilities to accommodate ferry service on the east side, and establish a new ferry terminal on the west side of Treasure Island. Design both facilities to accommodate water taxis;
- Develop ferry access to be widely available, frequent, and attractive to patrons. Encourage the use of water taxis to supplement regularly scheduled ferries for occasional trips; and
- Ensure that all development agreements, owner participation agreements (OPAs) and leases contribute to the establishment of the Treasure Island ferry access system, commensurate with the level of demand projected for each use.

The following 15 policies from the *Naval Station Treasure Island Reuse Plan Transportation Background Report* were developed during the community reuse planning process to assist in the

formulation of a Reuse Plan. These policies support the use of transit in the form of ferries and buses to NSTI, and the assumptions used in the estimation of trip generation.

1. Support the earliest possible development of ferry service to NSTI from both San Francisco and the East Bay.

2. Ferry access should be widely available, frequent and attractively priced. Regularly scheduled ferries would be supplemented by ferry taxis for occasional trips.

3. Support a visitor-oriented development that requires most visitors to travel by ferry and all visitors to travel via high occupancy modes. Enforce this policy by requiring ticket sales to be completed at landside terminals for tickets that combine ferry and admission. Prohibit visitor parking and ticket sales at the themed attraction to ensure that visitors would in fact take the ferry.

4. All children attending the planned elementary school would arrive via school bus. Pick up and drop off by parents would be prohibited, except for emergencies.

5. Bus transit services would continue to have a role at NSTI. Bus services would be developed connecting the ferry terminal to island destinations (island shuttle) and providing local on-site circulation.

6. Bus services between the island and the mainland would continue to play a role in moving people between the island and the mainland areas.

7. Ferry service should be initially established in the area of Pier 1/Pier ½ on the east side of the island, and would accommodate ferries from both the East Bay and San Francisco. This would serve as the "front door" to the visitor-oriented use. Convenient shuttle services would connect this location with other sites on the island.

8. Ferry service would ultimately be implemented at a new terminal on the west side of the island, separating the travel to and from the East Bay and San Francisco locations. Regularly scheduled ferry service would ultimately be offered from multiple locations in both East Bay and San Francisco. The initial services would be offered from San Francisco Ferry Building and Jack London Square in Oakland.

9. The ferry plan must consider the landside impacts, including parking demand on the landside and traffic impacts for travel to the ferry terminals.

10. All employers on the island would be encouraged to provide transit passes at no charge to employees to encourage transit use.

11. All employers providing parking on the island would be required to charge employees for parking, minimizing auto use.

12. All development agreements would include detailed Travel Demand Management (TDM) plans designed to show how the developer would ensure that traffic generation is minimized.

13. Any residential development planned for the NSTI, beyond the initial Phase I units, would be developed as a "unique community," which would limit auto ownership and auto use so as not to unduly impact the SFOBB.

14. Other TDM measures, including flextime, employer provided shuttles and subsidy of transit services should be aggressively pursued on the island.

15. Encourage the use of alternative fuels for all transit vehicles on the island, including the island shuttle.

Transportation Features Assumed for the Three Reuse Alternatives

The following discussion summarizes the transportation features assumed for the three Community Reuse Alternatives:

- The Treasure Island street grid system would maximize the use of existing streets and access points;
- All street rights-of-way on Treasure Island would contain sidewalks;
- Pedestrian and bicycle facilities would be provided;
- Ferry service would be provided between Treasure Island and San Francisco and the East Bay;
- Bus and shuttle service would be provided on NSTI and to NSTI from San Francisco and the East Bay;
- A coordinated transit plan for access to NSTI with the San Francisco Municipal Railway (Muni) and ferry operators would be established;
- A transportation demand management (TDM) program would be established. Measures that would be implemented would include the following:
  - establish ferry ridership targets for new users;
  - restrict visitor parking;
  - require employers to provide incentives to reduce vehicular demand;
  - establish an employee transportation coordinator;
  - require that residential development develop and implement measures to minimize auto usage (limits on parking, road pricing, integrated community design);
  - prohibit parking for certain uses such as the themed attraction;
  - require school students from San Francisco to arrive by bus;
  - establish parking restrictions;

- prohibit free parking;
- require TDM plans for all new users to meet transit ridership targets and require monitoring;
- require facilities for bicycles in new uses, as well as in all ferries; and
- consider car-share and bicycle rental programs

Planned Seismic Retrofit of the SFOBB/I-80. The suspension bridge that connects San Francisco and Yerba Buena Island will undergo major work on its towers, superstructure, foundation, and approaches during the planning horizon. A new replacement east span will be constructed in place of the existing bridge. The SFOBB east span project will include an upgrade of the eastbound on-ramp on the east side of the tunnel. This on-ramp will be built to Caltrans standards with improved sight and merging distances. A bicycle lane from Oakland to Yerba Buena Island on the new east span is also a possible component of that project.

In evaluating the reuse alternatives it has been assumed that the SFOBB/I-80 structure and connecting ramps to NSTI would remain as they are, except the eastbound on-ramp on the east side of the tunnel. The capacity of this ramp has been assumed to be 900-1,000 vph instead of 330 vph as it exists today. The substandard geometries of other ramps limit their vehicle processing capacities.

Transportation Plan Assumptions

In order to fulfill the transportation policies for NSTI listed above, a number of transportation improvements would need to be in place. The reuse planning effort developed a transportation plan for various phases of development on NSTI. The transportation service assumptions that were assumed for each community reuse alternative are summarized below. The transportation plan for the Reuse Plan was presented in the *Naval Station Treasure Island Reuse Plan Transportation Background Report.*

Alternatives 1 and 2 - Phase 3 of the Reuse Plan Transportation Plan

- Both Alternatives 1 and 2 depend heavily on ferry service to NSTI to handle the predicted levels of visitors. On Treasure Island, the southeastern pier (either Pier 1 or Pier 12) would still be in service. In addition, a new pier on the western side of the island would be constructed.
- Ferry access would be extended on both sides of the bay. New terminals could be created at Golden Gate Fields on Gilman Street, along the border of Albany and Berkeley, and at Candlestick Point in San Francisco.

Due to the increased intensity of land uses, there would be a heightened demand for ferry service. The numbers of parking spaces identified in the plan that would be needed at ferry terminals are as follows:

-- 1,100 parking spaces at the San Francisco Ferry Building;

-- 1,100 parking spaces at Candlestick Point; and,

-- 1,850 parking spaces in the East Bay, evenly split between Jack London Square and Golden Gate Fields.

- The Reuse Plan Implementation Strategy identified the need to provide off-site parking at the San Francisco Ferry Building, Jack London Square, Candlestick Point and the East Bay (Golden Gate Fields).
- Additional vessels would be needed to handle the ferry service increase in the bay. The new facilities at Golden Gate Fields and Candlestick Point would each require two dedicated ferries. In addition, there would be an extra vessel for the Ferry Building during peak periods, plus limited use of supplemental ferries during peak periods.

Frequency during peak periods:

-- 10 trips per hour from the Ferry Building (6 minute headways);

-- 5 trips per hour from Candlestick Point (12 minute headways); and

-- 8 trips per hour from the East Bay, divided between the 2 terminals (15-minute headways for each terminal).

- Shuttle bus service around the two islands would be provided. A total of four vehicles, plus one back-up vehicle would be provided. Furthermore, two additional back-up vehicles would be used to cover the peak periods, plus a secondary shuttle loop.
- The AC Transit T route would also be expanded, with headways shortened to 10 minutes during the peak and 15 minutes during the non-peak times. Since this service is no longer provided, the service requirement to accommodate demand during the peak and non-peak periods was determined, and included in section 4.5, Transportation as mitigation.

Alternative 3 - Phase 2 of the Reuse Plan Transportation Plan

- The intensity of the land uses in Alternative 3 is sufficient to warrant the addition of ferry service to NSTI. Either Pier 1 or Pier 12 would be used, both located on the southeast corner of Treasure Island. Modifications would have to be made for either pier, so they can be used by conventional ferries, and in order to meet American with Disabilities Act (ADA) requirements.
- For the ferry service, four vessels would be in use, two each from the San Francisco Ferry Building and from Jack London Square in Oakland. At the Ferry Building, an additional float would be needed to handle the new ferry service, while no modifications would be needed for the Jack London Square service.
- Parking requirements for the new ferry service include a need for significant parking at the two terminal sites. The off-site parking requirement was identified to be 950 and 950 parking spaces, at Jack London and the Ferry Building, respectively.
- On NSTI, a shuttle bus service would be implemented. This service would be necessary to connect the Treasure Island ferry terminal to the major activity centers of the two islands. A fleet of 3 buses would be needed for this service, and would run approximately every 15 minutes.

- In addition to the on-island buses, there also would be expanded AC Transit T route service to both Treasure Island and Yerba Buena Island. No new stops are planned, but headways would be decreased to 15 minutes during the peak, and between 20 and 30 minutes off-peak. Similar to Alternatives 1 and 2, since the AC Transit service is no longer provided, the service requirement to accommodate demand during the peak and non-peak periods was determined, and included in section 4.5, Transportation, as mitigation.

Travel Demand

Travel demand refers to new auto, transit and pedestrian traffic generated by proposed land uses. These include traffic (in trips) entering and leaving NSTI, as well as trips between the various land uses on NSTI. Preliminary trip generation estimates were conducted during the reuse planning effort. Trip generation, trip distribution and mode split estimates were determined for the various land uses proposed on NSTI. Due to the isolated nature of NSTI, standard San Francisco and national rates were adjusted. The reuse planning team conducted this effort in cooperation with the San Francisco Planning Department.

For this EIS, the work conducted by the reuse planning team and the San Francisco Planning Department was reviewed. In general, trip generation rates, distribution and mode split estimates developed by the reuse planning team were used. Travel demand information needed to be developed, however, for other land uses not evaluated for the Reuse Plan. In addition, auto occupancy factors for vehicle trips to NSTI, and vehicle trips to ferry terminals were reviewed, and adjusted in some cases.

Trip Generation

Tables F-10 and F-11 summarize the trip generation rates used to estimate community reuse alternative-generated traffic, for weekday and weekend conditions, respectively. Tables F-12 and F-13 present the work/non-work split for weekday and weekend conditions, respectively.

Overall community reuse alternative travel demand to and from NSTI was estimated from person-trip generation rates obtained from a variety of sources, including the San Francisco Planning Department's *Citywide Travel Behavior Survey* (*CTBS*) and *Guidelines for Environmental Review: Transportation Impacts* (July 1991), the *Port of San Francisco Waterfront Land Use Plan Draft EIR* (December 1996), *Hunters Point Transportation Plan* (1996), information from existing operations on NSTI (e.g., brig and elementary schools), as well as input from the San Francisco Planning Department. Weekday and weekend person-trips projected to be generated in 2010 under the three reuse alternatives are shown in Tables F-14 and F-15, respectively, as summarized below.

The Reuse Plan for NSTI provides for a balanced mix of land uses that would serve to create a new neighborhood. As such, it is anticipated that there would be a substantial number of trips that would occur between the various land uses, such as between residential and retail uses and between themed attraction and restaurant uses. Such trips were classified as "internal" trips. Internal trips within NSTI would also occur due to the fact that the development would occur on the islands that have delay penalties for bridge crossings due to congestion and substandard ramp configurations, and, therefore, residents and visitors would limit the number of crossings they would make throughout the day.

Table F-10
Trip Generation and In/Out Split—Weekday

		Person-Trip Rate			AM Peak				PM Peak			
			Peak		Worker		Visitor		Worker		Visitor	
Land Use	Units	Daily	AM	PM	In	Out	In	Out	In	Out	In	Out
Themed Attraction (1)	acres	30400.00	1.7%	9.8%	1.00	0.00	1.00	0.00	0.37	0.63	0.30	0.70
Themed Attraction	acres	12200.00	1.7%	9.8%	1.00	0.00	1.00	0.00	0.37	0.63	0.30	0.70
Themed Attraction	acres	6100.00	1.7%	9.8%	1.00	0.00	1.00	0.00	0.37	0.63	0.30	0.70
Office (2)	ksf	18.10	13.8%	17.3%	1.00	0.00	0.50	0.50	0.00	1.00	0.50	0.50
Hotel (3)	rooms	6.92	3.3%	9.5%	0.37	0.63	1.00	0.00	0.37	0.63	0.47	0.53
Retail (4)	ksf	168.00	0.0%	9.2%	1.00	0.00	0.50	0.50	0.00	1.00	0.50	0.50
Outdoor Recreation (5)	acres	50.00	4.0%	8.0%	0.70	0.30	1.00	0.00	0.30	0.70	0.30	0.70
Open Space (6)	acres	20.00	4.0%	8.0%	0.70	0.30	1.00	0.00	0.30	0.70	0.30	0.70
Marina (7)	slips	2.96	2.7%	6.4%	0.33	0.67	0.33	0.67	0.60	0.40	0.60	0.40
Museum (8)	ksf	50.00	0.0%	9.2%	1.00	0.00	1.00	0.00	0.30	0.70	0.30	0.70
Brig (9)	trips	109.00	37.9%	33.1%	0.67	0.33	0.90	0.10	0.40	0.60	0.40	0.60
Job Corps (10)	trips	635.00	43.0%	43.5%	1.00	0.00	0.50	0.50	0.00	1.00	0.50	0.50
Elementary School (11)	trips	152.00	49.3%	19.7%	1.00	0.00	0.60	0.40	0.00	1.00	0.00	1.00
Film Production (12)	ksf	1.14	0.0%	0.4%	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
Fire School (13)	trips	244.00	46.0%	50.0%	1.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00
Conference (14)	ksf	5.93	9.8%	9.8%	1.00	0.00	0.90	0.10	0.00	1.00	0.10	0.90
Residential (15)	units	10.00	13.8%	17.3%	0.00	1.00	0.34	0.66	1.00	0.00	0.32	0.68
Restaurant (16)	ksf	96.51	1.0%	7.9%	0.94	0.06	0.94	0.06	0.70	0.30	0.70	0.30
Warehouse (17)	ksf	4.88	11.7%	15.2%	0.72	0.28	0.72	0.28	0.35	0.65	0.35	0.65
Golf Course (18)	holes	37.59	8.6%	8.9%	0.83	0.17	0.83	0.17	0.52	0.48	0.52	0.48
Water Treatment Plant (19)	acres	0.00										
Entertainment Center (20)	ksf	46.81	0.0%	3.0%	1.00	0.00	0.50	0.50	0.50	0.50	0.50	0.50
Amphitheater (21)	seats	2.01	0.0%	30.0%	1.00	0.00	0.50	0.50	0.50	0.50	0.50	0.50
Community / Institutional (22)	ksf	50.00	10.0%	10.0%	1.00	0.00	0.50	0.50	0.00	1.00	0.00	1.00
Child Development Center (23)	ksf	0.00										
Police, Fire & Medical (24)	ksf	24.00	10.0%	10.0%	1.00	0.00	0.50	0.50	0.20	0.80	0.20	0.80
Wedding Chapel (25)	ksf	0.00										
Mixed Use (26)	ksf	45.50	2.0%	2.0%	1.00	0.00	0.50	0.50	0.00	1.00	0.50	0.50

Sources:

(1) Korve Engineering, Distribution of visitors to So. Cal. themed attraction; N/N 3/25 memo to Dave Fellham
Trip generation based on projected number of visitors for each development alternative.

(2) CTBS Table A3, Table 39, AM Peak from ITE AM Peak/Weekday ADT relationship

(3) CTBS SD1, AM Peak from ITE relationship, PM Peak per 4/11/96 DCP memo, weekend rate per 4/1/96 DCP memo

Table F-10
Trip Generation and In/Out Split—Weekday (continued)

(4) S.F. Waterfront EIR SD 2,3,4, weekend rate per 4/11/96 DCP memo
(5) Draft Hunter's Point Transportation Plan, 1996; weekday, weekend same per 4/23 memo
(6) Draft Hunter's Point Transportation Plan, 1996; passive open space
(7) ITE (420)
(8) Draft Hunter's Point/Weekday-weekend relationship from Exploritorium, 4/11/96, and work/non-work splits from CTBS Cultural
(9) San Francisco City and County Sheriff, based on 180 inmates
(10) Job Corps Environmental Evaluation
(11) 4/9/96 DCP Memorandum
(12) Conversation with Robin Eisman at SF Film and Video Arts Commission 4/10/96
(13) 4/10/96 DCP memo; Conversation with Assistant Director of Navy Fire Training Facility 4/10/96, Butte College Fire Sciences Dept. 4/6/96
(14) Presidio Transportation Planning & Analysis Technical Report, Oct 1993
(15) DCP Guidelines - ITE AM Peak/ADT relationship, weekend same as PM weekday, per 4/24/96 DCP memo
(16) ITE (831)
(17) ITE (150)
(18) ITE (430)
(19) Trip generation rate assumed to be 0.0, due to minimal number of trips. Korve Engineering, April 1997
(20) ITE (320)
(21) Trip generation rate based on two visitor trips per seat and one worker per 100 seats. All amphitheater events would occur in the evening, with one event per day. Korve Engineering, April 1997
(22) CTBS SD1 - Institutional
(23) Trip generation rate assumed to be 0.0. Majority of trips linked to Job Corps, Elementary School, and residential. Korve Engineering, April 1997
(24) ITE (630)
(25) Wedding Chapel not anticipated to generate trips on a daily basis. Korve Engineering, April 1997
(26) Draft Hunter's Point Transportation Plan, 1996

Table F-11. Trip Generation and In/Out Split—Weekend

		Person-Trip Rate		Midday			
				Worker		Visitor	
Land Use	Units	Daily	Peak	In	Out	In	Out
Themed Attraction (1)	acres	30400.00	5.5%	0.0%	1.00	0.90	0.10
Themed Attraction	acres	12200.00	5.5%	0.0%	1.00	0.90	0.10
Themed Attraction	acres	6100.00	5.5%	0.0%	1.00	0.90	0.10
Office (2)	ksf	0.00	17.3%	0.0%	1.00	0.50	0.50
Hotel (3)	rooms	6.92	8.2%	37.0%	0.63	0.47	0.53
Retail (4)	ksf	168.00	9.9%	0.0%	1.00	0.50	0.50
Outdoor Recreation (5)	acres	50.00	8.0%	30.0%	0.70	0.30	0.70
Open Space (6)	acres	20.00	8.0%	30.0%	0.70	0.30	0.70
Marina (7)	slips	3.22	27.0%	44.0%	0.56	0.44	0.56
Museum (8)	ksf	75.00	14.4%	70.0%	0.30	0.70	0.30
Brig (9)	trips	195.00	33.1%	40.0%	0.60	0.40	0.60
Job Corps (10)	trips	1646.00	12.1%	0.0%	1.00	0.50	0.50
Elementary School (11)	trips	0.00					
Film Production (12)	ksf	1.14	4.0%	50.0%	0.50	0.50	0.50
Fire School (13)	trips	1.00	9.2%	0.0%	1.00	0.00	1.00
Conference (14)	ksf	5.93	9.8%	50.0%	0.50	0.50	0.50
Residential (15)	units	10.00	17.3%	0.0%	1.00	0.50	0.50
Restaurant (16)	ksf	92.65	11.9%	53.0%	0.47	0.53	0.47
Warehouse (17)	ksf	1.22	9.8%	64.0%	0.36	0.64	0.36
Golf Course (18)	holes	42.43	10.8%	72.0%	0.28	0.72	0.28
Water Treatment Plant (19)	acres	0.00					
Entertainment Center (20)	ksf	46.81	10.0%	50.0%	0.50	0.50	0.50
Amphitheater (21)	seats	2.01	20.0%	50.0%	0.50	0.50	0.50
Community / Institutional (22)	ksf	75.00	5.0%	0.0%	1.00	0.00	1.00
Child Development Center (23)	ksf	0.00					
Police, Fire & Medical (24)	ksf	24.00	10.0%	20.0%	0.80	0.20	0.80
Wedding Chapel (25)	ksf	0.00					
Mixed Use (26)	ksf	45.50	10.0%	50.0%	0.50	0.50	0.50

Sources:

(1) Korve Engineering, Distribution of visitors to So. Cal. themed attraction; N/N 3/25 memo to Dave Fellham
Trip generation based on projected number of visitors for each development alternative.
(2) CTBS Table A3, Table 39, AM Peak from ITE AM Peak/Weekday ADT relationship
(3) CTBS SD1, AM Peak from ITE relationship, PM Peak per 4/11/96 DCP memo, weekend rate per 4/1/96 DCP memo
(4) S.F. Waterfront EIR SD 2,3,4, weekend rate per 4/11/96 DCP memo
(5) Draft Hunter's Point Transportation Plan, 1996; weekday, weekend same per 4/23 memo
(6) Draft Hunter's Point Transportation Plan, 1996; passive open space
(7) ITE (420)
(8) Draft Hunter's Point/Weekday-weekend relationship from Exploritorium, 4/11/96, and work/non-work splits from CTBS Cultural
(9) San Francisco City and County Sheriff, based on 180 inmates
(10) Job Corps Environmental Evaluation
(11) 4/9/96 DCP Memorandum
(12) Conversation with Robin Eisman at SF Film and Video Arts Commission 4/10/96
(13) 4/10/96 DCP memo; Conversation with Asst. Director of Navy Fire Training Facility 4/10/96, Butte College Fire Sciences Dept. 4/6/96
(14) Presidio Transportation Planning & Analysis Technical Report, Oct 1993
(15) DCP Guidelines - ITE AM Peak/ADT relationship, weekend same as PM weekday, per 4/24/96 DCP memo
(16) ITE (831)
(17) ITE (150)
(18) ITE (430)
(19) Trip generation rate assumed to be 0.0, due to minimal number of trips. Korve Engineering, April 1997
(20) ITE (320)
(21) Trip generation rate based on two visitor trips per seat and one worker per 100 seats. All amphitheater events would occur in the evening, with one event per day. Korve Engineering, April 1997
(22) CTBS SD1 - Institutional
(23) Trip generation rate assumed to be 0.0. Majority of trips linked to Job Corps, Elementary School, and residential. Korve Engineering, April 1997
(24) ITE (630)
(25) Wedding Chapel not anticipated to generate trips on a daily basis. Korve Engineering, April 1997
(26) Draft Hunter's Point Transportation Plan, 1996

Table F-12
Work, Non-work Splits – Weekday

Land Use	Daily		AM Peak # of		PM Peak # of	
	Workers	Visitors	Workers	Visitors	Workers	Visitors
Themed Attraction	0.10	0.90	0.19	0.81	0.19	0.81
Office	0.08	0.92	0.50	0.50	0.50	0.50
Hotel	0.10	0.90	0.45	0.55	0.45	0.55
Retail	0.08	0.92	0.08	0.92	0.08	0.92
Outdoor Recreation	0.05	0.95	0.05	0.95	0.05	0.95
Open Space	0.05	0.95	0.05	0.95	0.05	0.95
Marina	0.08	0.92	0.08	0.92	0.08	0.92
Museum	0.08	0.92	0.08	0.92	0.08	0.92
Brig	0.79	0.21	0.97	0.03	0.97	0.03
Job Corps	0.37	0.63	0.57	0.43	0.57	0.43
Elementary School	0.47	0.53	0.50	0.50	1.00	0.00
Film Production	1.00	0.00	1.00	0.00	1.00	0.00
Fire School	0.11	0.89	0.11	0.89	0.11	0.89
Conference	0.08	0.92	0.08	0.92	0.08	0.92
Residential	0.33	0.67	0.50	0.50	0.50	0.50
Restaurant (1)	0.08	0.92	0.08	0.92	0.08	0.92
Warehouse (2)	0.10	0.90	0.10	0.90	0.08	0.92
Golf Course (3)	0.08	0.92	0.08	0.92	0.08	0.92
Entertainment Center (4)	0.08	0.92	0.08	0.92	0.08	0.92
Amphitheatre (5)	0.005	0.995	0.00	0.00	0.10	0.90
Community/Institutional (6)	0.08	0.92	0.08	0.92	0.08	0.92
Police/Fire/Medical (7)	0.05	0.95	0.50	0.50	0.50	0.50
Mixed Use	0.08	0.92	0.08	0.92	0.08	0.92

Notes:

(1) Based on Specialty Retail
(2) From Korve Engineering, May 1997
(3) Based on Museum
(4) Based on Specialty Retail
(5) From Korve Engineering, May 1997
(6) Based on Museum
(7) Based on Office

Table F-13
Work, Non-work Splits—Weekend

	Daily # of		Midday Peak # of	
Land Use	Workers	Visitors	Workers	Visitors
Themed Attraction	0.10	0.90	0.00	1.00
Office	0.00	0.00	0.00	0.00
Hotel	0.10	0.90	0.45	0.55
Retail	0.08	0.92	0.08	0.92
Outdoor Recreation	0.05	0.95	0.05	0.95
Open Space	0.05	0.95	0.05	0.95
Marina	0.08	0.92	0.08	0.92
Museum	0.08	0.92	0.08	0.92
Brig	0.79	0.21	0.97	0.03
Job Corps	0.37	0.63	0.57	0.43
Elementary School	0.00	0.00	0.00	0.00
Film Production	1.00	0.00	1.00	0.00
Fire School	0.00	0.00	0.00	0.00
Conference	0.08	0.92	0.08	0.92
Residential	0.10	0.90	0.10	0.90
Restaurant (1)	0.08	0.92	0.08	0.92
Warehouse (2)	0.10	0.90	0.10	0.90
Golf Course (3)	0.08	0.92	0.08	0.92
Water Treatment Plant	1.00	0.00	1.00	0.00
Entertainment Center (4)	0.08	0.92	0.08	0.92
Amphitheatre (5)	0.005	0.995	0.01	0.99
Community/Institutional (6)	0.08	0.92	0.08	0.92
Child Development Center	0.50	0.50	0.08	0.92
Police/Fire/Medical (7)	0.05	0.95	0.50	0.50
Wedding Chapel	0.50	0.50	0.08	0.92
Mixed Use	0.08	0.92	0.08	0.92

Notes:

(1) Based on Specialty Retail
(2) From Korve Engineering, May 1997
(3) Based on Museum
(4) Based on Specialty Retail
(5) From Korve Engineering, May 1997
(6) Based on Museum
(7) Based on Weekday percentages

Table F-14
Estimated Person-trip Generation by Travel Mode[1]
Weekday Daily, AM and PM Peak Hour (2010)[2]

Mode	*Maximum Construction Alternative*			*Medium Construction Alternative*			*Minimum Construction Alternative*		
	Daily	**AM**	**PM**	**Daily**	**AM**	**PM**	**Daily**	AM	**PM**
				Person-trips					
Auto	19,570	1,645	2,660	11,660	715	1,365	10,440	1,075	1,430
Vanpool/ Other	5,890	310	610	4,120	255	455	2,665	280	335
Bus	9,600	700	1,280	7,100	285	910	3,925	430	585
Ferry	34,635	1,530	3,900	35,040	555	4,410	9,580	735	1,260
Internal[3]	48,285	2,835	4,830	17,790	1,150	1,405	18,755	1,820	2,185
Total Person- trips	***117,980***	***7,020***	***13,280***	***75,710***	***2,960***	***8,545***	***45,365***	***4,340***	***5,795***

[1]Includes inbound and outbound trips.

[2]The AM peak hour of 8:00 to 9:00 AM occurs within the AM peak period of 6:00 to 9:00 AM. The PM peak hour of 5:00 to 6:00 PM occurs within the PM peak period of 3:00 to 7:00 PM.

[3]Internal person-trips are by walking, bicycle, and shuttle, internal to the two islands.

Source: Korve Engineering 1997.

Table F-15
Estimated Person-trip Generation by Travel Mode[1]
Weekend Daily and Midday Peak Hour (2010)[2]

Mode	*Maximum Construction Alternative*		*Medium Construction Alternative*		*Minimum Construction Alternative*	
	Daily	**Midday**	**Daily**	**Midday**	**Daily**	**Midday**
Person-trips						
Auto	18,640	2,630	15,780	1,585	13,655	1,555
Vanpool/Other	6,340	585	7,080	525	5,180	340
Bus	8,760	1,110	8,170	875	4,650	510
Ferry	32,120	3,115	36,170	4,235	9,675	1,005
Internal[3]	53,470	4,950	36,365	1,920	40,780	2,550
Total Person-trips	***119,330***	***12,390***	***103,565***	***9,140***	***73,940***	***5,960***

[1]Includes inbound and outbound trips.
[2]The midday peak hour of 12:00 to 1:00 PM occurs within the midday peak period of 10:00 AM to 1:00 PM.
[3]Internal person-trips are by walking, bicycle, and shuttle, internal to the two islands.
Source: Korve Engineering 1997.

Alternative 1 is estimated to generate approximately 117,980 weekday daily person-trips, including 7,020 weekday AM peak hour and 13,280 weekday PM peak-hour person-trips. Under weekend conditions, Alternative 1 would generate approximately 119,330 daily person-trips, including 12,390 midday peak-hour person-trips. Internal trips would represent approximately 40 percent of the daily and peak hour person-trips.

Under Alternative 2, approximately 75,710 weekday daily person-trips would be generated, including 2,960 weekday AM peak hour and 8,545 weekday PM peak hour person-trips (Table F-14). Under weekend conditions, Alternative 2 would generate approximately 103,565 daily person-trips, including 9,140 midday peak hour person-trips (Table F-15).

The number of daily and peak-hour person-trips generated by Alternative 2 would be less than the number generated by Alternative 1. During the weekday, the number of daily person-trips generated by Alternative 2 would be approximately 64 percent of Alternative 1, while during the weekend, the number of daily person-trips generated by Alternative 2 would be approximately 87 percent of Alternative 1. Internal trips would range between approximately 16 to 37 percent of daily and peak hour trips.

Under Alternative 3, it is estimated that approximately 45,365 daily person-trips would be generated during a typical weekday, including approximately 4,340 AM peak hour and approximately 5,795 PM peak hour person-trips (Table F-14). During weekend conditions, Alternative 3 would generate approximately 73,940 daily person-trips, including approximately 5,960 midday peak hour person-trips (Table F-15).

Except as noted, this alternative would generate fewer daily and peak hour person- trips than the other reuse alternatives. During the weekday and weekend trips, Alternative 3 would generate from approximately 40 to 60 percent of Alternative 1 person-trips and from approximately 60 to 70 percent of Alternative 2 person-trips. However, during the weekday AM peak hour, the number of person-trips would be greater than Alternative 2, reflecting the greater number of residential dwelling units in Alternative 3 (approximately 1,065 units in Alternative 3 versus approximately 250 units in Alternative 2).

Trip Distribution

Travel distribution to and from Treasure Island was based on existing factors from the *CTBS* and the *Waterfront Land Use Plan Draft EIR*. Trip distribution factors are specific to the type of trip generated. For example, work trips to the visitor-oriented attractions would not be expected to follow the same distribution patterns as those of the visitors. Table F-16 presents the trip distributions between NSTI and four areas—San Francisco, the East Bay, the North Bay and the South Bay.

Mode Split

Mode split assumptions were made primarily based on a combination of existing and modified policies that emphasized high occupancy modes and recognized the impact of capacity constraints on mode choice. See Policy Summary of this appendix. In general, mode splits were adjusted to recognize the limited roadway access to the islands and accordingly to emphasize non-auto travel modes. Table F-17 presents the mode split assumptions, while Tables F-18 and

F-19 present, respectively, the average vehicle occupancy for vehicle trips to and from NSTI and to the ferry terminals.

Table F-16
Person-trip Distribution—Weekday and Weekend

	San Francisco		East Bay		South Bay/Peninsula		North Bay		Internal	
	Work	Visitor	Work	Visitor	Work	Visitor	Work	Visitor	Work	Visitor
Land Use	%	%	%	%	%	%	%	%	%	%
Themed Attraction	55.4	52.5	24.2	45.0	14.3	0.0	6.1	2.5	0.0	0.0
Office	56.6	11.6	25.4	5.8	13.7	1.4	4.3	1.2	0.0	80.0
Hotel	55.4	19.9	24.2	17.5	14.3	9.3	6.1	3.3	0.0	50.0
Retail	45.4	0.0	24.2	0.0	14.3	0.0	6.1	0.0	10.0	100.0
Outdoor Recreation	55.4	70.0	24.2	30.0	14.3	0.0	6.1	0.0	0.0	0.0
Open Space	55.4	70.0	24.2	30.0	14.3	0.0	6.1	0.0	0.0	0.0
Marina	55.4	52.5	24.2	45.0	14.3	0.0	6.1	2.5	0.0	0.0
Museum	55.4	58.0	24.2	29.0	14.3	7.0	6.1	6.0	0.0	0.0
Brig	55.4	50.0	24.2	50.0	14.3	0.0	6.1	0.0	0.0	0.0
Job Corps	55.4	50.0	24.2	50.0	14.3	0.0	6.1	0.0	0.0	0.0
Elementary School	55.4	100.0	24.2	0.0	14.3	0.0	6.1	0.0	0.0	0.0
Film Production	55.4	50.0	24.2	50.0	14.3	0.0	6.1	0.0	0.0	0.0
Fire School	55.4	50.0	24.2	50.0	14.3	0.0	6.1	0.0	0.0	0.0
Conference	55.4	58.0	24.2	29.0	14.3	7.0	6.1	6.0	0.0	0.0
Residential	69.1	15.8	17.2	3.4	1.7	0.3	2.0	0.4	10.0	80.0
Restaurant (1)	55.4	15.0	24.2	15.0	14.3	0.0	6.1	0.0	0.0	70.0
Warehouse (2)	55.4	50.0	24.2	50.0	14.3	0.0	6.1	0.0	0.0	0.0
Golf Course (3)	55.4	70.0	24.2	30.0	14.3	0.0	6.1	0.0	0.0	0.0
Water Treatment Plant	55.4	50.0	24.2	50.0	14.3	0.0	6.1	0.0	0.0	0.0
Entertainment Center (4)	55.4	52.5	24.2	45.0	14.3	0.0	6.1	2.5	0.0	0.0
Amphitheatre (5)	55.4	52.5	24.2	45.0	14.3	0.0	6.1	2.5	0.0	0.0
Community/Institutional (6)	55.4	15.0	24.2	15.0	14.3	0.0	6.1	0.0	0.0	70.0
Child Development Center	55.4	100.0	24.2	0.0	14.3	0.0	6.1	0.0	0.0	0.0
Police/Fire/Medical (7)	55.4	0.0	24.2	0.0	14.3	0.0	6.1	0.0	0.0	100.0
Wedding Chapel	55.4	20.0	24.2	17.5	14.3	9.3	6.1	3.3	0.0	50.0
Mixed Use	27.7	40.6	12.1	20.3	7.2	4.9	3.1	4.2	50.0	30.0

Notes:

(1) Based on Hotel, with modifications to reflect predominantly internal trips for visitors.

(2) Based on Film Production

(3) Based on Outdoor Recreation

(4) Based on Themed Attraction

(5) Based on Themed Attraction

(6) Based on Museum, with modifications to reflect predominantly internal trips for visitors.

(7) Based on Brig, with modifications to reflect predominantly internal trips for visitors.

Table F-17. Mode Split—Weekday and Weekend

Land Use	Mode	San Francisco		East Bay		South Bay/Peninsula		North Bay		Internal	
		Work	Non-Work	Work	Non-Work	Work	Non-Work	Work	Non-Work	Work	Non-Work
		%	%	%	%	%	%	%	%	%	%
Themed Attraction	Auto	34.0	0.0	39.0	0.0	57.4	0.0	51.0	0.0	7.7	8.8
Amphitheater	Carpool	14.0	0.0	4.0	0.0	2.0	0.0	5.0	0.0	0.0	0.0
Entertainment Center	Bus	13.0	10.0	43.0	10.0	10.2	10.0	0.0	10.0	39.6	28.1
	Ferry	39.0	90.0	14.0	90.0	30.4	90.0	44.0	90.0	0.0	0.0
	Other*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	63.1
Office, Museum, Brig	Auto	34.0	36.0	39.0	47.0	57.4	60.0	51.0	71.0	7.7	9.6
Mixed Use, Job Corp	Carpool	14.0	30.0	4.0	28.0	2.0	16.0	5.0	19.0	0.0	0.0
Elem Sch; Police, Fire, Med	Bus	13.0	9.0	43.0	19.0	10.2	6.0	0.0	7.0	39.6	28.7
Comm/Inst.	Ferry	39.0	26.0	14.0	6.0	30.4	18.0	44.0	3.0	0.0	0.0
	Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	61.7
Hotel	Auto	34.0	35.5	39.0	47.0	57.4	60.0	51.0	71.4	7.7	8.8
Conference	Carpool	14.0	30.0	4.0	28.0	2.0	16.0	5.0	19.4	0.0	0.0
Restaurant	Bus	13.0	9.0	43.0	19.0	10.2	6.0	0.0	7.2	39.6	28.1
	Ferry	39.0	25.5	14.0	6.0	30.4	18.0	44.0	2.0	0.0	0.0
	Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	63.1
Retail	Auto	34.0	50.0	39.0	50.0	57.4	0.0	51.0	0.0	7.7	8.8
	Carpool	14.0	0.0	4.0	0.0	2.0	0.0	5.0	0.0	0.0	0.0
	Bus	13.0	50.0	43.0	50.0	10.2	0.0	0.0	0.0	39.6	28.1
	Ferry	39.0	0.0	14.0	0.0	30.4	0.0	44.0	0.0	0.0	0.0
	Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	63.1
Outdoor Recreation	Auto	34.0	36.0	39.0	47.0	57.4	60.0	51.0	71.0	7.7	8.8
Golf Course	Carpool	14.0	30.0	4.0	28.0	2.0	16.0	5.0	19.0	0.0	0.0
	Bus	13.0	9.0	43.0	19.0	10.2	6.0	0.0	7.0	39.6	28.1
	Ferry	39.0	26.0	14.0	6.0	30.4	18.0	44.0	2.0	0.0	0.0
	Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	63.1
Open Space	Auto	34.0	84.0	39.0	84.0	57.4	84.0	51.0	84.0	7.7	8.8
Marina	Carpool	14.0	0.0	4.0	0.0	2.0	0.0	5.0	0.0	0.0	0.0
	Bus	13.0	12.0	43.0	12.0	10.2	12.0	0.0	12.0	39.6	28.1
	Ferry	39.0	4.0	14.0	4.0	30.4	4.0	44.0	4.0	0.0	0.0
	Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	63.1
Film Production	Auto	58.0	36.0	66.0	47.0	89.0	60.0	52.0	71.0	7.7	8.8
Warehouse	Carpool	19.0	30.0	0.0	28.0	5.0	16.0	10.0	19.0	0.0	0.0
	Bus	6.0	9.0	17.0	19.0	3.0	6.0	19.0	7.0	39.6	28.1
	Ferry	17.0	26.0	17.0	6.0	3.0	18.0	19.0	2.0	0.0	0.0
	Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	63.1
Fire School	Auto	34.0	34.0	39.0	39.0	57.4	57.4	51.0	51.0	7.7	8.8
	Carpool	14.0	14.0	4.0	4.0	2.0	2.0	5.0	5.0	0.0	0.0
	Bus	13.0	13.0	43.0	43.0	10.2	10.2	0.0	0.0	39.6	28.1
	Ferry	39.0	39.0	14.0	14.0	30.4	30.4	44.0	44.0	0.0	0.0
	Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	63.1
Residential	Auto	34.0	66.0	66.0	84.0	34.0	62.5	66.0	0.0	7.7	9.6
	Carpool	2.0	2.0	2.0	0.0	2.0	3.0	2.0	0.0	0.0	0.0
	Bus	16.0	24.0	24.0	12.0	16.0	9.0	24.0	10.0	39.6	28.7
	Ferry	48.0	8.0	8.0	4.0	48.0	25.5	8.0	90.0	0.0	0.0
	Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	61.7

Note: * Other = Pedestrian or bicycle.

	Work	Non-Work
Vehicle Occupancy Rates: Carpool	3.0	8.0
Auto	1.5	3.0

Table F-18
Average Vehicle Occupancy for Trips to NSTI
(persons per vehicle)

Vehicle type	*Work*	*Non-work*
Vanpool/Other	3	8
Auto	1.5	3

Table F-19
Average Vehicle Occupancy for Vehicle Trips to Ferry Terminals
(persons per vehicle)

Vehicle type	*Work*	*Non-work*
Vanpool/Other	3	8
Auto	1.5	3

SFOBB/I-80 Analysis

Freeway Operation Analysis

This section presents the approach to and results of the freeway operation analysis conducted for the existing conditions and all the community reuse alternatives. It also includes the on- and off-ramp analysis for Yerba Buena Island. Table F-20 provides level of service definitions for freeway sections. Analyses of freeway operations were conducted for the following freeway sections and directions:

Westbound direction I-80 in the AM peak period

Westbound direction I-80 in the PM peak period

Eastbound direction I-80 in the AM peak period

Eastbound direction I-80 in the PM peak period

Table F-20
Level of Service Definitions for Freeway Sections

LOS	*Average Speed (mph)*
A	≥60
B	≥55
C	≥49
D	≥41
E	≥30
F	<30

Network Development

The freeway operations area studied included the section of I-80 freeway from east of Treasure Island to the west of the I-80/U.S. 101 junction. This study area is approximately 4.3 miles (7 km) long and includes the mainline freeway and the associated ramps.

The analysis employed the FREQ11 software program, a freeway corridor simulation model developed by the Institute of Transportation Studies of the University of California at Berkeley. This program evaluates the basic freeway segments, ramp junctions, and weaving areas based on the 1985 *Highway Capacity Manual* (HCM) procedures as a system, and provides system wide average speeds and queue spillback data over a three-hour peak period. The purpose of the three-hour analysis period is to analyze the network before, during and after the peak hour to analyze the congestion build-up and dissipation. The calibrated AM and PM peak conditions network developed for the *Alternatives to Replacement of the Embarcadero Freeway and the Terminal Separator Structure* (November 1994) was used as a base for this exercise. This network included the section of I-80 freeway from west of Treasure Island to the west of the I-80/U.S. 101 junction based on 1993/1994 traffic conditions.

For the NSTI Disposal and Reuse EIS, the FREQ11 freeway network was expanded to include NSTI and the on- and off-ramps associated with it in both the eastbound and westbound directions. Ramp volumes from 1994 Caltrans counts were used as an input into the expanded network.

In addition to the AM and PM peak networks, a third network, the weekend midday peak period, was developed. Since weekend ramp volumes were not available for year 1993/1994, it was assumed that ramp traffic volumes during the weekend midday peak period are similar to the AM peak. Mainline volumes for weekend conditions were obtained from Caltrans for 1996/1997 conditions, and these volumes were used as an input into the model.

The following input parameters were adjusted to calibrate the new model to the existing conditions as reported in *Alternatives to Replacement of the Embarcadero Freeway and the Terminal Separator Structure* and existing conditions observed in 1997:

- Speed flow curves for each freeway subsection was developed to reflect the maximum flow rate of 2,100 passenger cars per hour per lane.
- A speed-flow curve (65-mph) was used, based on the data on the I-80 freeway provided by FREQ11.
- Weaving section capacities were based on the existing operations. The weaving section capacities in the model were adjusted to reflect the existing operation.
- On- and off-ramp capacities were based on existing counts and HCM procedures. The field-measured counts were used at ramp locations where the actual ramp counts exceeded the HCM maximum recommended capacity.

Development of SFOBB/Yerba Buena Island Ramp Capacities

Since the existing ramps, especially the westbound and eastbound on-ramps, have substandard geometries, a number of approaches were taken to determine the on- and off-ramp capacities of these ramps. These methods included an HCM methodology procedure, linear regression methodology, and field measured maximum volume throughput counts.

Linear Regression Methodology

The HCM uses a methodology that calculates the capacity of an on-ramp merge area in terms of the maximum total flow that can enter the merge influence area. This is the sum of the ramp flow plus the flow in lanes one and two. A survey was conducted to find the relationship between the on-ramp volume, the time it takes for a given vehicle to enter the traffic stream from the on-ramp, the measured lane one (right-most lane) volume and the calculated lane two volume. A regression analysis was conducted with the above data, in which a relationship was not found between the collected data (i.e., R square value of 0.08).

HCM Methodology

The Yerba Buena on-ramps to I-80/SFOBB function similar to a STOP controlled T-intersection due to the existing configuration. As a result, the on-ramps were evaluated using the 1985 Highway Capacity Manual (Special Report 209, Transportation Research Board, 1994 Update) operations methodology, as outlined in Chapter 10 (Unsignalized Intersections). This method determines the capacity of the minor street intersection approach (on-ramp) by estimating the availability and the usefulness in gaps in major street traffic (so that vehicles on the minor street can merge with traffic on the major street). A survey was conducted to measure the time it takes for a given vehicle to enter the traffic stream from the on-ramp. This value (averaged by the total number of vehicles) was used as an accepted gap value. This method was not used because actual counts on the on-ramps exceeded the HCM maximum recommended capacity.

Field Measured Data

Using 1994 on-ramp and off-ramp traffic counts (a complete set of ramp volume counts for when NSTI was operational was only available for 1994 conditions) provided by Caltrans, the maximum number of serviced vehicles were used as the capacity of the on- and off-ramps. Caltrans data indicate that the eastbound on-ramp from Yerba Buena Island had the highest demand. In addition, during field surveys in 1994, a queue at the eastbound on-ramp was

observed during the ramp peak hour, this signifying that the on-ramp was operating at capacity. The merging distances for the eastbound on-ramp is less than 50 feet (15 m) and the bridge piers severely restrict sight distances for drivers trying to get onto the bridge. With the operational constraints on the eastbound on-ramp, this ramp was used as a worst-case scenario, and an on-ramp capacity of 330 vph was used for all on-ramps. An off-ramp capacity of 560 vph was used for all off-ramps, except for the eastbound off-ramp west of the tunnel in which a lower capacity of 500 vph was used due to its steep grade and tight turning radius.

The capacity data input into the FREQ11 model for the freeway and ramps is presented in Table F-21.

Table F-21
Freeway and Ramp Capacity at Yerba Buena Island (vph)

Freeway Mainline	*Eastbound SFOBB/I-80*			*Westbound SFOBB/I-80*		
	off-ramp (west of YBI[1])	off-ramp (east of YBI[1])	on-ramp	on-ramp (east of YBI[1])	off-ramp	on-ramp (west of YBI[1])
10,500	500	560	900	330	560	330

[1]Yerba Buena Island.

Future Travel Forecasts

SFOBB/I-80

Year 2010 conditions AM and PM peak period traffic volumes were estimated using the MTC travel demand model. An annualized growth rate, which was determined by comparing the existing 1994 counts and year 2015 model volumes obtained from the *Alternatives to Replacement of the Embarcadero Freeway and the Terminal Separator Structure Report*, was applied to existing 1994 traffic counts to derive Year 2010 baseline volumes. These growth rates were based on ABAG Projections '94. Recently developed San Francisco 2015 Cumulative Update to the ABAG Projections '96 land use database was not used in the analyses. Such data is useful only when the project under review is broadly physically integrated into the larger region. NSTI is connected to the region by 1 route – the SFOBB/I-80. Since the SFOBB/I-80 is already operating at capacity, the new data would not affect any analyses done using the Projections '94 data.

Based on the growth rate developed for the *Alternatives to the Replacement of the Embarcadero Freeway and Terminal Separator Structure EIS/EIR*, the AM peak traffic hour demand on the SFOBB is anticipated to increase over 1994 by approximately 6 percent in the westbound direction and 14 percent in the eastbound direction east of Treasure Island by the year 2010. Overall increases in traffic volumes during the PM peak hour are anticipated to be approximately 13 percent in the westbound direction and an additional 3 percent in the westbound direction east of Treasure Island by the year 2010.

For the EIS, year 2010 conditions needed to be developed for weekend conditions. The year 2010 weekend midday peak hour volumes were developed using 1996/1997 mainline traffic volumes for weekday and weekend conditions, and projected growth for weekday conditions. The existing relationship between the weekend midday peak and weekday AM peak period was calculated. This distribution was then applied to the projected year 2010 weekday AM peak hour volumes to obtain year 2010 weekend midday peak period mainline traffic volumes.

The weekend midday peak hour traffic demand growth on the SFOBB is projected to be similar to the AM peak. The increase would be approximately 6 percent in the westbound direction and 14 percent in the eastbound direction east of Treasure Island by the year 2010.

Year 2025 forecast and analyses were prepared and included in Appendix F.3-A for both SFOBB freeway mainline and on- and off-ramps to NSTI, using the same methodology for the year 2010 analyses.

On- and Off-ramps

The land use components of Alternatives 1, 2, and 3 were used to determine the projected travel to and from NSTI during the weekday AM and PM peak hours, and the weekend midday peak hour.

Conditions in 2010 without the Project

SFOBB /I-80 Operations

During peak period of operation, traffic demand projected for future year 2010 conditions is expected to exceed the current maximum volumes on the SFOBB of 10,000 vph. However, existing metering practices in the westbound direction at the toll plaza would limit the number of vehicles that could access the SFOBB/I-80. Westbound traffic accessing the SFOBB/I-80 is restricted to approximately 10,500 vehicles during the AM peak hour and 9,000 vehicles during the PM peak hour. More vehicles are metered in the PM peak due to congestion and backups from I-80 in San Francisco. With the projected increases in traffic demand, the peak period is anticipated to spread over a longer period than under existing conditions. During both the AM and PM peak hours, the westbound traffic on the SFOBB/I-80 is projected to operate at capacity for more than three hours during the peak period.

In the eastbound direction, the capacity and congestion in downtown segments of I-80 restrict the number of vehicles accessing the SFOBB/I-80 to approximately 9,500 vph. This condition is anticipated to continue, as there are no planned improvements at the downtown San Francisco approach of the SFOBB/I-80. As in the westbound direction, the increase in eastbound demand results in the spread of the peak period.

Ramp Operations

As a result of the closure of the NSTI, traffic volume on the ramps connecting the SFOBB/I-80 with Yerba Buena Island would decrease. During both the weekday AM and PM peak hours, the ramp volumes are anticipated to be approximately a third of the 1994 levels. Under No Action conditions, total traffic entering and exiting NSTI in both the eastbound and westbound directions would be approximately 277 vph during the AM peak hour, and 249 vph during the

PM peak hour. During the weekend midday peak hour, volumes are estimated to be similar to weekday AM conditions (277 vph). These vehicles would include trips to and from the Coast Guard Station, the museum, and sightseeing trips.

Analysis Results

Table F-22 presents a summary of the analysis results of the SFOBB/I-80 freeway operations for the peak hour conditions. Tables F-23 and F-24 present the SFOBB/I-80 operations for the three-hour FREQ11 run, for the eastbound and westbound directions, respectively. Traffic volumes, speeds and LOS are presented for five segments of the SFOBB/I-80. Table F-25 presents the SFOBB/I-80 results for weekend conditions. Table F-26 presents the SFOBB/I-80 ramp volumes and queues for the Yerba Buena Island on- and off-ramps.

Intersection Analysis

Operating characteristics of intersections are described by use of the concept of Level of Service (LOS). LOS designations are a qualitative description of an intersection's performance based on traffic delays. An intersection's LOS could range from LOS A, representing free-flow conditions, to LOS F, representing congested conditions. All intersections analyzed for the community reuse alternatives are unsignalized, and Table F-27 provides detailed descriptions of the various LOS operating conditions for unsignalized intersections.

Operations at unsignalized intersections (both two-way and all-way stop-controlled) were evaluated using the methodology outlined in Chapter 10 of the 1994 Update to the *1985 Highway Capacity Manual.* For two-way stop-controlled intersections, the analysis method determines the conflicting traffic volumes, the capacity of the gaps in the major traffic stream, and estimates the average total delay for each movement. Total delay is defined as the total elapsed time from when a vehicle joins the queue until the vehicle departs from the stopped position at the head of the queue. Level of service is then based on the average total delay. Level of service for unsignalized intersections ranges from LOS A, which is generally free-flow conditions with easily made turns by the minor street traffic, to LOS F, which indicates very long delays for the minor street traffic. For all-way STOP-controlled intersections, the analysis methodology estimates the capacity and delay for each roadway approach based upon the intersection geometry and the turning movements at the intersection. The LOS is then determined based on the average total delay for the intersection as a whole.

Table F-28 presents a summary of the weekday and weekend peak hour analyses for the 5 study intersections.

Table F-22
Summary of SFOBB / I-80 Weekday and Weekend Peak Hour Traffic Conditions

Scenario / Time	Eastbound		Westbound	
	Speed	LOS	Speed	LOS
Weekday AM Peak Hour (7:30 - 8:30)				
Existing	57	B	45	D
No Action (Year 2010)	57	B	23	F
Maximum Alternative (Year 2010)	57	B	22	F
Medium Alternative (Year 2010)	57	B	23	F
Minimum Alternative (Year 2010)	57	B	23	F
Weekday PM Peak Hour (4:30 - 5:30)				
Existing	46	D	56	B
No Action (Year 2010)	46	D	18	F
Maximum Alternative (Year 2010)	46	D	17	F
Medium Alternative (Year 2010)	46	D	17	F
Minimum Alternative (Year 2010)	46	D	17	F
Weekend Midday Peak Hour (12:30 - 1:30)				
Existing	57	B	57	B
No Action (Year 2010)	57	B	57	B
Maximum Alternative (Year 2010)	56	B	57	B
Medium Alternative (Year 2010)	57	B	57	B
Minimum Alternative (Year 2010)	56	B	57	B

(1) Eastbound I-80/SFOBB east of the tunnel
(2) Westbound I-80/SFOBB east of the tunnel
(3) LOS is based on mainline travel speeds consistent with San Francisco CMP LOS designations
Source: Korve Engineering, Inc., May 1997

Table F-23
Freeway Mainline Travel Speeds, Volumes, and LOS (SFOBB / I-80 Eastbound) – Weekday Conditions

AM Peak Period

Scenario / Time Period	Fremont On-ramp to I-80 Mainline			I-80 Bay Bridge to TI Road Left Off-ramp			TI Road Left Off-ramp to TI Road Right Off-ramp			TI Road Right Off-ramp To TI Road On-ramp			TI Road On-ramp to I-80 Mainline		
	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS
Existing															
6:30-7:30 AM	6,889	53	C	6,889	57	B	7,051	57	B	6,721	57	B	7,049	57	B
7:30-8:30 AM	7,048	53	C	7,048	57	B	7,367	57	B	6,916	57	B	7,133	57	B
8:30-9:30 AM	6,328	53	C	6,328	57	B	6,870	57	B	6,249	57	B	6,387	57	B
No Action															
6:30-7:30 AM	7,135	52	C	7,135	57	B	6,984	57	B	7,046	57	B	7,127	57	B
7:30-8:30 AM	7,410	52	C	7,410	57	B	7,376	57	B	7,366	57	B	7,407	57	B
8:30-9:30 AM	6,922	52	C	6,922	57	B	6,835	57	B	6,867	57	B	6,908	57	B
Maximum Alternative															
6:30-7:30 AM	7,186	52	C	7,186	57	B	6,985	57	B	6,864	57	B	7,162	57	B
7:30-8:30 AM	7,483	52	C	7,483	57	B	7,376	57	B	7,310	57	B	7,459	57	B
8:30-9:30 AM	6,962	52	C	6,962	57	B	6,836	57	B	6,761	57	B	6,910	57	B
Medium Alternative															
6:30-7:30 AM	7,176	52	C	7,176	57	B	7,001	57	B	6889	57	B	7,024	57	B
7:30-8:30 AM	7,468	52	C	7,468	57	B	7,376	57	B	7,317	57	B	7,385	57	B
8:30-9:30 AM	7,339	52	C	6,955	57	B	6,847	57	B	6,776	57	B	6,844	57	B
Minimum Alternative															
6:30-7:30 AM	7,185	52	C	7,185	57	B	6,984	57	B	6,864	57	B	7,053	57	B
7:30-8:30 AM	7,483	52	C	7,483	57	B	7,376	57	B	7,310	57	B	7,405	57	B
8:30-9:30 AM	6,961	52	C	6,961	57	B	6,835	57	B	6,760	57	B	6,855	57	B

PM Peak Period

Scenario / Time Period	Fremont On-ramp to I-80 Mainline			I-80 Bay Bridge to TI Road Left Off-ramp			TI Road Left Off-ramp to TI Road Right Off-ramp			TI Road Right Off-ramp To TI Road On-ramp			TI Road On-ramp to I-80 Mainline		
	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS
Existing															
3:30-4:30 PM	9,451	47	D	9,451	46	D	9,393	46	D	9,373	46	D	9,620	46	D

Table F-23
Freeway Mainline Travel Speeds, Volumes, and LOS (SFOBB / I-80 Eastbound) — Weekday Conditions (continued)

PM Peak Period

	Fremont On-ramp to I-80 Mainline			I-80 Bay Bridge to TI Road Left Off-ramp			TI Road Left Off-ramp to TI Road Right Off-ramp			TI Road Right Off-ramp To TI Road On-ramp			TI Road On-ramp to I-80 Mainline		
Scenario / Time Period	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS
4:30-5:30 PM	9,456	47	D	9,456	46	D	9,394	46	D	9,359	46	D	9,473	46	D
5:30–6:30 PM	8,965	51	D	8,965	46	D	8,897	47	D	8,875	47	D	9,005	46	D
No Action															
3:30-4:30 PM	9,499	47	D	9,499	46	D	9,423	46	D	9,421	46	D	9,460	46	D
4:30-5:30 PM	9,457	47	D	9,457	46	D	9,399	46	D	9,393	46	D	9,471	46	D
5:30-6:30 PM	8,965	51	D	8,965	46	D	8,937	46	D	8,936	46	D	8,975	46	D
Maximum Alternative															
3:30-4:30 PM	9,450	47	D	9,450	46	D	9,206	46	D	9,140	46	D	9,290	46	D
4:30-5:30 PM	9,455	47	D	9,455	46	D	8,933	47	D	8,790	47	D	9,090	46	D
5:30-6:30 PM	8,965	51	C	8,965	46	D	8,706	47	D	8,633	47	D	8,783	47	D
Medium Alternative															
3:30-4:30 PM	9,450	47	D	9,450	46	D	9,360	46	D	9,339	46	D	9,476	46	D
4:30-5:30 PM	9,456	47	D	9,450	46	D	9,260	46	D	9,214	46	D	9,487	46	D
5:30-6:30 PM	8,965	51	C	8,965	46	D	8,869	47	D	8,847	47	D	8,984	46	D
Minimum Alternative															
3:30-4:30 PM	9,450	47	D	9,450	46	D	9,338	46	D	9,311	46	D	9,435	46	D
4:30-5:30 PM	9,458	47	D	9,458	46	D	9,211	46	D	9,150	46	D	9,397	46	D
5:30-6:30 PM	8,965	51	C	8,965	46	D	8,845	47	D	8,814	47	D	8,938	46	D

LOS is based on mainline travel speeds consistent with San Francisco CMP LOS designations

Source: Korve Engineering, Inc., May 1997

Table F-24
Freeway Mainline Travel Speeds, Volumes, and LOS (SFOBB / I-80 Westbound) — Weekday Conditions

AM Peak Period

	I-80 Bay Bridge to YBI On-ramp			YBI On-ramp to YBI Off-ramp			YBI Off-ramp to YBI On-ramp			YBI On-ramp to I-80 Mainline			I-80 Mainline to Fremont Off-ramp		
Scenario / Time Period	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS
Existing															
6:30-7:30 AM	10,540	34	E	10,628	36	E	10,429	46	D	10,472	37	E	10,500	28	F
7:30-8:30 AM	9,571	45	D	9,644	45	D	9,540	46	D	9,572	55	B	9,823	25	F
8:30-9:30 AM	8,120	49	C	8,184	49	C	8,034	50	C	8,056	57	B	8,056	57	B
No Action															
6:30-7:30 AM	9,115	21	F	9,130	21	F	9,090	21	F	9,125	22	F	9,125	22	F
7:30-8:30 AM	9,568	23	F	9,575	23	F	9,553	23	F	9,571	24	F	9,571	24	F
8:30-9:30 AM	8,422	48	D	8,429	49	C	8,410	42	D	9,041	27	F	9,041	22	F
Maximum Alternative															
6:30-7:30 AM	8,729	20	F	8,876	21	F	8,725	20	F	9,005	22	F	9,055	22	F
7:30-8:30 AM	9,274	22	F	9,348	22	F	9,260	22	F	9,439	23	F	9,439	23	F
8:30-9:30 AM	8,883	27	F	8,957	21	F	8,887	20	F	9,057	22	F	9,057	22	F
Medium Alternative															
6:30-7:30 AM	9,297	22	F	9,336	22	F	9,198	21	F	9,291	23	F	9,291	23	F
7:30-8:30 AM	9,553	23	F	9,572	23	F	9,502	23	F	9,549	24	F	9,549	24	F
8:30-9:30 AM	8,473	42	D	8,494	27	F	8,431	24	F	9,046	22	F	9,046	22	F
Minimum Alternative															
6:30-7:30 AM	9,126	21	F	9,200	22	F	9,045	21	F	9,217	22	F	9,217	22	F
7:30-8:30 AM	9,474	23	F	9,510	23	F	9,431	22	F	9,517	24	F	9,517	24	F
8:30-9:30 AM	8,482	35	E	8,519	22	F	8,963	20	F	9,049	27	F	9,049	22	F

PM Peak Period

	I-80 Bay Bridge to YBI On-ramp			YBI On-ramp to YBI Off-ramp			YBI Off-ramp to YBI On-ramp			YBI On-ramp to I-80 Mainline			I-80 Mainline to Fremont Off-ramp		
Scenario / Time Period	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS
Existing															
3:30-4:30 PM	8,191	56	B	8,327	56	B	8,072	57	B	8,097	57	B	8,097	56	B
4:30-5:30 PM	8,347	56	B	8,423	56	B	8,210	56	B	8,233	56	B	8,199	19	F
5:30-6:30 PM	7,966	57	B	8,047	56	B	7,890	57	B	7,909	57	B	7,909	57	B
No Action															

Table F-24
Freeway Mainline Travel Speeds, Volumes, and LOS (SFOBB / I-80 Westbound) -- Weekday Conditions (continued)

PM Peak Period

	I-80 Bay Bridge to YBI On-ramp			YBI On-ramp to YBI Off-ramp			YBI Off-ramp to YBI On-ramp			YBI On-ramp to I-80 Mainline			I-80 Mainline to Fremont Off-ramp		
Scenario / Time Period	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS
3:30-4:30 PM	9,000	56	B	9,008	56	B	8,990	56	B	7,822	38	E	7,822	18	F
4:30-5:30 PM	7,960	18	F	7,975	18	F	7,941	17	F	8,001	18	F	8,001	18	F
5:30-6:30 PM	8,498	20	F	8,506	20	F	8,489	20	F	8,520	20	F	8,520	20	F
Maximum Alternative															
3:30-4:30 PM	7,722	48	D	7,764	37	E	7,568	32	E	7,790	23	F	7,745	17	F
4:30-5:30 PM	7,795	17	F	7,879	18	F	7,513	16	F	7,923	17	F	7,843	18	F
5:30-6:30 PM	8,406	19	F	8,449	20	F	8,259	19	F	8,474	19	F	8,435	20	F
Medium Alternative															
3:30-4:30 PM	7,687	47	D	7,724	37	E	7,650	32	F	7,798	23	F	7,798	18	F
4:30-5:30 PM	7,697	17	F	7,768	17	F	7,627	16	F	7,922	17	F	7,922	18	F
5:30-6:30 PM	8,365	19	F	8,401	19	F	8,329	19	F	8,476	19	F	8,476	20	F
Minimum Alternative															
3:30-4:30 PM	7,708	51	C	7,740	40	E	7,568	35	E	7,745	24	F	7,790	18	F
4:30-5:30 PM	7,743	17	F	7,810	17	F	7,513	16	F	7,843	17	F	7,923	18	F
5:30-6:30 PM	8,388	19	F	8,420	19	F	8,259	19	F	8,435	19	F	8,474	20	F

LOS is based on mainline travel speeds consistent with San Francisco CMP LOS designations

Source: Korve Engineering, Inc., May 1997

Table F-25
Freeway Mainline Travel Speeds, Volumes, and LOS (SFOBB / I-80)
Weekend Conditions

EASTBOUND WEEKEND MIDDAY PEAK

	Fremont On-ramp to I-80 Mainline			I-80 Bay Bridge to TI Road Left Off-ramp			TI Road Left Off-ramp to TI Road Right Off-ramp			TI Road Right Off-ramp To TI Road On-ramp			TI Road On-ramp to I-80 Mainline		
Scenario / Time Period	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS
Existing															
11:30-12:30 PM	6,584	53	C	6,584	57	B	6,510	58	B	6,487	58	B	6,640	57	B
12:30-1:30 PM	7,152	53	C	7,152	57	B	7,050	57	B	7,038	57	B	7,171	57	B
1:30-2:30 PM	7,435	53	C	7,435	57	B	7,329	57	B	7,304	57	B	7,409	57	B
No Action															
11:30-12:30 PM	7,378	52	C	7,378	57	B	7,330	57	B	7,328	57	B	7,369	57	B
12:30-1:30 PM	7,692	52	C	7,692	57	B	7,604	57	B	7,600	57	B	7,681	57	B
1:30-2:30 PM	7,434	52	C	7,434	57	B	7,390	57	B	7,389	57	B	7,430	57	B
Maximum Scenario															
11:30-12:30 PM	7,403	52	C	7,403	57	B	7,292	57	B	7,264	57	B	7,504	57	B
12:30-1:30 PM	7,795	52	C	7,795	56	B	7,587	57	B	7,533	57	B	7,863	56	B
1:30-2:30 PM	7,435	52	C	7,435	57	B	7,334	57	B	7,308	57	B	7,638	57	B
Medium Scenario															
11:30-12:30 PM	7,399	52	C	7,399	57	B	7,298	57	B	7,272	57	B	7,420	57	B
12:30-1:30 PM	7,778	52	C	7,778	56	B	7,589	57	B	7,543	57	B	7,838	57	B
1:30-2:30 PM	7,434	52	C	7,434	57	B	7,343	57	B	7,321	57	B	7,469	57	B
Minimum Scenario															
11:30-12:30 PM	7,391	52	C	7,391	57	B	7,312	57	B	7,297	57	B	7,457	57	B
12:30-1:30 PM	7,744	52	C	7,744	56	B	7,598	57	B	7,570	57	B	7,890	56	B
1:30-2:30 PM	7,434	52	C	7,434	57	B	7,363	57	B	7,350	57	B	7,510	57	B

WESTBOUND WEEKEND MIDDAY PEAK

	I-80 Bay Bridge to YBI On-ramp			YBI On-ramp to YBI Off-ramp			YBI Off-ramp to YBI On-ramp			YBI On-ramp to I-80 Mainline			I-80 Mainline to Fremont Off-ramp		
Scenario / Time Period	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS
Existing															
11:30-12:30 PM	7,600	57	B	7,727	57	B	7,586	57	B	7,609	57	B	7,609	57	B
12:30-1:30 PM	7,131	57	B	7,283	57	B	7,094	57	B	7,106	57	B	7,106	57	B
1:30-2:30 PM	7,087	57	B	7,233	57	B	7,094	57	B	7,111	57	B	7,111	57	B

Table F-25
Freeway Mainline Travel Speeds, Volumes, and LOS (SFOBB / I-80)
Weekend Conditions (continued)

WESTBOUND WEEKEND MIDDAY PEAK

	I-80 Bay Bridge to YBI On-ramp			YBI On-ramp to YBI Off-ramp			YBI Off-ramp to YBI On-ramp			YBI On-ramp to I-80 Mainline			I-80 Mainline to Fremont Off-ramp		
Scenario / Time Period	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS	Volume (vph)	Speed (mph)	LOS
No Action															
11:30-12:30 PM	8,064	57	B	8,071	57	B	8,050	57	B	8,067	57	B	8,067	57	B
12:30-1:30 PM	7,611	57	B	7,624	57	B	7,582	57	B	7,616	57	B	7,616	57	B
1:30-2:30 PM	7,498	57	B	7,504	57	B	7,485	57	B	7,504	57	B	7,504	57	B
Maximum Scenario															
11:30-12:30 PM	8,130	57	B	8,227	56	B	8,146	57	B	8,432	56	B	8,432	56	B
12:30-1:30 PM	7,744	57	B	7,937	57	B	7,770	57	B	8,100	57	B	8,100	57	B
1:30-2:30 PM	7,563	57	B	7,659	57	B	7,582	57	B	7,912	57	B	7,912	57	B
Medium Scenario															
11:30-12:30 PM	8,118	57	B	8,163	57	B	8,090	57	B	8,221	56	B	8,221	56	B
12:30-1:30 PM	7,717	57	B	7,807	57	B	7,664	57	B	7,925	57	B	7,925	57	B
1:30-2:30 PM	7,550	57	B	7,594	57	B	7,528	57	B	7,660	57	B	7,660	57	B
Minimum Scenario															
11:30–12:30 PM	8,093	57	B	8,148	57	B	8,099	57	B	8,257	56	B	8,257	56	B
12:30–130 PM	7,669	57	B	7,778	57	B	7,682	57	B	7,999	57	B	7,999	57	B
1:30–2:30 PM	7,526	57	B	7,581	57	B	7,537	57	B	7,697	57	B	7,697	57	B

LOS is based on mainline travel speeds consistent with San Francisco CMP LOS designations

Source: Korve Engineering, Inc., May 1997

Table F-26
Volume and Maximum Queue on Connector Ramps—Weekday & Weekend Conditions

Ramp	No Action		Maximum Alternative		Medium Alternative		Minimum Alternative	
	Volume (vph)	Queue (veh.)	Volume (vph)	Queue (veh.)	Volume (vph)	Queue (veh.)	Volume (vph)	Queue (veh.)
Weekday AM Peak								
Westbound On- (east of Tunnel)	14	0	147	0	39	0	74	0
Westbound Off-	44	0	160	0	144	0	162	0
Westbound On- (west of Tunnel)	35	0	337	3	93	0	172	0
Eastbound Off- (west of Tunnel)	97	0	237	0	206	0	237	0
Eastbound Off- (east of Tunnel)	6	0	143	0	133	0	143	0
Eastbound On-	81	0	298	0	135	0	190	0
Weekday PM Peak								
Westbound On- (east of Tunnel)	15	0	85	0	72	0	66	0
Westbound Off-	34	0	375	0	142	0	161	0
Westbound On- (west of Tunnel)	61	0	352	22	295	0	272	0
Eastbound Off- (west of Tunnel)	55	0	536	22	191	0	241	0
Eastbound Off- (east of Tunnel)	6	0	146	0	46	0	60	0
Eastbound On-	78	0	300	0	273	0	247	0
Weekend Midday Peak								
Westbound On- (east of Tunnel)	14	0	194	0	90	0	109	0
Westbound Off-	44	0	176	0	151	0	102	0
Westbound On- (west of Tunnel)	35	0	569	239	261	0	318	0
Eastbound Off- (west of Tunnel)	97	0	232	0	210	0	161	0
Eastbound Off- (east of Tunnel)	6	0	59	0	50	0	31	0
Eastbound On-	81	0	480	150	295	0	320	0

**Note:* On-ramp queue based on a measured capacity of 330 vph on the Treasure Island On-ramps.

Off-ramp queue based on a measured capacity of 560 for all off-ramps except the EB Treasure Island off-ramp (east of T.I.) with a capacity of 500 vph.

Source: Korve Engineering, Inc., May 1997

Table F-27
Level of Service Definitions for
Two-Way and All-Way Stop-Controlled Intersections

LOS	Average Total Delay (sec/veh)	Typical Traffic Condition
A	0 - 5	Little or no delay
B	5.1 - 10	Short traffic delays
C	10.1 - 20	Average traffic delays
D	20.1 - 30	Long traffic delays
E	30.1 - 45	Very long traffic delays
F	>45	(1)

(1) For two-way stop-controlled intersections, LOS F exists when there are insufficient gaps of suitable size to allow side street demand to cross safely through major street traffic stream. This LOS is generally evident from extremely long total delays experienced by side street traffic and by queuing on the minor approaches. When demand volume exceeds the capacity of the lane, extreme delays would be encountered with queuing, which may cause severe congestion affecting other traffic movements in the intersection. This condition usually warrants improvement to the intersection.

Source: *Highway Capacity Manual*, Special Report No. 209, Transportation Research Board, 1985, Updated 1994.

Table F-28
Intersection Level of Service—Year 2010 Conditions
Weekday AM and PM Peak Hours

Study Intersection	*Maximum Construction Alternative*				*Medium Construction Alternative*				*Minimum Construction Alternative*			
	AM		PM		AM.		PM		AM		PM	
	Delay (1)	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Avenue of Palms/ California Avenue	6.2	B	28.9	D	0.7	A	3.4	A	2.8	B	3.8	A
Avenue C/ California	0.1	A	0.9	A	0.1	A	0.0	A	0.1	A	1.2	A
Avenue C/ 9th Street	0.2	A	2.4	B	0.2	A	0.1	A	0.3	A	2.5	A
Avenue H/ 4th Street	0.3	A	0.3	B	0.4	A	0.6	A	0.5	A	0.4	A
Avenue H/ 9th Street	2.5	A	4.5	A	1.1	A	1.3	A	1.2	A	1.2	A

Weekend Midday Peak Hour

Intersection	*Alternative 1*		*Alternative 2*		*Alternative 3*	
	Delay (1)	LOS	Delay	LOS	Delay	LOS
Avenue of Palms/California Avenue	21.9	D	3.4	A	3.5	A
Avenue C/ California Avenue	0.1	A	0.0	A	0.1	A
Avenue C/ 9th Street	0.2	A	0.2	A	0.5	A
Avenue H/ 4th Street	0.0	A	0.2	A	0.1	A
Avenue H/ 9th Street	4.1	A	1.1	A	1.1	A

Delay is expressed in seconds per vehicle.

Source: Korve Engineering 1997.

Transit Analysis

Ferry Service

The key determinants to the ferry requirement tables (Figures 40, 44 and 47 in the *Naval Station Treasure Island Reuse Plan Transportation Background Report*) were the number of vessels and trips required to meet the peak travel hour/peak direction requirements. For example, if the peak direction ferry travel demand to Treasure Island is 709 passengers, 3 vessels would be required during that hour assuming a standard vessel capacity of 300 persons and a single ferry route. Table F-29 summarizes peak hour/peak direction ferry travel demand to Treasure Island for the community reuse alternatives.

Table F-29
Summary of Treasure Island Ferry Trips
Peak Hour/Peak Direction

Analysis Period	*Maximum Construction Alternative*	*Medium Construction Alternative*	*Minimum Construction Alternative*
Weekday daily	34,632	35,036	9,578
Weekday AM peak	1,529	554	739
Weekday PM/peak direction	3,898/2,082	4,416/2,482	1,260/709
Weekend daily	32,118	36,170	9,681
Weekend midday peak/peak direction	3,118/1,706	4,233/2,262	1,004/633

If the peak demand hour is during a commute period, when all available vessels are in service, the entire fleet of vessels required to NSTI must be dedicated to that service. In contrast, if the peak travel demand for NSTI is midday or evenings during the weekdays or any time on the weekend, there would be some reserve capacity in the existing and projected Bay Area ferry fleet to provide additional trips to NSTI, and somewhat less than 100 percent of the fleet requirement would need to be dedicated to NSTI service. Because of this, the Reuse Plan ferry analysis focused on the weekday demand when excess vessels are not available. In comparing the daily and peak hour ferry demand calculated for the Reuse Plan and for the alternatives in the EIS, the following conclusions were developed.

- The Reuse Plan Phase 3 ferry plan would be adequate to serve the trip demand generated by Alternatives 1 and 2. Although the 30,668 trips using the ferries during Phase 3 of the Reuse Plan would be less than the 34,632 daily riders under Alternative 1 and less than the 35,036 under Alternative 2, the weekday PM peak hour/peak directional use was projected to be 2,300 for the Phase 3 plan, compared with the demand of 2,082 and 2,482 peak directional trips with Alternatives 1 and 2, respectively.

  Although Alternative 2 would generate eight percent more ferry trips during the 5:00 to 6:00 PM peak hour than the Reuse Plan Phase 3 ferry plan, due to differences in land

uses from the Reuse Plan, Alternative 2 has somewhat different distributions to the Ferry Building, Candlestick Point, and the East Bay terminals. Thus, in comparison with the Phase 3 plan, Alternative 2 would result in 3 percent fewer trips to the Ferry Building, 15 percent more trips to the East Bay, and 19 percent more trips to Candlestick Point. However, since ferry increments serve up to 300 passengers, the comparison trips indicates that the same number of peak hour and peak period (the peak hour for ferry was assumed to be 7:00 to 8:00 PM), trips could carry the incremental peak hour demand. For example, 2 ferry trips are required to carry 506 persons from NSTI to Candlestick Point, the same number of ferry trips required to carry 436 persons between 5:00 and 6:00 PM in the Phase 3 plan.

Because of parking deficiencies at the Ferry Building and Jack London Square, the Phase 3 plan included additional vessels from Candlestick Point in San Francisco and Golden Gate Fields on the Albany/Berkeley border, locations where additional parking capacity is available. This level of service required three vessels from the Ferry Building, three vessels from Candlestick Point, and four from the two East Bay ferry terminals.

- The Reuse Plan Phase 2 would be adequate to serve the trip demand generated by Alternative 3. The Phase 2 plan was developed to serve weekday daily transportation of 10,222 trips by ferry, as compared to 9,578 daily weekday trips for Alternative 3. Assuming 15-knot vessels between the Ferry Building and Treasure Island, and 25-knot vessels operating from Jack London Square, a total of 4 vessels would be required to serve the travel demand.

  During development of the Reuse Plan ferry program, at least 2 ferry trips were assigned per hour from each terminal so that wait times would never exceed 30 minutes. Since 4 vessels could provide 2 trips per hour from Oakland and 3 trips per hour from the Ferry Building, they would have a capacity of 900 persons per hour in the peak direction from the Ferry Building and 600 passengers an hour from Jack London Square, significantly above the indicated demand for 790 passenger trips during the weekday PM peak hour for Alternative 3.

Proposals for additional ferry service from NSTI and Larkspur, Vallejo, Alameda and Oakland have been discussed as part of the community reuse alternative definition. While ferry service is expected from Oakland (and a stop at Alameda is possible), service from Larkspur and Vallejo is unlikely to be warranted, with passengers from those locations taking regularly scheduled service to the Ferry Building and transferring to the short route from the Ferry Building to NSTI. Demand from those locations would be insufficient to justify new vessels for dedicated service on Larkspur to NSTI or Vallejo to NSTI routes. Adding an additional NSTI stop to existing San Francisco trips from these terminals would have an adverse impact on existing ridership and would disrupt standard sequential schedules (typically service once every hour or two).

Bus Service

AC Transit bus service between NSTI, San Francisco, and the East Bay was discontinued in 1996. Subsequently, San Francisco Muni has provided bus service between NSTI and San Francisco. The *Naval Station Treasure Island Reuse Plan* Transportation Plan assumed that bus service would be provided to and from both San Francisco and the East Bay.

With the three proposed community reuse alternatives, the existing Muni service would be inadequate. The number of projected bus trips to Treasure Island was, therefore, calculated for each of the three community reuse alternatives. These trips were determined for both inbound and outbound of San Francisco and the East Bay. Due to the bus connections from the North Bay and South Bay within San Francisco (Golden Gate Transit and SamTrans, respectively), all transit trips from these two regions were combined with the San Francisco trips. Bus transit person-trips are summarized in Table 4.5-5 in section 4.5, Transportation.

Under Alternative 1, approximately 9,600 weekday daily and approximately 8,760 weekend daily bus transit patrons are estimated between NSTI and the East, North, and South Bays (including San Francisco). During the weekday, approximately 700 AM and 1,280 PM peak bus transit person-trips are estimated, as well as 1,110 weekend midday bus person-trips.

Under Alternative 2, approximately 7,100 weekday daily and approximately 8,170 weekend daily bus transit patrons are estimated between NSTI and the East, North, and South Bays (including San Francisco). During the weekday, approximately 285 AM and 910 PM peak bus transit person-trips are estimated, as well as 875 weekend midday bus person-trips.

Approximately 3,925 weekday daily and approximately 4,650 weekend daily bus transit patrons are estimated under Alternative 3 between NSTI and the East, North, and South Bays (including San Francisco). During the weekday, approximately 430 AM and 585 PM peak hour bus transit person-trips are estimated, as well as 510 weekend midday bus person-trips.

For both eastbound and westbound travel, the average bus size was estimated to be 40 passengers and the maximum load factor was taken to be 1.55 passengers/seat, based on bus size and load factor standards for San Francisco Muni. From these values and the projected number of transit users, the headways necessary to ensure adequate transit service were calculated for weekday AM and PM peak hours and off-peak conditions. A similar effort was conducted for weekend midday and off-peak conditions. These headways are summarized in Table F-30.

Parking Analysis

Long-term and short-term parking demand for all the proposed land uses was determined based on the methodology outlined in Appendix 5.1 of the *San Francisco Guidelines for Environmental Review: Transportation Impacts (SF Guidelines)*. For the proposed residential uses, long-term parking demand was estimated for residents using a rate of 1.5 spaces per unit. For the proposed commercial uses (i.e., all uses other than residential), both long-term parking demand was estimated for employees and short-term parking demand was estimated for visitors.

Table F-30
Summary of Bus Service Requirements

Alternative	*Weekday Headways*	*Weekend Headways*
Maximum Construction	10 minutes	15 minutes
Medium Construction	15 minutes	15 minutes
Minimum Construction	20 minutes	

Long-term parking demand for employees of the commercial uses was based on the estimated number of work trips by auto, while short-term parking demand for visitors was based on the estimated number of non-work trips by auto. As described in the *SF Guidelines*, the use of parking turnover rates[1] is required in order to estimate short-term parking demand. Parking turnover rates were obtained from the *Naval Station Treasure Island Reuse Plan Transportation Background Report* and are summarized in Table F-31 for each land use.

Table F-31
Parking Turnover Rates

Land Use	*Parking Turnover Rate (Vehicles Per Space)*
Brig, child development center, entertainment center, film production, fire school, golf, police, themed attraction, water treatment plant, and wedding chapel	1.0
Amphitheater, mixed-use, restaurant, and retail	1.5
Community/institutional, conference, elementary school, hotel, and job corps	2.0
Museum, office, and warehouse	4.0
Marina, open space, and outdoor recreation	5.0

Source: Naval Station Treasure Island Reuse Plan Transportation Background Report.

[1] - A parking turnover rate represents the number of vehicles, in a parking lot or garage, that occupy one parking space during the day (i.e., the number of times one parking space turns over throughout the day).

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APPENDIX F-4

Air Quality

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APPENDIX F-4. AIR QUALITY

OZONE, CARBON MONOXIDE, AND PM_{10}

Ozone usually is considered the primary indicator of photochemical smog, a complex mixture of secondary pollutants created by chemical reactions that occur in the presence of ultraviolet light. Because photochemical reaction rates depend on the intensity of ultraviolet light and warm air temperatures, photochemical smog is primarily a summer and early fall air pollution problem. The constituents of photochemical smog include respiratory irritants, such as ozone, nitrogen dioxide, sulfuric acid, and sulfate aerosols; eye irritants, such as aldehydes (including acrolein and formaldehyde), nitrogen dioxide, and organic nitrates; a range of toxic or potentially carcinogenic organic compounds; and visibility-reducing aerosols. Ambient air quality standards have been set for two of the major components of photochemical smog, namely ozone and nitrogen dioxide. All combustion processes, including motor vehicle engines, produce emissions of ozone precursors (reactive organic compounds and nitrogen oxides).

Carbon monoxide is primarily a winter period pollution problem, with motor vehicles being the dominant emission source in most areas. The winter seasonality occurs because vehicle emission rates increase at low temperatures and because meteorological factors that limit pollutant dispersion (low wind speeds and strong temperature inversions) are more prevalent during the winter than at other times of the year. Ambient air quality standards for carbon monoxide have been set for both one- and eight-hour periods.

Inhalable particulate matter (PM_{10}) is an aggregation of solid particles and liquid aerosols capable of penetrating to the lower respiratory tract. PM_{10} includes directly emitted particulate matter plus secondary aerosols formed from gaseous pollutants through chemical reactions and condensation processes. Major categories of secondary aerosols include low-volatility organic compounds, nitrate salts, and sulfate salts. The constituents of PM_{10} include a range of particle sizes, shapes, densities, and chemical compositions. Federal and state PM_{10} standards have been set for concentrations averaged over 24-hour and annual periods. PM_{10} concentrations are expressed on a weight basis as micrograms per cubic meter ($\mu g/m^3$).

The "10" in PM_{10} does not refer to a particle size limit but refers to a statistical measure of monitoring equipment performance called a cutpoint diameter. A cutpoint diameter is the size range at which 50 percent of the mass of ambient particles will be collected by a sampling device. A PM_{10} sampler collects 50 percent by weight of the particles in the 9.5 to 10.5 micron size range, more than 50 percent by weight of particles in smaller size ranges, and less than 50 percent by weight of particles in larger size ranges. The Federal and state PM_{10} standards do not define any absolute upper size limit for the included particles, but particles with aerodynamic equivalent diameters larger than 50 microns are unlikely to be collected.

APPLICABLE FEDERAL AND STATE AIR REGULATIONS

The Federal Clean Air Act, 42 U.S.C.A. §§ 7401-7671q (West 1995 & Supp. 1998), requires each state to develop, adopt, and implement a state implementation plan (SIP) to achieve, maintain, and enforce Federal air quality standards throughout the state. These plans must be submitted to and approved by the US Environmental Protection Agency (EPA). In California, the state

implementation plan consists of separate elements for different regions of the state. SIP elements are generally developed on a pollutant-by-pollutant basis whenever one or more air quality standards are being violated.

Local councils of governments and air pollution control districts have had the primary responsibility for developing and adopting the regional elements of the California SIP. In the San Francisco Bay region, SIP document preparation has been a coordinated effort involving three regional agencies: the Bay Area Air Quality Management District (BAAQMD), the Association of Bay Area Governments (ABAG), and the Metropolitan Transportation Commission (MTC).

Areas that violate a Federal or state ambient air quality standard are generally categorized as nonattainment areas. Ozone, carbon monoxide, and PM_{10} nonattainment designations are further categorized by severity of the problem. Those areas that meet Federal or state ambient air quality standards are categorized as attainment areas. Areas that lack sufficient monitoring data are generally categorized as unclassified areas.

In July 1997, the EPA revised the violation criteria for the existing Federal PM_{10} standards, adopted a new 8-hour ozone standard (an 8-hour average of 0.08 parts per million [ppm]), and adopted new fine particle ($PM_{2.5}$) standards (15 micrograms per cubic meter as an annual average and 65 micrograms per cubic meter as a 24-hour average).

In June 1998, the San Francisco Bay Area was reclassified from an attainment/maintenance area to an unclassified nonattainment area for the federal 1-hour ozone standard. The urbanized portions of the San Francisco Bay Area are presently categorized as attainment areas for the Federal carbon monoxide standards. The Bay Area is currently designated as unclassified for the Federal PM_{10} standard (Libretti 1998). If future monitoring data results in a nonattainment designation for the Federal $PM_{2.5}$ standards, a $PM_{2.5}$ SIP would be required (probably in 2005).

The California Clean Air Act of 1988, 1988 Cal. Stat. 1568, Cal. Health & Safety Code § 39607 note (West 1996), requires air pollution control districts and air quality management districts to develop air quality management plans for meeting state ambient air quality standards for ozone, carbon monoxide, sulfur dioxide and nitrogen dioxide. The state Air Resources Board (ARB) is responsible for developing a plan for meeting state PM_{10} standards. The entire San Francisco Bay Area is classified as a moderate nonattainment area for the state ozone standard. The Bay Area is also classified as a nonattainment area for the state PM_{10} standard. The entire San Francisco Bay Area is currently classified as an attainment area for the state carbon monoxide standards.

The California Clean Air Act does not set specific deadlines for achieving state air quality standards. Instead, attainment is required "as expeditiously as practicable". Emission control programs that must be implemented are more stringent for areas that do not expect rapid attainment of the ozone and carbon monoxide standards.

CLEAN AIR ACT CONFORMITY REQUIREMENTS

Section 176(c) of the Clean Air Act, 42 U.S.C.A. § 7506(c), requires Federal agencies to ensure that actions undertaken in nonattainment or maintenance areas are consistent with the Clean Air Act and with Federally enforceable air quality management plans. EPA has promulgated

separate rules that establish conformity analysis procedures for transportation-related actions and for other (general) Federal agency actions.

A formal conformity determination is required for Federal actions occurring in nonattainment or maintenance areas (such as the San Francisco Bay area) when the total direct and indirect emissions of nonattainment pollutants (or their precursors) exceed specified thresholds. The Federal nonattainment and maintenance pollutants subject to conformity analyses in the San Francisco Bay area include ozone precursors (reactive organic compounds and nitrogen oxides) and carbon monoxide. Applicable threshold levels for Federal actions in the San Francisco Bay Area are 100 tons (91 metric tons) per year of reactive organic compounds, 100 tons (91 metric tons) per year of nitrogen oxides, and 100 tons (91 metric tons) per year of carbon monoxide.

Several categories of Federal agency actions are identified in the general conformity rule as actions that are presumed to result in emissions below the threshold level. Transfers of ownership, interests, and titles in land, facilities, real property, or personal property to other public agencies or to private parties are presumed to have emissions below the threshold level because the agency transferring the facilities or property will not retain responsibility or control over subsequent activities. Lease arrangements, however, may be subject to the requirements of the conformity rule if the terms of the lease allow Federal agencies to control the leasee's emission-generating activities.

Air Pollution Control Programs

Air pollution control programs were established in California prior to the enactment of Federal requirements. Responsibility for air quality management programs in California is divided between ARB as the primary state air quality management agency and air pollution control districts as the primary local air quality management agencies. Federal Clean Air Act legislation in the 1970s resulted in a gradual merger of local and Federal air quality programs, particularly industrial source air quality permit programs.

The roles and responsibilities of both ARB and local air pollution control districts were expanded by the California Clean Air Act of 1988. Local air pollution control districts were given added responsibility and authority to adopt transportation control measure programs and emission reduction programs for indirect and areawide emission sources. Recent state legislation restricts the types of transportation control measure programs that can be established by air pollution control districts. Mandatory trip reduction programs can be established only if necessary to achieve Federal air quality standards.

Many types of industrial and commercial facilities require air quality permits for their equipment and operations. The BAAQMD has the primary air quality permit authority throughout the San Francisco Bay Area. Permit authority is derived from a combination of Federal and state legislation, and can be categorized into construction or installation authorizations for individual pieces of equipment and permits for continued operation of equipment and facilities. This results in a two-step permit process for new emission sources: an initial authority to construct (ATC) permit and a subsequent permit to operate (PTO).

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DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY, WEST
NAVAL FACILITIES ENGINEERING COMMAND
900 COMMODORE DRIVE
SAN BRUNO, CALIFORNIA 94066-5006

IN REPLY REFER TO:

Record of Non-Applicability

Disposal and Reuse of Naval Station Treasure Island

Pursuant to Section 176(c) of the Clean Air Act, 42 U.S.C. § 7506(c), the General Conformity Rule, 40 C.F.R. Part 93, Subpart B, and the Chief of Naval Operations Interim Guidance on Compliance with the Clean Air Act General Conformity Rule, March 8, 1995, the Department of the Navy has determined that the actions to dispose of and reuse Naval Station Treasure Island are exempt from the requirement for a conformity determination. This finding is based on the following exemptions as stated in 40 C.F.R. § 93.153(c)(2):

> (xi) The granting of leases, licenses such as for exports and trade, permits, and easements where activities conducted will be similar in scope and operation to activities currently being conducted.
>
> . . .
>
> (xiv) Transfers of ownership, interests, and titles in land, facilities, and real and personal properties, regardless of the form or method of transfer.
>
> . . .
>
> (xix) Actions (or portions thereof) associated with transfers of land, facilities, title, and real properties through an enforceable contract or lease agreement where the delivery of the deed is required to occur promptly after a specific, reasonable condition is met, such as promptly after the land is certified as meeting the requirements of CERCLA, and where the Federal agency does not retain continuing authority to control emissions associated with the land, facilities, title, or real properties.
>
> . . .
>
> (xx) Transfers of real property, including land, facilities, and related personal property from a Federal entity to another Federal entity and assignments of real property, including land, facilities, and related personal property from a Federal entity to another Federal entity for subsequent deeding to eligible applicants.

The Environmental Protection Agency's preamble to the General Conformity Rule explained the exemption for Federal land transfers as follows: "Under the exclusive definition of indirect emissions, Federal land transfers are unlikely to be covered since the Federal agency will not maintain authority over reuse activities on that land. Consequently, Federal land transfers are included in the regulatory list of actions that will not exceed the de minimis levels and thus are exempt from the final conformity rules." 58 Fed. Reg. 63231 (1993).

Based on the foregoing regulations and policies, I have determined that the Navy's actions to dispose of and reuse Naval Station Treasure Island are exempt from the requirement for a conformity determination.

ERNEST R. HUNTER
Captain, CEC, US Navy
Commanding Officer

5/18/1999
DATE

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Table F-32
Characteristics of Roadway Network Used for CALINE4 Dispersion Modeling

ROADWAY	SEGMENT	LINK SEGMENT COORDINATES X1	Y1	X2	Y2	LINK HEIGHT	LINK SEGMENT LENGTH	LANES	PM PEAK HOUR VOLUMES BY SCENARIO NO ACTION	MINIMUM	MEDIUM	MAXIMUM
UPPER DECK	EAST 1UD	2100	5170	1970	3890	55	1287	5	9000	8300	8300	8300
	EAST 2UD	1970	3890	1950	3590	55	301	5	9000	8300	8300	8300
	EAST 3UD	1950	3590	1980	3325	40	267	5	9000	8300	8300	8300
	EAST 4UD	1980	3325	2160	2810	25	546	5	9000	8300	8300	8300
	EAST 5UD	2160	2810	2480	2030	25	843	5	9000	8300	8300	8300
	TUNNELUD	2480	2030	2670	1510	25	554	5	9000	8300	8300	8300
	WEST 1UD	2670	1510	2790	1210	25	323	5	9000	8300	8300	8300
	WEST 2UD	2790	1210	3310	-140	55	1447	5	9000	8300	8300	8300
LOWER DECK	EAST 1LD	2100	5170	1970	3890	30	1287	5	9500	9500	9500	9500
	EAST 2LD	1970	3890	1950	3590	30	301	5	9500	9500	9500	9500
	EAST 3LD	1950	3590	1980	3325	15	267	5	9500	9500	9500	9500
	EAST 4LD	1980	3325	2160	2810	0	546	5	9500	9500	9500	9500
	EAST 5LD	2160	2810	2480	2030	0	843	5	9500	9500	9500	9500
	TUNNELLD	2480	2030	2670	1510	0	554	5	9500	9500	9500	9500
	WEST 1LD	2670	1510	2790	1210	0	323	5	9500	9500	9500	9500
	WEST 2LD	2790	1210	3310	-140	30	1447	5	9500	9500	9500	9500

Table F-33
Receptor Coordinates

RECEPTOR	X-COORD (FEET)	Y-COORD (FEET)	OFFSET (FEET)
N OF SEGMENT EAST3	1915	3452	50
	1890	3449	75
	1866	3446	100
	1766	3435	200
	1667	3424	300
S OF SEGMENT EAST3	2015	3463	50
	2040	3466	75
	2064	3469	100
	2164	3480	200
	2263	3491	300
N OF SEGMENT EAST5	2274	2401	50
	2251	2392	75
	2227	2382	100
	2135	2344	200
	2042	2306	300
S OF SEGMENT EAST5	2366	2439	50
	2389	2448	75
	2413	2458	100
	2505	2496	200
	2598	2534	300
N OF SEGMENT WEST1	2684	1341	50
	2660	1332	75
	2637	1323	100
	2544	1286	200
	2451	1249	300
S OF SEGMENT WEST1	2776	1379	50
	2800	1388	75
	2823	1397	100
	2916	1434	200
	3009	1471	300

Table F-34
PM Peak Hour Operating Modes, Freeway Traffic

TRIP PURPOSE	TRIP PURPOSE MIX	HOT STABLE FRACTION		COLD START FRACTION	HOT START FRACTION
H-W	50.00%	90.00%		9.25%	0.75%
H-S	10.00%	90.00%		5.27%	4.73%
H-O	20.00%	90.00%		6.81%	3.19%
O-W	10.00%	90.00%		6.24%	3.76%
O-O	10.00%	90.00%		2.87%	7.13%
CHECKSUM:	100.00%	90.00%	WTD MEAN:	7.42%	2.58%

	COLD START	HOT START
CATALYST	7.44%	2.56%
NONCATALYST	5.70%	4.30%

CATALYST FRACTION FOR LDA + LDT + MDT + MCY: 98.97%

START MODE = FIRST 505 SECONDS OF VEHICLE TRAVEL
STABLE MODE = TRAVEL AFTER 505 SECONDS OF VEHICLE OPERATION

START MODE SPLIT FACTORS:

	CATALYST VEHICLES		NONCAT VEHICLES	
TRIP PURPOSE	COLD STARTS	HOT STARTS	COLD STARTS	HOT STARTS
H-W	92.63%	7.37%	80.04%	19.96%
H-S	52.89%	47.11%	33.61%	66.39%
H-O	68.35%	31.65%	43.38%	56.62%
O-W	62.64%	37.36%	40.73%	59.27%
O-O	28.90%	71.10%	8.25%	91.75%
WTD MEAN:	74.43%	25.57%	56.96%	43.05%

Table F-35
Basic Freeway Traffic Emission Rates

SUMMARY OF EMFAC7F INPUT ASSUMPTIONS:

CALENDAR YEAR: 2010 I&M PROGRAM: YES

VEHICLE MIX ASSUMPTIONS:

LDA	LDT	MDT	HDG	HDD	BUS	MCY
70.00%	22.25%	2.27%	2.07%	1.49%	0.99%	0.98%

AIR TEMPERATURE FOR EXHAUST RATES, SUMMER: 70 WINTER: 50

EVAPORATIVE EMISSIONS TEMPERATURE PATTERNS:

	MINIMUM	8 AM	9 AM	11 AM	1 PM	MAXIMUM
SUMMER	55	57	60	68	72	75
WINTER	40	40	42	51	58	60

OPERATING MODE ASSUMPTIONS:

COLD START	HOT START	HOT STABLE
7.42%	2.58%	90.00%

VEHICLE EMISSION RATES, GRAMS/MILE:

	GRAM/MILE RATES BY SPEED IN MPH					FIXED
	15	25	35	45	55	AMOUNT
ROG	0.44	0.25	0.20	0.16	0.16	
NOx	0.82	0.67	0.65	0.74	0.97	
CO-S	4.10	2.68	2.11	1.92	2.24	
CO-W	4.63	3.07	2.44	2.23	2.59	
PMEX	0.05	0.05	0.05	0.05	0.05	
PMTW	0.21	0.21	0.21	0.21	0.21	
HOT SOAK						0.21
DRNL/RSTL						1.21

NOTES: LDA = light duty autos
LDT = light duty trucks
MDT = medium duty trucks
HDG = heavy duty gasoline-fueled vehicles
HDD = heavy duty diesel-fueled vehicles
BUS = diesel-fueled urban buses
MCY = motorcycles
ROG = reactive organic gases (summer fuel volatility)
NOx = oxides of nitrogen (summer fuel volatility)
CO-S = carbon monoxide (summer fuel volatility)
CO-W = carbon monoxide (winter fuel volatility)
PMEX = exhaust particulate matter
PMTW = tire wear particulate matter
DRNL = summer diurnal evaporative emissions (grams/veh-day)
RSTL = summer resting loss evaporative emissions (grams/veh-day)
Hot Soak evaporative emission rate in grams/trip

Table F-36
Cold Start Emission Rates for Idle Adjustment Analyses

SUMMARY OF EMFAC7F INPUT ASSUMPTIONS:

CALENDAR YEAR: 2010 I&M PROGRAM: YES

VEHICLE MIX ASSUMPTIONS:

LDA	LDT	MDT	HDG	HDD	BUS	MCY
70.20%	22.20%	2.27%	2.07%	1.49%	0.99%	0.98%

AIR TEMPERATURE FOR EXHAUST RATES, SUMMER: 70 WINTER: 50

EVAPORATIVE EMISSIONS TEMPERATURE PATTERNS:

	MINIMUM	8 AM	9 AM	11 AM	1 PM	MAXIMUM
SUMMER	55	57	60	68	72	75
WINTER	40	40	42	51	58	60

OPERATING MODE ASSUMPTIONS:

COLD START	HOT START	HOT STABLE
100.00%	0.00%	0.00%

VEHICLE EMISSION RATES, GRAMS/MILE:

	GRAM/MILE RATES BY SPEED IN MPH					FIXED
	5	10	15	20	25	AMOUNT
ROG	1.96	1.06	0.75	0.63	0.57	
NOx	1.51	1.28	1.15	1.04	0.99	
CO-S	13.36	9.77	8.10	7.21	6.68	
CO-W	16.19	12.19	10.36	9.38	8.80	
PMEX	0.05	0.05	0.05	0.05	0.05	
PMTW	0.21	0.21	0.21	0.21	0.21	
HOT SOAK						0.21
DRNL/RSTL						1.21

NOTES: LDA = light duty autos
LDT = light duty trucks
MDT = medium duty trucks
HDG = heavy duty gasoline-fueled vehicles
HDD = heavy duty diesel-fueled vehicles
BUS = diesel-fueled urban buses
MCY = motorcycles
ROG = reactive organic gases (summer fuel volatility)
NOx = oxides of nitrogen (summer fuel volatility)
CO-S = carbon monoxide (summer fuel volatility)
CO-W = carbon monoxide (winter fuel volatility)
PMEX = exhaust particulate matter
PMTW = tire wear particulate matter
DRNL = summer diurnal evaporative emissions (grams/veh-day)
RSTL = summer resting loss evaporative emissions (grams/veh-day)
Hot Soak evaporative emission rate in grams/trip

Table F-37
Hot Stabilized Emission Rates for Idle Adjustment Analyses

SUMMARY OF EMFAC7F INPUT ASSUMPTIONS:

CALENDAR YEAR: 2010 I&M PROGRAM: YES

VEHICLE MIX ASSUMPTIONS:

LDA	LDT	MDT	HDG	HDD	BUS	MCY
70.00%	22.20%	2.27%	3.07%	1.49%	0.99%	0.98%

AIR TEMPERATURE FOR EXHAUST RATES: SUMMER: 70 WINTER: 50

EVAPORATIVE EMISSIONS TEMPERATURE PATTERNS:

	MINIMUM	3 AM	9 AM	11 AM	1 PM	MAXIMUM
SUMMER	55	57	60	68	72	75
WINTER	40	40	42	51	58	60

OPERATING MODE ASSUMPTIONS:

COLD START	HOT START	HOT STABLE
0.00%	0.00%	100.00%

VEHICLE EMISSION RATES, GRAMS/MILE:

	GRAM/MILE RATES BY SPEED IN MPH					FIXED
POLLUTANT	5	10	15	20	25	AMOUNT
ROG	1.62	0.71	0.41	0.29	0.23	
NOx	1.16	0.93	0.79	0.69	0.64	
CO-S	9.01	5.42	3.76	2.86	2.33	
CO-W	9.98	5.98	4.14	3.17	2.58	
PMEX	0.05	0.05	0.05	0.05	0.05	
PMTW	0.21	0.21	0.21	0.21	0.21	
HOT SOAK						0.21
DRNL/RSTL						1.21

NOTES: LDA = light duty autos
LDT = light duty trucks
MDT = medium duty trucks
HDG = heavy duty gasoline-fueled vehicles
HDD = heavy duty diesel-fueled vehicles
BUS = diesel-fueled urban buses
MCY = motorcycles
ROG = reactive organic gases (summer fuel volatility)
NOx = oxides of nitrogen (summer fuel volatility)
CO-S = carbon monoxide (summer fuel volatility)
CO-W = carbon monoxide (winter fuel volatility)
PMEX = exhaust particulate matter
PMTW = tire wear particulate matter
DRNL = summer diurnal evaporative emissions (grams/veh-day)
RSTL = summer resting loss evaporative emissions (grams/veh-day)
Hot Soak evaporative emission rate in grams/trip

Table F-38
Estimated Vehicle Delays by Roadway Segment

		DELAY TIME (SECONDS) BY SCENARIO				ESTIMATED VOLUME:CAPACITY RATIOS BY SCENARIO			
ROADWAY	SEGMENT	NO ACTION	MINIMUM	MEDIUM	MAXIMUM	NO ACTION	MINIMUM	MEDIUM	MAXIMUM
UPPER DECK	EAST 1UD	25	18	18	18	0.90	0.83	0.83	0.83
	EAST 2UD	6	4	4	4	0.90	0.83	0.83	0.83
	EAST 3UD	5	4	4	4	0.90	0.83	0.83	0.83
	EAST 4UD	11	8	8	8	0.90	0.83	0.83	0.83
	EAST 5UD	17	12	12	12	0.90	0.83	0.83	0.83
	TUNNELUD	11	8	8	8	0.90	0.83	0.83	0.83
	WEST 1UD	6	5	5	5	0.90	0.83	0.83	0.83
	WEST 2UD	29	21	21	21	0.90	0.83	0.83	0.83
LOWER DECK	EAST 1LD	32	32	32	32	0.95	0.95	0.95	0.95
	EAST 2LD	7	7	7	7	0.95	0.95	0.95	0.95
	EAST 3LD	7	7	7	7	0.95	0.95	0.95	0.95
	EAST 4LD	14	14	14	14	0.95	0.95	0.95	0.95
	EAST 5LD	21	21	21	21	0.95	0.95	0.95	0.95
	TUNNELLD	14	14	14	14	0.95	0.95	0.95	0.95
	WEST 1LD	8	8	8	8	0.95	0.95	0.95	0.95
	WEST 2LD	36	36	36	36	0.95	0.95	0.95	0.95

Table F-39
Emission Factor Adjustments for Excess Vehicle Idling Time: SFOBB Traffic, 2010

INPUT VARIABLES	EAST1UD	EAST2UD	EAST3UD	EAST4UD	EAST5UD	UNNELUD	WEST1UD	WEST2UD	EAST1LD	EAST2LD	EAST3LD	EAST4LD	EAST5LD	UNNELLD	WEST1LD	WEST2LD
SPEED (MPH) FOR BASE EMISSION RATE	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
LINK LENGTH, FEET	1287	301	267	546	843	554	323	1447	1287	301	267	546	843	554	323	1447
DELAY PER VEHICLE, SECONDS OF IDLE	25	6	5	11	17	11	6	29	32	7	7	14	21	14	8	36
BASE EMISSION RATE, GM/MI	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07
100% STABILIZED 5 MPH RATE, GM/MI	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98	9.98
100% STABILIZED 16 MPH RATE, GM/MI	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14
100% COLD START 16 MPH RATE, GM/MI	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36
% CATALYST VEHICLES	98.97	98.97	98.97	98.97	98.97	98.97	98.97	98.97	98.97	98.97	98.97	98.97	98.97	98.97	98.97	98.97
% NON-CATALYST COLD STARTS	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70
% CATALYST COLD STARTS	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44	7.44
OUTPUT																
HOT STABILIZED IDLE RATE, GM/MIN	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
ADJUSTED COLD START 5 MPH RATE, GM/MI	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97
COLD START IDLE RATE, GM/MIN	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812	2.0812
% IDLE TIME IN EMFAC/MOBILE RATES	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65	13.65
IDLE SECONDS IN EMFAC/MOBILE RATES	4.79	1.12	0.99	2.03	3.14	2.06	1.20	5.39	4.79	1.12	0.99	2.03	3.14	2.06	1.20	5.39
REQUIRED EXTRA IDLE SECONDS	20.71	4.84	4.31	8.80	13.61	8.94	5.19	23.31	27.04	6.33	5.59	11.48	17.72	11.61	6.81	30.35
WEIGHTED % COLD STARTS	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42
WEIGHTED COLD/HOT IDLE RATE, GM/MIN	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244	0.9244
BASE EMISSION RATE, GM/MI	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07
ADDED IDLE ADJUSTMENT, GM/MI	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71
ADJUSTED EMISSION RATE, GM/MI	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.38	4.78	4.78	4.78	4.78	4.78	4.78	4.78	4.78
ADJUSTMENT FACTOR, % INCREASE	42.6%	42.7%	42.8%	42.7%	42.8%	42.8%	42.6%	42.7%	55.7%	55.8%	55.5%	55.8%	55.7%	55.6%	55.8%	55.6%

Table F-40
Basic Input Parameters Used for CALINE4 Runs

MODEL PARAMETER	INPUT VALUES			
POLLUTANT CODE:	1			
POLLUTANT NAME:	CARBON MONOXIDE			
SURFACE ROUGHNESS:	75	cm		
MOLECULAR WEIGHT:	28.01			
SETTLING VELOCITY:	0	cm/sec		
DEPOSITION VELOCITY:	0	cm/sec		
NUMBER OF RECEPTORS:	16			
NUMBER OF LINKS:	30			
SCALE FACTOR:	0.3048	feet/meter		
LINK TITLE OPTION CODE:	1			
RECEPTOR TITLE OPTION CODE:	1			
ALTITUDE:	0	feet		
LINK TYPE CODE:	4	(bridge)	1	(tunnel ends)
LINK HEIGHT:	0-30	(lower deck)	25-55	(upper deck)
MIXING CELL WIDTH:	60			
RIGHT SIDE CANYON CODE:	0			
LEFT SIDE CANYON CODE:	0			
LINK CONTINUATION CODE:	1			
RUN TYPE CODE:	1			
TRAFFIC VOLUME CHANGE CODE:	1	(first link)	0	(other links)
EMISSION RATE CHANGE CODE:	1	(first link)	0	(other links)
INTERSECTION CHANGE CODE:	0			
MET SCENARIO CHANGE CODE:	1			
WIND SPEED:	1	meters/second		
WIND DIRECTION:	0	to 350 degrees in 10 degree increments		
STABILITY CLASS:	5	(Class E, isothermal/mild inversion)		
MIXING HEIGHT LIMIT:	50	meters		
SIGMA THETA:	10	degrees		
BACKGROUND CONCENTRATION:	0	ppm		
AIR TEMPERATURE:	25	degrees C		

Note: The CALINE4 model source code was modified to accept large numbers of links and receptors, and to eliminate the inappropriate adjustment of concentration results to study area altitude and temperature; concentration results must be computed for 1 atmosphere pressure and 25 degrees C to provide a direct comparison to federal and state ambient air quality standards.

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APPENDIX G

Fish Management Plan Species

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APPENDIX G. FISH MANAGEMENT PLAN (FMP) SPECIES

Coastal Pelagics Fishery Management Plan	
Northern anchovy - *Engraulis mordax*	
Pacific sardine - *Sardinops sagax*	
Pacific (chub) mackerel - *Scomber japonicus*	
Jack mackerel - *Trachurus symmetricus*	
Market squid - *Loligo opalescens*	
Pacific Groundfish Fishery Management Plan	
Butter sole - *Isopsetta isolepis*	Flag rockfish - *Sebastes rubrivinctus*
Curlfin sole - *Pleuronichthys decurrens*	Gopher rockfish - *Sebastes carnatus*
Dover sole - *Microstomus pacificus*	Grass rockfish - *Sebastes rastrelliger*
English sole - *Parophrys vetulus*	Greenblotched rockfish - *Sebastes rosenblatti*
Flathead sole - *Hippoglossoides elassodon*	Greenspotted rockfish - *Sebastes chlorostictus*
Pacific sanddab - *Citharichthys sordidus*	Greenstriped rockfish - *Sebastes elongatus*
Petrale sole - *Eopsetta jordani*	Harlequin rockfish - *Sebastes variegatus*
Rex sole - *Glyptocephalus zachirus*	Honeycomb rockfish - *Sebastes umbrosus*
Rock sole - *Lepidopsetta bilineata*	Kelp rockfish - *Sebastes atrovirens*
Sand sole - *Psettichthys melanostictus*	Mexican rockfish - *Sebastes macdonaldi*
Starry flounder - *Platichthys stellatus*	Olive rockfish - *Sebastes serranoides*
Arrowtooth flounder - *Atheresthes stomias*	Pink rockfish - *Sebastes eos*
Ratfish - *Hydrolagus colliei*	Quillback rockfish - *Sebastes maliger*
Finescale codling - *Antimora microlepis*	Redbanded rockfish - *Sebastes babcocki*
Pacific rattail - *Coryphaenoides acrolepis*	Redstripe rockfish - *Sebastes proriger*
Leopard shark - *Triakis semifasciata*	Rosethorn rockfish - *Sebastes helvomaculatus*
Soupfin shark - *Galeorhinus zyopterus*	Rosy rockfish - *Sebastes rosaceus*
Pacific Groundfish Fishery Management Plan (continued)	
Spiny dogfish - *Squalus acanthias*	Rougheye rockfish - *Sebastes aleutianus*
Big skate - *Raja binoculata*	Sharpchin rockfish - *Sebastes zacentrus*
Longnose skate - *Raja rhina*	Shortraker rockfish - *Sebastes borealis*
Pacific ocean perch - *Sebastes alutus*	Silvergrey rockfish - *Sebastes brevispinis*
Shortbelly rockfish - *Sebastes jordani*	Speckled rockfish - *Sebastes ovalis*
Widow rockfish - *Sebastes entomelas*	Splitnose rockfish - *Sebastes diploproa*
Aurora rockfish - *Sebastes aurora*	Squarespot rockfish - *Sebastes hopkinsi*
Bank rockfish - *Sebastes rufus*	Starry rockfish - *Sebastes constellatus*
Black rockfish - *Sebastes melanops*	Stripetail rockfish - *Sebastes saxicola*
Black-and-yellow rockfish - *Sebastes chrysomelas*	Tiger rockfish - *Sebastes nigrocinctus*
Blackgill rockfish - *Sebastes melanostomus*	Treefish - *Sebastes serriceps*
Blue rockfish - *Sebastes mystinus*	Vermilion rockfish - *Sebastes miniatus*
Bocaccio - *Sebastes paucispinis*	Yelloweye rockfish - *Sebastes ruberrimus*
Bronzespotted rockfish - *Sebastes gilli*	Yellowmouth rockfish - *Sebastes reedi*
Brown rockfish - *Sebastes auriculatus*	Yellowtail rockfish - *Sebastes flavidus*
Calico rockfish - *Sebastes dallii*	Longspine Thornyhead - *Sebastolobus altivelis*
California rockfish - *Scorpena guttatta*	Shortspine Thornyhead - *Sebastolobus alascanus*
Canary rockfish - *Sebastes pinniger*	Cabezon - *Scorpaenichthys marmoratus*
Chilipepper - *Sebastes goodei*	Kelp greenling - *Hexagrammos decagrammus*
China rockfish - *Sebastes nebulosus*	Lingcod - *Ophiodon elongatus*
Copper rockfish - *Sebastes caurinus*	Pacific cod - *Gadus macrocephalus*
Cowcod rockfish - *Sebastes levis*	Pacific whiting - *Merluccius productus*
Darkblotched rockfish - *Sebastes crameri*	Sablefish - *Anoplopoma fimbria*
Dusky rockfish - *Sebastes ciliatus*	
Pacific Coast Salmon Plan	
Chinook salmon-*Oncorhynchus tshawytscha*	
Coho Salmon-*Oncorhynchus kisutch*	
Puget Sound Pink Salmon-*Oncorhynchus gorbuscha*	

Sources: PFMC 1999, CPS FMP 1998, and NMFS 1998.

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APPENDIX H

MOA between the Department of the Navy and the California State Historic Preservation Officer for the Disposal and Reuse of Naval Station Treasure Island

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Memorandum of Agreement
Between
The Department of the Navy
And
The California State Historic Preservation Officer
For the Layaway, Caretaker Maintenance, Interim Leasing, Sale, Transfer, and Disposal of Historic Properties on the Former Naval Station Treasure Island, San Francisco, California

WHEREAS, the Department of the Navy (DoN) has been directed to close, lease and dispose of its property at the former Naval Station Treasure Island (NSTI) pursuant to the Defense Base Closure and Realignment Act of 1990 (undertaking), has determined that the undertaking will affect properties located on the former NSTI that are listed on, have been determined eligible for, or may be potentially eligible for listing on the National Register of Historic Places (historic properties), has consulted the California State Historic Preservation Officer (SHPO) pursuant to 36 CFR Part 800, regulations implementing Section 106 of the National Historic Preservation Act, as amended (16.U.S.C. 470f) (NHPA)), has notified the Advisory Council on Historic Preservation (Council) of the effect finding pursuant to 36 CFR Section 800.6(a)(1), and has received notification that the Council declines to participate in the consultation (See Attachment 1); and

WHEREAS, NSTI is located within the limits of the City and County of San Francisco (City), a Certified Local Government under Section 101(c) of the NHPA, and Article 10 of the San Francisco Planning Code specifically addresses *Preservation of Historical Architectural and Aesthetic Landmarks;* and

WHEREAS, the Treasure Island Development Authority (TIDA), a non-profit, public benefit corporation established by the City, is recognized by the Department of Defense as the Local Redevelopment Authority for NSTI, and

WHEREAS, upon disposal of the historic properties from the DoN to a non-Federal entity, any Federal jurisdiction ceases and the jurisdiction of the historic properties reverts exclusively to the City;

WHEREAS, the DoN has informed consulting parties and members of the public about the undertaking and involved such parties and the public in the consultation process using agency procedures for public involvement under the National Environmental Policy Act;

NOW THEREFORE, the DoN and the SHPO agree that the layaway, caretaker maintenance, interim leasing, sale, transfer, and disposal of historic properties (hereinafter, "leasing and disposal) at NSTI shall be implemented in accordance with the following stipulations in order to take into account the effect of the undertaking on historic properties, and that these stipulations shall govern leasing and disposal at NSTI until this Memorandum of Agreement (hereinafter, "MOA") is terminated.

STIPULATIONS

The DoN will ensure that the following measures are carried out:

I. NATIONAL REGISTER NOMINATIONS

A. The DoN will nominate the following historic properties, depicted in Attachment 3, to the National Register in accordance with Section 110(a)(2) of the National Historic Preservation Act (16 U.S.C. 470h2):

1. The Senior Officers Quarters Historic District (Yerba Buena Island): as follows:
   (a) Quarters 1 through 7
   (b) Building 83
   (c) Building 205, and
   (d) Building 230
2. Quarters 10 (Yerba Buena Island) Officers Quarters
3 Building 267 (Yerba Buena Island) Garage to Building 10
4. Building 262 (Yerba Buena Island) The Torpedo Building
5. Building 1 (Treasure Island), Administration Building, Golden Gate Exposition
6. Building 2 (Treasure Island), Hall of Transportation, Golden Gate Exposition
7. Building 3 (including Building 111) (Treasure Island), Palace of Fine and Decorative Arts and Annex, Golden Gate Exposition

B. The DoN will submit the above nominations to the Keeper of the National Register in accordance with 36 CFR § 60.9 prior to disposal.

II. ARCHAEOLOGY

A. The DoN completed an inventory of the archeological resources located on the former NSTI. The potential Archeological Sensitive Zones were identified in the *Archeological Resource Inventory and Assessment of Naval Station Treasure Island Disposal and Reuse Project, San Francisco County, California, June 1997* and are depicted in Attachment 4.

B. Prior to the DoN's disposal of NSTI, the DoN will submit a Research Design/Discovery Plan to the SHPO, that clearly delineates specific procedures to be taken, under various scenarios. The Navy will seek SHPO concurrence prior to conducting field work. The Research Design/ Discovery Plan will outline the procedures to be followed, the decision-making process and consultation process with SHPO and other appropriate parties. As will be discussed in the Research Design/Discovery Plan, the Navy will conduct additional archaeological survey and / or archaeological testing and mitigation within identified Archaeological Sensitive Zones 1 – 4 that may be required and which may include:

1. Accurate delineation of sensitive areas and known archaeological sites on DoN property, including those contiguous portions that may occur on adjacent property.

2. Testing of known sensitive areas and archaeological sites to determine the significance of potential buried archaeological deposits.

3. Survey of submerged sensitive areas by qualified maritime archaeologists to determine the presence of potentially significant submerged resources.

4. Consultation with the SHPO to determine significance of any buried or submerged resources discovered during the testing and delineation of sensitive areas.

5. Development of treatment plans and implementation of mitigation measures in consultation with the SHPO for archaeological sites discovered through testing that are determined significant.

6. Consultation with the Bay Miwok prior to any ground disturbing archaeological testing or mitigation activities in areas believed to contain archaeological deposits that may be significant to the Bay Miwok. The Navy will make every attempt to contact the Bay Miwok, including correspondence, phone calls, e-mails, etc., and will assume no interest on the part of the Bay Miwok if no formal correspondence is received within 30 days.

C. Non-Applicability

1. The Federal Highway Administration obtained fee title to a portion of NSTI from the DoN and subsequently conveyed that property by deed dated October 26, 2000, to the California Department of Transportation (CALTRANS) for purposes of the San Francisco

Bay Bridge Seismic Retrofit. As a result of these actions, this MOA does not apply to the historic properties which are located within the former NSTI and which are now owned by CALTRANS (see Attachment 2). Such properties include:

a. Potential archaeological sites and sensitive zones at Yerba Buena Island that are documented in the *Archeological Resource Inventory and Assessment of Naval Station Treasure Island Disposal and Reuse Project, San Francisco County, California, June 1997,* including the following:

1. A portion of Archeological site CA-SFr-4/H in Zone 1; and
2. A portion of an Historic/Prehistoric archaeological deposit in Zone 2;
3. A portion of Zone 3, (which may include undocumented submerged resources); and
4. A portion of the Twentieth Century Landfill in Zone 4.

III. HISTORIC ARTIFACTS AND RECORDS

A. DoN-owned historic artifacts and records that were included in the Treasure Island Naval and Marine Corps Museum will remain the responsibility of the Director of the Naval Historical Center, Washington Navy Yard, District of Columbia.

B. The DoN has coordinated the disposal of Naval Station Treasure Island photographs with the National Archives Pacific-Sierra Region, San Bruno, and will transfer them to the National Archives from the DoN's Caretaker Site Office upon completion of preservation measures.

C. The DoN has turned over to the City Department of Public Works plans, building drawings and construction photographs that were in the possession of the Naval Station Treasure Island Staff Civil Engineer's Office.

D. Financial and administrative records were transferred to Naval Station San Diego and Naval Base San Diego, respectively, because these facilities assumed operation responsibilities for NSTI at closure.

IV. RECORDATION

A. DoN shall ensure that the non-archaeological historic properties listed in Stipulation I.A. of this MOA, with the exception of Building 1 (Treasure

Island) and Building 262 (Yerba Buena Island), are recorded prior to disposal from Federal ownership.

1. Buildings 1 and 262 are called out in the City's *Naval Station Treasure Island Reuse Plan* (June 1996) as being priorities for preservation.

B. The DoN shall contact the Pacific-Great Basin System Support Office, National Park Service (NPS), Oakland, California to determine what level and kind of recordation is recommended by NPS for such historic properties.

C. The DoN shall provide copies of the final documentation prepared pursuant to paragraph A. of this stipulation to the SHPO, the City, and the San Francisco International Airport Bureau of Exhibitions, Museums, and Cultural Exchange.

V. LICENSING AND LEASING OF HISTORIC PROPERTIES

A. In order to maintain and protect historic properties covered by this agreement, the DoN may enter into licenses and leases for the use of DoN real property at NSTI prior to disposal in accordance with Section 5 of the *Base Reuse Implementation Manual* (Attachment 5).

1. The DoN shall require all licensees/lessees to submit written plans for any proposed work on historic properties for DoN review and approval. Work may not proceed until the licensee/lessee has received written approval from the DoN, which shall not be granted unless the proposed work conforms to the Secretary of the Interior's *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings (Rehabilitation Standards).*

   a. DoN review of plans submitted for proposed work on historic properties shall be conducted by persons who shall, at a minimum, meet the Secretary of the Interior's Professional Qualification Standards (Qualification Standards) in the appropriate disciplines (Attachment 6).

2. No further consultation with the SHPO shall be required hereunder unless the DoN determines that the proposed work does not and cannot be modified to conform to the *Rehabilitation Standards.*

   a. If the DoN determines that the proposed work does not and cannot be modified to conform to the *Rehabilitation Standards.* the DoN may either reject the proposed work or consult pursuant to 36 CFR Part 800.

3. Further consultation with the SHPO will not be required for painting previously painted interior and exterior surfaces in non-traditional colors for temporary uses, provided that the lessee has posted an adequate bond to insure that the property will be restored when the temporary use is complete.

4. Lease Agreements prevent lessees from undertaking any activity that may affect an identified historic or archaeological property, without the approval of the DoN. The DoN shall provide a list of traditional and non-traditional colors to lessees planning to paint historic properties covered by this MOA and only those colors may be used to paint the subject properties. The DoN shall retain the option that, prior to conveyance, lessee shall be required to restore historic properties to their original color scheme. The DoN will prepare a Technical Memorandum Report (TMR) identifying the "original conditions". The TMR will be submitted for review and approval by the SHPO prior to the commencement of any such restoration efforts.

5. The DoN shall retain the right to inspect leased historic properties at least annually to ensure that the *Rehabilitation Standards* are followed and shall take appropriate remedial action to assure compliance where deviations are observed.

VI. LONG TERM PRESERVATION PLANNING

A. Upon conveyance of NSTI from the DoN, all historic properties conveyed as set forth herein shall fall within the jurisdiction of the City, a Certified Local Government under Section 101(c) of the NHPA. As such, all historic properties conveyed as set forth herein shall be subject to the City of San Francisco Planning Code, Article 10, Preservation of Historical, Architectural, and Aesthetic Landmarks (Attachment 7).

B. Upon conveyance of NSTI from the Navy to the TIDA or other designated property recipient, and in the event of a discovery in an Archeological Sensitive Zone, the City may designate a lot or site as a landmark site pursuant to Section 1004 of San Francisco Planning Code, Article 10, Preservation of Historical Architectural, and Aesthetic Landmarks (Attachment 7).

VII. PERSONNEL QUALIFICATIONS STANDARDS

A. The DoN shall ensure that all historic preservation work pursuant to this MOA, including but not limited to the planning and physical rehabilitation of historic properties is carried out by or under the direct supervision of a

person or persons meeting, at a minimum, the Qualification Standards in the appropriate disciplines.

VIII. DOCUMENT REVIEW AND COMMENT

A. The SHPO shall be afforded forty-five (45) days after receipt to comment on any documentation submitted by the Navy as a result of consultation efforts or as a result of implementation of this MOA. Should the SHPO decline to participate or fail to respond within forty-five (45) days to a written request for comments, the DoN may assume the SHPO's concurrence in the DoN's proposed action.

IX. REPORTING

A. Until the terms of this MOA have been fulfilled and /or the MOA has been terminated, the DoN shall provide a written annual status report to all other parties.

1. The annual report shall be submitted by December 15th of each year and, at a minimum, shall address the following topics:

a. Status of the nomination of the Senior Officers Quarters Historic District (Yerba Buena Island) and those other buildings being nominated by DoN.

b. Discussion of problems or unanticipated issues related to management of historic properties during the previous year, including proposals for resolution of such problems and issues.

X. DISCOVERIES

A. Buried cultural materials may be present on the leased properties. If such materials are encountered by the City at NSTI prior to conveyance, the City shall immediately notify the DoN.

1. The City shall stop work immediately and notify the DoN so that the DoN can initiate consultation with the SHPO. The City shall not proceed with any work without the approval of the DoN.

2. If the newly discovered property has not previously been included in, or determined eligible for inclusion in, the National Register, the DoN may assume that the property is eligible for purposes of this MOA. Otherwise, the DoN may also proceed through the

process outlined in 36 CFR 800.4 for the identification of historic properties.

3. The DoN will notify the SHPO at the earliest possible time and consult to develop actions that will take into account any effects of the undertaking on any property assumed, or determined pursuant to 36 CFR 800.4, to be National Register eligible.

4. The DoN will notify the SHPO of any time constraints, and the DoN and the SHPO will mutually agree upon time frames for this consultation.

5. The DoN will provide the SHPO with written recommendations that take the effects of the undertaking into account.

   a. If the SHPO does not object to the DoN's recommendations within the agreed upon time frame, the DoN will modify the scope of work as necessary to implement its recommendations. The DoN may then authorize the action to proceed.

XI. RESOLUTION OF OBJECTIONS

A. Should any party object to the manner in which the terms of this MOA are implemented, to any action carried out or proposed with respect to implementation of the MOA, or to any documentation prepared in accordance with and subject to its terms, the DoN shall immediately consult with all other parties for no more than thirty (30) days to resolve the objection. If the objection is resolved through such consultation, the action subject to dispute may proceed in accordance with the terms of that resolution. If, after initiating such consultation, the DoN determines that the objection cannot be resolved through consultation, the DoN shall forward all documentation relevant to the objection to the Council, including the DoN's proposed response to the objection, with the expectation that the Council will respond within thirty (30) days after receipt of such documentation:

   1. Advise the DoN that the Council concurs in the DoN's proposed response to the objection, whereupon the DoN will respond to the objection accordingly; or

   2. Provide the DoN with recommendations, which the DoN will take into account in reaching a final decision regarding its response to the objection; or

3. Notify the DoN that the objection will be referred for comment pursuant to 36 CFR 800.7(a)(4), and proceed to refer the objection and comment. The DoN shall take the resulting comment into account in accordance with 36 CFR 800.7(c)(4) and Section 110 (1) of the NHPA.

4. Should the Council not exercise one of the above options within 30 days after receipt of all pertinent documentation, the DoN may assume the Council's concurrence in its proposed response to the objection.

5. The DoN shall take into account any Council recommendation or comment provided in accordance with this stipulation with reference only to the subject of the objection. The DoN's responsibility to carry out all actions under this agreement that are not the subjects of the objection will remain unchanged.

B. At any time during implementation of this MOA, should an objection pertaining to such implementation be raised by a member of the public, the DoN shall notify in writing the other parties and take the objection into account. The DoN shall consult with the objector and, if requested by the objector, consult with any or all of the other parties to this MOA with respect to the objection. The time frame for such consultation shall be reasonably determined by the DoN. The DoN will render a decision regarding the objection and notify all parties hereunder of its decision in writing within a reasonable period of time following closure of this consultation period. In reaching its decision, the DoN will take all comments from the parties into consideration. The DoN's decision regarding resolution of the objection will be final.

C. The DoN shall provide the SHPO and the Council, when Council comments have been issued hereunder, and any parties that have objected pursuant to paragraph B., above, with a copy of any final written decision regarding any objection.

D. The DoN may authorize any action subject to objection under this stipulation to proceed after the objection has been resolved in accordance with the terms of this stipulation.

XII. AMENDMENTS TO THE MOA

A. If any party believes that this MOA should be amended, that party may at any time propose amendments, whereupon the parties will consult to consider the amendment pursuant to 36 CFR § 800.6(c)(7) and § 800.6(c)(8).

B. This MOA may be amended only upon the written concurrence of the signatory parties and the invited signatory party.

XIII. TERMINATION

A. This MOA may be terminated only by either signatory party or by the invited signatory party. If this MOA is not amended as provided for in Stipulation XII., or if any of these parties proposes termination of this MOA for other reasons, the party proposing termination shall in writing notify all other parties, explain the reasons for proposing termination, and consult with the parties for no more than 30 days to seek alternatives to termination.

1. Should such consultation fail, the signatory party or the invited signatory party proposing termination may terminate this MOA by promptly notifying all other parties in writing.

2. Termination hereunder shall render this MOA without further force or effect. Should this MOA be terminated before all historic properties covered by this MOA have been conveyed out of federal ownership or before the DoN, in consultation with all other parties has determined that all of its terms have been fulfilled, then beginning with the date of termination the DoN shall do the following:

   a. Promptly consult with all other parties to this MOA to develop a new agreement pursuant to 36 CFR Part 800.

   b. Ensure that until a new agreement is executed for the undertaking, that the DoN will not take or sanction any action or make an irreversible commitment that would result in an adverse effect or foreclose alternatives that could avoid or mitigate the adverse effect on historic properties until the consulting process has been completed.

XIV. DURATION OF THE MOA

A. Unless it is terminated pursuant to Stipulation XIII above, this MOA shall remain in effect until all stipulations have been fulfilled as determined by the DoN in consultation with all the other parties, or until such time as the historic properties covered by this MOA are no longer under federal ownership, whichever occurs first. Upon a determination by the DoN that either of these conditions has been met, this MOA will terminate and have no further force or effect. The DoN will promptly provide the other parties to this MOA with written notice of its determination and of termination of this MOA.

XV. ANTI-DEFICIENCY ACT

A. All requirements set forth in this MOA requiring the expenditure of DoN funds are expressly subject to the availability of appropriations and the requirements of the Anti-Deficiency Act (31 U.S.C. Section 1341).

1. No obligation undertaken by the DoN under the terms of this MOA shall require or be interpreted to require a commitment to expend funds not appropriated for a particular purpose.

B. If the DoN cannot perform any obligation set forth in this MOA because of the unavailability of funds, the DoN and the SHPO intend that the remainder of the MOA be executed.

1. Any obligation under the MOA, which cannot be performed because of the unavailability of funds, must be renegotiated between the DoN and the SHPO.

EXECUTION OF THIS MEMORANDUM OF AGREEMENT by the DoN and SHPO, its transmittal by the DoN to the Council in accordance with 36 CFR 800.6(b)(1)(iv) and subsequent implementation of its terms, shall be evidence pursuant to 36 CFR 800.6(c), that this Memorandum of Agreement is an agreement with the Council for purposes of Section 110(1) of the NHPA, and shall further evidence that the DoN has afforded the Council an opportunity to comment on the "leasing and disposal" of NSTI and its effects on historic properties, that the DoN has taken into account the effects of the undertaking on historic properties, and that the DoN has satisfied its responsibilities under Section 106 of the National Historic Preservation Act and its implementing regulations codified at 36 CFR Part 800.

SIGNATORY PARTIES:

UNITED STATES DEPARTMENT OF THE NAVY,

BY: _____ Date: 2 Jan 03
D.S. BLANCHI
Captain, CEC, USN Commanding Officer,
Engineering Field Activity West

CALIFORNIA STATE HISTORIC PRESERVATION OFFICER

BY: _____ Date: 2 Jan 03
DR. KNOX MELLON
State Historic Preservation Officer

INVITED SIGNATORY PARTY:

CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

BY: _____ Date: _____

City of San Francisco

CONCURRING PARTIES:

BAY MIWOK BAND

BY: _____ Date: _____
KATHERINE EROLINDA PEREZ
Bay Miwok Band

CALIFORNIA PRESERVATION FOUNDATION

BY: _____ Date: _____

California Preservation Foundation

SAN FRANCISCO ARCHITECTUAL HERITAGE

BY: _____Date: _____

San Francisco Architectural Heritage

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Naval Station Treasure Island
Reuse Plan

Draft Plan

Prepared for the Office of Military Base Conversion, Planning Department,
City & County of San Francisco, and the San Francisco Redevelopment Agency

July 1996

Naval Station Treasure Island
Reuse Plan

This Study was prepared under contract with the San Francisco Redevelopment Agency with financial support from the Office of Economic Adjustment, Department of Defense. This Draft Report was prepared for the Federal Base Closure Process, and it has been endorsed by the Citizens Reuse Committee, San Francisco Redevelopment Agency, Planning Commission and Board of Supervisors. The content reflects the views of the Planning Department for the City and County of San Francisco and the San Francisco Redevelopment Agency and does not neccesarily reflect the views of the Office of Economic Adjustment.

Prepared for the Office of Military Base Conversion, Planning Department, City & County of San Francisco, and the San Francisco Redevelopment Agency

July 1996

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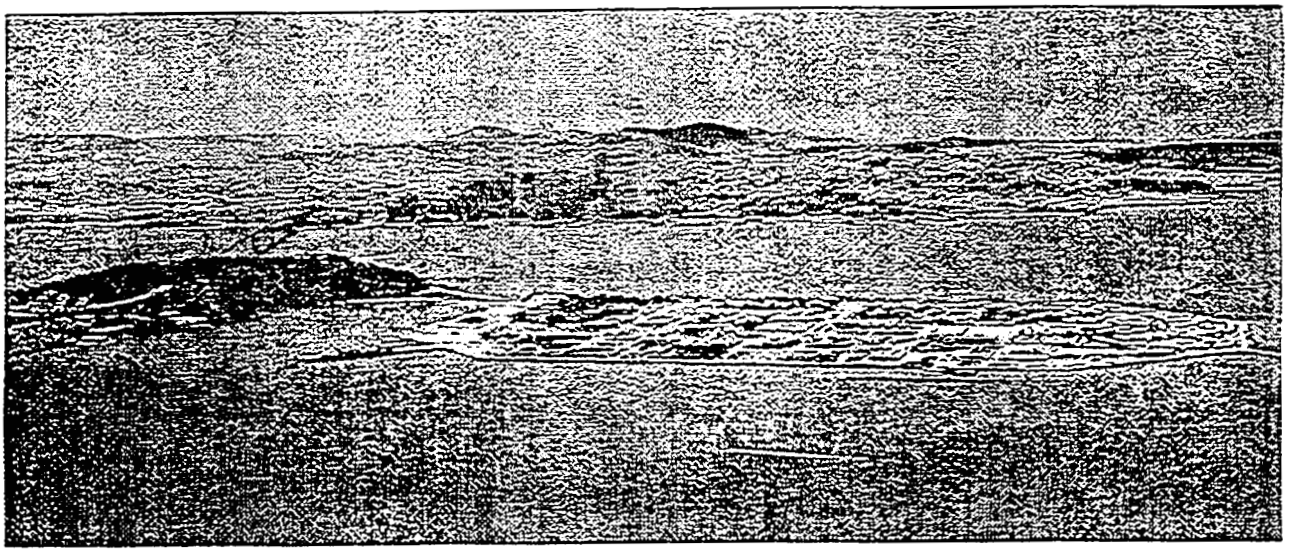
EXECUTIVE SUMMARY

A Vision for the Future

The closure of Naval Station Treasure Island, slated to occur in September 1997, affords San Francisco the opportunity to reclaim lands long held in military use and reintegrate them within the life of the city. Originally built to become a municipal airport, later becoming the site of the 1939 Golden Gate International Exposition, Treasure Island established close ties with the city and contributed to San Francisco's emerging image and identity as a major urban center in the early years of the 20th Century. During the Exposition, the island provided a visual backdrop to the city with the bay as a stage. For many, it represented the prospect of linkage to far-off and distant lands and the power of the imagination to transport one there.

In the future, Naval Station Treasure Island can play an important role in supporting San Francisco's economic base, enhancing its image and identity, expanding the range of recreational and entertainment opportunities, and adding to the overall livability of the city and region. Opportunities exist for a select number of uses that can take advantage of both the central location and visual excitement of the island setting, and which can successfully operate with controlled vehicular access. Ferries will bring visitors



Looking across Treasure Island to the distant San Francisco skyline

from the Ferry Building and other parts of the bay to Treasure Island. Waterfront promenades and bike and pedestrian paths will connect a wide array of recreational and entertainment facilities with restaurants, shops and hotels. Major attractions, such as a theme park, will provide a unique entertainment and educational experience, reinforced by film production activities, youth training and social service programs. A mixed-income residential community will incorporate homeless services and offer a unique opportunity to live close to work and within a short ferry ride from downtown San Francisco.

The plan for reuse of Treasure Island is forward-seeking and envisions a dramatic transformation in the type, intensity and character of activities. With the assistance of federal and state partners as well as private development, Treasure Island can become a model of success for military reuse and urban redevelopment.

Background and Setting

Treasure Island and Yerba Buena Island are centrally located within San Francisco Bay and lie entirely within the municipal boundaries of the City and County of San Francisco. Connected by a causeway, the two islands are extremely different from each other in origin and character. Yerba Buena Island is a natural rock outcropping of approximately 150 acres which is steeply sloped

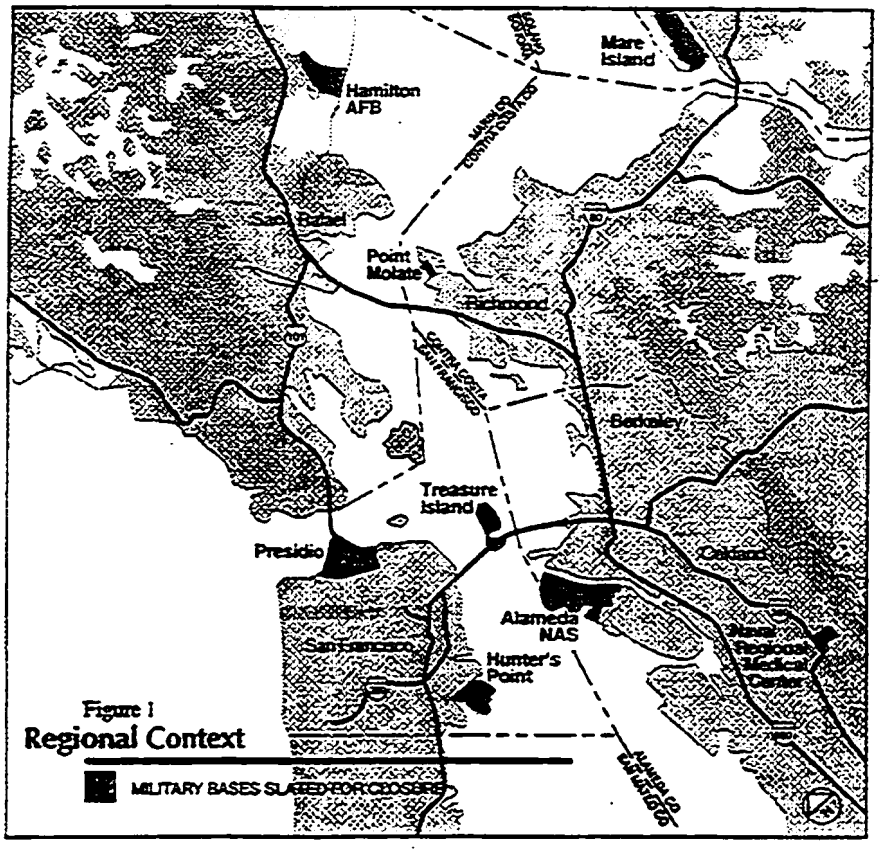
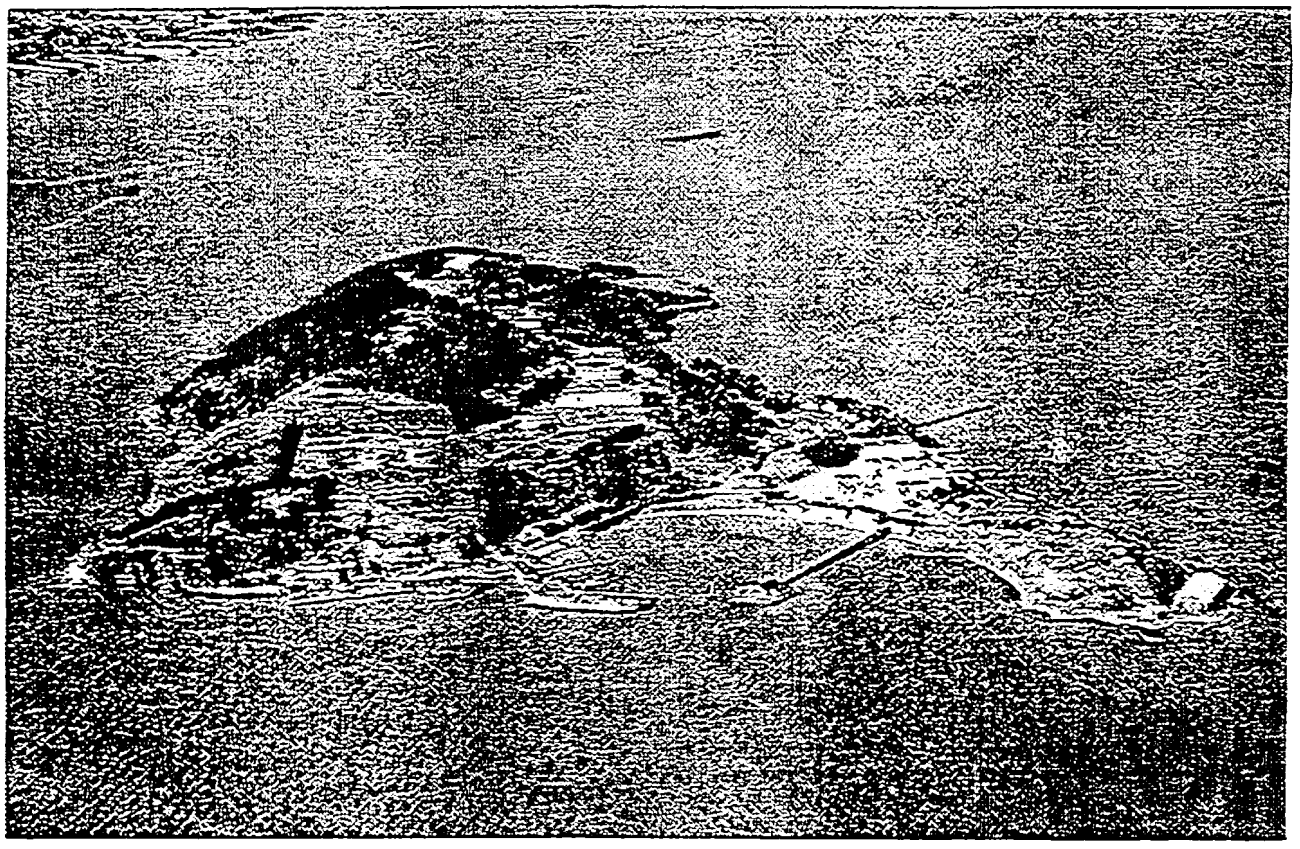


Figure 1
Regional Context

and highly vegetated, with elevations rising to over 300 feet above the water. In contrast, Treasure Island is a 403-acre flat and low-lying rectangle of filled land. The Bay Bridge crosses Yerba Buena Island; a series of ramps provides access to the Islands from the bridge. Both islands are highly visible within the region, from both the Bay Bridge and along the Embarcadero in downtown San Francisco. Both have had histories of use and identities that predate the current military character.

Naval Station Treasure Island comprises Treasure and Yerba Buena Islands, excluding the 32.5-acre portion of Yerba Buena Island occupied by the United States Coast Guard. Since it became a military installation in 1941, Treasure Island has served as a place of assembly, transfer and embarkation of troops as well as an administrative, legal and training support center. Nonresidential buildings total approximately 2.5 million square feet. There are also approximately 1,000 existing family housing units on the two islands.



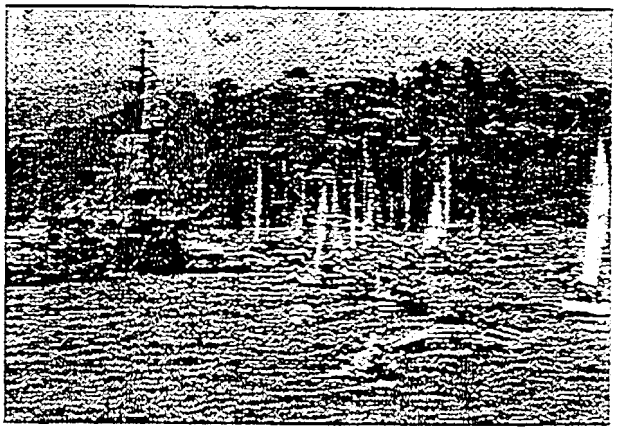
Goat Island, showing early military presence before Treasure Island and the Bay Bridge were built

Treasure Island was placed on the military base closure list in 1993. Naval operations are scheduled to cease September 30, 1997. This impending closure offers the City and County of San Francisco a unique opportunity to plan for reuse and to shape the destiny of these important islands in the bay.

Planning for Reuse

Reuse planning for Treasure Island has been undertaken by the City and County of San Francisco through its Office of Military Base Conversion (OMBC), a joint effort of the San Francisco Redevelopment Agency, the Planning Department and the Port under the policy direction of a Citizens Reuse Committee appointed by the Mayor. This Draft Reuse Plan was developed through the efforts of the OMBC and the CRC, and informed by public input and technical direction from City departments in collaboration with a planning consultant team led by ROMA Design Group.

The planning process included the development of goals and objectives for the reuse of Treasure Island, the preparation of studies of existing conditions that create both opportunities and constraints for development, the exploration of land use and development alternatives, and the articulation of plans for reuse. The proposed Reuse Plan reflected in this document offers a vision for the future which capitalizes on the unique strengths of Treasure Island, and which is mindful of the serious constraints presented by the island as well.



Treasure Island creates a unique opportunity to view maritime festivities, such as Opening Day, on the bay.

Reuse Plan Overview

The following describes the major elements of the Reuse Plan:

Development Constraints

With its central bay location and panoramic views, Treasure Island offers unique opportunities for development. However, there are serious constraints that must be considered in redevelopment planning:

- **Seismic.** Consulting engineers have reported serious concerns about the seismic safety of Treasure Island. It is projected that a major earthquake could result in ground liquefaction and substantial differential settlement, seawall failure, and severe lateral spreading. Over the long term, the island can be made safer for major redevelopment through seawall reinforcement and ground improvements. The cost of such improvements is a serious challenge for the project. Seismic concerns may also affect immediate reuse of certain buildings, particularly those closest to the perimeter, which may be deemed unsafe without costly retrofits.

- **Transportation.** Vehicular access to Treasure Island is relatively poor, due to congested levels of Bay Bridge traffic and the substandard configuration of the on and off-ramps. With limitations on the number of vehicular trips that the

bridge and ramps can support, ferries will be the desirable primary mode of transport for large-scale redevelopment. Successful service will require a number of embarkation points around the bay.

- **Tidelands Trust.** Because Treasure Island was created through landfill on tide and submerged lands, it is likely that when it is no longer under federal ownership, it will fall within the restrictions of the Tidelands Trust created by the California constitution. (Yerba Buena Island, as a natural island, is not affected.) Under the Tidelands Trust, land uses are generally restricted to maritime-related uses, publicly oriented uses that attract people to the waterfront (including hotels), recreation and open space. Residential and general office/industrial uses are largely prohibited. Limited continued use of existing facilities as nonconforming interim uses may be permitted by agreement of the State Lands Commission, which oversees the Trust. Property held in Trust may not be conveyed by the public trustee (the State or City) to private ownership. Thus, land can only be leased, and not sold, for development. Revenue received by the trustee from lands subject to the Tidelands Trust must be used only for Trust purposes; reinvestment in developing and managing Treasure Island would satisfy this requirement.

Proposed Land Use Plan

The land use plan proposed for redevelopment of Treasure Island aims to maximize a range of public benefits within the major constraints of the site. The plan emphasizes publicly oriented recreational, entertainment, and hospitality uses that recall the spirit of the 1939 Golden Gate International Exposition. These uses take good advantage of the island's central location and outstanding views, and can be linked to the city and the Bay Area by ferry service, expanding upon the "recreational" use of ferries at Alcatraz and Angel Island. They are also generally allowable under the Tidelands Trust.

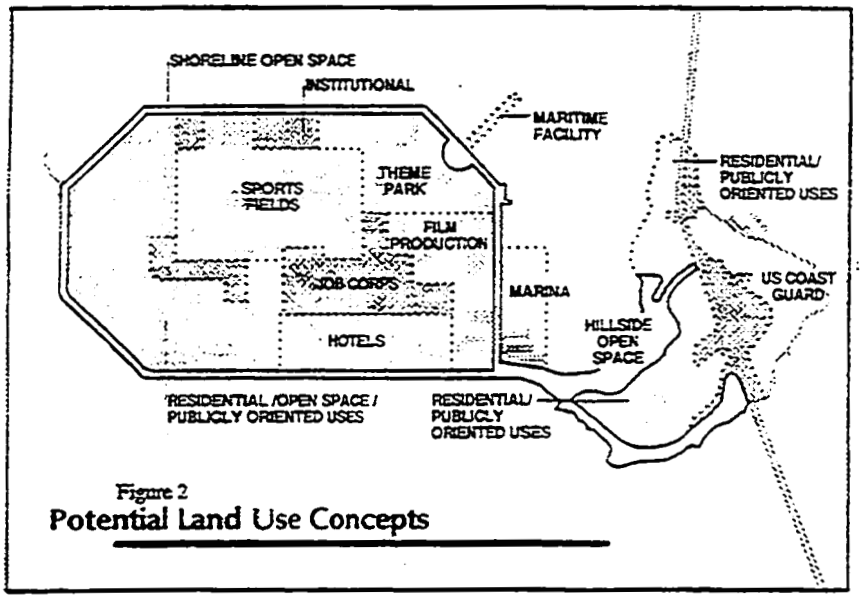


Figure 2
Potential Land Use Concepts

Key aspects of the proposed land use plan for Treasure Island include:

- Broadly defined publicly oriented uses, including development of hotels; one or more theme park attractions, which may integrate the continuing film production activities; destination entertainment activities; and active and spectator recreational areas.

- A public promenade and open area around the entire island, with parks and plazas to help connect the island to the bay setting. The existing marina is expected to continue, and may be expanded. The recreational areas may be the venue for special fairs and events.

- Preservation (as feasible) of historic structures, most prominently Building 1 (the Administration Building), which acts as a grand gateway to the island.

- Construction of a new ferry terminal on the San Francisco side of the island, to supplement likely initial ferry usage of the existing Pier 1 on the east side.

- Designation of a portion of the island for possible new residential development, but with important conditions for realization: the Tidelands Trust restrictions will have to be removed; and transportation issues carefully managed to avoid unacceptable additions to bridge and ramp congestion. Alternately, this area of Treasure Island may be used for expansion of the publicly oriented uses or for natural open space and wetlands. In the near term, some of the existing housing will be designated for very low-income and homeless San Franciscans.

- Development on Treasure Island will take place around the planned 36-acre federal Job Corps center, which will provide resident employment training to 850 young adults.

Key aspects of the proposed land use plan for Yerba Buena Island include:

- Development of a hotel and/or new housing in the hilltop area facing San Francisco. Homeless service providers will initially use a portion of the existing housing on this part of the island, but could be relocated if necessary to accommodate new development.

- Preservation of the historic circle of houses anchored by the Nimitz Mansion and reuse for public events, possibly as a conference and retreat center.

- Additional development of housing, which may include artists' live/work space, or visitor-oriented uses along Clipper Cove on the eastern portion of Yerba Buena Island.

This contemplated development program, focusing on entertainment features, theme parks, hotels and resorts, and sports and recreation facilities, will create thousands of new jobs and generate taxes and revenues to help defray the costs of capital improvements and public services.

Homeless Services Plan

Under the base closure process, localities must give consideration to homeless needs, and must balance these needs with other community interests in developing a base reuse plan. This homeless services plan must be accepted by the United States Department of Housing and Urban Development (HUD) as part of the Draft Reuse Plan review process.

For Treasure Island, homeless service providers have been represented by the Treasure Island Homeless Development Initiative (TIHDI), a consortium of 14 nonprofit organizations. The proposed homeless services plan aims to ensure meaningful opportunities for homeless and low-income San Franciscans, consistent with the overall redevelopment plan for Treasure Island. Key elements include:

- **Housing.** TIHDI organizations will have the opportunity to lease approximately 375 existing units on Treasure and Yerba Buena Islands to provide permanent and transitional housing for homeless clients. In the event of large-scale housing development on Treasure Island, developers will be required to include affordable units in their projects, and property will be set aside for the development of affordable housing by nonprofit groups.

- **Economic Development.** The economic development component is designed to create jobs and training venues for homeless and economically disadvantaged individuals. TIHDI will have the opportunity to lease buildings to operate at least three businesses on Treasure Island, such as a restaurant and convenience store, with additional opportunities as the Islands are developed. These businesses will create significant job opportunities, and any excess revenues will be used to support homeless services.

- **Employment Policy.** The goal of the proposed employment policy is to provide homeless and economically disadvantaged San Franciscans with job opportunities on Treasure Island while maintaining flexibility to meet the needs of individual

employers. The policy establishes project-wide goals for 50 percent of new permanent jobs to be filled by San Francisco residents, including 25 percent by trained and job-ready homeless or economically disadvantaged San Franciscans. Within these overall project-wide goals, the City will enter into specific goals with developers and employers, customized to the characteristics of the business operation.

Public Improvements

Substantial public improvements will be needed over time to promote and accommodate the redevelopment of Treasure Island. These improvements include infrastructure upgrading as well as seismic improvements. It is proposed that the causeway and shoreline of Treasure Island be reinforced through the creation of a stabilized perimeter which can contain lateral spreading forces, with new utility main lines placed within this reinforced strip. Other planned improvements include eventually replacing the sewage treatment plant and upgrading other in-street utility systems. One or more ferry terminals will be needed to provide large-scale access to the project.

The projected "ballpark" costs of the public improvement program are preliminarily estimated at over $260 million in 1996 dollars. Much of this figure, however, is related to the special concerns of Treasure Island—shoreline stabilization alone is projected at over $70 million, and ferry improvements (including off-island improvements at the San Francisco Ferry Building and other sites) are estimated at nearly $20 million. Demolition of buildings remaining from military use is also costly, and is estimated at over $35 million (excluding hazardous materials remediation).

Implementation Phasing

The reuse of Treasure Island is conceived as a long-term project. However, the project can be developed in phases, so that public infrastructure investments can be made over time. Each segment of Treasure Island shoreline improvement "opens" additional property for new, revenue-producing development. Growing

requirements for improvements and services, including new ferry terminals, higher levels of municipal services, and the new sewage treatment plant, are stimulated by increases in demand as additional portions of Treasure Island are developed. The proposed phasing is illustrative rather than prescriptive; future market conditions will influence the exact path of development, just as the availability of public funds will affect the timing of improvements.

Early Reuse

An important aspect of the reuse plan for Treasure Island is the encouragement of early civilian uses through leasing of existing facilities from the Navy. Such leasing of existing buildings will generate revenue to defray operating costs, and more importantly, promote the transformation of Treasure Island toward visitor-oriented and recreational uses while marketing and financing efforts are underway for major new projects.

Expected early revenue-producing uses include continued leasing of the hangar structures for film production, the development of recreational playing fields, operation and possibly expansion of the marina, and the leasing of existing small structures for restaurant and retail use. Public uses will include development of the federal Job Corps center, conversion of the Navy brig to a City jail for women, leasing of the state-of-the-art Fire Training School by the City's Fire Department, and continued operation of the Treasure Island Elementary School by the San Francisco Unified School District. Nonprofit organizations are expected to lease some of the existing housing on both islands to provide housing for homeless families and individuals. The Treasure Island Museum housed in Building 1 is also slated for continued operation.

Certain early uses, such as the Job Corps center, recreational facilities, the marina, and certain public activities, are likely to remain in place over the long term. Other uses may be replaced when new large-scale development commences.

Financial Feasibility

As discussed above, the development of Treasure Island will require major public infrastructure improvement, much of it related to the unique challenges of the island setting and geology. Planned uses and development activities are expected to generate revenues of over $225 million over time, and will help cover these costs. However, there is a significant "gap" of nearly $40 million between expected project-based revenues, which would be derived from long-term capitalized leases and building leases as well as tax increment and theme park admission tax debt proceeds, and costs.

Securing up-front monies to defray the costs not funded through project-based activities will be a major challenge for the redevelopment of Treasure Island. The City will need to work closely with the federal government to secure funding. Existing programs to be explored include Clean Water grants (for new sewage treatment plants) and Economic Development Administration grants for infrastructure. The Coast Guard will benefit from some of the infrastructure upgrading, and may agree to contribute to certain improvements. Special funding will likely ultimately be needed to cover the extraordinary costs of the project, including building demolition and shoreline stabilization.

Major Concepts

Underlying the Draft Reuse Plan, in addition to the Goals and Objectives articulated by the Citizens Reuse Committee and presented in the Planning Process chapter, are a number of fundamental concepts and approaches. Many of these are an outgrowth of the first phase of the planning effort and have helped shape both the land use plan and the implementation strategy. They include the following:

- **Emphasizing Publicly Oriented Uses.** Enhanced ferry and transit access to the Islands will enable intensified use by the public to provide a wide range of recreational, cultural and economic opportunities. These uses would relate to culture, economics and recreation. The emphasis in the Draft Reuse

Plan is on the development of a range of publicly oriented uses that will attract large numbers of people to both public spaces and paid attractions. These include entertainment attractions, cultural and historic settings, recreation and spectator sports events, and attendant uses, in particular, hotel and retail activities. The range of activities will appeal to regional residents as well as tourists, and will complement the array of attractions that draw millions to the Bay Area each year.

- **Taking Advantage of the Island Setting.** The fact that Treasure Island and Yerba Buena Island are surrounded entirely by water is perhaps their most distinctive characteristic. This plan emphasizes taking advantage of the island setting, heightening the awareness of the water, and extending the amenity of the bay. It encourages building on the qualities that water can provide in creating a magical and exciting place through lighting and landscaping. Finally, it keeps the water's edge open and accessible for the public, to add to the enjoyment and appreciation of the bay.

  Most people visiting Treasure Island are impressed with its extraordinary location and the stunning views that it offers, not only of the city, but of the entire region. It provides a sense of detachment while, at the same time, being at the heart of the urban area. Its low, flat form provides a unique perspective, almost akin to being out on a ship at sea. Regardless of the uses that ultimately are implemented, protecting the island from being irrevocably lost is a basic underlying premise of this planning effort.

- **Creating Attractive and Viable Ferry Service.** While the Bay Bridge and existing bus transit service are adequate to serve levels of reuse comparable in trip generation to existing use, ferries are the recommended transportation for high-level visitor use at Treasure Island. Historically a major transportation mode in the Bay Area and the primary mode for the 1939 International Exposition, new vessels and improved terminals are once again making ferries attractive for transbay travel. Relatively short travel times, proximity of reuse activity to proposed Clipper Cove and west side ferry docks,

avoidance of bridge congestion and substandard access ramps, and most importantly, the attractiveness of the water journey will make ferry travel viable for visitor trips to Treasure Island. Promotion of ferry service as the primary access mode will help emphasize the unique "island setting" of Treasure Island. The proposed ferry service is compatible with the goals and objectives of the MTC Regional Ferry Plan. The high level of ferry activity between Treasure Island and San Francisco, as well as between Treasure Island and East Bay locations, will increase the visibility of and stimulate the use of other existing or planned ferry services.

- **Establishing a Publicly Spirited Environment of Innovation and Enjoyment.** Although highly visible from the City and Bay Bridge, Treasure Island and Yerba Buena Island as military properties have for decades appeared to be off limits to the general public. One of the most significant challenges in the transition to new civilian uses has to do with changing the image and identity of the place, and creating a more extroverted and public-spirited place that has the potential to attract large numbers of people to the site. Clearly, the emphasis on potential theme parks and sports complexes as well as new hotels and restaurants accessible primarily by public transit and ferry will play a significant role in the transformation of the area. In addition, the Draft Reuse Plan further places an emphasis on innovation in design and in utilizing the most effective technologies in environmental design to create a sustainable and attractive place for visitors to the island.

- **Building Value Over Time.** As part of the incremental approach to improvements and economic reuse, the early improvements that are made and uses which are supported should be those which add to the value of the island as a whole. As discussed more specifically in the Implementation Strategy, emphasis is placed on those new uses that can be attracted to the relatively stable core of Treasure Island early on; that change the image and identity of the island; and that make it more attractive for civilian reuse. Such uses would include on Treasure Island recreational, sports, golf courses

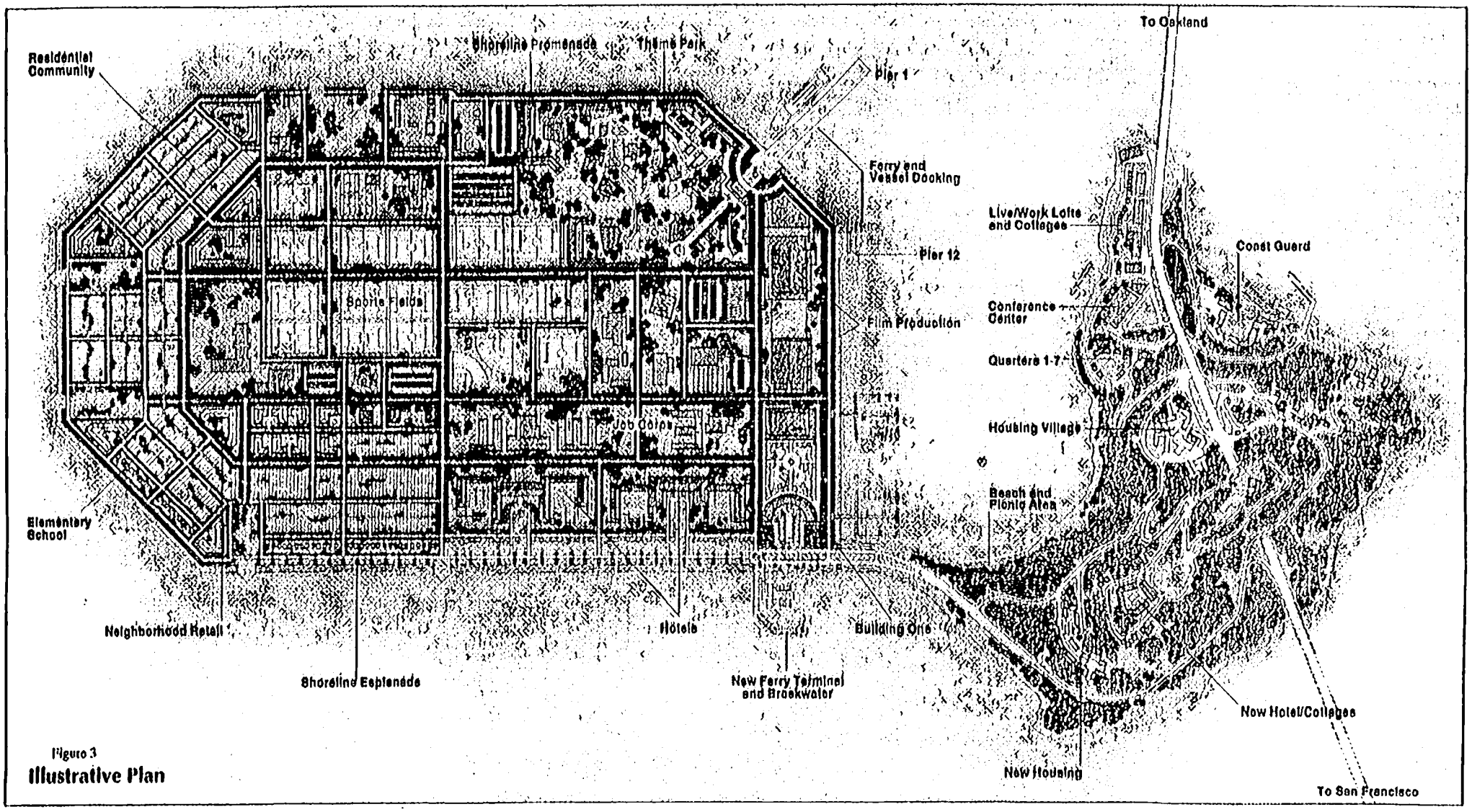


Figure 3

Illustrative Plan

Note: The Illustrative Plan is developed to show the implications of some of the plan policies and guidelines. It is intended to provide an example, but is by no means reflective of the only way development could occur. Rather, the plan is intended to provide flexibility to respond to changes in market and technology and it is possible that build-out of the island will look different upon completion than what has been depicted here.

and facilities; and on Yerba Buena Island, new residential, and potentially, hotel and conference center development. These would add to the visual appeal of the Islands and would help to attract new users.

- **Preserving Treasure Island as an Urban Amenity.** A basic premise underlying the Reuse Plan is that Treasure Island is a significant asset for the City and the region and should be redeveloped for future use. The choice facing policymakers which leads to this premise is whether to invest in and develop the island or allow it to remain vacant or underutilized after the Navy departs. Redeveloping the island entails substantial financial investment, particularly related to the need for seismic stabilization. However, "nondevelopment" could also require substantial public expenditure. As discussed in detail later in the Reuse Plan, a major earthquake in the coming years could cause the perimeter dike on Treasure Island to fail and at least portions of the island to slide into the bay. To prevent contaminating and degrading the bay, all buildings, roadways, infrastructure and hazardous materials on the island should be demolished and removed. The cost of such removal would likely range from $60 to $100 million or more. To further reduce the risk of affecting the bay, the island itself could be removed by dredging and hauling the landfill material to an on-shore site. This approach would be staggeringly expensive.

  The investment in developing Treasure Island offers the return of a safe, attractive and exciting development, with thousands of new jobs and ongoing public benefit for San Francisco and the area. It will preserve a unique part of the history of our century, and will offer a unique vision and appreciation of the bay region for generations to come.

- **Investing in Seismic Safety for Treasure Island.** It is an additional premise of the Reuse Plan that Treasure Island should be brought up to a contemporary level of seismic safety over the course of development. Because it is composed of homogeneous fill surrounded by a rock wall subject to failure, Treasure Island represents a greater risk to life and property in

the event of a major earthquake on a nearby fault than possibly any other district in the city of San Francisco. The Navy has occupied Treasure Island for over 50 years. During this period, there have been no major earthquakes on nearby faults (the 1989 Loma Prieta earthquake, though intense, was of short duration with a distant epicenter, and caused damage consistent with current scientific models). With a major earthquake likely in the coming years, it is critical that prudent steps be taken to reinforce the perimeter and interior of the island. The level of knowledge and technology regarding seismic safety has increased dramatically since Treasure Island was constructed in the mid 1930s, and numerous seismic safety initiatives—including the Bay Bridge retrofit, the UMB upgrade ordinance, and statewide designation of seismic hazard zones—are now underway. As a new "neighborhood" of the city, San Francisco has the opportunity and obligation to incorporate Treasure Island in a manner consistent with current standards of seismic safety. The need for causeway and perimeter improvements has been acknowledged by the Navy, which was planning to undertake causeway upgrading prior to the base closure announcement.

The proposed seismic upgrade program contemplates phased perimeter and infrastructure improvements linked to creating improved land for development. The costs, though substantial, are linked to new uses and revenue generation. It provides for the long-term, prudent development of Treasure Island as a safe environment for residents, visitors and workers.

- **Undertaking Improvements that Serve Multiple Purposes.** The idea of trying to combine a number of different objectives in a single improvement is one that originates from need, but which can also produce excellence in design and function. At Treasure Island, the attempt is made to make improvements that stabilize the shoreline edge; create a protected utility corridor and circulation system; and produce a waterfront open space spine that is publicly accessible and attractive. By combining seismic, infrastructure and access improvements within a single corridor along the shoreline, the opportunity arises to reduce costs and increase benefits.

This is a common approach taken in waterfront locations, where major public works have historically been utilized to accomplish simultaneously numerous objectives related to recreation, circulation, service support, and ground stabilization.

- **Seeking Uses that Contribute to Film Production and the Tourist Economy.** Tourism is San Francisco's biggest industry, and the city attracts hundreds of thousands of visitors every year. Treasure Island has the capability of adding to the visitor attractions in the Bay Area, and San Francisco specifically, through developments planned at the Islands and through enhanced ferry service. In addition, film production is a growing industry, with an increasing number of films shot annually in San Francisco. At Treasure Island, Hangars 2, 3 and 180 are currently in use for film production, and it is anticipated that this use can expand in association with theme park activities and be supported by the nearby office and production facilities that exist on the base today.

Publicly oriented uses have the potential to:

- Generate more than 8,000 permanent and seasonal jobs.
- Create a new focus of activity and a destination that will extend the average length of stay of tourists in San Francisco.
- Create spin-off economic effects of benefit to existing hotels, restaurants, and attractions within the city.
- Support the burgeoning field of multimedia productions and film-related industries that has begun to grow within San Francisco.
- Support ferry service.
- Create a compatible environment with other uses, such as hotels, recreation and sports.

- **Fostering Federal and Local Partnerships.** Like many military base conversions, the reuse of Naval Station Treasure Island will not be feasible without the assistance and support of the federal government, working with local government and private developers to implement the Draft Reuse Plan. Currently, federal responsibilities are primarily focused upon toxics remediation; however, the need for federal investment in the property needs to be more closely tied to the unique circumstances and obstacles which will be faced in achieving economic reuse. More specifically, the special geological conditions of Treasure Island and the need for improvements make Treasure Island very different from other base reuse projects. The most extraordinary costs relate to demolition and shoreline and ground stabilization, but other important areas for partnering include financial support of homeless services and housing, and utilities improvements. A strong commitment of the federal and local governments will be needed to implement the plans for reuse.

Plan Outline

Following this Executive Summary and the description of the Planning Process, this report contains four major sections:

- **Site and Context.** This section describes the existing conditions which affect reuse. The information presented in this section draws primarily upon Existing Conditions Reports (Volumes 1 and 2) prepared by the consultant team and the City Planning Department in the first phase of the planning effort. It summarizes key findings related to physical characteristics, environmental and cultural characteristics, transportation and infrastructural systems, and the economy.

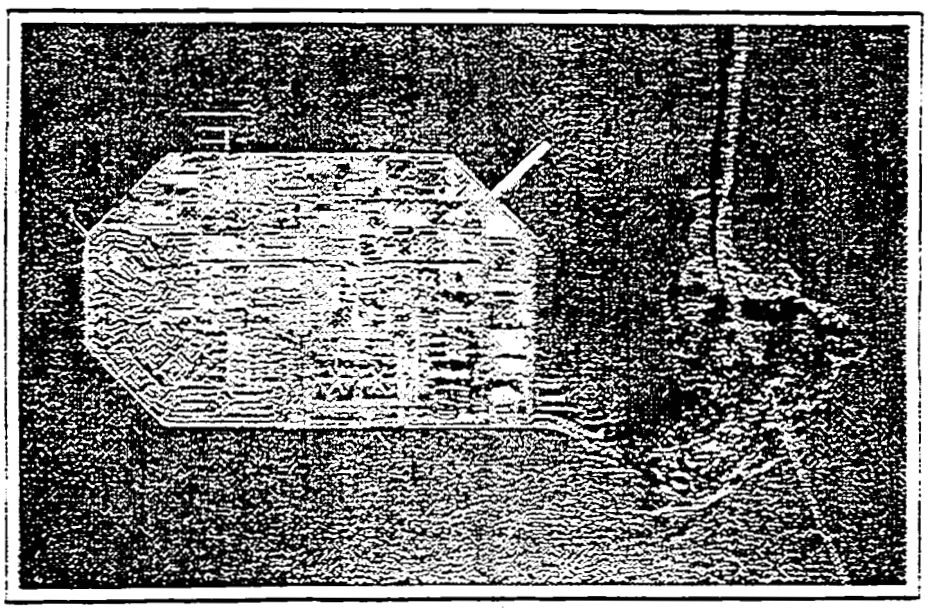
- **Recommended Policies.** This section builds on the draft goals and objectives as set forth by the CRC, and expands upon each of these to give more specific direction for future reuse. It establishes a series of guiding and specific policies governing each of the elements of the Reuse Plan, as follows:

- Land Use
- Urban Design
- Homeless Needs and Services
- Access and Circulation
- Utilities and Public Services
- Community Safety

- **Conveyance Requests.** This section sets forth the proposals for conveying land and property from the Department of Defense to federal, state and local entities.

- **Implementation Strategy.** The Implementation Strategy outlines approaches and options for the various components of reuse, including conveyances, phasing and interim reuse, financing options and fiscal considerations.

PART ONE:



Site and Context

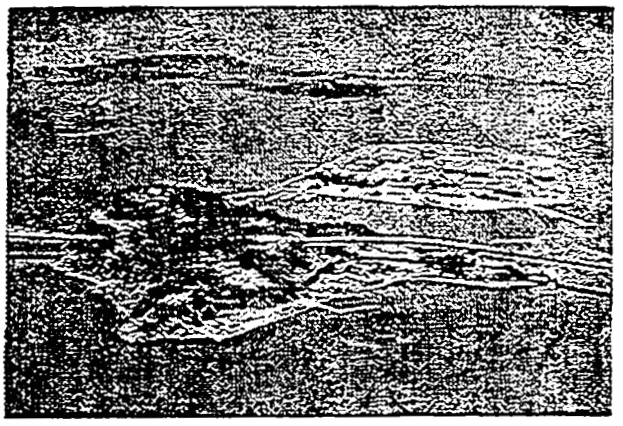
PLANNING PROCESS

Purpose of the Reuse Plan

This Reuse Plan has been prepared by and for the City and County of San Francisco. It describes the land uses planned for Treasure Island and Yerba Buena Island when the Naval Station Treasure Island closes and is transferred from federal to local jurisdiction. It includes a phased strategy for conversion of the base to civilian uses, and is intended to help guide the Navy's actions regarding property disposition, utility transfer, toxics remediation, and compliance with environmental and historic preservation.

Naval Station Treasure Island is one of 30 California military bases placed on the closure list since 1988. In the Bay Area, Treasure Island is also one of several bases that have recently closed or are closing, encompassing over 10,000 acres (see Figure 1). Three of these bases—Hunter's Point Naval Shipyard, the Presidio, and Treasure Island—are located within the City and County of San Francisco. Cumulatively, these three base closures involve about 2,400 acres of land (about five percent of the land area of the city). They will result in the loss of jobs which, during wartime peaks, were in excess of 20,000 for the military alone.

Treasure Island was selected for closure and disposition by the Base Realignment and Closure Commission in 1993, acting under Public Law 101-510 and its subsequent amendments. The



View looking north to the Islands

Commission's recommendation was subsequently approved by Congress and the President in 1993. Treasure Island is scheduled to be closed in September 1997. In March 1995, the Bureau of Land Management and General Services Administration determined that adjacent Yerba Buena Island was surplus to its needs and could be transferred to the administrative jurisdiction of the Department of Defense for disposal under the Base Closure and Realignment Act of 1990, as amended. Consequently, jurisdictional authority will pass from federal to local control, and land and property within Treasure Island will be available for civilian use in accordance with the state retrocession process.

The Department of Defense, Office of Economic Adjustment, has designated the City and County of San Francisco as the Local Reuse Authority (LRA) for Naval Station Treasure Island. The Office of Military Base Conversion, which is a partnership of San Francisco's Planning Department, Redevelopment Agency and Port, is coordinating base conversion activities. A Citizens Reuse Committee was formed to review the progress of reuse planning efforts and to make recommendations for consideration by the Planning and Redevelopment Commissions for ultimate adoption by the Board of Supervisors.

Planning for base closure is different than other planning efforts typically undertaken within local jurisdictions in California; it is not only regulatory in nature, it also directly results in the disposition of property and the transfer of utilities. Under federal law, the process of property disposition begins once a military installation is slated for closure. First priority is given to federal agencies; then the property is made available to state and local government agencies and homeless service providers. The City and County notified all state and local government agencies, homeless service providers, nonprofit organizations, economic interests and private individuals of the availability of base facilities and requested Notices of Interest by November 1, 1995. Under the public benefit conveyance screening process, state and

local public agencies or nonprofit entities may receive property at no cost or reduced cost for public health, homeless, educational, correctional, recreational, airport, port, and other specified uses.

Public Participation and Planning Process

The reuse planning process for Treasure Island began in late June 1994 with appointment of the Treasure Island Citizens Reuse Committee (CRC) and the convening of a public workshop in June 1994 to develop goals and objectives. CRC members are a diverse group of community activists, environmentalists, architects, labor union representatives, educators, municipal finance experts, developers, homeless service providers, real estate analysts, neighborhood and cultural leaders, planners, and lawyers. The CRC has met regularly since June 1994—usually on a monthly basis, but occasionally more frequently—at meetings which are open to the public and where public comment is invited. Minutes for the meetings are available to the public and are mailed to more than 100 individuals and organizations throughout the Bay Area.

In early 1995, a planning consultant team led by ROMA Design Group was selected to assist the Office of Military Base Conversion and the CRC. The team of consultants includes specialists in the areas of planning and urban design, geotechnical engineering, transportation, transit and ferry service, structural and civil engineering, utility planning, coastal engineering, housing and social services, and finance and implementation.

The planning process has been organized in four major phases, as shown in the following diagram, undertaken over a period of a year (Figure 4). During the first four months, an assessment of existing conditions related to geology, buildings, infrastructure, market, transportation and access, and social needs was undertaken. At the end of this first phase of work, a two-volume report on Existing Conditions was prepared and preliminary findings were summarized in an Issues and Opportunities Report (July 1995). In the second phase of work, a number of alternatives which examined land use and planning options were developed. The work completed in this phase was documented in an Alternatives Report (January 1996). Since that time, the elements

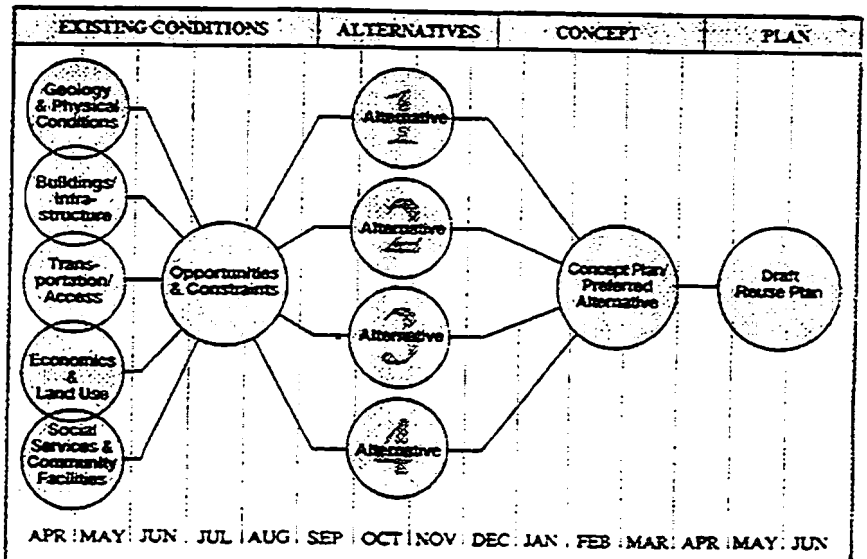


Figure 4

Summary of Reuse Planning Process

of a Concept Plan were developed and endorsed by the CRC (February 1996), and were then developed into this Draft Reuse Plan.

The Draft Reuse Plan has been prepared in a close working relationship with the CRC and San Francisco's Planning Department and Redevelopment Agency, as well as with public input and the technical review and support of a Technical Advisory Committee comprised of key public agencies and city departments. In addition, the United States Navy has been actively involved in all phases of the planning effort as a resource, providing information, identifying specific issues for further study, suggesting specific opportunities for use and reuse, and giving input into the disposition process and schedule.

On February 5, 1996, the CRC unanimously endorsed a Conceptual Planning Framework for Treasure Island. They recommended that the concept be developed into a Draft Reuse Plan for endorsement by the Board of Supervisors and submission to the Department of Defense and the United States Housing and Urban Development Department by July 15, 1996. Upon endorsement of the Draft Reuse Plan, San Francisco's Planning Department and Redevelopment Agency will continue to develop

required implementation documents, such as a Master Plan Amendment, Area Plan, Preliminary Plan, and Redevelopment Plan. During this same period, the Navy will be preparing the Environmental Impact Statement/Environmental Impact Report, which is expected to be complete in mid 1997. Adoption of the Reuse Plan and related documents will occur after certification of the EIS/EIR by the Planning Commission, expected in Fall 1997.

Public Participation

Public participation in the reuse process began early, and will continue through the assessment of environmental impacts until adoption of the Final Reuse Plan.

The initial public workshop convened on June 4, 1994 at Treasure Island to provide preliminary information on the closing military base, and to outline the reuse planning process. The workshop, which was initiated by the San Francisco Planning Department, provided a forum for public input on goals and objectives to guide the reuse planning effort and address key planning issues. The workshop was preceded by a bus tour to acquaint participants with Treasure Island's physical layout and facilities. A draft set of reuse planning goals and objectives was produced as a result of this workshop, which was subsequently refined and approved by the Citizens Reuse Committee.

The first issue of *Treasure of the Bay*, a newsletter presenting information about reuse planning, was published in Spring 1994. Several issues of the newsletter were published thereafter and sent to a special mailing list of 2,400, including community leaders, neighborhood organizations, and citizens of San Francisco and the Bay Area. Newsletter issues have focused on important aspects of the reuse planning process and have informed the public about other ways to get information, including the Treasure Island Information Line, which provides timely information about events and meetings. The newsletters have also advertised the availability of reuse planning reports, provided free of charge, which present a more detailed account of reuse planning for the Islands.

In July 1995, an exhibit was prepared by the CRC for the public at the Treasure Island Museum to describe the reuse process. It was accompanied by copies of *Treasure of the Bay* and provided for on-the-spot returns of public questionnaires and comment sheets. A more compact version of the exhibit was prepared for display at the San Francisco Main Library and several branch libraries, also accompanied by copies of *Treasure of the Bay*.

The Citizens Reuse Committee hosted the August 1995 Public Planning Forum to inform the public about existing conditions on Treasure Island and Yerba Buena Island, and to gather ideas about possible reuse options based on the existing conditions information. A press release describing the event was distributed to print and broadcast media, and resulted in advance notice and coverage of the event. A well-attended bus tour of Treasure Island and Yerba Buena Island oriented participants to aspects of the Islands discussed at the forum.

Assisted by members of the Citizens Reuse Committee, OMBC staff and consultants have informed various San Francisco political leaders, departments/agencies and commissions, and regional and state agencies about reuse planning for the Islands on an ongoing basis via briefings, workshops and meetings. Briefings and workshops for the San Francisco Redevelopment Commission and Planning Commission have included opportunities for public comment.

The public outreach process for the base closure environmental impact evaluation will include the mailing list used for the reuse planning process, to ensure continuity and to facilitate public participation throughout this phase of the reuse process.

Next Steps

The Draft Reuse Plan is a critical step in the successful conversion of Treasure Island and Yerba Buena Island to civilian use. The Draft Reuse Plan identifies the kinds of uses to be accommodated in the future, proposes specific actions and improvements to enable reuse, and describes the options and fiscal implications for the provision of utilities, public services and community facilities.

It provides a framework for negotiations with the Navy regarding property transfers, and it incorporates a plan for addressing homeless services as required under the Base Closure Community Redevelopment and Homeless Act of 1994. An Environmental Impact Statement and an Environmental Impact Report will then be prepared in conformance with both NEPA and CEQA, enabling the Final Reuse Plan to be adopted by the Board of Supervisors and used by the Department of the Navy for the preparation of its Record of Decision.

Goals and Objectives

Planning for the reuse of Treasure Island is a process that has been guided by goals and objectives formulated initially at the public workshop in Spring 1994, and then subsequently revised and refined numerous times by the Citizens Reuse Committee as information on the site and existing conditions became available and as alternatives and concepts were developed further.

As stated in the preamble:

> *The draft Goals and Objectives for Treasure Island and Yerba Buena Island are a work in progress. As more is learned about the Islands and as a planning consensus about reuse is reached, these goals will be refined. A fundamental basis for the Goals and Objectives is the development of a feasible reuse plan that reflects the unique opportunities, constraints and character of the Islands. All planning and reuse of Treasure Island and Yerba Buena Island are governed by a body of laws, plans, policies and regulations enacted by city, state and federal governments. Among those that are applicable are Affirmative Action and the San Francisco Master Plan. In the interest of brevity, these policies are not repeated in the Goals and Objectives, but they will influence them.*

The Draft Goals and Objectives, as approved by the CRC on December 11, 1995, are as follows:

Economics

a. Promote economic activities on Treasure Island and Yerba Buena Island that will be catalysts for job creation and contribute to the economic vitality of the Bay Area.

b. Focus reuse planning for the Islands on tourism, job creation, education, and training.

c. Housing, jobs, and programmatic assistance targeted to the homeless are to be elements of the Reuse Plan.

d. Accommodate economic activities that complement and reinforce the Reuse Plan.

e. Ensure that interim uses and public investments provide flexibility and facilitate long-term reuse.

f. Promote opportunities for rehiring and retraining existing employees.

g. Ensure that new revenue streams from island-based businesses and activities will provide for future Treasure Island and Yerba Buena Island service needs.

h. Assure flexibility in the Reuse Plan to allow adaptation to market conditions and decrease reliance on specific uses.

Community

a. Offer housing and recreational opportunities on the Islands to people who represent the socioeconomic and cultural diversity of San Francisco and the Bay Area.

b. Ensure broad participation, equal opportunity, accessibility, and affirmative action in all aspects of reuse planning, economic development, employment, and future uses.

c. Maintain public safety and community services on the Islands.

Character

a. Take advantage of the Islands' unique position in the center of San Francisco Bay, with spectacular views of surrounding areas.

b. Recognize, celebrate and incorporate the Islands' identity, history, art, and architectural heritage as part of the Reuse Plan.

c. Capitalize on the Islands' marine setting for recreational uses and boating.

d. Make all uses and facilities visually attractive.

e. Promote a spirit of innovation in all new development.

f. Maximize the opportunity for a publicly accessible waterfront perimeter.

g. Plan open space to encourage recreational uses and to enhance buildings and activities.

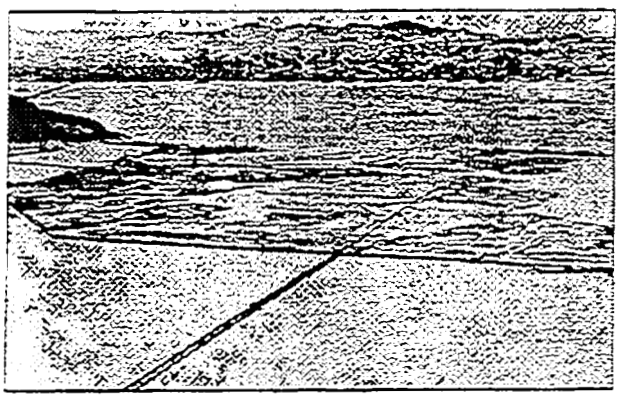
Transportation

a. Minimize increases in traffic on the Bay Bridge during weekday and weekend peak periods due to reuses on Treasure Island and Yerba Buena Island.

b. Assure adequate regional public transportation to support uses on the Islands.

c. Establish water transportation connections to the rest of the region in cooperation with regional transportation planning agencies and ferry service providers.

d. Create a pedestrian-oriented environment on the Islands by limiting vehicles and creating a system of walking paths, bike paths, shuttles, and innovative vehicles.



Yerba Buena Shoals, 1936

Environment

a. Use, encourage, and provide incentives for environmentally sustainable development.[1]

b. Recognize the need for environmental cleanup consistent with the Reuse Plan, and to maximize utilization of federal funds to ensure cleanup.

Safety

a. Through a phased program prior to long-term reuse of Treasure Island, reinforce the perimeter and causeway to protect areas suitable for development, design new development to current seismic standards, and reduce life safety hazards from existing buildings.

The intent of the Goals and Objectives permeates all aspects of the Reuse Plan. The Goals and Objectives are reasserted and further articulated in each of the elements of the Reuse Plan, in both the guiding and the specific policies. Goals and objectives are broadly stated and indicate consensus upon a general intent. Guiding policies and specific policies, as set forth in each of the elements, provide greater guidance on how the goals and objectives might be achieved. In particular, the specific policies are more geographically or functionally precise. Furthermore, design guidelines outlined in the Urban Design chapter suggest even more definitive approaches that may be taken. They provide guidance and suggest alternative solutions that meet policy intent, but are not mandatory. As a clarification, policies are shown in emboldened text; the descriptive text which accompanies these is explanatory and illustrative only; it would not be subject to adoption as policy.

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[1] "Environmentally sustainable development" is to be defined further.

SITE AND CONTEXT

Naval Station Treasure Island consists of two islands joined by a narrow causeway, totaling approximately 523 acres of land[1] at the center of San Francisco Bay. Treasure Island, artificially created in 1938/1939, consists of 403 acres with level topography. Yerba Buena Island, a naturally occurring island, is comprised of 147 acres, 32 of which are owned and operated by the Coast Guard and are excluded from this plan. In addition, there are several major easements on the Islands for the Bay Bridge, utilities, and communications equipment (see Figure 5). Naval Station Treasure Island is entirely within the corporate limits of the City and County of San Francisco.

This chapter of the Draft Reuse Plan provides a summary of the historical, physical and market conditions which characterize Treasure and Yerba Buena Islands. These considerations provide the context for planning and the foundation for the recommendations of the Reuse Plan. Much of the information in this chapter is summarized from the existing conditions background reports prepared in August 1995.

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[1] Acreage excludes the Coast Guard station on Yerba Buena Island and submerged land which reverts to the state upon transfer of the land. Treasure Island is approximately 403 acres, the causeway is approximately 5 acres, and the portion of Yerba Buena Island addressed in this report is approximately 115 acres. Source: EFA West, May 1995.

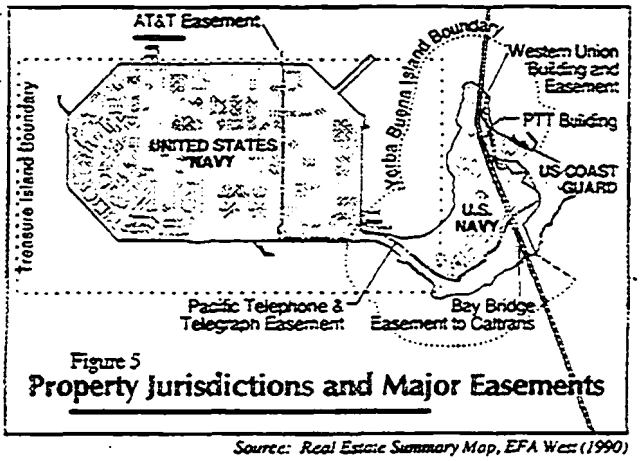

Figure 5
Property Jurisdictions and Major Easements

Source: Real Estate Summary Map, EFA West (1990)

Historical Overview and Current Use

Yerba Buena Island[2]

Yerba Buena Island is a natural island that was occupied by American Indians for hundreds of years before the arrival of Europeans. Over the years, the island has been known by a variety of names, such as Isla de Alcatraces (Pelican Island), Yerba Buena Island (Yerba Buena meaning "good herb" in Spanish and referring to wild mint indigenous to the island), and Goat Island. During early Spanish and European settlement, the island was used extensively by smugglers until it was claimed by the military.

In 1867, the United States Army established a post on the eastern side of the island adjacent to the cove. In 1872, a lighthouse was constructed on the island (in the area used by the Coast Guard), and is in use today. Later, it was decided that the island would be a prime location for a torpedo station and gun emplacement that would deal with invading ships that made it past Fort Mason. The island was difficult to support, and in 1879, the detachment was moved back to the Presidio. In 1891, the Army reasserted its presence and built a torpedo station complex, including a mine assembly building, a storehouse, wharf and officers quarters. The Mine Assembly Building (Building 262) remains in place today at the tip of the island. The Army maintained facilities at Yerba Buena Island until 1960.

In 1898, the United States Navy established a presence on Yerba Buena Island. The Navy used the island as a training station until 1922, when problems with overcrowding of the island prompted the relocation of the training facility to San Diego. The island primarily served as a station for men returning from overseas.

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[2]This section is based on the *Historical Study of Yerba Buena Island, Treasure Island and their Buildings*, prepared by Eric Hice and Daniel Schierling, Mare Island Naval Shipyard Base Realignment and Closure (BRAC) Environmental Technical Division, August 1995.

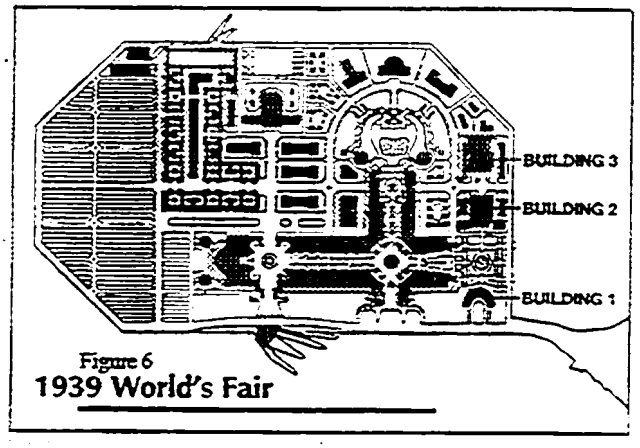

Figure 6
1939 World's Fair

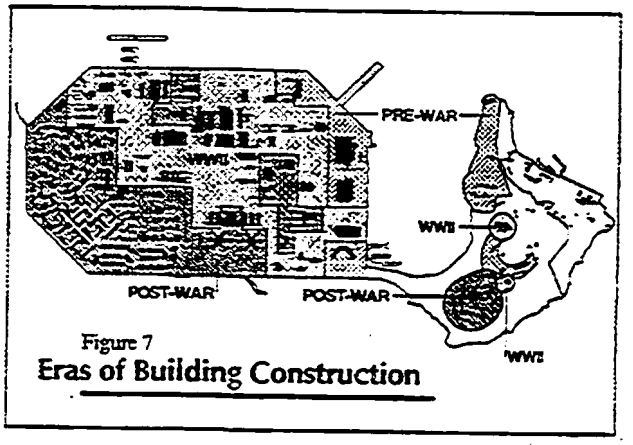

Figure 7
Eras of Building Construction

In 1946, Yerba Buena Island became primarily a residential facility and home to the Coast Guard; these functions have continued to the present.

Treasure Island[3]

Treasure Island was constructed by the New Deal-era WPA in 1938/1939, over a time period of 18 months, for the purpose of hosting the Golden Gate International Exposition to celebrate the engineering marvels achieved by the Golden Gate and Bay bridges. The name "Treasure Island" refers to the gold-laden fill dirt that washed down from the Sierras into the bay, from which fill was dredged to create the island. Original plans included holding a two-year long exposition, and then converting the facility into an international airport. The first three buildings constructed on the island were two hangars (Buildings 2 and 3) for the Pan American China Clippers, which began service in 1938, and a terminal building (Building 1). In 1945, the Clipper fleet was removed from service, as it had become obsolete because of the aircraft technology developed during World War II.

"A Pageant of the Pacific" was the theme of the Exposition and included buildings and exhibits from countries around the Pacific. The Expo opened in February of 1939 and ran through September 1940. The centerpiece of the fair was the 400-foot Tower of the

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[3]Ibid.

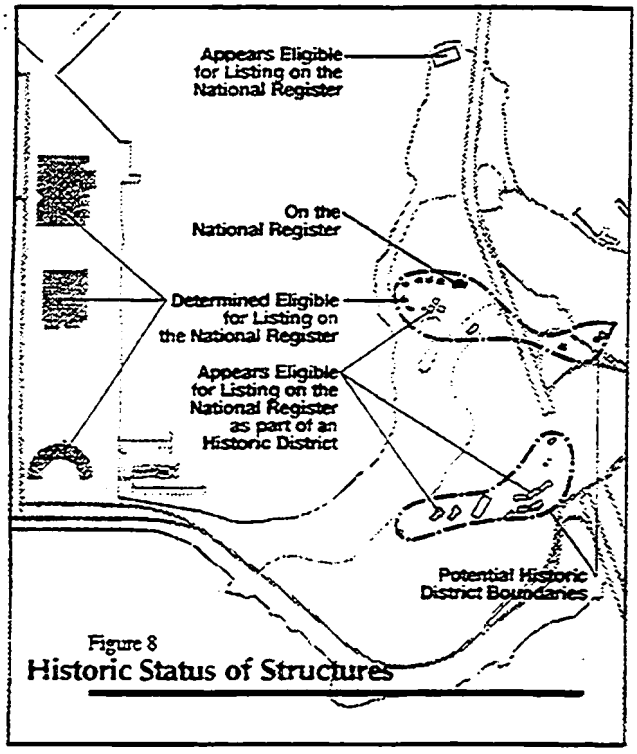

Figure 8
Historic Status of Structures

Source: Carey & Company, 1996, Lou Wall EFA West, 1996.

Sun, a slim, octagonal needle with a statue of a phoenix at the top representing San Francisco's rise from the ashes of the 1906 earthquake and fire. The main quad of the World's Fair is illustrated in Figure 6. During the waning months of the Expo, American involvement in the Second World War was becoming more certain; upon the closure in 1940, plans were already underway to convert the island to a naval base.

During World War II, the island was used as a center for receiving, training and dispatching service personnel. During this period, Exposition structures were temporarily used for barracks and training centers, and new structures were constructed to house military functions.

Treasure Island has been primarily used as a training and administrative center in the years following World War II. Approximately 3,000 military and 1,000 civilian personnel worked at the naval station. Some of the major functions were the Fleet Training Center; Commander Naval Base San Francisco; waterfront facilities; troop and family housing; personnel support, including the processing of Pacific-bound and homecoming personnel; and a Navy and Marine Corps museum. Figure 7 illustrates how Treasure Island was developed over time.

Historic Structures and Cultural Resources

On Treasure Island, Buildings 1, 2 and 3 have been determined eligible for listing in the National Register of Historic Places in consultation with the State Historic Preservation Officer. On Yerba Buena Island, Quarters 1 is listed in the National Register. Other officers housing clustered with Quarters 1, as well as Quarters 8, have been determined eligible for listing in the National Register as a discontinuous historic district in consultation with the State Historic Preservation Officer.[4]

A survey of buildings on Yerba Buena Island conducted as a part of the reuse planning process concluded that the Mine Assembly Building (Building 262) appears eligible for listing in the National Register. In addition, there are three groupings of buildings that were identified as potential National Register Historic Districts. These include the "Officers Row" housing (Quarters 1 through 7); a grouping of residential structures at the center of the island dating from 1917 to 1934; and the fire tower, reservoir, and related structures at the top of the island. The status of historic structures is summarized in Figure 8.[5]

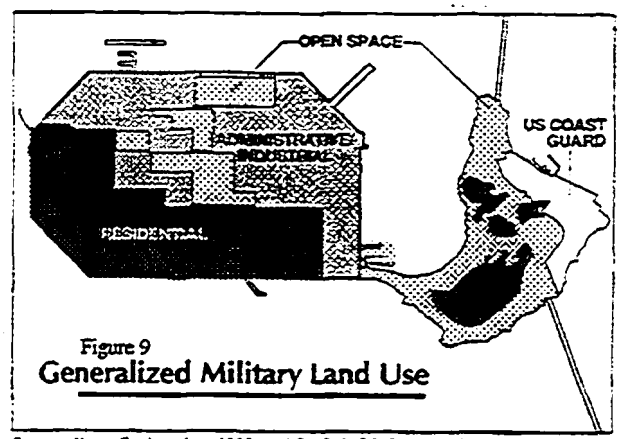

Figure 9
Generalized Military Land Use

Source: Korve Engineering (1995) and Cal Poly S.L.O. Urban Design Interns (1994)

Treasure Island is an artificially created land mass; therefore, no prehistoric archaeological sites exist on the island. Yerba Buena Island is a natural island that was occupied by American Indians for hundreds of years before the arrival of Europeans. Previously recorded village sites and burials have been removed by subsequent development.[6]

Existing Buildings and Uses

The 403 acres at Treasure Island support 150 military buildings and 904 housing units. The military buildings serve a broad range of functions (see Figure 9), and include a medical/dental building, fire training facility, prison (brig), administrative offices, conference center, restaurants and barracks, as well as miscellaneous storage and equipment buildings, for a total of 2.5 million square feet. Approximately 30 buildings, mainly miscellaneous storage and equipment buildings, with some 300,000 square feet are in the process of, or are identified for, demolition. The housing units are constructed in various groupings of 2, 3 and 4 units to a building, predominantly

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[4]Memo from Lou Wall, EFA West, May 31, 1996.
[5]Carey & Company, Yerba Buena Island Historic Resources Survey, January 1996.
[6]Mare Island Naval Shipyard BRAC Environmental Technical Division, op. cit.

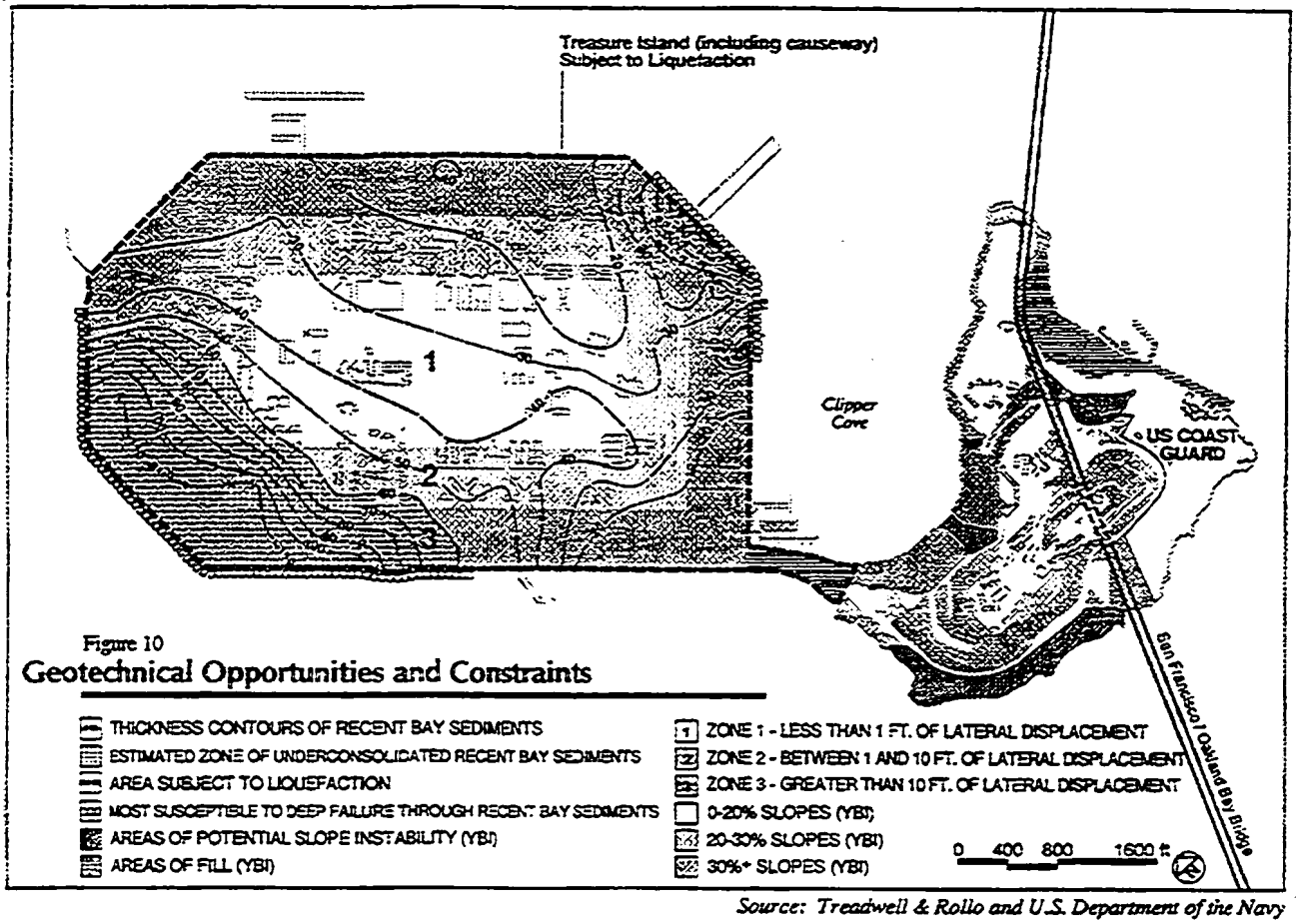
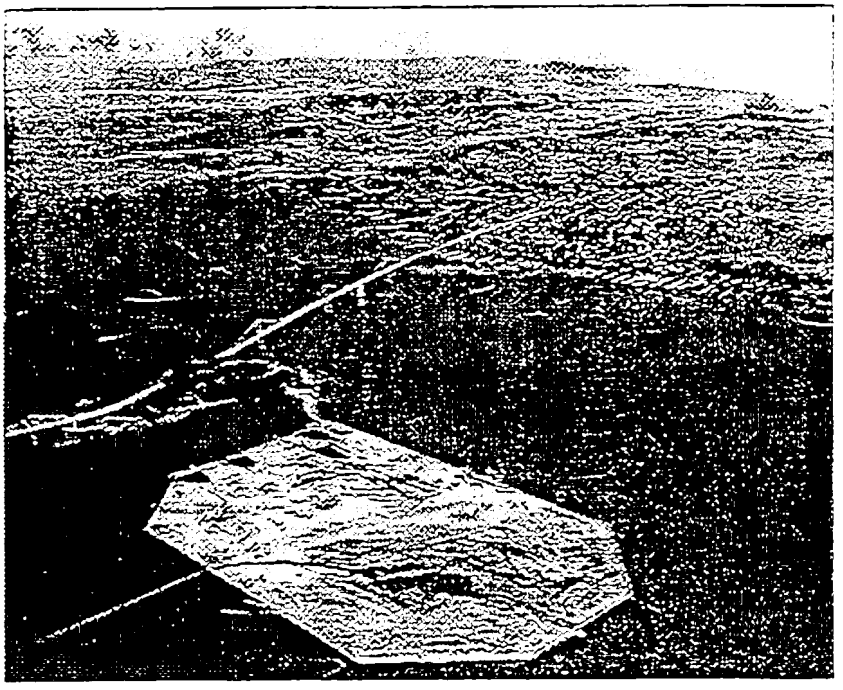


Figure 10
Geotechnical Opportunities and Constraints

Source: Treadwell & Rollo and U.S. Department of the Navy

multi-story structures. There are a broad range of recreational facilities, including a marina, ball fields, a gym, theater, bowling alley, fitness center, tennis courts, a picnic area, and other open spaces.

Within the Navy jurisdiction on Yerba Buena Island, there are approximately 10 buildings used by the military primarily for storage, communications, fire safety and administrative purposes. Approximately one-half are abandoned sheds and are proposed for demolition. In addition, there are 105 housing units, 10 of which are large single-family residences; the remainder are assembled as 2, 3 and 4-unit buildings, generally single-story.



Treasure Island under construction

Environmental Conditions

Geologic Conditions[7]

Treasure Island. Treasure Island and the causeway are artificially constructed lands created using nonengineered fill. The fill was placed over a shoal and a layer of weak, compressible bay mud. The fill is held in place by a series of rock dikes constructed around the perimeter of the island.

Treasure Island is expected to perform poorly in the event of a major earthquake on a nearby portion of the San Andreas or Hayward faults. The primary geotechnical concerns from earthquake-induced hazards include soil liquefaction[8] and lateral spreading.[9] Other concerns include consolidation of recent

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[7]This section based on the *Existing Conditions Report, Volume II: Geotechnical Report* prepared by Treadwell and Rollo. August 1995.

[8]Liquefaction is a phenomenon where loose to medium-dense, saturated, cohesionless soil experiences a temporary reduction in strength during cyclic loading such as that produced by earthquakes.

[9]Lateral spreading occurs when soil liquefies at depth and the soil layers above move downslope or toward an unsupported face, such as a shoreline slope.

bay sediments under the added weight of new fill and building loads, and the effects of differential settlement resulting from non-uniformly compacted and potentially expansive surficial fill.

Although the island has been in active use since it was created more than half a century ago, it has not been subjected to an earthquake of magnitude 7.0 or greater on a nearby portion of the Hayward or San Andreas faults. The United States Geological Survey forecasts a 67 percent probability that one or more earthquakes of that magnitude will occur by the year 2020.

The areas closest to the shoreline on Treasure Island are generally subject to the greatest potential for damage during an earthquake. Lateral spreading could affect all parts of the island to some degree, but it would increase as one approaches the shoreline edge. In the first 500 feet inland of the dike, it is anticipated that lateral spreading in a major earthquake could exceed 10 feet in some areas. In areas where mud depths are greater than 60 feet, the dike could also fail. The core of the island, more than 1,000 feet from the shoreline perimeter, would be subject to lateral spreading of less than one foot. All areas of the island are likely to experience liquefaction-induced settlement in the event of a major earthquake unless the ground is improved. Figure 10 illustrates the geotechnical conditions of the Islands.

Treasure Island raises the potential for significantly greater risks than other areas of San Francisco known for similar geotechnical problems related to artificial fill. The additional risk primarily comes from potentially unstable perimeter dikes which surround the entire island. Under current conditions, liquefaction-induced settlement is likely to be greater on Treasure Island than in the filled portion of the Marina District. In addition, lateral spreading would also be greater in the shoreline area of Treasure Island than in the Marina during a major seismic event. If the dikes on Treasure Island are improved, then the risk of lateral spreading is reduced; however, the buildings on Treasure Island would still be subjected to liquefaction-induced settlement unless ground improvements are also made.

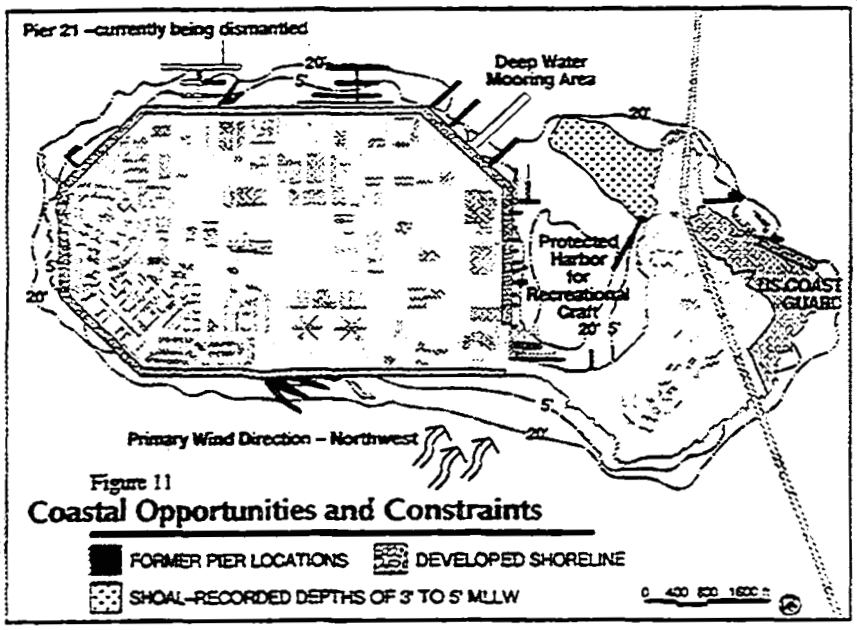

Figure 11
Coastal Opportunities and Constraints

Source: Moffatt & Nichol

Yerba Buena Island. Yerba Buena Island is a natural island consisting of steep hillside slopes with some low-lying artificially filled areas created along the east side of the island. The ground surface elevation varies between approximately 0 feet along the shoreline to 350 feet above sea level at the peak of the island. The island is comprised of Franciscan Formation sandstone overlain with colluvium and artificial fill. The sandstone is relatively stable; however, the colluvium forms a mantle of relatively weak and highly erodible soil along the side of the slopes and on hilltops. The introduction of surface water, groundwater, wave action or strong ground shaking could trigger slope movements or cause slopes to fail. Areas of potentially unstable slope conditions are shown in Figure 10.

Flooding

Flooding in low-lying parts of Treasure Island due to tsunamis, seiches and storms is considered to be a potential hazard, especially if the existing ground surface experiences large settlement resulting from earthquake-induced densification of the sand fill and shoal materials (discussed below). Future tsunami/seiche wave heights at Treasure Island are expected to be less than approximately three feet.

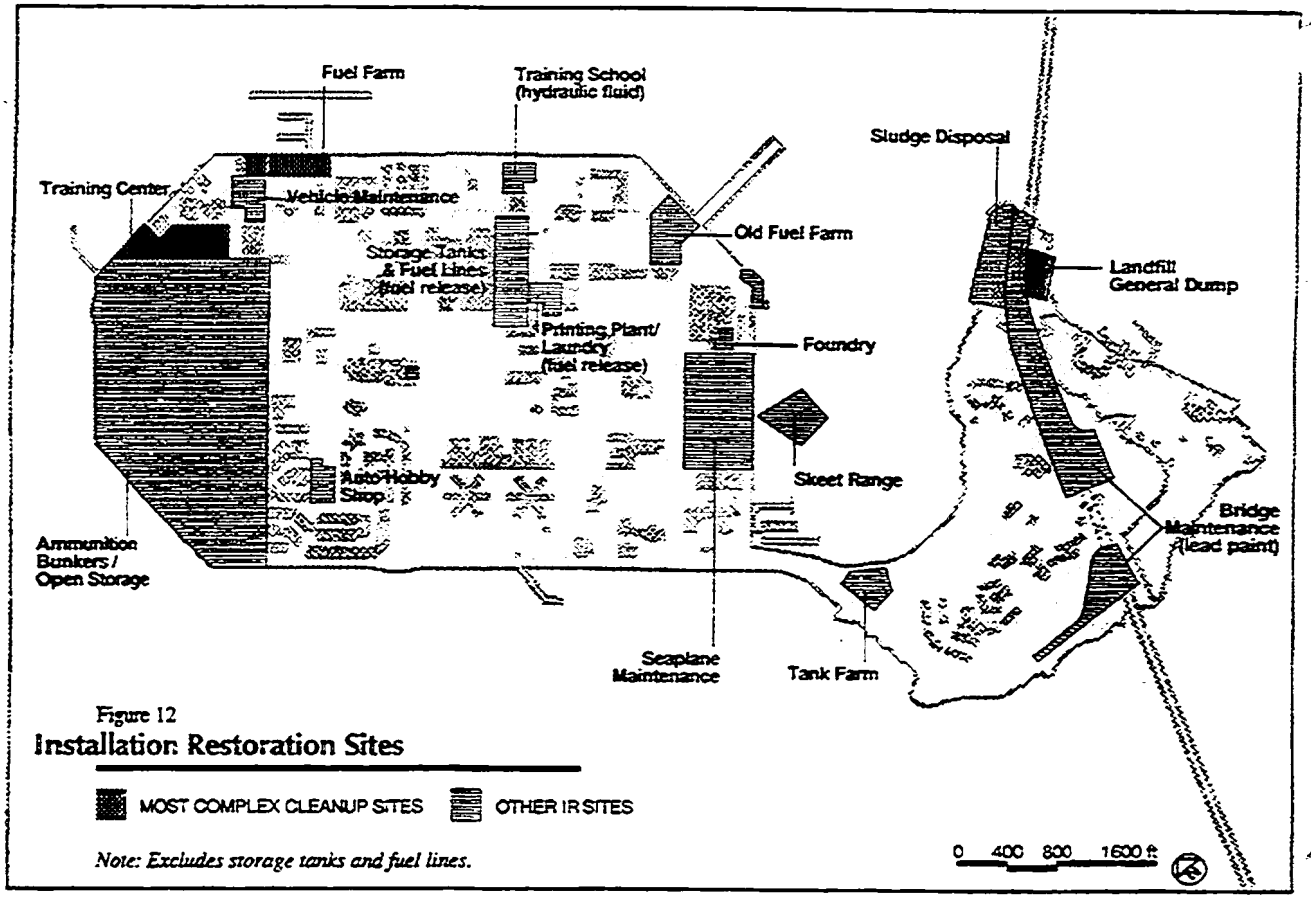

Figure 12
Installation Restoration Sites

Note: Excludes storage tanks and fuel lines.

Source: U.S. Department of the Navy, Jim Sullivan (1995)

Hazardous Waste Cleanup[10]

Investigation of both islands has been undertaken, and further investigations are being conducted to adequately characterize the site for the purpose of developing and evaluating effective remedial alternatives. The Department of Defense (DOD) oversees its own Installation Restoration (IR) program which identifies, characterizes and remediates environmental contamination at military facilities. IR sites are remediated under the auspices of the United States and California Environmental Protection Agencies in accordance with the processes and procedures set forth in the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). Federal law does not permit conveyance by the Department of Defense of a contaminated property until the

[10]PRC Environmental Management, Inc., op. cit.

cleanup has been successfully completed. Successful completion means that remedial systems are in place, demonstrated to be working properly, and approved by the United States and California EPAs.

Installation Restoration Sites. Much of the contamination on Treasure Island is related to fuel storage and the use of solvents in maintenance operations. Figure 12 shows the Installation Restoration sites on both islands. Currently, there are 25 IR sites, 7 of which are considered to be sites of major concern. The fire training area, fuel farm and service station, clustered at the northeast corner of Treasure Island, have soil and groundwater contamination by petroleum hydrocarbons due to fuel storage and fire training activities. The landfill on the south side of Yerba Buena Island contains multiple contaminants, including petroleum hydrocarbons, volatile organic compounds, and metals. These four sites will not be fully remediated prior to the anticipated September 1997 base closure. The former ammunition bunkers under the single-family housing area are the largest IR site, at approximately 20 acres, and are contaminated with petroleum hydrocarbons due to past disposal activities. The vessel waste oil recovery area near Pier 11 and the dry cleaning plant have groundwater contaminated with chlorinated solvents.

The former skeet range in Clipper Cove has a site cleanup order from the Regional Water Quality Control Board (RWQCB) requesting that the site be investigated and remediated.

Underground Storage Tanks (USTs) and Fuel Lines. Based on historical records, a total of 74 USTs were identified at Treasure Island; upon investigation, 20 were found to not exist. Of the 54 confirmed USTs (including 35 removed, 3 closed in place, and 16 inactive tanks), contaminants were detected in the soil samples at several sites. Currently, 31 tanks and sites are recommended for further investigation (11 under the IR program, and 20 under the UST program), 8 are recommended for closure in place, and no further action is recommended on the remaining 15. The Navy has prepared plans and specifications for the removal of approximately 11,000 linear feet of abandoned fuel lines;

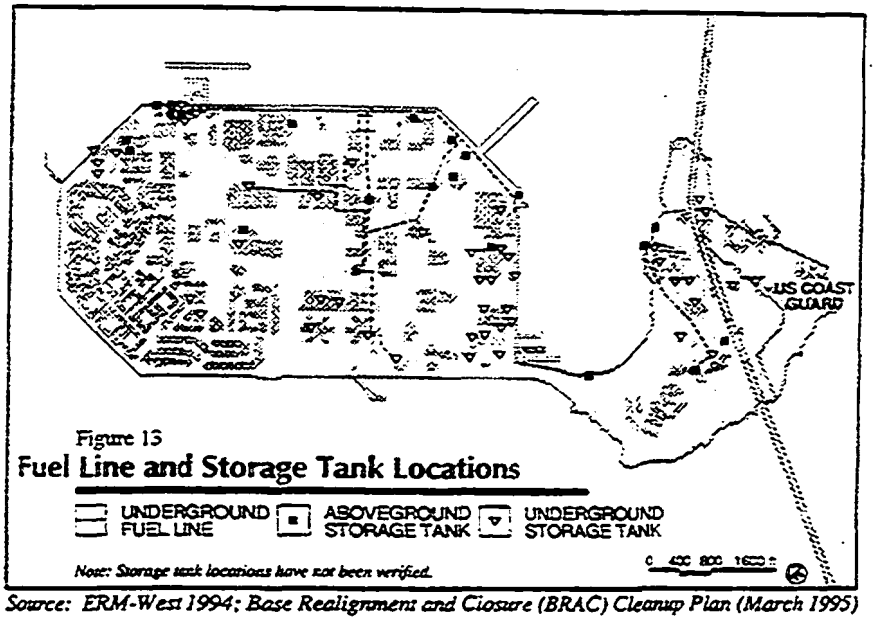

Figure 13
Fuel Line and Storage Tank Locations

Source: ERM-West 1994; Base Realignment and Closure (BRAC) Cleanup Plan (March 1995)

however, funding has not been provided. Storage tanks and fuel lines are shown in Figure 13.

Above-ground Storage Tanks (ASTs). A total of 53 ASTs have been identified, 26 of which have been removed. Of the remaining 27 tanks, 21 are active, serving the gasoline station, fire training school and boiler plant, and will be kept in service until base closure. Two of the nonactive tanks are included in IR sites, and there is currently no removal program for the remaining four nonactive tanks. Nine of the 27 existing ASTs (2 nonactive, 7 active) are included in IR program sites, and any contamination will be addressed in association with the remediation of those sites.

PCBs, Asbestos and Lead Paint. Surveys by the United States Navy are underway to determine the status and required remedial actions related to these contaminants.

Noise

Noise from traffic on the Bay Bridge is of concern for portions of Yerba Buena Island. Although other noise sources, such as local traffic and aircraft flyovers, generate short duration noise events, Bay Bridge traffic controls the long-term average noise levels at most areas of Yerba Buena Island. The noise level at any

particular location on Yerba Buena Island depends on the distance to the Bay Bridge and the presence of terrain which provides acoustical shielding. The noisiest areas are close to the east and west side tunnel openings. The quietest areas are distant from the Bay Bridge or are not in its line of sight because of buildings or terrain. The noise exposure on Yerba Buena Island is diagrammed in Figure 47[11] (see chapter on Community Safety).

Vegetation and Wildlife[12]

Vegetation. Treasure Island is an artificial construct of developed flat land covered with buildings, roads, parking lots and artificially landscaped areas. Natural shoreline does not exist, although there are mudflats and natural sand shores along Clipper Cove north of Yerba Buena Island. Yerba Buena Island contains four vegetative communities: eucalyptus woodland, mixed woodland, brushlands, and grasslands.

Wildlife. The species of concern that are known to exist include the following: double-crested cormorants (California Department of Fish and Game Species of Special Concern), brown pelicans (endangered as listed by state and federal governments), Forster's terns and Caspian's terns (State Species of Special Concern nesting colony). The California brown pelican uses the general area for feeding and roosting during summer months.

Shorebirds in the area provide a prey base for the peregrine falcon and other raptors. A pair of peregrine falcons is known to frequent an area near the Bay Bridge Towers and is reportedly nesting on the bridge. The peregrine falcon is listed as endangered by the federal government.

Lastly, an area on the southwest side of Yerba Buena Island is used by a number of harbor seals as a "haul out" spot from December to April.

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[11] Charles Salter and Associates, Yerba Buena Noise Analysis, April 1996.

[12] This section is based on the *Existing Conditions Report, Volume 1: Biological Resources Section*, prepared by the City and County of San Francisco Planning Department.

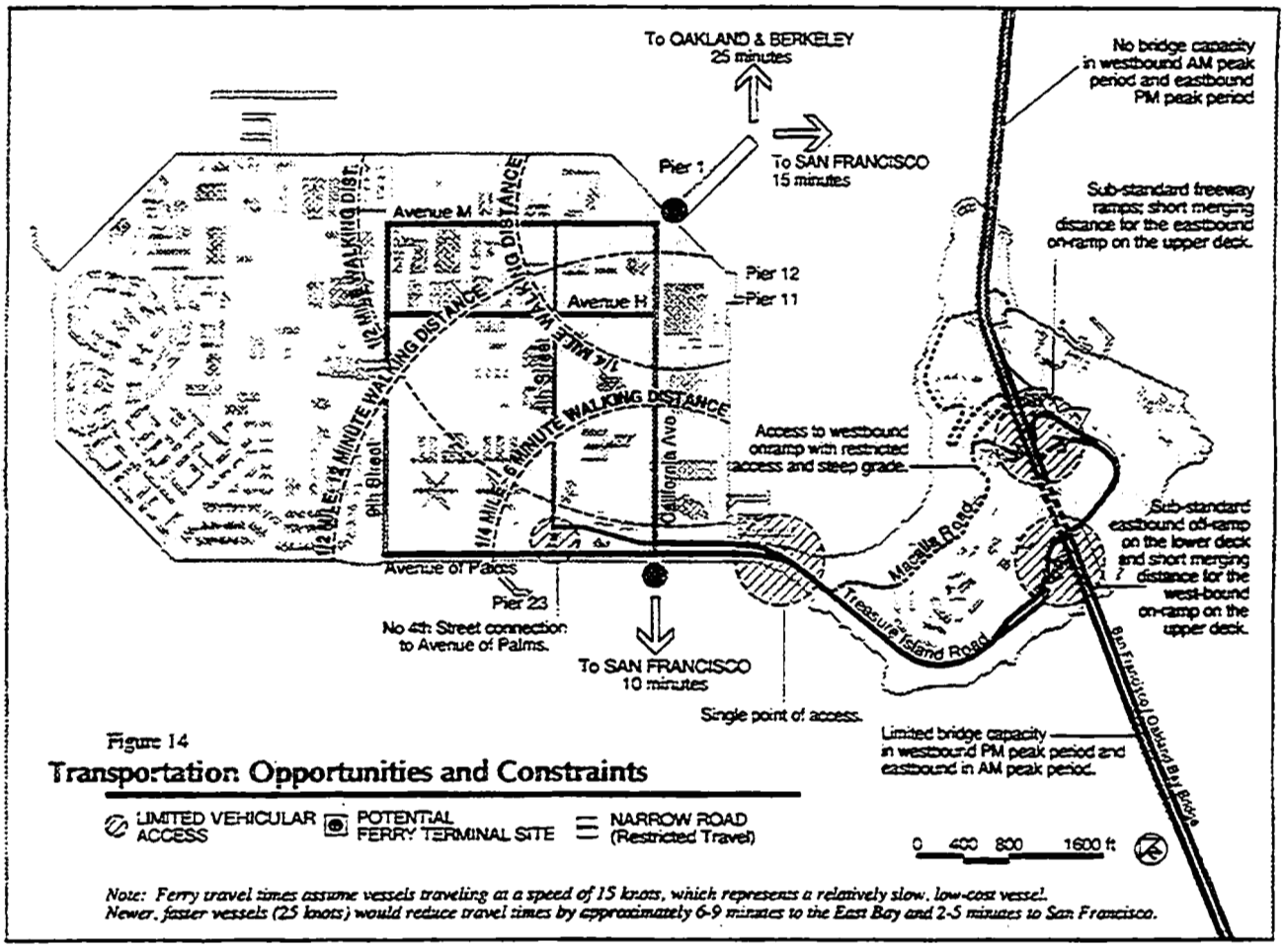


Figure 14

Transportation Opportunities and Constraints

Note: Ferry travel times assume vessels traveling at a speed of 15 knots, which represents a relatively slow, low-cost vessel. Newer, faster vessels (25 knots) would reduce travel times by approximately 6-9 minutes to the East Bay and 2-5 minutes to San Francisco.

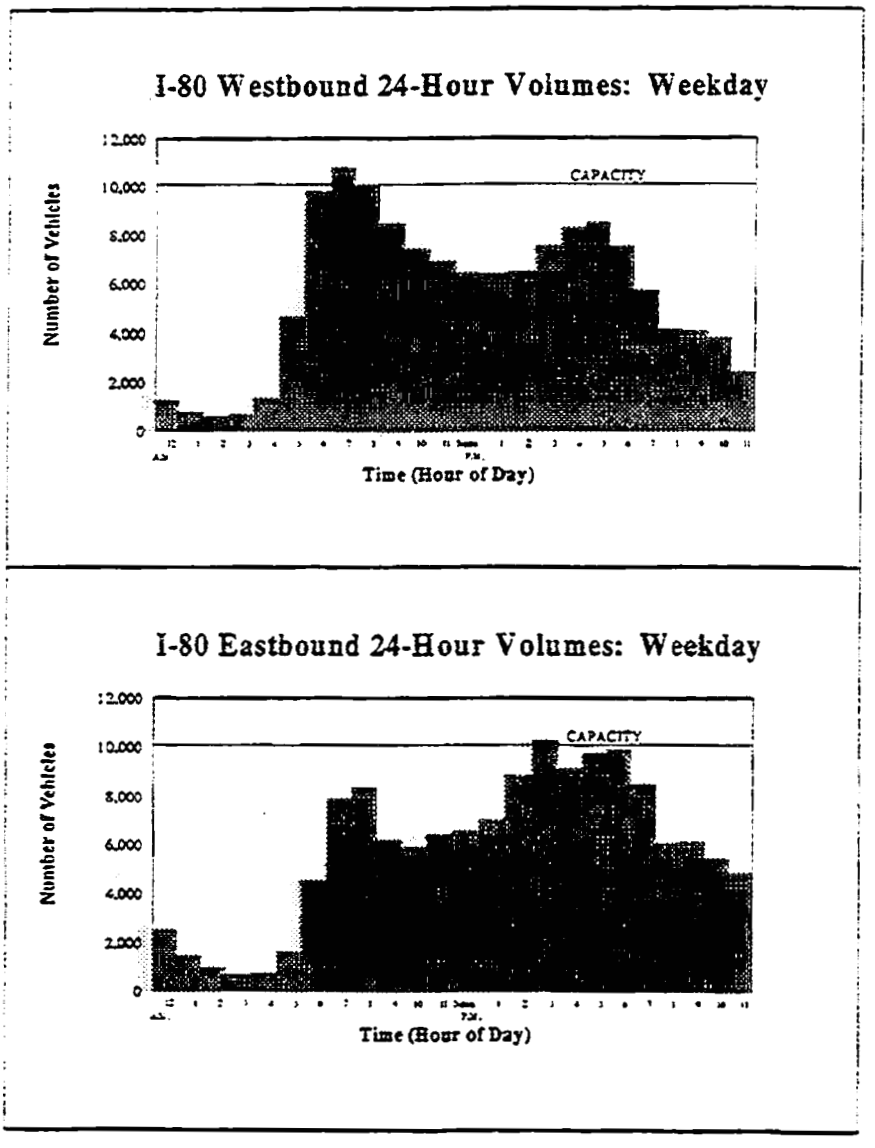
Source: Korve Engineering, 5/17/95

Transportation

Regional Transportation Network[13]

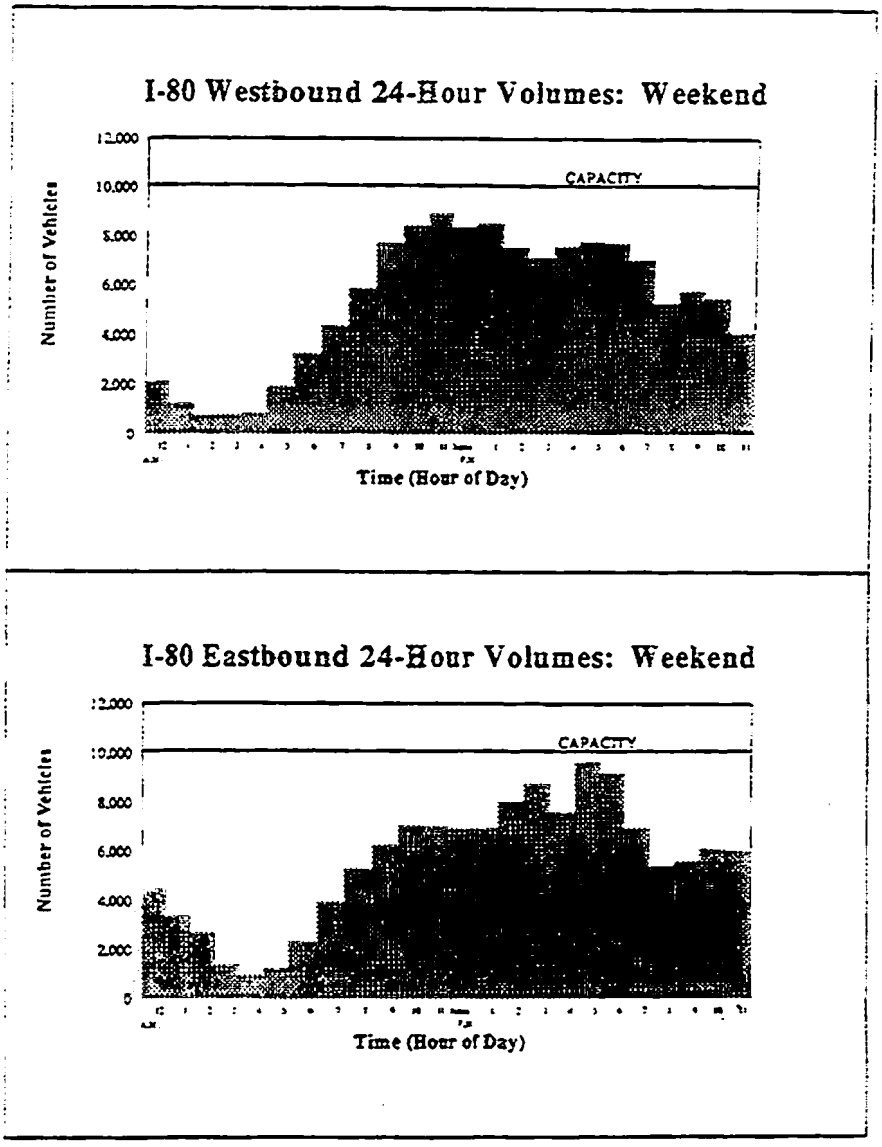
Highway System. Regional access to Treasure Island is currently provided by the Bay Bridge. At the present time, the Bay Bridge is operating at capacity (10,000 vehicles per hour in each direction) throughout many of the peak hours. Vehicle access onto the Bridge is therefore constrained during these peak periods. As shown below, excess capacity exists during the weekday nonpeak hours and during weekends, and a limited amount of capacity

[13]This section is solely based on the *Existing Conditions Report, Volume 1: Transportation Study* prepared by Korve Engineering, Nelson-Nygaard, and Pacific Transit Management, August 1995.



(3,000 vehicles per hour) exists during the peak hours in the nonpeak direction. There is effectively no available capacity during peak periods in the peak direction (i.e., into San Francisco during the morning commute and to the East Bay during the evening commute).

Based on 1990 Census information, Yerba Buena Island and Treasure Island support a residential population of 4,531 people and an employee population of 1,957 persons, including both civilian and armed forces personnel. In addition, the Coast Guard base has 224 employees. Forty percent of those who



live on Treasure Island work there as well, making the commute population equal to approximately 1,100 individuals, most of whom come to the island from the East Bay (73 percent), and primarily during early morning hours (6:00 to 7:00 a.m.). Even through there has been some downsizing at Treasure Island over the past few years, total volumes on the Bay Bridge ramps are actually two to four percent higher than they were 10 years ago.

Although it can be assumed that the existing peak-period volumes generated by Treasure and Yerba Buena Islands can be replaced in the future reuse of the property, these volumes are very small.

In addition, the existing six west and eastbound ramps on Yerba Buena Island have substandard geometrics, with merge distances ranging between 50 and 100 feet, well below the Caltrans standard of 600 feet. Making ramp improvements to better accommodate traffic from Treasure Island would require substantial investment in new ramp structures and roadways leading to the ramps. Certain approaches to the bridge would be extremely difficult to configure because of slope and bridge constraints.

Bus Transit. AC Transit currently operates the only public transit service to Treasure Island. This service provides bidirectional service between the Alameda Naval Air Station and the Transbay Terminal in San Francisco. The service operates at approximately 20 to 30-minute frequencies during peak periods, and 30 to 60-minute frequencies at other times. The internal roadway system on Treasure Island is generally adequate for the current volume and routing of bus traffic. Entering and exiting the Bay Bridge is more problematic. The grades of the roads leading to the Bay Bridge exceed AC Transit's standards for safe transit operation.

Ferry Transit. Although ferries do not currently service Treasure Island, it has been a historically significant means of access to the island, and is the only mode of access to other islands in the bay. Today, there are six active ferry routes in the Bay Area; all of them connect the San Francisco financial district to other locations, including Sausalito, Tiburon, Larkspur, Vallejo, Alameda/Oakland, and Bay Farm Island. The first three are in Marin County; Vallejo is in Solano County; and the latter two are in Alameda County. In addition to these routes, there is a recreation-oriented service to Angel Island from Tiburon and to Alcatraz Island from Fisherman's Wharf. Transportation considerations are summarized in Figure 14.

Ferry service is being expanded in the Bay Area due to increasing congestion on regional highways. In addition to the Alameda/Bay Farm Island to San Francisco service, the MTC Regional Ferry Plan found three other routes to be potentially feasible. These included a route between Albany/Berkeley and San Francisco, and routes from Martinez and Port Sonoma to San Francisco. In addition, the San Francisco Giants have provided special event

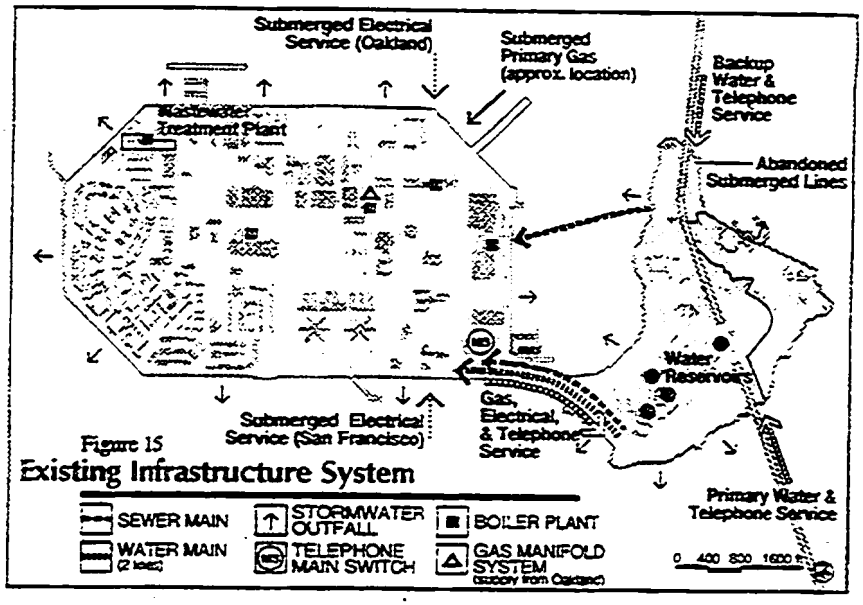


Figure 15
Existing Infrastructure System

ferry service to Candlestick Park and are planning ferry services to the planned new ballpark in South Beach. In 1997, construction of an expansion of the San Francisco Downtown Ferry Terminal is anticipated.

Infrastructure and Community Services

Infrastructure[14]

Water Supply. There are two water supply lines serving Treasure and Yerba Buena Islands. The primary supply is provided by the San Francisco Water Department (SFWD) through a SFWD-owned 10-inch diameter steel pipe which is attached to the Bay Bridge. The secondary or emergency supply is provided by the East Bay Municipal Utilities District (EBMUD) through a Navy-owned 12-inch diameter pipe, which also runs along the Bay Bridge and is connected to the EBMUD system in Emeryville. The water distribution system consists of four concrete reservoirs that serve as both the potable and fire

[14]This section is based on the *Existing Conditions Report, Volume II: Infrastructure Condition Report* prepared by Olivia Chen Consultants and Moffatt and Nichol, August 1995; some information updated April 1996 for the Treasure Island Reuse Plan.

protection water supplies for Treasure and Yerba Buena Islands. All utility systems are diagrammed in Figure 15.

Sanitary Sewer. The wastewater collection system on the Islands is composed of both gravity and forced lines, and includes 24 lift stations which are varied in terms of configuration and equipment. Wastewater generated on both islands is conveyed to the Treasure Island sewage treatment plant, where it is treated to a secondary level prior to discharge into the bay.

Storm Drainage. The existing storm drainage system consists of underground pipes, 6 stormwater lift stations, and approximately 24 outfalls of various sizes located around the perimeter of Treasure Island. Yerba Buena Island has a similar collection system and approximately 26 outfalls. The condition and capacity of the existing infrastructure is unknown.

Power and Telecommunications. Electrical power supply is provided to both islands by the Western Area Power Administration and allocated to the Navy for service on Treasure and Yerba Buena Islands. The supply is conveyed via submarine cables from both San Francisco and Oakland. The gas system consists of a submarine pipeline and main metering station and a distribution system on Treasure and Yerba Buena Islands. The distribution system is currently limited in extent, serving on Treasure Island only the steam plants and the residential area. Telecommunications service is provided to Treasure and Yerba Buena Islands from San Francisco via a conduit system located on the Bay Bridge.

Schools, Parks and Recreation, and Cultural Facilities[15]

Treasure Island currently supports a significant number of community and recreational facilities, which are summarized as follows:

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[15]This section is based on the *Existing Conditions Report, Volume II: Public Services Report* prepared by Economic and Planning Systems, August 1995.

Public Schools and Child Care. The elementary school on Treasure Island has a capacity of up to 1,000 students, serving kindergarten through fifth grade, and is operated by the San Francisco Unified School District. As the school serves children from San Francisco neighborhoods as well as Treasure Island, the District has indicated that it will remain open after base closure. A child care facility with a capacity for 139 children, including separate facilities for infants, has been established adjacent to the elementary school. This facility is operated by the Navy.

Recreational Facilities. There is a broad range of recreational facilities established on the island, including a 100-slip marina, 30,000 square foot gymnasium, 1,000-seat theater, approximately 4 acres of ball fields, a 5-acre golf driving range, 12 tennis courts, a recreational boat ramp, a fishing pier, and several picnic areas.

Cultural and Special Event Facilities. There is a conference center of 25,000 square feet on the southern portion of the island and the 15,000 square foot Treasure Island Museum located in Building 1.

Market Considerations[16]

Uses on Treasure Island will be subject to supply and demand conditions for different uses within the larger San Francisco Bay Area real estate market, plus the unique market factors associated with Treasure and Yerba Buena Islands. The findings of a market assessment for Treasure Island, prepared as a part of the reuse planning effort, are summarized as follows:

- **Entertainment Attraction or Theme Park.** Market demographics and the dearth of competitive entertainment facilities suggest strong potential support for a theme park

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[16]This section is based on the *Existing Conditions Report, Volume I: Market Opportunity Report* prepared by Economic and Planning Systems, Sedway and Associates, and Theresa Hughes and Associates, 1995, and an assessment of the potential for residential development on Treasure Island prepared by Tsen and Associates, April 1996.

on Treasure Island. Projected attendance at a theme park on Treasure Island could range from 3.1 to 4.2 million annual visitors.

- **Film Production and Industry Uses.** Film production has almost entirely shifted away from the traditional studios and is accomplished on a project-by-project basis today, involving a network of producers, directors, camera crews, prop and hardware suppliers, computer specialists, management service providers and financial experts. As a result, companies seeking studio space are often focused on a specific project. At Treasure Island, there has been a demonstrated demand for larger film production facilities, with desired bookings of Buildings 2 and 180 exceeding availability.

- **Hotel, Resort and Conference Center.** The San Francisco hotel market has historically been one of the strongest in the nation, with a broad base of demand from tourists, trade shows, conferences and conventions. Following a period of depressed performance of the hotel sector brought on by overbuilding and the recession, the last several years have seen occupancies and room rates improving. With an improving market and little construction planned, there appears to be strong potential for a hotel and conference facility on Treasure Island or Yerba Buena Island, if strong recreational amenities, an attractive environment and excellent meeting facilities can be provided.

- **Residential.** As a result of strong general market demand for housing in the Bay Area, the site could potentially be marketable for both for-sale condominium and rental housing. Traditional residential uses would, however, raise a number of issues related to transportation and access, the private nature of the use, and potential conflicts with the State Tidelands Trust. Success of new residential uses would be dependent on a "critical mass" of units that could create a sense of neighborhood, estimated to be a minimum of 2,000 units and up to 3,000 units. There is an opportunity to develop a unique pedestrian-oriented community or "village" on Treasure Island. The community can be exemplary, if properly

designed and executed, of an auto-free environment, with services, shops and community facilities within close walking or biking distances to housing. Automobiles can be parked on the periphery of the development. Although automobiles will be allowed, the community would be primarily dependent on ferry or bus service. The housing can serve a wide range of income levels if local, state and federal subsidies exist to write down the affordability for lower income households. The housing can also serve a mix of household types, from singles and couples without children to families and the elderly. The housing types must be carefully targeted to different population segments.

- **Office.** With modest projected demand and a substantial supply of available sites, Treasure Island offers poor prospects for capturing a significant amount of new speculative office development. Office development, as well as research and development, light industrial and multimedia, would also raise issues that would need to be addressed by the State Lands Commission.

- **Research and Development (R&D).** The demand for R&D space on Treasure Island is likely to be modest and restricted to reuse of any existing facilities that may be appropriate for these users. Access constraints and competition from Alameda, Emeryville, and established R&D centers in the South Bay limit the potential of this use.

- **Light Industrial.** As light industrial locational decisions are based largely on easy vehicular access and inexpensive land, the potential for this use is very limited on Treasure Island.

- **Multimedia.** The demand for Treasure Island facilities by small-scale, stand-alone multimedia companies is likely to be limited due to the site's isolation from support services and amenities in the city. There could be potential demand from a limited number of users in conjunction with film industry, theme park, or related entertainment uses.

- **Retail.** Due to access constraints, new retail uses are likely to be limited to activities supporting other uses on the island.

- **Marina.** Given the overall weakness of demand and slip rates in most Bay Area marinas, the feasibility of marina expansion at Treasure Island will be highly dependent upon costs. While a marina in itself may not be strong economically, it would be an attractive asset for related retail and restaurant uses, as well as for residential and business uses.

- **Educational/Institutional.** These users are generally very cost sensitive, and will primarily be candidates for reuse of existing facilities.

PART TWO:

Plan Policies

LAND USE

This chapter of the plan sets forth the type, location and intensity of the land uses to be accommodated in the civilian reuse of Naval Station Treasure Island. The plan builds upon the market opportunities set forth in the market overview report as well as guidance received from the Citizens Reuse Committee and proposals for reuse made by various public and private entities, including requests for homeless services. It focuses on those uses that can overcome site constraints related primarily to access as well as on those uses capable of generating revenues to help pay for needed seismic stabilization and other site improvements.

The plan recommendations emphasize publicly oriented recreation, cultural and entertainment activities that recall in spirit the Golden Gate International Exhibition held at Treasure Island in 1939. These uses further build upon the American tradition of island amusement destinations accessible to urban residents by ferry. They are evocative of such places as Rocky Point (Rhode Island), Boblo Island (south of Detroit), and Nantasket (in the Boston area). In the Bay Area, these uses provide an opportunity to link Treasure Island by ferry with a necklace of island and waterfront destinations, including Angel Island and Alcatraz Island, the Golden Gate National Recreation Area, the Presidio, the San Francisco Embarcadero, Fisherman's Wharf and Jack London Square. The expanding panoply of new activities at the closing military bases, including Alameda Naval Air Station, Mare

Figure 16. Potential Recreational Ferry Linkages

Island and Hunter's Point, could also be linked by ferry to create a system that is unmatched in the United States.

There are a number of related activities that are compatible with and supportive of the publicly oriented entertainment and recreation attractions that make up the core of the Treasure Island Reuse Plan. These include film production studios, currently housed in Buildings 2, 3 and 180 and which are currently anticipated to remain; recreation and sports fields, which could feature competitive games and spectator events as well as intramural leagues; and hotels for visitors to the island attractions as well as to San Francisco as a whole. In addition, commitments have been made to a number of institutional users, including the Jobs Corps, for vocational training, and these uses will form an important part of the civilian reuse as well. Finally, provision is made for the possibility of developing an innovative new residential community at Treasure Island—one which is pedestrian oriented and which creates a mix of housing opportunities for future residents.

Table 1
Land Use Overview

Land Use	Acres
Treasure Island	
Publicly Oriented Attractions	184
Residential Neighborhood/Open Space	106
Institutional and Community Facilities	69
Shoreline Open Space	44
Total	403
Yerba Buena Island	
Publicly Oriented Attractions/Residential	69
Institutional	14
Hillside Open Space	30
Total	113

Acreages in all tables in this chapter are approximate only and subject to revision.

On Yerba Buena Island, new development would include residential uses, with visitor-oriented attractions tied to Treasure Island or the potential for conference and retreat facilities as well as hotel or lodging in the hillside area.

Guiding Policies

Provide for new civilian uses that contribute to the economic well being of the Islands and San Francisco by generating jobs and revenues.

Economic development and job creation lie at the heart of many reuse plans because, in the process of closure, a significant number of military and civilian jobs are lost within a region and must be regained. San Francisco has experienced three base closures since 1989, and many other Bay Area bases are also closing. Federal base closure and reuse legislation recognizes economic development as a significant concern and places a priority on economic recovery in as short a time frame as possible. In the case of Treasure Island, reuse and recovery are complicated by the physical condition of the island and the high costs of site preparation caused by the need for seismic stabilization. This, in turn, places an even greater emphasis on the ability of new uses to generate revenues that can offset costs and contribute significantly to the city's economy.

Table 2
Projected Employment by Land Use Category

Land Use	Projected Employees
Publicly Oriented Attractions:	
Theme Park	5,000*
Hotels	1,450
Sports Complex	50
Entertainment Retail	486
Conference	10
Museum	6
Related Uses:	
Film Production	201
Office	789
Institutional:	
School	34
Fire Training School	48
Brig	100
Child Care	10
Job Corps	300
Marina	30
Total	**8,514**

*Seasonal and permanent employees.

Of the potentially marketable uses at Treasure Island, publicly oriented recreation and entertainment attractions are especially well suited to the unique qualities of the island setting and are not as easily accommodated elsewhere in the city. More specifically, these uses could include entertainment, cultural, recreational and educational attractions that can draw large numbers of people. They may range from a theme park and an urban entertainment center to fairs, performances, markets and festivals, and spectator and competitive sports facilities. At Treasure Island, although some of these facilities (such as a theme park) will depend upon entrance fees, there also will be recreation on the island that will be free and accessible at no cost. Related and support facilities would include hotels, conference and meeting facilities, office, cultural facilities, as well as film production studios.

The recreation and entertainment attractions can take advantage of the island setting and the use of ferries for access, and also present potential for job creation and revenue generation. They offer the possibility of being able to support thousands of jobs at the site

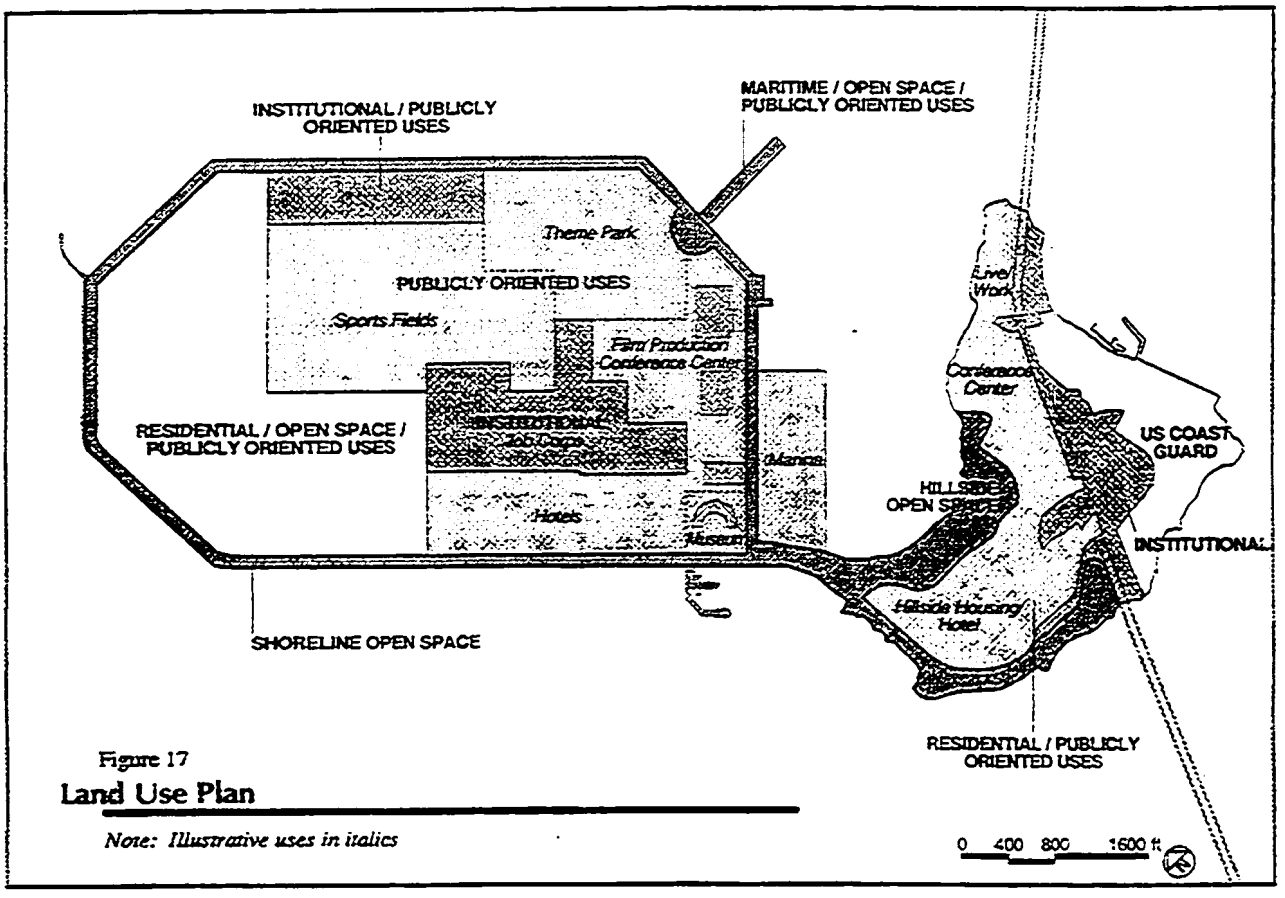


Figure 17
Land Use Plan

Note: Illustrative uses in italics

as well as generate revenues through admissions tax, transient occupancy tax, and other sources.

Limit uses to those which can be accommodated primarily by ferry.

Vehicular access to Yerba Buena Island and Treasure Island is highly constrained by capacity limitations of the ramps and congestion during peak periods on the Bay Bridge. Since this is currently the only means of access, reuse would be seriously limited if alternatives were not available. In the Bay Area, the most obvious alternative in an island setting is ferry service, which is expanding as new facilities are built. Ferries today are the only means of access to two other island destinations—Alcatraz and Angel Island. While the visitor-oriented attractions described above can be supported for the most part by ferries, other uses will require a greater degree of automobile or vehicular access. In any

case, the mix, amount and intensity of new uses will be limited by the capacity constraints on the bridge, and must be able to be served by ferry and transit.

Allow flexibility to respond to market opportunities and changes in technology over time.

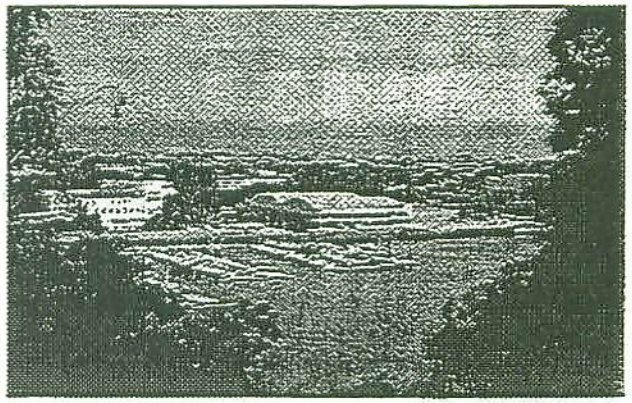
The size of Treasure and Yerba Buena Islands is sufficient to support a mix of complementary activities that can add to the vitality and economic success of the place. At Treasure Island and Yerba Buena Island, the planned mix of uses includes publicly oriented attractions, open space, institutional uses, hotel and, potentially, residential, retail and community facilities which can support these uses. These uses are listed in Table 2.

Redevelopment of portions of the Islands and full conversion to civilian uses may take several decades to complete and will likely occur in phases, with investments tied to stabilization and site improvements. If reuse and redevelopment occur over an extended period, it is unlikely that plans will come to fruition exactly as set forth today. Therefore, a degree of flexibility in planning is necessary to take advantage of opportunities as they arise.

Publicly oriented recreation, cultural and entertainment attractions (including competitive and spectator sports fields, hotels, and associated film production studios and offices) would occupy the largest amount of land at Treasure Island. However, the plan also provides flexibility in land use and provides the opportunity for these uses to extend into areas that may initially be designated for institutional use or residential. The intention is to allow for major attractions on the island and to provide the opportunity for residential uses to be developed at Treasure Island, contingent upon the resolution of specific issues related to Bay Bridge access and the application of the Tidelands Trust.

At Yerba Buena Island, flexibility in land use would be specifically permitted in two areas: at the easterly end of the island, where the plan provides for the possibility of either visitor-oriented uses (potentially tied to those on Treasure Island

and to conference and meeting facilities) or housing; and in the westerly hillside, where the plan would provide for housing as well as redevelopment for a small hotel (150 rooms), which could take advantage of proximity to Macalla Road and access to the Bay Bridge as well as views to downtown San Francisco.



View to Treasure Island

Attract initial uses and users that facilitate and are compatible with the development of desired long-term uses.

A number of prospective users have proposed initial reuse of military facilities upon closure of the base in 1997. Most prominent among these is the Job Corps, which will occupy an approximate 36-acre site to be developed by the Department of Labor, and will include vocational and training facilities for some 850 youths—most of whom will live on the island. Other uses have also been proposed for initial and interim reuse of existing facilities.

Film production, which currently is accommodated in Buildings 2, 3 and 180, builds upon a growing industry, contributes to the economic strength and well being of the city, and has the potential to create an attraction that can be developed in conjunction with a film or technology-related theme park. This kind of use would be considered compatible with long-term plans for the island. Other appropriate interim uses would be those, such as sports fields, a marina and other recreational amenities, which can help to change the image and identity of the island from a military environment to a more attractive civilian setting.

Initial or interim uses need to be considered in light of a number of "tests" to ensure that short-term interests are not facilitated at the expense of the long-term opportunity for economic reuse. Specific criteria for evaluating the proposals for initial reuse are as follows:

1. Encourage early implementation of a long-term use, and thus accelerate the creation of jobs and revenue, as well as

Table 3
Examples of Allowable Uses By Category

Publicly Oriented Recreation/Cultural/Entertainment Uses

In the long-term reuse plan, the visitor-oriented land uses would predominate all others, and could be allowed to extend to most parts of the island, with the exception of the area reserved for the sewage treatment plant.

- Theme park(s)
- Destination entertainment
- Hotels/resort
- Conference/meeting rooms
- Spectator sports and recreation areas (including golf)
- Commercial recreation
- Specialty restaurants and retail
- Performance, exposition, exhibition and display
- Festivals, markets and fairs
- Film production and associated office
- Museums/cultural institutions
- Neighborhood retail
- Employee housing for publicly oriented uses

Institutional

This land use would accommodate community facilities, major utilities, and opportunities for nonprofit institutions.

- Schools, day care, and other public and nonprofit uses
- Job Corps
- Fire/police
- Transportation facilities
- Medical/health facilities and services
- Other service/support facilities
- Water reservoirs
- Sewage treatment plant
- Employee or trainee housing for institutional facilities

Residential Uses

This includes the new housing at Treasure Island as well as existing and additional new housing at Yerba Buena Island, ranging from affordable to luxury, pedestrian-oriented to live/work artist studios. Housing targeted to workers and trainees on the Islands shall be encouraged, and may be provided by developers of major uses for their employees, assuming this is determined to be compatible with the Trust and the overall resident population stays within plan projections. Residential uses at Treasure Island would only be permitted if the following conditions were met:

1. Residential areas are built that are not dependent upon automobiles for access, and traffic demands on the Bay Bridge do not exceed the current situation.
2. Residential uses are compatible with the primary land use relating to visitor-oriented uses.
3. Services are provided on the island to provide a measure of self sufficiency and to reduce the dependency upon city services in San Francisco.
4. Issues related to the potential Tidelands Trust are resolved.

Open Space and Recreation

This includes shoreline open space at Treasure Island and hillside open space on Yerba Buena Island.

conversion toward uses fully compatible with the Tidelands Trust.

2. Help provide funding or facilities that facilitate more intensive long-term reuse.

3. Help promote Treasure Island and Yerba Buena Island as a location for long-term uses.

4. Support other long-term uses and activities, helping to attract visitors and users.

5. Generate revenue to offset base conversion and reuse planning and implementation costs.

6. Retain flexibility to attract major uses and respond to market opportunities.

7. Produce social and/or environmental benefits.

Publicly Oriented Uses

Provide for a broad mix of publicly oriented attractions at Treasure Island.

Publicly oriented recreational, cultural and entertainment uses are envisioned to be the dominant reuse of Treasure Island. They would be focused on the southerly end of the island (south of Ninth Street) and would surround three sides of the planned Job Corps facility, but could extend to the north as well. The types of uses that would comprise the publicly oriented attractions would range from a theme park(s) with paid admission to sports fields that are accessible at no cost (see Table 3). The uses could be year-round or seasonal in nature, and could include a fair, festival, or an event like the original Golden Gate Exposition, which spans a year or a couple of seasons. Also within this category are a number of related uses, such as hotels, restaurants, entertainment retail, film production, support office and cultural facilities (for exhibits, performances, etc).

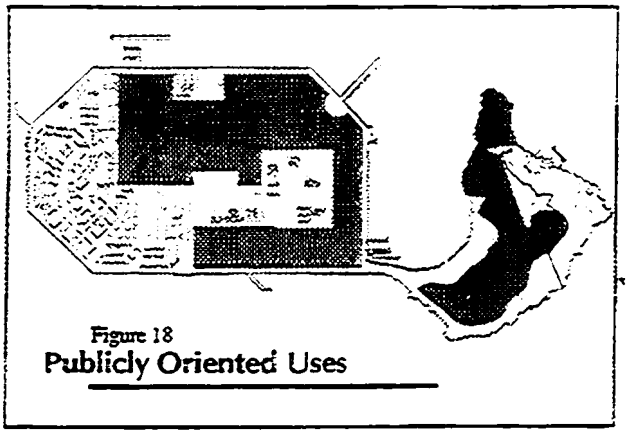


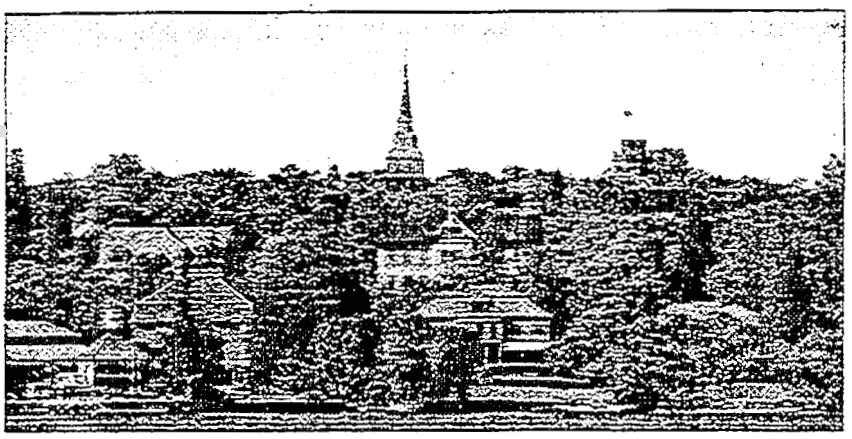
Figure 18
Publicly Oriented Uses

Provide for a theme park or major attraction at Treasure Island, adjacent to Pier 1.

At Treasure Island, a theme park is at the heart of publicly oriented uses. The theme park would occupy approximately 50 acres adjacent to Pier 1, at the easterly terminus of California Boulevard. This is one of the more accessible and readily developable areas of the island, and is adjacent to the existing film production studios. This entertainment attraction is envisioned as a facility that can build upon historical, cultural and recreational themes that relate to Treasure Island, the city and the region, and which celebrates the contributions of the region to the growing economy in the areas of multimedia, technology and entertainment.

There are a number of precedents of attractions in island settings tied to historic and cultural themes. For instance, Skansen is an island park in Stockholm which features rural buildings and scenes of domestic life from preindustrial times as well as children's playgrounds, amusements and forested preserves—all of which are accessible by a tramway once one arrives by ferry from downtown. Sentosa Island in Singapore is another example of a theme park built on filled land in an island setting that makes use of cultural history and environmental themes to create a popular amusement center with a resort and golf course. Closer to home, Alcatraz Island—a part of the Golden Gate National Recreation Area—is a cultural attraction that draws some one million visitors annually to visit and learn about the notorious prison in the center of San Francisco Bay.

This Reuse Plan provides for an attraction with potential at full buildout to draw some five million annual visitors. For purposes of comparison, this scale of attraction is slightly less than half the annual visitation at Disneyland in roughly half its land area (net of parking). If similar to Disneyland in employment/visitation ratios, the planned attraction would create some 5,000 permanent and seasonal jobs.



Skansen is an example of an island cultural and amusement destination in Stockholm.

Provide for a sports complex at Treasure Island.

The development of a sports complex, with facilities for field sports and competitive games, is envisioned as one of the initial reuses for Treasure Island. The sports complex would provide San Francisco youth with opportunities for soccer and other sports as well as the opportunity for occasional competitive events. The sports fields would be located within the core of the island, adjacent to the theme park. They would be an unfenced facility open to the public, incorporating picnic grounds and playground facilities as well as facilities for organized and competitive field sports. As part of the competitive fields, bleachers and seating to accommodate larger numbers of spectators would be included, as well as surface parking that could serve both the sports complex and theme park employees.

Provide for the development of a hotel/entertainment complex on the city side of the island.

In the area south of Ninth Street and adjacent to the water are hotel, conference, resort and entertainment uses. The predominant use in this area would be one or more hotels, with up to 1,300 rooms and views to San Francisco Bay and downtown San Francisco. The buildings in this area are envisioned to be landmark buildings that create a strong edge at the bay and a strong identity for the area, similar to the Hotel Claremont in Oakland. They would emulate some of the original buildings on the island, stepping back from the water with terraces. Buildings

would be aligned with Building 1, behind a large grassy open space similar in quality to the Marina Green in San Francisco.

Provide for the maintenance and expansion of film production uses.

Film production is currently housed in three hangar buildings at Treasure Island, with more than 300,000 square feet of production space. There is an opportunity to intensify this activity and expand these uses into adjacent areas with the development of a new hangar/sound stage as well as associated offices, theaters, and other facilities. Film production presents a tremendous opportunity not only as the most significant new use at Treasure Island today, but also because of its capability to expand. It is anticipated that some 40,000 square feet of additional hangar/sound stage or support facilities could be developed within the island, providing for the growth and development of this industry within San Francisco.

Provide for the opportunity for publicly oriented uses at Yerba Buena Island.

At Yerba Buena Island, there are two sites where visitor-oriented uses are envisioned. They include: (1) the easterly tip of the island, where a portion of the property could be developed as an attraction that is tied by boat to activities taking place at Treasure Island; and (2) Quarters 1-7, which could be used for conference (60,000 square feet) and limited lodging. At the westerly tip of the island, there is the potential to redevelop an existing housing area above Treasure Island Road but accessible from Macalla Road for a small hotel (less than 150 rooms), with views to the city.

Allow for the expansion of publicly oriented uses.

If the publicly oriented uses require a larger "footprint" and if circumstances make other properties available, then the expansion of publicly oriented uses should be accommodated. In an island setting such as Treasure Island, where land is limited, this policy gives the publicly oriented attractions a priority and provides greater flexibility to assemble the properties which they need

Table 4
Publicly Oriented Uses

Land Use	Program
Treasure Island	
Theme Park	35,000 visitors/day
Sports Complex	1,400 visitors/day (average)
Film Production	400,000 s.f.
Cultural/Office	250,000 s.f.[1]
Hotels	1,300 rooms
Destination Entertainment	200,000 s.f.
Conference and Meeting Facilities[2]	75,000 s.f.
Yerba Buena Island	
Conference/Meeting	60,000 s.f.
Hotel/Lodging	100–150 rooms

Notes:

[1]Building 1 and Building 450.

[2]Nimitz Conference Center and Austin Hall.

to be successful and to, in turn, help generate jobs and increased revenue, providing a range of activities of value to the economic base of the city and region.

In certain cases, areas are shown with multiple land use designations, providing the opportunity at Treasure Island and Yerba Buena Island to retain some flexibility and create an opportunity for a broader range of potential activities. Specifically, two land use categories include alternate uses. These include the band of institutional uses in the easterly portion of Treasure Island and the residential community to the north. Publicly oriented uses are a possibility at Yerba Buena Island as well, in the flatter areas on the easterly tip of the island (including Quarters 1-7) and on the promontory overlooking the Bay Bridge with views to downtown San Francisco (for hotel use).

Open Space and Recreation

Focus public open space on the natural features and amenities of the island setting.

Two primary types of open spaces are envisioned at Yerba Buena and Treasure Islands. Both types of open space build on the inherent natural and aesthetic qualities of the Islands and add

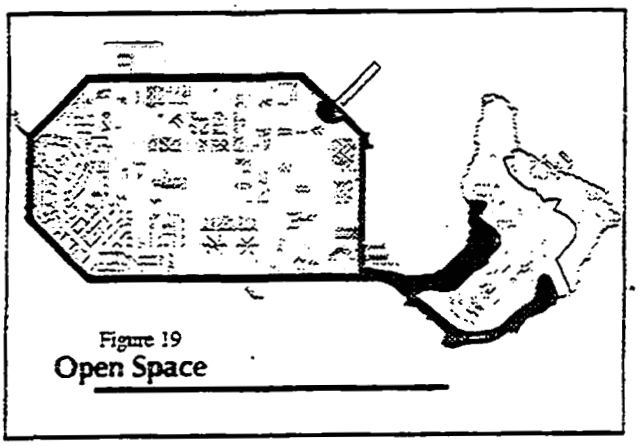


Figure 19
Open Space

to the quality of the place. At Treasure Island, a shoreline open space system encompassing the entire island is envisioned which will create opportunities for walking, bicycling, rollerskating, and other linear activities linked to the ferry terminals as well as birdwatching, enjoyment of surrounding views, and other passive recreational activities. At Yerba Buena Island, the open space is primarily located in hillside areas, where slopes would be protected from development and to create a strong visual "frame" for Clipper Cove.

Develop a continuous system of open spaces around the shoreline at Treasure Island.

Along the shoreline at Treasure Island, a reinforced shoreline perimeter is planned that includes a bikeway and road as well as a path for pedestrian movement along it. At this stage in the planning process, it is envisioned that the improvements will occur, for the most part, within a 100-foot band along the shoreline.

The required open space includes the shoreline perimeter open space as well as a one-and-one-half acre plaza adjacent to Pier 1, and other open spaces are suggested to be developed as a part of redevelopment and reuse. The waterfront open space system would be linked to a series of parks, plazas, greens and overlooks that would be privately developed, but open and accessible to the public. Some of these open spaces and portions of not yet developed land could be landscaped with native plants to provide a naturalistic setting for birdwatching and other outdoor activities.

Protect hillside and shoreline open space at Yerba Buena Island.

At Yerba Buena Island, a continuous band of hillside open spaces adjoins the water on the westerly and southern sides, located on the downslope side of Treasure Island and Macalla roads.

While this open space is primarily visual, it will also play a role in enhancing the stability of Yerba Buena Island by keeping development from steep slopes, avoiding potential landslide areas. It also provides a habitat for birds and other wildlife of the hillside and water's edge. The mudflats at Clipper Cove should also be protected as a shorebird foraging habitat.

Palm-lined shoreline

Maintain and expand waterfront recreational and transportation facilities to enliven the water's edge and improve access.

A number of waterfront recreational and transportation facilities are associated with open space areas. On Yerba Buena Island, the existing beach and picnic grounds at the foot of Clipper Cove would be maintained. The existing marina adjacent to the shoreline at Treasure Island would be maintained, and the plan would allow for its expansion. Within Clipper Cove, priority would be given to the transient mooring of recreational craft, to take advantage of the role that can be played by this sheltered water body as one of the few destinations for sailors in the bay. The transient mooring of vessels on buoys would enliven the shoreline with boaters and would not need extensive landside support facilities (such as parking or haul-out facilities), as would be found in a traditional full-service marina.

In addition, Clipper Cove plays an important role in providing a harbor for the mooring of a wide range of vessels providing access to both Treasure and Yerba Buena Islands. The opportunity for ferry facilities should be developed (where possible) along Yerba Buena Island as well as in the area around Pier 1 and Pier 12 on Treasure Island. In addition, the opportunity for berths and floats to serve smaller craft (such as water taxis) as well as ferries should be provided. At Pier 1, the mooring of large ships on the north side of the pier should be encouraged, in order to maintain the maritime character of the area, create a use in scale with the size of the pier, and allow the continuation of certain maritime functions and traditions in the Bay Area.

Table 5
Public Open Space

Open Space	Program
Treasure Island Shoreline	44 acres
Yerba Buena Hillside	30 acres

Institutional Uses

Provide a range of institutional uses that can satisfy a broad range of public purposes. Encourage collaboration between users to reduce costs for facilities and services.

Institutional uses at Treasure Island primarily include the Job Corps, which will be developed by the Department of Labor and is anticipated to be one of the earliest projects to be undertaken, open immediately upon closure in 1997. Although many Job Corps facilities are largely self-contained, it is hoped that this facility will be well integrated, both functionally and visually, with the larger Treasure Island community. The Job Corps trainees could provide restaurant service, medical and technical support services to island uses, employees, visitors and residents. Key facilities such as day care centers, meeting rooms, clinics, workshops and recreational facilities could be shared with other island users, thereby fostering collaboration and reducing costs.

In addition, an area along the eastern shoreline could also be developed for institutional use, providing for the possibility that uses such as the fire training school and the brig be retained for the long term, and indicating a five-acre site for a new wastewater treatment plant. This latter area is one of the "swing" sites which is described in greater detail below, where more than one primary use could be permitted. The elementary school and day care facility are also included and are associated with the adjacent residential uses, although children of island employees and trainees may also use these facilities.

On Yerba Buena Island, the range of institutional uses includes the Bay Bridge structure and ramps as well as the radar station and other communication facilities at the top of the island. Water

Table 6
Recreational Facilities

Recreational Facilities	Program
Marina	300 slips
Transient Mooring	
Clipper Cove Beach and Picnic Grounds	1 acre

reservoirs outside of the hilltop area as well as other residential support facilities are allowed within residential areas.

Residential Community

Provide the opportunity for future residential uses at Treasure Island, contingent upon the resolution of specific issues.

There are a number of obstacles to the development of new residential uses at Treasure Island, including the possible application of the State Tidelands Trust over the property, which may prohibit such uses. More specifically, the State Tidelands Trust, which is applicable to tidal and submerged lands, including land created through landfill such as Treasure Island, contains restrictions that would affect the use of Treasure Island. Land uses would be restricted to maritime-related uses, publicly oriented uses that attract people to the waterfront, recreation and open space. Residential, general office, industrial, and research and development uses are largely prohibited by the Trust. Should it be determined that the Trust restrictions are applicable to Treasure Island, temporary use of existing housing stock may be allowable, but substantial renovation or replacement would not be permissible. In the long term, residential may be possible if this land is swapped for other non-Trust-restricted land which may be considered to be more valuable for public use. If residential is not feasible, this area could be used for publicly oriented uses, similar to other portions of Treasure Island.

Perhaps the most obvious and apparent constraint on residential use has to do with the existing congestion on the Bay Bridge during peak commute periods. This would greatly affect

Table 7
Institutional Uses

Use	Program
Job Corps:	
Academic Education	27,169 s.f.
Vocational Education	21,735 s.f.
Vocational Shops	45,839 s.f.
Cafeteria	39,709 s.f.
Housing	154,855 s.f.
Recreational	30,789 s.f.
Medical/Dental	13,787 s.f.
Administration	9,922 s.f.
Nonresidential Student Support	3,086 s.f.
Storage/Support	32,603 s.f.
Elementary School (K–5) (Bldg. 999)	
Child Care (Bldg. 502)	10,123 s.f.
Brig (Bldg. 670)	25,110 s.f.
Fire Training School (Bldg. 600)	17,030 s.f.
Fire Stations (TI and YBI)	1.4 acres (TI)
Police Station (TI)	0.5 acre (YBI)
Water Reservoirs	

a conventional residential development that relies on automobile access and utilizes the transportation system during peak periods for home/work trips.

Since additional peak-period traffic must be extremely limited on the Bay Bridge, a new residential community at Treasure Island would need to be one that is not primarily dependent on vehicular access, but on ferry service, or one that supports a population that is not tied to off-island employment (such as a leisure or retirement community, housing for island employees, live/work environments, etc.).

Seismic safety is also a consideration, particularly with respect to use of existing housing. Geotechnical and structural evaluation would be required prior to allowing the reuse of existing housing.

Provide for the opportunity for pedestrian-oriented residential uses in the northern portion of Treasure Island.

Currently, residential uses are concentrated in the northern portion of Treasure Island, on land that had been used for parking during the Golden Gate International Exposition and which later was

used for storage by the military. The Reuse Plan provides for the redevelopment and intensification of this area, creating new building stock that meets contemporary standards for seismic safety. The plan provides for up to 2,500 housing units. Because of the underlying soil conditions, it is anticipated that the buildings will be predominantly one to two-story, lightweight wood frame structures on structural mats. These structures will be higher density single-family with a very low proportion of garages and auto storage. In addition, higher density attached and multiple-family housing will also be provided in larger buildings in key locations and will incorporate a greater mixture of uses, including the possibility for retail, restaurant and community functions. Densities range from around 10 dwelling units per net acre to up to 90 dwelling units per net acre for multiple-family dwellings, with limited parking. Residential densities average around 25 to 30 dwelling units per gross acre overall.

In the residential community, a variety of complementary support uses are included under the plan. These include retail, restaurant, community facilities and meeting areas, live/work functions, and ancillary office to nonprofit or residential structures. In addition, approximately 10 acres of recreational area will be developed to serve the residential community.

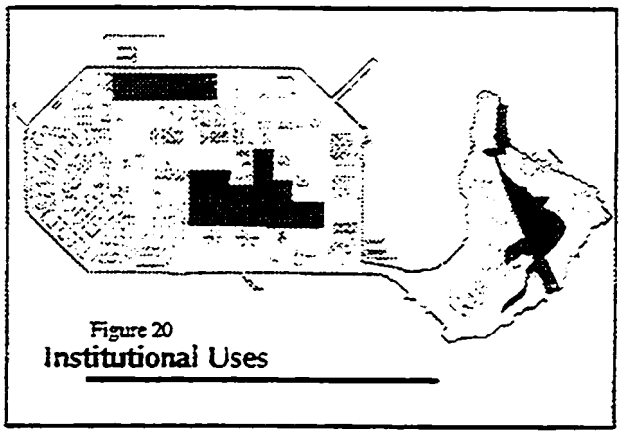


Figure 20
Institutional Uses

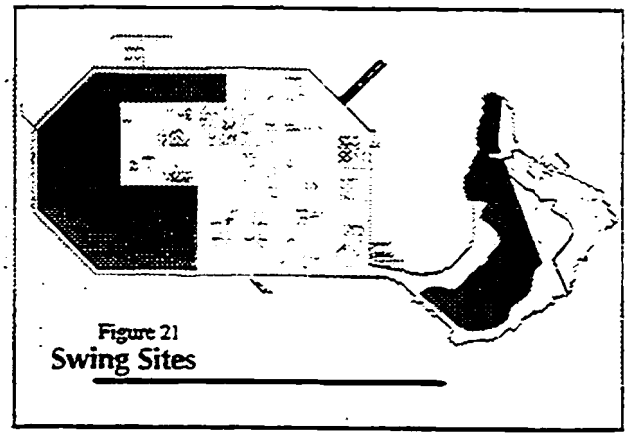


Figure 21
Swing Sites

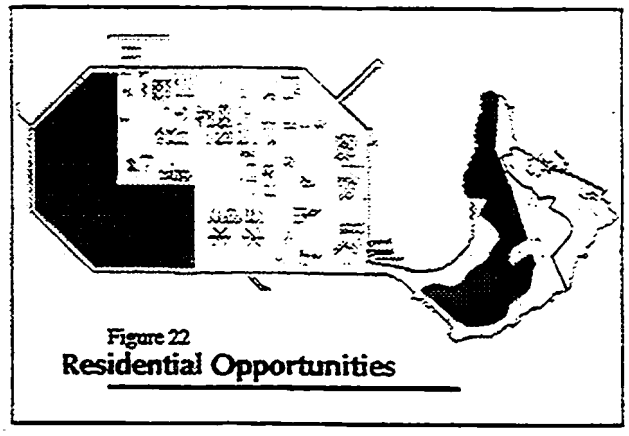


Figure 22
Residential Opportunities

Provide for existing and new housing at Yerba Buena Island.

The plan allows for existing and new housing on Yerba Buena Island. For Yerba Buena Island, residential uses may include single-family attached and detached as well as live/work studios and artist cottages. A maximum of 300 units would be allowed

Table 8
Residential Community

Residential	Program
Treasure Island	up to 2,500 du's
Yerba Buena Island	up to 300 du's

at Yerba Buena Island, and would be distributed in both the hillside and flat land areas. On Treasure Island, housing would be predominantly single-family, although a range of densities would be possible, for a total of 2,500 dwelling units.

While it is anticipated that the housing at Yerba Buena Island would be accessible by automobile, it is assumed that all of the new housing at Treasure Island within the neighborhood would be pedestrian oriented with significant limitations on auto use as a result of the existing peak-period constraints on Bay Bridge capacity. This residential neighborhood would be considered to be extremely innovative in nature, and would be oriented to a broad economic cross section comprised of diverse income groups. The residential community at Treasure Island and Yerba Buena Island should provide a mix of housing types that ranges from market rate to affordable (including for lower income San Francisco residents below 25 percent of median income). Housing is envisioned as a complement to the employment uses at Treasure Island, and priority would be given to employees on the island for housing whenever feasible. Approvals to permit this use would be contingent upon submission of a detailed transportation management plan and traffic study indicating the project can be accommodated within Bay Bridge capacity constraints.

HOMELESS NEEDS AND SERVICES

This chapter outlines those aspects of the Reuse Plan that directly benefit homeless and economically disadvantaged San Franciscans through the provision of affordable housing, employment, and economic development opportunities on Treasure and Yerba Buena Islands. A more detailed description of the homeless component is contained in the Homeless Assistance Submission, which is auxiliary to this Draft Reuse Plan.

The Community Redevelopment and Homeless Assistance Act of 1994 gives homeless service providers equal priority with other groups, including local governments, in requesting surplus military property. Under the 1994 Act, the Local Reuse Authority must, in preparing base closure redevelopment plans, undertake the following:

> *(ii)(J) ...to prepare legally binding documents that provide for the use to assist the homeless of buildings and property, resources, and assistance on and off the installation. The implementation of such agreements will be contingent upon approval of the redevelopment plan by the Secretary of HUD.*

The federal regulations governing the Community Redevelopment and Homeless Assistance Act of 1994 require the LRA to submit three documents to HUD as part of its final reuse application: (1) the Draft Reuse Plan; (2) the Homeless Assistance Submission, including legally binding agreement between the LRA and local homeless service providers; and (3) a copy of all public comments on both the Reuse Plan and the Homeless Assistance Plan.

Within 60 days of receiving a local reuse application, the Secretary of HUD must review it to determine if it was "developed in consultation with representatives of the homeless and homeless assistance planning boards" and if it makes a reasonable attempt to balance the needs of the homeless in the area with the local community's "need for economic and other development."

The City of San Francisco, as the LRA for Treasure Island, and its Treasure Island Citizens Reuse Committee (CRC) have, from the outset, involved representatives of the homeless in every aspect of reuse planning. The Homeless Assistance Plan is an integral part of the overall Reuse Plan for the Islands.

TIHDI's 1995 Notice of Interest (NOI)

For Treasure Island, 14 nonprofit social service and homeless service organizations have formed a coalition called the Treasure Island Homeless Development Initiative (TIHDI), which has acted in concert to represent the needs of the homeless and to negotiate with the LRA.

TIHDI submitted a comprehensive Notice of Interest to the LRA on November 1, 1995. This was the only Notice of Interest submitted for homeless services at Treasure Island. In the NOI, TIHDI articulated its commitment to balanced development on Treasure Island through its "Principles Guiding the TIHDI Plan":

> *Throughout the lengthy planning process, TIHDI has sought to achieve a balanced development plan for Treasure and Yerba Buena Islands that creates both for-profit commercial activity (and critically needed*

increased tax revenues for San Francisco) and a continuum of services for San Francisco's homeless population. Indeed, one the most innovative features of this proposal is the extent to which homeless providers have anticipated the for-profit development of the island and have sought ways in which symbiotic relationships can be nurtured and sustained between the for-profit sector and the homeless providers. The TIHDI plan for use of Treasure Island and Yerba Buena Island facilities embraces five principles:

- *The Treasure Island Homeless Project will be fully integrated into the larger economic development plan for the island to prevent becoming a homeless ghetto and to facilitate the development of for-profit commercial activity that can generate badly needed revenues for the City of San Francisco and create a balanced economy for the island.*

- *The Treasure Island Homeless Project will respect consumer choice, providing the full range of housing, service and training opportunities to enable clients to return to permanent affordable housing.*

- *The Treasure Island Homeless Project will provide a range of economic development training and placement opportunities that assist participants in accessing employment that can lead to an income adequate to achieving self sufficiency and affordable housing.*

- *The Treasure Island Homeless Project will respect individuals from diverse backgrounds, facing different physical and emotional challenges.*

- *The Treasure Island Homeless Project will be fully integrated into the developing Continuum of Care for the City of San Francisco.*

The NOI proposed a range of specific policy and property requests, discussed how specific programs would work, how they would fill gaps in the City's Continuum of Care plan, who would manage them, and how they would be financed. Submission of the NOI set the stage for the next phase of the reuse planning process and helped establish the parameters for negotiations between TIHDI and the LRA on the legally binding agreement for the proposed homeless services plan.

The Homeless Assistance Plan and The Legally Binding Agreement

The Homeless Assistance Submission which accompanies the Draft Reuse Plan includes the legally binding agreement which codifies the agreement between the LRA and TIHDI for homeless services on Treasure and Yerba Buena Islands. In negotiating the legally binding agreement, the core of the homeless assistance plan, both the LRA and TIHDI were committed to creating meaningful and immediate benefits for the homeless while preserving flexibility to promote long-term economic development on Treasure Island and Yerba Buena Island.

This approach to the legally binding agreement addresses the LRA's need to maintain maximum flexibility in areas with development potential while protecting TIHDI's interests and giving them a stake in the successful development of the Islands. While the LRA needs to pursue major economic development opportunities to pay for infrastructure and operating costs, each new development benefits the homeless and economically disadvantaged by creating jobs, tax increment revenue, and customers for TIHDI's own economic development opportunities on Treasure Island. In addition, should a developer need some of TIHDI's occupied housing in future years, TIHDI has agreed, in advance, to a buyout option.

The following serves as a summary of the major components of the legally binding agreement. Each component is preceded by the policy goals the LRA and TIHDI seek to achieve.

Guiding Policies

Address homeless needs identified in San Francisco's Continuum of Care as part of a balanced overall reuse plan in accord with federal base closure regulations.

Maintain maximum flexibility in areas with development potential while giving homeless service providers a stake in successful development of the Islands.

Housing Policies

Over the life of the Reuse Plan, seek to balance and integrate TIHDI housing for homeless and economically disadvantaged persons within a broader spectrum of housing types and income groups.

Provide TIHDI with immediate housing opportunities on Treasure Island and Yerba Buena Island while preserving the ability to use all parts of the Islands for economic development and major employment opportunities over time.

Proposed Housing Component

To the extent permitted by State law (i.e., Tidelands Trust restrictions) and seismic conditions, TIHDI will receive options to lease up to 375 units of existing housing on Treasure Island and Yerba Buena Island to be acquired by the LRA for this purpose through a Homeless Assistance Conveyance, as follows:

- Yerba Buena Island: 90 residential units.
- Treasure Island: 204 units of "1400 Series" housing.
- Treasure Island: 81 units of "1200 Series" housing.

For all of the above housing, once buildings are actually conveyed, the LRA will identify those housing facilities to be offered and notify TIHDI in writing. TIHDI will have six months

to present a proposal from a TIHDI member organization for leasing and operating the facility. The Agency's criteria for judging such proposals will include, among other things:

(i) *identifying a lessee which has, either on its own or in concert with a joint venture partner, sufficient experience and organizational capacity;*

(ii) *showing financial viability for housing operations; and*

(iii) *showing that appropriate social services, transportation, goods and ancillary services will be available to residents.*

Once the LRA determines a proposal is acceptable, it will enter into exclusive negotiations with the proposed lessee. If the lessee cannot execute a lease, the property will be reoffered through TIHDI to another member organization.

In the event that the LRA identifies a market-rate developer for these housing areas, the LRA may choose to sell the sites and use the proceeds to fund replacement housing for TIHDI. Any proceeds remaining will then be shared with the federal government.

- **New Housing Development.** If substantial new residential development occurs on the Islands, TIHDI will be offered additional sites for the construction of new affordable housing, at the rate of 1 acre for every 1,000 developer units.

- **Funding for Support Services.** In the early years, Treasure Island will not generate sufficient tax increment funds to pay for support services. To help fill that gap, City staff and consultants have worked closely with TIHDI to support a request for $2,000,000 in federal funds through the City's most recent McKinney application (HUD).

Economic Development Policies

Provide TIHDI with the right to negotiate exclusively for contracts for its members to provide certain services and the rights to package additional economic development opportunities on the Islands.

Provide TIHDI member groups with a source of revenue to support homeless services as well as job training and employment opportunities for their clients.

Proposed Economic Development Component

The overall goal is to provide TIHDI with: (a) the right to negotiate exclusively for contracts for its members to provide certain services, such as landscaping and grounds maintenance (which a TIHDI member currently provides under contract to the Navy), janitorial, etc.; and (b) the right to package at least three "economic development opportunities" with additional opportunities in proportion to the level of development on the Islands.

- **Service Contracts.** To the extent the LRA ultimately controls these activities pursuant to caretaker agreements with the Navy, it agrees to enter into exclusive negotiations with TIHDI members for contracts on Treasure Island and Yerba Buena Island for grounds maintenance, janitorial services and recycling (if doing so does not violate any existing contract or law).

- **Economic Development Opportunities.** TIHDI will initially be offered the opportunity to operate three businesses on Treasure Island, which may include the conference center at Building 140 (meeting rooms, catering, wedding chapel,

cafe), a convenience store, and a destination restaurant. The TIHDI organization selected to operate each business will have six months after notification to submit a business plan that addresses criteria such as experience, capacity, financial viability, etc. In businesses operated through TIHDI, 75 percent of nonmanagerial work hours will go to San Francisco homeless or economically disadvantaged residents. All excess revenues generated will be used to subsidize homeless activities or services in San Francisco.

Employment Policies

Maximize the ability of job-ready homeless and economically disadvantaged persons to access employment opportunities on Treasure Island and Yerba Buena Island.

Individualize job training programs by meeting with potential employers on the Islands and discussing their specific employment needs.

Proposed Employment Component

The goal of this component of the agreement is to maximize the ability of job-ready homeless and economically disadvantaged San Franciscans to access a variety of construction and permanent jobs. This will be accomplished through the establishment of an overall employment goal for the Islands that can be adjusted up or down by the LRA for a specific employer based on workforce characteristics, and a job broker system.

For this employment policy, "economically disadvantaged" is defined as San Francisco residents earning 25 percent or less of median income for the area. This definition includes those working full time earning as much as approximately $5 per hour. This employment policy will therefore create long-term employment opportunities for the working poor as well as job-ready homeless individuals. The service-oriented land use plan for Treasure Island is expected to generate a high number of entry-level jobs that could provide permanent exits from homelessness and poverty.

New Permanent Jobs

Project-wide goals:

- 50 percent San Francisco residents, including
- 25 percent homeless or "economically disadvantaged" San Franciscans (persons whose annual income is not greater than 25 percent of median income).

Goals for each employer may be higher or lower as determined in their Development Agreement with the LRA, depending on the industry; employers may also be given time to reach their goal (i.e., first year 15 percent, second year 20 percent, third year 25 percent).

Construction Jobs

Goals:

- First consideration for hiring should go to San Francisco homeless and economically disadvantaged persons (i.e., 25 percent of median income or less).
- Second consideration to San Francisco residents at or below 50 percent of median income.

Except where otherwise required by union agreements.

Job Broker

TIHDI will establish a job broker system to assist Treasure Island employees in meeting their employment goals. The job broker will:

1. Provide a central job listing for employers on Treasure Island in cooperation with existing organizations and employment collaboratives;
2. Certify income eligibility of job applicants;

3. Refer screened applicants to prospective employers;

4. Provide technical assistance to employers using existing government programs (i.e., job training subsidies, enterprise zone benefits, etc.);

5. Maintain income data on referrals and track hiring by each employer; and

6. Develop specific, customized job training programs geared to employment opportunities on Treasure Island and Yerba Buena Island.

The Homeless Assistance Submission and the Legally Binding Agreement between the City and County of San Francisco and TIHDI present greater detail on the homeless services plan.

URBAN DESIGN

This chapter addresses the character of the site and the elements which help structure and shape it. It is intended to guide the transition of the image and identity of Treasure Island from an introverted and self-contained military installation to a vividly memorable and publicly spirited pleasure island reminiscent of the International Exposition held at Treasure Island in 1939. Ways of reconnecting Treasure Island to the identity of San Francisco and increasing its visibility and sense of immediacy with the city are an important part of the urban design intentions set forth in this chapter.

For the most part, urban design policies center on the public framework for future reuse and development—on the open spaces, streets, promenades and visible places that provide structure and a sense of orientation. Additionally, the preservation and adaptive reuse of historic structures and guidelines for the development of new buildings are suggested as they relate to environmental, cultural and spatial qualities. Bulleted items, although emboldened, are not policies, but design guidelines that may more specifically address how policies might be implemented. They, together with the illustrative plans and height map, indicate treatments that are not mandatory, but suggested ways of achieving design intent.

Guiding Policies

Improve the appearance and identity of Treasure Island.

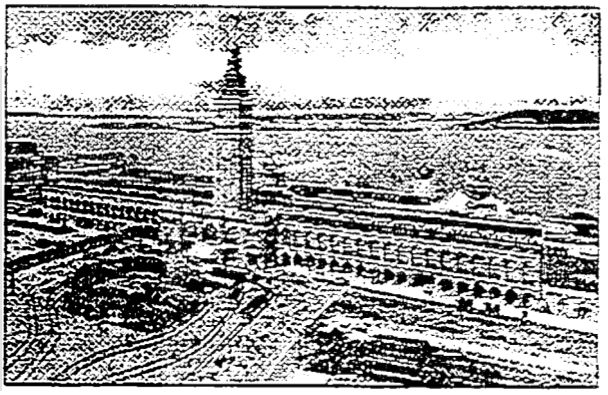
The military presence at Treasure Island and Yerba Buena Island has spanned over 50 years. During this period of time, there has been a slow and incremental transformation in character. The buildings from the 1939 International Exposition have been removed and replaced by military buildings or, in some cases, opened up for recreation and sports fields. The appearance of the island today is that of a postwar military installation, well maintained and serviceable for the needs of the Navy, but relatively undistinguished in character.

Priority should be placed in the reuse of Treasure Island on conscious and purposeful efforts to change the character of the facility to make it more appealing as a destination and as a location for new civilian uses. There are a number of simple approaches that can be taken to accomplish this. They include the following guidelines:

- **Emphasize new public amenities and site features.** One of the most effective ways of transforming the character of a place can come from landscape and site amenities oriented to a new population of users. At Treasure Island, the demolition of selected military buildings and the implementation of landscape improvements as well as pedestrian and landscape treatments along the shoreline would help to create a more publicly accessible and attractive place.

- **Create a new vocabulary of building prototypes.** New buildings at Treasure and Yerba Buena Islands will be unlike those built by the military, and will serve different functions and users. Emphasis should be placed on qualities such as individuality, innovation, permanence and sustainability. For new types of buildings, such as exhibit halls, spectator seating and entertainment centers, a festive, playful and public-spirited character should be encouraged through the design of buildings and open spaces and through the use of graphics, lighting and color.

Heighten the visibility and sense of immediacy between Treasure Island and the city.

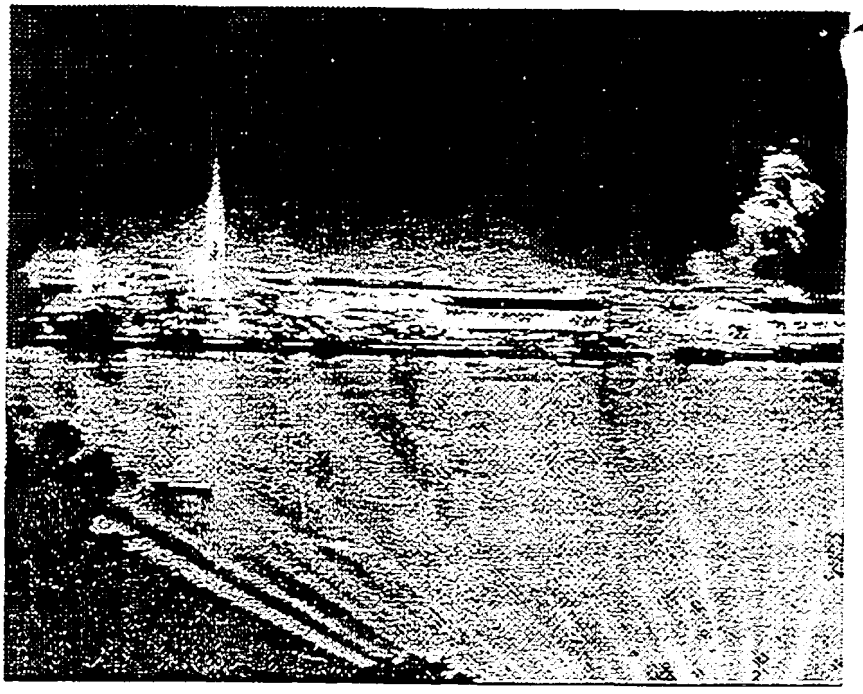


View down Market Street to the Ferry Building and Treasure Island beyond

During the Golden Gate International Exposition in 1939, Treasure Island was integrally tied to the image and identity of San Francisco. It was envisioned as a stage set and backdrop to the city, and became a strong visual terminus extending down Market Street and beyond the Ferry Building into the bay. The island was made even more prominent through the 400-foot high Tower of the Sun and the strong landscape treatment of palms along the water's edge. Although tall buildings such as those built during the Golden Gate Exposition may be limited, the visibility of the island can be enhanced through such means as improved landscaping, night lighting (similar in quality to the Palace of Fine Arts), and frequent ferry service from the Ferry Building.

- **Utilize palm trees to mark the shoreline and create a strong edge statement.** The palm trees on the east and west sides of Treasure Island today create a memorable identity and attractive gateway to the island in the spirit of the Avenue of the Palms created for the 1939 Exposition. While the shoreline edge will be reconstructed, the palms can be relocated to the new edge and extended around the shoreline, and up the waterside of the causeway to Yerba Buena Island.

- **Utilize night lighting to enliven the edge and to heighten the prominence of the Islands.** Night lighting, fireworks and searchlights are in the tradition of visitor-oriented extravaganzas, adding interest and excitement to the Islands. Lighting can take advantage of the island setting and the reflective quality of light on bay waters. During the Golden Gate Exposition, mica was mixed with paint to enhance the reflective, sparkling quality of buildings when lit up at night, and lighting from offshore vessels was used to showcase the fair. Approaches to lighting that are showy, dramatic, and large scale should be considered along with publicly oriented (in particular, theme park) uses.



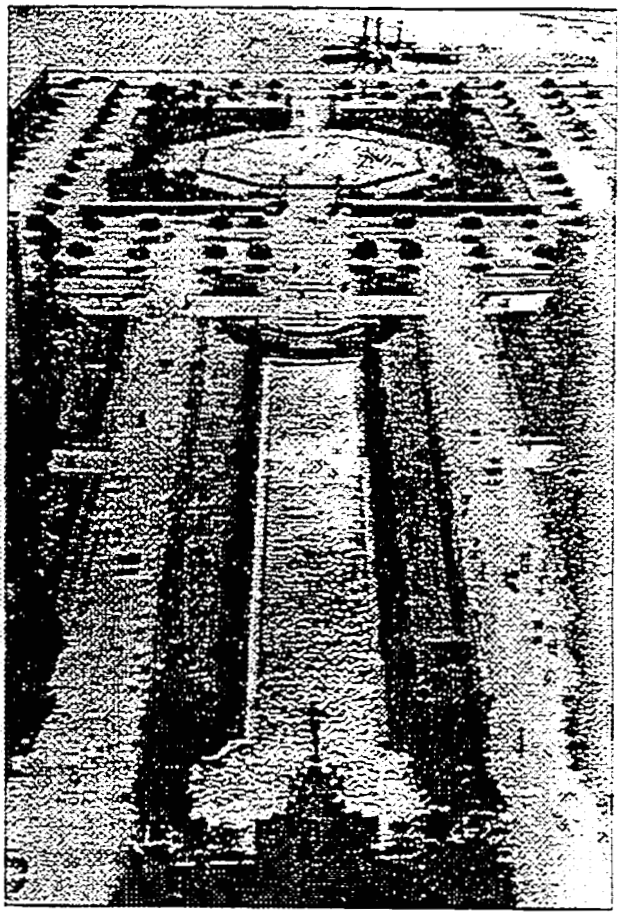
Colored lights and fireworks added to the festive character of the 1939 fair.

- **Establish a direct point of access from the Ferry Building to Treasure Island, to create a strong visual linkage across bay waters to the island.** In the years of the Golden Gate Exposition, there was a strong connection for San Franciscans to Treasure Island. Visually, it was a prominent feature down Market Street and along the Embarcadero. This same sense of connection could be reestablished through increased ferry boat activity along a direct route to the island.

Heighten the visibility of the shoreline and continuity of access along it.

The shoreline is perhaps the single most important physical feature of both islands, and its prominence should be visually expressed and made more physically accessible. Future stabilization and improvement of the shoreline should incorporate open spaces, walkways and bicycle paths as well as roads for limited auto access to create a more active and publicly oriented edge. The use of tall trees should be encouraged to heighten the prominence of the shoreline.

- **Create a continuous open corridor along the shoreline edge.** As part of the stabilization of the shoreline, a pedestrian space oriented to the water should be developed to increase visual access and physical proximity to the water. This shoreline promenade will serve as the primary public gathering place on Treasure Island. Although this space is likely to be constructed back from the existing shoreline, depending on the design of the perimeter dike, opportunities for overlooks and vista points with direct adjacency to the water should be encouraged, if feasible, particularly at the terminus of major streets or in combination with parks or larger open spaces.

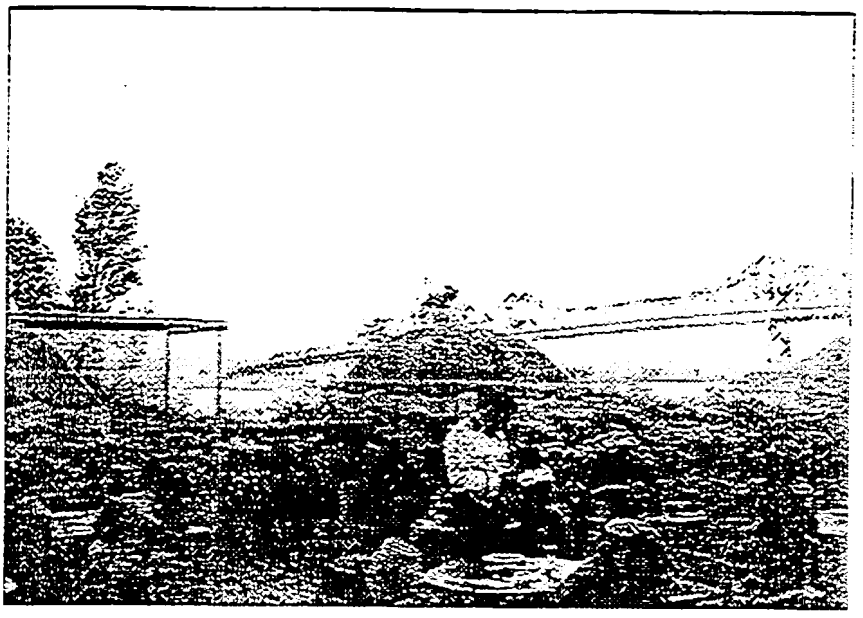


Formal landscaped open spaces created a clear organization for the 1939 fair and a strong relationship to the water.

- **Utilize landscaping, lighting and building setbacks of at least 100 feet from the water's edge to heighten the visibility of the shoreline.** Consistent with BCDC policies to protect the shoreline band, a 100-foot open area should be maintained, and buildings should be restricted from this zone in order to create a continuous open shoreline. In this area, a street primarily oriented to bicycle and nonauto vehicular circulation should be allowed. Landscaping and pedestrian-scale lighting should be incorporated to create an attractive water's edge.

- **Maintain and encourage visual corridors to the shoreline from inland areas.** As discussed more fully below, linkages across the island utilizing the existing grid pattern should be encouraged. If public access needs to be restricted, visual access along the extension of the grid should be encouraged.

- **Create landscaped spaces which open onto the water.** In key areas, gardens or parks should be constructed along the shoreline to focus on the water. These should be located



Restaurant on the terraces overlooking Clipper Cove

in public areas, at the gateway entrance to the island, and at the terminus of main linking streets.

Encourage public accessibility to and around the Islands.

The emphasis on a public-spirited place as part of reuse and recovery will depend to a great extent on the sense of accessibility (both visual and physical) throughout the Islands. At the same time, new users of the island may require physical detachment and isolation. For instance, a theme park is gated and fenced; and residential and institutional users may desire separation from surrounding uses.

- **Maintain the grid pattern on Treasure Island and complete it, where possible.** On Treasure Island, the dominant grid pattern provides views and direct access to the water and adds to a sense of orientation. The grid should be maintained as a structuring element and extended in the northern portion of the island as redevelopment and reuse occurs.

- **Minimize the appearance of walls and fences.** Some of the planned uses will be fenced and gated. Fencing should

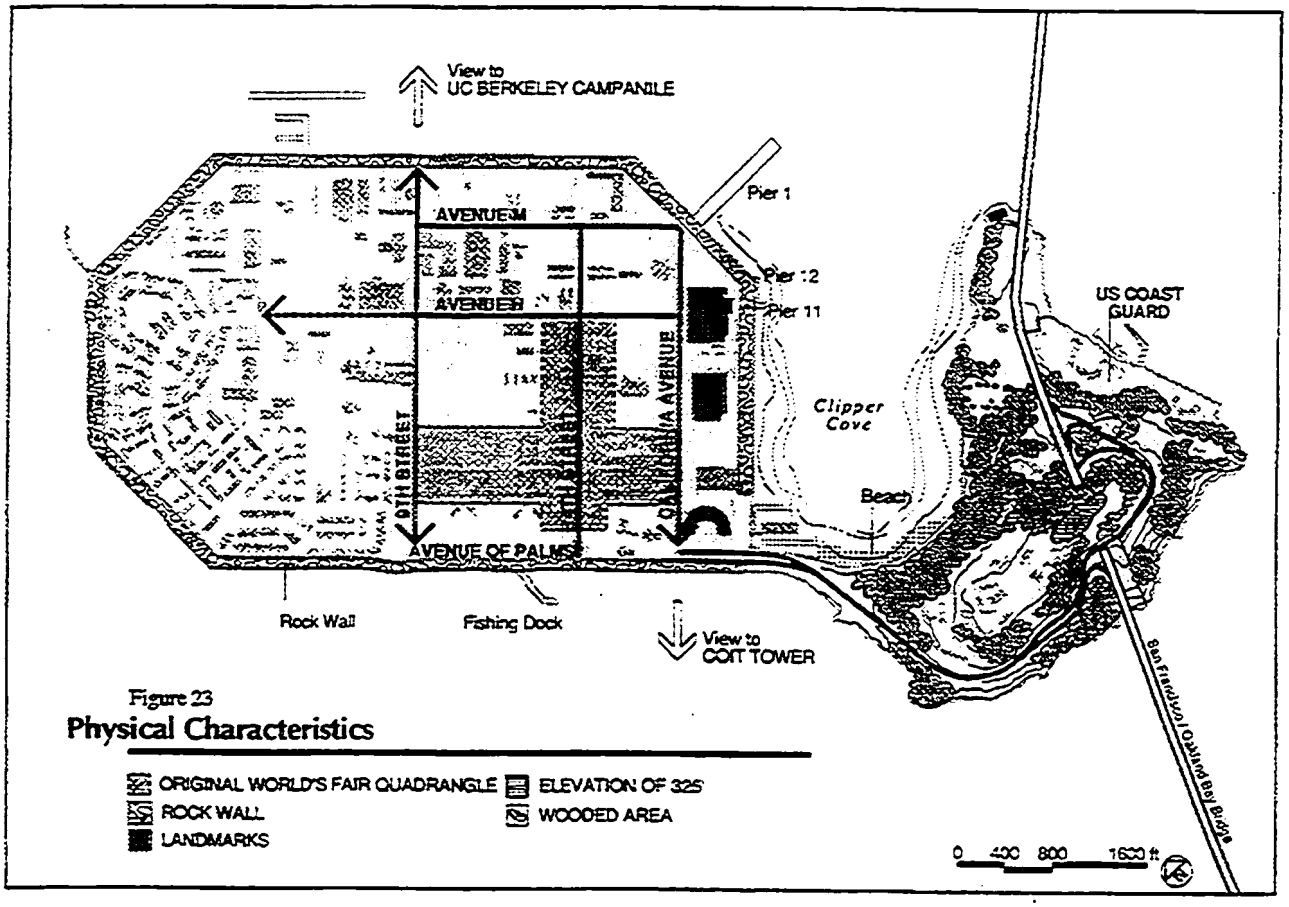


Figure 23
Physical Characteristics

be limited to the extent necessary and incorporated with landscaping.

- **Maintain cross-island connections.** There are two cross-island connections of importance to the sense of broader accessibility to Treasure Island: California, and Ninth Avenue. These should be open for movement across the island, to the extent feasible.

Encourage preservation of structures and places of historic significance and architectural interest.

Of the buildings on Treasure Island, Buildings 1, 2 and 3 have already been identified as having historic significance, and have been determined eligible for listing in the National Register of Historic Places. These three buildings date from before the Golden Gate International Exhibition, when the island was planned for airport use. Of the three buildings, Building 1 has a landmark

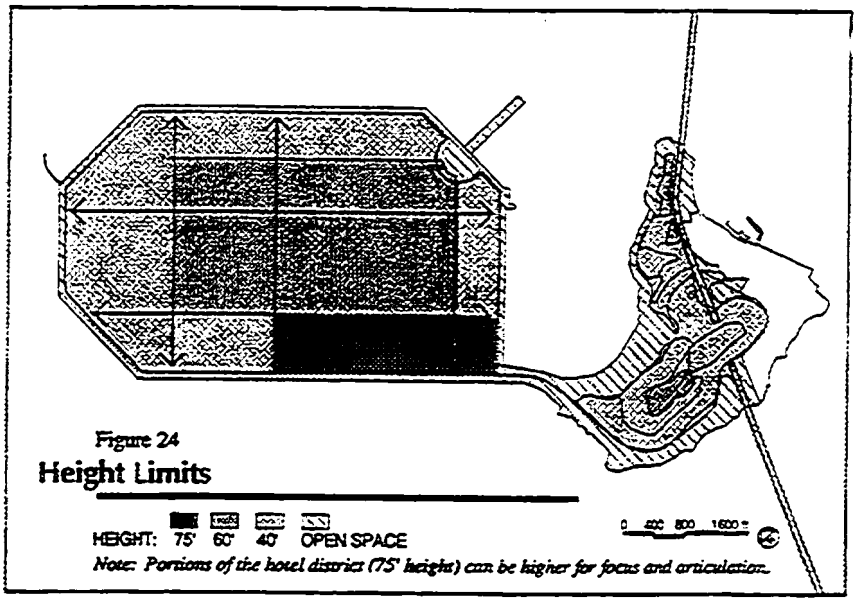


Figure 24
Height Limits

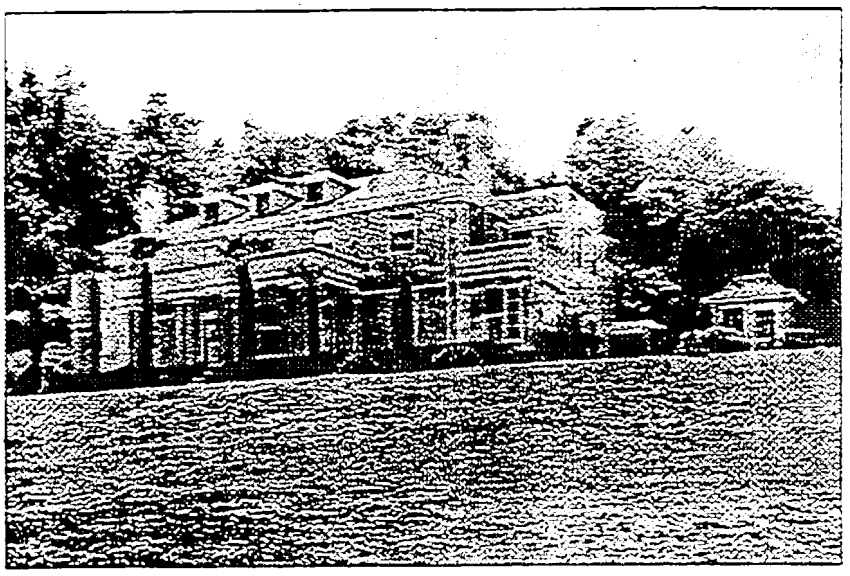
Note: Portions of the hotel district (75' height) can be higher for focus and articulation.

quality, with a distinctive 1930s facade and a control tower that makes it clearly visible from San Francisco. It is a memorable structure that provides an image and identity for the island, and it houses a notable historical museum as well as upper floor office uses.

On Yerba Buena Island, Quarters 1 through 8[1] have special architectural value, as does the secluded Torpedo Assembly Building at the easterly tip of the island. These buildings recall an earlier era, dating from the last quarter of the 1800s. Additional analysis of building condition as well as structural, code and other necessary upgrades for reuse should be undertaken. If feasible, all of these structures should be preserved and adaptively reused. In addition, a small group of Craftsman-style buildings dating from 1917 to 1934 and several structures at the top of the island may be eligible and warrant preservation and restoration.

- **Place a priority on the preservation and rehabilitation of Building 1 at Treasure Island.** Of the three oldest buildings at Treasure Island, Building 1 is the most prominent. Its role as a gateway and landmark structure should be maintained

[1]Quarters 1 is listed in the National Register of Historic Places, and Quarters 2–8 have been determined eligible for National Register listing as part of a noncontinuous historic district that includes Quarters 1.



Nimitz House circa 1901

and enhanced and, if possible, the existing museum should be incorporated with new uses and activities.

- **Place a priority on the preservation of the Torpedo Assembly Building at Yerba Buena Island.** The Torpedo Assembly Building is the oldest structure within the naval property at Yerba Buena Island, and it dates from 1891—a time when the island was redesignated as a receiving station for the United States Navy. The results of a preliminary survey identified this building as having potential individual eligibility for listing in the National Register of Historic Places. The building is not only interesting architecturally, but it also recalls an era when the island was entirely serviced via vessels. Today, the structure lies in the shadow of the Bay Bridge overhead. Located at the end of a restricted lane and concealed behind a bluff, its windows are boarded up, and the facility is used for storage.

  The Torpedo Factory should be preserved and rehabilitated, if feasible. The simple form and industrial character of the building should be maintained. If possible, windows should be reconstructed to match the original ones based upon any existing window fragments and any available historical documentation, and the skylight repaired to provide a lighted interior that can be used for artist studios, loft-type live/work

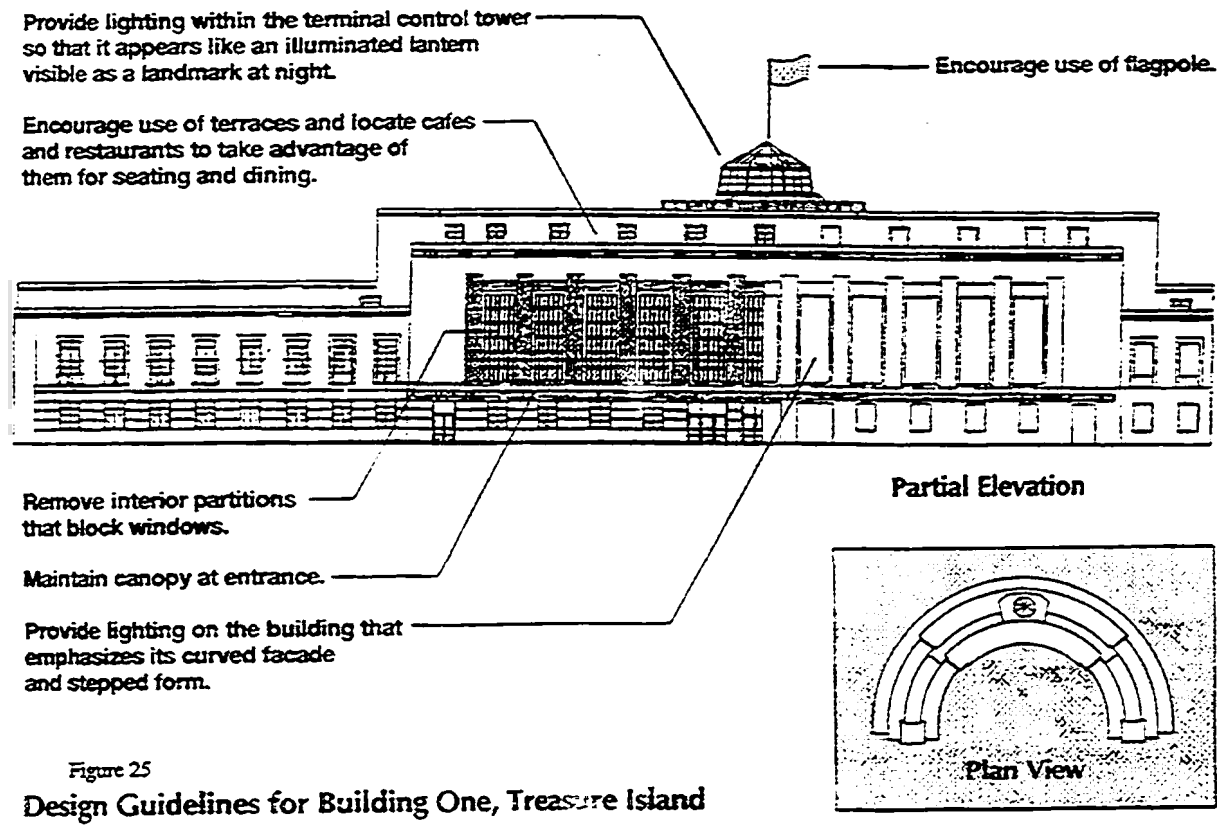


Figure 25
Design Guidelines for Building One, Treasure Island

space, a community meeting hall, and other types of uses that could effectively utilize large-volume lighted spaces to best advantage.

- **Preserve the Quarters 1-7 complex and reunite it with a larger assembly of structures.** Quarters 1—the Admiral Nimitz House—is currently individually listed in the National Register of Historic Places, and the crescent of smaller houses associated with it (Quarters 2-7) has been determined eligible for the National Register with Quarters 8 as a noncontinuous historic district that includes Quarters 1. The buildings, as well as the gardens, paths and terraces, form a composition of intimate spaces that reflect the Colonial Revival Period. Built in 1900, these buildings should be preserved as a grouping. In addition, the flat field below the Quarters 1-7 complex should be designed in such a way as to recall the historic Administration Building and Parade Ground that once

occupied the site, thus reconnecting the housing complex more meaningfully with its site and surroundings.

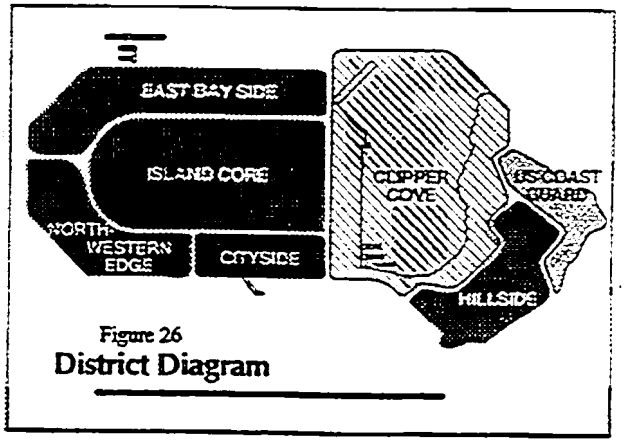


Figure 26
District Diagram

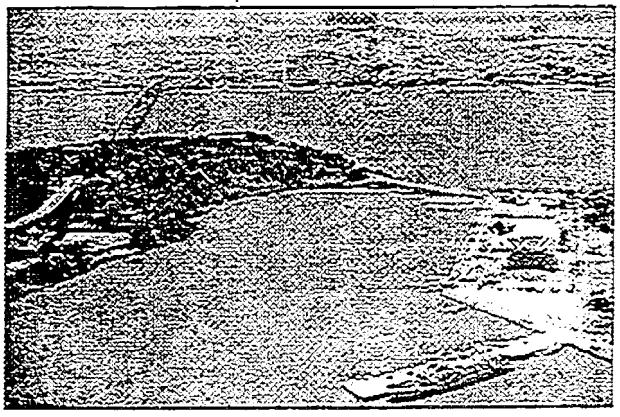
- **Display the remaining statuary and fountain from the 1939 fair.** The heroic sculptures created for the 1939 fair reflect the pageantry and bold representative artistry of that era. Even at the time of their making, they were celebrated for their depiction of international themes and skillful use of new materials and techniques employed at a large scale. Although many of the sculptures were destroyed, some still exist and are in storage. These should be reassembled and displayed in a prominent location in meaningful arrangements that properly recall the spirit of the exposition.

Incorporate environmental factors in site, building and street design.

- **Design individual buildings and groupings of buildings to shield wind.** Treasure Island is low and flat and particularly vulnerable to winds throttling unimpeded through the Golden Gate and across the bay. Buildings should be designed to shelter and create comfortable environments for people. In particular, consideration should be given to the design of courtyards, quads, and other protected spaces.

- **Shield buildings and uses from the impacts of high noise levels associated with the Bay Bridge.** The arrangement of buildings to open away from the noise source and the siting of buildings into "U" or courtyard arrangements are some of the approaches that can be taken to reduce outdoor noise from the Bay Bridge.

- **Preserve significant solar access to sidewalks and pedestrian spaces.** Considering the cool and often windy microclimate of Treasure Island, the siting and height of buildings should be developed, where possible, to enhance



Clipper Cove

solar access and wind protection of important pedestrian spaces and sidewalks.

- **Establish height limits that consider the need to create focal points on Treasure Island and the hillside form of Yerba Buena Island.** Building heights on Treasure Island would be the highest along the western edge, where hotels or other publicly oriented buildings would take advantage of views to San Francisco. On other portions of Treasure Island, higher buildings are allowed in the center, with building heights stepping down toward the shore. Exemptions to the overall height limits would be allowed in the hotel zone to encourage towers and architectural accents that break up building mass and add interest to building silhouettes. Similarly, in the theme park areas, exceptions to the height limits would be allowed for landmarks, monuments, or special facilities and attractions. On Yerba Buena Island, taller buildings are allowed at the top of the hill to reinforce the hillside form. On hillsides, buildings that conform to the slope and fit with the terrain and within the canopy of trees should be encouraged as well. Height limits are diagrammed in Figure 24. No bulk limitations would be placed on buildings 40 feet high or less. Buildings higher than 50 feet would be subject to a maximum plan dimension of 110 feet by 125 feet above a 40-foot base.

District Policies

Enhance the distinctive areas that comprise Treasure Island and Yerba Buena Island.

Treasure Island and Yerba Buena Island are comprised of a number of distinctive physiographic areas or districts. The unique characteristics of each of these districts should shape the nature of their activities, their organization and desired treatment.

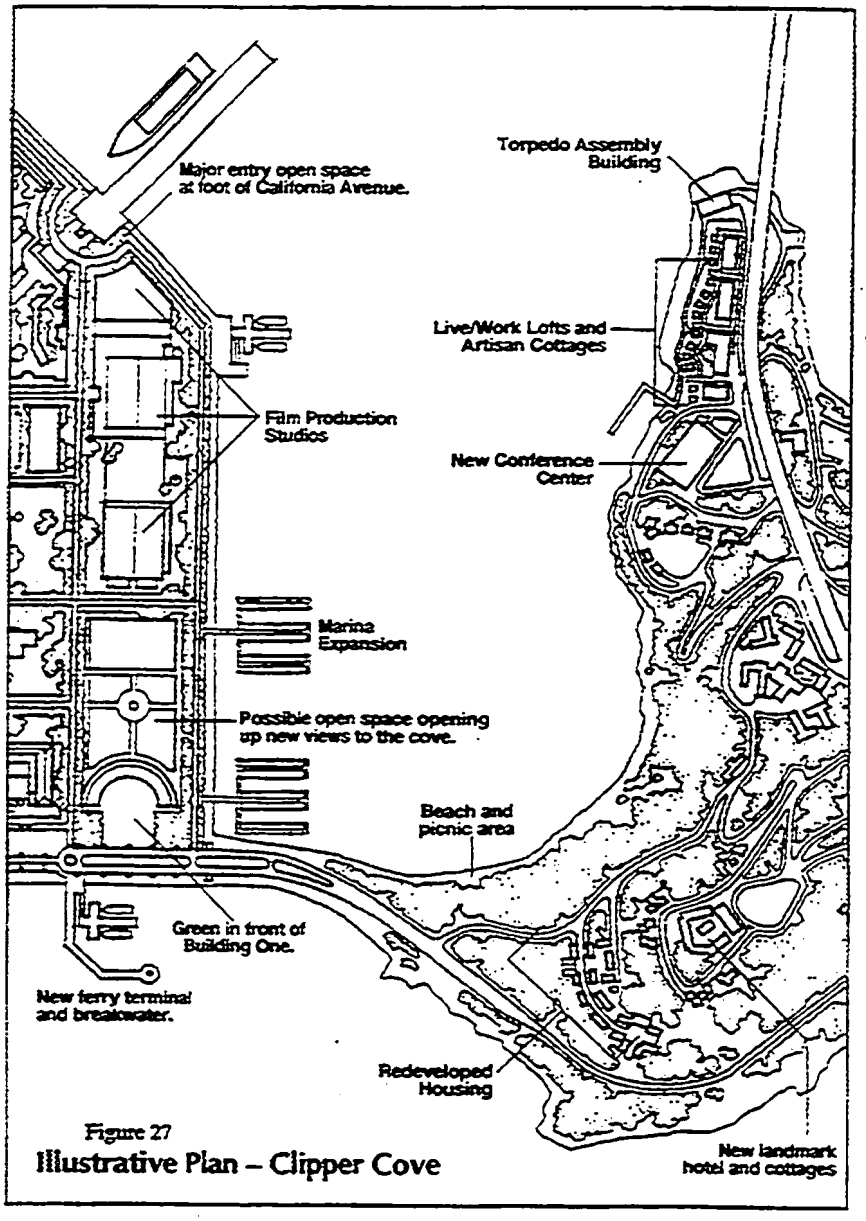
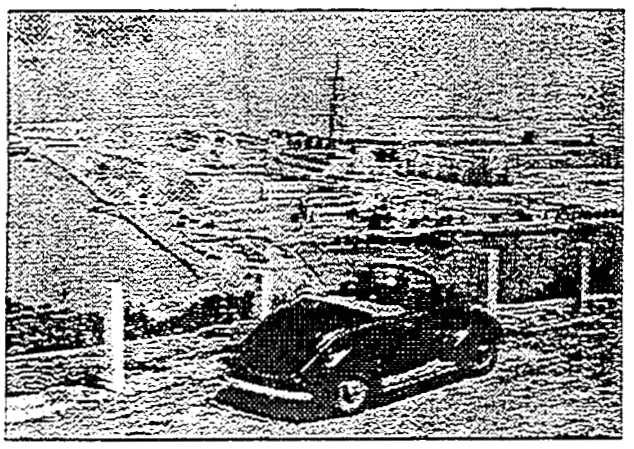


Figure 27
Illustrative Plan – Clipper Cove

Clipper Cove

This sheltered bay creates a watery plaza and open space that brings together Yerba Buena Island and Treasure Island and heightens the sense of contrast between the two. Clipper Cove is a unique resource in the bay, because it creates a protected water area that can become a destination for visiting recreational vessels and it provides a place for the mooring of ferries, water taxis, and other forms of waterborne transportation as well. As publicly oriented recreational, cultural and entertainment attractions are developed at both Treasure Island and Yerba Buena Island, it will



View of 1939 World's Fair from Yerba Buena Island

be important to consider the opportunity of Clipper Cove as a stage and focus of these activities. It is envisioned that the types of activities that could occur would be water shows, nighttime fireworks displays, small craft recreational boating, and promenading along a continuous edge extending from Pier 1 to the beach at the foot of Clipper Cove.

- **Reinforce the role of Clipper Cove as the focus of water-oriented recreational activity.** A wide range of recreational activities would be encouraged at Clipper Cove, expanding the opportunity to experience the bay for residents and visitors. These activities are envisioned as physical—relating to the potential for boating, swimming and fishing—as well as visual in nature—relating to the use of the sheltered waters of the cove both as a stage for certain activities as well as a place to view both islands simultaneously.

- **Provide for the continuity of publicly accessible shoreline, extending from Pier 1 to the beach at Yerba Buena Island.** Although steep slopes at Yerba Buena Island would limit the completion of a walkway around the entire cove, a large extent of shoreline can be made more accessible through the development of a walkway from Pier 1 past the marina to the beach and picnic grounds at Yerba Buena Island. This shoreline pathway should be a minimum of eight feet in width, with passable overlooks along the water's edge wherever feasible. On Treasure Island, the walkway may be somewhat elevated above grade; to provide a greater visual connection to the water and along the causeway, the walkway should be at a lower elevation.

- **Reorient buildings and uses at Treasure Island toward Clipper Cove.** During the Golden Gate Exposition, Clipper Cove was a focus of activity. Treasure Gardens occupied the land between Buildings 1 and 2, creating an opening to the water and a terminus to a long axis extending north. Clipper Cove served as a part of the stage set during this time, and

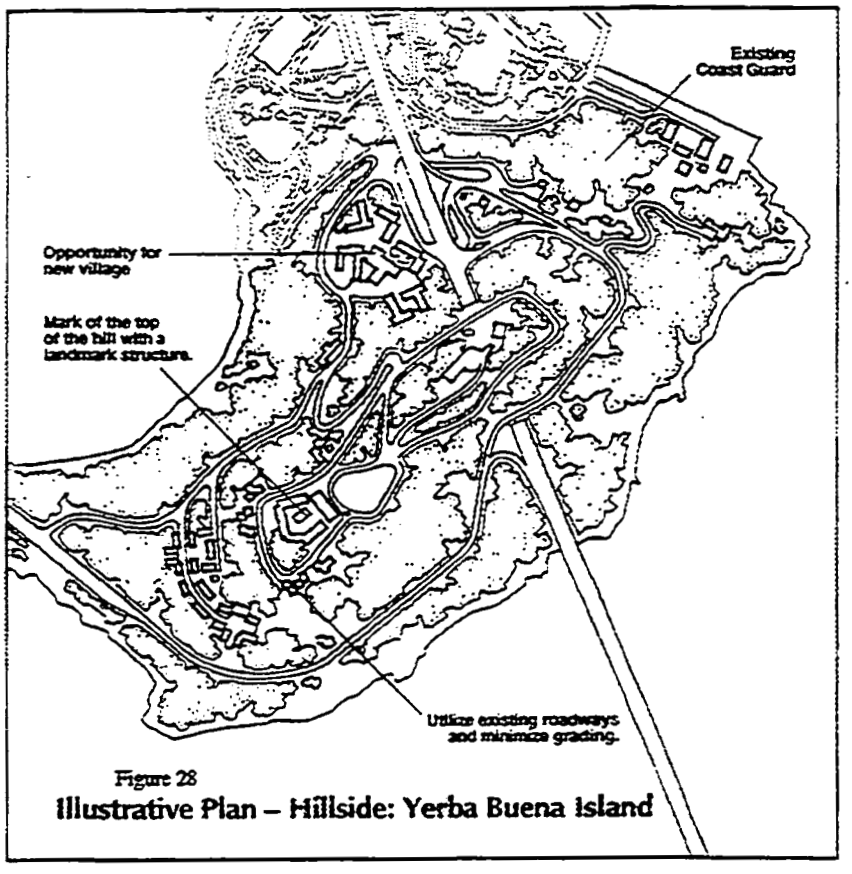


Figure 28
Illustrative Plan – Hillside: Yerba Buena Island

it was envisioned as a place of embarkation for the clippers during its design as an airport. Today, however, the cove is disconnected from surrounding activities, and the space along the shoreline is used for parking and storage. If existing buildings are demolished in this area and new ones are built, they should front on Clipper Cove and establish publicly oriented activities that complement those along the shoreline.

- **Build on the historic character of this area.** The buildings which remain within this district are among the oldest on Treasure Island, and they include Buildings 1, 2 and 3, which predate the Golden Gate International Exposition. Although they are all of historic significance, the economic feasibility and constructability of adaptive reuse need to be considered in light of the unique geologic conditions of the island. The historic qualities of this area, the reuse of buildings, and the display of statuary should be emphasized.

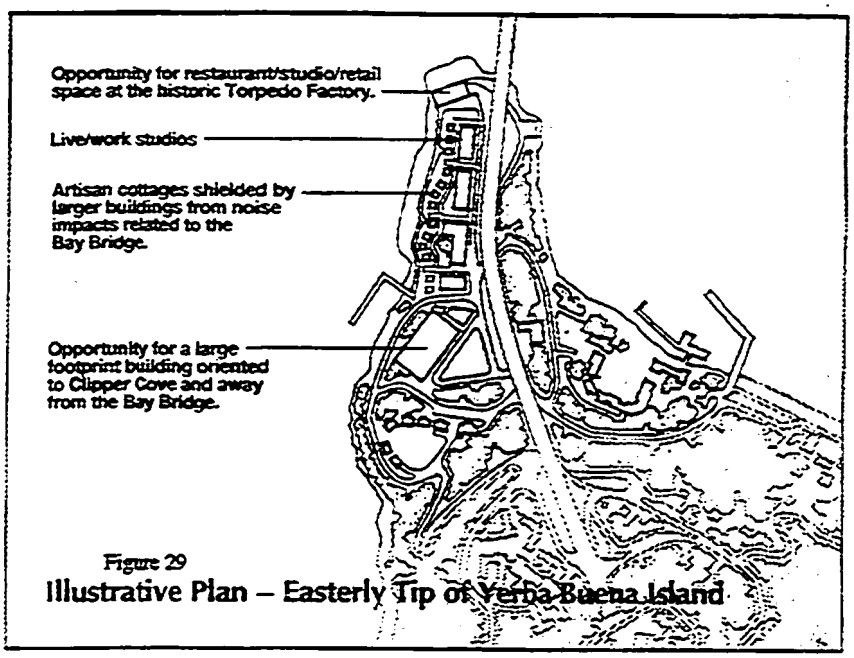


Figure 29
Illustrative Plan – Easterly Tip of Yerba Buena Island

- **Emphasize the role of the area as a gateway.** On Treasure Island, this area at the foot of the causeway and adjacent to ferry terminals can become a major gateway. Open spaces that create a proper entryway to the island should be encouraged on the west, and are required on the eastern side of the island. Specifically, as auto access to the island is replaced by ferry and the need for parking is reduced, the parking in front of Building 1 should be removed and replaced with a grassy lawn with areas for the possible display of statuary, including the statues and sculptural fountain which remain from the 1939 Exposition.

Hillside at Yerba Buena Island

Yerba Buena Island, in contrast to Treasure Island, is dominated by steep and vegetated hillsides rising high above the bay. The guidelines are aimed at building on the landscape tradition of Yerba Buena and protecting the hillsides from extensive grading, as follows:

- **Limit the extent of grading in hillside areas to the minimum necessary.** Most of Yerba Buena Island is very steep, with slopes over 20 percent. While new roads will be

limited, development in the hillside areas will likely require some grading in order to accommodate buildings and parking. Leveling the slope beyond the footprint of the building should be limited, and wide step terracing of the landscape for building pads should be prohibited. Contour grading that works with the existing slope of the terrain and the eccentricities of the topography should be encouraged.

- **Limit the construction of new roads.** The development of roads in hillside areas often contributes most to the need for grading. At Yerba Buena Island, new development should be focused in areas along existing or slightly reconfigured roads. New roads should be extended where necessary to create better access and circulation and create through connections by completing looped street patterns.

- **Encourage the construction of stepped or terraced building forms that adapt to the slope.** Buildings in hillside areas should be in the best tradition of those built throughout San Francisco. They should step up or down in the direction of the slope, rather than emphasizing a horizontal, high-volume appearance that would visually contrast with the hillside.

- **Encourage the replacement of the eucalyptus trees with native and/or drought-tolerant trees.** Like many other hillside landscapes, eucalyptus trees dominate large parts of Yerba Buena Island. While they contribute to the attractive appearance of the island as a green landscaped setting, at the same time, they are a fire hazard and are of little habitat value for wildlife. As development proceeds at Yerba Buena Island, the removal of the eucalyptus trees, except along Macalla Road and certain other streets, should be encouraged along with their subsequent replacement with native and/or drought-tolerant trees. For each tree removed to accommodate new development, two trees should be planted to replace it.

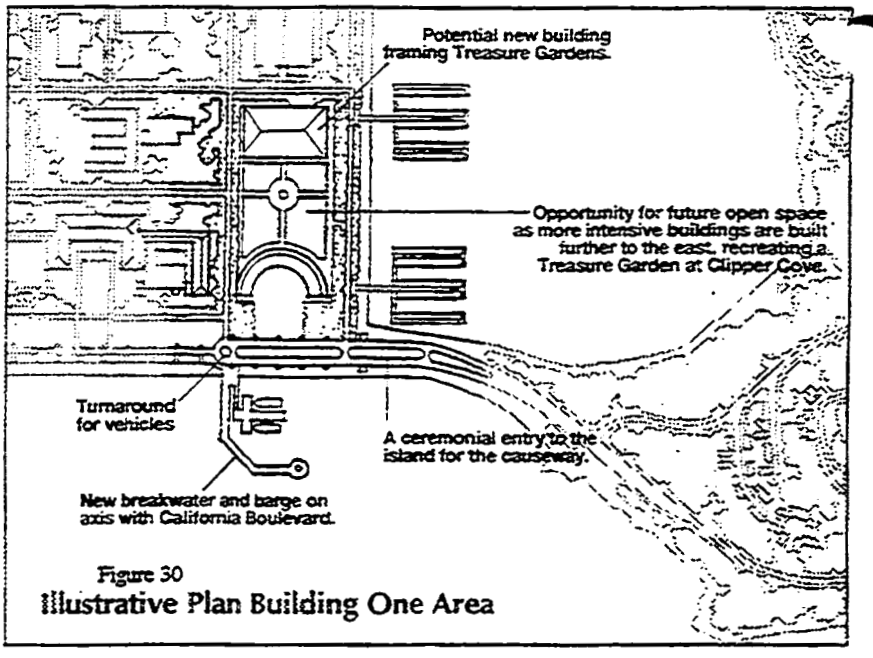


Figure 30
Illustrative Plan Building One Area

Cityside

This portion of Treasure Island extends from Building 1 to Ninth Street along the Avenue of the Palms, with spectacular views to the city and bay. It is integral to the island's image, especially when viewed from San Francisco. Therefore, it is important that design guidelines include:

- **An expansion of the shoreline open space to create a gracious threshold to the west.** A broad shoreline promenade is suggested in this area to expand public orientation and the opportunities for recreation and water-oriented leisure activities. This open space would emulate many of the qualities of the Marina Green, and is envisioned as a flat grassy lawn approximately 300 feet in width (including the shoreline esplanade) that could be used as a public gathering space, taking advantage of views to San Francisco and the Golden Gate Bridge. Smaller buildings and structures would be allowed within this space to generate activity (somewhat akin to the Tavern on the Green in Central Park) and to add to the range of recreational and open space experiences.

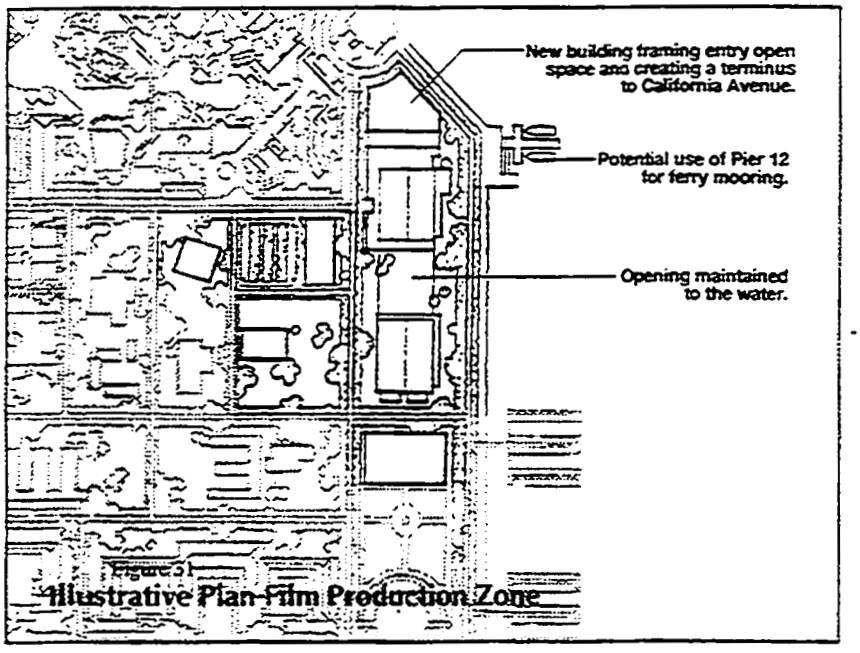


Figure 31
Illustrative Plan-Film Production Zone

- **Encouragement of the design of buildings which orient public uses to the bay and which, in form, respond to the views and sense of access with the water's edge.** In a similar fashion to Building 1, new development should be stepped in terraces and should orient public activities along the new green or commons at the bay. Buildings should be light in color, and should create a strong "front" and edge to the water.

East Bayside

The eastern waterfront at Treasure Island is quite different from the cityside. It has less of a sense of immediacy and connection with the urban environment than the western waterfront, with distant views to Oakland and Berkeley. In addition, this portion of the site is currently occupied by a number of institutional uses and facilities, including the Fire Training School, the Brig, and the Sewage Treatment Plant, which are located immediately adjacent to the shoreline. If these facilities are to remain in the future, issues of adjacency and compatibility will arise. In addition, alternative approaches to the stabilization of the shoreline which require a more narrow width than 100 feet may be needed to accommodate improvements without disrupting existing facilities. Specific guidelines in this area would include:

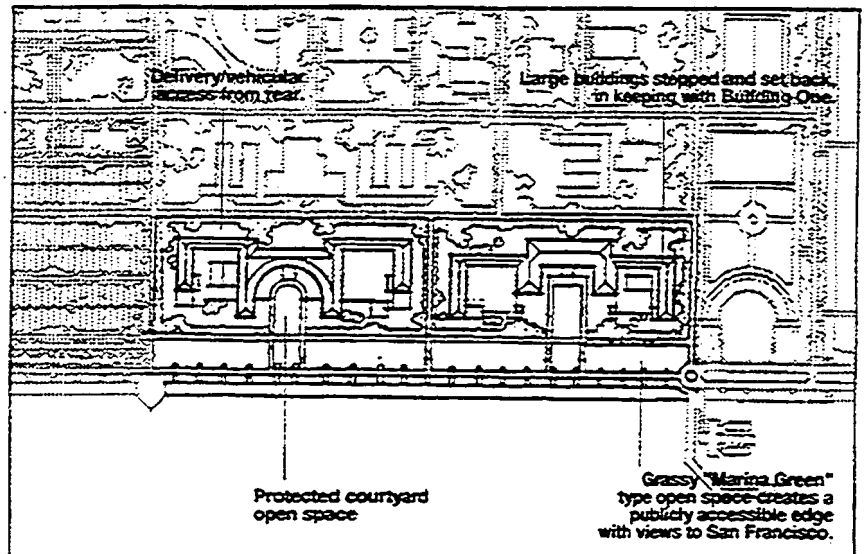


Figure 32
Illustrative Plan Hotel/Retail Complex

- **Establish a buffer between the Brig and Fire Training School and new uses on the island.** Between the Brig and Fire Training School is a parcel of land available for new uses, which could continue to be institutional in character, or which could take better advantage of the setting and link publicly oriented uses to the water (see Land Use chapter). In either case, a landscape buffer should be implemented on both sides of these uses to visually screen the adjacent uses and to focus on the shoreline and the bay. This buffer should be a minimum of 15 feet in width, and should be planted with tall trees that frame views to the east and to the water.

- **Create new openings to the water.** Given the fact that the shoreline edge in this area is currently occupied by buildings, it would be important in this area to create new openings and reestablish a stronger connection from the interior of the island to the water. As discussed above, the parcel between the Fire Training School and the Brig could be a suitable candidate for opening this area to the water, perhaps through the extension of recreation and sports activities to the water. Another appropriate location may be at the site of the existing Sewage Treatment Plant when it is demolished and a new plant is built more centrally within the island. In these areas, the predominant (greater than 60 percent) portion of the land

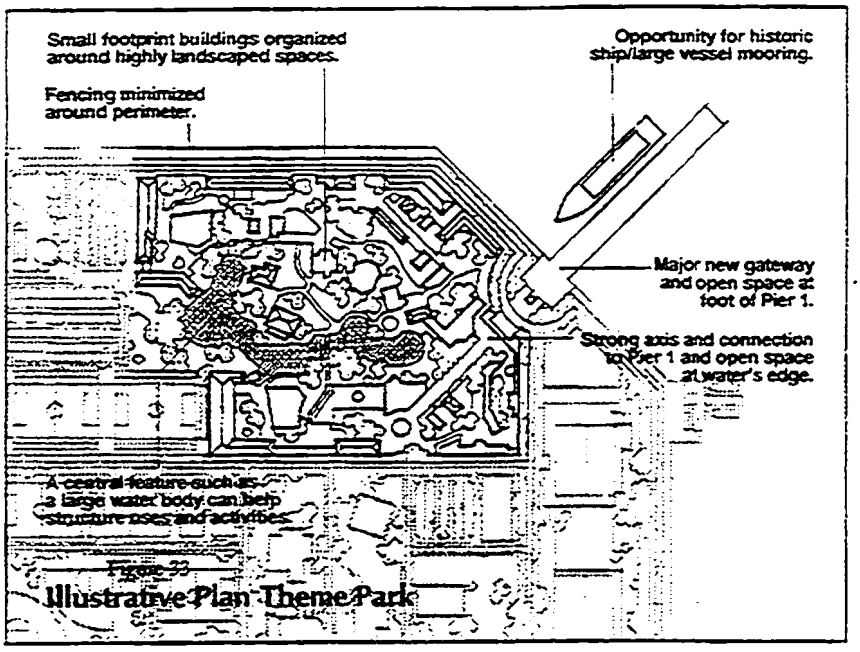


Figure 33
Illustrative Plan Theme Park

should not be built upon, and consideration should be given to the design of visual connections to the bay.

- **Design a state-of-the-art Wastewater Treatment Plant that minimizes noise and odors, and fits within a highly visible location on the shoreline.** The Reuse Plan recommends that the new Wastewater Treatment Plant be sited more centrally on the island, probably along the shoreline but closer to Ninth Street. This new facility will be adjacent to publicly oriented uses (both sports and entertainment-oriented) and will need to be designed to minimize its intrusiveness into a highly public and visible setting. San Francisco has a tradition of building state-of-the-art wastewater facilities, and it is in the best spirit of this tradition that the new one should be constructed at Treasure Island. The new facility should minimize noise and odors, and be compact and well landscaped.

Island Core

Since Treasure Island is extremely flat, the core of the island appears to be isolated from the water's edge and from the sense of being in the bay. During the Golden Gate Exposition, a strong pattern was overlain on this part of the island, and a number of

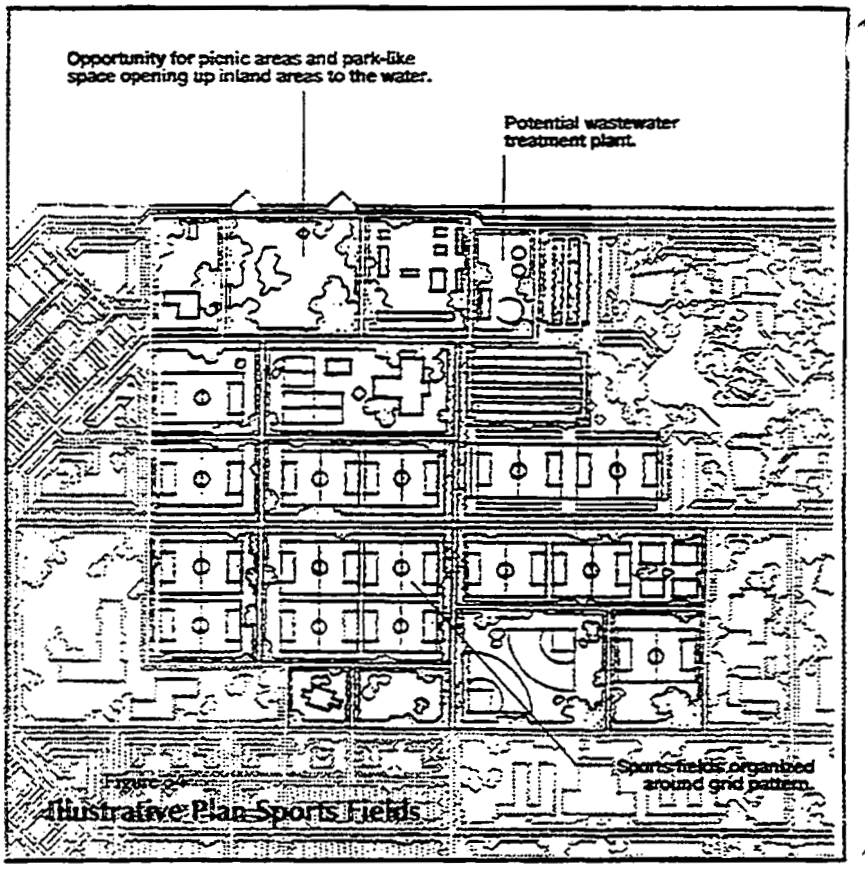


Figure 6
Illustrative Plan Sports Fields

amenities were used, such as lakes, fountains and towers, that created an internal focus and organization for activities. In the future, much of the land in the core will be devoted to institutional uses—primarily the Job Corps—and therefore, recreating the bold pattern of the 1939 fair is not likely to be possible. At the same time, with strong recreational and entertainment themes planned for this area, a number of improvements could be made. Guidelines for this area include:

- **Encourage a system of amenities and focal points internal to the island.** Recreational areas, amusement and theme parks all rely upon the treatment of outdoor spaces for image making and to create attractive settings for activities. In keeping with the planned uses, a system of amenities should be considered, including the possibility for lakes, fountains, well-landscaped open spaces, natural areas for wetlands, sculptures and fanciful monuments.

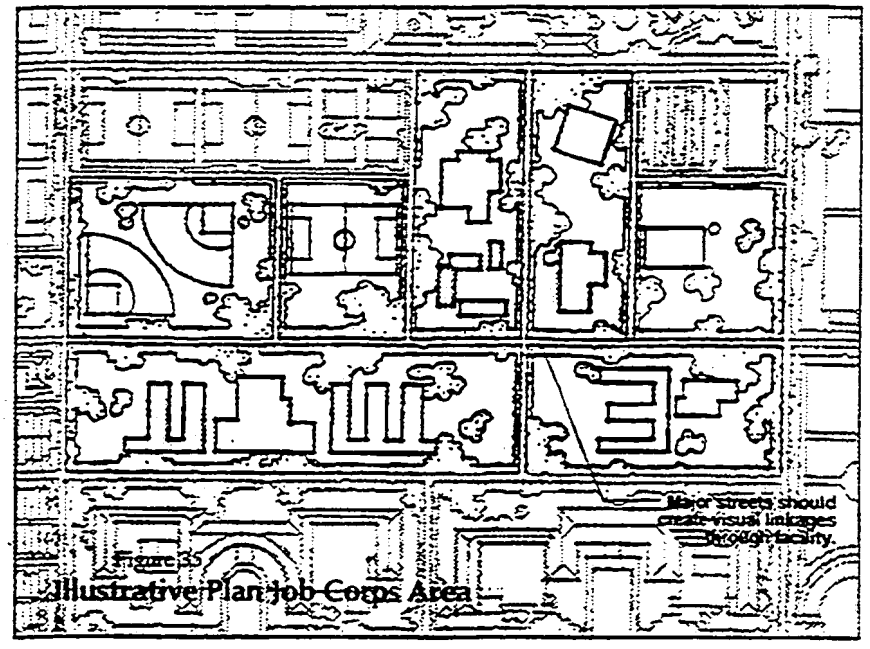


Figure 35
Illustrative Plan Job Corps Area

- **Maintain visual corridors and connections between uses and to the bay.** In this area, it will be important that uses are not isolated from one another and from the water. To the extent feasible, through connections to the water should be maintained in order to avoid creating the sense of a series of isolated and unrelated facilities on the island.

Northwesterly Area

The northwesterly area is comprised of land that developed at a much later date than other portions of Treasure Island. During the 1939 fair, much of this portion of the island was used for parking (car ferries brought autos to this location), and later the area was used for munitions storage. In the 1960s, this part of the island was developed for residential use, and a curvilinear street pattern was introduced. The issues in this area which are addressed by guidelines focus on linking it more effectively with other areas of the island and introducing new features that provide a sense of place and community.

- **Extend the grid pattern into this area.** Currently, this portion of the island is organized around a series of looped roadways that tend to separate it from surrounding areas and

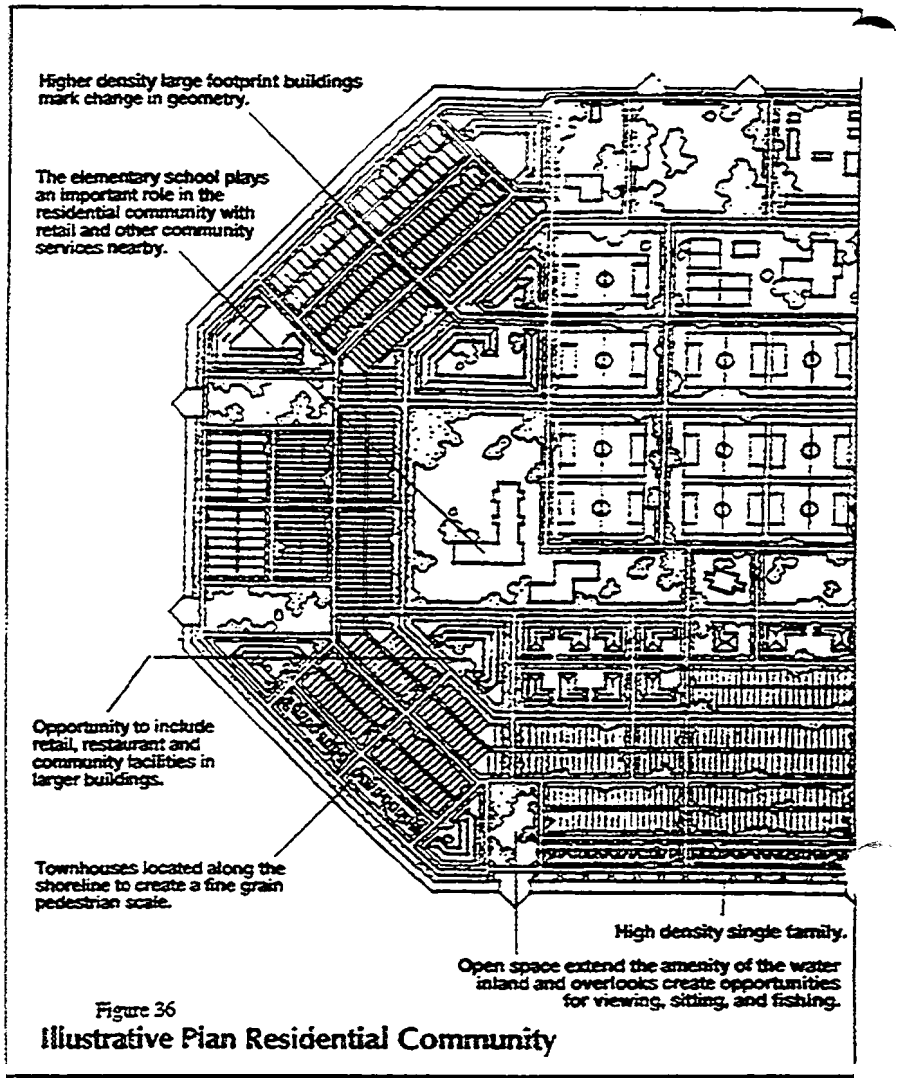


Figure 36
Illustrative Plan Residential Community

reduce the visibility of the shoreline edge. As the area is rebuilt, emphasis should be placed on the extension of the grid pattern to open up this area to the water and create a stronger connection to adjacent uses.

- **Open up views from inland areas to the water.** As the area is redeveloped, openings to the water through open spaces should be created, to heighten the sense of the bay and increase its amenity value to inland areas. In particular, two key locations at the northernmost "prow" of the island should be emphasized by the possibility of locating two parks at the terminus of the new north-south roads.