Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, CA 92108-4310

FINAL

RADIOLOGICAL SURVEY WORK PLAN

August 22, 2006

RADIOLOGICAL SURVEY AT
IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT
ALAMEDA, CALIFORNIA

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CONTRACT NO. N62473-06-D-2201
CTO NO. 0008

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ALAMEDA POINT
ALAMEDA, CALIFORNIA

DCN: ECSD-RACIV-06-0406

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ABBREVIATIONS AND ACRONYMS

α	alpha
β	beta
γ	gamma
µR/hr	microroentgen per hour
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ATV	all-terrain vehicle
BCT	BRAC Cleanup Team
bgs	below ground surface
BRAC	Base Realignment and Closure
CAD	computer-assisted draft
Cal/EPA	California Environmental Protection Agency
CBR	California Bearing Ratio
CCS	California Coordinate System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
cm	centimeter
cm^2	square centimeter
cm^3	cubic centimeter
cpm	count per minute
CQC	Contractor Quality Control
CRL	Corporate Reference Library
CRM	count rate meter
CSO	Caretaker Site Office
DCE	dichloroethene
DCGL	derived concentration guideline level
DERP	Defense Environmental Restoration Program
DMP	dimethylphenol
DoD	Department of Defense
DON	Department of the Navy

ABBREVIATIONS AND ACRONYMS
(Continued)

DOT	Department of Transportation
dpm	disintegration per minute
DQO	data quality objective
DTSC	Department of Toxic Substances Control
E&E	Ecology and Environment
EHS	Environmental Health and Safety
EMI	electromagnetic instrument
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FCR	Field Change Request
FWENC	Foster Wheeler Environmental Corporation
GIS	Geographic Information System
GPR	ground-penetrating radar
HPGe	high-purity Germanium
IR	Installation Restoration
IRP	Installation Restoration Program
LARADS	Laser-assisted Ranging and Data System
L_C	critical level
L_D	detection limit
LLRW	low-level radioactive waste
m/s	meter per second
m^2	square meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Contaminant Level
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MDER	minimum detectable exposure rate
MEC	munitions and explosives of concern
min	minute
mm	millimeter

ABBREVIATIONS AND ACRONYMS
(Continued)

mR/hr	milliroentgen per hour
m/s	meter per second
N/A	not applicable
NAD	North American Datum
NaI	sodium iodide
NAS	Naval Air Station
NAVFAC SW	Naval Facilities Engineering Command, Southwest
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCR	Nonconformance Report
NGS	National Geodetic Survey
NGVD	National Geodetic Vertical Datum
NIST	National Institute of Standards and Technology
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NWRSA	National Wildlife Refuge System Administration Act
OEW	ordnance and explosives waste
OSHA	Occupational Safety and Health Administration
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/g	picocurie per gram
PESM	Project Environmental Safety manager
PHP	Project Health Physicist
PIC	pressurized ion chamber
PjM	Project Manager
PPE	personal protective equipment
PQCM	Project Quality Control Manager
PRC	PRC Environmental Management, Inc.
PRG	Preliminary Remediation Goal
QA	quality assurance
QC	quality control

ABBREVIATIONS AND ACRONYMS
(Continued)

^{226}Ra	radium 226
RAB	Restoration Advisory Board
RAC	Remedial Action Contract
RASO	Radiological Affairs Support Office
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RI	Remedial Investigation
ROICC	Resident Officer in Charge of Construction
RPM	Remedial Project Manager
RTS	Radiological Task Supervisor
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
Shaw	Shaw Environmental & Infrastructure, Inc.
SHSP	Site-specific Health and Safety Plan
SHSS	Site Health and Safety Specialist
SOP	Standard Operating Procedure
^{90}Sr	strontium-90
SSPORTS	Supervisor of Shipbuilding, Conversion and Repair, Portsmouth
SVOC	semivolatile organic compound
TLD	thermoluminescence dosimeter
TPH	total petroleum hydrocarbons
TtEC	Tetra Tech EC, Inc.
TtEMI	Tetra Tech EM, Inc.
TtFW	Tetra Tech FW, Inc.
UFGS	Unified Facilities Guide Specification
USACE	United States Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
UXO	Unexploded Ordnance
VOC	volatile organic compound

EXECUTIVE SUMMARY

This Radiological Survey Work Plan has been prepared to describe the specific activities pertaining to the radiological survey that is scheduled to be performed at Installation Restoration (IR) Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack area located at Alameda Point, Alameda, California. The radiological survey of IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack in IR Site 2 will be conducted to characterize radioactive contamination, if present, and will be used to evaluate potential remedial alternatives. Radium-226 (Ra^{226}) is the primary radionuclide of concern at IR Sites 1, 2 and 32.

IR Sites 1 and 32 are located in the northwest corner of Alameda Point, while IR Site 2 is located in the southwest corner. IR Site 1 was operated between 1943 and 1956 as the former Naval Air Station (NAS) Alameda's main site for waste disposal. IR Site 2 was used as a disposal area for Alameda Point from approximately 1952 through 1978. IR Site 32 was historically used for ordnance storage. An open space area in the eastern portion of IR Site 32 was used for equipment, vehicle, and aircraft storage.

Preliminary radiological surveys were completed at IR Sites 1 and 2 in September 1995. In June 1996, a second preliminary radiological survey was conducted at a different area within IR Site 1. IR Site 2. Based on results from the preliminary surveys, the Supervisor of Shipbuilding, Conversion and Repair, Portsmouth (SSPORTS) Environmental Detachment conducted a more comprehensive radiological survey at IR Sites 1 and 2 in 1998 and 1999. The results of these surveys showed that ^{226}Ra was present at IR Sites 1 and 2 in soils at levels above background.

In 2004, Tetra Tech EC, Inc. (TtEC) conducted a radiological characterization survey at IR Sites 1 and 2. The primary objective of the survey was to characterize the potential ^{226}Ra contamination that may be present. The survey included a 100 percent surface scan using 2-inch by 2-inch sodium iodide (NaI) detectors, as well as fixed gamma and exposure rate surveys, gamma energy analysis with a portable high-purity Germanium (HPGe) system, and soil sampling. However, due to accessibility issues, neither the shorelines of IR Site 1 and 2 nor the former Radiological Shack area located within IR Site 2 were surveyed. During the radiological survey of IR Site 1, an elevated radiological reading was identified on the eastern boundary, which borders IR Site 32.

A radiological characterization survey will be conducted at IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack area using guidance from the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (Department of Defense [DoD] et al., 2000). The background soil concentration of ^{226}Ra (0.365 picocurie per gram [pCi/g]) was determined during the IR Sites 1 and 2 land area survey performed in 2004 (Tetra Tech FW, Inc.

[TtFW], 2005a; TtFW, 2005b). This concentration will be used to determine if ^{226}Ra is present in soil samples at concentrations greater than 3 sigma above background (0.559 pCi/g). Locations where activity has been determined to be above this level shall be marked for possible further investigation. This Radiological Survey Work Plan provides detailed descriptions of the proposed survey including pre-survey, survey, and post-survey activities. Project-specific plans will be referenced, as appropriate, to provide further detailed support to the Radiological Survey Work Plan and are included as appendices. These plans include the Site-specific Health and Safety Plan (SHSP), Sampling and Analysis Plan (SAP), Project Contractor Quality (CQC) Plan, Standard Operating Procedures (SOPs), Scope of Work, and Survey Instrumentation Information prepared for the work activities.

Pre-survey activities will include an environmental resource survey and vegetation clearance activities. Additional pre-survey activities will include finalization of the Work Plans, pre-mobilization conferences, subcontracting, and procurement. Site work will initiate upon completion of the pre-survey site activities. Survey activities include site mobilization and preparation, background instrument readings, radiological survey, dosimetry study, soil sampling, and demobilization. Survey activities are estimated to begin in July 2006 and finish in September 2006.

Radiological levels will be determined for both surface activity and Ra^{226} soil concentrations at biased locations within IR Sites 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack area. Static background measurements will be obtained to verify the background count rate for the NaI detectors and Micro-REM meter used in the radiological survey.

A Laser-assisted Ranging and Data System (LARADS) will be the primary field survey system used for the land area survey. The LARADS collects and stores the positional coordinates and radiological readings on a point-per-second basis in electronic files. These field files are then downloaded and processed with Geographic Information System (GIS) software to produce both a color-coded contour map (based on radiological reading) and a map of the survey trace overlain upon a computer-assisted draft (CAD) base map or digital photograph of the site or area.

For those areas along the shoreline where towed or hand-held LARADS surveys cannot be performed, static 10-second surveys will be performed on 10-foot centers using an articulating man lift and a NaI detector attached to a retractable line. In addition, pressurized ion chamber measurements will be collected in IR Site 32 (10-minute at 10-foot centers) and the shorelines of IR Sites 1, 2 and 32 (1-hour at 50-foot intervals).

An environmental dosimetry study will be conducted to determine if there is any measurable difference between exposure rate along the shorelines of IR Sites 1, 2 and 32 and background.

Thermoluminescence dosimeters will be placed every 50 feet along the shorelines for a period of 3 months.

After reviewing the survey data, up to 15 soil samples at biased locations will be collected and analyzed for gamma spectroscopy. Five of these samples will also be analyzed for strontium-90. Soil samples will be collected from zero to 20 inches below ground surface using a hand-auger. In addition, gamma energy analysis using a portable HPGe system will be performed to characterize select subsurface point sources and to quantify the Ra^{226} concentration in collected soil samples.

Post-construction activities involve preparing a Radiological Survey Report to provide a record of activities conducted during the project and to provide radiological characterization data that will be used to evaluate potential remedial alternatives.

1.0 INTRODUCTION

This Radiological Survey Work Plan describes the specific activities pertaining to the radiological survey that is scheduled to be performed at Installation Restoration (IR) Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack in IR Site 2 located at Alameda Point, Alameda, California (Figure 1-1). The Naval Facilities Engineering Command, Southwest (NAVFAC SW) has authorized Tetra Tech EC, Inc. (TtEC) to perform the subject radiological survey under Contract Task Order No. 0008 through the contracting mechanism of NAVFAC SW, Remedial Action Contract (RAC) IV No. N64273-06-D-2201. Regulatory oversight and guidance for the survey will be provided by the U.S. Environmental Protection Agency (EPA), the California Environmental Protection Agency (Cal/EPA), Department of Toxic Substances Control (DTSC), and the Radiological Affairs Support Office (RASO). In addition, the United States Fish and Wildlife Service (USFWS) will provide guidance with regards to sensitive species.

IR Sites 1 and 32 are located in the northwest corner of Alameda Point, while IR Site 2 is located in the southwest corner (Figure 1-1). IR Site 1 was operated between 1943 and 1956 as the former Naval Air Station (NAS) Alameda's main site for waste disposal. IR Site 2 was used as a disposal area for Alameda Point from approximately 1952 through 1978. IR Site 32 was historically used for ordnance storage. An open space area in the eastern portion of IR Site 32 was used for equipment, vehicle, and aircraft storage.

In 2004, TtEC conducted a radiological characterization survey at IR Sites 1 and 2. The primary objective of the survey was to characterize the potential radium-226 (^{226}Ra) contamination that may be present. The survey included a 100 percent surface scan using 2-inch by 2-inch sodium iodide (NaI) detectors, as well as fixed gamma and exposure rate surveys, gamma energy analysis with a portable high-purity Germanium (HPGe) system, and soil sampling. However, due to accessibility issues, neither the shorelines of IR Sites 1 and 2 nor the former Radiological Shack area located within IR Site 2 were surveyed. During the radiological survey of IR Site 1, an elevated radiological reading was identified on the eastern boundary, which borders IR Site 32. This Radiological Survey Work Plan discusses the requirements and provides the procedures for conducting a near 100 percent surface scan of IR Site 32 (excluding the concrete runways and locations of permanent facility structures), the shorelines of IR Sites 1 and 2, and the former Radiological Shack in IR Site 2.

1.1 SCOPE OF WORK

A radiological survey of IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack in IR Site 2 will be conducted to characterize the contamination, if present, and will be used to evaluate potential remedial alternatives. Figure 1-2 identifies the areas to be

surveyed. This Radiological Survey Work Plan includes the procedures for the radiological survey and soil sampling. A Site-specific Health and Safety Plan (SHSP), Sampling and Analysis Plan (SAP), Project Contractor Quality Control (CQC) Plan, and Standard Operating Procedures (SOPs) are included as Appendices A through D and provide additional details of the work to be performed. Work will be conducted using guidance from the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (Department of Defense [DoD] et al., 2000). MARSSIM provides processes and procedures for survey and sample collection using data quality objectives (DQOs), quality assurance/quality control (QA/QC) and data quality assurance guidelines. The scope of the radiological survey at IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack at IR Site 2 consists of the following work elements:

- Radiological Survey Work Plan and Vegetation Clearance Plan preparation
- Mobilization
- Background instrument readings
- Environmental resource survey
- Vegetation clearance
- Near 100 percent radiological scan survey (except in concrete runway areas or where there are permanent facility structures) of IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack in IR Site 2
- Subsurface soil sampling and gamma energy analysis for discrete survey areas
- Dosimetry study at IR Sites 1, 2 and 32
- Demobilization
- Radiological Survey Report preparation

These work elements are based on the scope of work provided by the Department of the Navy (DON) on January 16, 2006 (Appendix E). Prior to the radiological survey being performed, all vegetation is required to be cleared. A Draft Vegetation Clearance Plan (TtEC, 2006a) has been prepared and submitted as a separate document.

1.2 WORK PLAN ORGANIZATION

The Radiological Survey Work Plan has been structured to provide details on the major aspects of the radiological survey. The Radiological Survey Work Plan has been organized into 17 sections and eight appendices (Appendices A through H). Section 1.0 provides an introduction and defines the scope of work. Section 2.0 discusses the background and past operational history of the site; the physical, chemical, and radiological characteristics of the site; and a brief discussion of the results of previous surveys and removal actions. The regulatory framework and the applicable, relevant, and appropriate requirements (ARARs) are presented in Section 3.0. Project and personnel requirements, including training, inspection, and audit

requirements, are identified in Section 4.0. Section 5.0 provides the survey plan and design and discusses the survey objectives, survey area, instrumentation, release criteria and investigation levels. Mobilization activities are discussed in Section 6.0. A description of all radiological survey activities is detailed in Section 7.0. The control practices to be used during the radiological survey are summarized in Section 8.0. Section 9.0 describes the demobilization and decontamination procedures. Waste management procedures are provided in Section 10.0. Section 11.0 identifies the environmental protection requirements and includes a discussion of the pre-survey site conditions, vegetation clearance activities, existing natural resources and endangered species, specific site protection requirements, and spill prevention procedures. Section 12.0 describes project management and identifies key project personnel from the DON, regulatory agencies, and TtEC. A project schedule and miscellaneous management functions are also presented. Section 13.0 summarizes the QA program and identifies data quality, document control and audit requirements. Community relation activities, including public information and participation, are discussed in Section 14.0. Section 15.0 presents data review requirements. A survey summary and conclusions are provided in Section 16.0. References are included in Section 17.0.

The following appendices are included to provide additional details regarding the radiological survey and sampling activities:

- Appendix A, SHSP
- Appendix B, SAP
- Appendix C, Project CQC Plan
- Appendix D, SOPs
- Appendix E, Scope of Work
- Appendix F, Survey Instrument Information
- Appendix G, Pre-survey Photographs
- Appendix H, Glossary

2.0 SITE CONDITIONS AND BACKGROUND

Several investigations have been performed to assess the physical and environmental conditions at IR Sites 1, 2 and 32. Background information pertinent to the radiological survey includes the site-specific features, history of land usage, site geology and hydrogeology, and previous investigations describing the chemical and radiological characteristics of the site.

2.1 SITE DESCRIPTION AND HISTORY

Alameda Point is located on the western end of Alameda Island, which lies on the eastern side of San Francisco Bay, adjacent to the city of Oakland. Alameda Point is rectangular in shape, approximately 2 miles long east-to-west, 1 mile wide north-to-south, and was occupied by the 1,734-acre former NAS Alameda until its closure in 1997. IR Sites 1 and 32 are located at the northwestern corner, while IR Site 2 is located at the southwest corner of Alameda Point, Alameda, California.

2.1.1 Site Description

IR Site 1

IR Site 1 encompasses approximately 78 acres. San Francisco Bay borders the site to the north and west. IR Site 2, which consists of a former disposal area and wetlands, and Runway 7 are located to the south, and the remaining section of Runway 13 and a former sewage pump station are located east of the site.

IR Site 1 is relatively flat with slight depressions that sometimes flood during the winter rains. Shoreline slopes exist on the northern and western boundary and are currently stabilized by large boulders (riprap). The site was previously used as a waste disposal site and consisted of several disposal areas. An earthen berm (dike) 10 to 15 feet high is located adjacent to the shoreline near the former small arms range area. There are several paved roads that run through the site. Public access to IR Site 1 is currently restricted and a chain-linked fence west of Runway 13 restricts access to the main portion of the site. A site detail map of IR Site 1 is provided as Figure 2-1.

IR Site 2

IR Site 2 encompasses approximately 110 acres and is bordered by San Francisco Bay to the south and west. The disposal area at IR Site 2 covers approximately 77 acres in the most southwestern portion of Alameda Point. A wetland covers approximately 30 acres and is bounded by the disposal area to the north and east and by the coastal margin adjacent to San Francisco Bay on the south and west. The former Radiological Shack is located on the west side of the northern boundary.

The thin strip of land between the disposal area or wetland and the bay is referred to as the coastal margin. It acts as a buffer for the disposal area and the wetland and is composed of the perimeter dike and riprap seawall. Subsurface materials in the coastal margin differ from those in the disposal area and wetland. A site detail map of IR Site 2 is provided as Figure 2-2.

IR Site 32

IR Site 32 is approximately 5.8 acres in size and includes three environmental baseline survey subparcels (Subparcels 8A, 5E, and a portion of 5D). The site was previously referred to as the Northwestern Ordnance Storage Area. Recently, the DON expanded the boundaries of IR Site 32 north to the Oakland Inner Harbor by annexing the northern portion of Subparcel 5D.

Most of IR Site 32 is open space covered with asphalt, gravel, weeds and brush. Structures on the site include two buildings: Building 594, the Physical Section Reaction Force Facility, and Building 82, a guard shack. A site detail map of IR Site 32 is provided as Figure 2-1.

2.2 SITE HISTORY

IR Site 1

IR Site 1 was mainly used for waste disposal at former NAS Alameda from 1943 to 1956. Prior to 1940, early maps show that the disposal area at IR Site 1 was underwater (San Francisco Bay) at a depth of approximately 20 feet along the current western shoreline of the site. This area was reclaimed by dredging operations, which involved the placement of sunken barges and pontoons on the western edge of the disposal area and clay and silt sediments in the disposal area. These operations are visible in aerial photographs taken in the 1940s. A jetty was later transformed into a seawall protecting the harbor entrance, which is now the northern edge of the disposal area. New taxiways and runways were extended over the disposal area in the 1950s.

Information regarding the history of disposal area contents is limited. The primary method used by NAS Public Works to dispose of wastes was to bulldoze trenches to the water table, fill them with waste, and then compact the surface. In the early years of operation, the waste was simply pushed into the water. There are no records of placement of any liners in the disposal area. Soil cover material was applied to the disposal area in later years.

Accurate estimates of the types and amounts of wastes deposited at IR Site 1 over the years are not available, but are believed to be approximately 15,000 to 200,000 tons of assorted refuse and debris, including scrap metal, waste oil, aircraft engines, low-level radioactive wastes (LLRW) (mainly ^{226}Ra from the rework of dials and gauges), solvents, paint wastes, cleaning compounds, creosote, waste medicines, reagents, asbestos, pesticides, mercury, and construction debris. Other naval installations, including Oak Knoll Naval Hospital, Naval Supply Center Oakland, and Treasure Island, also used the site for waste disposal.

IR Site 2

IR Site 2 was used as the main disposal area for Alameda Point from approximately 1952 through 1978. An estimated 1.6-million tons of waste were deposited (Ecology and Environment [E&E], 1983). The wastes included municipal solid waste, waste chemical drums (contents unknown), solvents, oily waste and sludge, paint waste, plating wastes, industrial strippers and cleaners, acids, mercury, polychlorinated biphenyl (PCB)-containing liquids, batteries, low-level radiological waste from radium dials and dial painting, scrap metal, inert ordnance, asbestos, several pesticides (solid and liquid), tear gas agent, biological waste from the Oak Knoll Naval Hospital, creosote, dredge spoils, and waste medicines and reagents (E&E, 1983). Ordnance and explosives waste (OEW) may have also been deposited in the 2.5-acre (approximate) Possible OEW Burial Site located in the southern part of the disposal area. A seawall was constructed along the southern and western edges of the site, and a 36-inch culvert was installed in the seawall to hydraulically connect San Francisco Bay to waters within the seawall. A substantial (10- to 15-foot) dike was installed around the perimeter of the site when disposal operations ceased.

IR Site 32

The historical use for IR Site 32 was ordnance storage. An open space area in the eastern portion of the site was used for equipment, vehicle, and aircraft storage. Two buildings are located within IR Site 32: Buildings 594 and 82. Building 594 contains dormitory rooms, a kitchen, and a security-monitoring panel and was previously used as a storage and repair shop for underwater weapons. Building 82 is a concrete guard shack. Buildings 594 and 82 were constructed in 1979. There are no documented releases of hazardous substances in either of these buildings.

In 1883, the South Coast Pacific Railroad constructed a rail causeway over 2 miles long that extended into San Francisco Bay from the northwest corner of Alameda Island (Bechtel, 2005). The former causeway crossed the northern portion of present-day IR Site 32 and consisted of railroad tracks built on a mud- and rubble-filled double-rock wall, with a rail yard and a passenger terminal built on a trestle at the end. A fire destroyed the original rail line in 1902; a second line was built parallel to the original rail path. Based on aerial photographs, it appears that all railroad tracks in the vicinity of and at IR Site 32 were removed by 1960; no surface evidence of the former railroad is visible at IR Site 32.

Fill activities at IR Site 32 began in 1919 and the area was completely filled by 1936. It is suspected that the fill material was dredge material from San Francisco Bay. Except for the Alameda Mole, the site had been entirely under water prior to 1919.

IR Site 32 was identified as an IR site after evaluation of data resulting from soil and groundwater sampling performed during previous investigations. A summary of these investigations is provided in Section 2.3.1.

2.3 PHYSICAL CHARACTERISTICS

Alameda Point is located on Alameda Island, at the base of a gently sloping plain that extends from the Berkley Hills on the east to the shore of the San Francisco Bay on the west. Alameda Island is a low-lying flat area composed partly of artificial fill and partly of tidal-flat marshy sediments. Originally, the island was a peninsula connected to land on the southeast, but dredging in the late 19th century and the early part of the 20th century deepened and extended the San Antonio Creek channel southeasterly to form the Oakland Inner Harbor, thus creating the island. The island was enlarged by extending it northwesterly with materials dredged from the surrounding San Francisco Bay and Oakland Inner Harbor. IR Sites 1, 2 and 32 are located entirely over this dredged material.

2.3.1 Geologic Setting

IR Sites 1, 2 and 32 at Alameda Point are located on Alameda Island on the eastern side of the central San Francisco Bay. The San Francisco Bay region is located within an elongated basin or valley that extends southeasterly to the Santa Clara Valley. San Francisco Bay and Santa Clara Valley are bounded by the Santa Cruz Mountains to the southwest and the East Bay Hills and Diablo Range to the northeast.

There are no known faults directly at or in the near vicinity of the subject sites. No earthquake fault zones (Alquist-Priolo Zones) have been designated at the sites. The nearest active fault is the Hayward Fault, which is about 6.5 miles east of the site. Another nearby active fault is the San Andreas Fault within the hills on the west side of San Francisco Bay at a distance of about 12 miles. Other major faults in the region include the Calaveras Fault system on the east side of the East Bay Hills and the Green Valley and Greenville Fault systems, which are located farther to the east.

Five Quaternary time (within the past two million years) sedimentary rock units have been identified as underlying IR Sites 1, 2 and 32. These sedimentary units record a sequence of fillings and evacuations of San Francisco Bay in response to global glacial/climate changes and local tectonics. The five rock units, from oldest to youngest, are the Alameda Formation, the Yerba Buena Mud, the San Antonio Formation, the Merritt Sand and the Young Bay Mud. These sedimentary units are overlain by artificial fill deposited by mechanical processes.

A brief geological description specific to each site is provided below.

IR Site 1

The artificial fill comprising most of IR Site 1 is composed of mixtures of sand, silt, and clay dredged from the surrounding bay and a rock dike to retain the fill in place. The fill ranges in thickness from about 10 to 30 feet. The fill is thinnest in the eastern part of the site. The varying thickness is a result of natural variation in the depth of the estuary before filling, which began in

the late 1800s. Throughout most of the site, the bottom of the fill is near sea level. The fill is predominantly a sandy silt similar to the Merritt Sand, which served as the primary source of the fill. The fill typically has abundant shell fragments and debris including gravel. As reported earlier, the fill area incorporates the 1943-1956 Disposal Area. Due to lack of sufficient waste disposal characterization information, the lateral and vertical extent of existing waste material in the fill is not well defined. Refuse was observed under a thin cover of fill in selected test pits during the geotechnical investigation (Foster Wheeler Environmental Corporation [FWENC], 2002a) and included items such as cables, plexi-glass, wire, asphalt, and miscellaneous wood, aluminum, and metal objects.

IR Site 2

The Young Bay Mud is thinnest in the eastern and southern parts of IR Site 2 and is thickest in the northern part of IR Site 2 where it appears to represent an ancient channel fill. In previous reports (Tetra Tech EM, Inc. (TtEMI), 1999], the Young Bay Mud unit was considered to consist of both the mud (clay, silty clay, clayey silt) and some of the underlying sands, and these were combined into a unit called Bay Sediments. Recent geotechnical investigations revealed that most of the sands underlying the upper soft mud are generally soft to moderately dense sands, silts, and clayey sands and these appear to also be Holocene-age bay deposits. Adopting the terminology from previous reports, these are Bay Sediments and range from about zero to 50 feet thick and also appear to represent an ancient channel. Both the Young Bay Mud and the Bay Sediments appear to pinch out to the south, where they may have been removed by dredging in the offshore area (Tetra Tech FW, Inc. [TtFW], 2004a).

The Merritt Sand shows indications of marine reworking during the most recent sea level rise. The unit has been entirely removed by erosion in the northern part of IR Site 2. The Merritt Sand is up to 25 feet in thickness in the south and pinches out toward the northern part of the site. The underlying Upper San Antonio Formation is also discontinuous at IR Site 2. Broad channels were eroded within the surface of the upper San Antonio Formation. It is present in the southern portion of the site, but absent through the erosional channeling to the north.

The fill encountered at most of the site is composed of mixtures of sand, silt, and clay dredged from the surrounding bay and a rock dike to retain the fill in place. The fill ranges in thickness from about 25 feet in the northwest to 45 feet in the southwest part of IR Site 2. The varying thickness is a result of natural variation in the depth of the estuary before filling, which began in the late 1800s. The lower Young Bay Mud and Merritt Sand served as primary sources of the fill. The fill typically has abundant shell fragments and debris including gravel. The strength of the fill varies widely because of the wide variety of materials it contains. The existing waste material in the fill is not well-defined due to lack of sufficient information on the waste disposal history at the site. Solid wastes deposited in the disposal area included dredge spoils, batteries, ordnance, radiological materials (instrument dials with radium paint), asbestos, scrap metal, and spent

sandblast abrasives. Liquid wastes placed in the disposal area include solvents, paints, plating bath sludge, waste oil, PCBs, pesticides, and medical wastes (TtEMI, 1999; E&E, 1983). Also, the existence of OEW at the site has been a major concern and a critical part of recent investigation and remediation activities.

IR Site 32

The fill material that comprises IR Site 32 is composed of mixtures including sand, silt, and clay dredged from the surrounding bay. A rock dike serves as the northernmost boundary of IR Site 32 adjacent to the Oakland Inner Harbor. The fill ranges in thickness from about 10 to 30 feet. The fill is thinnest in the eastern part of the site. Throughout most of the site, the bottom of the fill is near sea level. The fill is predominantly silty sand similar to the Merritt Sand, which served as the primary source of the fill. Due to lack of sufficient information on the waste disposal history at the site, the existing waste material in the fill is not well defined.

2.3.2 Hydrogeologic Setting

Two aquifer zones specific to remedial investigations have been identified beneath IR Sites 1, 2 and 32 by others (TtEMI, 1999). The first water bearing zone is unconfined and present in the artificial fill. Depth to water ranges from 2 to 8 feet below ground surface (bgs). The Young Bay Mud situated beneath the artificial fill acts as a semi-confining layer that separates the first water bearing zone from the second water bearing zone. The second water bearing zone is situated in the lower portion of the Young Bay Mud unit and top of the Merritt Sand and extends into the San Antonio Formation. The Yerba Buena Mud unit acts as an aquitard. Previous site investigations by others suggest that a vertical gradient between the first and second water bearing units is minimal.

Groundwater flow in the first water bearing zone is horizontal and flows radially from the center portion of Alameda Point toward Oakland Inner Harbor, San Francisco Bay and Seaplane Lagoon. In the vicinity of IR Sites 1 and 32, groundwater flow is generally west toward San Francisco Bay and north and northwest into the Oakland Inner Harbor. In the vicinity of IR Site 2, groundwater flow is generally west and south toward San Francisco Bay. The first water bearing zone is tidally influenced and seawater intrusion is a consequence of climatic variations. Investigators report that the first water bearing zone at the site is characterized by thin lenses of freshwater recharged by precipitation floating on brackish to saline water.

2.4 CHEMICAL AND RADIOLOGICAL CHARACTERISTICS

The nature and extent of the chemical and radiological contamination at IR Sites 1, 2 and 32 have been investigated and are detailed in various site investigation reports as mentioned above.

The following sections summarize the findings of the previous investigations but are not intended to provide the complete detailed history. Readers are directed to review the referenced reports for more detailed information. The information provided has been used to define the scope of the radiological survey proposed for the site. The results were also reviewed for the purpose of establishing the specific health and safety requirements in the SHSP (Appendix A) prepared for this work activity.

2.4.1 Chemical Characteristics

IR Site 1

Soil and groundwater chemical investigations were conducted at various locations on IR Site 1 in 1985, 1990, 1991, 1994, 1995, 1996, 1998, and 1999. Two documents (TtEMI, 1999; 2001) contain various information including geology, hydrogeology, background chemical concentrations, sample collection, soil and groundwater analyses, ARARs, and human health and ecological risk assessments.

Soil investigation activities showed that total petroleum hydrocarbons (TPH), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, PCBs, radionuclides, and metals are present in IR Site 1 soils. The most prominent chemicals are SVOCs of the polynuclear aromatic hydrocarbons (PAHs) class that were detected at several locations. Metals and radionuclides were also detected at various locations and depths. TPH, pesticides, and PCBs were detected in shallow soil samples. Although no apparent distribution pattern was identified for these chemicals, many of the highest concentrations were detected in samples collected at soil boring clusters along the western boundary near the shoreline extending from the "former burn area" to south of the pistol range (TtEMI, 1999).

Based on the IR Site 1 Remedial Investigation (RI) Report (TtEMI, 1999), the following chemicals in soil at IR Site 1 pose a human health cancer risk exceeding 1 in a million: chromium, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, indeno[1,2,3-cd]pyrene, and dibenzo[a,h]anthracene. According to site historical information, the disposal area was originally filled with dredge spoils from the bay before wastes were placed in the area. When the construction of Runways 13 and 7 began, spoils stockpiled during dredging operations were used again as fill. The origin of some of the detected chemicals is believed to be the hydraulic fill. However, because the highest chemical concentrations are at locations adjacent to the disposal area, the disposal activities are also likely to have contributed to the elevated chemical concentrations detected. The consistently elevated concentrations of soil borings located in the burn area suggest that refuse burning in the early 1950s contributed to both the SVOCs and metals detected.

Radiological groundwater data for eight rounds of sampling (June 2002 through April 2004) at IR Sites 1 and 2 were evaluated by Shaw Environmental & Infrastructure, Inc. (Shaw) to

determine whether the source of detected radiological activity is naturally occurring or attributable to activities at these sites. The data set for IR Site 1, which included 195 samples from 29 wells, was evaluated for anomalies and compared to Maximum Contaminant Levels (MCLs). Results were presented in a December 2004 memorandum (Shaw, 2004). The evaluation did not suggest any significant anomalies in the first water-bearing zone.

IR Site 2

Soil and groundwater chemical investigations have been conducted at various locations on IR Site 2. Based on historical information, contaminants detected in soil at IR Site 2 include volatile organic substances, TPH, SVOCs , PAHs, PCBs, and ^{226}Ra.

Metals, pesticides, and PCBs were detected in the sediments from ponds associated with the wetlands. Pesticides and PCBs were detected in soil above 1996 EPA Region 9 Preliminary Remediation Goals (PRGs). The presence of these constituents in soil, although not necessarily found in groundwater, identifies them as potential constituents of concern (Shaw, 2004).

According to site historical information, the disposal area was originally filled with dredge spoils from the bay before wastes were placed in the area. When the construction of Runways 13 and 7 began, spoils stockpiled during dredging operations were used again as fill. The origin of some of the detected chemicals is believed to be the hydraulic fill. However, because the highest chemical concentrations are at locations adjacent to the disposal areas, the disposal activities are also likely to have contributed to the elevated chemical concentrations detected.

Radiological groundwater data for eight rounds of sampling (June 2002 through April 2004) at IR Sites 1 and 2 were evaluated by Shaw to determine whether the source of detected radiological activity is natural or attributable to activities at these sites. The data set for IR Site 1, which included 195 samples from 29 wells, was evaluated for anomalies and compared to MCLs. Results were presented in a December 2004 memorandum (Shaw, 2004). The evaluation did not suggest any significant anomalies in the first water-bearing zone.

IR Site 32

IR Site 32 was identified as an IR site after the evaluation of data resulting from soil and groundwater sampling performed during previous investigations. These investigations identified VOCs at levels above California MCLs in shallow groundwater in the vicinity of Building 594. Soil and groundwater samples were analyzed for VOCs, TPH, SVOCs, pesticides, PCBs, metals, gross alpha and beta, and radium. Analytical results for soil samples were compared to residential PRGs and metals results in soil were also compared to Alameda Point background ranges. The only analyte with results that exceeded the corresponding PRG was arsenic. However, naturally occurring arsenic concentrations in soil exceeded the PRG throughout Alameda Point, and arsenic results for soil at IR Site 32 were within the background range.

Groundwater samples from IR Sites 1 and 32 contain levels of a variety of analytes exceeding MCLs, including aromatic and chlorinated VOCs, SVOCs, metals, and radionuclides (Innovative Technical Solutions, Inc., 2005). The highest concentrations are generally found in the first water bearing zone and along the western shoreline of the former IR Site 1 landfill. A smaller area of TCE contamination exists along the northern shoreline of IR Site 1, and a low-concentration VOC plume is found in the area east of IR Site 32.

2.4.2 Radiological Characteristics

IR Sites 1 and 2

Information on the radiological history of IR Site 1 is limited. In 1983, a DON Environmental Initial Assessment Report (E&E, 1983) reported the use of radioactive materials at Alameda Point starting in the 1940s, particularly at the dial painting section of the instrument shop at Building 5.Dial painting consisted of a two-step process. First, refurbished old aircraft dials were scraped and cleaned in solvent. Then the dials were repainted with radioluminescent paint containing ^{226}Ra.

Radium-impacted waste (scraping solids, rags, used paint brushes, and so forth from refurbishing dials and gauges) was collected from the shop and discarded at IR Site 1 and IR Site 2. The radium painting shop was closed in the early 1960s (exact dates unknown), and a contractor decontaminated the facility. According to site personnel interviews, the contractor was unable to decontaminate an unknown number of work materials from the facility and disposed of them in IR Site 1. The radioactive material was reported to have been disposed in an unlined trench 50 feet long, 11 feet wide and 8 feet deep north of the rifle range, approximately 50 feet north of an aboveground water outlet.

Building 5 housed the radium paint shop until the late 1950s when it was relocated to Building 400. Building 400 shared a common sewer with Building 5. Additional radium contamination was detected in 1979 in Building 400. Operations associated with radium dials at Building 400 were restricted to their removal and replacement with non-radioluminescent materials. Radium-contaminated benches, ducting and drains were removed and disposed off site.

IR Site 32

IR Site 32 is not considered to be a source of radiological constituents. An elevated radium reading identified at the site is considered to be an isolated detection associated with the disposal activities at the adjacent IR Site 1.

2.5 PREVIOUS RADIOLOGICAL SURVEYS

IR Sites 1 and 2

Preliminary radiological surveys were completed at IR Sites 1 and 2 in September 1995. In June 1996, a second preliminary radiological survey was conducted at a different area within IR Site 1. Details on the methodology used during the preliminary surveys and the data results are presented in the IR Sites 1 and 2 radiation survey report (PRC Environmental Management, Inc. [PRC], 1997). Based on results from the preliminary surveys, a comprehensive radiological survey was initiated by the DON in September 1998. The Supervisor of Shipbuilding, Conversion and Repair, Portsmouth (SSPORTS) Environmental Detachment conducted a more comprehensive radiological survey at IR Sites 1 and 2 in 1998 and 1999. The details of this survey are provided in the *Alameda Naval Air Station Landfill #1 and #2 Final Radiological Survey Report* (SSPORTS, 1999).

In 2004, TtEC conducted a radiological characterization survey at IR Sites 1 and 2. The primary objective of the survey was to characterize the potential ^{226}Ra contamination that may be present. The survey included a 100 percent surface scan using 2-inch by 2-inch NaI detectors, as well as fixed gamma and exposure rate surveys, gamma energy analysis with a portable HPGe system, and soil sampling. However, due to accessibility issues, neither the shorelines of IR Sites 1 and 2 nor the former Radiological Shack area located within IR Site 2 were surveyed. The findings of the radiological characterization surveys are presented in the *Final Installation Restoration Site 1 Radiological Characterization Survey Report* (TtFW, 2005a) and the *Final Installation Restoration Site 2 Radiological Characterization Survey Report* (TtFW, 2005b).

IR Site 32

The DON is currently within the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RI process for IR Site 32. IR Site 32 has no historical indications of being radiologically impacted. However, during the IR Site 1 radiological characterization survey conducted in 2004, an elevated radiological reading was found to exist along the border between IR Sites 1 and 32 (TtFW, 2005a). Another incidental elevated radiological reading was documented during the IR Site 32 RI field activities conducted by Bechtel (Bechel, 2005).

3.0 REGULATORY FRAMEWORK

The radiological survey is being conducted under the Installation Restoration Program (IRP). Activities conducted under the IRP are to be performed in accordance with the CERCLA and National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Under Executive Order (EO) 12580, the DON is the lead agency responsible for the implementation of the IRP. The EPA is the lead regulatory agency with state regulatory oversight provided by DTSC. USFWS will provide guidance regarding sensitive species issues.

3.1 REGULATORY PROCESS

Alameda Point is listed on the National Priorities List (NPL), which is a list developed by the EPA of hazardous waste sites nationwide that pose the greatest risk to the public health, and thus, warrant priority responses under the CERCLA. Therefore, the radiological survey proposed in this Radiological Survey Work Plan for IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack area will be conducted in accordance with the CERCLA and NCP regulatory process.

3.2 STATE AND LOCAL AUTHORITIES' ROLE

Federal EO 12580 delegates the President's authority to undertake CERCLA response actions to the DoD. Congress further outlined this authority in its Defense Environmental Restoration Program (DERP) Amendments, which can be found at 10 United States Code (USC), Sections 2701 through 2705. Both CERCLA, Section 120(f), and 10 USC, Section 2705, require DON facilities to ensure that the EPA and state and local officials be given the timely opportunity to review and comment on DON-proposed response actions and related studies under the DoD's IRP. CERCLA Section 120 further requires the DON to consider state regulatory requirements at its facilities. Accordingly, DTSC has provided technical advice, oversight, and approval during previous activities conducted under the IRP at Alameda Point.

EPA and DTSC currently provide technical oversight to the IRP, assist at monthly program management meetings for Alameda Point, and review documents produced under the IRP for the Alameda Point facility. Monthly Base Realignment and Closure (BRAC) Cleanup Team (BCT) meetings are held to facilitate the IRP process. The BCT consists of the DON, DON contractors, the EPA, and the DTSC. The status and schedule for the various IRP sites are discussed, and pertinent technical topics and issues are presented. The BCT participation and oversight will continue throughout the IRP process.

3.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This investigation-related scope of work does not constitute a CERCLA removal or remedial action, and therefore, does not trigger the CERCLA provisions for formally identifying and complying with ARARs. However, since the work is being conducted in some potentially environmentally sensitive areas, this section provides an evaluation of certain biological resource laws and regulations. A plan for meeting the substantive aspects of these laws and regulations and for minimizing impacts to biological resources is provided in Section 11.0, Environmental Protection Requirements. Additionally, Table 3-1, Applicable or Relevant and Appropriate Requirements, provides radiological ARARs. The substantive aspects of these laws and regulations will be adhered to during the survey activities. The SHSP (Appendix A) for this project addresses the issues related to worker safety, including issues relevant to monitoring and mitigation for exposure to potentially radioactive materials.

Federal ARARs

Migratory Bird Treaty Act of 1918 (16 USC, 703 through 712; Chapter 128). This act makes it unlawful to pursue, hunt, kill, capture, possess, buy, sell, purchase, or barter any migratory bird, including the feathers or other parts, nests, eggs, or migratory bird products. Several species of migratory birds have been previously identified in areas to be surveyed. Specific mitigation measures to be taken to minimize potential impacts to migratory birds are presented in Section 11.0 of this Radiological Survey Work Plan.

National Wildlife Refuge System Administration Act ([NWRSA] – Title 16, Chapter 5A, Subchapter III, Section 668d). Discrete portions of the areas to be surveyed are proposed for annexation with the local National Wildlife Refuge. All planned site activities are coordinated with local National Wildlife Refuge staff. The NWRSA prohibits the disturbance or possession of any real or personal property of the United States, including natural growth in any area of the system. In addition, this law prohibits unlawful entry of these areas or taking or possession of wildlife, unless such activities are performed by authorized personnel (for instance, refuge managers, licensed personnel, and so forth). Planned radiological survey activities at the site are authorized and their impact on the existing local flora and fauna will be minimized through proper planning, adequate resource agency participation, and appropriate implementation of preventative/protective measures as described in Section 11.0 of this Radiological Survey Work Plan.

Endangered Species Act of 1973 (16 USC, Sections 1531 et seq.). Endangered species are unlikely to occur within IR Sites 1, 2 and 32. The radiological survey activities will be planned to minimize impacts to listed and candidate species that could potentially be discovered on the site. Intrusive impacts will be carefully located and timed so as to avoid impacts on listed and candidate species. Specific mitigation measures to be taken to minimize potential impacts to listed and candidate species are presented in Section 11.0 of this Radiological Survey Work Plan.

State ARARs

In addition to the federal ARARs, the planned field activities may trigger compliance with certain state laws and regulations relating to protection of biological resources such as endangered species. Potential state ARARs to be evaluated for this project are presented below.

California Fish and Game Code (Sections 1600, 2014, 2080, 3005, 3500 and 5650). Regulations that apply to actions that include responsibility and damages for negligently harming wildlife, the illegal taking of endangered/threatened species, other birds, and mammals, and the discharge or release of hazardous materials into California waters are all relevant regulations. Section 11.0 presents mitigation measures to be implemented to prevent impacts to sensitive habitats and listed species.

California Endangered Species Act. Listed species are unlikely to occur within IR Sites 1, 2 and 32. The radiological survey activities will be planned to minimize impacts to wildlife. Intrusive impacts will be carefully located and timed so as to avoid impacts on listed species. Specific mitigation measures to be taken to minimize potential impacts to endangered species are presented in the Section 11.0 of this Radiological Survey Work Plan.

4.0 PROJECT AND PERSONNEL REQUIREMENTS

TtEC personnel training requirements and inspection programs applicable to the radiological survey activities at IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack area are described below. Protocols for inspections by regulatory agencies and third parties are also addressed.

4.1 PERSONNEL TRAINING/CERTIFICATION REQUIREMENTS

Personnel training and certification requirements include the following:

- Site personnel must have Occupational Safety and Health Administration (OSHA) 40-hour Health and Safety/Emergency Response Hazard Communication and Resource Conservation and Recovery Act (RCRA) training.
- Site personnel performing Department of Transportation (DOT) functions (including selecting, packaging, marking, labeling, preparing shipping papers, and loading) must be trained in accordance with the requirements of HM-126F. Subcontractors performing DOT functions must supply proof of training.
- All project personnel (subcontractors and TtEC) will be trained according to TtEC compliance policies and procedures, including TtEC's Radiological Protection Program (RP-1).
- All project personnel performing fieldwork activities will receive general awareness training for radiation.
- All project personnel performing waste management will be certified under TtEC waste management training in accordance with 40 Code of Federal Regulations (CFR), Part 265.16.
- All project personnel will attend a briefing on munitions and explosives of concern (MEC). The briefing will address what MEC may look like and the procedures to follow if encountered.
- The TtEC Project Biologist will brief all field personnel on the protection of natural resources prior to commencement of fieldwork.
- All-terrain vehicle (ATV) operators shall provide certification of completion of a nationally recognized accredited ATV training course. In addition, operators must pass an operating skills test prior to being allowed to operate an ATV.
- Man lift operators must have a minimum of 2 years of experience operating man lifts or similar equipment.
- TtEC and subcontractor training records will be verified prior to project activities commencement.

4.2 INSPECTION AND AUDIT PROCEDURES

Site inspections and audits may occur during the radiological survey activities to ensure compliance with the applicable state and federal regulations and this Radiological Survey Work Plan and its associated appendices.

Inspections by TtEC Personnel

TtEC inspections will be conducted regularly to document compliance with environmental health and safety regulations and TtEC procedures. These inspection requirements are documented within this Radiological Survey Work Plan, as well as the SHSP and Project CQC Plan.

Inspections by Regulatory Agencies

Regulatory inspections will be handled (by TtEC) in accordance with the TtEC Compliance Procedure for Environmental Inspections by Regulatory Agencies. These procedures require that in addition to contacting the Remedial Project Manager (RPM) and Caretaker Site Office (CSO), site personnel or the Project Manager (PjM) must notify the Program Environmental Health and Safety Manager, Mr. Roger Margotto.

Designated Representative for Inspections by Regulatory Agencies

The PjM has designated Ms. Jennifer Dessort (Project Quality Control Manager [PQCM]/Site Health and Safety Specialist [SHSS]) as the TtEC on-site representative. In the event of site visits by regulatory agencies, Ms. Dessort will notify and be accompanied by the CSO representative, Resident Officer in Charge of Construction (ROICC) or other DON representative when conducting an inspection.

Inspections by Non-Regulatory Third Parties

Any non-regulatory third party requesting access to inspect the site must be referred to the client for access. TtEC personnel or their subcontractors must not grant site access or answer questions for unauthorized personnel. The PjM will notify the RPM and CSO of any attempts to gain site access by third parties.

Members of the media asking questions or attempting to access the site should be referred to the RPM and the CSO representative.

5.0 SURVEY PLANNING AND DESIGN

Survey planning and design define the survey activities and methodologies employed to perform a survey in accordance with MARSSIM guidelines (DoD et al., 2000). These activities include, for example, identifying the proposed survey methods, instrumentation, minimum detectable concentrations (MDCs), decision levels, and methodology used for determining instrument background for the reference areas.

5.1 OBJECTIVE OF SURVEY

The objective of the survey is to determine if radioactive material distinguishable from background is present at IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack area in IR Site 2. The survey will be conducted in accordance with MARSSIM guidance (DoD et al., 2000). The intent is to perform a characterization survey such that if no radiological contamination is discovered, the data can be used to support a Final Status Survey.

5.2 SURVEY CRITERIA

The survey criteria for this project will be ^{226}Ra activity indistinguishable from background. This means that the characterization survey will identify locations where ^{226}Ra activity is distinguishable from the natural variation of ^{226}Ra naturally occurring in the background reference areas.

5.3 SURVEY AREA

A review of historical radiological records and past survey reports provides evidence that IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack area have the potential for radiological contamination above established limits. A near 100 percent surface scan of the survey area that comprises these areas will be conducted. The radiological survey will not be conducted in areas where there are concrete runways or where there are permanent facility structures. A typical flexible pavement design for an average 400,000-pound gross military aircraft weight at the time of the runway installation, having annual departure operations (landings and takeoffs) of 25,000, would have an approximate thickness of 30 inches with a minimum base course of 15 inches over an assumed California Bearing Ratio (CBR)-10 for compacted fill material. Since all of the proposed soil samples will be collected in the upper 20-inch zone, it is not anticipated that any point sources, soil, or LLRW will be present in that zone in the runway.

5.4 INSTRUMENTATION

A Laser-assisted Ranging and Data System (LARADS) will be the primary field survey systems used for the land area survey. Several types of other portable field survey instruments may be used to conduct the radiation surveys, provide analytical data, and monitor radiation control practice.

5.4.1 Measuring Equipment

During the performance of the survey, different instrumentation will have to be used to detect the various forms of radioactive material that may be present. Table 5-1 identifies the instrumentation that may be used. Each instrument is explained in further detail in the following sections.

5.4.1.1 Instrument for Alpha/Beta Surveys

Surveys for alpha/beta radiation will be performed using an Eberline E-600 with a SHP380AB scintillation probe. The instrument measures alpha and beta radiation levels and presents data in a digital display. Static measurements for particulate radiations are displayed and recorded by the rate meter after positioning the detector, a scintillation probe, directly over a designated surveillance surface.

5.4.1.2 Instrument for Gamma Surveys

Surveys for gamma (photon) radiation will be performed using an Eberline E-600 using a 2-inch by 2-inch NaI crystal. The instrument is programmed to respond to the full spectrum of gamma photon energies since it is capable of detecting gamma photon energies ranging from 60 kiloelectron volts to 3 million electron volts. These measurements are always made with the instrument audio "on" to facilitate rapid detection of changes in instrument count rate. Static photon measurements require positioning the detector assembly approximately 4 inches (10 centimeters [cm]) above the designated surveillance surface and completing a stationary 60-second survey. Scan measurements are obtained by traversing a path at a maximum speed (scan rate) of approximately 0.5 meters per second and slowly sweeping the detector assembly in a serpentine (snakelike, S-shaped) pattern, while maintaining the detector 2.5 to 4 inches (6 to 10 cm) above the area surveyed. These measurements are always made with the instrument audio 'on' to facilitate rapid detection of changes in the instrument count rate.

5.4.1.3 Gamma Spectroscopy Instrumentation

In situ or field sample gamma energy analysis will be performed using a portable HPGe system when the need for radionuclide speciation arises. Typically, this will be when verification of the radionuclide species of a subsurface point source is required. The gamma energy analysis will be performed using a HPGe scintillator detector system. The HPGe detector system will be a 40 percent to 73 percent efficient coaxial HPGe detector coupled to a 7-liter portable liquid nitrogen dewar. An adjustable Putnam cart will be available with a 2-inch-thick circular lead collar for

shielding unwanted background gamma rays from the sides and behind. The detector will be operated using a portable ORTEC DigiDART module connected to a laptop computer running ORTEC's GammaVision® or Maestro acquisition software. Data analysis may be performed using spectral nondestructive assay platform analysis software. Additional information about the portable HPGe system is provided in Appendix D-1, Gamma Spectroscopy System.

5.4.1.4 Instrumentation for Swipe Samples

Swipe samples will be processed using an Eberline HandEcount portable alpha and beta/gamma radiation counter (or equivalent). A microprocessor allows for data processing, and the unit provides a full range of simultaneous alpha and beta/gamma analysis at levels required for environmental release surveillance. Data is reported in units of disintegrations per minute (dpm) per 100 square centimeters (cm^2).

5.4.1.5 Instrument for Exposure Rate Surveys

Exposure rate surveys will be performed when it is desired to measure the ambient exposure rate at a given location on the site. One example of this is to measure the surface exposure rate produced by a subsurface point source to determine if additional radiological controls are needed to ensure worker safety.

Exposure rate surveys, obtained approximately 1 meter from contact with area surfaces, are conducted using a MicroREM meter (or equivalent). The MicroREM meter is equipped with an internally mounted, tissue-equivalent organic scintillation detector.

Exposure rate will also be collected using a pressurized ion chamber (PIC). A PIC typically is an argon-filled ionization chamber with a diameter of 7.32 cm (2.88 inches) and a volume of 220 cubic centimeters (cm^3) (13.4 cubic inches).

5.4.1.6 Instrument for Land Area Scan Surveys

LARADS land area surveys will be performed when it is desired to collect geo-referenced survey data. The majority of the survey activities planned during the IR Sites 1, 2 and 32 surveys will be LARADS-based surveys. LARADS uses a commercially available count rate meter (CRM), the Eberline E-600. This CRM contains circuitry that may be configured to support a wide variety of detector types. NaI (2-inch by 2-inch) detectors will be used for the radiological land surveys. The LARADS systems will use four NaI (2-inch by 2-inch) detectors positioned in a linear array spaced approximately 1 foot apart.

The system collects and stores the positional coordinates and radiological readings on a point-per-second basis in electronic files. These field files are then downloaded and processed with Geographic Information System (GIS) software to produce both a color-coded contour map

(based on radiological reading) and the survey trace overlain upon a computer-assisted draft (CAD) base map or digital photograph of the site or area.

It permits the surveyor to monitor a trace of his survey path and current radiological readings in real time to verify coverage of any given area. Areas that exceed a user-set radiological trigger point activate an audio cue and are visually highlighted, providing instant notification. Additional information about the LARADS (vehicle and hand-held equipment) is provided in Appendix D-2.

5.4.2 Instrument Calibration and Efficiency

TtEC will use the services of a radiological instrumentation supplier for the radiological instruments and check sources used during the survey. The equipment supplier is required to provide calibration documentation for each radiological instrument supplied.

The PQCM or his designee will review the calibration documentation prior to the instrument being used.

The supplier will perform the necessary calibration of their radiological instrumentation annually. The instruments will not be accepted from the supplier, unless they have been calibrated prior to shipment to TtEC. The supplier will include certificates of calibration and calibration data with each instrument. TtEC will not perform calibrations in the field for these instruments; therefore, the SOPs for the calibration of these instruments are not being provided. Operational checks will be performed daily to verify that the instruments are functioning properly. These checks are discussed in Section 5.4.3.

The supplier of the HPGe will provide the calibration service and procedure for the HPGe system. The system will be calibrated using a National Institute of Standards and Technology (NIST) traceable source. The supplier of the HPGe system will provide a copy of the "Certificate of Certification" for the calibration source. The SOP used by the HPGe supplier is included in Appendix D-1, Gamma Spectroscopy System.

5.4.3 Instrument Operational Checks

Prior to use of the radiological instruments, calibration verification, physical inspection, battery check, and source response check will be performed. All portable radiological instruments will have a current calibration label. Calibration verification will be performed daily prior to use of the instrument.

Physical inspection of the instrument will include:

- Inspect the general physical condition of the instrument and detector prior to each use.

- Inspect for loose, damaged knobs, buttons, cables, connectors, broken/damaged meter movements/displays, dented or corroded instrument cases, punctured/deformed probe/probe window(s), cables, and any other physical impairments that may affect the proper operation of the instrument or detector.

Any instrument or detector having a questionable physical condition will not be used until corrected.

A battery check will be performed to ensure that there is sufficient voltage being supplied to the detector and instrument circuitry for proper operation. This check will be performed in accordance with the instrument's operations manual; although, it is generally performed as follows:

- Position the appropriate selector switch to the "Batt" position or depress the "Batt Check" button with the instrument on.
- Observe the indication for the current battery condition. Typically, the current battery condition will be indicated by a meter deflection into the "Batt OK" region or "Batt OK" on the display.

If unsatisfactory results are obtained, refer to the operations manual for replacement of the batteries and repeat the check. The instrument will display a satisfactory battery check prior to use.

Upon receipt of the instruments, a response check range will be established. On a daily basis, the instrument will be exposed to the check source to verify that the instrument response is within the +/- 20 percent range determined during the initial response check.

The results of the daily operation checks discussed above will be entered into the field logbook. The PQCM will review the entries daily for completeness and conformance with acceptance criteria (response within +/- 20 percent). These reviews will also facilitate identifying trends that could indicate possible deterioration of the instruments. Instruments that do not pass the daily operation checks will be removed from service and returned to the supplier for maintenance. Details regarding operation procedures are provided in Appendix D-3, Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use.

5.4.4 Static Measurement Techniques and Data Interpretation

One-minute stationary readings will be taken at a distance of approximately 3 inches above the ground using a (2 inch by 2 inch) NaI gamma scintillation detector. The highest reading will be recorded in counts per minute (cpm). The process for collecting static measurements is discussed in Section 7.3.3.

5.4.5 Scanning Measurement Techniques

A vehicle-based LARADS will be used to perform the scanning measurements. The four (2-inch by 2-inch) NaI detectors will be positioned in a linear array spaced approximately 1 foot apart and

approximately 6 inches above the ground. The detectors will not be in a shielded configuration. The LARADS will collect readings and transmit the data to the master controller for entry into the survey database. Each detector produces a signal every second. The data is recorded in cpm. SOP for performing LARADS scanning measurements is provided in Appendix D-2, Laser-assisted Ranging and Data System (Vehicle- and Backpack-based Procedures).

5.4.6 Gamma Spectroscopy by Measurement Techniques

Gamma energy analysis using a portable HPGe system will be performed to characterize subsurface point sources and to quantitatively identify the presence of ^{226}Ra in collected soil samples. Specific locations for in situ gamma energy analysis will be determined by the Project Health Physicist (PHP) with concurrence from the RASO based on a review of the radiological survey data collected. Soil samples collected will have a gamma energy analysis preformed on them prior to being released and shipped to the contract laboratory for ^{226}Ra analysis.

5.4.7 Sampling Procedures

Soil samples will be collected from zero to 20 inches bgs using a hand-auger upon completion of the surface scan. Up to 15 samples will be collected and analyzed by gamma spectroscopy for radiological isotopes. Five of these samples will be selected for strontium-90 (^{90}Sr) analysis. The proposed sample locations and the samples selected for ^{90}Sr analysis will be approved by the RASO. The soil samples will be packaged in containers specified by the analytical laboratory. Prior to release for shipment to the laboratory, each container will be tightly capped, securely sealed, and clearly labeled. Prior to packaging for shipment, all sample containers are to be checked for beta/gamma and alpha contamination. All samples are to be direct frisked for beta/gamma prior to packaging for shipment. Procedures for sample collection and shipment are provided in the SAP (Appendix B) and Appendix D-4, Sampling Procedures for Radiological Surveys.

5.4.8 Minimum Detectable Activity/Minimum Detectable Concentration Determination

Determining the minimum detectable activity (MDA)/MDC for the measurements and the scans involves many variables that include: area of contamination, depth of contamination, attenuation of radiation, surveyor efficiency, time interval the probe is over the contaminated area, and desired rates of true positives and acceptable rates of false positives. The methodology presented in MARSSIM (DoD et al., 2000) will be followed to establish the MDA/MDC for each survey instrument.

5.4.8.1 Instrument Efficiency

The instrument efficiency (ε_i) is defined as the ratio between the net count rate, in cpm, of the instrument and the surface emission rate of the calibration source for a specified geometry. The surface emission rate is the 2π particle fluence that is affected by both the attenuation and backscatter of the radiation emitted from the calibration source.

Equation 5-1 will be used to calculate the instrument efficiency in counts per particle; although, efficiency is typically reported as having no units or unitless.

Equation 5-1

$$\varepsilon_i = \frac{R_{S+B} - R_B}{q_{2\pi}\left(\frac{W_A}{S_A}\right)}$$

Where:

R_{S+B} = the gross count rate of the calibration measurement (cpm)
R_B = the background count rate in cpm
$q_{2\pi}$ = surface emission rate of the calibration source (NIST traceable) (particles per minute)
W_A = active area of the detector window (cm^2)
S_A = area of the source (cm^2)

The instrument efficiency is determined by obtaining static counts with the detector over a calibration source that has a NIST traceable surface emission rate. The 2π particle fluence rate is corrected for decay, attenuation and scatter. Then the surface emission rate of the source must be corrected for the area subtended by the probe. Factors that can also affect the instrument's efficiency are discussed below:

Efficiency Check Sources. Efficiency check sources that emit alpha or beta radiation with energies similar to those expected from the contaminant in the field [similar to the expected radionuclide(s) of concern] will be selected.

Source Geometry Factors. Instrument efficiency will usually be determined with an efficiency check source equal to or greater than the area of the probe. If a source that is smaller than the probe is used, a conversion factor is applied to the MDC to account for the active region of the probe.

Source-to-detector Distance. The detector efficiency will be calculated at a source-to-detector distance that is the same as the detector-to-surface distance used in the field.

5.4.8.2 Count Detection Probability for Alpha Scans

Scanning for alpha emitters differs significantly from scanning for beta and gamma emitters in that the expected background response of most alpha detectors is very close to zero. The following sections cover scanning for alpha emitters.

Since the time a contaminated area is under the probe varies and the background count rate of some alpha instruments is less than 1 cpm, it is not reasonable to determine a fixed MDC for scanning. Instead, it is more practical to determine the probability of detecting an area of contamination at a predetermined derived concentration guideline level (DCGL) for given scan rates.

For alpha survey instrumentation with backgrounds ranging from less than 1 to 3 cpm, a single count provides a surveyor sufficient cause to stop and investigate further. Assuming this to be true, the probability of detecting given levels of alpha surface contamination can be calculated by use of Poisson summation statistics.

Given a known scan rate and a surface contamination release limit, the probability of detecting a single count while passing over the contaminated area is given by Equation 5-2:

Equation 5-2

$$P(n \geq 1) = 1 - e^{-\frac{GEd}{60v}}$$

Where:

$P(n \geq 1)$ = probability of observing a single count
G = contamination activity (dpm)
E = detector efficiency (4π)
d = width of detector in direction of scan (cm)
v = scan speed (centimeters per second)

Once a count is recorded and the guideline level of contamination is present, the surveyor should stop and wait until the probability of getting another count is at least 90 percent. This time interval can be calculated by Equation 5-3:

Equation 5-3

$$t = \frac{13,800}{CAE}$$

Where:

t = time period for static count(s)
C = contamination guideline (dpm/100 cm^2)
A = physical probe area (cm^2)
E = detector efficiency (4π)

5.4.8.3 Minimal Detectable Count Rate and Minimum Detectable Concentration for Beta Scans

The minimum detectable number of net source counts in the scan interval can be arrived at by multiplying the square root of the number of background counts (in the scan interval) by the detectability value associated with the desired performance (as reflected in d') as shown in Equation 5-4.

Equation 5-4

$$MDCR = \mathrm{d}'\sqrt{\mathrm{b_i}}\left(\frac{60}{i}\right)$$

Where:

d' = index of sensitivity (α and β errors [performance criteria])
b_i = number of background counts in scan time interval (count)
i = scan or observation interval (s)

The required rate of true positives will be 95 percent, and the false positives will be 5 percent. From Table 6.5 of MARSSIM, the value of d', representing this performance goal, is 3.28.

The scan MDC is determined from the minimum detectable count rate (MDCR) by applying conversion factors that account for detector and surface characteristics and surveyor efficiency. As discussed below, the MDCR accounts for the background level, performance criteria (d'), and observation interval. The observation interval during scanning is the actual time that the detector can respond to the contamination source. This interval depends on the scan speed, detector size in the direction of the scan, and area of elevated activity.

The scan MDC for structure surfaces is calculated using Equation 5-5.

Equation 5-5

$$Scan\ MDC = \frac{MDCR}{\sqrt{p}\ \varepsilon_i \varepsilon_s \frac{W_A}{100\ cm^2}}$$

Where:

MDCR is discussed above
p = surveyor efficiency factor
ε_i = instrument efficiency (count per particle)
ε_s = contaminated surface efficiency (particle per disintegration)
W_A = area of the detector window (cm^2)

5.4.8.4 MDC for Static Alpha and Beta Counts

The static MDC will be determined prior to the start of the removal activities and will be used to estimate the level of activity that can be detected by the proposed survey method. The RASO's concurrence of static MDC and scan MDC shall be obtained prior to commencing the survey activities.

The static MDC is the level of radioactivity that is practically achievable by the overall measurement process. Equation 5-6 is used to calculate instrument MDC in dpm per 100 cm^2 when the background and sample are counted for the same time intervals.

Equation 5-6

$$MDC = \frac{3 + 4.65\sqrt{R_B T_B}}{\varepsilon_s \varepsilon_i \frac{W_A}{100} T_B}$$

Where:

R_B = background count rate (cpm)
T_B = background counting time (min)
ε_i = instrument efficiency (count per particle)
ε_s = contaminated surface efficiency (particle per disintegration)
W_A = active area of the detector window (cm^2)

In Equation 5-6, W_A is the size of the "active" area of the detector window. If the area of the detector window (cm^2) does not equal 100 cm^2, it is necessary to convert the detector response to units of dpm per 100 cm^2.

If the background and sample are counted for different time intervals, Equation 5-7 is used to calculate the MDC in dpm per 100 cm^2.

Equation 5-7

$$MDC = \frac{3 + 3.29\sqrt{R_B T_{S+B}\left(1 + \frac{T_{S+B}}{T_B}\right)}}{\varepsilon_i \varepsilon_s \frac{W_A}{100\ cm^2} T_{S+B}}$$

Where:

R_B	=	background count rate (cpm)
T_B	=	background counting time (min)
T_{S+B}	=	sample counting time (min)
ε_i	=	instrument efficiency (count per particle)
ε_s	=	contaminated surface efficiency (particle per disintegration)
W_A	=	active area of the detector window (cm^2)

5.4.8.5 MDC for Gamma Scans of Surface Areas

The scan MDC (in picocurie per gram [pCi/g]) is based on the area of elevated activity, depth of contamination, and the radionuclide (energy and yield of gamma emissions.) To establish the scan MDC, the relationship between the detector's net count rate to net exposure rate must be established first. This is accomplished by determining the MDCR using Equation 5-4, then applying a surveyor efficiency factor p to get the $MDCR_{Surveyor}$ as show below in Equation 5-8 below:

Equation 5-8

$$MDCR_{Surveyor} = MDCR / \sqrt{p}$$

The $MDCR_{Surveyor}$ is then converted into the corresponding minimum detectable exposure rate (MDER) by use of the manufacturer-provided count rate to exposure rate ratio for the detector. For example, the manufacturer-provided count rate to exposure rate ratio for the Ludlum Model 44-10 2-inch by 2-inch NaI scintillation detector is 900 cpm/microroentgen per hour (μR/hr) (5.4×10^{10} counts/R). This value can be used to determine the ratio of cpm to μR/hr, as shown in Equation 5-9 below:

Equation 5-9

$$MDER\ (\mu R / hr) = \frac{MDCR_{Surveyor} * 6 \times 10^7}{cc}$$

Where:

$MDCR_{Surveyor}$ = as calculated in Equation 5-x8
$6x10^7$ = a conversion factor accounting for differences in time and activity units [(μR-min)/(R-hr)]
cc = 5.4×10^{10} [(counts)/(R)]

Next, the relationship between the radionuclide concentration and exposure rate is established. This is accomplished by modeling (using MicroShield) to determine the net exposure rate produced by the radionuclide at a distance above the ground. The factors considered in modeling include:

- The dose point above the surface.
- The density of material in grams per cubic centimeter (g/cm3).
- DCGL of the radionuclide of concern in pCi/g.
- The depth of detection for the DCGL.
- The circular dimension of the cylindrical area of detector capability (square meters [m^2]).

The concentration of the radionuclide of concern (scan MDC) necessary to yield the MDER may be calculated by taking the ratio of the MDER to the exposure rate calculated by MicroShield, as shown in Equation 5-10 below:

Equation 5-10

$$Scan\ MDC(pCi/g) = \frac{DCGL\ pCi/g * MDER\ \mu R/hr}{MicroShield\ Exposure\ Rate\ \mu R/hr}$$

5.4.8.6 Minimum Detectable Count Rate for Static Gamma Counts

For gamma surveys, MDCR, rather than MDC, is calculated in cpm. If the background and sample are counted for the time intervals, Equation 5-11 is used to calculate the MDCR.

Equation 5-11

$$MDCR = \frac{3 + 4.65\sqrt{R_B T_B}}{T_B}$$

Where:

$3 + 4.65$ = constant factor provided by MARSSIM
R_B = background count rate (cpm)
T_B = background counting time (min)

If the background and sample are counted for different time intervals, Equation 5-12 is used to calculate the MDC.

Equation 5-12

$$MDC = \frac{3 + 3.29\sqrt{R_B T_B}}{T_B}$$

Where:

$3 + 3.29$	=	constant factor provided by MARSSIM
R_B	=	background count rate (cpm)
T_B	=	background counting time (min)

5.4.9 Documentation of Radiological Measurements

The LARADS enables the system operator to document scanning measurements, stationary radiological measurements, and sample locations of surfaces with the radiological readings and exact coordinates automatically logged in real time. After the survey has been completed, the information is downloaded to a GIS, and the radiological information is overlaid on a digital picture of the survey area or is generated as a CAD drawing. The final product is a map of the survey area that clearly shows the area covered by the detector and the locations that had readings above background. The reproducibility of data allows for locating areas above release criteria for remediation and provides for objective review by regulators and verifiers.

Other radiological surveys performed that do not use LARADS will be documented and contain sufficient detail to be meaningful even after the originator is no longer available. These radiological surveys will be recorded on a standard radiological survey form (Appendix D-5, Release of Materials and Equipment from Radiologically Controlled Areas) and will include the following information:

- Site or facility name, specific location(s), purpose, and process being documented
- Signature of the surveyor(s) and the date of preparation
- Instrument(s) used, model and serial number
- Instrument efficiency and calibration date
- Instrument reading(s) at each measurement location and background reading(s) from background reference areas
- Specific locations of each measurement and sample collected, such that these locations can be accurately relocated

- Instrument settings—voltage, threshold, window thickness, and so forth (or reference to a specific operating procedure on the survey form)
- Check source used and identification number
- Notes on the survey findings, including the location of areas found to contain high concentrations of localized contamination
- All blanks completed or lined out as "not applicable"
- Supervisory signatures to ensure review and proper completion of forms

5.5 INVESTIGATION CRITERIA

The scope of work for the radiological survey is to perform a near 100 percent surface scan of IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack in IR Site 2. The radiological surface survey is to be conducted in accordance with the guidance provided in MARSSIM (DoD et al., 2000). The survey is to be based on a scenario B survey design. Detection criteria for this project will be indistinguishable from background (e.g., measurements observed to be greater than 3-sigma above background). Locations where activity has been determined to be above this level shall be marked for possible further investigation.

5.5.1 Step-out Procedure

If an anomalous location is identified at the south or east edge of the IR Site 32 boundary, a step-out procedure will be implemented. At the location of the anomaly, the survey will step 10 feet outside the current boundary in each direction to identify any discrete sources. If an additional anomaly is identified within this area, the survey area will be extended in 10-foot increments until no further anomalies are encountered.

5.6 INVESTIGATION LEVELS

The investigation levels will be set at 3 standard deviations above the measured mean background for both static and scan surveys. The established background levels are provided in Section 7.2.

6.0 MOBILIZATION

Mobilization activities will include a kickoff meeting, site preparation, movement of equipment and materials to the site, training and orientation for site field personnel, and land and geophysical survey activities.

6.1 KICKOFF MEETING

At least 2 weeks prior to the start of the field activities at the site, a kickoff meeting will be held between the DON and TtEC. The purpose of this meeting is to develop a mutual understanding of the radiological survey activities and the CQC details, forms to be used, administration of on-site work, and coordination of the investigation management and schedule. TtEC will prepare minutes of the meeting for submittal to the DON. The following individuals will be requested to attend: the RPM, the ROICC, the RASO representative, and the BRAC Environmental Compliance Manager. TtEC representatives will include the PjM, PQCM/SHSS, and the PHP.

6.2 SITE PREPARATION

Site preparation will include movement of equipment and materials to the site, as well as training and site orientation of field personnel. At least 2 weeks prior to mobilization, the appropriate DON personnel, including the RPM, ROICC, and the BRAC Environmental Compliance Manager will be notified about the planned schedule for mobilization and site survey tasks.

Upon completion and approval of procurement activities, appropriate field personnel and required support facilities will be mobilized to the site in preparation of the radiological survey and soil sampling activities. The support facilities will include an office trailer with a generator for electrical service, one or more secure storage (conex) boxes for short- and long-term storage of materials, restroom facilities, hand-washing station, an equipment storage area, drum staging areas, and workers' parking area. Figure 6-1 depicts the location of the temporary support facilities. Site preparation will be initiated approximately 2 to 3 days prior to site survey activities to ensure that facilities are in place for the remaining field crews and supplies.

Equipment and material mobilization will be initiated upon the completion of the site preparation activities. Equipment and materials will be mobilized to the site on an as-needed basis to minimize storage requirements. Equipment and materials will include the LARADS vehicle and hand-held equipment, radiological monitoring equipment, sampling supplies, health and safety equipment, waste containment supplies, and various office supplies.

TtEC and its subcontractors will provide the materials, labor, and equipment necessary to accomplish the work and complete the radiological survey and sampling tasks as identified in

this Radiological Survey Work Plan. Equipment will be selected and sized to perform the designated tasks associated with the radiological survey and soil sampling.

Prior to the start of field activities, all field personnel will be briefed on the protection of natural resources. The TtEC Biologist will perform the worker education briefing, emphasizing the need for minimizing impacts on sensitive biological resources, as well as methods for avoiding and minimizing potential impact on the species and communities of concern.

The TtEC PHP will provide a radiological training to the crew members prior to starting survey work activities. The briefing will include:

- Sources of radiation
- Nonionizing/ionizing radiation
- Risks in perspective
- Radiological controls
- Monitoring/dosimetry
- Emergency procedures
- As low as reasonably achievable (ALARA) results
- Exposure reports

6.3 LAND SURVEY

Prior to the radiological survey at IR Site 32, the shorelines of IR Sites 1 and 2, and the Radiological Shack area in IR Site 2, a licensed California land surveyor will perform land survey services for the purpose of providing accurate topographic reference points.

The proposed radiological survey uses LARADS technology as an integral part of the data collection process. Prior to the radiological survey, the land surveyors will provide accurate topographic reference points to be used by the radiological survey crews as control for survey areas, as required by MARSSIM (DoD et al., 2000). TtEC subcontractors will use those reference points to establish a base station for their LARADS equipment.

The primary survey control for the site is based on a monument located at the northwest corner of Main Street and Atlantic Avenue in the city of Alameda. The location of the monument was provided by the DON and described by the National Geodetic Survey (NGS) as "Main/Atl". The NGS defines and manages the National Spatial Reference System – the framework for latitude, longitude, height, scale, gravity, orientation, and shoreline throughout the United States.

The site coordinates are currently based on the California Coordinate System (CCS) Zone III, North American Datum (NAD) of 1927. The NAD27 value for "Main/Atl" was derived from the

NAD conversion of the published NAD83 coordinates. The coordinates for the control point at "Main/Atl" based on NAD27 are provided as follows:

- Northing - 471,068.97
- Easting - 1,482,604.56

The site elevations are based on the National Geodetic Vertical Datum (NGVD) of 1929. The published elevation of the "Main/Atl" is provided as follows:

- Elevation - 6.69 feet

6.4 GEOPHYSICAL SURVEY

Prior to collecting shallow (zero to 20 inches bgs) soil samples, a geophysical survey will be performed at the proposed sample locations in addition to contacting Underground Service Alert. The geophysical survey will be conducted using ground-penetrating radar (GPR) and/or an electromagnetic instrument (EMI). The results of the geophysical survey will be compared to the available as-built drawings to evaluate if undocumented utilities or other features exist in the background survey areas. Appropriately colored paints will be used to mark the identified utilities within the vicinity of the proposed soil sampling locations.

7.0 GENERAL SURVEY PLAN ACTIVITIES

General radiological survey activities will include establishing instrument background for the reference areas. The radiological survey will use static, scan, gamma energy analysis, and soil sampling survey methods.

The radiological survey will not be conducted in areas where there is concrete (runways) or where there are permanent facility structures. As previously discussed in Section 5.3, the typical thickness of the concrete is 30 inches. Since soil samples will be collected in the upper 20-inch zone, it is not anticipated that any point sources, soil, or LLRW will be present in that zone in the runway.

7.1 IDENTIFICATION OF REFERENCE AREAS

A map locating operable units (OUs) and CERCLA sites at Alameda Point was reviewed (TtEMI, 2003) to identify areas that had not been impacted by environmental activities. The locations of the reference areas were selected a minimum of 200 feet outside any impacted areas. The locations selected should not have been impacted by site activities and would therefore be representative of background levels. Three 2,000-m^2 reference areas were identified for background determination. The reference areas have similar physical, chemical, geological, radiological, and biological characteristics as IR Sites 1, 2 and 32 but have not been contaminated by site activities. The locations of the reference areas are identified on Figure 7-1.

A reference area for the shoreline will be established in collaboration with the DON prior to the commencement of the shoreline surveys.

7.2 BACKGROUND LEVELS

The ambient gamma background will be established for the NaI detector, and the ambient dose rate will be established for PIC and the MicroREM meter. The standard deviation of these fixed readings in the background areas will be used for determining the investigation criterion of 3 sigma above background. This is accomplished by summing the measurements from the background areas and calculating the average and standard deviation of the measurements.

Nine static background measurements and one field duplicate from each reference area identified in the IR Site 1 Radiological Survey Work Plan (TtFW, 2004b) will be obtained to establish the average background count rate for the NaI detector, exposure rate for the PIC, and dose rate for the MicroREM meter. Five 10-second stationary readings will be taken at a distance of 6 inches above the ground at each of the locations within a reference area using a 2-inch by 2-inch NaI detector. The average of the NaI readings will be recorded for each sample location. In addition, the exposure rate will be obtained at 3 feet (waist high) above the ground at each of the 10 locations within a reference area using the PIC and MicroREM meter.

The towed array and backpack-based systems will perform a 10-minute scan survey in each reference area to establish the background count rate during a surface scan survey. Surveying at a speed of 1 foot per second for 10 min will yield upwards of 600 data points, which is sufficient to statistically determine a scanning background count rate for the systems.

The background soil concentration of ^{226}Ra (0.365 pCi/g) was determined during the IR Site 1 and 2 land area survey performed in 2004 (TtFW, 2005a; TtFW, 2005b). This concentration will be used to determine if ^{226}Ra is present in soil samples at concentrations greater than 3 sigma above background (0.559 pCi/g).

7.3 RADIOLOGICAL SURVEY

The radiological survey will consist of both static and scan surveys, a dosimetry study, as well as soil sampling and gamma energy analysis using a portable HPGe system. The survey methods to be used are described in the following subsections and in Appendix D-6, Radiation and Contamination Surveys.

7.3.1 LARADS Scanning (vehicle-based)

High-density radiation surveys will be performed over the majority of IR Site 32 using LARADS technology coupled to a linear array of four 2-inch by 2-inch NaI high-sensitivity scintillation detectors. The detectors will be mounted so that the detector surface is approximately 6 inches from the ground, depending on the terrain being surveyed. This arrangement is capable of surveying a path approximately 4 feet wide and providing reliable survey data to a depth of approximately 12 inches.

The vehicle-based LARADS will be operated with a speed control to maintain an approximate speed of 1 foot per second. Operating at this speed will result in generation of more than 40,000 data points per acre. This equates to an average of one data point per square foot. The scan speed can affect the scan MDC when attempting to measure gamma radiation from discrete sources. This is due to the amount of time the active area of the detector is over the discrete source. At slower speeds, the active area of the detector is over the discrete source longer than at faster speeds.

Due to access restrictions, the vehicle-based LARADS will not be used along the shorelines of IR Sites 1, 2 and 32 or the former Radiological Shack area. In these areas, a LARADS hand-held device or a man lift with a NaI detector will be used as discussed below.

7.3.2 LARADS Scanning (hand-held)

The high-density survey performed using the LARADS mounted on a vehicle/cart will result in a 100 percent scan survey when terrain is reasonably smooth and clear of obstructions. For those areas where terrain will not allow the vehicle-based LARADS to safely operate (the shorelines of

IR Sites 1, 2 and 32 and the former Radiological Shack in IR Site 2), the survey will be performed using a single NaI high-resolution scintillator detector connected to a backpack-based LARADS. The backpack unit is capable of providing reliable survey data to a depth of approximately 12 inches. The surveyor will scan the terrain suspending the detector approximately 6 inches above the ground. The backpack unit will hold the LARADS equipment. The survey speed will be such that an average of one data point per square foot will be collected by this survey method.

7.3.3 Static Surveys

For those areas along the shoreline where towed or hand-held surveys cannot be performed, the following survey approach will be used. A 10-foot by 10-foot grid will be established along the shoreline from the end of the previous survey to the mean low tide elevation. Static 10-second surveys will be performed at each grid point (e.g., on 10-foot centers). This will be accomplished by using an articulating man lift and a NaI detector attached to a retractable line. The detector will be lowered to within 6 inches of the shoreline (e.g., riprap) surface and a measurement collected. Laser-based global positioning survey technology will be used to geo-reference these static measurements.

Static surveys will be performed at each soil sample location using a 2-inch by 2-inch NaI high-resolution scintillator detector. The sample location will be surveyed to identify the area of greatest activity. The NaI reading will be recorded for this location and a sample will be collected. In addition, the exposure rate will be obtained at 3 feet above the ground at each sample location using a MicroREM meter.

The static counts per minute data will be correlated to the measured ^{226}Ra soil activity. This correlation will allow estimation of soil concentrations at other locations within the survey area based on the LARADS data and will facilitate remediation decisions.

Ten-minute PIC measurements will be collected on 10-foot centers at IR Site 32, except along the shoreline and/or where the use of a man lift is required. One-hour PIC measurements will be performed along the shorelines of IR Site 1, 2 and 32 at 50-foot intervals where the environmental thermoluminescence dosimeters (TLDs) associated with the dosimetry study (refer to Section 7.3.6) are to be located.

The NaI static cpm data will be correlated to the PIC exposure rate measurements and the TLD readings. This will allow estimates of the exposure rates based on the NaI measurements collected throughout the site.

7.3.4 Soil Sampling

Up to 15 hand-augered soil samples will be collected. Sample locations will be identified by the PHP with concurrence from the RASO after the surface scan is complete. These samples will be collected and controlled as described by the SAP provided in Appendix B.

7.3.5 Gamma Spectroscopy

Gamma energy analysis using a portable HPGe system will be performed to characterize subsurface point sources and to qualitatively identify ^{226}Ra in the collected soil samples. Specific locations for in situ gamma energy analysis will be determined by the PHP based on a review of the radiological survey data collected. Soil samples collected will have a gamma energy analysis performed on them prior to being released and shipped to the contract laboratory for ^{226}Ra analysis.

7.3.6 Dosimetry Study

An environmental dosimetry study via the use of TLDs will be performed. The purpose of the dosimetry study is to determine if there is any measurable difference between exposure rate along the shorelines of IR Sites 1, 2 and 32 and background. The TLDs will be placed along the shorelines of IR Sites 1, 2, and 32 for a period of 3 months. The TLDs will be placed every 50 linear feet along the shorelines. A maximum of 200 TLDs will be installed for this survey.

7.3.7 Discrete Source Management

If a discrete source is located during the radiological characterization surveys, TtEC will collect the source and remove the surrounding soil 1 foot of soil in each direction. The source and surrounding soil will be placed in a container and relocated to a location approved by the RPM, CSO, and RASO. The area where the discrete source was removed will be re-surveyed to ensure that no further discrete sources remain.

If upon removal more contamination is identified, work at that specific site will stop and the DON RPM and RASO will be notified to determine further actions. It is not within the scope of this Radiological Survey Work Plan to perform removal activities; however, discrete surface sources will be properly collected for future disposal as discussed in the previous paragraph.

7.4 VEGETATION CLEARANCE

Vegetation clearance activities will be conducted in accordance with the Vegetation Clearance Plan (TtEC, 2006a) prior to conducting the radiological survey. The Vegetation Clearance Plan describes the planned approach and methodology for surface clearance at IR Sites 1, 2 and 32, as necessary. A brief summary of vegetation clearance activities is provided in Section 11.2.

7.5 MUNITIONS AND EXPLOSIVES OF CONCERN

A complete MEC surface sweep of IR Site 1 was conducted in June 2001. No live MEC items were encountered during the sweep. A small amount of 20 millimeter (mm) target practice rounds, some MEC scrap, and other non-MEC debris were encountered. A surface sweep for MEC was performed at IR Site 2 in 2002. An OEW characterization was conducted (TtFW, 2004a). In addition to these surface characterization activities within IR Site 2, a time-critical removal action to excavate OEW to a depth of 1 foot from the Possible OEW Burial Site was also performed in 2002 (FWENC, 2002b). An MEC sweep of IR Site 32 has not been conducted.

Prior to beginning the radiological survey, all site personnel will be given a MEC briefing that will describe likely shapes and sizes of MEC items that might be encountered and procedures to follow if any are found. If an MEC item or suspected MEC item is discovered during non-intrusive activities, the survey crew will not disturb it in any manner. An area around the item will be marked with stakes and caution tape, and the SHSS will be notified immediately. The SHSS will immediately notify the Unexploded Ordnance (UXO) Specialist (Lance Humphrey or his designee), who in turn, will respond to the call and arrive at Alameda Point within 1 hour of notification. The contact information for the UXO Specialist is provided in Section 12.2. The UXO Specialist will identify the MEC item and determine its disposition (safe, unsafe to move) and will take necessary measures to make the site safe to resume surveying.

A UXO Specialist will be present during all intrusive soil sampling activities. The UXO Specialist will investigate each proposed sample location with a White or Schonstedt magnetometer to determine if any metallic debris is present. If the magnetometer indicates that subterranean metal is present, the UXO Specialist will carefully excavate with non-sparking hand tools to that ensure the item(s) is not MEC, or MEC-related.

If MEC items are encountered that are safe to move, the UXO Specialist(s) will place them in a sand-filled box (or other suitable container), transport them to Magazine M353 or M354, place them on a pallet, and lock the magazine. Disposition of the MEC item(s) will occur at a later date. If MEC items are uncovered that are unsafe to move, all non-UXO personnel will evacuate the area (to a distance determined by the UXO Specialist, but no less than 1,250 feet) and the Travis Air Force Base Explosive Ordnance Disposal Detachment will be notified.

8.0 RADIOLOGICAL CONTROL PRACTICES

Radiological control procedures will be implemented during the radiological survey activities at IR Sites 1, 2 and 32. These practices comply with the TtEC corporate radiological protection procedures and are intended to protect the health and safety of workers and the general public.

8.1 ON-SITE RADIOLOGICAL CONTROLS

8.1.1 Personnel Exposure Monitoring

Dose rates at IR Sites 1, 2 and 32 are expected to be below the Nuclear Regulatory Commission (NRC) unrestricted area dose rate of 0.002 rem per hour. The site dose rate is below 0.002 rem per hour, and therefore, it is not likely that workers will receive a dose in excess of 0.5 rem. Therefore, occupational exposure monitoring, in the form of personnel dosimeters, is not required in accordance with 10 CFR 20.1502.

Occupational monitoring will be performed during field activities periodically by collecting dose rates at IR Sites 1, 2 and 32 to ensure that personnel do not encounter dose rates greater than 0.002 rem per hour.

8.1.2 Periodic Monitoring

Periodic contamination and dose rate surveys will be performed during work activities to ensure that project personnel are aware of any changes to the site radiological conditions.

8.1.3 Investigation-derived Waste

All waste generated within the controlled areas of IR Sites 1, 2 and 32 will be managed as described in Section 10.0, Waste Management, of this Radiological Survey Work Plan.

8.1.4 Personnel Survey Procedure

Personnel exiting the controlled area of IR Sites 1, 2 and 32 will undergo a personnel survey prior to exiting the controlled area if, during the field activities, elevated radiological readings are observed.

If a worker finds contamination while surveying out of the controlled area, they are to stop and notify the PHP or designee. The potentially contaminated worker will stay at the controlled area entrance to minimize potentially spreading contamination. The PHP or designee will assist the worker in decontaminating the affected areas using standard decontamination techniques. A stop work order will be issued while the potential causes are evaluated and the DON (RASO) is notified of the personnel contamination. Personnel surveys and decontamination will be

performed in accordance with Appendix D-7, Radiological Protective Clothing Selection, Monitoring, and Decontamination.

8.2 RADIOLOGICAL SURVEYING AND SAMPLING

8.2.1 Radiological Surveys

Both portable and fixed radiation monitoring equipment will be used to monitor the radiological condition at the site during work activities. The instruments described in Section 5.4, or equivalent, will be used.

All radiation monitoring equipment used will be calibrated annually in accordance with nationally recognized calibration methods.

Daily monitoring equipment operational checks will be performed prior to first use of the equipment. The daily operational checks will include visual inspection for damage, confirmation of current calibration by inspecting the attached calibration sticker, battery check, and response check.

8.2.2 Sampling

Soil samples will be collected from up to 15 locations to establish the residual 226Ra activity in the soil. Soil sampling activities will be carefully controlled, with personnel collecting the sample, at a minimum, wearing gloves. Samples will be surveyed before they are removed from the area to ensure that the radiation levels of the sample are acceptable to permit release. Release limits are discussed in Section 8.3. Procedures for sample collection, packaging, and shipment are provided in the SAP (Appendix B) and Appendix D-4, Sampling Procedures for Radiological Surveys.

8.2.3 Gamma Spectroscopy

Gamma energy analysis using a portable HPGe system will be performed to scan subsurface point sources for ^{226}Ra. Specific locations for in situ gamma energy analysis will be determined by the PHP based on a review of the radiological survey data collected. Soil samples collected will have a gamma energy analysis performed on them prior to being released and shipped to the contract laboratory for ^{226}Ra analysis. Unconditional release procedures are provided in Appendix D-3, Preparation of Portable Radiation and Contamination Survey Meters and Instruments for Field Use.

8.3 EQUIPMENT AND MATERIAL

A radiological release survey will be performed on equipment used inside the IR Site 1, 2 and 32 controlled areas during the radiological survey to verify that radiological release limits are not exceeded. The release limits will be based on Atomic Energy Commission (AEC) Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors* (AEC, 1974).

The amount of removable radioactive material per 100 cm^2 of surface area will be determined by wiping the area with dry filter or soft absorbent paper and evaluating the wipe for alpha and beta-gamma activity using the sample in a low-background scaler.

The SOP, Release of Materials and Equipment from Radiologically Controlled Areas, which will be followed for the unconditional release of equipment, is provided in Appendix D-5.

The following applies to the release of equipment and material:

1. Removable contamination, determined by smearing with a dry filter: 20 dpm/100 cm^2
2. Average, (fixed and removable) based on a maximum area of 1 m^2: 100 dpm/ 100 cm^2, beta/gamma
3. Maximum, (fixed and removable) based on an area of not more than 100 cm^2: 100 dpm/100 cm^2

8.4 ALARA CONSIDERATIONS

The basic concept in radiation protection specifies that exposures to ionizing radiation and releases of radioactive material should be managed to reduce collective doses to workers and the general public ALARA. The work activities performed by TtEC and subcontractors will be conducted in a manor that minimizes any potential exposure to radioactive material.

8.5 TRAINING

All personnel conducting fieldwork described by this Radiological Survey Work Plan will be provided with general awareness training for radiation. General awareness training provides the worker with a basic knowledge of the hazards, health concerns, and protective practices related to radiation and radioactive materials. Additional training requirements are discussed in Section 4.1, Personnel Training/Certification Requirements.

9.0 DEMOBILIZATION

Demobilization will consist of decontamination, radiological screening, and removal of all temporary site facilities, equipment used to conduct the investigation, as well as collection and disposal of all contaminated material, including decontamination water and disposable equipment for which decontamination is inappropriate.

9.1 DECONTAMINATION

Prior to removal from the site, equipment and material that had the potential to become radiologically contaminated will be decontaminated in accordance with Appendix D-8, Decontamination of Equipment and Tools. Heavy equipment will be decontaminated using heavy brushes to remove soil and dirt attached to the equipment surfaces. Special attention will be paid to remove material on the undercarriage of the ATVs and man lifts. Items for which decontamination is difficult or impossible to verify, such as plastic liners, will remain on site until completion of the work for subsequent packing and off-site disposal at an approved disposal facility. Decontamination of temporary facilities located within the support zone will be limited to exterior cleaning. Hand tools used for the radiological survey and soil sampling activities will be decontaminated per the procedures presented in the SAP (Appendix B). An unconditional release survey will be performed on equipment and material decontaminated as summarized in the section below and detailed in Appendix D-5, Release of Materials and Equipment from Radiologically Controlled Areas, which will be followed for the unconditional release of equipment.

9.2 FREE-RELEASE SURVEY

As part of the demobilization activities, free-release surveys will be conducted on all equipment, tools, and storage units prior to their demobilization and decommissioning. Free-release surveys will be performed using both an alpha survey meter and a beta-gamma survey meter. The free-release criteria is less than 20 dpm for removable alpha contamination and less than 100 dpm total for the combined fixed and removable beta-gamma contamination. Swipes will be taken to ensure that no removable contamination is present. Free-release survey details and measurement results will be recorded in a radiological release survey report and the radiological release log. The radiological release survey report and radiological release log are attachments to the unconditional release survey procedure provided in Appendix D-5, Release of Materials and Equipment from Radiologically Controlled Areas.

Free-release survey elements for ATVs, man lifts and similar rubber tire equipment will include surface scans and may include removable contamination smears taken on all four tires, the cab interior and undercarriage.

Hand tools used for the radiological survey and soil sampling activities will be surveyed for free release. Tools include a hand auger, shovels, hand tools, brooms, and similar items. If equipment survey results are below the site free-release criteria, the equipment will be released to the appropriate responsible party.

9.3 DEMOBILIZATION

Demobilization will consist of cleaning the project site, final inspection, and certification of completion (including the free-release certification described in Section 9.2). The activities will include collection and disposal of all non-contaminated and all contaminated material including decontamination water and disposable equipment for which decontamination is inappropriate.

Demobilization work will include repair of any erosion or runoff-related damage. Cleaning the project site will include cleaning of all areas used for temporary facilities (site trailer, conex boxes, sanitary units, and waste storage areas); off-site removal of temporary facilities and all materials such as excess investigation materials and supplies; and disposal of all contaminated material including decontamination water, disposable personal protective equipment (PPE), and materials for which decontamination is inappropriate.

10.0 WASTE MANAGEMENT

Minimal waste will be generated from the planned field activities. Waste will be limited to small quantities (for example, a few 55-gallon drums) of non-hazardous investigation-derived waste from the radiological survey and soil sampling activities. The waste streams will include decontamination water and used PPE such as booties and gloves. Although not anticipated during this phase of the project, if radiological materials (point sources) are encountered, they will be characterized using on-site gamma spectroscopy, containerized, the containers will be labeled per Title 10 CFR, Part 20 federal regulations and placed on a pallet in a designated LLRW temporary storage area.

10.1 USED PERSONAL PROTECTIVE EQUIPMENT

All used PPE will be non-hazardous and once frisked and cleared for radiation, will be placed within DOT-approved 55-gallons drums, labeled, and then staged within the designated waste container storage area. If elevated radioactive levels are encountered, PPE will be placed in a separate drum for further evaluation. This area will be pre-designated prior to commencement of survey and sampling activities, and it will be secured to prevent unauthorized access and commingling of incompatible materials pending characterization and appropriate disposal.

10.2 WASTEWATER

Small volumes of wastewater, generated from equipment and personnel decontamination, will be collected in 55-gallon drums, and labeled as "Non-hazardous Decontamination Water." The drums will be temporarily staged within a pre-designated and secondarily contained on-site waste accumulation area pending characterization and appropriate disposal.

Containers of free liquids will be stored in accordance with the following secondary containment requirements including the following:

- A base free of cracks or gaps and sufficiently impervious to contain leaks, spills, and accumulated precipitation until the collected material is detected and removed.
- The base will be sloped or the containment system will be otherwise designed and operated to drain and remove liquids resulting from leaks, spills, or precipitation. Alternatively, the containers may be elevated on pallets to prevent contact with accumulated liquids.
- The containment system will have sufficient capacity to contain 10 percent of the volume of containers or the volume of the largest container, whichever is greater, plus the maximum rainfall from a 25-year, 24-hour storm event.

Spilled or leaked waste and accumulated precipitation will be removed from the sump or collection area in a timely manner to prevent overflow of the collection system.

10.3 CONTAINER LABELING

Containers determined to contain non-hazardous waste will be labeled accordingly, and a non-hazardous label will be completed and attached to each drum. The label will include the following:

- Name and address of the generator
- Description and origin of the contents
- Date of generation (date first waste drop placed in container)

Although not anticipated during this phase of the project, if radiological materials are encountered, each drum containing radiological waste will be properly labeled, placed on a pallet in a designated LLRW temporary storage area, and labeled per Title 10 CFR Part 20 federal regulations. The drums will be posted with a "Caution – Radioactive Materials" sign and the maximum surface radiation level will be measured in milliroentgens per hour (mR/hr) and will be noted on the sign.

10.4 INSPECTIONS

Inspections of the container storage areas will be conducted and documented weekly and will include an evaluation for proper labeling, secure closure, the condition of each container/tank, number of containers/tanks, and condition of the storage area(s). Any signs of deterioration, leaking, or dents will be noted, and containers will be immediately overpacked, if necessary. Standing water will be removed from the containment area as necessary. Inspection results will be provided to the ROICC, as requested. All containers will be checked to ensure that labels and markings are in good condition. DOT information, including proper shipping descriptions and hazard class labels, will be added to containers prior to shipping. Containers of LLRW, if present, will also be inspected and logged weekly pending proper disposition.

10.5 WASTE TRANSPORTATION AND DISPOSAL

This section describes the disposal methods for the non-radiological waste materials generated at the site. Although not anticipated, the transportation and disposal of any LLRW will be coordinated by the RASO through the DoD/DON LLRW program.

10.5.1 Waste Transportation

Wastes will be transported by a subcontractor approved under TtEC subcontractor qualification procedures. The transporter will have all appropriate licenses, including an EPA identification number. All wastes will be properly classified, described, packaged, marked, and labeled for

shipment as required by applicable sections of Title 49 CFR, Parts 171, 172, 173, 178, and 179. Properly DOT-trained personnel will perform DOT functions.

Shipping Description – Material that does not exhibit one of the nine DOT hazard classes (for example, explosive, flammable, poison, combustible, and so forth) is not regulated under DOT rules for the transportation of hazardous material. The Compliance Officer or the DOT Coordinator will confirm this description prior to shipment. The applicable DOT shipping description will be selected based on the results of the waste characterization.

- Marking and Labeling – The shipping name, hazard class, identification number, technical names, EPA markings and waste code numbers, and consignee/consignor designations must be marked on packages for shipment in accordance with Title 49 CFR, Part 172. This information will be marked on each container, as required, after consultation with the Compliance Officer or DOT Coordinator.
- Manifest – All wastes shipped off site must be sent under a non-hazardous manifest. Manifests will be completed or reviewed by TtEC and require DON signature before the waste leaves the site. Copies of all manifests will be retained in the project files; original copies will be sent with the transporter.

10.5.2 Off-site Disposal

All wastes intended for off-site disposal will be processed according to the final waste classification and approved profile from the intended disposal facility. Used PPE and wastewater classified as non-hazardous waste will be transported to an appropriately permitted and CERCLA Off-site rule-approved landfill for disposal subject to approval under TtEC subcontractor qualification procedures.

11.0 ENVIRONMENTAL PROTECTION REQUIREMENTS

The existing natural resources within the vicinity of the site consist of marine and biological resources; however, due to the disturbed and developed nature of the site, there are no sensitive or critical habitat or biota in the site area. Descriptions of pertinent information about resources in the area of the site are presented below.

11.1 PRE-SURVEY SITE CONDITIONS

A site visit was conducted in February 2006, by Mr. Glenn Nardin of TtEC's Construction Division, to document existing environmental conditions and physical features of IR Site 32 and the shorelines of IR Sites 1 and 2 prior to vegetation clearance and radiological survey activities. Photographs taken that day depict typical vegetation, terrain features, and the general condition of the site and surrounding areas. Photographs documenting the pre-survey site conditions are provided in Appendix G.

11.2 VEGETATION CLEARANCE

Prior to the start of field activities, all on-site personnel will be briefed on the protection of natural resources. The TtEC Biologist will perform the worker education briefing, emphasizing the need for minimizing impacts on sensitive biological resources, as well as methods for avoiding and minimizing potential impact on the species and communities of concern. A Vegetation Clearance Plan (TtEC, 2006a) has also been prepared that details vegetation clearance activities.

Prior to initiation of vegetation mowing, the TtEC Biologist will examine all areas proposed for mowing. No active nests will be directly impacted during mowing activities. If potentially active nests are discovered, then these specimens will be temporarily avoided until nesting status can be determined. For the potentially active nests, two survey events (separated by a 24-hour interval) will be initiated to determine nesting status that will document animal behavior (nest building, eggs or young present, and so forth). If active nesting status is determined during vegetation removal activities, TtEC will not conduct any vegetation removal activities within 3 meters of nests and will immediately notify the appropriate regulatory agency (USFWS). Inactive nests are those nests discovered from last season that are unoccupied and show no physical signs of recent activity (no whitewash, feathers, and so forth, discovered). Inactive nests are void of fresh sign and typically contain cobwebs. These nests will be included as part of the vegetation clearance.

TtEC will clear the vegetation in the work area, as defined by the scope of work presented by the DON. For the purpose of this plan, "clearing and grubbing" is defined as the cutting of grasses and brush to a height of 2 inches above the existing ground surface. Field crews will use a variety of equipment in a manner needed to meet the work objectives. Open field areas may be

cut with power mowers. The TtEC Biologist will assist the field crews on the identification of the appropriate vegetation to be removed and method of removal. All cut vegetation will remain in place or hauled to bare ground areas within the site limits. Mature trees (dominant and codominant crown class), as identified by the TtEC Biologist, will not be removed and some hand-clearing may be required around them. Large brush/woody multi-stemmed shrubs (stems 2 inches to 10 inches in DBH) will be evaluated by the TtEC Biologist prior to removal. Large material (if required) will be mulched and cuttings broadcasted across site. No off-site disposal of vegetation is planned.

The following equipment may be mobilized to the site for the vegetation clearance:

- Kubota skip loader with mower (1)
- Brush chipper (1)
- 500-gallon vehicle trailer-mounted water tank (1)
- Portable toilets and sinks (2)
- Brush trimmers (3)

Equipment mobilized to the site will be inspected by TtEC field personnel for work suitability in accordance with established health and safety procedures.

Radiological Protocol During Vegetation Clearance

The former Radiological Shack area in IR Site 2 and areas in IR Site 32 are expected to require some form of vegetation clearance prior to performing radiological surveys. Vehicles and machinery that are used for vegetation clearance will be appropriately monitored for radiation before being released from the site. Loose soil and debris will be removed from machinery before demobilization and swipe samples are to be taken from the seats, control surfaces, tires (or tracks) and blades from each piece of equipment. Appendix D-5, Release of Materials and Equipment from Radiologically Controlled Areas, will be followed for the unconditional release of equipment.

Personnel exiting the controlled area of IR Sites 1, 2 and 32 will undergo a personnel survey prior to exiting the controlled area, if during the field activities, elevated radiological readings were observed in accordance with Appendix D-7, Radiological Protective Clothing Selection, Monitoring, and Decontamination.

11.3 EXISTING ENVIRONMENTAL CONDITIONS

IR Sites 1 and 32 are located in the northwest section of Alameda Point, while IR Site 2 is located in the southwest section. IR Sites 1 and 32 are bordered on the north by the Oakland Inner Harbor and IR Sites 1 and 2 are bordered on the west by the San Francisco Bay. There are

numerous existing uses of the San Francisco Bay, which are designated in the *Water Quality Control Plan, San Francisco Bay* (Regional Water Quality Control Board [RWQCB], 1995) and include industrial service supply; navigation; water contact recreation; non-contact water recreation; ocean commercial and sport fishing; saline water habitat; and preservation of rare and endangered species, marine habitat, fish migration, and shellfish harvesting (RWQCB, 1995). The information provided below is specific to the survey areas (Figure 1-2, Radiological Survey Areas).

IR Site 32

IR Site 32 is approximately 5.8 acres in size, located in the northwest portion of Alameda Point. It abuts IR Site 1 on the west and the Oakland Inner Harbor on the north. A taxiway runs adjacent to the site, between the site and the harbor; several abandoned buildings and a munitions bunker are on the site. The perimeter of the site is fenced.

The primary vegetation on the site is comprised of non-native grasses, with occasional clumps of ice plant. Approximately half of the site is covered with vegetation, the remainder with concrete, asphalt, or buildings. There are no trees or shrubs. Canada geese, *Branta canadensis*, nest in the ice plant and Black phoebe, *Sayornis nigricans*, nest in the abandoned buildings. Ground squirrels, feral rabbits, and black-tailed jack rabbits are found in the area, but none were seen on the site during the April 2006 survey.

IR Site 1 Shoreline

The shoreline along IR Site 1 (San Francisco Bay) has been reinforced with broken concrete and asphalt. This area is referred to as the coastal margin. It averages approximately 50 feet wide; it is offset from the site proper by a low berm. The berm slopes fairly steeply to the water. The primary vegetation is ice plant, with some non-native grasses mixed in. The ice plant and riprap are used by nesting Canada geese, *Branta canadensis*; the riprap is used for shelter by feral rabbits and ground squirrels. There are a few small (less than 4 feet) coyote bushes in the northernmost portion of the site. Red-tailed hawks use several of the trees located in IR Site 1 and a nearby communications tower as perches, but no nests have been seen in the trees or on the tower.

IR Site 2 Shoreline

The area between the berm and the shoreline on the south and west side of IR Site 2 is referred to as the coastal margin. It averages about 100 to 150 feet wide. It is characterized by shoreline riprap, primarily broken concrete and asphalt debris, and large amounts of flotsam and wind-blown debris. The primary vegetation is ice plant. There are no structures, trees, or electrical poles or wires; periodic "No Trespassing" signs are spaced above the high water mark. Ground squirrels, feral rabbits, and feral cats use the riprap for shelter. Ground squirrels use the ice plant

as a food source. Western gulls, *Larus occidentalis*, and Canada geese, *Branta canadensis*, use the coastal margin for nesting, both on the riprap and in the ice plant. Killdeer, *Charadrius vociferous*, nest on gravel areas in the coastal margin and on the dirt road on the top of the berm. Other avian species (raptors) use the "No Trespassing" poles for resting or feeding, but do not nest in the coastal margin.

Former Radiological Shack Area

A structure known as the Radiological Shack was located in the northernmost portion of IR Site 2, immediately adjacent to the chain-link fence. The structure is no longer there, but is shown on historical maps. The actual dimensions of the Radiological Shack are not known; however, it is thought to encompass an approximate area of 25-foot by 25-foot. The approximate location of the Radiological Shack is shown on Figure 2-2.

Several (six to eight) large trees, non-native grasses and thistles, and stockpiles of dirt/gravel comprise this area are located within the vicinity of the Radiological Shack. Ground squirrels, feral cats and rabbits, and black-tailed jack rabbits are found in the area and use the area under the trees for shelter and feeding. No bird nests were found in the trees during an April 2006 biological survey, but some nesting by small passerines such as house finches probably occurs. The trees are used as perches by red-tailed hawks.

There are no structures, utility poles, or wires in this small area. A dirt road, used to access the remainder of IR Site 2 runs through the area

11.3.1 Threatened, Endangered and Sensitive Species

Special-status species that could potentially occur at IR Site 1 are summarized below. The species listed below are federally or state-designated threatened or endangered species. Some species do not have legal status under federal or state endangered species acts but are identified by the state of California as "Species of Special Concern." However, none of the plants or wildlife identified below have been found during historical or present vegetation and wildlife surveys performed from 1995 to 2004 at IR Site 1.

Contra Costa goldfields *(Lasthenia conjugens)*

Santa Cruz tarplant *(Holocarpha macradenia)*

Kellogg's horkclia *(Horkelia cuneata sericea)*

Point Reyes bird's beak *(Cordylanthus maritimus palustris)*

Adobe sanicle *(Sanicula maritima)*

Chinook salmon *(Oncorhynchus tshawytscha),* winter run

Longfin smelt *(Spirinchus thaleichthys)*

Delta smelt *(Hypomesus transpacificus)*

Coho salmon *(Oncorhynchus kzsutch)*

Alameda whip snake *(Masticophis lateralis euryxanthus)*

California least tern *(Sterna antillarum browni)*

American peregrine falcon *(Falco peregrinus anatum)*

Western snowy plower *(Charadrius alexandrinus nivosus)*, coastal population

Saltmarsh common yellowthroat *(Geothlypis trichas sinuosa)*

Alameda song sparrow *(Melospiza melodia pusillula)*

Double-crested cormorant *(Phalacrocorax auritus)*, rookery sites

California black rail *(Laterallus jamaicensis coturniculus)*

California clapper rail *(Rallus longirostris obsoletus)*

Caspian tern *(Sterna caspia)*, nesting colonies

Forster's tern *(Sternaforsteri)*, nesting colonies

California brown pelican *(Pelecanus occidentalis californicus)*, nesting colony

California horned lark *(Eremophila alpestris actia)*

Loggerhead shrike *(Lanius ludovicianus)*

California gull *(Larus californicus)*

Northern harrier *(Circus cyaneus)*, nesting sites

Merlin *(Falco columbarius)*

Long-billed curlew *(Numenius americuanus)*, breeding sites

Burrowing owl *(Athene cunicularia)*, burrowing sites

Common loon (*Gavia imer)*, breeding colony

Fork-tailed storm petrel *(Ocanodromafurcata)*, rookery sites

American white pelican *(Pelicanus erythrorhynchos)*, nesting colony

Clark's grebe *(Aechmophorus clarkii)*

Western grebe *(Aechmophorus occidentalis)*

Great blue heron *(Ardea herodias)*, rookery sites

Great egret *(Casmerodius albus)*, rookery sites

Snowy egret *(Egreta thula)*, rookery sites

Black-crowned night heron *(Nycticorax nycticorax)*, rookery sites

Black-shouldered kite *(Elanus caeruleus)*, nesting colony

Common murre *(Uria aalge)*, nesting colony

Saltmarsh harvest mouse *(Reithrodonomys raviventris)*

San Francisco dusky-footed woodrat *(Neotomafuscipes annectens)*

Townsend's western big-eared bat *(Plecotus townsendii townsendii)*

California mastiff bat *(Eumops perotis californicus)*

Northern (Steller) sea lion *(Eumetopias jubatus)*

Saltmarsh wandering shrew *(Sorex vagrens halicoetes)*

Alameda Island mole *(Scapanus latimanus parvus)*

11.4 WORK COMPLIANCE REQUIREMENTS

This section describes the associated environmental compliance procedures and the specific environmental permitting, regulatory, procedural, and training requirements. This section is also a primary component of TtEC's Compliance Program, which includes on-site environmental compliance inspections.

Worker Education

Prior to the start of field activities, all on-site personnel will be briefed on the protection of natural resources, including compliance with the Migratory Bird Treaty Act, Endangered Species Act, and so forth. The TtEC Project Biologist will perform the worker education briefing, emphasizing the need for minimizing impacts on sensitive biological resources, as well as methods for avoiding and minimizing potential impacts to specific species and communities of concern.

Migratory Bird Treaty Act

Migratory birds identified under Section 10 of the Migratory Bird Treaty Act are protected from unregulated taking (destruction). The site is on an essential portion of the Pacific Flyway bird migration route. Migratory birds have been observed at the site. The established breeding season is typically between March 31 and September 15.

No active nests or migratory birds will be directly impacted during activities. Prior to initiation of work, the TtEC Project Biologist will examine all areas proposed for disturbance for the presence of nesting birds. Inactive nests are those nests discovered from last season that are unoccupied and show no physical signs of recent activity (no whitewash, feathers, and so forth discovered). Inactive nests are void of fresh sign and typically contain cobwebs. If potentially active nests are discovered, then these specimens will be temporarily avoided until nesting status can be determined. If potentially active nests are discovered, two survey events will be initiated to determine status and to document animal behavior (nest building, eggs or young present, foraging, and so forth). If active or resident status is determined during survey activities, no activities will be conducted within 3 meters of nests and the appropriate regulatory agency (USFWS) will immediately be notified.

Endangered Species Act

To comply with the requirements of the Federal Endangered Species Act, prior to initiation of work, the TtEC Project Biologist will examine all areas proposed for disturbance for the presence of listed and candidate species. If species protected under Endangered Species Act are discovered within the site or within 1,000 feet of the project impact area, site activities with the potential to adversely affect these species will be prohibited until the appropriate regulatory agency (USFWS or National Marine Fisheries Service) can be consulted.

National Wildlife Refuge System Administration Act

The DON will coordinate with USFWS refuge staff during site activities to comply with the NWRSA. The USFWS refuge staff will be informed of the survey schedule and dates prior to conducting any activities. The USFWS refuge staff will be consulted prior to and during the implementation of the site activities to minimize adverse effects to sensitive species on site.

11.5 SPILL PREVENTION, RESPONSE, AND REPORTING

Spill prevention, including secondary containment requirements, response, and reporting requirements, are provided below.

11.5.1 Spill Prevention

Secondary containment will be used in the liquid substance storage areas to contain spills and releases should they occur. Secondary containment will include lined, bermed areas constructed of polyethylene sheeting. Secondary containment will be inspected and maintained to ensure the integrity of the containment system. In addition, to prevent, minimize, and clean up oil and/or fluid leaks from field equipment, all vehicles will be frequently inspected and properly repaired. Equipment leaks will be addressed immediately, or the equipment will be removed from the site. Sufficient quantities of drip pans and other spill control materials (absorbent pads, booms, materials, and so forth) will be stored on site in readily accessible locations.

11.5.2 Spill Response

An emergency response section is included as a part of the SHSP (Appendix A). The SHSP is designed to prevent the spread of contaminants to adjacent, populated areas and to delineate contingency procedures to be used in the event of injuries to employees or other site-related accidents. Off-site contamination could occur as a result of an accidental release of contaminated materials. The emergency response includes the procedures to be used to mitigate the harmful effects of such a release, as well as rescue and first aid services to be rendered.

11.5.3 Spill Reporting

The following steps describe the chain of communications to be followed to evaluate reporting requirements if a significant spill of any hazardous substance occurs. Site personnel involved in the spill will immediately contact the PQCM.

The PQCM will contact the PjM, who will in turn contact the DON RPM. In addition, the PQCM will also notify the following Project Environmental Safety Manager (PESM) as appropriate.

PESM	Roger Margotto TtEC (619) 471-3503

If a release of a hazardous substance could threaten human health or the environment or if it exceeds a reportable quantity, the PjM will recommend that the DON RPM notify the following:

Local Emergency Response Coordinator:	911 or (925) 447-4257 if calling from a cellular phone
California Office of Emergency Services:	(800) 852-7550
National Response Center:	(800) 424-8802

The report, to be made by the DON RPM immediately upon knowledge, but no later than 24 hours, will indicate:

1. Name, address, and EPA identification number, if applicable, of the generator
2. Date, time, and type of incident
3. Quantity and type of hazardous waste involved
4. Extent of injuries, if any
5. Quantity and disposition of any recovered materials

A written report from the DON RPM may also be required within 5 days.

12.0 PROJECT MANAGEMENT

The project management team will be responsible for all technical and administrative aspects of the radiological survey activities. Included among the team's responsibilities are the project schedule, staffing, data management, document control, project meetings, and reporting.

12.1 PROJECT SCHEDULE

The proposed schedule for implementation of the survey is included in this Radiological Survey Work Plan as Figure 12-1. The schedule is presented in a critical path method format. The schedule has been prepared using a PC-based cost, scheduling, and control system called PRIMAVERA®. PRIMAVERA has many features, including the identification of critical paths and the ability to compare the initial base plan to the current project schedule.

The schedule includes preparatory activities; background static measurements, survey and sampling of IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack area in IR Site 2, demobilization, and final report preparation. Survey activities have been planned to start after approval of the Radiological Survey Work Plan and procurement of the necessary equipment, materials, and subcontracting services.

Six main activities will be followed during the course of this project:

- **Stage 1 – Preparatory activities.** This stage includes preparation of the project submittals including the Radiological Survey Work Plan, notifications and procurement.
- **Stage 2 – Background measurements.** This stage includes mobilization and conducting radiological measurements in three background areas.
- **Stage 3 – Radiological survey and sampling of IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack in IR Site 2.** This stage includes conducting the surface radiological survey and biased subsurface radiological sampling.
- **Stage 4 – IR Sites 1, 2 and 32 Dosimetry Study.** This stage includes placement of up to 200 TLDs along the shoreline areas for a period of up to 3 months.
- **Stage 5 – Demobilization.** This stage includes decontamination of all project equipment; removal of decontamination wastewater, used PPE, and other wastes; followed by demobilization of all equipment and materials.
- **Stage 6 – Final Report.** This stage includes preparation of a final report to document the results of all radiological survey activities performed at IR Sites 1, 2 and 32.

12.2 PROJECT RESPONSIBILITIES

The DON RPM for this project is Mr. Andrew Baughman. Mr. Baughman is responsible for project management, budget control, schedule maintenance, and contacting regulatory agencies. Mr. Baughman is also responsible for community relations and ensuring that the radiological survey activities are in compliance with the applicable rules and regulations. Mr. Doug Delong of the CSO is responsible for coordination of survey activities with different DON and City of Alameda departments and personnel. Mr. Gregory Grace is the ROICC, responsible for the technical oversight and QC. Mr. Matthew Slack is the technical representative for the RASO and is responsible for the technical oversight and review of the project documents and all issues related to radiological activities.

TtEC's PjM, Mr. Abram Eloskof, will be responsible for general project administration. Mr. Eloskof oversees budget, schedule, document preparation, and will ensure the quality of all project activities and deliverables. Ms. Jennifer Dessort will act as the PQCM and is responsible for managing the field activities, providing oversight to the subcontractors, and coordinating with the CSO, ROICC, and the PjM. As the PQCM, Ms. Dessort will coordinate with the QC Program Manager (Ms. Mary Schneider) to ensure that all field activities are in compliance with the project specifications. Ms. Dessort will also be the SHSS on site and will be responsible for ensuring that field activities are conducted in compliance with the SHSP (Appendix A). As the SHSS, she will coordinate with the PESM, Mr. Roger Margotto, Certified Industrial Hygienist (CIH). Additional support will be provided by other engineering and technical resources. A project organization chart showing the relationship among select team members is provided as Figure 12-2.

The following is a list of the key project, DON, and regulatory contacts:

Agency	Contact	Project Title
NAVFAC SW 1455 Frazee Road, Suite 900 San Diego, CA 92108-4310	Mr. Andrew Baughman (619) 532-0902 andrew.baughman@navy.mil	RPM
NAVFAC SW Attn: Code 06CA.TM 1455 Frazee Road, Suite 900 San Diego, CA 92108-4310	Mr. Thomas Macchiarella (619) 532-0940 thomas.macchiarella@navy.mil	BRAC Environmental Coordinator
NAVFAC SW CSO – San Francisco Bay Area 410 Palm Ave., Building 1, Suite 161 San Francisco, CA 94130-1806	Mr. Doug DeLong (415) 743-4713 (510) 772-8832 (cellular) douglas.delong@navy.mil	BRAC Environmental Compliance Manager
NAVFAC SW 1455 Frazee Road, Suite 900 San Diego, CA 92108-4310	Ms. Joyce Howell-Payne (619) 532-0923 joyce.howell-payne@navy.mil	Contract Specialist

Agency	Contact	Project Title
NAVFAC SW 1220 Pacific Coast Highway San Diego, CA 92132	Mr. Narciso Ancog (619) 619-532-3046 narciso.ancog@navy.mil	QA Officer
NAVFAC SW 2450 Saratoga Street, Building 110, Suite 200 Alameda Point, Alameda, CA 94501-7545	Mr. Gregory Grace (510) 749-5940 gregory.grace@navy.mil	ROICC
NAVFAC SW 2450 Saratoga Street, Building 110, Suite 200 Alameda Point, Alameda, CA 94501-7545	Mr. Robert Perricone (510) 749-5942 robert.perricone@navy.mil	ROICC/Construction Management Technician
RASO Building 1971 NWS P.O. Box Drawer 260 Yorktown, VA 23691-0260	Mr. Matthew Slack (757) 256-1414 matthew.slack@navy.mil	RASO/Radiological Site Manager
EPA 75 Hawthorne Street (SFD-8-2) San Francisco, CA 94105-3901	Ms. Anna-Marie Cook (415) 972-3029 cook.anna-marie@epa.gov	EPA-RPM
USFWS P.O. Box 159 Alameda, CA 94501	Ms. Rachel Hurt (510) 377-8375 rachel_hurt@fws.gov	USFWS
TtEC 1940 E. Deere Ave., Suite 200 Santa Ana, CA 92705	Mr. Abram Eloskof (949) 756-7521 (714) 620-5530 (cellular) abram.eloskof@tteci.com	PjM
TtEC 1940 E. Deere Ave., Suite 200 Santa Ana, CA 92705	Ms. Mary Schneider (949) 756-7586 mary.schneider@tteci.com	QC Program Manager
TtEC 1230 Columbia St., Suite 750 San Diego, CA 92101	Mr. Lance Humphrey (619) 471-3519 (619) 988-5974 (cellular) lance.humprey@tteci.com	UXO Specialist
TtEC 1230 Columbia St., Suite 750 San Diego, CA 92101	Mr. Roger Margotto (619) 471-3503 (714) 810-3742 (pager) roger.margotto@tteci.com	PESM
TtEC 3200 George Washington Way, Suite G Richland, WA 99352-3429	Mr. Cliff Stephan (509) 371-0140 (509) 430-4655 (cellular) cliff.stephan@tteci.com	PHP
TtEC 1940 E. Deere Ave, Suite 200 Santa Ana, CA 92705	Mr. Nathan Mudry (949) 756-7509 (949) 230-7847 (cellular) nathan.mudry@tteci.com	Project Biologist

Agency	Contact	Project Title
TtEC 1940 E. Deere Ave, Suite 200 Santa Ana, CA 92705	Ms. Jennifer Dessort (949) 756-7541 (949) 466-7573 (cellular) jennifer.dessort@tteci.com	PQCM/SHSS
TtEC 1940 E. Deere Ave., Suite 200 Santa Ana, CA 92705	Ms. Lynn Jefferson (949) 756-7558 lynn.jefferson@tteci.com	Project Chemist

12.2.1 Project Manager

The PjM is responsible for the direction, execution, and successful completion of project tasks to achieve overall project goals. The PjM has the primary responsibility for coordinating activities and concerns with the DON RPMs and RASO. The PjM also has the responsibility and authority to perform the following:

- Coordinating work activities of subcontractors and TtEC personnel and ensuring that all personnel adhere to the administrative and technical requirements of the project
- Monitoring and reporting the progress of work and ensuring that project deliverables are completed on time and within budget
- Ensuring adherence to the requirements of the contract, project scope of work, and the project plans
- Ensuring that all work activities are conducted in a safe manner in accordance with the SHSP
- Attending required meetings, including the pre-construction conference, weekly QC meetings, pre- and post-construction site inspections, and other scheduled and unscheduled meetings
- Serving as the senior contact between the DON and TtEC for actions and information related to the work
- Ensuring effective implementation of the radiological record management program
- Ensuring that all personnel assigned to perform fieldwork are appropriately monitored for exposure to ionization radiation
- Coordinating regulatory site visits

12.2.2 Project Environmental and Safety Manager

The PESM has authority to implement and oversee the TtEC Health and Safety Program. The PESM has the responsibility and authority to perform the following:

- Ensuring that all staff, including subcontractors, comply with the SHSPs, state and federal regulations, and corporate policies
- Interacting with the PjM on all aspects of health and safety from the initial planning phase through fieldwork and closeout
- Providing advice and assistance on any safety, industrial hygiene, or accident prevention issue to the PQCM/SHSS and PjM
- Reviewing all site health and safety documents and cost estimates, and working to properly staff projects
- Working to pre-qualify field subcontractors

12.2.3 Quality Control Program Manager

The QC Program Manager will report directly to the Corporate QC Manager and has the responsibility and authority to perform the following:

- Establishing and maintaining the QC program for the project
- Overseeing the QC program including data acquisition
- Working directly with the PjM and NAVFAC SW QA Officer to ensure implementation of the Program QC Plan
- Acting as a focal point for coordination of all QC project-related matters and resolving all QC issues
- Providing QC direction and training to the PQCM and others who are performing QC functions
- Suspending project activities if quality standards are not maintained
- Interfacing with the DON, including the NAVFAC SW QA Officer, on quality-related items
- Conducting field QC audits to ensure that site QC plans are being followed
- Performing reviews of audit and surveillance reports conducted by others
- Implementing DON technical direction letters related to QC topics

12.2.4 Project Quality Control Manager

The PQCM is responsible for overall management of project QC and will report to the QC Program Manager. The PQCM or an alternate PQCM will be on-site at all times during field activities. The PQCM has the responsibility and authority to perform the following:

- Monitoring activities to ensure conformance with the work plan and that policies, procedures, contract specifications, and sound practices are followed
- Preparing the Daily QC Reports

- Ensuring that the three phases of inspection (preparatory, initial, and follow-up) are implemented for all definable features of work
- Ensuring that required tests and inspections are performed and the results reported
- Attending required meetings, including the pre-construction conference, weekly QC meetings, pre- and post-construction site inspections, and other scheduled and unscheduled meetings
- Issuing and maintaining Field Change Requests (FCRs) and Nonconformance Reports (NCRs) for project activities (construction- and radiological-related)
- Maintaining an NCR and FCR log
- Ensuring that planning documents are current and controlled
- Maintaining the Submittal Register and a Submittal Log
- Stopping work that is not in compliance with the contract

12.2.5 Project Health Physicist

The PHP is responsible for implementing, directing, and supervising all radiological project-related activities. The PHP has the responsibility and authority to perform the following:

- Assisting in the development and approval of the SHSP
- Assisting in identifying radiological analysis needs
- Providing technical support in subcontractor selection
- Providing health physics guidance on an as-needed basis
- Providing radiological control protection services, if required
- Directing and assisting project personnel in proper completion of radiological records
- Ensuring that the required radiological safety training is provided to project personnel
- Reviewing and approving project field procedures that involve the handling of radioactive materials or access to radiological areas
- Ensuring timely and thorough review of records in accordance with Appendix D-9, Radiological Records, prior to approval
- Approving records with verifiable signature and date once records meet the quality standards as described in Appendix D-9, Radiological Records
- Conducting radiation incident investigations
- Conducting radiological project inspections
- Conducting data assessment

12.2.6 Site Health and Safety Specialist

The SHSS ensures that all elements of the approved SHSPs are implemented and enforced on site. The SHSS will report directly to the CIH and will assist in implementing and enforcing the SHSP in the field. The SHSS has full authority to issue stop work orders or evacuation orders where work operations or noncompliance(s) may threaten the health and safety of site workers or the public. The SHSS has the responsibility and authority to perform the following:

- Ensuring that all personnel understand the requirements of TtEC's Environmental Health and Safety (EHS) program and procedures through training and communication
- Ensuring enforcement of SHSPs by means of daily site inspections
- Investigating all accidents, injuries, illnesses, near-misses, and other incidents
- Ensuring that project personnel are trained on the hazards of hazardous substances on the project, maintaining Material Safety Data Sheet file to provide easy access to project personnel and performing inspections to ensure that all waste containers are correctly labeled
- Ensuring that the SHSP is read, understood, and signed by all personnel including subcontractors
- Ensuring that tailgate safety meetings are conducted on days that work is performed and that documentation of all meetings and any other additional training is completed
- Verifying that project safety equipment is inspected, as required by the EHS program
- Coordinating site health and safety requirements with the PjM
- Ensuring maintenance of all health and safety monitoring and personal protective equipment and directing site-monitoring activities
- Coordinating site safety and emergency response duties; verifying site communications system with site personnel
- Performing inspection of safety equipment
- Reporting to the ROICC within 2 hours, all incidents required to be reported by Engineer Manual 385-1-1 (United States Army Corps of Engineers, 2003); and immediately reporting to the ROICC any fatal injury, one or more persons admitted to a hospital, or property damage to government property
- Verifying that all personnel have the necessary training and medical clearance prior to entering the exclusion zone or contamination reduction zone at the site
- Determining and posting routes to medical facilities and emergency telephone numbers arranging for emergency transportation to medical facilities
- Serving as the Project Hazard Communication Coordinator

- Maintaining training records and medical certifications for all on-site personnel including subcontractors
- Initiating necessary revisions or changes to the SHSP
- Maintaining site control procedures
- Maintaining current records of certification for first aid and cardiopulmonary resuscitation for project field personnel
- Attending required meetings, including the pre-construction conference, weekly QC meetings, pre- and post-construction site inspections, and other scheduled and unscheduled meetings

12.2.7 Project Chemist

The Project Chemist oversees sample collection, handling, analysis, and analytical data reporting. The Program Chemist has responsibility and authority for the following:

- Developing the SAP
- Evaluating and selecting qualified subcontract laboratories
- Implementing data QC procedures and performing audit of field performance
- Reviewing off-site laboratory data prior to use
- Coordinating data validation of off-site laboratory data
- Reviewing data validation reports
- Preparing analytical reports and supports project report preparation

12.2.8 Radiological Task Supervisors

Radiological Task Supervisors (RTSs) will direct field survey personnel and health physics operations. The RTS has the responsibility and authority to perform the following:

- Supervising field staff for survey, site remediation and decontamination, use of survey equipment and instrumentation, and support of programs and projects
- Ensuring compliance by Radiological Control Technicians (RCTs) with the applicable SOPs for safety program, survey, and/or remediation actions
- Ensuring compliance with NRC, OSHA, and EPA directives, as well as applicable local, state, and federal statutes and codes
- Interpreting and verifying data accumulated from surveys and monitoring activities
- Maintaining inventory and ensuring safe use and serviceability of tools, equipment, and vehicles on site
- Informing the PjM of work progress

12.2.9 Radiological Control Technicians

The RCTs will support projects in the field. The RCT has the responsibility and authority to perform the following:

- Conducting and documenting field surveys, sampling, and laboratory support in accordance with the Radiological Survey Work Plan and SOPs
- Interpreting and verifying field data accumulated from surveys and monitoring activities
- As assigned, assisting in training support personnel in health physics and safety
- Supporting dose assessments and assuring compliance with QC programs, emergency plans, and procedures
- Performing survey equipment efficiencies, response checks, and daily checks of the survey instruments
- Conducting safety evaluations of health physics field equipment

12.2.10 Remedial Project Manager

The RPM has primary responsibility within the DON for day-to-day management of the project activities performed under this Radiological Survey Work Plan and for their successful completion. The RPM's duties and authority include the following:

- Performing project management for the DON
- Ensuring that the project scope of work requirements are fulfilled
- Overseeing the project cost and schedule
- Providing formal technical direction to the TtEC project team, as needed
- Coordinating with RASO to ensure proper controls are in place
- Acting as lead interface with agencies on non-radiological issues
- Together with the Radiological Site Manager, negotiating radiological release criteria with regulatory agencies

12.2.11 Radiological Site Manager

As a representative of RASO, the Radiological Site Manager has primary responsibility within the DON for the technical accuracy and the regulatory conformance of work performed under this Radiological Survey Work Plan. The Radiological Site Manager's duties and authority include the following:

- Reviewing and approving project work plans and procedures
- Acting as lead interface with regulatory agencies on radiological survey plans and reports

- Together with the RPM, negotiating radiological release criteria with regulatory agencies
- Reviewing and approving project reports
- Ensuring compliance with applicable MARSSIM requirements
- Recommending changes in TtEC scope to the RPM, as appropriate
- Supporting public meetings

12.2.12 Quality Assurance Officer

The QA Officer is the DON representative with primary responsibility for ensuring that contract-required quality assurance measures are in place and effective for the work performed under this Radiological Survey Work Plan. The QA Officer's duties and authority include the following:

- Reviewing and approving the SAP
- Providing DON oversight of the TtEC QA Program
- Providing quality-related directives through Contracting Officer Representative
- Providing technical and administrative oversight of TtEC surveillance audit activities
- Acting as point of contact for matters concerning quality assurance and the DON's Laboratory QA Program
- Coordinating training on matters pertaining to generation and maintenance of quality of data
- Authorizing the suspension of project execution if QA requirements are not adequately followed

12.2.13 Resident Officer in Charge of Construction

The ROICC has the primary responsibility for providing on-site QA and safety oversight of contractors performing work. The ROICC's duties and authority include the following:

- Verifying that all work has been completed per contract and technical specifications prior to final government acceptance
- Performing ongoing field inspections to verify that all work is in compliance with both contract and technical specifications
- Notifying the contractor of any work that is not in compliance
- Interacting with the contractor's PQCM on quality-related issues
- Reviewing and signing waste manifests for non-radiological wastes as the generator's representative
- Reviewing contractor daily reports for completeness and accuracy
- Attending preparatory phase, initial phase, pre-final, and final acceptance inspections

- Attending weekly QC meetings

12.3 DATA MANAGEMENT

The following is a summary of the data management tools that will be employed for the duration of this project:

- PRIMAVERA and Harper Shuman accounting software will be used for all schedule and project cost tracking.
- Home and field office staff for technical data management will use Microsoft® Excel spreadsheets. Microsoft Word will be used for word processing.

12.4 DOCUMENT CONTROL

TtEC's internal document control procedures will be followed for the duration of the project. Additional guidance provided by the DON will be used for document control, particularly for matters relating to regulatory compliance. Management of internal and external correspondence will be administered at the home office in San Diego, California. Document control will include assigning an alphanumeric code to each submittal.

Radiological field records will be prepared, reviewed, and maintained in accordance with Appendix D-9, Radiological Records. The SOP also addresses the retention of radiological records following completion of the project.

12.5 MEETINGS AND REPORTS

Project status/CQC meetings will be held weekly (or at less frequent intervals if desired by the ROICC). The meeting will be held at the project site and will be attended by the PQCM/SHSS, ROICC, and ROICC Construction Management Technician. The PQCM will notify the ROICC at least 48 hours in advance of each meeting. The following shall be accomplished at each meeting:

- Review the minutes of the previous meeting.
- Review the schedule.
- Review the status of submittals.
- Review the work to be accomplished in the following 2 weeks and documentation required. Schedule the three phases of control and testing.
- Resolve QC and production problems.
- Address items that may require revisions to the Project CQC Plan.

Minutes of the meetings will be prepared by TtEC and submitted to the DON. Daily reports will be prepared by the PQCM and submitted to the ROICC. Monthly reports will be prepared by the

PjM and submitted to the RPM. The monthly reports will include work completed by the end of each month and work that is planned for the following month.

13.0 QUALITY ASSURANCE PROGRAM

TtEC's policy is to achieve the highest standards of quality throughout all activities and operations in accordance with all applicable regulations and standards. TtEC's commitment to quality, environmental compliance, and health and safety is fundamental to the Client Service Quality®, Do It Right®, and Shared Vision™ operating philosophies. The Client Service Quality is implemented with Do It Right principles by developing Shared Vision with the client to define cost-effective quality goals, and through internal programs and systems that train, implement, and reinforce a quality work culture.

Quality Control

In order to meet corporate quality commitments, the Program Construction Quality Management Plan (TtEC, 2006b) was prepared for the NAVFAC SW RAC. This plan identifies and describes the elements of the QC system integral to the performance of the program as well as provides framework and criteria for establishing Project CQC Plan (Appendix C).

For each project (also referred to as Contract Task Order), a Project CQC Plan is prepared to provide an effective QC system to ensure the quality of work performed by TtEC and its subcontractor personnel. The purpose of this plan is to establish the specific procedures and methods for field inspections to be performed.

Quality Organization

An organization chart for the NAVFAC SW program is presented in the Program Construction Quality Management Plan (TtEC, 2006b), and an organization chart specific to this project is presented in Figure 12-2. The quality organization presented in the Program Construction Quality Management Plan consists of a QC Program Manager reporting directly to the Director of Quality Programs and works directly with the Program Manager. A PQCM is appointed for each project by the QC Program Manager to serve in the quality function on site. The responsibilities of the QC Program Manager and PQCM are described in Sections 2.2 and 2.3 of the Project CQC Plan (Appendix C), respectively.

Quality Control Plans

The Project CQC Plan (Appendix C) and SAP (Appendix B) identify specific quality requirements for this project. The Project CQC Plan complies with the intent of the Unified Facilities Guide Specifications (UFGS) 01450N (Naval Facilities Engineering Command, 2003). Section 5.0, Field Inspection Plan, of the Project CQC Plan (Appendix C) describes implementation of three phases of control, field QC documentation requirements, and identification, disposition and corrective action of nonconformances.

In addition to information presented in the Project CQC Plan, the following TtEC quality procedures will be used:

- QP-2 Selection and Qualification of Quality Control Personnel
- QP-3 Qualification/Certification of Quality Program Audit Personnel
- QP-11 Control of Nonconforming Conditions
- QP-12 Corrective Action
- QP-13 Surveillances

These procedures can be found in the Corporate Reference Library (CRL) and are available electronically to all TtEC employees. A copy of the CRL on a compact disc will be available at the project site. Employees are notified of all updates to the CRL via e-mail. It is the responsibility of the PjM or designee to make the revised copy of CRL for the site office.

13.1 DATA QUALITY AND REPORTING

Data must be of sufficient quantity and adequate quality in order to make defensible project decisions. The quality system will be applied to the planning, implementation, and assessment phases of this project.

13.1.1 Planning Phase

The planning phase consists of development of DQOs and preparation of the Radiological Survey Work Plan. The DQO process is used in determining the type, quantity, and quality of data to be collected. Results of this process are documented in a table summarizing the DQOs for this project and is presented in the SAP (Appendix B). The SAP also describes sample collection procedures and the established QC program for samples to be submitted to an off-site laboratory. SOPs to be used for collection of field data are included as Appendix D.

13.1.2 Implementation Phase

Prior to data collection, the PQCM will verify that all field personnel have required trainings, and have read and understood the entire approved Radiological Survey Work Plan. All personnel will collect data and calibrate equipment in accordance with applicable SOPs and this Radiological Survey Work Plan. The PHP, who is a Certified Health Physicist, will review field data collected on a weekly basis to determine usability and identify data gaps. If data gaps are determined, the PjM will be consulted prior to directing field personnel to conduct additional measurements. The PQCM will verify that data collection is being performed in accordance with the SOPs (Appendix D), and data collection activities are documented on daily basis.

The PQCM will also verify that samples are collected and shipped to an off-site laboratory for analyses in accordance with the procedures identified in the SAP (Appendix B). Data provided

by the laboratory will be reviewed by the Project Chemist as described in the SAP. Data validation requirements for laboratory data are also provided in the SAP.

13.1.3 Assessment Phase

After data collection is completed, both field and laboratory data will be reviewed and assessed by the PHP and his/her team. The review of data during the survey process is to ensure that data anomalies and missed data are corrected in the field as opposed to having to remobilize to recapture data. Field teams will download their electronic files and provide them on a daily basis along with a completed a Daily Survey Log Form to the Subcontractor's Radiation Control Supervisor. Information contained in this daily log will include, as a minimum, the following: field crews' names, survey date, survey locations, radiological instruments used, electronic data file names, and any "out of the ordinary" conditions or events.

Upon completion of each day's activities, the Subcontractor's Radiation Control Supervisor will sign this log and provide a copy to the PQCM. The PQCM will review this log weekly.

The Subcontractor's Radiation Control Supervisor will process the survey files in GIS software and provide an updated "Site Survey Coverage Map" and electronic database files of the survey data weekly to the PHP.

Survey data will be reviewed by the PHP for soundness and adequacy of areal coverage prior to survey team demobilization from the site. Additional data review and assessment process requirements are described in Section 15.0. Results of this data assessment will be documented in the Final Radiological Survey Report.

13.2 DOCUMENTS AND RECORDS CONTROL

TtEC's quality procedure, QP-1, Preparation, Review and Approval of QA/QC Plan, defines responsibilities and provides requirements and guidance for project QC. This procedure can be found in the CRL.

The PjM and author of the Project CQC Plan identify reviewer(s) for the Project CQC Plan. At a minimum, the QC Program Manager for the NAVFAC SW RAC must review and approve all CQC Plans. Revision to the Project CQC Plan is subject to the same level of review as required by the original CQC Plan.

13.3 AUDIT AND SURVEILLANCES

The TtEC Environmental Safety and Quality Department conducts an internal audit on a regular frequency in the areas of environmental safety and quality of the NAVFAC SW RAC program. This audit program evaluates conformance to the following:

- Project operation procedures
- Scientific, construction, and engineering procedures
- Environmental Health Safety Programs and procedures
- QA/QC programs and procedures
- Project-specific plans and procedures
- Contractual and Regulatory Environmental Safety and Quality requirements
- Management systems
- Other procedures to verify that the process produces the desired results

For each project, compliance of project-specified requirements are evaluated by conducting surveillance of activities. The QC Program Manager or designee typically conducts project surveillances. The TtEC's procedure, QP-13, Surveillances, defines responsibilities and provides requirements and guidance for performing and documenting surveillances. This procedure is also available in the CRL.

A condition or action noted during the surveillance that does not comply with the requirements shall be immediately identified to the personnel responsible to allow them to correct the condition. Corrections that are made immediately shall be reported as such in the Surveillance Report.

If deficient areas were found and were not corrected during the course of the surveillance, they shall be identified for nonconformance or corrective action reporting and appropriate follow-up under QP-11, Control of Nonconforming Conditions, or QP-12, Corrective Action.

If the surveillance performer finds that significant deficiencies exist, and with concurrence of the PjM, Program Manager and other responsible manager(s) it is determined that a work suspension is necessary, an order to suspend/stop work may be issued to suspend activities until the deficiencies are resolved.

14.0 COMMUNITY RELATION ACTIVITIES

Several community relation activities will be conducted to inform the public about the ongoing activities. As the lead agency for the environmental IRP activities at Alameda Point, the DON is responsible for conducting community relation activities for the work at IR Sites 1, 2 and 32.

14.1 PUBLIC INFORMATION

For a complete record of activities associated with this radiological survey, documents will be contained in information repositories that are located at:

1) Alameda Main Public Library (Historic Alameda High School)
   2220-A Central Avenue
   Alameda, California

2) Alameda Point, Former NAS Alameda
   950 West Mall Square, Suite 141
   Alameda, California

The complete Administrative Record is located at 1220 Pacific Highway, San Diego, California, and is maintained by Ms. Diana Silva, NAVFAC SW Administration Record Manager, (619) 532-3676.

14.2 PUBLIC PARTICIPATION

To encourage local participation in the hazardous waste cleanup program at Alameda Point, the DON established a Restoration Advisory Board (RAB). This board is a citizen-based committee representing local community interests. RAB meeting agendas, minutes, and presentation materials are included in the Administrative Record for public review.

The work at IR Sites 1, 2, and 32 will be discussed at regularly scheduled community meetings and with the RAB. All meetings are advertised locally in an effort to encourage public attendance and participation.

15.0 DATA REVIEW

Records and data generated during the radiological survey will receive some level of review. The level and depth of the data review will vary according to the type of record or data generated. During the survey, data may be used in the preliminary assessment before review, but will be reviewed before use in the final survey report.

Three types of records will be generated and reviewed during the radiological survey of IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack within IR Site 2. These records can be classified into three distinct categories: 1) field operation records, 2) laboratory records, and 3) data handling records. Each record type is discussed in the following subsections.

15.1 FIELD OPERATION RECORDS

Field operation records document the activities that will be performed in the field during the radiological survey. Documentation of these reviews will typically consist of an entry into the field logbook noting any correction or deficiencies, and that the review was completed. Field operation records can be divided into the following four categories:

Field measurement records: These records are used to document the measurement protocol used during the field survey. Field notebooks will typically be used to record raw data and make references to prescribed procedures and changes in planned activities. Data collected from the LARADS survey will be transferred electronically to a field computer system for data reduction and analysis. Data transfer records will be produced documenting the transfer of reduced LARADS data to the TtEC PHP for review.

Sample tracking records: Sample-tracking records (chain-of-custody) are used to document the progression of samples as they travel from the original sampling location to the laboratory. The PQCM is responsible for this data review.

QC measurement records: These records include instrument calibration and radiological check/calibration source traceability documentation. The PQCM is responsible for this data review.

Standard Operating Procedures: These records provide the direction for activities to be performed during the survey to ensure that the proper survey protocols are performed during the survey. The PQCM is responsible for ensuring that the SOPs are implemented during field activities.

15.2 LABORATORY RECORDS

Laboratory records are used to document the laboratory analyses performed on soil samples collected during the survey to ensure that the proper analytical and sample management protocols were followed. These records can be divided into the following four categories:

Laboratory measurement results and sample data: These records contain information on the sample analysis used to verify that prescribed analytical methods were followed. A review of the overall number of samples, sample identification, sample measurement results, and any deviations from the requested analytical method will be performed by the PQCM and documented in accordance with the Project CQC Plan (Appendix C). These records will be used to as part of the data review to qualify the sample results.

Sample tracking records: Sample tracking records document sample receipt, handling, and storage. The records will verify that sample tracking requirements were maintained, reflect any anomalies in the samples (receipt of damaged samples), and note proper log-in of samples into the laboratory. The PQCM is responsible for this data review.

Test methods: Test methods describe how the analyses were carried out in the laboratory. This documentation will include sample preparation and analysis, instrument standardization, detection and reporting limits, and method-specific QC requirements. The Project Chemist is responsible for this data review.

QC laboratory measurement records. These include the general QC records, such as initial demonstration of capability, instrument calibration, routine monitoring of analytical performance, calibration verification, blanks, spikes, calibration check samples, replicates, and splits, used to document the QC of the requested analytical method. A third-party validation subcontractor is responsible for this data review.

15.3 DATA HANDLING RECORDS

Data handling records document protocols and methodologies used in data reduction, verification, and validation. Data reduction addresses data transformation operations such as converting raw data into reportable quantities and units, using significant figures and measurement uncertainties.

16.0 SURVEY REPORT

A project survey report will be prepared following the completion of the fieldwork and demobilization. The report will provide a record of activities conducted under the project, document decisions made regarding work options, and describe the basis for considering the work as completed. The report will include the results of field testing, sampling records, and certificates of waste disposal. The report will also provide copies of drawings generated to specify survey activities and final survey maps.

Upon completion of the radiological survey, a survey report will be drafted and submitted to the DON for review and comment. The report will document:

- Measurement and sample locations; provide information on measurement system MDC and measurement errors.
- Observations, abnormalities, and deviations from the SAP or SOPs.
- The need for additional action (none, remediation, more surveys).
- The variability in the background radiation levels at IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack at IR Site 2.

The primary objective of the survey report is to provide a record of the radiological status of IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack at IR Site 2 relative to elevated radiation levels. An additional objective is to identify variability in residual ^{226}Ra activity in collected soil samples that is distinguishable from background.

17.0 REFERENCES

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TABLES

TABLE 3-1

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Regulation	Requirement	Citation	ARAR Determination	Comments
Action-specific ARAR				
Storage and control of licensed material	The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.	10 CFR, Part 20.1801	Relevant and appropriate	Potentially relevant and appropriate for a restricted land use scenario since waste will be left on site.
	The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.	10 CFR, Part 20.1802	Relevant and appropriate	Potentially relevant and appropriate for sites where radioactive material may remain on site if the site can meet the criteria.
Protection of the general population from releases of radioactivity	Performance objectives for the land disposal of LLRW. Concentrations of radioactive material that may be released to the general environment must not result in an annual dose exceeding 25 mrem to the body or any organ of a member of the general public.	10 CFR, Part 61.41	applicable	Applicable for sites where radioactive materials may remain on site if the site can meet the criteria.
Protection of the individuals from inadvertent intrusion	Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.	10 CFR, Part 61.42	Relevant and appropriate	Potentially relevant and appropriate for sites where radioactive waste may remain on site if the site can meet the criteria.
Protection of individuals during operation	Every reasonable effort shall be made to maintain radiation exposures ALARA.	10 CFR, Part 61.43	Applicable	Potentially relevant and appropriate for sites where radioactive waste will remain on site.
Stability of the disposal site after closure	The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.	10 CFR, Part 61.44	Relevant and appropriate	Potentially relevant and appropriate for a site with radionuclides.

Notes:

ALARA – as low as reasonably achievable
ARAR – applicable or relevant and appropriate requirement
CFR – Code of Federal Regulations
LLRW – low-level radioactive waste

TABLE 5-1

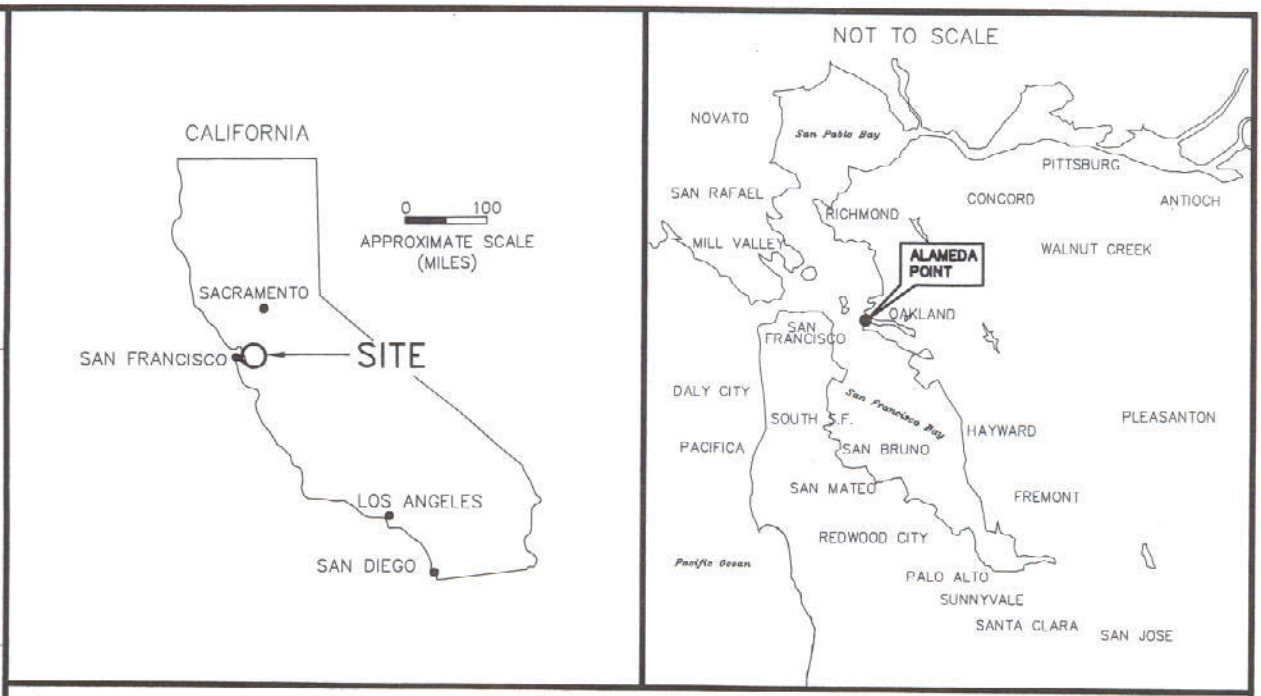
INSTRUMENTATION FOR RADIOLOGICAL SURVEYS

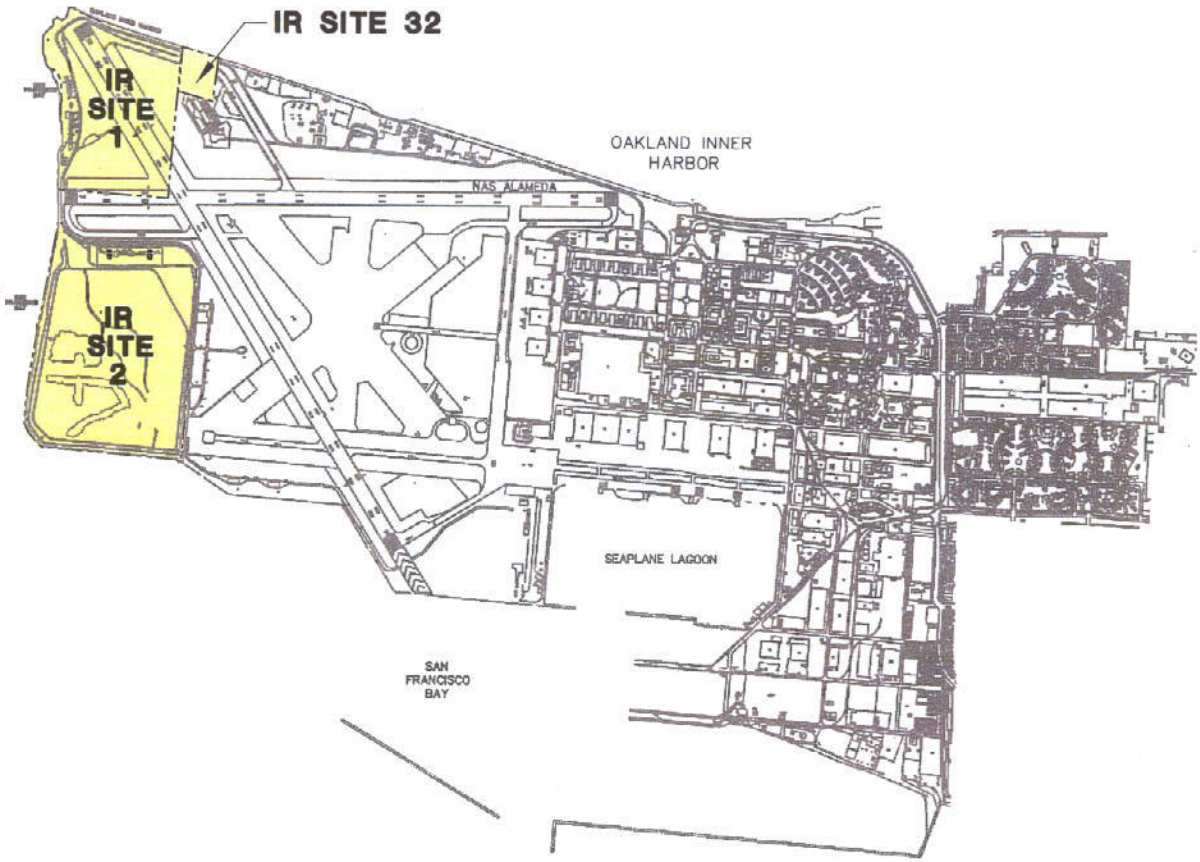
Measurement/ Technique	Type of Instrumentation		Typical Background	Typical Efficiency (%)	Detection Sensitivity
	Detector	Meter			
Surface gamma scans (vehicle-based or hand-held LARADS) or static direct measurement (at soil sample locations)	NaI 2-inch by 2-inch scintillation, Ludlum Model 44-10	Thermo Eberline E-600 (or equivalent)	100 to 12,000 cpm; varies with calibration γ	N/A	200 cpm-2,000 cpm γ. Varies with calibration.
Static alpha/beta scan (contamination surveys)	Dual phosphor (ZnS/NE102) general purpose survey probe HP 380AB (or equivalent) (100 cm^2)	Thermo Eberline E-600 (or equivalent)	100-200 cpm β 5-10 cpm α	~22 β total efficiency ~11 α total efficiency	~ 110 dpm/100 cm^2 β ~ 20 dpm/100 cm^2 α
Exposure rates (area monitoring)	Thermo Eberline MicroREM Meter (or equivalent)	(Same as detector)	7-8 µR/hr	N/A	2 µR/hr
Low background scaler	5-cm (2-inch) diameter alpha and beta sensitive scintillator (or equivalent)	Thermo Eberline HandECount	N/A	~50 β total efficiency ~83 α total efficiency	~ 110 dpm/100 cm^2 β ~ 20 dpm/100 cm^2 α
Gamma energy analysis	High-purity Germanium detector	ORTEC DigiDART	N/A	40-70	N/A

Notes:

α – alpha
β – beta
γ – gamma
µR/hr – microroentgen per hour
cm – centimeter
cm^2 – square centimeter
cpm – count per minute
dpm – disintegration per minute
LARADS – Laser-assisted Ranging and Data System
N/A – not applicable
NaI – sodium iodide

FIGURES





N

N.T.S.

Figure 1-1
SITE VICINITY MAP

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

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DATE: 08/22/06	REVISION: 0		CTO: #0008	

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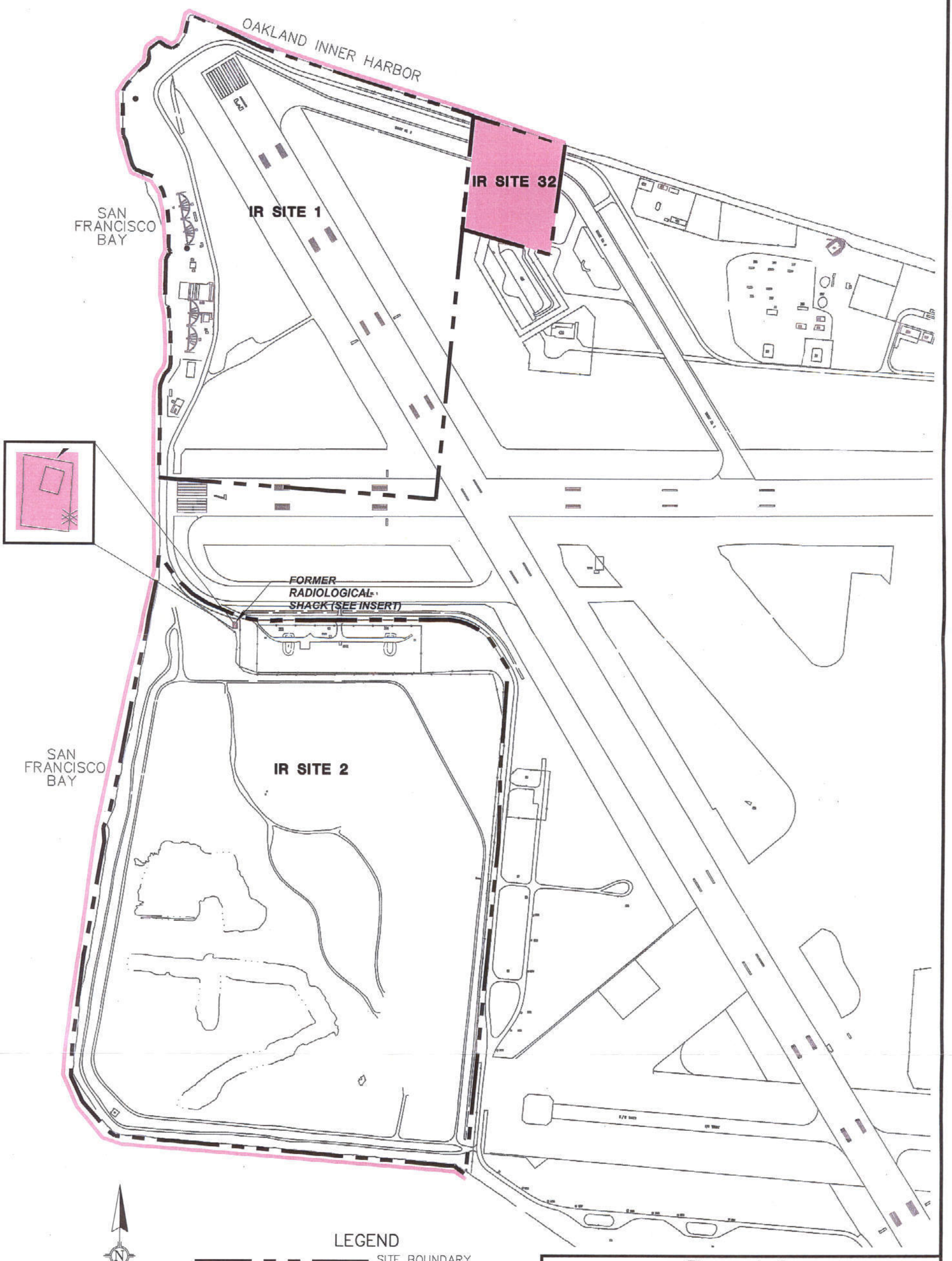
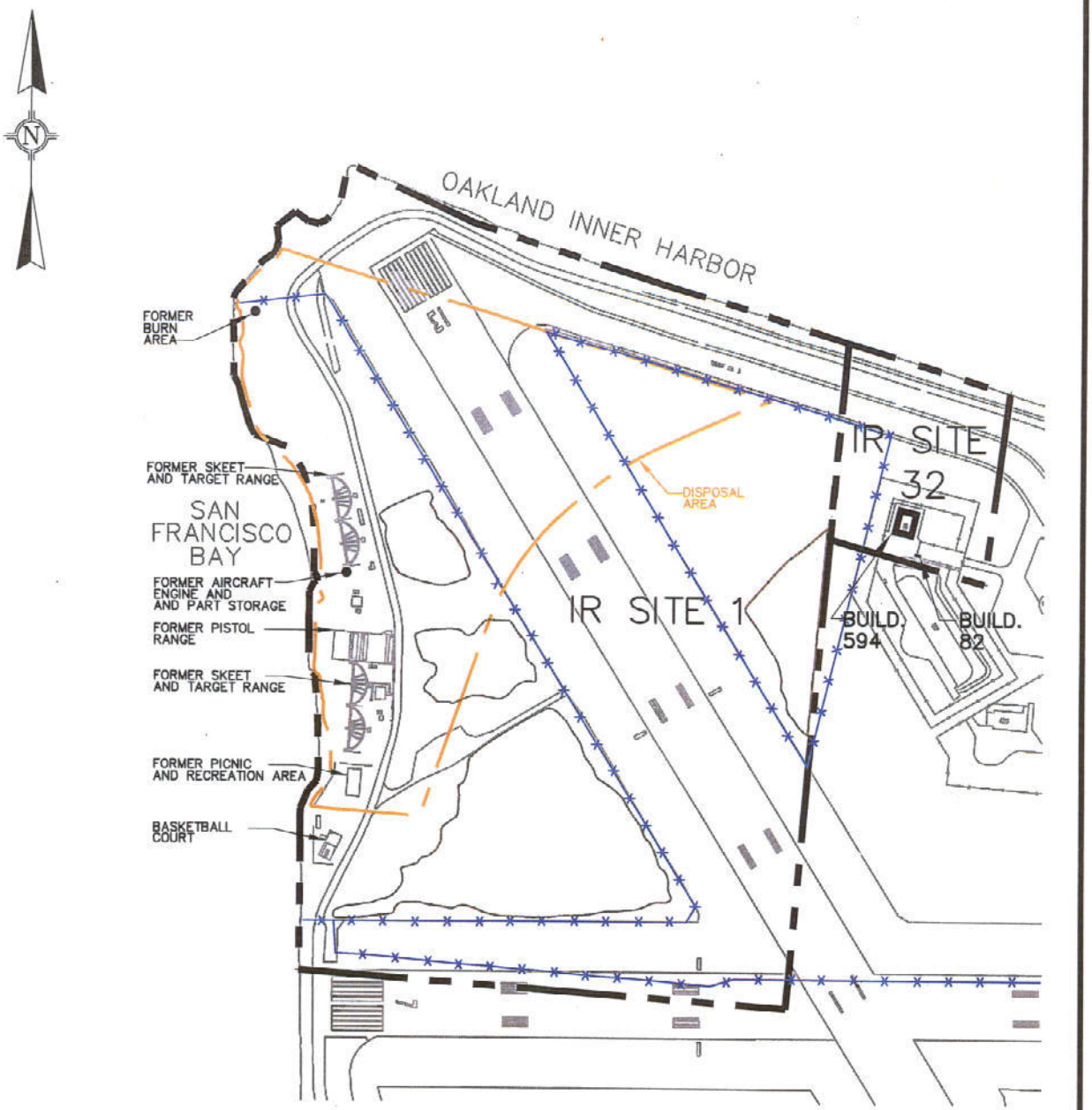


Figure 1-2
RADIOLOGICAL SURVEY AREAS

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.



LEGEND

- IR SITE 1 AND 32 BOUNDARIES
- DISPOSAL AREA BOUNDARY
- FENCE LINE
- SEASONAL WETLAND BOUNDARY

SOURCE:
OU-3 REMEDIAL INVESTIGATION REPORT, FINAL BY TETRA TECH EM INC., PUBLISHED IN RANCHO CORDOVA IN 1999.

500 250 0 500
SCALE IN FEET

Figure 2-1
IR SITE 1 AND 32 SITE DETAIL MAP

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

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CHECKED BY: JA
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DATE: 08/22/06

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LEGEND

- IR SITE 2 BOUNDARY
- FENCE LINE
- PERMANENT WETLAND BOUNDARY
- *SEASONAL WETLAND BOUNDARY*
- BERM
- WE — WETLAND
- OEW — ORDINANCE AND EXPLOSIVE WASTE

500 250 0 500

SCALE IN FEET

Figure 2-2
IR SITE 2
SITE DETAIL MAP

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

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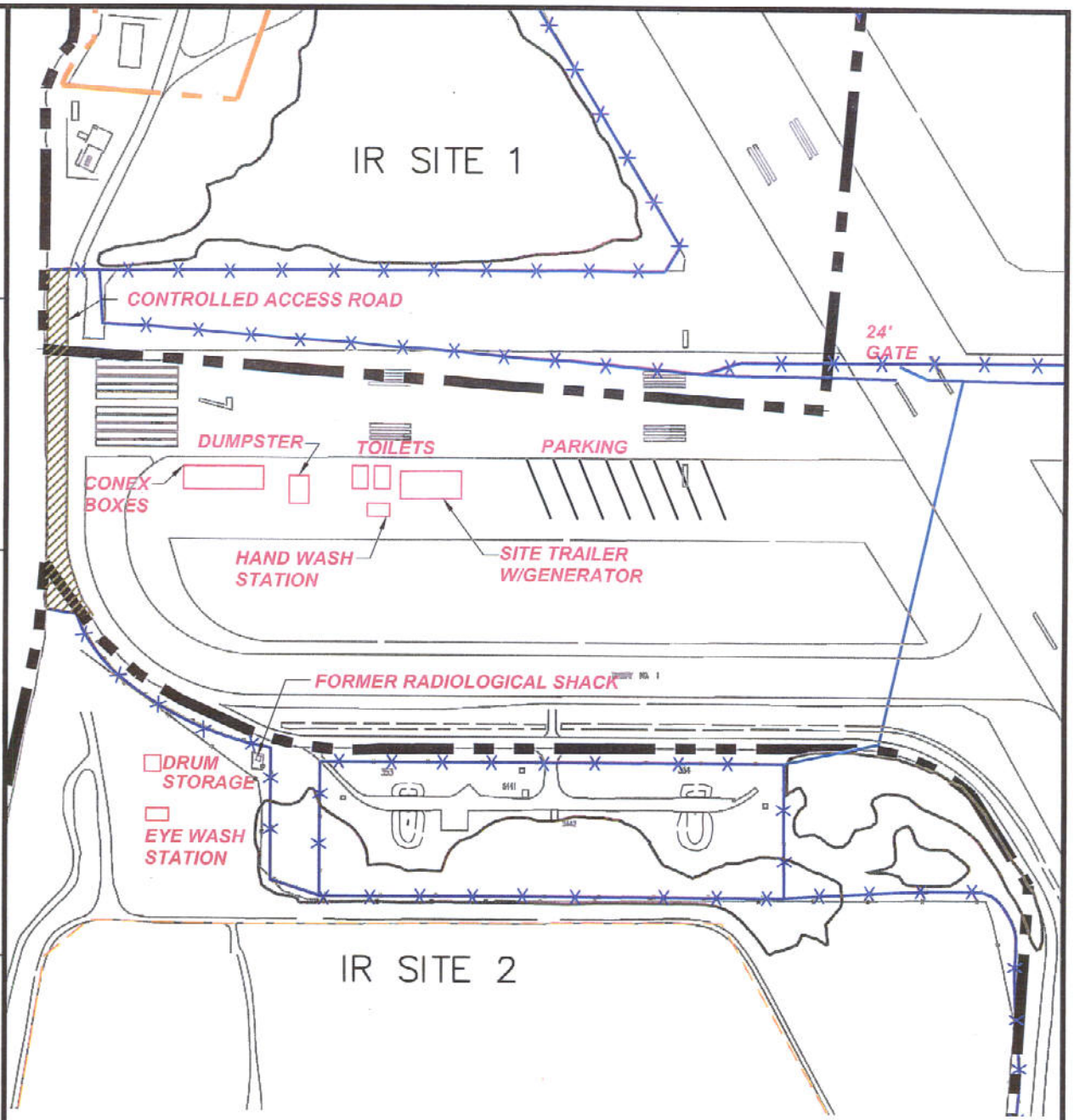

LEGEND

- IR SITE 1 AND IR SITE 2 BOUNDARIES
- DISPOSAL AREA BOUNDARY
- EXISTING FENCE LINE
- SEASONAL WETLAND BOUNDARY
- TEMPORARY FENCE
- BERM ROAD

N

NOT TO SCALE

Figure 6-1

TEMPORARY FACILITIES

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

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DRAWN BY: MD
DATE: 08/22/06

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PLOT/UPDATE: AUG 17 2006 10:28:14

OAKLAND INNER HARBOR

IR SITE 32

IR SITE 1

IR SITE 2

SAN FRANCISCO BAY

SAN FRANCISCO BAY

NAS ALAMEDA

SEAPLANE LAGOON

SAN FRANCISCO BAY

BACKGROUND REFERENCE AREA 2

9/10	4	3
8	5	2
7	6	1

NOT TO SCALE

BACKGROUND REFERENCE AREA 3

9/10	4	3
8	5	2
7	6	1

NOT TO SCALE

BACKGROUND REFERENCE AREA 1

4	5		6
3	8	7	
2	9/10		
1			

NOT TO SCALE

LEGEND

IR SITE BOUNDARIES

1000 500 0 1000 2000

SCALE IN FEET

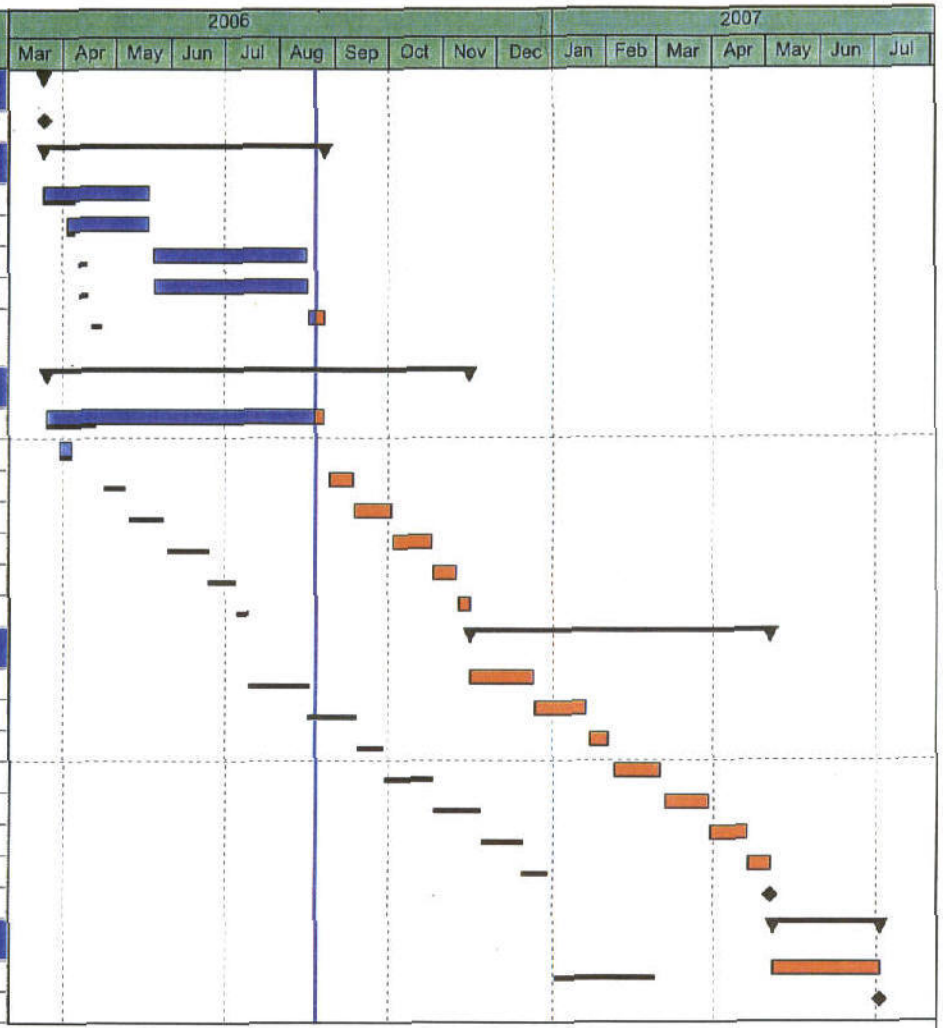
Figure 7-1

BACKGROUND REFERENCE AREAS AND INSTRUMENT READING LOCATIONS

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

Activity Name	At Completion Duration	Start	Finish
PMO and Pre Award Activities	0	21-Mar-06 A	21-Mar-06 A
CTO Award	0	21-Mar-06 A	
Pre-Construction Submittals	112	21-Mar-06 A	25-Aug-06
Draft Work Plan for IR 1,2 and 32	44	21-Mar-06 A	19-May-06 A
Draft Vegetation Clearance Plan	35	03-Apr-06 A	19-May-06 A
Navy Reviews of IR 1, 2, & 32 Work Plan	60	22-May-06 A	16-Aug-06 A
Navy Reviews Draft Vegetation Clearance Plan	60	22-May-06 A	16-Aug-06 A
Incorporate Navy's Comments & Issue Final Vegetation Clearance Plan and Final Work Plan	7	17-Aug-06 A	25-Aug-06
Construction	167	23-Mar-06 A	15-Nov-06
Conduct Procurement of Materials	110	23-Mar-06 A	25-Aug-06
Conduct Biological Baseline	5	30-Mar-06 A	05-Apr-06 A
Mobilize to IR 2	10	28-Aug-06	11-Sep-06
Survey IR 2 Shoreline and Rad Shack	15	12-Sep-06	02-Oct-06
Survey IR 1 Riprap and Shoreline	17	03-Oct-06	25-Oct-06
Survey IR 32	10	26-Oct-06	08-Nov-06
Demobilization	5	09-Nov-06	15-Nov-06
Post-Construction Reports	117	16-Nov-06	03-May-07
Prepare Pre-Draft Radiological Report	24	16-Nov-06	21-Dec-06
Review of Pre-Draft Report by Navy	19	22-Dec-06	19-Jan-07
Incorporate Navy's Comments and Issue Draft Rpt	10	22-Jan-07	02-Feb-07
Review of Draft Report by Regulators	20	05-Feb-07	02-Mar-07
Incorporate Regulators Comments & Issue DF Rpt	19	05-Mar-07	29-Mar-07
Review of DF Rpt by Navy & Regulators	15	30-Mar-07	19-Apr-07
Incorporate Comments and Issue Final Rpt	10	20-Apr-07	03-May-07
Technical Completion	0		03-May-07*
Project Closeout	41	04-May-07	02-Jul-07
Closeout	41	04-May-07	02-Jul-07
CTO Complete	0		02-Jul-07*



Remaining Level of Effort
Summary
Actual Level of Effort
Primary Baseline
Actual Work
Remaining Work
Critical Remaining Work
Milestone

NAVFAC SW RAC IV - CTO 0008

Figure 12-1

Radiological Survey Work Plan for IR Site 32

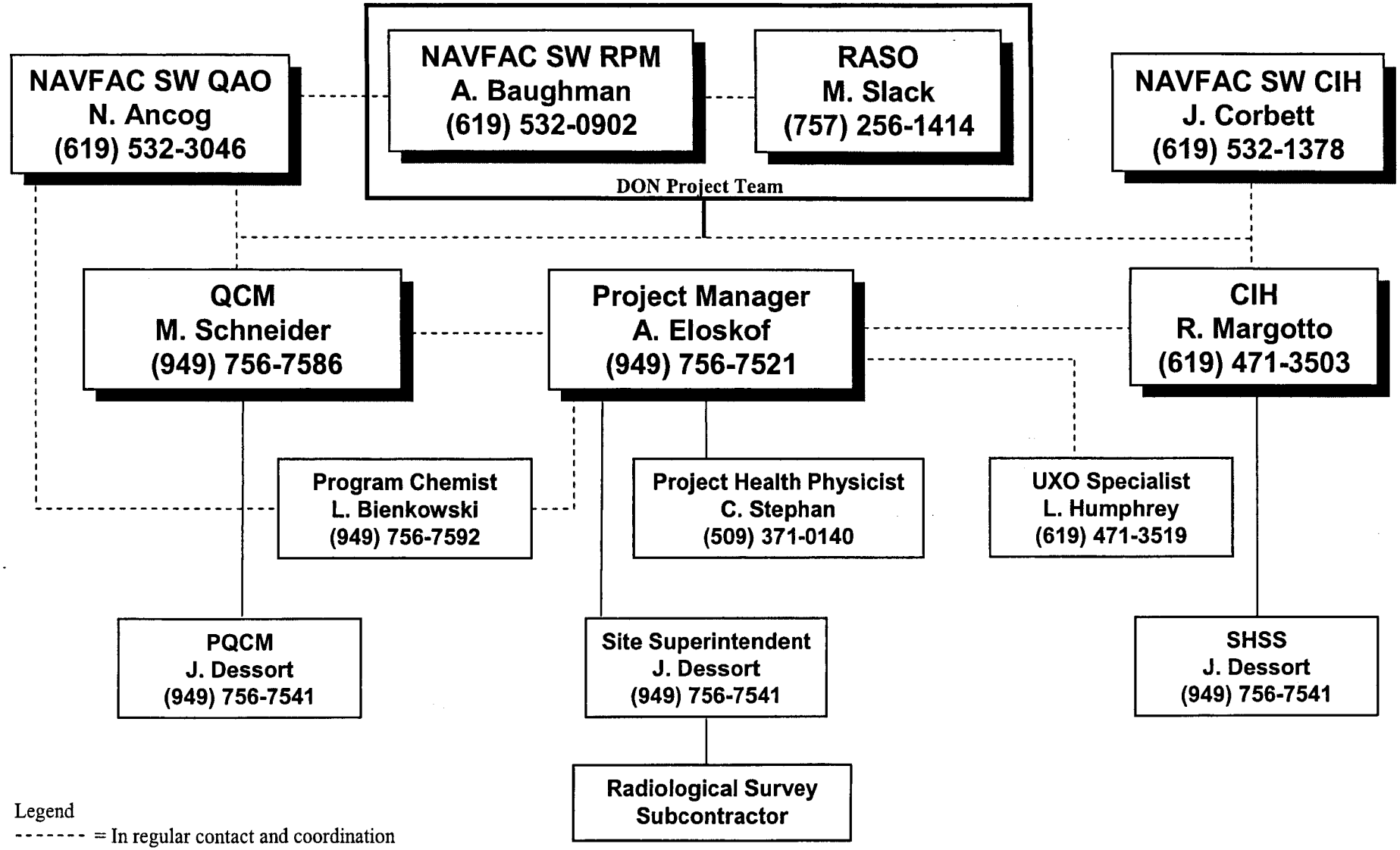
and the Shorelines of IR Sites 1 and 2

Alameda Point, Alameda, CA

TETRA TECH EC, INC.

Figure 12-2

Project Organization Chart



Legend

------- = In regular contact and coordination

——— = Directly reports to above

APPENDIX A

SITE-SPECIFIC HEALTH AND SAFETY PLAN

Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, California 92108-4310

CONTRACT NO. N62473-06-D-2201
CTO NO. 0008

APPENDIX A

FINAL

SITE-SPECIFIC HEALTH AND SAFETY PLAN

August 22, 2006

RADIOLOGICAL SURVEY
AT IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT
ALAMEDA, CALIFORNIA

DCN: FWSD-RAC-06-0406

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ABBREVIATIOPNS AND ACRONYMS

°F	degrees Fahrenheit
µCi/yr	microcurie per year
AHA	Activity Hazard Analysis
AL	action level
ATV	all-terrain vehicle
Cal-OSHA	California Occupational Safety and Health Administration
CFR	Code of Federal Regulations
CHP	Certified Health Physicist
CIH	Certified Industrial Hygienist
CMC	Corporate Medical Consultant
CNS	central nervous system
CQC	Contractor Quality Control
CTO	Contract Task Order
dBA	decibels, A-scale
DON	Department of the Navy
E&E	Ecology & Environment
EHS	Environmental Health and Safety
EM	Engineer Manual
EMS	Emergency Medical Services
EPA	U.S. Environmental Protection Agency
EZ	exclusion zone
GI	gastrointestinal
IDLH	immediately dangerous to life and health
IR	Installation Restoration
LLRW	Low-level Radioactive Waste
MEC	munitions and explosives of concern
mg/kg	milligram per kilogram
mg/m^3	milligram per cubic meter
mm	millimeter
MPPEH	material potentially presenting explosive hazard

ABBREVIATIONS AND ACRONYMS
(Continued)

MSDS	Material Safety Data Sheet
N/A	not applicable
NAS	Naval Air Station
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEL	permissible exposure level
PESM	Project Environmental Safety Manager
PHP	Project Health Physicist
PPE	Personal Protective Equipment
ppm	parts per million
RASO	Radiological Affairs Support Office
RCRA	Resource Conservation and Recovery Act
ROICC	Resident Officer in Charge of Construction
ROPS	rollover protection system
RPE	respiratory protective equipment
RPM	Remedial Project Manager
SCBA	self-contained breathing apparatus
SHSP	Site-specific Health and Safety Plan
SHSS	Site Health and Safety Specialist
STEL	short-term exposure limit
SZ	support zone
TLV	threshold limit values
TP	target practice
TtEC	Tetra Tech EC Inc.
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
UXO	Unexploded Ordnance

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The Site-specific Health and Safety Plan (SHSP) applies to work to be performed under Contract No. N62473-06-D-2201, Contract Task Order (CTO) Number 0008 to complete surface and shallow subsurface radiation surveys at Installation Restoration (IR) Site 32, the shoreline areas of IR Sites 1 and 2, and the former Radiological Shack area in IR Site 2 at the former Naval Air Station (NAS) Alameda Point, in Alameda, California. This work is a follow-on survey to the surveys performed under N68711-95-D-5713, CTO 0087, awarded on February 26, 2004, to perform the radiological survey and vegetation clearance at Alameda Point IR Sites 1 and 2.

1.2 APPLICATION

This SHSP will be used with the Final Alameda Point Base-Wide Health and Safety Plan (Base-wide Plan) (Attachment 1) and is applicable to all work conducted by Tetra Tech EC, Inc. (TtEC) employees and its subcontractors under the basic contract and this CTO. Refer to the Base-wide Plan (Attachment 1) for additional details common to all work performed at Alameda Point.

1.3 SUMMARY OF MAJOR RISKS

The potential hazards associated with this project include hazards associated with pickup trucks, all-terrain vehicles (ATVs), man lifts, and their use on undeveloped roads and off road. There is potential for exposure to contaminants associated with the landfill dust and vegetation that may contain radionuclides. It is also possible that munitions and explosives of concern (MEC) may be found, although the possibility is remote since the site has been previously surveyed and cleared of MEC.

2.0 ORGANIZATION OF THE PROJECT

Figure A.2-1 identifies the individuals from the Department of the Navy (DON) and TtEC who have responsibility for the oversight and/or implementation of this project.

3.0 SITE HISTORY AND PROJECT DESCRIPTION

Alameda Point is located on the west end of Alameda Island, which lies on the east side of San Francisco Bay adjacent to the city of Oakland. Alameda Point is rectangular in shape, approximately 2 miles long east to west, 1 mile wide north to south, and occupies 1,734 acres. The location of IR Sites 1, 2 and 32 are shown in Figures A.3-1, A.3-2, A.3-3, and A.3-4. A description of each site is provided below:

IR Site 1

IR Site 1, the 1943-1956 Disposal Area, is located in the northwestern corner of Alameda Point. The site was operated between 1943 and 1956 as the former NAS Alameda's main site for waste disposal. An estimated 15,000 to 200,000 tons of waste were placed in IR Site 1, including old aircraft engines, low-level radiological wastes, scrap metal, waste oil, paint wastes, solvents, cleaning compounds, and construction debris. In addition, other naval installations disposed of wastes at this site, including the Oak Knoll Naval Hospital, Naval Supply Center Oakland, and Treasure Island. Materials reportedly placed in the disposal area included municipal garbage, sludges, plating wastes, acids, mercury, polychlorinated biphenyl (PCB)-contaminated fluids, rags, batteries, inert ordnance, spoiled food, asbestos, pesticides, creosote, waste medicines, and reagents.

The former pistol range area is located in the western portion of IR Site 1 and consists of a pistol range, a shotgun range, and an area immediately north of the pistol range used for disposal of spent ordnance (20 millimeter [mm], lead bullets, and pellets). According to employee interviews, during the construction of the pistol range, excavation went to a depth of 8 feet to remove buried debris such as fence material, aircraft engine parts, and so forth. At the same time, an unknown number of 55-gallon drums filled with fired 20mm projectiles were dumped in this excavation. These projectiles were also mixed into concrete (as aggregate) used for the pistol range foundations. Soil sampling at the pistol range showed that total lead concentrations were in the range of less than 10 to 34,000 milligrams per kilogram (mg/kg); cadmium was detected at concentrations of 130 mg/kg and zinc at 7,400 mg/kg at two sampling locations.

IR Site 2

IR Site 2 encompasses approximately 110 acres and is bordered by San Francisco Bay to the south and west. The disposal area at IR Site 2 covers approximately 77 acres in the most southwestern portion of Alameda Point. The wetland covers approximately 30 acres and is bounded by the disposal area to the north and east and by the coastal margin adjacent to the San Francisco Bay on the south and west. The wetland contains two perennial ponds. The northern pond is connected to the bay by a culvert. The southern pond was created by removal of dredged materials for use as a cover for the disposal area. Freshwater has since filled the excavation area

and created the pond. The only material known to have been deposited in the wetland is scrap metal (Ecology & Environment [E&E], 1983).

The thin strip of land between the disposal area or wetland and the bay is referred to as the coastal margin. It acts as a buffer for the disposal area and the wetland and is composed of the perimeter dike and riprap seawall. Subsurface materials in the coastal margin differ from those in the disposal area and wetland. The interior margin lies outside the disposal area and wetland to the north and east. It also contains part of the perimeter dike and includes all areas outside the dike to the north and east. It is a geographic definition used primarily for classifying sampling locations. Grasses and thistles are the dominant vegetation of the upland areas while birds-foot trefoil, brass buttons, and pickleweed inhabit the wetlands.

A time-critical removal action was completed in 2001 and 2002 by TtEC to remove surface material potentially presenting explosive hazard (MPPEH) from terrestrial areas within IR Site 2, and subterranean MPPEH from the top 12 inches of soil within the potential MPPEH burial site.

Vegetation was cut to a height of no more than 4 inches to facilitate surface MPPEH characterization of the site that resulted in the discovery of one anti-tank/anti-personnel (AT/AP) inert land mine and one 20-millimeter (mm) target practice (TP) projectile.

During the intrusive investigation of the potential MPPEH burial site, the approximate boundaries of the burial site were installed (using map locations from an earlier survey) and the soil within the site periphery was removed to a depth of one foot. A total of 8,675 20-mm TP projectiles were uncovered during that effort from several burial pits within the site boundaries. None of the MPPEH encountered contained any explosives or energetics. The AT/AP inert landmine was turned over to DON Explosive Ordnance Disposal (EOD) personnel. All of the TP projectiles were demilitarized and shipped to a Class III landfill facility for disposal as non-hazardous scrap steel.

3.1 IR SITE 32

IR Site 32 is approximately 5.8 acres in size and includes three environmental baseline survey subparcels (Subparcels 8A, 5E and a portion of 5D). The site was previously referred to as the Northwestern Ordnance Storage Area. Recently, the DON expanded the boundaries of IR Site 32 north to the Oakland Inner Harbor by annexing the northern portion of Subparcel 5D.

The historical use for IR Site 32 was ordnance storage. An open space area in the eastern portion of the site was used for equipment, vehicle, and aircraft storage. Two buildings are located within IR Site 32: Buildings 594 and 82. Building 594 contains dormitory rooms, a kitchen, and a security-monitoring panel and was previously used as a storage and repair shop for underwater weapons. Building 82 is a concrete guard shack. Buildings 594 and 82 were constructed in 1979. There are no documented releases of hazardous substances in either of these buildings.

In 1883, the South Coast Pacific Railroad constructed a rail causeway over 2 miles long that extended into San Francisco Bay from the northwest corner of Alameda Island (Bechtel, 2005). The former causeway crossed the northern portion of present-day IR Site 32 and consisted of railroad tracks built on a mud- and rubble-filled double-rock wall, with a rail yard and a passenger terminal built on a trestle at the end. A fire destroyed the original rail line in 1902; a second line was built parallel to the original rail path. Based on aerial photographs, it appears that all railroad tracks in the vicinity of and at IR Site 32 were removed by 1960; no surface evidence of the former railroad is visible at IR Site 32.

Fill activities at IR Site 32 began in 1919 and the area was completely filled by 1936. Except for the Alameda Mole, the site had been entirely under water prior to 1919.

3.2 PROJECT DESCRIPTION

This project involves performing a radiological survey of IR Site 32, the shorelines of IR Sites 1 and 2, and the former Radiological Shack area located within IR Site 2. The field activities will include:

- Mobilization and setup of project's infrastructure (trailer/portable toilets, connex box, etc.)
- Conduction radiological surveys using ATVs, man lifts, and backpack survey units
- Collection of subsurface soil samples

3.3 PROJECT DURATION

This project is estimated to require up to 3 months of field activity.

4.0 POTENTIAL HAZARDS

The Base-wide Plan (Attachment 1) identifies hazards that are common to all construction projects within Alameda Point. Site-specific hazards associated with this CTO are summarized below.

4.1 CHEMICAL HAZARDS

There is little likelihood for significant exposure to chemical contaminants on site. Historical analytical results show low levels of chlorinated solvents, as well as polynuclear aromatic hydrocarbons (PAHs). However, records show that the landfill has accepted a wide variety of wastes including, lead, acid batteries, grease, oil and antifreeze, and demolished military aircraft engines. There may also be very low levels of metals in the first few inches of soil in the area. This SHSP has copies of Material Safety Data Sheets (MSDSs) for the contaminants that can be anticipated (Attachment 2). The Site Health and Safety Specialist (SHSS) will also acquire MSDSs for all materials and chemicals brought on to the site. The SHSS will ensure that site personnel have received training on all of these chemicals, in accordance with TtEC's Environmental Health and Safety (EHS) 4-2, Hazard Communication Procedure. If unknown materials or chemicals are encountered, the SHSS will contact the Project Environmental Safety Manager (PESM) for additional guidance regarding these materials and to evaluate the need for additional training and protection. Table A.4-1, Chemical and Radiological Hazards Assessment, summarizes the chemical and radiological hazards at the project site.

Dust control measures will be implemented as needed to minimize visible dust and potential inhalation exposures, especially during vegetation clearance

4.2 ENVIRONMENTAL HAZARDS

The project is to be performed in an outdoor area with grasses and shrubs. Workers may encounter poison oak, snakes, wild animals, bees, ticks, and other insects. The degree of hazard can range from annoyance to death from bites or anaphylactic shock. Recognition and avoidance are critical in maintaining a safe worksite. Personnel with sensitivities, such as bee stings, should notify the SHSS prior to site activities.

Since all planned work activities will be conducted outside where temperature conditions are unpredictable, there is a risk that site workers could develop heat stress. The likelihood of this occurring is dependent on environmental conditions, the level of work activity, and the personal control measures that are used to manage heat loads (work/rest cycles, use of cooling devices, hydration, and so forth). Heat stress procedures described in the Base-wide Plan (Attachment 1) and EHS 4-6, Temperature Extremes, will be followed. In addition, all site workers will be instructed in the recognition and control of thermal stress symptoms.

Workers must take special precautions regarding exposure to the aforementioned hazards and other environmental hazards described in the Base-wide Plan (Attachment 1).

4.3 ALL-TERRAIN VEHICLES AND MAN LIFTS

Every ATV operator shall have completed a nationally recognized accredited ATV training course (such as provided by the Specialty Vehicles Institute of America or in-house resources that have been certified as trainers by an accredited organization) prior to operation of the vehicle. The operator must pass an operating skills test prior to being allowed to operate an ATV. Proof of completion of this training shall be made available to the SHSS and upon request, to the Resident Officer in Charge of Construction (ROICC).

Class I ATVs are less than 800 pounds and 50 inches wide. Class II ATVs are 800 pounds or more but less than 10,000 pounds and 50 inches or greater in width. Class III ATVs are off-road motorcycles.

Every ATV will be inspected when it is received on site. All ATVs shall be equipped with a warning signal device (horn), tail lights, and stop lights. A copy of the operator's manual will be kept on the vehicle. A copy will be maintained by the SHSS. Tires shall be inflated to the pressures recommended by the manufacturer. ATVs will be equipped with mufflers. All ATVs will be equipped with spark arresters. All Class II ATVs shall be equipped with a rollover protection system (ROPS). The manufacturer's recommended payload shall not be exceeded at any time. ATVs will be inspected each day before use.

Only ATVs with four or more wheels may be used. Gloves and an approved motorcycle helmet with full-face shield or goggles shall be worn at all times while operating a Class I ATV. ATVs will be used only off road (no paved road use, unless allowed by the manufacturer). ATVs will be driven during daylight hours only. ATVs will be driven slowly and at no time will exceed 15 miles per hour. ATV operators will ensure that the operation of the ATV will not generate dust. ATV's will be equipped with a high-visibility flag or windsock that is mounted on a flexible nylon pole or equivalent so that the ATV location can readily be seen from a distance. Passengers are prohibited on Class I ATVs. A portion of these requirements are specified in the Safety and Health Requirements Engineer Manual (EM) 385-1-1 (United States Army Corps of Engineers [USACE], 2003).

A man lift will be used to facilitate radiological surveys along the shoreline. The man lift will be operated by remote controls at ground level. A Radiological Control Technician will be located in the man lift bucket and suspended over the shoreline while collecting radiological measurements. Operators will be selected based on operating proficiency, which will be observed and documented by the SHSS prior to field activities.

4.4 PHYSICAL HAZARDS

Several safety hazards are likely to be associated with the planned work, including heavy lifting; noise; slip, trip, and fall hazards; working with and around mechanical equipment and poor driving conditions. These hazards and the controls that will be applied to manage them are discussed below.

4.4.1 Heavy Lifting

Collecting samples and handling of radiation survey equipment may involve heavy lifting. Such activities carry the risk of back and muscle strain. To control this hazard, workers will be instructed to use proper lifting techniques when moving heavy loads. These techniques will include using mechanical lifting devices whenever feasible to move equipment or supplies. When lifting exceptionally heavy loads individually, workers will maintain ergonomically safe lifting postures and have others help if mechanical lifting devices cannot be used. Workers will not lift loads of more than 50 pounds without assistance.

4.4.2 Slips, Trips, and Falls

There are likely to be slip, trip, and fall hazards in the areas where the surveyors will be working. These hazards will be controlled by maintaining proper housekeeping and general employee awareness. Site workers will wear high-traction, steel-toed safety boots and will pay careful attention to surface conditions to prevent slip, trip, and fall injuries. The work areas will be inspected and evaluated before the start of each workday to identify any hazards that could cause injury. The results of these inspections will be communicated to site personnel during the daily tailgate safety briefing.

4.4.3 Contact with Mechanical Equipment and Heavy Equipment

ATVs, pickup trucks, and man lift will be used on this project to sample soil, conduct surveys and to transport equipment and supplies to the work area.

Equipment operators must become thoroughly knowledgeable with the hazards associated with each piece of equipment in addition to reviewing applicable Activity Hazard Analyses (AHAs) and EHS 3-13, Motorized Vehicle and Equipment. The ATVs, man lift, and any hand and power tools all require competent workers trained in the proper operation of each piece of equipment. The competent person or designee shall perform daily pre-inspections on all equipment and tools to prevent personal injury or property damage due to faulty equipment. All personnel will also wear reflective vests when working around mechanical equipment.

4.4.4 Noise

Noise levels in excess of 85 decibels, A-scale (dBAs) are not expected to occur during field activities. Refer to Base-wide Plan (Attachment 1) and EHS 4-4, Hearing Conservation, for additional information.

4.4.5 Driving Hazards

The drive to the worksite may include unpaved roads. It requires drivers to recognize that driving on such roads have different hazards than driving on paved roads. It is possible for vehicles to lose traction or slide off of embankments. Seat belts shall be worn. Speed limits and all traffic control signs and devices shall be complied with at all times. Avoid sharp turns up or down steep grades. If you get stuck, call for help and wait by your vehicle. Review TtEC Project Rules Handbook Volume II, Section 2.11, Motor Vehicle Safety. Personnel shall be trained in approved site access routes and all base-specific traffic rules.

4.4.6 General Precautions and Controls

The following are general precautions and controls to obey during all activities:

- Hazard assessment is a continuous process and all personnel must be aware of their surroundings and constantly aware of the chemical and physical hazards that are or may be present.
- The use of the "Buddy System" is mandatory.
- Site personnel will be familiar with the physical characteristics of each site, including site access, emergency assembly areas and evacuation routes, and the location of communication devices and safety equipment.
- DO NOT touch any unknown objects lying on the ground.
- During field activities, workers shall wear steel-toed boots with steel shanks at all times, except when performing any work with a magnetometer. Suitable work gloves shall be used for the work being done.
- AHAs will be developed for each specific task to further characterize and define potential physical hazards and to implement control measures to prevent personal injury and/or property damage.

4.5 MUNITIONS AND EXPLOSIVES OF CONCERN

Some areas of the site may have MEC. Although the area has been pre-screened by prior consultants, TtEC, and Explosives Ordnance Disposal (EOD) personnel, TtEC personnel must be aware of the potential for MEC. The project will use the services of a TtEC Unexploded Ordnance (UXO) Specialist. If workers observe anything suspicious, all work will stop and the UXO Specialist will be notified. If the material is MEC, a separate Work Plan will be followed to manage the MEC.

4.6 RADIOLOGICAL SCREENING

Workers will follow the Radiological Survey Work Plan and Attachment 3, Radiation Safety Controls and Monitoring for Workers. At no time will workers directly touch or handle any material that is potentially radioactive without first notifying the Project Health Physicist (PHP). Workers will follow safe work practices described in the radiological protection plan. All radioactive work procedures and policies are reviewed and approved by the PHP.

5.0 ACTIVITY HAZARD ANALYSIS

The AHAs for this project are included as Attachment 4. The SHSS will modify these AHAs as appropriate, add new AHAs for any changes in tasks, and ensure that all employees who perform these tasks receive a briefing on the appropriate AHA. The SHSS will forward any modified or new AHAs to the PESM for review and approval. The equipment used for the task can vary dependent upon which subcontractors are used for work. The AHAs will be expanded to include specific equipment as the Radiological Survey Work Plan becomes final.

6.0 PERSONAL PROTECTIVE EQUIPMENT

The personal protective equipment (PPE) for each task on this project is listed in Table A.6-1. Level D protection will be required during site setup, radiological surveys, and soil and wastewater sampling activities. This table is prepared based on data provided prior to the start of the project. As additional testing, monitoring, and background information become available, the SHSS may adjust the action levels and PPE accordingly. Any changes to PPE require approval by the PESM and the PHP. PPE levels were selected based on the presumption that there are low-level contaminants associated with organic vapors, radioactive material (radium-226), and metals.

6.1 RESPIRATORY PROTECTION PROGRAM

Given the known site conditions and the planned work activities to be performed, respiratory protection is not expected to be required. If site conditions change such that respiratory protection is warranted, a stop work order will be issued and the appropriate measures taken to implement respiratory protection. If respiratory protection is required to prevent exposure of workers to dusts that may be contaminated or have low levels of radioactive isotopes, the TtEC Respiratory Protection Program, EHS 5-2, and Respiratory Protection for Radiological Activities, RP12-6, will apply. In the event respiratory measures are deemed necessary, the Respiratory Protection Program Administrator for this project is the SHSS. The PESM, a Certified Industrial Hygienist (CIH), and the PHP, a Certified Health Physicist (CHP), will provide technical guidance and approve the selection of the level of protection used for each task.

The SHSS will be responsible for:

- Ensuring that adequate quantities of approved respiratory protective equipment are available for non-emergency and emergency use
- Ensuring that personnel have the necessary training and fit testing for the use of each type of respirator and ensuring that proper documentation is available
- Monitoring the use of respiratory protective equipment (RPE)
- Ensuring that RPE is maintained and inspected in accordance with the EHS procedures and program requirements
- Evaluating the effectiveness of the respiratory protection program on each site
- Recommending changes to the types of RPE being used, as necessary
- Conducting air sampling to quantify the hazard
- Conducting surveys as necessary and determine the type(s) of respiratory protection required for a particular task
- Scheduling personnel to submit bioassay samples, if needed.

The PESM is responsible for selection and specification of RPE in accordance with the requirements of this program, EHS 5-1 (PPE) and EHS 3-2 (SHSPs), and applicable regulations.

The Corporate Medical Consultant (CMC) is responsible for providing clearance for TtEC personnel to use RPE in accordance with EHS 4-5, Medical Surveillance.

6.1.1 Selection of Respiratory Protective Equipment

All respiratory equipment used on TtEC projects shall be certified by the National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration. The type of respiratory protection selected is based upon potential hazards at a specific site. Selection of appropriate respiratory protection is documented in the EHS procedures and approved by the PESM, CHP and/or a CIH.

There are three general classes of respiratory protection available:

- Self-contained breathing apparatus (SCBA)
- Air-supplied devices
- Air-purifying devices

To select which type of respiratory protection is appropriate for a given project, the following questions must be answered:

1. Is there a possibility of an oxygen-deficient atmosphere?
2. Are the contaminants and concentrations in the worker breathing zones known or unknown?
3. What are the allowable concentration limits (permissible exposure limits or threshold limit values) for the contaminants? What are their physical properties?
4. What are the maximum expected concentrations of known contaminants? Are the concentrations immediately dangerous to life and health (IDLH)?
5. What is the expected duration of personnel exposure?
6. What are the warning properties and symptoms of the contaminants?
7. Can the contaminant be absorbed through the skin and/or eyes?
8. Are the contaminants flammable?
9. Is there any other pertinent information concerning the contaminants that may be pertinent to selecting appropriate respiratory protection?

Atmosphere-supplying respirators (pressure demand SCBAs or airline systems) shall be used when one of the following occurs: 1) the hazardous substance has been identified and requires the highest level of protection based on the measured (or potential for) high concentration of atmospheric vapors, gases, or particulates; 2) site operations involve a high potential for splash,

immersion, or exposure to unexpected vapors, gases, or particulates; or 3) operations are being conducted in confined, poorly ventilated areas that could contain hazardous concentrations of atmospheric vapors, gases, or particulates and/or reduced oxygen concentrations less than 19.5 percent. Escape packs are used with all airline systems. It should be noted that employees shall not be required to enter atmospheres that are immediately dangerous to life or health without the approval of the PESM, or without specific hazardous atmosphere rescue training.

Negative pressure air purifying respirators, equipped with appropriate filter cartridges for the expected contaminants, may be used only when the atmospheric contaminants have been identified, and expected concentrations are within limits that can be effectively removed by the respirator cartridges. For air purifying respirators used for protection against gases or vapors, a cartridge change schedule shall be included in this SHSP, along with a description of the information or data relied upon to develop the schedule. In most cases, this will consist of recommendations by the manufacturers when they become available.

6.1.2 Fit Testing

A qualitative fit test shall be conducted for each employee during the initial 40-hour health and safety training course and/or at site-specific training and annually thereafter. Fit testing may also be performed when a condition that may affect the face fit of the respirator has occurred, such as weight gain or loss, dental work, facial surgery, or deformity. Employees shall be clean shaven during fit testing.

Qualitative fit tests shall be administered using irritant smoke or Bitrex in accordance with the Occupational Safety and Health Administration (OSHA) respiratory protection standard in 29 Code of Federal Regulations (CFR) 1910.134.

Qualitative fit testing will be limited to situations where a negative pressure respirator is used and a protection factor of 10 or less is needed. If a protective factor of greater than 10 is needed, the SHSP will require either a positive pressure/pressure demand respirator or quantitative fit testing of the negative pressure respirator.

All positive pressure/pressure demand respirators with tight-fitting facepieces will be fit-tested qualitatively or quantitatively in the negative pressure mode.

A record of the fit test shall be maintained using the qualitative respirator fit test record form. Records of employee respiratory protection training shall be maintained by the SHSS in the training records file.

6.1.3 Respirator Use

All TtEC personnel are required to:

- Use RPE when required and in the proper manner.
- Inspect RPE prior to each use and obtain replacement equipment when found to be defective.
- Perform a user seal check each time they put on a tight-fitting respirator.
- Take proper care of the RPE.
- Be clean shaven where the seal of the respirator contacts the face whenever using RPE.
- Leave the respirator use areas whenever necessary to wash face or respirator to avoid skin irritation, if contaminant breakthrough is detected, a change in breathing resistance, or leakage of the facepiece, or to change filters or cylinders.

Low temperatures may fog the lenses of the respirator and use of anti-fog spray and a nose cup may be beneficial. Nose cups are part of the NIOSH approval for air-supplied respirators at ambient temperatures of 32 degrees Fahrenheit (°F) and below. Minimum temperatures recommended by the manufacturer for operation of a SCBA shall be consulted prior to use in low temperatures.

Under no circumstances are employees permitted to use escape provisions of atmosphere-supplying respirators for routine and egress of work areas.

Wearing any respirator in conjunction with other types of protective equipment will impose some physiological stress on the wearer. Use of respirators in conjunction with protective clothing can greatly affect human response and endurance, especially in hot environments. Refer to EHS 4-6, Temperature Extremes, for additional information.

6.1.4 Cleaning and Storage

Each person has the responsibility to clean, disinfect, and care for their respirator in accordance with the training they have received. The following procedure shall be followed for cleaning and storage of respiratory protection equipment:

- Personal respirators shall be cleaned and disinfected after each day's use, or more frequently, if necessary.
- Respirators for emergency use and all SCBAs shall be cleaned and inspected after each use, and inspected on a monthly basis. Monthly inspections shall be documented, including serial number, date, findings, and remedial action and signature inspector.

- Routine cleaning shall be completed as follows:
  - Remove the filters and dispose of per the EHS procedure requirements, if applicable.
  - Wash respirator in disinfecting solution.
  - Rinse respirator in clean water.
  - Allow respirator adequate time to air dry.
- Routine inspection shall be completed as follows:
  - Check all connections for gaskets and "O" rings and proper tightness.
  - Check the condition of the facepiece and its parts for tears, cracks, abrasions, or brittleness.
  - Check the condition of the connecting air hose, regulator, and harness, if applicable.
  - Check the condition of the headband for tears, cracks, abrasions, or brittleness.
  - Inspect all rubber or elastic parts for pliability and signs of deterioration.
  - Check alarms, if applicable.
  - Report any worn, missing, or broken parts to health and safety personnel on site.
- Clean and dry respirators shall be stored in zippered plastic bags. These bags shall be placed in a clean, dry place out of direct heat and sunlight.
- Repairs and parts replacement will only be made by individuals trained to do so using only the manufacturer's NIOSH approved parts. Only manufacturers or technicians trained by the manufacturer can repair/replace reducing and admission valves, regulators, and alarms.

6.1.5 Air Monitoring of Work Areas

To determine if the selected respiratory protection is appropriate, the work area shall be monitored for contaminant concentrations at the beginning of each phase of work activity as required by the site safety plan. Sampling should be in the breathing zone of the exposed employee. Periodic sampling throughout the project will be conducted per the EHS procedures to ensure that the selected respirator protection is appropriate.

6.1.6 Evaluation of the Program

The SHSS shall monitor the project implementation of the respiratory program during routine and informal inspections. The PESM will perform evaluations of project implementation of the program during EHS inspections. The inspections shall include consultation with affected employees required to use respirators. The Director of Health and Safety Programs will evaluate overall program implementation through a review of inspection reports, incident reports and investigations, and audit reports.

Refer to A-21, Audits, and EHS 3-3, Inspections, for information on the TtEC audit and inspection programs.

6.1.7 Medical Surveillance

Site personnel shall meet the medical surveillance requirements of OSHA, 29 CFR 1910.134, 1910.120 and EHS 4-5, Medical Surveillance, for respirator use prior to engaging in any field work requiring or potentially requiring the use of a respirator. Personnel with medical conditions, which prevent or limit their ability to wear a respirator, shall be notified in writing by the CMC.

6.1.8 IDLH Atmospheres

TtEC personnel shall immediately evacuate areas where an IDLH atmosphere develops. TtEC personnel shall not enter IDLH atmospheres except for rescue or when authorized by the PESM. If necessary, at least one standby person equipped with proper rescue equipment and a pressure-demand SCBA is present. Communication between the field team and the standby person shall be maintained at all times. If the IDLH atmosphere exists in a confined space, the entry shall be conducted in accordance with EHS 6-1, Confined Space Entry.

6.1.9 Training

Personnel required to use respiratory protection shall be trained in the selection, use, and maintenance of the equipment. Respiratory protection training is included as part of the initial health and safety training, the 8-hour refresher course, and the site-specific training described in EHS 1-11, Training. The training shall be conducted annually. Site-specific respiratory protection training includes the following:

- Hazard identification to include symptoms of exposure
- Use of engineering controls to minimize exposure, and an explanation of why engineering controls are not feasible
- A description of the type of respiratory protection chosen and the protection provided to the employee
- Assurance that the employee understands the protection capabilities and limitations of the method of respiratory protection used
- Recognition of medical signs and symptoms that may limit or prevent effective use of respirators
- A thorough demonstration of the selected method of respiratory protection to include how to put it on, how to check the seals, use, troubleshooting, and maintenance followed by hands-on training by the employee
- How to use the respirator in an emergency, including situations in which the respirator malfunctions

- A description of the on-site storage and maintenance facilities for maintaining respiratory protection equipment

Training records shall be maintained in accordance with EHS 1-9, Recordkeeping.

6.2 RESPIRATORY PROTECTION PROGRAM ADMINSTRATOR FOR THE PROJECT

The Respiratory Protection Program Administrator for this project is the SHSS. For this project, Ms. Jennifer Dessort is appointed as the administrator. The PESM, a CIH, and the PHP, a CHP, will provide technical guidance and approve the selection of the level of protection used for each task. If respirators other than particulate respirators are used, the PESM will specify the cartridge change schedule.

7.0 AIR MONITORING AND OTHER MONITORING ACTIVITIES

Ambient air monitoring for particulate respirable dusts will be conducted during soil sampling and any work that generates dust. Personal air sampling will not be performed unless specified by the PHP as part of the radiological monitoring programs. The SHSS will contact the PESM if conditions change from those now anticipated. This portion of the plan addresses only industrial hygiene monitoring equipment. Any equipment used in the evaluation of radioactivity is addressed in Attachment 3, Radiation Safety Controls and Monitoring for Workers and Work Plans.

7.1 DIRECT READING INSTRUMENTS

7.1.1 Particulate Monitor

A MiniRAM may be used to evaluate the presence of particulates during dust generating activities:

Instrument:	MiniRAM Particulate Monitor or equivalent
Action Level:	>1.5 milligrams per cubic meter (mg/m^3) in breathing zone for sustained amount of time (15 minutes).
Action:	Stop work, re-evaluate, and implement dust control measures.

7.2 MONITORING STRATEGY

Dust suppression will be used at all times when encountering dry soils. Monitoring with a MiniRAM particulate monitor (or equivalent) will ensure that levels remain below the selected action levels. Levels will be measured before work commences for background levels and during site radiological survey activities, as deemed necessary by the SHSS. It should be noted that acceptable dust levels are based on industrial hygiene concerns. Health physics and industrial hygiene concerns relative to radioactive dust are discussed in Attachment 3.

7.3 QUALITY ASSURANCE/QUALITY CONTROL

Adherence to the Project Contractor Quality Control (CQC) Plan (Appendix C) is essential for a meaningful air sampling effort. The major monitoring concerns of the CQC Plan are calibration of equipment and document control.

7.3.1 Calibration and Maintenance Procedures

The MiniRAM will be checked daily for instrument zero level. If it exceeds the 3.5 mg/m^3, the instrument will be cleaned and a new zero level will be established. This level must be below 3.5 mg/m^3. The MiniRAM must be annually calibrated by the factory.

7.3.2 Documentation

Strict adherence to document and data control procedures is essential for good quality assurance/quality control. Data and calibration records must be accounted for and retrievable at all times. Types of documents that are essential include notes, logbooks, maps, data sheets, equipment calibration logs, and reports. Forms required for this CTO are presented in Attachment 5. These must be placed in the project files. Copies of all field data reports and personal sampling records will be sent to the PESM and the PHP for review.

8.0 SITE CONTROL

The proposed survey areas are considered unsafe because of the hazardous materials and MEC items known to have existed there at one time. Most of the MEC at IR Sites 1 and 2 are expected to have been removed. However, it is possible there are some remaining MEC materials and low levels of radiation in the surface or shallow subsurface soil. Existing fencing around the sites will be maintained throughout the operation. Access into the worksite will be strictly controlled and limited to authorized personnel only. No unauthorized access is permitted within the perimeter boundaries.

Site control requires the establishment of a regulated area and designated site work zones. To minimize the transfer of potentially hazardous substances from the site, project personnel will:

- Schedule operations that use minimum numbers of personnel.
- Establish site work zones around each worksite location.
- Implement appropriate decontamination procedures.

8.1 EXCLUSION ZONE

The exclusion zone (EZ) for this project is the area at each site where workers are working. This may be a large area. Barricades or cones will delineate the EZ if such a zone is established within the fenced area. It should be noted that barricades will be required for any opening in the ground that is left unattended. Workers will place contaminated tools, if any, and equipment on plastic sheeting in this zone to prevent contamination of the surrounding area. Postings shall be placed at the entry of the EZ to inform site personnel, visitors, and subcontractors of the requirements necessary for entry. This shall include, but not limited to, PPE requirements, contact personnel, "Danger No Unauthorized Entry" sign, "No Smoking" sign, and EZ sign-in log.

8.2 CONTAMINATION REDUCTION ZONE

In proximity to the EZ, is the contamination reduction zone where workers will wrap any contaminated tools and equipment with plastic when preparing to leave the area. Workers will decontaminate the equipment and themselves in this area before moving to the next work area. This area will also be used for surveying all workers and equipment coming in contact with Low-level Radioactive Waste (LLRW).

8.2.1 Decontamination Procedures

The equipment, such as sampling tools, pickup trucks, ATVs, man lifts and other equipment that has come in contact with potentially contaminated soil or debris, will be brushed off and wiped clean. This procedure will be done whenever equipment and tools are taken from one area to

another and at the end of each project site activities. If decontamination water or debris are generated during these decontamination procedures, refer to Section 10.0, Waste Management, of the Radiological Survey Work Plan for proper handling, storage, and labeling requirements. An unconditional release survey procedure for equipment is provided in Appendix D-5, Release of Materials and Equipment from Radiologically Controlled Areas, of the Radiological Survey Work Plan.

8.2.2 Personnel Decontamination

Before leaving the survey or sampling location, each worker will brush off work boots and remove any PPE that has been in contact with contaminated soil or debris. Personnel exiting the controlled area of IR Sites 1, 2 and 32 will undergo a personnel survey prior to exiting the controlled area.

Personnel exiting the controlled area will undergo a personnel survey prior to exiting the controlled area, if/when performing survey activities, personnel come into contact with removable contamination (i.e., greater than 3 sigma above background). The personnel survey, at a minimum, will require a survey of the hands and feet of the person exiting the controlled area.

If a worker finds contamination while surveying out of the controlled area, the SHSS or his designee will assist the worker in decontaminating the affected area and then resurvey the worker. Procedures for performing the personnel survey are provided in Attachment 3 and Appendix D-7, Radiological Protective Clothing Selection, Monitoring, and Decontamination, of the Radiological Survey Work Plan.

8.3 SUPPORT ZONE

The support zone (SZ) will be arranged considering accessibility, utility availability, wind direction, and line-of-sight to work. Included in this area will be the vehicle parking, toilets, handwashing facilities, municipal trash bin, storage trailer(s), drinking water, and a break/lunch area. Access to toilets and hand-washing facilities are also required in the vicinity of the work areas.

9.0 MEDICAL SURVEILLANCE PROCEDURES

There are no additional medical surveillance procedures for this project at this time. However, the PHP may specify a medical monitoring program for exposure to radioactivity (refer to Attachment 3).

10.0 SAFETY CONSIDERATIONS

For safety considerations, refer to the Base-wide Plan (Attachment 1). In addition, these guidelines should be adhered to:

- Ensure that there are functional communications in place. Check this function daily.
- Workers will work in sight of each other. If it is necessary for workers to work out of sight of each other, the buddy system will be used and each team will have a means of communicating with a team that has radio communication with the SHSS (each team would have local radio communication with all other teams, but at least one team has the radio that can contact the SHSS).
- In the event that MEC is encountered, the UXO Specialist will be immediately contacted. The UXO Specialist must be present during any MEC activities.
- Each work team will have an air horn to be used to summon help.
- All workers must comply with the TtEC *Project Rules Handbook, Volume I and Volume II.* Refer to the Base-wide Plan (Attachment 1) for other rules.
- Workers will wear seat belts in all vehicles.
- Workers will wear reflective safety vests at all times when working in the EZ so that they are readily visible to other workers and at any time they are working near vehicle traffic, including roads and parking lots.
- Ensure that the area is clear of personnel other than TtEC personnel and subcontractors.
- Use care when driving vehicles. Stay on roads. If the vehicle must be driven off a road, be sure to drive slowly. Be aware that there can be sudden dips or depressions, or that there can be a sudden drop off. Drive on unpaved roads only during daylight hours.
- At a minimum, a shaded break area will be provided for employees.
- The SHSS shall set up a Daily On-site Log to track all individuals on site at any given moment and to ensure that all personnel, visitors, and subcontractors are accounted for in case of emergency.
- Refer to the Base-wide Safety Plan, Emergency Response Plan (Attachment 1) within the Base-wide Plan in the event of an earthquake.
- Refer to the AHA regarding operation of ATVs and man lifts.

11.0 DISPOSAL PROCEDURES

Refer to the Base-wide Plan (Attachment 1) for general guidelines and to Section 10.0, Waste Management, of the Radiological Survey Work Plan for details on the types of waste streams to be generated and the appropriate methods for packaging and disposal. This project is not expected to generate hazardous waste.

12.0 EMERGENCY RESPONSE PLAN

Refer to the Base-wide Plan (Attachment 1) for emergency response activities. Evacuation routes for IR Sites 1, 2 and 32 are found in Figure A.12-1. The evacuation meeting point will be established during the mobilization activities. The city of Alameda Fire and Rescue Service will be contacted to provide the necessary emergency support. Response will depend upon the location of the site and whether the worker may be transported more quickly for treatment by a site vehicle. The routes to Alameda Hospital and Concentra Medical Center are found in Figure A.12-2.

The decision to transport injured workers by ground transportation must be evaluated carefully. The Alameda Fire and Rescue Service may place TtEC in contact with an emergency medical provider who may assist in making decisions. The decision to transport an injured worker by ground transportation is based on many factors, including the stability of the injured worker, whether the worker can be safely moved without causing further injury to the worker, the severity of the injury and the need for immediate treatment, the location of the project site, the proximity of nearby medical services, and the response time for emergency service to arrive at the site.

Table A.12-1 is the list of emergency contacts and telephone numbers. Both Figures A.12-1 and A.12-2, along with Table A.12-1, must be placed on the dashboard of each vehicle. The evacuation assembly area for the work area will be posted with a sign so that all personnel can identify the meeting point.

The Base-wide Plan (Attachment 1) does not describe emergency response to an MEC incident. This project will have at least one worker who has experience with UXO either on site or within a 1-hour response time. The UXO Specialist will be in charge of any operations involving the handling or certification of MEC where TtEC employees are working. If MEC should detonate, all personnel will back away from the area. The UXO Specialist will act as the Site Emergency Coordinator for any incident/accidents involving MEC.

13.0 TRAINING

All personnel will receive training in the recognition of MEC and general site awareness training. Workers operating ATVs must have the specific training mentioned in this SHSP. All workers will receive radiation awareness training during the review of this plan prior to starting field activities. Personnel performing radioactive material screening will have documented training on the use of instrumentation and the protocols to be followed as required by TtEC radiological protection procedures. Additional required training is discussed in the Base-wide Plan (Attachment 1).

14.0 LOGS, REPORTS, AND RECORDKEEPING

Refer to the Base-wide Plan (Attachment 1) for requirements.

15.0 FIELD PERSONNEL REVIEW

All personnel are required to review the Base-wide Plan (Attachment 1) and this SHSP. Upon completion of their review, all project personnel will sign the SHSP review form for each document.

16.0 REFERENCES

Bechtel. 2005. *Work Plan for Remedial Investigation IR Site 32, Northwest Ordinance Storage Area,* Alameda Point, Alameda, California.

Ecology and Environment (E&E). 1983. *Initial Assessment Study of Naval Air Station, Alameda, California, Final Report.* Prepared for Navy Assessment and Control of Installation Pollutants and Naval Energy and Environmental Support Activity, Port Hueneme, California.

Tetra Tech EC, Inc. (TtEC). Most recent version available. *Project Rules Handbook, Volume I and Volume II.*

United States Army Corps of Engineers (USACE). 2003. *EM 385-1-1, Safety and Health Requirements Manual.* November.

TABLES

TABLE A.4-1
CHEMICAL AND RADIOLOGICAL HAZARDS ASSESSMENT

Chemical Name	ALI/AL/PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Radium-226	2 μCi/yr (Oral)[a] 0.6 μCi/yr (Inhalation)[a]	Inhalation ingestion	Evidence of contamination on personnel or elevated air sample result.	Bone
Gasoline	PEL – 300 ppm (Cal-OSHA) TLV – 300 ppm	Skin absorption, inhalation, ingestion	Acute: nose, throat, lung irritation; headaches; blurred vision; vomiting; dizziness; fever; slurred speech; unconsciousness. Chronic: appetite loss, nausea, weight loss, insomnia, sensitivity in digital extremities.	Skin, eye, respiratory, and CNS
Diesel fuel	PEL – none established TLV – none established	Skin contact, inhalation, ingestion	Acute: eye irritation; skin irritation; nose, throat, lung irritation; nausea; vomiting; diarrhea; restlessness; drowsiness; loss of coordination. Chronic: repeated contact with skin causes dermatitis.	CNS, skin, respiratory system
PAHs, coal tar pitch volatiles (chrysene, pyrene, phenanthrene, etc.) from residuals of diesel fuel	PEL – 0.2 mg/m^3 TLV – 0.2 mg/m^3	Inhalation Ingestion Contact	Acute: skin contact may cause irritation, redness, burning, itching, dermatitis, and burns. Photosensitization may occur (rash worsens with exposure to sunlight). Inhalation irritating to respiratory tract. Eye contact may cause conjunctivitis, keratitis, or corneal burns. Ingestion may result in nausea, vomiting, abdominal pain, respiratory distress and shock. Exposure to large doses, especially by ingestion, may be fatal. Chronic: dermatitis, skin cancer, lung cancer.	Respiratory system, skin, bladder, kidneys (lung, kidney and skin cancer)
Benzene	PEL – 1 ppm TLV – 0.5 ppm STEL – 5 ppm	Inhalation Ingestion Contact	Carcinogen. Acute: irritation of eyes, nose, respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure can cause convulsions and unconsciousness. Skin contact may cause dermatitis. Chronic: blood disorders including leukemia.	Blood, CNS, bone marrow, eyes, skin, upper respiratory tract

TABLE A.4-1

CHEMICAL AND RADIOLOGICAL HAZARDS ASSESSMENT

Chemical Name	ALI/AL/PEL/TLV	Routes of Exposure	Symptoms of Exposure	Target Organs
Toluene	PEL – 50 ppm (Cal-OSHA) TLV – 50 ppm STEL – 150 ppm	Inhalation Skin contact	Acute: respiratory irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, dermatitis, insomnia, parasthesis, vertigo, narcotic coma, death. Chronic: mucous membrane irritation, headache, vertigo, nausea, appetite loss, intolerance to alcohol. Encephalopathies, liver enlargement and kidney dystrophy.	CNS, liver, kidney, skin
Ethylbenzene	PEL – 100 ppm TLV – 100 ppm STEL – 125 ppm	Inhalation Skin and eye contact	Acute: eye and nose irritation, chest constriction. High concentrations: narcosis, cramps, death. Chronic: dermatitis, fatigue, sleepiness, headache, leukopenia.	Eyes, respiratory system, CNS, skin, blood.
o-Chlorobenzalmalonitrile	PEL – 0.05 ppm TLV – None established Ceiling – 0.05 ppm	Inhalation Skin	Acute: highly irritating to eyes, nose, and skin.	Eyes and skin
Xylene	PEL – 100 ppm TLV – 100 ppm STEL –150 ppm	Inhalation Skin and eye contact, Ingestion	Acute: dizziness, nausea, vomiting, abdominal pain, eye, nose, throat irritation; pulmonary edema, drowsiness, unconsciousness. Eye contact can cause conjunctivitis and corneal burns. Chronic: dermatitis, peripheral and central neuropathy, liver damage.	CNS, eyes, GI tract, liver, kidneys and skin
Methane	PEL – None established TLV – None established	Inhalation Skin	Acute: irritability, headache, unconsciousness, death. Simple asphyxiant.	Eyes, respiratory system, CNS, blood
Lead	PEL – 0.05 mg/m^3 TLV – 0.05 mg/m^3 AL – 0.030 mg/m^3	Inhalation Ingestion	An animal carcinogen. Acute: Seizures, coma, death (very high doses). Chronic: Appetite loss, nausea, metallic taste, constipation, anxiety, weakness, insomnia, muscle and joint pain, irritability, headache, numbness, kidney damage.	Systemic poisoning; CNS, kidneys, reproductive system, blood, GI system

Notes:

[a] Limit from Appendix B of 10 Code of Federal Regulations 20

µCi/yr – microcurie per year
AL – action level
Cal-OSHA – California Occupational Safety and Health Administration
CNS – central nervous system
GI – gastrointestinal
mg/m^3 – milligram per cubic meter
PAH – polynuclear aromatic hydrocarbon
PEL – permissible exposure level
ppm – parts per million
STEL – short-term exposure limit
TLV – threshold limit values

TABLE A.6-1

PERSONAL PROTECTIVE EQUIPMENT

Task	EPA Level	Respiratory Protection	Head	Hand	Clothing	Boots	Face	Eye	Hearing	Additional
Site setup, surveys (land, geophysical and radiological)	D	None required, unless dust exceeds action level	Hard hat	Leather work gloves, as needed	Work uniform or Tyvek® coveralls to keep clean	Steel-toe, leather	N/A	Safety glasses	Protection when noise levels exceed 85 dBA	Reflective safety vests
Hand auger/soil sampling	D	None required, unless probe releases vapors above action limits	Hard hat	Leather work gloves or puncture/cut-resistant gloves; Nitrile gloves when sampling	Work uniform or Tyvek coveralls to keep clean	Steel-toe, leather	N/A	Safety glasses	Protection when noise levels exceed 85 dBA	Reflective safety vests, USCG life preservers when working near water
Sampling of decontamination water	D	None required	Hard hat	Leather work gloves when opening or handling drums or containers; Nitrile gloves when sampling	Work uniform or Tyvek coveralls to keep clean	Steel-toe, leather	N/A	Safety glasses	Protection when noise levels exceed 85 dBA	Reflective safety vests, USCG life preservers when working near water

Notes:
dBA – decibels, A-scale
EPA – U.S. Environmental Protection Agency
N/A – not applicable
USCG – United States Coast Guard

TABLE A.12-1

EMERGENCY INFORMATION

REPORT ALL FIRES, SERIOUS INJURY, OR UNCONTROLLED SPILLS IMMEDIATELY: 911 (CALL WILL ROUTE TO CALIFORNIA HIGHWAY PATROL IN VALLEJO ON A CELL PHONE)

Hospital:	Alameda Hospital (510) 522-3700 2070 Clinton Avenue Alameda, CA			
Directions:	Starting at the front of the base, turn left on Ranger Avenue. Turn right on Lexington and left on Navy Way. Take Navy Way to Main Street and turn right. Continue to Central Avenue. Central Avenue becomes CA/61. Continue on to CA/61 to Chestnut Street and turn left onto Clinton.			
Clinic:	Concentra Medical Center (510) 465-9565 384 Embarcadero W Oakland, CA			
Directions:	From Atlantic, turn left onto SR-61 (Webster Street) for 0.6 miles. Bear right onto Posey Tube for 0.6 miles and continue north on Harrison Street for about 150 yards. Turn left onto 6th Street for about 200 yards, left onto Broadway Street for 0.3 miles, and right onto West Embarcadero for 80 yards to Concentra Medical Clinic.			
Fire/Police/EMS:	911 This number will connect you to emergency dispatch. ***911 calls from a cell phone do not go directly to base emergency services, but through the California Highway Patrol.*** **If using a cell phone, call Alameda Fire Dispatch directly at (925) 447-4257.**			
TtEC Contacts:	Project Manager Abram Eloskof (949) 756-7521	PESM (CIH) Roger Margotto (619) 471-3503 pager: (714) 810-3742	Project SHSS Jennifer Dessort cellular: (949) 466-7573	CHP Cliff Stephan cellular: (509) 430-4655
RPM:	Claudia Richardson, (619) 532-0935			
ROICC:	Gregory Grace, (510) 749-5940			
RASO	Matthew Slack, (757) 887-4692			
Poison Control Center:	California Poison Control System, Central Office University of California, San Francisco School of Pharmacy, Box 1262 San Francisco, CA 94143 Emergency Phone: (800) 876-4766 [All of CA]			

TABLE A.12-1

EMERGENCY INFORMATION

CHEMTREC:	(800) 424-9300
National Response Center:	(800) 424-8802
RCRA Hotline:	(800) 424-9346

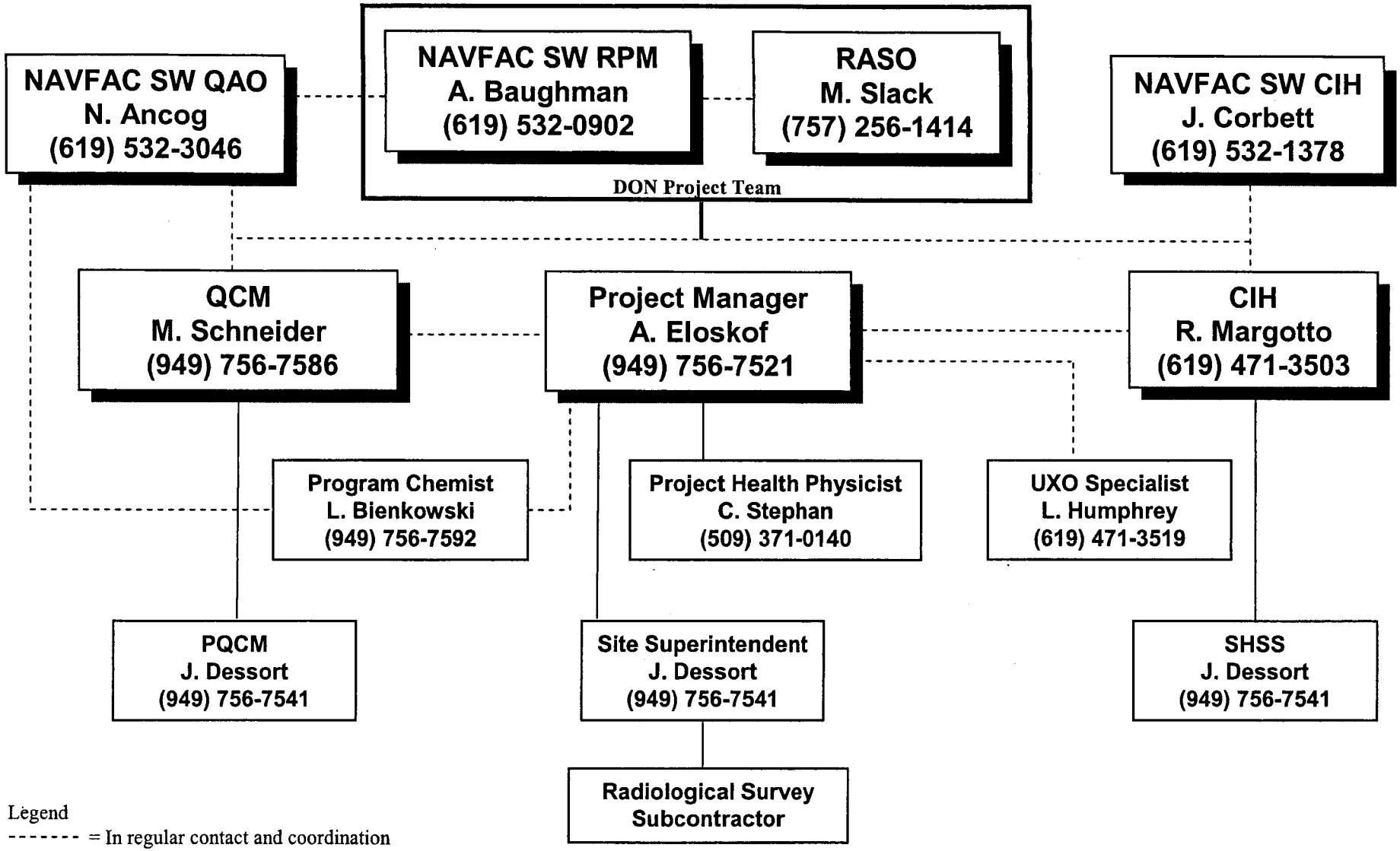
Notes:

CHP – Certified Health Physicist
CIH – Certified Industrial Hygienist
EMS – Emergency Medical Services
PESM – Project Environmental Safety Manager
RASO – Radiological Affairs Support Office
RCRA – Resource Conservation and Recovery Act
ROICC – Resident Officer in Charge of Construction
RPM – Remedial Project Manager
SHSS – Site Health and Safety Specialist
TtEC – Tetra Tech EC, Inc.

FIGURES

Figure A.2-1

Project Organization Chart



Legend

------- = In regular contact and coordination

——— = Directly reports to above

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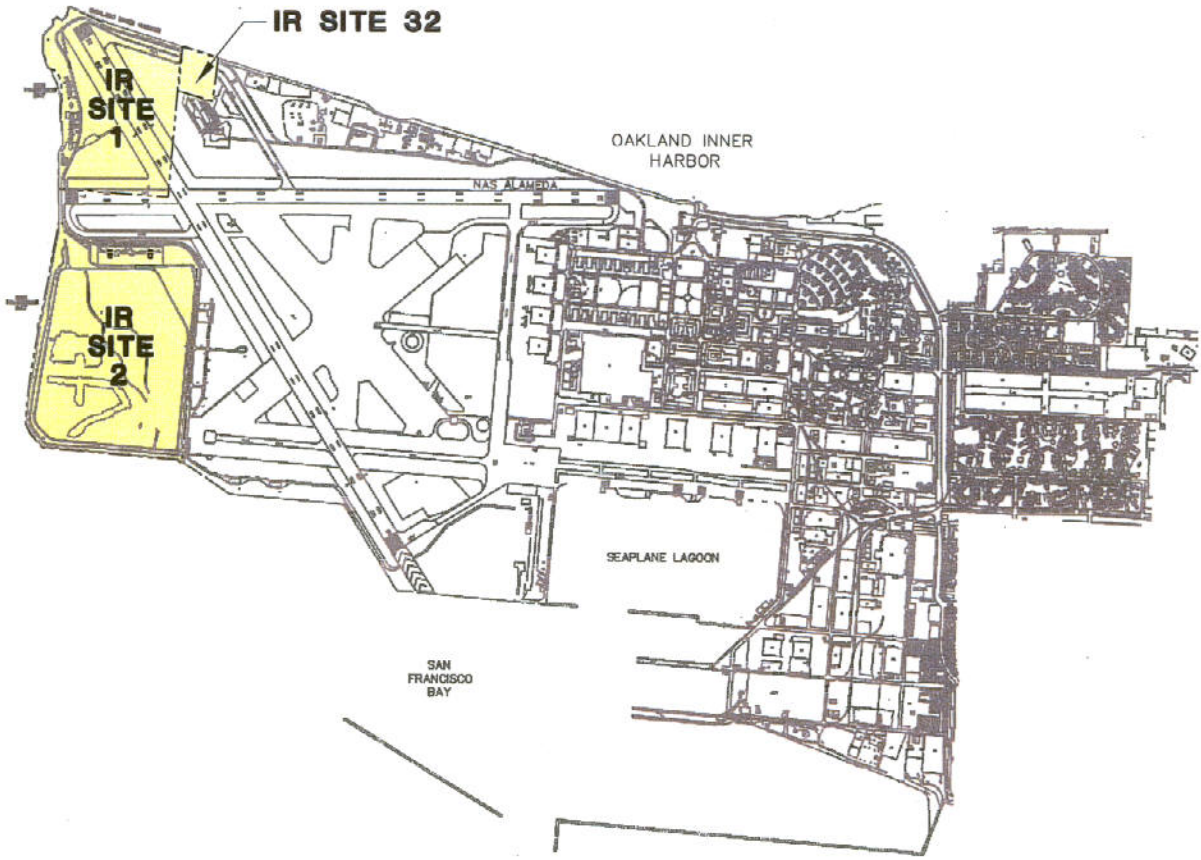
DCN: ECSD-RACIV-06-0406 | CTO: #0008

APPROVED BY: AE

CHECKED BY: JA | REVISION: 0

DRAWN BY: MD | DATE: 08/22/06



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N.T.S.

Figure A.3-1

SITE VICINITY MAP

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

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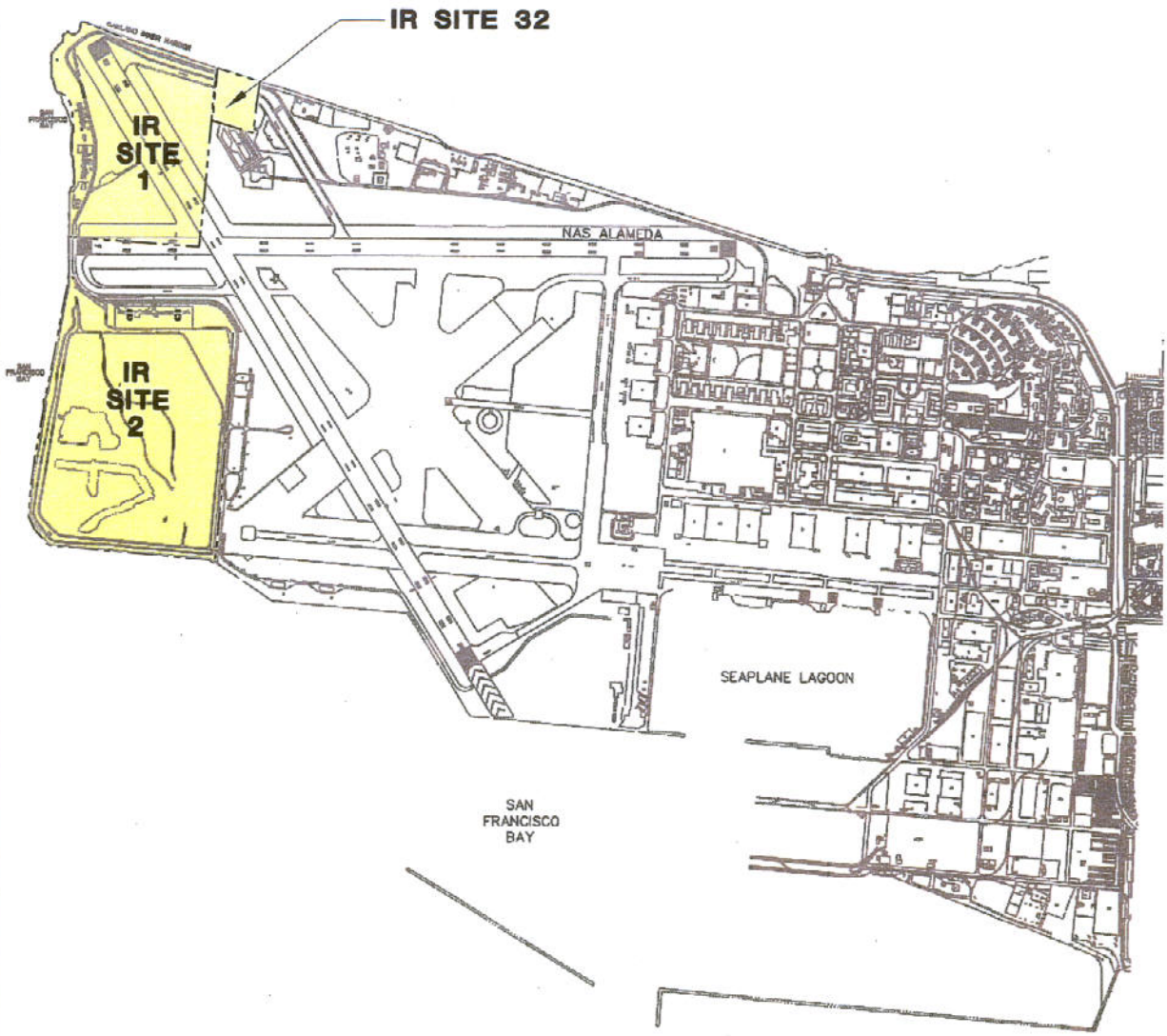

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N.T.S.

Figure A.3-2
IR SITE 1, 2 AND 32
LOCATION MAP

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

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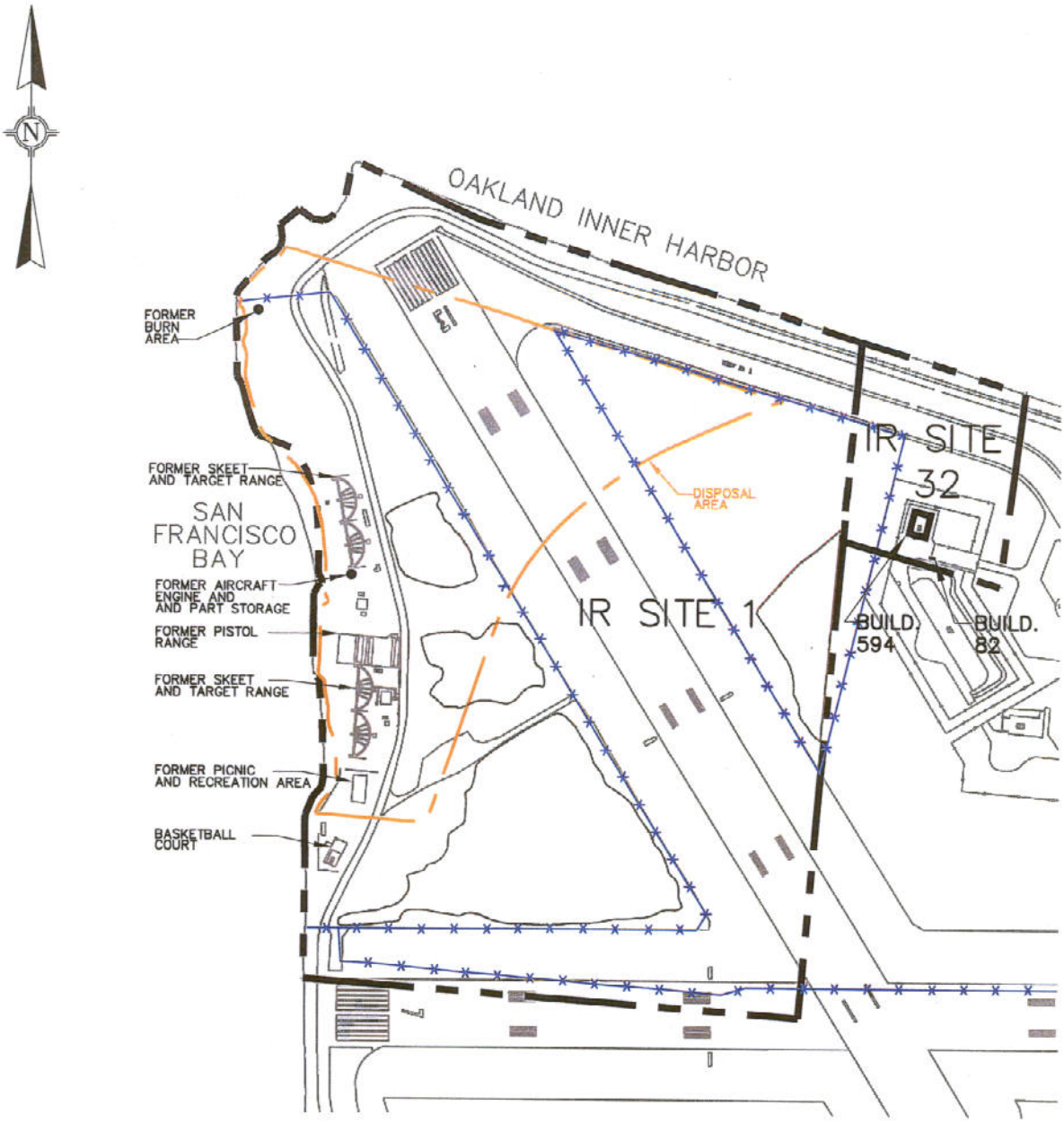

LEGEND

- IR SITE 1 AND 32 BOUNDARY
- DISPOSAL AREA BOUNDARY
- FENCE LINE
- SEASONAL WETLAND BOUNDARY

SOURCE:
OU-3 REMEDIAL INVESTIGATION REPORT, FINAL BY TETRA TECH EM INC., PUBLISHED IN RANCHO CORDOVA IN 1999.

500 250 0 500

SCALE IN FEET

Figure A.3-3
IR SITE 1 AND 32
SITE DETAIL MAP

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

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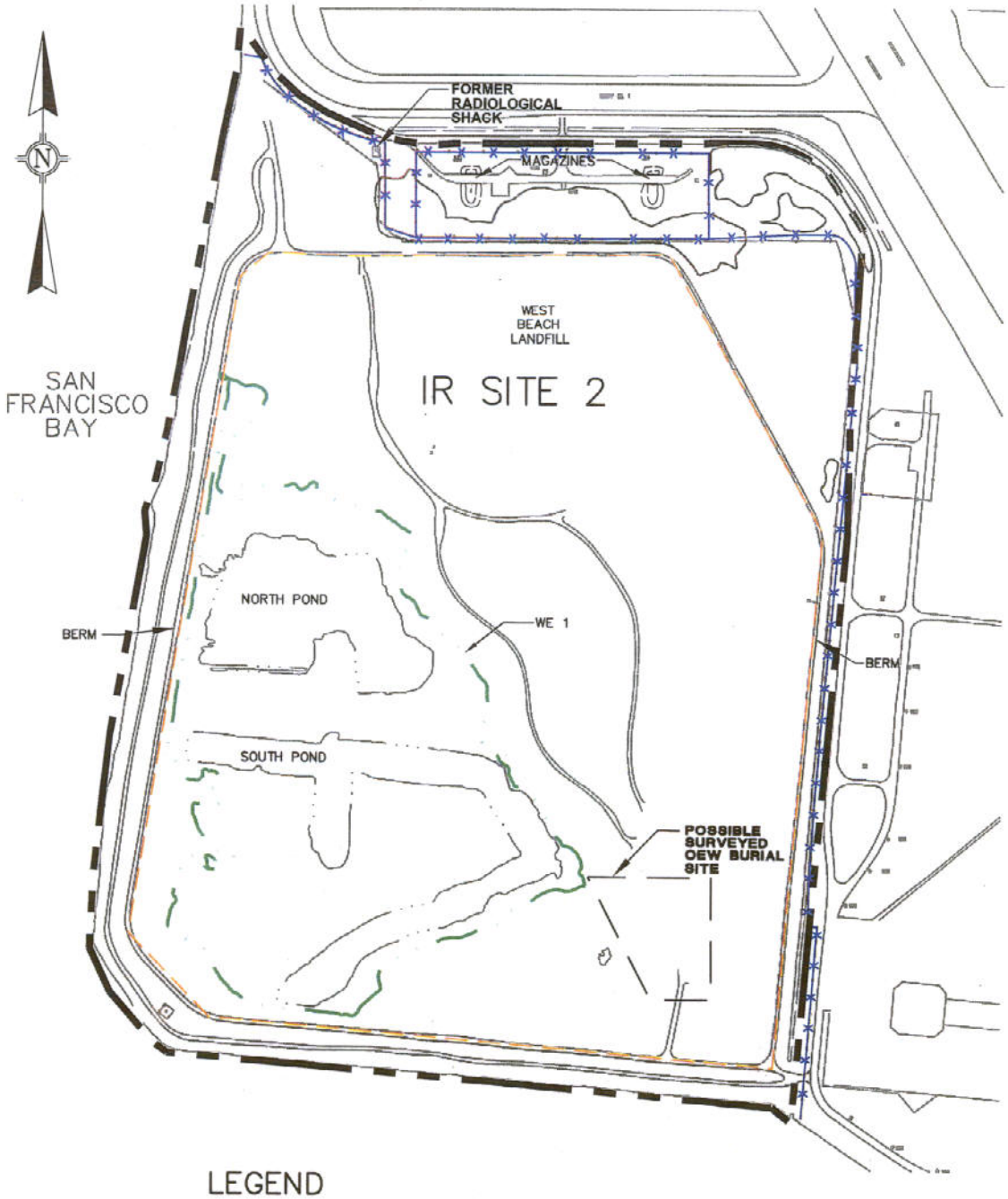

LEGEND

- IR SITE 2 BOUNDARY
- FENCE LINE
- PERMANENT WETLAND BOUNDARY
- SEASONAL WETLAND BOUNDARY
- BERM
- WE — WETLAND
- OEW — ORDINANCE AND EXPLOSIVE WASTE

500 250 0 500

SCALE IN FEET

Figure A.3-4
IR SITE 2
SITE DETAIL MAP

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

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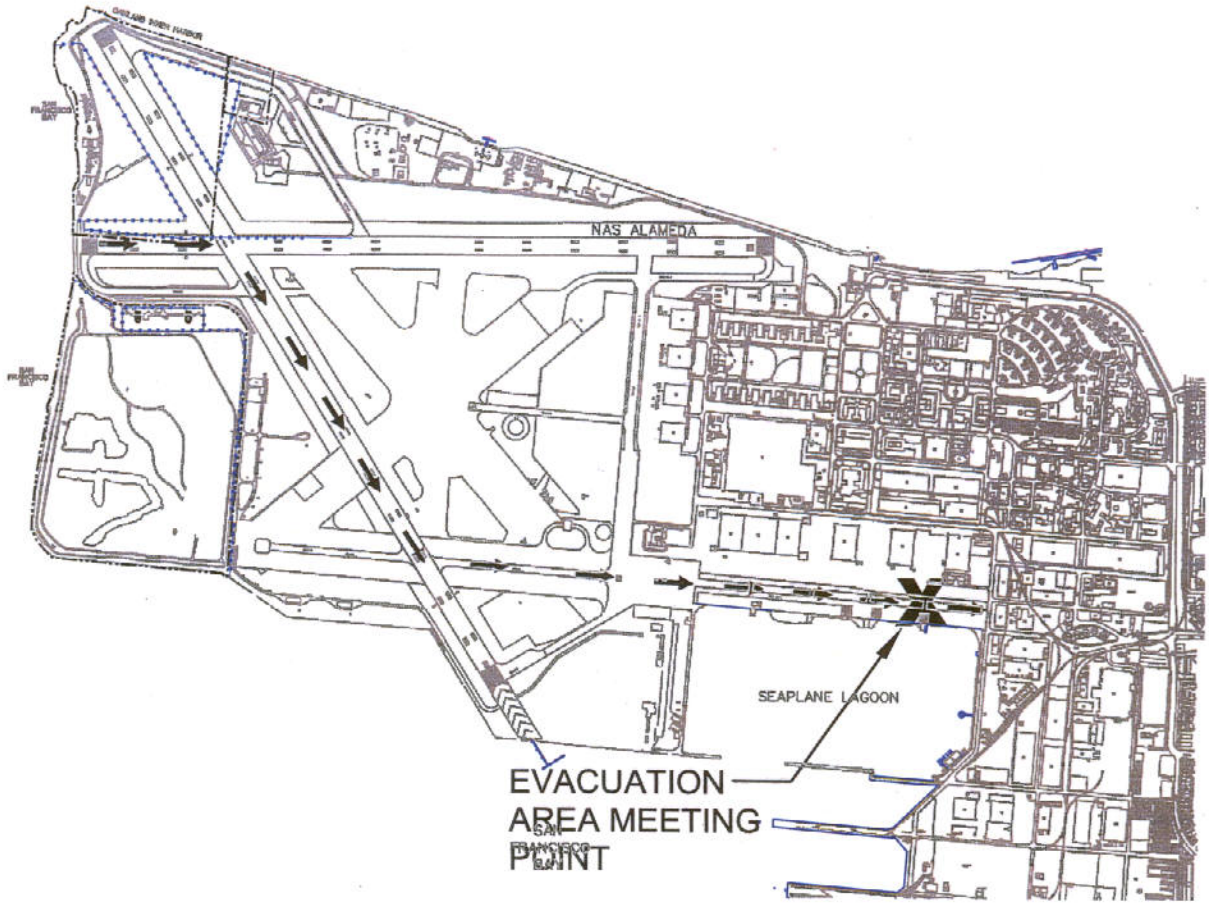

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Figure A.12-1
EMERGENCY EVACUATION ROUTE

IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT – ALAMEDA, CA

TETRA TECH EC, INC.

DRAWING NO: 060406A122.DWG
DCN: ECSD-RACIV-06-0406
CTO: #008
APPROVED BY: AE
CHECKED BY: JA
REV: REVISION 0
DRAWN BY: MD
DATE: 08/22/06

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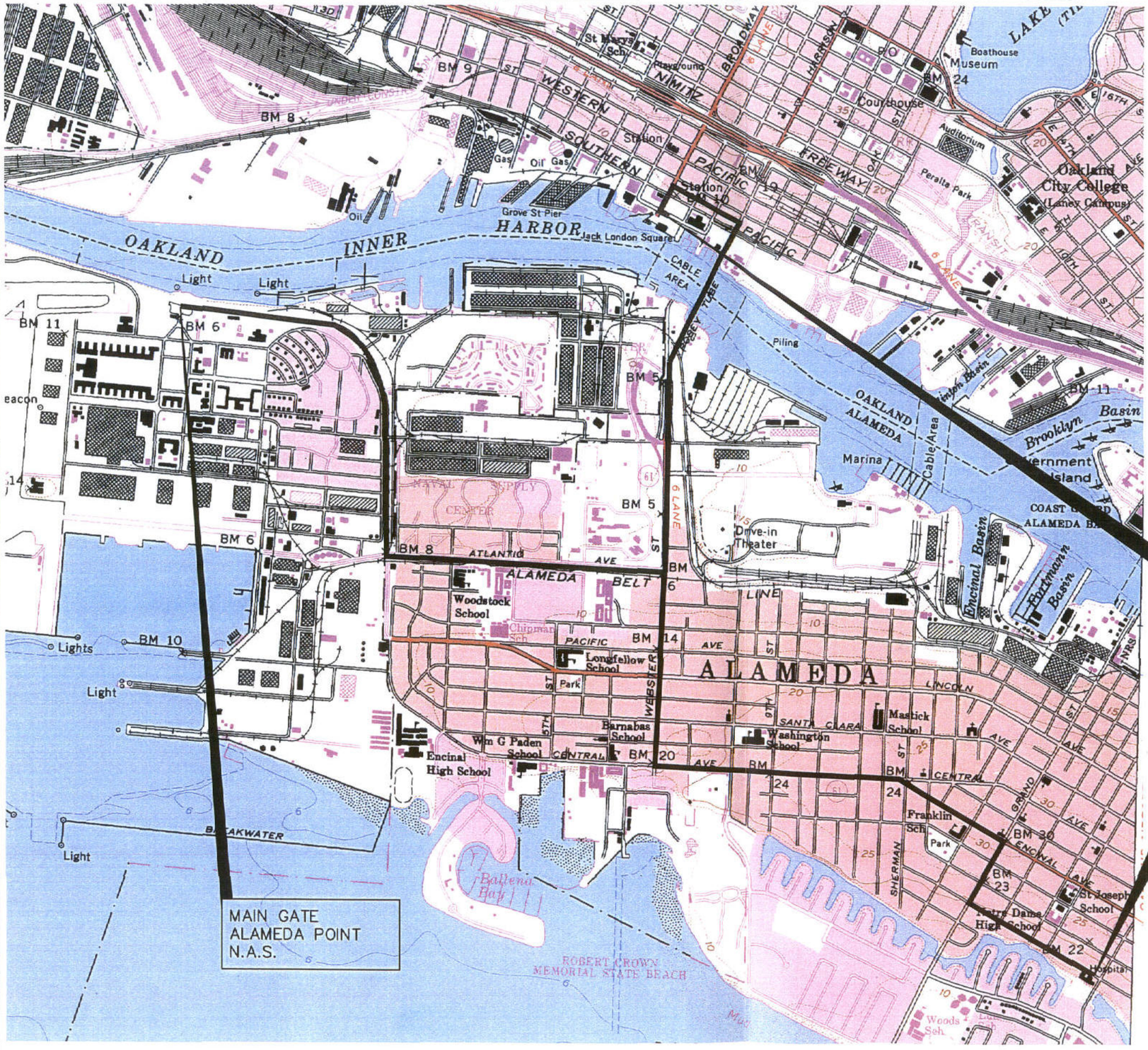

HOSPITAL DIRECTIONS:

Exit Main Gate onto Main Street heading west and continue on Main Street as it turns south. Continue south, turn left at Atlantic and head east. Turn right on Webster and head south to Central Avenue. Turn left onto Central Avenue heading east to Encinal Avenue. Make slight right onto Encinal Avenue heading southeast to Grand Street. Turn right on Grand Street heading south to Clinton Avenue. Turn left onto Clinton Avenue heading southeast to Alameda Hospital (2070 Clinton Avenue).

CLINIC DIRECTIONS:

Exit Main Gate onto Main Street heading west and continue on Main Street as it turns south. Continue south, turn left at Atlantic and head east. Turn right on Webster and continue north through Posey Tunnel. Exit tunnel and continue north to 8th Street (first one-way street heading west). Continue west on 8th Street to Broadway. Turn left and continue south to Embarcadero. Make left on Embarcadero to Concentra Medical Center. (384 Embarcadero).

Figure A.12-2
ROUTE TO HOSPITAL AND CLINIC
IR SITE 32 AND THE SHORELINES OF IR SITES 1 AND 2
ALAMEDA POINT - ALAMEDA, CA

TETRA TECH EC, INC.

ATTACHMENT 1

FINAL ALAMEDA POINT BASE-WIDE HEALTH AND SAFETY PLAN

Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway, Building 127, Room 112
San Diego, California 92132-5190

CONTRACT NO. N44255-95-D-6030
DO NO. 0095

FINAL
BASE-WIDE HEALTH AND SAFETY PLAN
Revision 0
October 30, 2001

ALAMEDA POINT
ALAMEDA, CALIFORNIA

DCN: FWSD-RACII-02-0019

FOSTER WHEELER ENVIRONMENTAL CORPORATION
1230 Columbia Street, Suite 640
San Diego, CA 92101

Jayne Fitzgerald for
Roger Margotto, CIH
Program Health and Safety Manager

Abid Loan, P.E.
Project Manager

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ABBREVIATIONS AND ACRONYMS

ABIH	American Board of Industrial Hygiene
ACGIH	American Conference of Governmental Industrial Hygienists
AHA	Activity Hazard Analysis
APR	air purifying respirator
Base-Wide Plan	Base-Wide Health and Safety Plan
Cal-OSHA	California Occupational Health and Safety Administration
CCR	California Code of Regulations
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
Corps	U.S. Army Corps of Engineers
COTR	Contracting Officer's Technical Representative
CPR	Cardiopulmonary Resuscitation
CRC	Contamination Reduction Corridor
dBA	decibels, A-scale
DO	Delivery Order
DoN	U.S. Department of the Navy
EHS	Environmental Health and Safety
ESQ	Environmental Safety and Quality
ESS	Environmental Safety Specialist
FCR	Field Change Request
FOPS	Falling Object Protective System
FWENC	Foster Wheeler Environmental Corporation
GFCI	Ground Fault Circuit Interrupters
HEPA	High Efficiency Particulate Air
IR	Installation Restoration
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
NAS	Naval Air Station
NIOSH	National Institute for Occupational Safety and Health
NTR	Navy Technical Representative

ABBREVIATIONS AND ACRONYMS
(Continued)

OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PESM	Project Environmental Health and Safety Manager
PjM	Project Manager
PM	Program Manager
PPE	Personal Protective Equipment
QC	quality control
RCRA	Resource Conservation and Recovery Act
RPM	Remedial Project Manager
RQ	Reportable Quantity
SCBA	self-contained breathing apparatus
SHSP	Site-Specific Health and Safety Plan
SHSS	Site Health and Safety Specialist
TLV	Threshold Limit Value
TWA	Time-weighted average
UXO	unexploded ordnance

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

Foster Wheeler Environmental Corporation (FWENC) has been contracted by the U.S. Department of the Navy (DoN) to conduct remedial actions for the cleanup of hazardous waste sites under Basic Contract N44255-95-D-6030. This Base-Wide Health and Safety Plan (Base-Wide Plan) applies to all work performed under this contract at the former Naval Air Station (NAS), now referred to as Alameda Point in Alameda, California. The FWENC Health and Safety Program for Alameda Point consists of this document, the FWENC Corporate Health and Safety Program Manual, and Site-Specific Health and Safety Plans (SHSPs) to be written for individual Delivery Orders (DOs).

1.2 APPLICATION

The Contract Health and Safety Program is applicable to all work conducted by FWENC and FWENC subcontractors under the basic contracts and/or individual DOs. Essentially equivalent or additional health and safety procedures and practices may be approved by FWENC and implemented by FWENC subcontractors where necessary. All subcontractors are required to follow the FWENC Health and Safety programs and procedures unless less restrictive or less conservative practices are approved by the FWENC Project Environmental Health and Safety Manager (PESM), who is a Certified Industrial Hygienist (CIH), and the Navy Contracting Officer. The FWENC PESM will review FWENC and subcontractor SHSPs prior to the initiation of fieldwork.

1.3 APPLICABLE STANDARDS, REGULATIONS, AND GUIDANCE DOCUMENTS

Adherence to applicable portions of federal, local, national consensus organization, and corporate health and safety standards, regulations, and guidance manuals is required during field activities. These include, but may not be limited to, the following:

- 29 Code of Federal Regulations (CFR), Part 1910, Occupational Safety and Health Standards, General Industry.
- 29 CFR, Part 1926, Occupational Safety and Health Standards, Construction Industry.
- 10 CFR, Part 20, Nuclear Regulatory Commission.
- State Regulations including Title 8 California Code of Regulations (CCR) California Occupational Health and Safety Codes (Cal-OSHA) and Title 24 CCR (Health and Safety Code).

- FWENC Corporate Health and Safety Program Manual.
- DoN/Marine Corps Installation Restoration Manual, August 2000.
- U.S. Army Corps of Engineers (Corps) Safety and Health Requirements Manual, EM 385-1-1, 3 September 1996.
- Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists (ACGIH), most current publication.
- Occupational Safety and Health Guidance for Hazardous Waste Site Activities, U.S. Department of Health and Human Services et al., October 1985.

1.4 SUMMARY OF MAJOR RISKS

The SHSP for each DO will describe the major risks for the specific work proposed in a project. All known or potential physical and chemical hazards that may pose a threat to the health and safety of site workers must be identified to ensure workers are adequately protected. Evaluation of work site characteristics and hazards is an ongoing process and will continue throughout the duration of the project.

There is potential unexploded ordnance (UXO) and chemical contamination in various areas of the facility. The contaminants may include fuels, solvents, metals, oils, polychlorinated biphenyls (PCBs), and pesticides. A security fence surrounds the entire facility so hazards associated with the general public are not significant.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 PROGRAM MANAGER

The Program Manager (PM) has the overall responsibility for the health and safety of site personnel at all projects under this contract. The PM will ensure that adequate resources are provided to the field health and safety staff to carry out their responsibilities as outlined below. The PM will also ensure that fieldwork is scheduled with adequate personnel and equipment resources to complete the job safely.

2.2 PROJECT MANAGER

The Project Manager (PjM) is responsible for managing all technical and business aspects of the project. This includes the development of the best technical approach and budget for the contract task order scope, managing technical, cost, schedule, and project issues as work progresses, and subcontractor oversight. The PjM will also ensure that adequate personnel and resources are available to complete the project safely. The PjM will conduct monthly health and safety inspections of the job site.

2.3 PROJECT SUPERINTENDENT

The Project Superintendent is responsible for ensuring that all work is performed in accordance with the contract requirements in a safe and healthful manner. The Project Superintendent will ensure that work crews have adequate resources to effectively conduct field activities, ensure [in conjunction with the Site Health and Safety Specialist (SHSS)] that proper protective equipment is being used by all personnel, enforce appropriate disciplinary actions when health and safety requirements are not being followed or when unsafe practices occur, and oversee work practices to verify they are in accordance with the SHSP. The Project Superintendent has the authority to suspend field activities if the health and safety of personnel are in danger.

The Project Superintendent will submit to the Navy Contracting Officer's Representative (COTR), upon request, copies of the certificates (or acceptable alternative documents) of most recent health and safety training required by 29 CFR, Part 1910.120 for all the personnel who will be working on site. Copies of the training certificates (or acceptable alternative documents) will also be kept at the work site.

2.4 PROJECT ENVIRONMENTAL HEALTH AND SAFETY MANAGER

The PESM is responsible for implementing and overseeing the Contract Health and Safety Program and to develop, implement, and approve all SHSPs. Any changes to the established Contract Health and Safety Program or SHSP is at the direction and approval of the PESM, with concurrence of the Navy Contracting Office. The PESM or designee will not necessarily be on site during all remedial activities, but will be readily available for consultation when required.

The PESM or designee is a CIH certified by the American Board of Industrial Hygiene (ABIH). The PESM supervises and directs the activities of the SHSS. The PESM has the authority to stop unsafe operations, remove unqualified personnel from the work area, and approve changes to the SHSP. Duties of the PESM include:

- Overseeing all aspects of the SHSP from development to implementation.
- Advising the SHSS on all related health and safety aspects.
- Reviewing site-specific plans for completeness and compliance.
- Reviewing other site documents as they affect health and safety (e.g., Activity Hazard Analyses, Sampling Plans).
- Reviewing and evaluating all monitoring results.
- Establishing and monitoring all related health and safety procedures through site safety inspections and audits.

2.5 SITE HEALTH AND SAFETY SPECIALIST

The SHSS will be present on site as required during the conduct of field operations and is responsible for all health and safety activities and the delegation of duties to the health and safety staff in the field. The SHSS is responsible for implementation of the SHSP, overseeing that appropriate personal protective equipment (PPE) is used relative to the hazard which may be encountered, verifying that communication systems are in place, monitoring conformance with safety and emergency response procedures, giving safety briefings, seeing that safety equipment is maintained, and conducting safety drills and exercises. The SHSS or designee is responsible for the setup and execution of decontamination procedures. The SHSS has stop work authorization, which will be executed upon determination of an imminent safety hazard or potentially dangerous situation. Work cannot restart until clearance has been authorized by the SHSS. The SHSS is responsible for maintaining the site health and safety log books.

The SHSS possesses the knowledge and experience necessary to ensure that all elements of the approved SHSP are implemented and enforced on site. FWENC employs full-time personnel as Environmental Safety Specialists (ESSs) and personnel who have been cross-trained as an ESS. The ESS is the equivalent of the SHSS. Each FWENC SHSS has a minimum of one year work experience with hazardous materials and has completed a minimum of 40 hours additional specialized training in personal and respiratory protective equipment, program implementation,

and in proper use of air monitoring instruments, air sampling methods, and interpretation of results. Every SHSS is certified as having completed training in first aid and cardiopulmonary resuscitation (CPR) by a recognized organization such as the American Red Cross Association.

2.6 SITE PERSONNEL

A list of personnel authorized to have access to the remediation or work site will be compiled and maintained on site by the SHSS. This list will include employees of FWENC, subcontractors, and representatives of governmental agencies that may require access, where possible. All authorized personnel shall meet the requirements of the contract task order SHSP and be approved by the SHSS or Project Superintendent prior to entering any exclusion zone or controlled area when potentially hazardous activities are being conducted.

Although the employer is responsible for providing a safe and healthful work place, each employee is responsible for their own safety as well as the safety of those around them. Employees will use all equipment provided in a safe and responsible manner as directed by the Superintendent. All FWENC personnel will follow the policies set forth in this SHSP and in the FWENC Health and Safety Program Manual. Each employee is responsible for reporting any injuries, incidents, and safety infractions to a project supervisor or the SHSS so treatment can be obtained and/or corrective action taken. Equipment operators are responsible for the maintenance, inspection, and safe operation of their equipment. They will report any equipment malfunctions or necessary repairs to a project supervisor.

2.7 SUBCONTRACTED PERSONNEL AND THIRD PARTIES

All subcontracted personnel are responsible for compliance with this SHSP and other applicable regulations. Subcontractor personnel must receive a briefing from the SHSS prior to unescorted access to the project site. They must fulfill the requirements established by this plan and the site-specific plans. They must acknowledge receipt of the plan and the hazard communication briefing. On-site subcontractors are responsible for providing their personnel with appropriate PPE as specified by the plan. Subcontractor and third party personnel have the authority to request a work area hazard assessment by the SHSS prior to the commencement or continuation of work.

3.0 SITE HISTORY AND PROJECT DESCRIPTION

3.1 SITE HISTORY AND PROJECT DESCRIPTION

Alameda Point is located on the West end of Alameda Island, which lies on the East side of San Francisco Bay adjacent to the City of Oakland. Alameda Point is rectangular in shape, approximately 2 miles long east to west, 1 mile wide north to south, and occupies 1,734 acres. Prior to 1930, at least two large industrial sites, a borax processing plant and an oil refinery, were located on the island near what is now the eastern end of the former NAS Alameda. The refinery was located at the site of the present-day Installation Restoration (IR) Site 13.

The U.S. Army first acquired the former NAS Alameda site from the city of Alameda in 1930 and began construction activities in 1931. The DoN acquired title to the land from the Army in 1936 and began building the air station in response to the military buildup in Europe prior to World War II. After the 1941 entry of the United States into the war, more land was acquired adjacent to the air station. Following the end of the war, the former NAS Alameda returned to its original primary mission of providing facilities and support for fleet aviation activities.

Projects at Alameda Point could include surveys, additional sampling and characterization, additional screening for UXO materials or ordnance debris, installation or removal of groundwater monitoring wells, and other work associated with restoration of the sites.

4.0 POTENTIAL HAZARDS

The SHSP for each DO will discuss the specific chemical, physical, and environmental hazards to workers on each specific site. The SHSP will discuss each contaminant and include information such as exposure limits and signs and symptoms of exposure. The SHSP will discuss site-specific physical hazards identified with the site including those associated with construction, use of heavy equipment, fire hazards, and electrical hazards. This Base-Wide Plan discusses the general hazards associated with most projects. The SHSP will describe site-specific environmental hazards, although most environmental hazards are associated with the physical location of the base and weather conditions such as heat stress, noise, and flora and fauna contact and are, therefore, described in this Base-Wide Plan.

4.1 CHEMICAL HAZARDS

The chemicals believed to be on a specific site, based on analytical data provided by previous investigations will be discussed in each SHSP. Material Safety Data Sheets (MSDS) for the contaminants and any additional chemicals found on a site or brought onto a site will be acquired and reviewed with all personnel during daily safety meetings. An attachment to the site SHSP will contain the MSDSs. The PESM and the SHSS will specify the levels of protection and air-monitoring requirements based initially on the data provided or obtained prior to remediation work. These requirements may change as site conditions are more fully evaluated when work is underway.

FWENC's protective equipment requirements combined with the requirement to wash arms, face, and hands before eating or smoking should prevent exposure through these routes. In addition, the project SHSS and project supervisors observe and warn the crew members to be aware of the initial symptoms of chemical exposure. The amount of exposure depends primarily on the specific activities undertaken and the care with which the activities are performed. A supervisor will remove any crew member from the work site and have the worker medically evaluated if the following initial symptoms persist and are unexplained by other causes (such as allergy, common cold, heat stress, etc.):

- Dizziness or stupor
- Nausea, headaches, or cramps
- Irritation of the eyes, nose, or throat
- Euphoria
- Chest pains and coughing
- Rashes or burns

4.1.1 Hazard Communication Program

The purpose of a Hazard Communication or Employee Right-To-Know program is to ensure that the hazards of all chemicals located at this field project site are communicated according to 29 CFR, Part 1926.59 8 CCR, Section 5194 regulations to all FWENC personnel and subcontractors. FWENC Environmental Health and Safety (EHS) Procedure 4-2 is the written hazard communication program. This program requires:

- ***Container Labeling***--Personnel will ensure that all drums and containers are labeled according to contents. These drums and containers will include those from manufacturers and those produced on site by operations. All incoming and outgoing labels will be checked for identity, hazard warning, and name and address of responsible party.
- ***MSDSs***--There will be an MSDS located on site for each hazardous chemical used or known to be on site.
- ***Employee Information and Training***--Training employees on chemical hazards is accomplished through formal safety training conducted annually and informal safety meetings. Project-specific chemical hazards are communicated to employees through an initial site orientation meeting and during daily safety meetings held at field projects.

4.2 ENVIRONMENTAL HAZARDS

The SHSS or a supervisor will discuss environmental hazards associated with each site at the orientation meeting prior to start up of remediation activities.

4.2.1 Least Tern Nesting Sites

There are California Least Tern nesting sites on Alameda Point. No field activities may be conducted in these areas between April and September.

4.2.2 Weather and Heat Stress

With the possible combination of ambient factors such as high air temperature, a few days with high relative humidity, low air movement, high radiant heat, and protective clothing, the potential for heat stress is a concern. The potential exists for:

- Heat rash
- Heat cramps
- Heat exhaustion
- Heat stroke

The FWENC EHS Procedure 4-6 describes the heat stress management and prevention program. At 75°F, ambient temperature, the supervisor on site initiates the procedures in the program.

Heat stroke, heat cramps, and heat exhaustion are covered in detail during the 40-Hour Occupational Safety and Health Administration (OSHA) 29 CFR, Part 1910.120 (8 CCR, Section 5192) pre-employment course. In addition, this information is discussed during a safety "tailgate" meeting before each workday where heat stress may be a factor. Workers are encouraged to increase consumption of water and electrolyte-containing beverages such as Gatorade during warm weather. Water and electrolyte-containing beverages will be provided onsite and will be available for consumption during work breaks.

At a minimum, workers will break every two hours for 10 to 15 minute rest periods. In addition, workers are encouraged to take rests whenever they feel any adverse effects, especially those effects that may be heat-related. The frequency of breaks may need to be increased upon worker recommendation or decision of the SHSS and a supervisor.

The EHS procedure also describes a cold stress program; however, due to the location of the former NAS, it is unlikely that there will be a need for this program.

4.2.3 Hearing Conservation Program

On projects where noise levels may exceed a time-weighted average (TWA) of 84 dBA (decibels, A-scale), hearing protection will be made available to all exposed employees. Additionally, sound level monitoring may be conducted onsite. All FWENC personnel on project sites have annual audiograms. Personnel with a standard threshold shift will be restricted from high noise exposure or will be required to wear hearing protection at all times. FWENC, EHS Procedure 4-4, is a hearing conservation program in compliance with OSHA regulations (29 CFR, Part 1910.95) (8 CCR, Sections 5095 –5100).

4.2.4 Biological Hazards

Biological hazards may be encountered on site. Workers should anticipate the increased likelihood of encounter of these hazards, especially in and around buildings and in undeveloped outdoor areas. Animal bites and insect stings can cause localized swelling, itching, and minor pain that can be handled by first aid treatment. In sensitized individuals, however, effects can be more serious such as anaphylactic shock, which can lead to severe reactions in the circulatory, respiratory, and central nervous system, and in some cases, even death. The SSHS will identify personnel with a known reaction to bites and stings at the pre-job safety orientation meeting. Personnel will not attempt to capture any wild or semi-wild animals such as cats or rats due to the possibility of a bite or parasitic infestation.

- Poison oak causes discomfort, irritation, and inflammation of the skin. Personnel will be warned to prevent contact with unknown plants. Protective clothing worn by site personnel should reduce the probability of such exposure. Cleaning the skin thoroughly with soap and water after contact will also reduce risk of severe symptoms.
- Animal and bird droppings often contain mold, fungus, or bacteria that represent a significant respiratory hazard including lung diseases and allergies. Personnel will not touch visual droppings, and will wear gloves and Tyvek protective wear, at a minimum, when going into normally limited access areas such as crawl spaces and high ceilings that may have become refuges or nesting areas.
- The hanta virus is sometimes transmitted by rodents found in the Southwestern United States, and causes respiratory distress, sometimes with fatal consequences. Similarly rats transmit the arenavirus. Transmission of the hanta virus or arenavirus occurs with exposure to rodent droppings. Good hygiene practices such as washing hands and face prior to eating and drinking will help to minimize the potential for exposure to the hanta virus. While work is in progress, use of high efficiency particulate air (HEPA) filter cartridges and work practices that minimize generation of dust and aerosols, will help protect employees. Avoiding areas where there are concentrations of mouse droppings (hanta virus) or rat droppings (arenavirus), for example, minimizes exposure to either virus. The virus can be inhaled in the dust from areas where mice or rats have nested or left their droppings. Minimizing dust inhalation or avoiding these areas will lessen the risks of exposure. Any work in such areas should be done only with full Level C protection including, at a minimum, a HEPA air-purifying respirator. Thorough washing of hands and face after removing the PPE will further minimize the potential for exposure.
- The area may have ground squirrels. Within certain areas of California, ground squirrels are known to have fleas that are a vector for the spread of the bacteria that causes plague. Plague is treatable with antibiotics. Workers should avoid working close to any ground squirrels and when necessary wear insect repellant.
- Personnel must use extreme caution when walking through an area, around buildings, and near objects such as drum and containers where a snake is likely to rest during the daytime. If a snake is encountered, slowly and quietly back away from the snake and inform all personnel of its location. Do not attempt to move or kill a snake as certain snakes are protected under state and federal laws. In the event of snakebite, do not try to move the affected individual. Wipe off the skin, as the venom will attack intact skin. Do not suck out the venom. Do not cut open the wound. Do not apply ice or ice packs. Do not use a tourniquet. Do not administer alcohol or medications. Call for medical assistance.

4.2.5 Storm Protection

If a warning of gale-force winds is issued, take precautions to minimize danger to persons, and protect the work and any nearby property. Precautions will include closing of all openings; removing loose materials, tools and equipment from exposed locations; and removing or securing scaffolding and other temporary work. Close all openings in the work site if storms of a

lesser intensity pose a threat to property. The SSHS will ascertain predicted daily weather conditions by listening to daily weather forecasts on radio or television. If particularly ominous weather conditions are predicted, the SSHS will monitor radio broadcasts regularly or through National Weather Service reports. Workers will not enter any excavations during a rainstorm. The supervisor or SHSS will stop all work when wind speeds are 25 miles per hour or higher. The supervisor and the SHSS will assess what work procedures can be safely performed when wind conditions exceed 25 miles per hour. They will give consideration to fugitive dust and odor emissions, the safety of equipment in high winds, and protection of workers from flying debris and dust in windy conditions. No crane or boom work is permitted in winds at 25 miles per hour or higher. (Certain crane manufacturers may specify lower wind speed limitations for safe operations. The SHSS must ensure that operational limitations of these cranes are not exceeded.)

4.3 PHYSICAL HAZARDS

There are numerous physical hazards associated with a project, which if not identified and addressed, could present accidents and personal injury to the work force, as well as operational problems. In order to minimize physical hazards, FWENC has developed standard safety protocols, which will be followed at all times. Failure to follow safety protocols or continued negligence of these policies will result in discipline of the employee. The FWENC Project Rules Handbook states the Health and Safety Project Rules and Guidelines. Some of these are described in this section and in Section 10 of this plan. Any site-specific rules are stated in the SHSP. All FWENC personnel will follow these requirements as specified here and in the Project Rules Handbook. Supervisors will observe the general work practices of each worker and enforce safe procedures to minimize physical hazards. Hard hats, safety glasses, and safety boots are required in all areas of the work site, unless specifically exempted by the PESM, SHSS, or a supervisor.

4.3.1 Tripping, Slipping, and Falling Hazards

Supervisors will remind personnel and subcontractors daily to maintain sure footing on all surfaces. The supervisor and/or the SHSS will inspect all work areas prior to the start of work to look for hazards. Any personnel working six feet above any surface, including man lifts, are required to wear safety harnesses and safety lanyards. The SHSS will inspect these before use. In order to minimize tripping hazards caused by debris, job supplies, and equipment, personnel will remove this material from the work areas daily and stockpile the materials and place equipment in storage areas. The SHSS will enforce this "housekeeping" effort throughout the day. Workers will not work near the edges of excavations without fall protection.

4.3.2 Head and Back Injuries

At a minimum, workers will don hard hats, safety boots, and safety glasses prior to performing any site activities. This will prevent minor injuries caused by bumping one's head while working around and under piping and other process related structures or equipment. Personnel are

instructed in proper lifting techniques and will not lift heavy items without assistance per FWENC EHS Procedure 3-1. Each worker will not lift more than 50 pounds. Objects heavier than 50 pounds require assistance from another person. Supervisors will use mechanical lifting equipment whenever possible to minimize worker exposure to lifting hazards.

4.3.3 Falling Objects

All items raised will be slowly lowered to the ground using a grapple and/or skip bucket. No personnel will work under equipment at any time. Also, the SHSS will ensure that an adequate area is clear of personnel while the equipment is in operation. Dump truck drivers will remain in their trucks while soil and debris is placed in their trucks, if their trucks are equipped with a Falling Object Protective System (FOPS). If their trucks are not equipped with FOPS, the drivers will get out of their trucks and stand clear of the loading operation. Workers will not work under other workers who are on scaffolds or levels higher than them unless those levels have protection to prevent objects from falling on workers below.

4.3.4 Heavy Equipment and Traffic

The use of heavy equipment for debris removal, excavation, and lifting presents the greatest potential for injury to personnel. In order to minimize these hazards, the PjM and supervisor will designate routes for mobilization through the NTR and establish specific traffic patterns. All trucks and heavy equipment will have spotters for backing maneuvers. Only qualified personnel will operate heavy equipment. Those crewmembers directly involved with spotting for the operator are the only personnel allowed in the vicinity of the heavy equipment. All others will remain a safe distance away from these operations. Personnel needing to approach heavy equipment while operating will observe the following protocols:

- Make eye contact with the operator (and spotter)
- Signal the operator to cease heavy equipment activity
- Approach the equipment and inform the operator of intentions

All FWENC personnel will follow all local traffic rules. Company vehicles will yield to all bikes and pedestrians. Personnel working in areas subject to vehicular traffic (i.e. streets, parking lots, etc.) will wear orange safety vests. Flashing light or reflectorized barricades will be used for all roads that are blocked due to equipment or excavation. Coordinate all traffic management issues with the Remedial Project Manager (RPM) and facility security.

4.3.4.1 Site Pre-Inspection of Equipment

The projects will only use heavy equipment that is in safe working order. To maintain this policy, the project supervisor(s), the SHSS, and the equipment operator will inspect all equipment brought onto the project site for structural integrity, smooth operational performance,

and proper functioning of all critical safety devices in accordance with the manufacturer's specifications and safety regulations. There will be an operator's manual for each heavy equipment and vehicle. All equipment not conforming to the operational and safety requirements set forth during this inspection will not be put into service until all necessary repairs are made to the satisfaction of the inspection group. The vendor providing the equipment or contractors that bring their equipment to the projects must provide a certificate from a mechanic that the equipment has been inspected and is acceptable for use.

4.3.4.2 Operator Qualifications

Only qualified operators familiar with the equipment to be used will be permitted to operate. Subcontractors will supply proof of their operator's capability and experience to operate the equipment in a safe manner. FWENC reserves the right to remove from the project site any operator if there is a question or doubt concerning the operator's capabilities. There are specific training requirements for industrial truck (forklift) operators and for crane operators. These requirements are specified in the FWENC EHS procedures and the U.S. Army Corps of Engineers EM 385-1-1 Safety and Health Requirements Manual.

4.3.5 Electrical Hazards

In order to prevent accidents caused by electric shock, the project SHSS will inspect all electrical connections on a daily basis. The SHSS will shutdown and lockout any equipment that is found to have frayed or loose connections until a qualified electrician is contacted and repairs are made. The equipment will be de-energized and tested before any electrical work is done. All equipment will be properly grounded prior to and during all work. In addition, Ground Fault Circuit Interrupters (GFCIs) will be installed for each circuit between the power source and tool. In the event that generators are used to supply power, these generators will contain GFCIs.

4.3.6 Confined Space Entry

A confined space is any enclosed area having a limited means of egress where ventilation is not adequate to remove a toxic or flammable atmosphere or oxygen deficiency, which may exist. Examples of confined spaces include, but are not limited to, the following: tanks; boilers; vessels; bins; manholes; tunnels; pipelines; underground utility vaults; or any open top space more than four feet in depth such as pits, tubes, trenches, or vessels.

EHS Procedure 6-1 outlines procedures in detail. No confined space entry is allowed per this plan. Prior to the start and during the conduct of each DO, the PESM, the SHSS and the project supervisor(s) will identify confined spaces or confined spaces created by the nature of the work. The SHSS will identify these confined spaces and will not allow entry into these spaces. If a confined space requires entry, the plan will be modified and approved per the amendment procedure described in this Base-Wide Plan.

4.3.7 Fire and Explosion Hazards

Atmospheric testing with a combustible gas indicator must be performed to determine the potential for a flammable atmosphere. A hot work permit must be issued to control the presence of equipment or operations producing open flames or sparks. Hot work permits and procedures are found in EHS Procedure 6-5. Permits are issued by the SHSS. The SHSS must also obtain a hot work permit from the Alameda Fire Department. The SHSS must establish a fire prevention and protection program by insuring that flammable materials are properly stored and that safe work procedures and rules are followed. Smoking is not permitted anywhere on a project site except in designated areas.

4.3.8 Drilling

Any drilling will be performed in accordance with EM 385-1-1, 16.M. A survey of the job site to identify overhead electrical hazards, potential ground hazards, and underground utilities must be performed before placement of the drilling equipment. MSDSs for drilling fluids must be provided to the SHSS before the start of work. Supervisors will ensure that a call has been made to Underground Service Alert (Dig Alert) and that drawings and maps from public works are reviewed to verify that there are no underground utilities that will be disturbed by the drilling operation.

4.3.9 Overhead Electrical Hazards

Overhead power lines may present a hazard to equipment and personnel. To prevent equipment contact with power lines and to prevent arcing, adequate clearance must be maintained. For lines rated 50 kV or below, the minimum clearance between the lines and any part of the crane or load will be 10 feet. For lines rated more than 50 kV, the minimum clearance between the lines and any part of the crane or load will be 10 feet plus 0.4 inch for each kV more than 50 kV.

4.3.10 Excavation Safety

Any excavation or trenching operation that is four feet or more in depth will be performed in accordance with EM 385-1-1 and EHS Procedure 6-3. A FWENC excavation permit must be completed by a competent person before excavation commences and at least each day thereafter. This permit requires daily inspections of the operation and adjacent areas. Specific situations addressed in these inspections are possible cave-ins, indications of failure of protective systems (benching, sloping, or shoring), hazardous atmospheres and other hazardous conditions. If the competent person finds evidence of any of these situations, exposed employees will be removed from the hazardous area until the necessary precautions have been taken to ensure their safety. In addition to the excavation permit, for work in California, a Cal-OSHA Activity Notification Form for Holders of Annual Excavation Permits must be filed with Cal-OSHA for any excavation 5-feet or greater in depth into which workers will enter. FWENC has an annual permit for excavations in the state of California. Also, Dig-Alert must be notified before any

excavation work begins regardless of depth. Exploratory techniques, such as "pot-holing" will be performed to insure that any excavation near utilities can be performed safely. Dust suppression measures may include the use of a compound, which will make the soil less likely to dust or use water. However, work procedures as soil is moved and especially as it is lifted and loaded must be performed in such a way to minimize the generation of dust. For example, loaders dumping soil into a dump truck or a stockpile may have to lower the bucket as close as possible to the truck or stockpile before dumping to reduce the drop height of the soil and, thereby, reduce the amount of dust generated.

5.0 ACTIVITY HAZARD ANALYSES

Each SHSP will have a section that evaluates the risks and associated precautions for remediation activities associated with the site-specific activities. An AHA is developed for each planned activity and operation occurring in each major phase of work. This AHA identifies the sequence of work, specific hazards anticipated, and the control measures to be implemented to minimize or eliminate each hazard. This AHA is used to augment daily safety meetings intended to heighten safety and hazard awareness on the job. This pre-task briefing will be documented and may be combined with the daily tailgate safety meeting. AHAs are the focal point for safe conduct of work on a project. Since each task is described and evaluated workers should be better prepared to perform work safely.

The SHSS will discuss the risks and precautions associated with each task identified in the DO and in the work plan. Daily "tailgate" safety meetings are held at the start of each shift. Prior to the day's remediation activity the safety meeting discusses the potential chemical, physical, and environmental hazards and preventive safety measures. During a workday, if there are any changes or new conditions, the SHSS will insure that the AHA is updated and that workers review the amended AHA. Attendance is mandatory for all employees involved in the specific work.

If there are changes required due to changing conditions or requirements, the SHSP may be modified by using the change form attached to the SHSP and by obtaining the approval of the PjM or Project Superintendent, the Project SHSS, and the PESM.

6.0 PERSONAL PROTECTIVE EQUIPMENT

PPE for site workers will be selected and used based upon the existing and potential hazards anticipated and the requirements of 29 CFR, Part 1910.120 (8 CCR, Section 5192). Different levels of personal protection will be provided to workers at the site depending on specific work tasks performed. The selection of PPE requires an evaluation of chemical contaminants, concentrations of these chemical contaminants, and physical hazards that may be encountered.

The initial PPE and action levels for each site activity will be established for each DO based on available data and defined in the SHSP. As additional testing, monitoring, and background information become available, the SHSS may adjust the action levels and PPE accordingly. The PESM will be consulted for approval to changes in the action levels. The decision to upgrade or downgrade the level of protection allowed in the field and will be communicated as appropriate to all site personnel. The decision and justification for the change in level of protection will be recorded in the health and safety logbook.

The SHSP will comply with 29 CFR, Part 1910.132 (8 CCR, Sections 3380 through 3390), which states that all PPE for eyes, face, head, and extremities, protective clothing, respiratory protection devices, and protective shields and barriers shall be provided, used, and maintained in a sanitary and reliable condition. PPE is required wherever it is necessary by reason of hazards from processes or environment, chemical hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact.

Respiratory protection is of primary importance in the protection of employee health since inhalation of air contaminants is a potential major route of exposure. The FWENC respiratory protection program is administered pursuant to the requirements established by 29 CFR, Part 1910.134 (8 CCR, Section 5144). The SHSS is assigned responsibility as the Respirator Program Administrator for the project. Selection, use, and maintenance of PPE at the project shall be in accordance with EHS Procedure 5-1, Personal Protective Equipment, and EHS Procedure 5-2, Respiratory Protection. The SHSS may upgrade or downgrade the level of protection based on the hazard anticipated, evaluation of site monitoring data, and established action levels by the SHSP and with the concurrence of the PESM.

The EPA Level categories are as follows:

- ***Level A***: Used when the greatest level of skin, eye, and respiratory protection is needed and consists of a totally encapsulated suit with supplied breathing air.
- ***Level B***: Used when the highest level of respiratory protection is needed but a lesser level (than Level A encapsulated suit) of skin protection is required.

- ***Level C:*** Used when criteria for using air-purifying respirators are met and a lesser level of skin protection is required.
- ***Level D:*** Used only as a work uniform and in an area without respiratory hazards.

Level D protection is used during site reconnaissance, mobilization, geophysical survey, base line surveying, and other activities that have no potential for exposure to chemical hazards. PPE for Level D includes:

- Coveralls, cotton and/or disposable coveralls
- Boots, leather or rubber, steel toe and shank
- Rubber overboots or disposable booties (as required)
- Safety glasses or goggles
- Hard hat
- Gloves as required by task (e.g., leather work gloves)
- Hearing protection (as required)

Level C protection is used during Resource Conservation and Recovery Act (RCRA) and non-RCRA soil excavation, temporary storage, loading, backfilling and compaction, decontamination of equipment, and other activities where there is a potential for chemical exposure but where that exposure is below permissible exposure levels with the provided PPE. If air-monitoring information dictates that a higher degree of PPE is necessary, levels of protection are increased. PPE for Level C includes:

- Full facepiece APR
- National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA)-approved air purifying respirator cartridges (approved for use with the specific types of contaminants)
- Emergency escape respirator (optional, depending on the potential for emergency conditions)
- Coveralls (inner), cotton
- Coveralls (outer), chemical-resistant, disposable (e.g., Tyvek)
- Gloves (outer), chemical-resistant (e.g., nitrile)
- Gloves (inner), cotton or nitrile
- Boots, chemical-resistant, rubber, with steel toe and shank, or Boots, leather, with steel toe and shank with chemically resistant rubber overboot
- Hard hat
- Hearing protection (optional or as required)

Level B protection is selected and implemented when it is determined through real time air monitoring and/or personnel sampling that the highest level of respiratory protection is necessary for site personnel. This level of protection is also used when the atmospheric contaminant(s) identified does not meet the selection criteria permitting the use of air purifying respirators or when contaminants are unknown. There is a possibility that this may occur for some DO specific work.

PPE for Level B includes:

- Pressure-demand, self-contained breathing apparatus (SCBA) or airline respirator (with attached 5-minute escape bottle)
- Coveralls (inner), cotton
- Coveralls (outer), chemical-resistant, disposable (e.g., Tyvek)
- Gloves (outer), chemical-resistant (e.g., nitrile)
- Gloves (inner), (e.g., nitrile)
- Boots, chemical-resistant, rubber, with steel toe and shank, or Boots, leather, with steel toe and shank with chemically resistant rubber overboot
- Hard hat
- Hearing protection (optional or as required).

Subcontractors are responsible for supplying, maintaining, their own PPE according to the manufacturers' procedures and guidelines and their own policies and procedures, which must be at least as protective as required by regulations and those procedures described in this Base-Wide Plan.

Most projects usually require the use of either Level D or Level C protection. With each level of protection there is a degree of variability or modification dependent on the specific tasks and the nature and concentration of contaminants. For example, different tasks on the same site may require gloves of different materials, length, or thickness. Variations of a level of protection will be indicated by a qualifier (e.g., "Modified Level C") and specify the modification required. Level A protection, if ever required, will require specific discussion in the SHSP.

For site work under this contract, FWENC or subcontractors will maintain protective equipment on site for use by government visitors as specified in each DO.

7.0 AIR, NOISE, AND OTHER MONITORING

The SHSS will conduct monitoring to ensure that each site worker is adequately protected. Required monitoring will be defined in the SHSP. Site monitoring and sampling may include personal air sampling, real-time air monitoring, perimeter monitoring, radiation monitoring, noise monitoring, and heat stress monitoring.

The SHSS shall have experience using the required monitoring or sampling equipment. The PESM shall ensure that each SHSS is qualified to operate all assigned instruments. The SHSS shall ensure that each piece of equipment is properly maintained and calibrated.

Personal sampling requirements will be defined in the SHSP, and will be based on potential airborne hazards and OSHA requirements. Personal sampling methods will be in accordance with NIOSH methods, OSHA instructions, or good industrial hygiene practice when established methods are not available or feasible. A laboratory accredited by the American Industrial Hygiene Association will conduct all laboratory analysis of industrial hygiene samples. Results will be compared to the ACGIH TLVs or OSHA Permissible Exposure Limits, whichever is more stringent. Results will be communicated to employees in accordance with OSHA requirements. All exposure records will be kept in accordance with 29 CFR, Part 1910.20 (8 CCR, Section 3204).

Real-time air monitoring will be used, as appropriate, to identify and quantify airborne levels of hazardous substances and safety and health hazards in order to determine the appropriate level of employee protection needed on site. Real-time monitoring may be necessary for airborne hazards such as flammable vapors, specific target compounds, organic vapors, and dust. Real-time monitoring requirements will be documented in the SHSP and based on the probability of encountering potential contaminants at each site. The PESM will establish action levels and the action required if levels should be reached or exceeded.

All instruments (both real-time and TWA) shall be calibrated according to the manufacturers' recommendations. All equipment shall be calibrated before and after use. A calibration log shall be kept to record all calibrations.

The SHSP may specify the use of colorometric tubes for direct reading of specific contaminants. The details will be discussed and action levels established.

The need for radiation monitoring will be established in the SHSP. Radiation monitoring procedures, action levels, and recordkeeping will be in accordance with 10 CFR, Parts 20 and 29 CFR, Part 1910.1096 (8 CCR, Sections 5075 through 5076).

Noise monitoring and hearing conservation requirements will be defined in the SHSP and implemented in accordance with Procedure EHS 4-4, Hearing Conservation Program, and 29 CFR, Part 1910.95 (8 CCR, Sections 5095 through 5100).

The SHSS will ensure that all data is documented in logs or logbooks including calibration, types of calibrants used, the manufacturer, model number of instruments used, the date and time of calibration and monitoring events, the area or personnel monitored, the atmospheric conditions and weather, unique site conditions, equipment operating in area, initials of individuals performing the monitoring, and any other information which affects the data or the actions taken based on the data.

8.0 SITE CONTROL

The PjM, Project Superintendent, and the SHSS will implement site control measures at each site. These measures will consist of general site control and specific work location site control. Site control measures are specified in the SHSP for each DO.

General site control measures pertain to the overall site and may include the use of security guards, perimeter fencing, sirens, posting of warning signs, and illumination. These control measures are geared toward visitors and the general public. The Project Superintendent and the SHSS implement control measures as necessary.

Location-specific control measures are designed to control contamination and worker entrance and exit from individual work areas. Prior to the commencement of any on-site work, controlled zones of activity will be established by the SHSS. This will reduce the spread of contamination to off-site areas and protect the health and safety of workers. The controlled zones will be included in one of the following categories: 1) exclusion zone—where contamination does or could occur, 2) contamination reduction zone—where decontamination will occur, and 3) support zone—clean zone outside the contamination reduction zone. Each work zone will be clearly identified and delineated by cones, rope, fences, signs, or barricades.

8.1 EXCLUSION ZONE

The exclusion zone may include all areas within the boundaries of a contaminated work area or merely the areas immediately surrounding the site of intrusive activity. Access points are provided to the exclusion zone. During activities where the possibility of airborne contaminants being carried outside the exclusion zone exists, the exclusion zone will be expanded to include areas of possible contamination. Only designated project team members and authorized government agency personnel shall be allowed in the exclusion zone. All personnel entering the exclusion zone must wear the appropriate level of protection designated for the work area. Personnel must also meet medical surveillance requirements, training requirements, and respirator fit test requirements. All personnel exiting the exclusion zone must be fully decontaminated in the contamination reduction zone.

8.2 CONTAMINATION REDUCTION ZONE

All personnel and equipment that may have been contaminated in the exclusion zone will be subject to decontamination in the contamination reduction zone. Temporary or field decontamination stations for personnel and equipment will also be located in the contamination reduction zone as needed. The contamination reduction zone is intended to be a buffer between the exclusion zone and the support zone and will be designed to prevent the transfer of contaminants from the exclusion zone to the support zone and off site. Within this zone is

usually located a Contamination Reduction Corridor (CRC). In the CRC, workers will find decontamination equipment, supplies, and stations.

8.2.1 Decontamination Procedures

Personal hygiene practices for field personnel will be described in the SHSP. At a minimum, site workers will be provided with adequate restroom and handwashing facilities and be required to wash exposed areas of the skin (i.e., hands and face) upon exiting potentially contaminated areas. Smoking, eating, or drinking will not be allowed in exclusion zone or contamination reduction zone work areas.

The SHSS is responsible for the functional activities of the decontamination facilities and shower trailer if one is required on the site. The SHSS will train site personnel in the steps used for decontamination. The SHSS will periodically inspect for compliance with decontamination procedures and correct any deficiencies.

Separate areas will be designated for equipment decontamination and personnel decontamination. These areas will be separated to minimize contamination of the personnel in the contamination reduction zone by overspray from equipment decontamination.

8.2.2 Personnel Decontamination

Personnel departing the exclusion zone are required to proceed through a decontamination line. The following decontamination procedure is an example and will be modified to meet site-specific requirements in the SHSP:

- ***Facility 1***—Segregated Equipment Drop: Drop equipment onto plastic liner or shelf.
- ***Facility 2***—Boot Cover Wash/Rinse and Removal: Wash and rinse outer boot covers with detergent and water. Remove boot covers and discard into proper container for disposal.
- ***Facility 3***—Boot Wash/Rinse, Outer Suit Wash/Rinse and Removal: Wash and rinse protective suits. Wash and rinse safety boots. Remove and discard outer suit and place into disposal containers.
- ***Facility 4***—Outer Glove Wash/Rinse and Removal: Wash and rinse outer gloves. Remove and discard into disposal container, leaving inner gloves on.
- ***Facility 5***—Respirator Removal: Decontaminate, remove, and sanitize respirator and backpack assembly. Place on the table.
- ***Facility 6***—Remove Boots and Inner Gloves: Remove boots, then inner gloves and discard inner gloves.

- ***Facility 7***—Field Wash: Wash hands and face with water. At shift's end, personnel are then required to enter the decontamination trailer and shower thoroughly (if a trailer and shower are required on the site).

In case of an emergency, gross decontamination procedures will be implemented and the person will be transported to the nearest medical facility immediately at the direction of the SHSS according to the Site Emergency Response Plan (reference Section 12.0). The medical facility will be informed that the injured person is on the way, and has not been fully decontaminated. The medical facilities will be notified of the potential chemicals present and of the exposure-prevention measures that can be used while treating the victim.

A commercial vendor may launder reusable protective clothing (cotton overalls). If the coveralls are contaminated with a hazardous waste, the vendor will be notified of the type of waste.

8.2.3 Equipment Decontamination

Heavy equipment, PPE, monitoring equipment, and sampling equipment may require decontamination. Procedures may be modified based on actual site conditions or DO requirements.

Decontamination of heavy equipment (including under carriage, chassis, and cab) will be performed using a high-pressure washer sprayer, and/or steam cleaner and appropriate biodegradable solvents. All equipment will be decontaminated on a pre-constructed decontamination pad designed to collect and store washings. The equipment will first be sprayed and scrubbed with water (and a low-sudsing detergent as required). Secondly, the equipment will be rinsed with water. If persistent contamination exists after cleaning based on visual assessment, other cleaning methods may be necessary. Air filters on equipment used in the exclusion zone will be removed and disposed with the materials used for decontamination if warranted. Depending on the contaminants, a simple scraping and brushing off of the equipment may be acceptable.

Outer PPE (such as protective suits, boot covers, and outer gloves) will be washed and rinsed with trisodium phosphate and water. These items will all be discarded at the end of the day. If they have become grossly contaminated during work operations, they will be changed as necessary during the day. Respirators will be sanitized by rinsing in a germicidal rinse followed by a clean water rinse, then air drying in a clean area.

Each person will be responsible for the gross decontamination of their own respirators at the end of each shift. A thoroughly trained SHSS will perform respirator maintenance.

Reasonable precautions will be taken to minimize monitoring equipment contamination. Decontamination will be accomplished using materials that will not damage the instrument(s). Delicate air monitoring and surveying equipment will be wiped off with alcohol or soap and water and protected from contamination when in use.

The following procedures will be used for cleaning sampling equipment used for chemical tests or sampling:

- Steam clean and/or pressure wash.
- Wash and scrub with laboratory grade detergent.
- Rinse with water.
- Rinse with other reagents according to the site work plan or quality control plan.

Decontaminated sampling equipment will be protected from contamination before use by wrapping with aluminum foil or placing in a clean container.

If decontamination pads are used, they will be constructed to facilitate containment and collection of all potentially contaminated water and decontamination fluids. The waste liquids will be transferred to appropriate drums, holding facilities, or waste systems. All PPE wastes generated will be bagged, labeled, and stored for off-site disposal or incorporation into other waste materials. FWENC will store waste in a manner and in an area designated by the facility. In no case will storage exceed 90 days from the start date of accumulation of the waste. Some facilities require that storage not exceed a period of time less than 90 days (e.g., 45 days). Each project manager will ensure that the specific requirements of the facility are followed.

8.3 SUPPORT ZONE

The support zone will be arranged considering accessibility, utility availability, wind direction, and line-of-sight to work. Included in this area will be the main office trailer, administration area, vehicle parking, security, toilets, water, electricity, and a break/lunch area. The support zone will be outside the contamination reduction zone and will be the area where support workers will provide assistance to workers inside the exclusion zone and contamination reduction zone. The support zone normally will begin at the exit from the decontamination line. Only clean or appropriately containerized equipment, material or personnel can enter the support zone from the contamination reduction zone.

9.0 MEDICAL SURVEILLANCE PROCEDURES

FWENC requires that site workers participate in a medical surveillance program that meets the requirements of 29 CFR, Part 1910.120(f) (8 CCR, Section 5192). The medical surveillance program, managed by the FWENC Medical Consultant, shall be instituted for the following employees:

- All employees who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year.
- All employees who wear a respirator for 30 days or more a year or as required by 29 CFR, Part 1910.134 (8 CCR, Section 5144).
- All employees who are injured, become ill, or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation.

All workers who must enter exclusion zones or who meet the criteria listed above must provide the SHSS with a written opinion from a licensed physician attesting to the employee's fitness for duty at a hazardous waste site. A physician's written opinion of the employee's ability to wear a respirator will also be required when there is reasonable possibility that a respirator may be required for site work. The physician's written opinion must be dated within the previous 12-month period, or an alternate time period as determined by the physician, for continued work. Additional medical surveillance requirements specific to the site or site contaminants may be required and will be defined in the SHSP. The PESM will implement additional medical surveillance requirements when specified in applicable OSHA standards (e.g., the lead standard), when recommended by consulting physicians, or when considered prudent to monitor potential employee exposure.

The SHSS will maintain a file for each person on site. This file will have a copy of the physician's statement of employee's fitness for duty, the employee's ability to wear a respirator and if there are any work restrictions. The SHSS will ensure that the employee and project supervisors comply with medical work restrictions, if any. The SHSS will also ask each employee to complete a form to indicate any known allergies, prescription medications, and any other medical information that will allow the SHSS to respond to any medical emergency in an appropriate manner. Personnel will notify the SHSS regarding any medications, including over-the-counter, they are using on each day of work. The SHSS in consultation with the PESM and/or a medical consultant will determine if any medications may have an effect on a worker that would impair the ability of the worker to perform work safely.

10.0 SAFETY CONSIDERATIONS

All workers must comply with the FWENC Project Rules Handbook, Volume I and Volume II. The following are some of these rules:

The following practices will be expressly forbidden during field operations:

- Entrance onto the site or into designated restricted area(s) without formal authorization, compliance with medical monitoring and training requirements, and/or compliance with the SHSP.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material in any area designated as contaminated.
- Approach or entry into areas or spaces where toxic or explosive concentrations of gases, vapors, or dusts exist without prior approval of the SHSS and/or utilization of proper protective equipment.
- Facial hair, which interferes with the satisfactory fit of the mask-to-face seal of respirators, is prohibited for personnel required to wear respiratory protection equipment.
- The use/wearing of personal stereo headphones. Their use may preclude reception of audible warning signals and/or hazard communication.

The following practices are required:

- Personnel and equipment in the contaminated area will be minimized, consistent with effective site operations.
- Equipment shall be bonded and grounded, spark-proof and explosion resistant, as appropriate to minimize or prevent the ignition or flammable materials in the work zone.
- A minimum of two employees, in constant communication (either visual or voice) with each other, will be required to perform any work within the exclusion zone.

10.1 VEHICLE AND EQUIPMENT OPERATIONS

Dust suppressants will be used to the extent possible for controlling airborne dust generation to the extent possible. In addition, vehicular traffic speed on non-paved roads will be restricted to 15 miles per hour. Motor vehicles and material handling equipment assigned to this site shall conform to the requirements of 29 CFR, Parts 1926.601, and 1926.602 (8 CCR, Sections 1590 through 1596). Crews utilizing personnel transport vehicles to and from the work site shall use the vehicle's safety belts. Drivers of vehicles shall be responsible for passenger utilization of the safety belts. Personnel are not allowed to ride in the bed of pickup trucks unless there is an

approved restraint system installed and used. The Project Superintendent is responsible for maintaining a clean job site free from hazards and for providing safe access and egress from the site. Traffic cones and/or high visibility barrier tape will be utilized, where appropriate, for traffic control into/out of hazardous or restricted. Personnel will wear reflective, orange safety vests whenever working in and around vehicles and on all roads.

10.2 MISCELLANEOUS SAFETY CONSIDERATIONS

The following is a list of precautions to minimize the possibility of injury-related accidents from occurring during field operations.

10.2.1 General Information

- Be your brother's keeper. Consider what you do in terms of the hazard it may create for others.
- Ask the SHSS if you do not know how or are in doubts as to the safe way of doing your job.
- No running at any time, except in extreme emergencies.
- Throwing of any object at personnel or equipment is prohibited.
- Minimum requirements on construction sites and in shop are long pants, a shirt with the shoulders covered, and good work shoes. Torn, ragged, or frayed items should not be worn because they can catch on obstructions or machine parts, or otherwise cause you to trip or fall.
- Know where emergency exits are, and how to get to them. Do not block them with material or equipment.

10.2.2 Housekeeping

- Clean work areas and storage areas encourage better incident prevention, and make the work easier to do.
- Dispose of trash and scrap in proper containers. This includes lunch papers, soft drink cans, banding straps, wood, rags, paper cups, etc.
- Keep tools, material, and equipment stored in an orderly manner, and in their proper places. This prevents unnecessary damage, and helps you to find them when you need them.
- Keep stored material, scrap, and other tripping hazards out of roads and walkways and away from emergency equipment. If it's in a walkway and it's not moving, it does not belong there.
- Cords, cables, and hoses crossing roads or walkways are to be covered to prevent tripping or damage, or are to be supported overhead, at least 7 feet above walkways, 14 feet above roads.

10.2.3 Fire Prevention

- Control "open flame" tools and equipment.
- Protect nearby combustible materials from heat, flames, sparks, and slag by moving or covering them.
- Keep flammables in closed containers. Use safety cans.
- All site workers will have training on the use of portable fire extinguishers.

10.2.4 Personal Protective Equipment

- Head
  - Hard hats are required at all times on construction sites. They are also required at other locations where overhead hazards exist. Bump hats are not permitted.
- Eyes and Face
  - Spectacle type safety glasses are required when hitting steel on steel, grinding, drilling, sawing, vibrating concrete, etc., or when working near someone else who is creating flying particles.
- Fall Protection
  - Safety harnesses and a fall restraint system, such as lanyards, attached to an approved support point are required when working from any support or surface where possibility of falls exist, or where guardrails are not installed.
  - Tie off to a solid, approved support. Tie off as short as possible allowing no more than a 36 inches for fall.

10.2.5 Hand Tools

- Every tool is designed for a specific use. Do not misuse. Inspect daily for defects.
- Keep tools in proper working condition - clean, sharp, oiled, dressed, and adjusted.
- Mushroomed chisels, drills, etc. cause dangerous flying objects. Keep them dressed.
- Never hit hardened steel with hardened steel, such as hitting a hatchet with a hammer.
- Do not use "cheaters" to increase capacity. Get a bigger sized tool.
- Carry tools in proper sheath, belt bag, or box. Points down.
- Know how to shut it off before turning it on. No locked "on" switches on hand held power tools.
- Eye protection is required for protection from flying particles.
- Power activated tools shall be inspected daily before use for proper operation of their safety devices. You must be authorized by your foreman to operate this equipment.

- Power supply must be properly attached to tool, and to source. Electric tools must be grounded (or "double insulated").
- Check area for other people before starting tool. Warn people nearby.
- Be prepared for jamming of rotating tools. Have good footing, good balance, and watch out for nearby obstructions. Check yourself for loose clothing.
- Shut off and bleed down air hose before disconnecting air tools. Never point an air hose toward another person or yourself.
- Unplug electric cords.
- Store in safe place when not in use. Protect from weather, dirt, and water.
- Power tools must be GFCI-protected.

10.2.6 Material Hoists

- Not to be used for hoisting people.
- Secure material to prevent it from shifting.
- Use tag lines.

10.2.7 Crane

- General
  - Know the crane capacity and the weight to be lifted before lifting.
  - Be sure air space and walkway are clear before moving bridge or trolley.
- Mobile
  - Solid footing. Use outriggers with rubber-tired cranes.
  - Barricade area of swing of counterweight.
  - Keep boom, lines, and loads at least 15 feet away from electric power lines. Minimum distance increases above 50,000 volts. Power lines must be de-energized to work closer than the minimum distance.
  - The operator shall avoid swinging loads over workmen's heads. Only one signalman at any one time.
  - Equipment shall be inspected before each use and all deficiencies corrected before further use.

10.2.8 Forklifts

- You must be authorized by your supervisor before operating this equipment.
- Keep forks spread as far apart as possible. Check stability of load before moving it.
- Look in direction of travel before moving and during moving. Watch out for overhead hazards.

- Back downgrades when carrying a load.
- No riders, unless a passenger seat is provided.
- Forks are not to be used as an elevator or as a work platform.
- Lower forks all the way down before leaving the equipment.
- Do not drive along the edge of raised docks, platforms, or ramps.

10.2.9 Mechanical Material Handling

- Know the weight of the load to be moved.
- Know the capacity of the equipment to be used to move the load.
- Use tag lines to control the load. Keep tag line free of your body, and free of obstructions during movement of the load.

10.2.10 Manual Material Handling

- Leg muscles are stronger than back muscles. Lift with your legs not your back. Bend knees, keep back straight, tighten abdomen, using legs, make a smooth controlled lift.
- Plan before you lift - consider weight, size, shape, path of travel, and set down location. Get help if necessary.
- Protect your hands and fingers from rough edges, sharp corners, metal straps. Keep hands and fingers out of pinch points between the load and other objects.

10.2.11 Overhead Work

- No one is to be unprotected under overhead work.
- Erect barricades, signs, or other devices to warn people of the work overhead. Respect the barricades or signs put up by others.
- Covered walkways are needed where people must pass under overhead work.

10.2.12 Portable Ladders

- General - All Portable Ladders
  - Inspect for defects. When defects are found, the ladder is to be withdrawn immediately from use. Set ladder feet on solid foundation.
  - Only one person is allowed on a ladder at one time.
  - Use ladders for climbing -not for material skids, walkways, or workbenches.
  - Face the ladder while climbing up or down, and while working from it. Use safety harness or fall protection when falls are possible.

- Both hands are needed for climbing. Use a hand line for material.
- No metal ladders are to be used.
- Store safely to prevent damage from vehicles, materials, etc.

- Straight and Extension Ladders
  - Correct slope of ladder is 1:4.
  - Secure ladder from slipping. Non-slip feet on bottom, and tie off with rope at top.
  - Extend ladder 3 feet above top landing where ladder is to be used for access to the landing.
  - Do not take extension ladders apart to get two ladders.
  - Keep hands off rungs while extending or lowering extension section. Be sure latches are in place before climbing.
- Stepladders
  - Open fully. Lock spreaders. Do not use as a straight ladder.
  - Do not stand or step on top platform.
  - Keep loose tools off steps and top platform.
  - Tie off stepladder if longer than 12 feet.

10.2.13 Compressed Gas Cylinders

- Always keep cylinders upright. Tie off vertically with strong wire, rope or chain, or keep chained in cylinder cart.
- Do not drop or roll the cylinders.
- Use a rack for lifting cylinders to and from upper elevations. Never lift a cylinder by the control valve or a valve cover.
- Always replace valve covers when gauges are removed. Valve covers must be placed on all cylinders before they are moved.
- Store oxygen cylinders 20 feet away from other cylinders, or separate by a solid approved divider. Do not store any cylinders inside a building.
- Keep oil and grease away from oxygen valves.
- Cylinders are to be kept at a safe distance or shielded from welding and cutting operations. They are not to be placed where they can contact an electric circuit.
- Acetylene cylinders must always be stored upright.
- Use only regulators specifically approved for the type of gas in the cylinder (read the front of the gauges for this information). Never modify regulators or use adapters.

10.2.14 Welding and Burning

- Electric
  - Keep leads out of walkways.
  - Shield arcs to protect others from direct arc rays.
  - Remove rod from electrode holder before laying it down. Put rod butts in a container, not on the floor.
  - Proper grounding from work to machine is a must.
  - Turn off machine at end of shift.
- Gas
  - Keep hoses out of walkways.
  - Check area-sides and below for possible fire hazards.
  - Remove gauges at end of shift and replace cap on cylinder. Toolboxes used to store hose and gauges are to be ventilated.
  - Use soapy water when checking for leaks.
  - Before using fuel gas cylinders:
    - Always crack cylinder valve before connecting gauges to clean dirt.
    - Open cylinder valve slowly and leave wrench in position while cylinder is in use.
    - A regulator shall always be used on fuel gas cylinders.
    - The cylinder valve shall always be closed before removing regulator.
    - When fuel gas cylinders connected to gauges have a leak it will be repaired or removed from service and tray way from the work area.

10.2.15 Electricity

- No "live electrical" work is allowed without the authorization from your supervisor.
- Temporary lighting circuits require guards over the bulbs. Metal guards must be grounded.
- Keep extension cords out of water, and at least 7 feet above walkways.
- Disconnect switches must be labeled to show the equipment or service they feed. Check before operating.
- Always shut down electrical equipment before servicing, repairing, or investigating questionable function.

10.2.16 Decontamination

- Personnel
  - Do not walk through areas of obvious or known contamination.
  - Do not handle or touch contaminated materials directly.

- Make sure all personal protective equipment has no cuts or tears prior to donning.
- Fasten all closures on suits, covering with tape, if necessary.
- Particular care should be taken to protect any skin injuries.
- Do not carry cigarettes, gum, etc., into contaminated areas.

- Heavy Equipment
  - Take care to limit the amount of contamination that comes in contact with heavy equipment.
  - If contaminated tools are to be placed on non-contaminated equipment for transport to the decontamination pad, use plastic to keep the equipment clean.

10.2.17 Illumination

All work on site when performed outdoors must be performed during daylight hours only (1/2 hour after sunrise to ½ hour before sunset). If work must be performed during hours of darkness or inside buildings, the project will insure that additional lighting is provided to meet the requirements of 29 CFR, Part 1910.120 (8 CCR, Section 5192) and the EM 385-1-1, Section 7.

10.3 ERGONOMIC CONSIDERATIONS

Routine activities at the project may involve tasks that, by their nature, may subject personnel to unexpected ergonomic stresses. Examples of ergonomic stresses include:

- Muscular sprains and strains.
- Musculo-skeletal trauma from impacts or vibrations.
- Fatigue due to extended work schedules.

Caution and workload awareness should be exercised by all site personnel during project activities. Tasks which involve manual manipulation of sampling devices, chemical storage drums, shoveling, and/or prolonged exposure to vibrating mechanical equipment should be monitored by the individuals involved with them to preclude the adverse effects of ergonomic stress.

11.0 DISPOSAL PROCEDURES

The Waste Management Plan describes the handling of wastes from the project site and the management of all decontamination liquids and disposable clothing and supplies that have come in contact with contaminated materials. All disposable PPE will be treated as contaminated waste and disposed of properly. Contaminated clothing will be placed in a drum lined with a polyethylene bag. Wastewater generated on site will be stored until ready for testing and disposal. Temporary waste storage areas will be set up by each exclusion zone during the work day. This waste will then be moved to a main storage area until ready for disposal, if required by environmental personnel. All waste containers will be properly labeled and stored consistent with regulatory requirements. Contents of the containers will be sampled by trained sample technicians and sent to a laboratory to determine regulatory permitted disposal methods. Decontamination water will be contained and captured utilizing submersible pumps and/or vacuum units. FWENC will arrange for the proper disposal of all decontamination fluids, contaminated debris, soil and other waste per contract requirements. In no case will accumulation be allowed to exceed 90 days from the date that the accumulation started. FWENC has policies and procedures that require that all disposal is managed by firms that have been pre-approved by an internal review process and by the DoN.

12.0 EMERGENCY RESPONSE PLAN

There are numerous emergency services nearby in the civilian community. This plan describes response activities as they apply to Alameda Point. Site-specific response procedures, if any different, will be discussed in the SHSP. Certain information will always be repeated in every SHSP to ensure that the information is readily available and "on top." For example, every SHSP will have a table that lists all the emergency contact numbers and the map to the nearest medical facilities.

12.1 RESPONSIBILITIES

The Project Superintendent or PjM, if there is no Project Superintendent, is the primary emergency coordinator for the project. In the absence of either or both the Project Superintendent and the PjM, the SHSS is the emergency coordinator. The emergency coordinator will take charge and determine, direct and delegate personnel and resources to manage the emergency. Key responsibilities of the emergency coordinator are to:

- Initiate evacuation, if needed.
- Initiate emergency response agency notification.
- Insure that response activities are commensurate with the level of the emergency and as discussed in this plan are implemented.
- Interface and coordinate with outside agencies responding to on-site emergencies.

12.2 COMMUNICATIONS

Personnel shall maintain verbal communication with each other. The following communications systems will be available during site activities:

- Cellular telephone or access to a land phone for emergency purposes.
- Hand held radios, as needed.
- Compressed air horn (signals emergency evacuation only) at the site.
- Hand signals, if used, will be diagrammed and posted.
- Posted location of evacuation assembly area(s).
- Posted route to the nearest hospital for the project site.
- Posted emergency phone numbers.

12.3 ACCIDENT/INCIDENT REPORT

After the emergency event is over or during the course of the emergency when possible, the SHSS will notify the PESM by telephone. Should an accident or incident occur, the Project Superintendent or PjM and the SHSS will immediately investigate the cause, notify the PESM, and promptly complete the following:

- ***FWENC Incident Report Form.*** Details of the incident shall be documented within 24 hours and copies of the report forwarded to the DoN RPM and the PESM. Reports of serious incidents will also be faxed to the PM by the Project Superintendent or PjM.
- ***Incident Investigation Report.*** The Incident Investigation Report will have the same distribution as the Incident Report Form within 3 days of the incident.

Any recommended additional hazard control measures must be discussed with the Project Superintendent, the SHSS, and the PESM and meet their approval, prior to implementation. Any occupational injuries and illnesses will be recorded, if applicable, on an OSHA Form No. 200. The SHSS shall report immediately by telephone or telegraph to the nearest District Office of the Division of Occupational Safety and Health (Cal-OSHA) any serious injury or illness, or death, of an employee occurring in a place of employment or in connection with any employment. Immediately means as soon as practically possible but not longer than 8 hours. Records of all site accidents and first aid treatments will be maintained by the SHSS.

12.4 PRE-EMERGENCY PLANNING

Prior to performing any work the Project Superintendent or PjM and the SHSS will verify all emergency action plans by insuring that planned support facilities are available and that emergency contact numbers are valid. As work proceeds the SHSS will continue to insure that plans specified in this section can be implemented at all times. Furthermore, the SHSS will constantly insure that plans are modified as necessary to accommodate changes. The SHSS will coordinate all changes with the PESM. Upon arrival at the site, the Project Superintendent will ensure that all personnel know the system for communication of emergency situations and how to use a radio or nearby phone to summon emergency assistance. A vehicle must be available to transport personnel to safe locations or to hospitals. All personnel on this project will know how to use a portable fire extinguisher. All personnel will know the location of all emergency equipment and supplies.

12.5 EMERGENCY MEDICAL TREATMENT

The following procedures should be observed if an accident with injury occurs:

12.5.1 First Aid

Only qualified personnel shall provide first aid and stabilize an individual needing assistance. Life support techniques such as CPR and treatment of life threatening problems such as airway obstruction and shock will be given top priority. At least two persons certified in First Aid techniques and CPR will be on each work site at all times; FWENC EHS Procedure 4-1, Bloodborne Pathogens, will be followed when first aid/CPR are administered. The SHSS will be current in First Aid and CPR. Professional medical assistance shall be obtained at the earliest possible opportunity. The nearest hospital to Alameda Point is shown on a map that is part of every SHSP. A general map to the nearest medical facility is attached to this plan (Figure 2).

12.5.2 Minor Injury

- Contact Task Foreman or "buddy."
- Have qualified first aid personnel treat injury.
- Record injury and include name of injured person, nature of injury, and treatment given.

12.5.3 Medical Emergency

In the event of a medical emergency when actual or suspected serious injury occurs, the following procedures shall be implemented:

- Survey scene and evaluate whether the area is safe for entry.
- Remove the exposed or injured person(s) from immediate danger.
- Render first aid if necessary. Decontaminate affected personnel after critical first aid is given.
- Obtain paramedic services or ambulance transport to local hospital. This procedure shall be followed even if there is no visible injury.
- Call 911 from phones on Alameda Point. If cell phones are used, 911 will contact the California Highway Patrol who will connect the call to the nearest responding agency.
- Identify location by number of nearest building, request medical assistance, provide name and telephone number.
- Request assistance from emergency medical service and/or additional assistance.
- Other personnel in the work area shall be evacuated to a safe distance until the Project Superintendent determines that it is safe for work to resume. If there is any doubt regarding the condition of the area, work shall not commence until all hazard control issues are resolved.
- Notify Navy Technical Representative (NTR) of incident and fill out accident reporting forms and associated documents.

12.5.4 Fatal Injury

If a fatal injury occurs, the following additional steps will be followed:

- Notify the Project Superintendent immediately.
- Notify PESM who will initiate contact with Cal-OSHA and other appropriate agencies.
- Notify NTR.
- All work activities on the project must be stopped on the project for 24 hours.
- Assist Cal-OSHA as directed.

12.6 DECONTAMINATION DURING MEDICAL EMERGENCIES

Any personnel requiring emergency medical attention shall be evacuated immediately from exclusion and contamination-reduction zones. Personnel shall not enter the area to attempt a rescue if their own lives would be threatened. The decision whether or not to decontaminate a victim prior to evacuation is based on the type and severity of the illness or injury and the nature of the contaminant.

For some emergency victims, immediate decontamination may be an essential part of life saving first aid. For others, decontamination may aggravate the injury or delay life saving treatment. If decontamination does not interfere with essential treatment, it should be performed.

If decontamination can be performed:

- Wash external clothing and cut it away.
- Wrap victim in clean blanket or towel if necessary.

If decontamination cannot be performed:

- Wrap the victim in blankets or plastic to reduce contamination of other personnel.
- Alert emergency and off-site medical personnel to potential contamination; instruct them about specific decontamination procedures.
- Send along site personnel familiar with the incident.

12.7 EMERGENCY SITE EVACUATION PROCEDURES

In the event of an emergency situation such as fire or explosion, the SHSS or a supervisor will activate an air horn for approximately 15 seconds indicating the initiation of evacuation procedures. All personnel in both the restricted and non-restricted areas will evacuate and assemble near the support zone or other safe area as identified by the SHSS. Prior to start of work at any project site the SHSS will identify and mark the location of an evacuation assembly area for that project site. The location should be upwind of the site as determined by the wind

direction. For efficient and safe site evacuation and assessment of the emergency situation, the Project Superintendent or SHSS will have authority to initiate proper action if outside services are required. Under no circumstances will incoming personnel or visitors be allowed to proceed into the area once the emergency signal has been given. The SHSS must ensure that access for emergency equipment is provided and that all equipment that may cause combustion has been shut down once the alarm has been sounded. As soon as possible, and while the safety of all personnel is confirmed emergency agency notification will commence. The SHSS will brief site personnel each day as to the location of the evacuation assembly area.

Prior to the start of each project work site the SHSS will establish safe egress routes from the site to the evacuation assembly area. The SHSS will prepare a drawing or map that diagrams these safe egress routes. The SHSS will use this same map to diagram egress from the evacuation assembly area to the facility gate to be used as an exit. From this point, the map showing the route to the nearest clinic and the nearest hospital will be used if medical services are required.

12.8 FIRE PREVENTION AND PROTECTION

Fire prevention and protection measures require pre-planning. At least one 20-pound dry chemical ABC fire extinguisher will be located at each project site. A mounted fire extinguisher is required in every vehicle including heavy equipment. Employees will follow safe work practices to include proper storage of flammable and combustible liquids. Smoking is permitted only in those areas designated specifically by the project manager, Project Superintendent or SHSS. Personnel will follow hot work procedures to insure that work is performed in a safe environment. In the event of a fire or explosion, summon the Fire Department immediately, take a head count and implement evacuation procedures.

12.9 SPILL CONTROL AND RESPONSE

All spills, leaks, and fires involving oil or hazardous substances at Alameda Point must be reported to the to the RPM and the PESM. The person reporting the leak, spill, etc. is required to provide the following information:

- His/her name
- Location of spill and facility number, if known
- Number of injured personnel and nature of injuries, if known
- Substance spilled
- Amount spilled (estimate)
- Extent of spill
- Rate that substance is currently being released (estimate)
- Time spill occurred (estimate)

- Any other pertinent information

The RPM in coordination with the PjM will manage notifications to regulatory agencies. In addition, all spills will be reported to the FWENC Regional Environmental Safety and Quality (ESQ) Manager. Project personnel will not report spills directly to any agency unless specifically requested by the RPM or Contracting Officer.

A minor spill would involve no immediate threat to human health or the environment, minimal property damage, and does not exceed the reportable quantity (RQ) for that material. In the event of a minor spill, the appropriate response action is for the responsible person to notify the RPM and the PjM and supply the responders with as much information as possible. In the case of a spill of contaminated or hazardous materials, the following procedures shall be followed:

- Notify the Project Superintendent
- Identify protective clothing or equipment required to respond
- Contain the spill
- Neutralize and/or solidify any product
- Transfer material into 55-gallon drums
- Document incident

12.9.1 Release Prevention and Minimization Measures

In addition to training, the following procedures will be implemented to prevent and minimize releases of hazardous materials:

- Do not conduct hazardous materials operation when the weather could cause significant risk to surrounding area if a spill should occur.
- Transfer all materials in or over a bermed or "protected" area. A protected area is one that is covered with an impermeable material, such as polyethylene.
- Dike temporary storage tanks containing hazardous wastes or potentially hazardous wastes to contain potential releases.
- Maintain a supply of basic spill response materials and protective equipment on site to include:
  - Absorbent sheets, pillows, booms or absorbent material
  - Open top 55-gallon drums or other containers with lids
  - Booms, shovels, and other tools, such as squeegees

12.10 SIGNIFICANT VAPOR RELEASE

Any project activity which releases significant amounts of vapor must be reported immediately as described in the spill release procedure. Every attempt to mitigate the release must be taken if

it can be safely performed. For example, during excavations vapor releases may be controlled by simply replacing cover on the excavation. Down-wind evacuation procedures may be required. These will be initiated through coordination with facility emergency coordinators.

12.11 EARTHQUAKE RESPONSE

If an earthquake should occur during the course of site activities, take the following steps:

- Stop working. Remain calm and do not panic.
- Do not use or do anything that might be a source of ignition (i.e., smoking, cutting, or welding).
- Avoid power lines, power poles, and windows.
- If in a vehicle, stay in the vehicle until the earthquake is over.
- If in a building, take cover under a heavy piece of furniture.

After the earthquake is over:

- Prepare for after shocks. Stay out of severely damaged buildings.
- Meet for a head count at a location designated by the Project Superintendent.
- Check for injuries. Do not move seriously injured personnel unless remaining where they are would create danger of further injury.
- Check vehicles, equipment, and buildings for any obvious damage.
- Check utility lines for damage. Switch off power, water and gas until a utility official has inspected the buildings and operational area and determined it is safe.
- If driving, watch carefully for hazards created by the earthquake (i.e., undermined roads, weak bridges, or overpasses, etc.).

12.12 EMERGENCY EQUIPMENT

The following emergency equipment will be brought onto the site or will be stationed near each work area:

- Fire extinguisher, minimum one 20-pound dry chemical ABC type in the CRC at the edge of exclusion zone.
- Industrial first aid kit, in the CRC, at the edge of the support zone.
- Portable eye wash, capable of supplying 15 minutes of water and protected from direct sunlight in the support area, at the edge of the support zone.
- Air horn at the support area, at the edge of the support zone.
- Spill control material consisting of either absorbent pillows or absorbent material and shovels, in the support zone by the CRC entrance.

The following equipment will be available at the support trailer for use in an emergency situation:

- Industrial first aid kit
- Blanket

Each SHSP may specify additional emergency equipment consistent with the hazards associated with the DO. For example, some projects may require that SCBAs be available for work on projects where exposure to contaminants may require their use.

12.13 POSTINGS

Emergency contact names and phone numbers will be posted at every project site. A map showing egress routes, evacuation assembly areas, and the route to the clinic and the hospital will also be posted. At some remote locations, posting may not be practical. In this case, the contact names, phone numbers and maps will be placed on the dashboard of every vehicle. These postings and maps are prepared for each SHSP.

13.0 TRAINING

In accordance with FWENC corporate policy and pursuant to 29 CFR, Part 1910.120 (8 CCR, Section 5192), hazardous waste site workers shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations unless excepted by the above reference. As a minimum, the training shall have consisted of instruction in the topics outlined in the above reference. Personnel who have not met the requirements for initial training shall not be allowed to work in any site activities that may expose them to chemical or physical hazards.

An employee's prior experience and/or training for equivalency may be considered to meet the training described above. The PESM will make the determination if previous experience and/or training meet the initial training requirements.

In addition to the required initial training, each employee shall have received 3 days of directly supervised on-the-job training at a hazardous waste site. This training shall have addressed the duties the employees are expected to perform and be properly documented. The FWENC Project Superintendent has the responsibility for ensuring that personnel assigned to field sites comply with these requirements. The Project Superintendent will provide the Navy Contracting Officer or designee with written certification of completion of the required training and maintain copies of required training records at the work site.

13.1 MANAGER/SUPERVISOR TRAINING

In accordance with 29 CFR, Part 1910.120 (8 CCR, Section 5192), on-site managers and supervisors directly responsible for, or who supervise employees engaged in hazardous waste operations, shall receive training as required above and at least 8 additional hours of specialized training on managing such operations by the time of job assignment.

13.2 ANNUAL 8-HOUR REFRESHER TRAINING

Annual 8-hour refresher training will be required of all hazardous waste site field personnel to maintain their qualifications for fieldwork. The following topics will be reviewed: toxicology, respiratory protection—including air purifying devices and SCBA—medical surveillance, decontamination procedures, and personal protective clothing. In addition, topics deemed necessary by the SHSS or PESM may be added to the above list.

13.3 SITE-SPECIFIC TRAINING

Prior to commencement of field activities, the SHSS will provide site-specific training to all personnel assigned to the site; this training will specifically address the activities, procedures, monitoring, and equipment for the site operations. Training will include site and facility layout, hazards, and emergency services at the site, hazard communication, and will highlight all provisions contained within the SHSP. This training will also allow field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and health for their particular activity. Additional training, if required for completion of field tasks during the site work, will be identified and provided for personnel as the work progresses.

13.4 ON-SITE SAFETY BRIEFINGS

Project personnel and visitors will be given daily on-site health and safety briefings by the SHSS, or designee, to assist site personnel in safely conducting their work activities. This training will be conducted prior to the start of new work activities using AHAs. The briefings will include information on new operations to be conducted, changes in work practices, or changes in the site's environmental conditions. The briefings will also provide a forum to facilitate conformance with safety requirements, and identify performance deficiencies related to safety during daily activities or as a result of safety inspections.

13.5 FIRST AID AND CPR

The SHSS will identify those individuals requiring first aid and CPR training. At a minimum, the SHSS will have received first aid and CPR training. At least two persons trained and current in certification of first and aid and CPR will be present at every work site. The training will be consistent with the requirements of the American Red Cross Association.

14.0 LOGS, REPORTS, AND RECORDKEEPING

The following is a summary of required health and safety logs, reports, and recordkeeping for this contract.

14.1 SITE HEALTH AND SAFETY PLAN CHANGE APPROVAL FORM

A Site Health and Safety Plan Change Approval Form is to be completed for all changes to the SHSP. This form requires the signatures of the PjM or Project Superintendent, the SHSS, and the PESM. The PESM sends a copy of this form to the DoN CIH within five workdays for review. Substantial changes to the SHSP may require a Field Change Request according to the Quality Control (QC) Plan in order to initiate a significant change to the SHSP. PESM approval of each Field Change Request (FCR) is required. Copies of the FCR affecting the SHSP are also sent to the DoN CIH.

14.2 MEDICAL AND TRAINING RECORDS

Full medical and training records are normally kept by the employer. Proof of the most recent training and medical qualification must be provided to the SHSS by the employee. The SHSS will keep a file containing appropriate training and medical qualifications for site workers. Medical records will be maintained in accordance with 29 CFR, Part 1910.20 (8 CCR, Section 3204). The examining physician retains custody of the complete medical record. Employee records have only the physician statement of medical qualification for duty and the employee's fitness to wear a respirator.

14.3 ON-SITE LOG

A log of personnel onsite each day (including job title, level of protection, and work location) will be kept by the SHSS or designee. Originals will be kept in the DO project file.

14.4 EXPOSURE RECORDS

Any personal monitoring results, laboratory reports, calculations, and air sampling data sheets are part of an employee exposure record. These records will be kept in accordance with 29 CFR, Part 1910.20 (8 CCR, Section 3204). For FWENC employees, the originals will be sent to the records coordinator. For subcontractor employees, the originals will be sent to the subcontractor employer and a copy kept in the DO project file.

14.5 ACCIDENT/INCIDENT REPORTS

A FWENC accident/incident report must be completed following any event involving emergency first aid, lost time, or property damage. The originals will be sent to the FWENC records coordinator for maintenance and distribution by FWENC. Copies will be distributed to the

PESM, Project Superintendent, subcontractor employees, if appropriate, and the Navy Contracting Officer. A copy of the completed forms will be kept in the DO project file.

14.6 OSHA FORM 200

An OSHA Form 200 (Log of Occupational Injuries and Illnesses) will be kept at the project site. All recordable injuries or illnesses will be recorded on this form. At the end of the project, the original will be sent to the FWENC records coordinator for maintenance. Subcontractor employers must also meet the requirements of maintaining an OSHA 200 form. The FWENC accident/incident report meets the requirements of the OSHA Form 101 (Supplemental Record) and must be maintained with the OSHA Form 200 for all recordable injuries or illnesses.

14.7 HEALTH AND SAFETY FIELD LOG BOOKS

The SHSS will complete and maintain the daily log book at the site. Log books will be used to document important events as they occur. Some general procedures will pertain to the use of all log books. The following information will be recorded on each page of all log books:

- Initials of persons making entry
- Date
- Time of each entry (military time)
- Location

The log will be signed at the end of each day or work shift. All entries will be made in black ink. No pages will be removed from the log book and each page will be numbered. Any corrections will be made with a single line through the entry, and initialed.

The log book will be used to record daily site conditions and activities within the exclusion zones. The log book will contain the following items:

- Names and job titles of all personnel in the work group
- Level of protection
- Health and safety monitoring equipment used
- Weather conditions
- Work/rest schedule (if appropriate)
- A description of the activities as they are occurring
- Any pertinent health and safety observations
- Sample number (if appropriate)

Copies of the log books will be submitted to the Project Superintendent as necessary. The original log books will become part of the exposure records file and will be maintained by the FWENC records coordinator.

14.8 MATERIAL SAFETY DATA SHEETS

MSDS will be obtained and kept on file at the project site for each hazardous chemical brought to, used, or stored at the site. An MSDS for each contaminant will also be maintained. The MSDS will be kept on file by the SHSS at the project site.

14.9 CLOSEOUT SAFETY REPORT

A final safety report will be provided to the PESM summarizing the safety performance achieved during the site work. Specific elements of the report will include the following:

- A description of significant events, exposures, accidents, illnesses, and actions taken to prevent their occurrence.
- A summary of monitoring results including air, noise, radiation, and heat stress samples.
- A description of any state or federal inspections involving the health and safety of site workers.

15.0 FIELD PERSONNEL REVIEW

All personnel are required to be trained in this Base-Wide Plan and the SHSP. Upon completion of this training and review, all project personnel will acknowledge this training by signing a SHSP review form.

16.0 REFERENCES

Note:

Specific references unique to a project will either be listed as an attachment to the SHSP or they will be incorporated as a separate section to the SHSP. For example, a specific procedure for personal air sampling may be included as a reference within the SHSP.

FIGURES

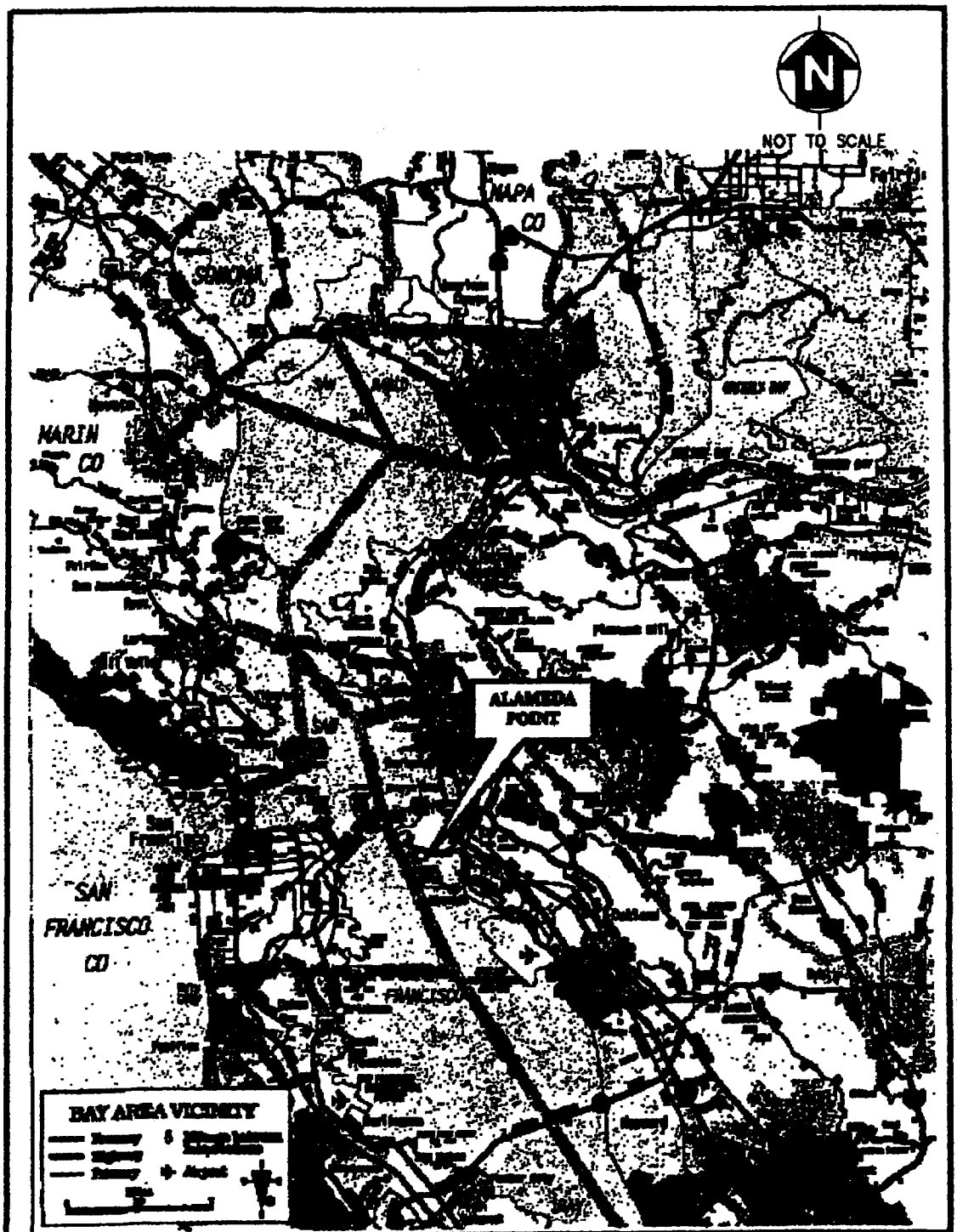
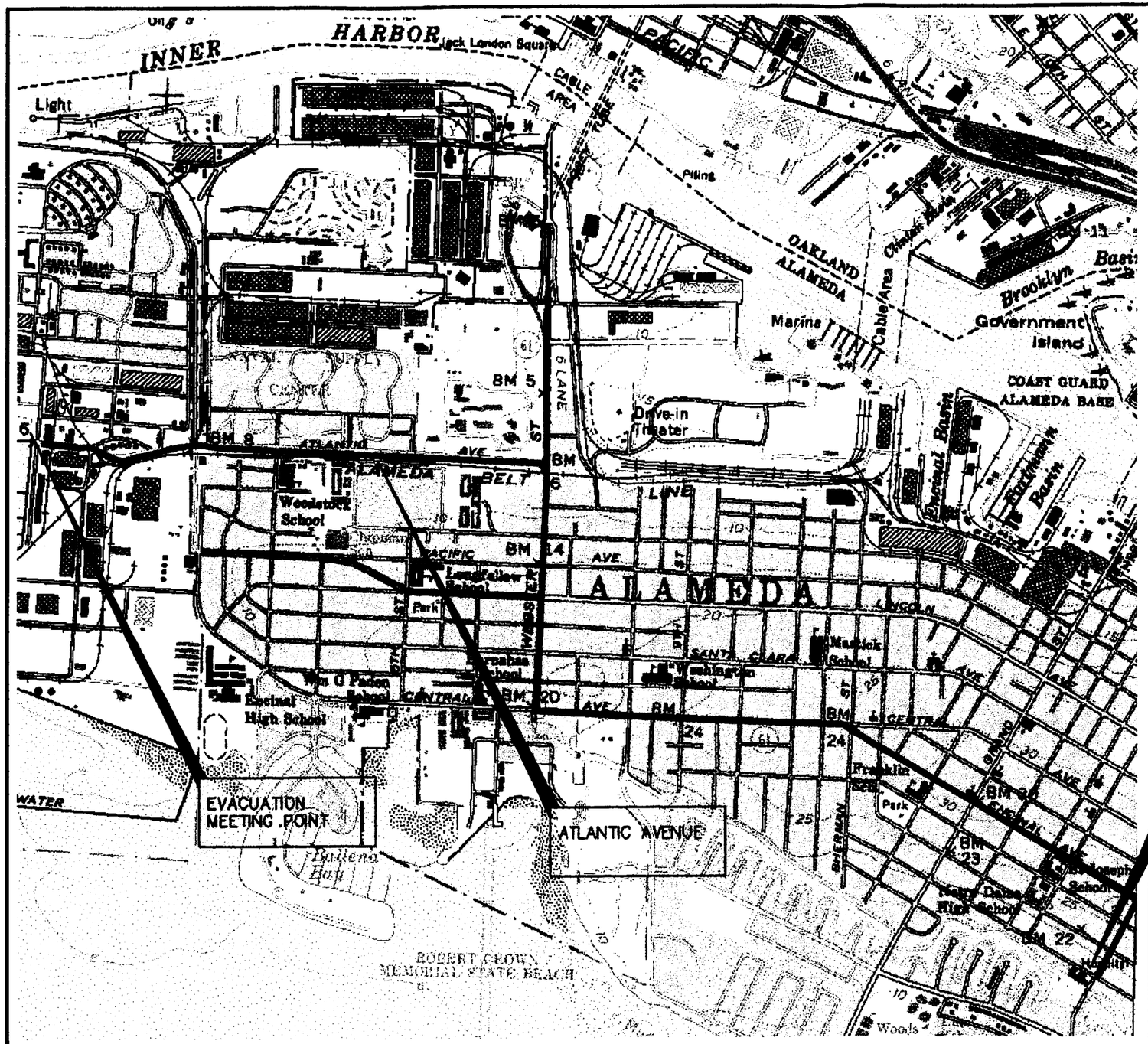


Figure 1
ALAMEDA POINT(NAS ALAMEDA)
VICINITY MAP

ALAMEDA, CALIFORNIA

FOSTER WHEELER
ENVIRONMENTAL CORPORATION

I:\2384-ALAMEDA\020010\020010J.DWG
PLOT/UPDATE: OCT 19 2001 14:20:42



HOSPITAL DIRECTIONS:

TAKE ATLANTIC AVENUE TO WEBSTER STREET AND TURN RIGHT. FOLLOW WEBSTER TO CENTRAL AVENUE AND TURN LEFT. FOLLOW CENTRAL UNTIL IT SPLITS AND TAKE THE RIGHT FORK THAT IS ENCINAL AVENUE. FOLLOW ENCINAL TO WILLOW STREET AND TURN RIGHT. TAKE WILLOW TO CLINTON STREET AND THE HOSPITAL IS LOCATED ON THE CORNER.

ALAMEDA HOSPITAL
2070 CLINTON AVENUE
ALAMEDA, CA 94501
(510) 522-3700

Figure 2
ROUTE TO HOSPITAL

Fleet and Industrial Supply Center Oakland
Alameda Facility/Alameda Annex

FOSTER WHEELER
ENVIRONMENTAL CORPORATION

ATTACHMENT 2

MATERIAL SAFETY DATA SHEETS

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:
Sheet No. 316
Benzene
Issued: 11/78 Revision: E, 8/90

Section 1. Material Identification 32

Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.

R 1
I 4
S 2*
K 4
*Skin absorption

NFPA

HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8
Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
%Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	**Autoignition Temperature:** 928 °F (498 °C)	**LEL:** 1.3% v/v	**UEL:** 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.
Unusual Fire or Explosion Hazards: Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source![103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)
DOT Hazard Class: Flammable liquid
ID No.: UN1114
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Packaging Group: II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection **References:** 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 757
Coal Tar Creosote

Issued: 7/91

Section 1. Material Identification

Coal Tar Creosote (molecular formula varies with purity) Description: Three main derivations: by distillation of coal tar produced by high-temperature carbonization of bituminous coal; by mixing strained naphthalene oil, wash oil, and strained or light anthracene oil; as a by-product of conventional coal coking. It typically contains up to 160 chemicals, mainly aromatic compounds such as phenol, pyrol and pyridine. Used mainly as a wood preservative for railroad ties, poles, fence posts, marine pilings, and other lumber for outdoor use; as a water-proofing agent, fuel oil constituent, frothing agent for mineral separation, hop defoliant, and lubricant for die molds; in manufacturing chemicals; and in medicine as an antiseptic, disinfectant, antipyretic, astringent, germicide, and styptic.
Other Designations: CAS No. 8001-58-9, Awpa,® brick oil, Caswell No. 225,® coal tar oil, creosote, creosote oil, creosotum, cresylic creosote, heavy oil, liquid pitch oil, naphthalene oil, Preserv-o-sote,® Sakresote,® tar oil, wash oil.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.
Cautions: Flammable, liquid coal tar creosote is toxic by inhalation, ingestion, and skin contact. The IARC and NTP classify it as *a human carcinogen.*

R 1
I 4
S 4*
K 2
* Skin absorption

NFPA

HMIS
H 2
F 2
R 0
PPG†
† Sec. 8

* Skin absorption can occur with phenol, a major component of coal tar creosote.

Section 2. Ingredients and Occupational Exposure Limits

Coal tar creosote, ca 100%

1990 OSHA PEL
8-hr TWA: 0.2 mg/m³*

1990-91 ACGIH TLV
TWA: 0.2 mg/m³*

1985-86 Toxicity Data†
Rat, oral, LD_{50}: 725 mg/kg; toxic effects not yet reviewed
Dog, oral, LD_{Lo}: 600 mg/kg; toxic effects not yet reviewed
Rat, TD_{Lo}: 52,416 mg/kg administered during 91 days prior to mating produces reproductive effects on fallopian tubes and ovaries
Mouse, skin, TD_{Lo}: 99 g/kg produces tumors in skin and appendages

1987 IDLH Level
700 mg/m³

1990 NIOSH REL
0.1 mg/m³ (cyclohexane extractable portion)

* As coal tar pitch volatiles.
† See NIOSH, *RTECS* (GF8615000), for additional mutation, reproductive, tumorigenic, and other toxicity data.

Section 3. Physical Data

Boiling Point: 381 to 752 °F (194 to 400 °C)
Distillation Range: 446 to 554 °F (230 to 290 °C)
Heat of Combustion: -12,500 Btu/lb
Heat of Vaporization: 107 Btu/lb
Molecular Weight: Varies with purity
Density/Specific Gravity: 1.07 to 1.08 at 68 °F (20 °C)
Water Solubility: Slightly soluble

Appearance and Odor: Pure coal tar creosote is colorless, but the industrial product is a yellow to black oily liquid with an aromatic smoky smell and a burning caustic taste.

Section 4. Fire and Explosion Data

Flash Point: 165.2 °F (74 °C), CC	**Autoignition Temperature:** 637 °F (336 °C)	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), or regular foam. For large fires, use fog or regular foam. Since water is least effective, use it as an extinguishing agent only when the preferred measures are unavailable. However, use water spray to cool fire-exposed containers.
Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. Containers may explode in heat of fire. Coal tar creosote presents a vapor explosion hazard indoors, outdoors, and in sewers.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear full protective clothing. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Immediately leave area if you hear a rising sound from venting safety device or notice any fire-caused tank discoloration. Isolate area for 1/2 mile in all directions if fire involves tank, rail car or tank truck. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Fully decontaminate or properly dispose of personal protective clothing.

Section 5. Reactivity Data

Stability/Polymerization: Coal tar creosote is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Creosote oil mixed with chlorosulfonic acid in a closed container causes an increase in temperature and pressure.
Conditions to Avoid: Avoid excessive heat and contact with chlorosulfonic acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of coal tar creosote can produce oxides of carbon and thick, black, acrid smoke.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA list coal tar creosote as a carcinogen.
Summary of Risks: Coal tar creosote is toxic by inhalation, ingestion, and skin contact. It contains a variety of hydrocarbons such as phenol and polycyclic aromatic hydrocarbons such as benzo[a]pyrene, benzanthracene, and phenol derivatives. The range of toxicity depends on the exposure concentration, amount, and duration. Effects may include irritation, burns, and several forms of cancer.
Medical Conditions Aggravated by Long-Term Exposure: Chronic respiratory or skin diseases.
Target Organs: Eyes, skin, bladder, kidneys, and respiratory system.
Primary Entry Routes: Inhalation, ingestion, and skin contact.
Acute Effects: Skin contact may cause irritation, burning, itching, redness, pigment changes, dermatitis (a rash of redness and small bumps), or burns. Photosensitization (worsening of rash with exposure to sunlight) may occur. Inhalation may be irritating to the respiratory tract. Eye contact may cause conjunctivitis (inflammation of the eye's lining), keratitis (corneal inflammation), or corneal burns with scarring. Ingestion may result in nausea, vomiting, abdominal pain, rapid pulse, respiratory distress, and shock. Systemic absorption by any route (including skin absorption) may cause trouble breathing, thready (continuous or drawn out) pulse, dizziness, headache, nausea, vomiting, salivation, and convulsions. Exposure to large doses (particularly by ingestion) may be fatal.
Chronic Effects: Dermatitis, skin cancer, and lung cancer.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* let victim rub eyes or keep them tightly closed. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Wash affected area with soap and flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of milk or water. *Do not induce vomiting!*
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Cresol may be detected in urine.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate hazard area, deny entry, and stay upwind of spills. Shut off all ignition sources–no flares, smoking, or flames in hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If possible with no risk, stop leak. Water spray may be used to reduce vapor but it may not prevent ignition in closed spaces. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Degradation: Coal tar creosote is fouling to shoreline. Ecotoxicity values are: TL_{50}, goldfish (*Carassius auratus*), 3.51 ppm/24 hr (60:40) mixture of creosote and coal tar; LD_{50}, bob white quail (*Colinus virginianus*), 1,260 ppm/8 days (60:40) mixture of creosote and coal tar.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Material No. U051
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed (as coal tar pitch volatiles) as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent all skin contact. Applying a layer of petroleum jelly or lanolin castor oil ointment to the face reduces vapor contact and penetration through skin. Frequent change of protective garments is an additional protective measure.
Ventilation: Provide general and local exhaust ventilation systems equipped with high-efficiency particulate filters to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Take particular care to avoid any contamination of drains or ventilation ducts. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in a cool, dry, well-ventilated area. Store coal tar creosote as close to area of use as possible to minimize transporting distance.
Engineering Controls: Use engineering controls to keep airborne concentrations below the OSHA PEL. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Always perform synthesis and purification procedures under a vertical ventilation hood and make regular operational safety checks. Label doors to rooms where coal tar creosote is produced, used, or stored as containing a carcinogen. Locate emergency equipment at well-marked and clearly identified stations in case emergency escape is necessary.
Other Precautions: Preplacement and periodic medical examinations of exposed workers emphasizing respiratory, skin, liver, and kidney disorders, including comprehensive work and medical history, physical examination, CXR, PFTs, urinalysis, LFT, and sputum cytology as the attending physician considers appropriate. Educate workers about coal tar creosote's carcinogenicity and proper handling procedures to avoid exposure.
Other Comments: Caution is in order when handling or sawing old creosote-treated lumber since it retains a considerable portion of creosote for up to 25 to 30 years.
Transportation Data (49 CFR 172.101)
DOT Shipping Name: Creosote
DOT Hazard Class: Flammable liquid
ID No.: UN1136
DOT Label: Flammable liquid

***MSDS Collection* References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 142, 143, 146, 148, 153, 159
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Mark Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 470
Diesel Fuel Oil No. 2-D

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

Diesel Fuel Oil No. 2-D Description: Diesel fuel is obtained from the middle distillate in petroleum separation; a distillate oil of low sulfur content. It is composed chiefly of unbranched paraffins. Diesel fuel is available in various grades, one of which is synonymous with fuel oil No. 2-D. This diesel fuel oil requires a minimum Cetane No. (efficiency rating for diesel fuel comparable to octane number ratings for gasoline) of 40 (ASTM D613). Used as a fuel for trucks, ships, and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.

R 1
I -
S 2
K 2

NFPA

HMIS
H 0
F 2
R 0
PPG*
* Sec. 8

Other Designations: CAS No. 68334-30-5, diesel fuel.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: Diesel fuel oil No. 2-D is a skin irritant and central nervous depressant with high mist concentrations. It is an environmental hazard and moderate fire risk.

Section 2. Ingredients and Occupational Exposure Limits

Diesel fuel oil No. 2-D*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data‡
None established	Mineral Oil Mist TWA: 5 mg/m^3† STEL: 10 mg/m^3	None established	Rat, oral, LD_{50}: 9 g/kg produces gastrointestinal (hypermotility, diarrhea) effects

* Diesel fuel No. 2-D tends to be low in aromatics and high in paraffinics. This fuel oil is complex mixture of: 1) >95% paraffinic, olefinic, naphthenic, and aromatic hydrocarbons, 2) sulfur (<0.5%), and 3) benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)]. Although low in the fuel itself, benzene concentrations are likely to be much higher in processing areas.
† As sampled by nonvapor-collecting method.
‡ Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 340 to 675 °F (171 to 358 °C)
Viscosity: 1.9 to 4.1 centistoke at 104 °F (40 °C)
Specific Gravity: <0.86
Water Solubility: Insoluble

Appearance and Odor: Brown, slightly viscous liquid.

Section 4. Fire and Explosion Data

Flash Point: 125 °F (52 °C) min.	Autoignition Temperature: >500 °F (932 °C)	LEL: 0.6% v/v	UEL: 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or foam to fight fire. Use a water spray to cool fire exposed containers. Do not use a forced water spray directly on burning oil since this will scatter the fire. Use a smothering technique for extinguishing fire.

Unusual Fire or Explosion Hazards: Diesel fuel oil No. 2-D is a OSHA Class II combustible liquid. Its volatility is similar to that of gas oil. Vapors may travel to a source of ignition and flash back.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to pollution and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Diesel fuel oil No. 2-D is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: It is incompatible with strong oxidizing agents; heating greatly increases the fire hazard.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of diesel fuel oil No. 2-D can produce various hydrocarbons and hydrocarbon derivatives, and other partial oxidation products such as carbon dioxide, carbon monoxide, and sulfur dioxide.

Section 6. Health Hazard Data

Carcinogenicity: Although the IARC has not assigned an overall evaluation to diesel fuels as a group, it has evaluated occupational exposures in petroleum refining as an IARC probable human carcinogen (Group 2A). It has evaluated distillate (light) diesel oils as not classifiable as human carcinogens (Group 3).
Summary of Risks: Although diesel fuel's toxicologic effects should resemble kerosine's, they are somewhat more pronounced due to additives such as sulfurized esters. Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, vomiting, and loss of coordination, depending on concentration and exposure time. When removed from exposure area, affected persons usually recover completely. If vomiting occurs after ingestion and if oil is aspirated into the lungs, hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result. A comparative ratio of oral to aspirated lethal doses may be 1 pt vs. 5 ml. Aspiration may also result in transient CNS depression or excitement. Secondary effects may include hypoxia (insufficient oxygen in body cells), infection, pneumatocele formation, and chronic lung dysfunction. Inhalation may result in euphoria, cardiac dysrhythmias, respiratory arrest, and CNS toxicity. Prolonged or repeated skin contact may irritate hair follicles and block sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system, skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal irritation, vomiting, diarrhea, and in severe cases central nervous system depression, progressing to coma or death. Inhalation of aerosols or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish discoloration of the skin and mucous membranes caused by deficient blood oxygenation).
Chronic Effects: Repeated contact with the skin causes dermatitis.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body have been exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately. Position to avoid aspiration.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use a noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Diesel fuel oil No. 2-D spills may be environmental hazards. Report large spills.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with a mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.*Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for a OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in storage or use areas.
Engineering Controls: Avoid vapor or mist inhalation and prolonged skin contact. Wear protective rubber gloves and chemical safety glasses where contact with liquid or high mist concentration may occur. Additional suitable protective clothing may be required depending on working conditions. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. At least weekly laundering of work clothes is recommended. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.
Transportation Data (49 CFR 172.101)
DOT Shipping Name: Fuel oil
DOT Hazard Class: Combustible liquid
ID No.: NA1993
DOT Label: None
DOT Packaging Exceptions: 173.118a
DOT Packaging Requirements: None

MSDS Collection **References:** 1, 6, 7, 12, 73, 84, 101, 103, 126, 127, 132, 133, 136, 143, 146
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 385
Ethylbenzene

Issued: 8/78 Revision: B, 9/92

Section 1. Material Identification 39

Ethylbenzene ($C_6H_5C_2H_5$) Description: Derived by heating benzene and ethylene in presence of aluminum chloride with subsequent distillation, by fractionation directly from the mixed xylene stream in petroleum refining, or dehydrogenation of naphthenes. Used as a solvent, an antiknock agent in gasoline; and as an intermediate in production of synthetic rubber, styrene, cellulose acetate, diethylbenzene, acetophenone, ethyl anthraquinone, propyl oxide, and α-methylbenzol alcohol.
Other Designations: CAS No. 100-41-4, ethylbenzol, EB, phenylethane, NCI-C56393.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 3
S 2*
K 4
* Skin absorption

NFPA

HMIS
H 2†
F 3
R 0
PPE - Sec. 8
† Chronic effects

Cautions: Ethylbenzene is a skin and mucous membrane irritant considered the most irritating of the benzene series. Inhalation causes acute and chronic central nervous system (CNS) effects. It is highly flammable and forms explosive mixtures with air.

Section 2. Ingredients and Occupational Exposure Limits

Ethylbenzene, ca >99.0%. Impurities include ~ 0.1% *meta* & *para* xylene, ~ 0.1% cumene, and ~ 0.1% toluene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m^3)
15-min STEL: 125 ppm (545 mg/m^3)
Action Level: 50 ppm (217 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH REL
TWA: 100 ppm (435 mg/m^3)
STEL: 125 ppm (545 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 125 ppm (545 mg/m^3)

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category 1: local irritants
Peak Exposure Limit: 200 ppm, 5 min momentary value, max of 8/shift
Danger of cutaneous absorption

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 100 ppm/8 hr caused eye effects, sleep, and respiratory changes.
Human, lymphocyte: 1 mmol/L induced sister chromatid exchange.
Rat, oral, LD_{50}: 3500 mg/kg; toxic effects not yet reviewed
Rat (female), inhalation, TC_{Lo}: 1000 ppm/7 hr/day, 5 days/wk, for 3 wk prior to mating and daily for 19 days of gestation produced pups with high incidence of extra ribs.(179)

* See NIOSH, *RTECS* (DA0700000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 277 °F (136 °C)
Melting Point: -139 °F (-95 °C)
Surface Tension: 31.5 dyne/cm
Ionization Potential: 8.76 eV
Viscosity: 0.64 cP at 77 °F (25 °C)
Refraction Index: 1.4959 at 68 °F (20 °C)
Relative Evaporation Rate (ether = 1): 0.0106
Bulk Density: 7.21 lb/Gal at 77 °F (25 °C)
Critical Temperature: 651 °F (343.9 °C)
Critical Pressure: 35.6 atm

Molecular Weight: 106.16
Density: 0.863 at 77 °F (25 °C)
Water Solubility: Slightly, 14 mg/100 mL at 59 °F (15 °C)
Other Solubilities: Miscible in alcohol, ether; soluble in carbon tetrachloride, benzene, sulfur dioxide, and many organic solvents; insoluble in ammonia
Odor Threshold: 2.3 ppm
Vapor Pressure: 7.1 mm Hg at 68 °F (20 °C); 10 mmHg at 78.62 °F (25.9 °C); 100 mm Hg 165.38 °F (74.1 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0768 lb/ft^3 or 1.2298 kg/m^3

Appearance and Odor: Colorless, flammable liquid with a pungent odor.

Section 4. Fire and Explosion Data

Flash Point: 64 °F (18 °C) CC	**Autoignition Temperature:** 810 °F (432 °C)	**LEL:** 1.0% v/v	**UEL:** 6.7% v/v

Extinguishing Media: Class 1B Flammable liquid. For small fires, use dry chemical, carbon dioxide, or 'alcohol-resistant' foam. For large fires, use fog or 'alcohol-resistant' foam. Use water only if other agents are unavailable; EB floats on water and may travel to an ignition source and spread fire. **Unusual Fire or Explosion Hazards:** Burning rate = 5.8 mm/min. Vapors may travel to an ignition source and flash back. Container may explode in heat of fire. EB poses a vapor explosion hazard indoors, outdoors, and in sewers. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Cool container sides with water until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Withdraw immediately if you hear rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Ethylbenzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Reacts vigorously with oxidizers.
Conditions to Avoid: Exposure to heat and oxidizers.
Hazardous Products of Decomposition: Thermal oxidative decomposition of EB can produce acrid smoke and irritating fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list EB as a carcinogen. **Summary of Risks:** Occupational exposure to EB alone is rare since it is usually present together with other solvents. EB is irritating to the eyes, skin, and respiratory tract. Vapor inhalation produces varying degrees of CNS effects depending on concentration. The liquid is absorbed through the skin but vapors are not. 56 to 64% of inhaled ethylbenzene is retained and metabolized. Urinary metabolites following exposure to 23 to 85 ppm for 8 hr are mandelic acid (64%), phenylglyoxylic acid (25%), and methylphenylcarbinol/1-phenyl ethanol (5%). Concurrent exposure to xylene and ethylbenzene causes slower excretion of EB metabolites. Based on the rat LD_{50}, one manufacturer gives 3 to 4 oz. as the lethal dose for a 100 lb person.

Continue on next page

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Skin and CNS diseases and impaired pulmonary function (especially obstructive airway disease). **Target Organs:** Eyes, respiratory system, skin, CNS, blood. **Primary Entry Routes:** Inhalation, skin and eye contact. **Acute Effects:** Vapor inhalation of 200 ppm caused transient eye irritation; 1000 ppm caused eye irritation with profuse watering (tolerance developed rapidly); 2000 ppm caused severe and immediate eye irritation and watering, nasal irritation, chest constriction, and vertigo; 5000 ppm was intolerable and caused eye and nose irritation. Inhalation of high concentrations may cause narcosis, cramps, and death due to respiratory paralysis. Skin exposed to pure ethylbenzene for 10 to 15 min absorbed 22 to 33 mg/cm^2/hr. Immersion of hand in solutions of 112 & 156 mg/L for 1 hr absorbed 118 & 215.7 µg/cm^2/hr, respectively. **Chronic Effects:** Repeated skin contact may cause dryness, scaling, and fissuring. Workers chronically exposed to > 100 ppm complained of fatigue, sleepiness, headache, and mild irritation of the eyes and respiratory tract. Repeated vapor inhalation may result in blood disorders, particularly leukopenia (abnormally low level of white blood cells) and lymphocytosis.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting! Aspiration of even a small amount of EB in vomitus can cause severe damage since its low viscosity and surface tension will cause it to spread over a large area of the lung tissue.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: BEI = mandelic acid in urine (1.5 g/g of creatinine), sample at end of shift at workweeks end. Since this test is not specific, test for EB in expired air for confirmation.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate and ventilate area, deny entry and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against vapor inhalation and skin/eye contact. Take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container. Dike far ahead of large spill for later reclamation or disposal. Report any release >1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, EB partially evaporates into the atmosphere, with a half-life of hrs to wks, and some leaches into groundwater, especially in soil with low organic carbon content. Biodegradation occurs with a half-life of 2 days. Some EB may absorb to sediment or bioconcentrate in fish. Evidence points to slow biodegradation in groundwater. In air, it reacts with photochemically produced hydroxyl radicals with a half-life of hrs to 2 days. Additional amounts may be removed by rain. **Ecotoxicity Values:** Shrimp (*Mysidopsis bahia*), LC_{50} = 87.6 mg/L/96 hr; sheepshead minnow (*Cyprinodon variegatus*) LC_{50} = 275 mg/L/96 hr; fathead minnow (*Pimephales promelas*) LC_{50} = 42.3 mg/L/96 hr in hard water & 48.5 mg/L/96 hr in softwater. **Disposal:** A candidate for rotary kiln incineration at 1508 to 2912°F (820 to 1600°C), liquid injection incineration at 1202 to 2912°F (650 to 1600°C), and fluidized bed incineration at 842 to 1796°F (450 to 980°C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.21): No. D001
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311 (b)(4) & CWA, Sec. 307 (a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use a powered air-purifying respirator with an appropriate organic vapor cartridge, a supplied-air respirator (SAR), SCBA, or chemical cartridge respirator with appropriate organic vapor cartridge. For < 2000 ppm, use a SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of Viton or polyvinylchloride to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a cool, dry, well-ventilated area away from ignition sources and oxidizers. Outside or detatched storage is preferred. If inside, store in a standard flammable liquids cabinet. Containers should have flame-arrester or pressure-vacuum venting. To prevent static sparks, electrically ground and bond all equipment used with ethylbenzene. Install Class 1, Group D electrical equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain levels as low as possible. Purge and ventilate reaction vessels before workers are allowed to enter for maintenance or cleanup. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, skin, blood, and respiratory system.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Ethylbenzene
DOT Hazard Class: 3
ID No.: UN1175
DOT Packing Group: II
DOT Label: Flammable liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60 L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: —

***MSDS Collection* References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 153, 159, 162, 163, 164, 167, 168, 171, 176, 179
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 467
Automotive Gasoline, Lead-free

Issued: 10/81 Revision: A, 9/91

Section 1. Material Identification 35

Automotive Gasoline, Lead-free, Description: A mixture of volatile hydrocarbons composed mainly of branched-chain paraffins, cycloparaffins, olefins, naphthenes, and aromatics. In general, gasoline is produced from petroleum, shale oil, Athabasca tar sands, and coal. Motor gasolines are made chiefly by cracking processes, which convert heavier petroleum fractions into more volatile fractions by thermal or catalytic decomposition. Widely used as fuel in internal combustion engines of the spark-ignited, reciprocating type. Automotive gasoline has an octane number of approximately 90. A high content of aromatic hydrocarbons and a consequent high toxicity are also associated with a high octane rating. Some gasolines sold in the US contain a minor proportion of tetraethyllead, which is added in concentrations not exceeding 3 ml per gallon to prevent engine "knock." However, methyl-tert-butyl ether (MTBE) has almost completely replaced tetraethyllead.
Other Designations: CAS No. 8006-61-9, benzin, gasoline, gasolene, motor spirits, natural gasoline, petrol.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

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* Skin absorption

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† Sec. 8

Cautions: Inhalation of automotive gasoline vapors can cause intense burning in throat and lungs, central nervous system (CNS) depression, and possible fatal pulmonary edema. Gasoline is a dangerous fire and explosion hazard when exposed to heat and flames.

Section 2. Ingredients and Occupational Exposure Limits

Automotive gasoline, lead-free*

1990 OSHA PELs
8-hr TWA: 300 ppm, 900 mg/m^3
15-min STEL: 500 ppm, 1500 mg/m^3

1990-91 ACGIH TLVs
TWA: 300 ppm, 890 mg/m^3
STEL: 500 ppm, 1480 mg/m^3

1990 NIOSH REL
None established

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 900 ppm/1 hr; toxic effects include sense organs and special senses (conjunctiva irritation), behavioral (hallucinations, distorted perceptions), lungs, thorax, or respiration (cough)
Human, eye: 140 ppm/8 hr; toxic effects include mild irritation
Rat, inhalation, LC_{50}: 300 g/m^3/5 min

* A typical modern gasoline composition is 80% paraffins, 14% aromatics, and 6% olefins. The mean benzene content is approximately 1%. Other additives include sulfur, phosphorus, and MTBE.
† See NIOSH, *RTECS* (LX3300000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Initially, 102 °F (39 °C); after 10% distilled, 140 °F (60 °C); after 50% distilled, 230 °F (110 °C); after 90% distilled, 338 °F (170 °C); final boiling point, 399 °F (204 °C)
Vapor Density (air = 1): 3.0 to 4.0
Density/Specific Gravity: 0.72 to 0.76 at 60 °F (15.6 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear (gasoline may be colored with dye), mobile liquid with a characteristic odor recognizable at about 10 ppm in air.

Section 4. Fire and Explosion Data

Flash Point: -45 °F (-43 °C)	**Autoignition Temperature:** 536 to 853 °F (280 to 456 °C)	**LEL:** 1.3% v/v	**UEL:** 6.0% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or alcohol foam as extinguishing media. Use of water may be ineffective to extinguish fire, but use water spray to knock down vapors and to cool fire-exposed drums and tanks to prevent pressure rupture. Do not use a solid stream of water since it may spread the fuel.
Unusual Fire or Explosion Hazards: Automobile gasoline is an OSHA Class IB flammable liquid and a dangerous fire and explosion hazard when exposed to heat and flames. Vapors can flow to an ignition source and flash back. Automobile gasoline can also react violently with oxidizing agents.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode, and full protective clothing. When the fire is extinguished, use nonsparking tools for cleanup. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Automotive gasoline is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Automotive gasoline can react with oxidizing materials such as peroxides, nitric acid, and perchlorates.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of automotive gasoline can produce oxides of carbon and partially oxidized hydrocarbons.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC list gasoline as a possible human carcinogen (Group 2B). Although the IARC has assigned an overall evaluation to gasoline, it has not assigned an overall evaluation to specific substances within this group (inadequate human evidence).
Summary of Risks: Gasoline vapors are considered moderately poisonous. Vapor inhalation can cause central nervous system (CNS) depression and mucous membrane and respiratory tract irritation. Brief inhalations of high concentrations can cause a fatal pulmonary edema. Reported responses to gasoline vapor concentrations are: 160 to 270 ppm causes eye and throat irritation in several hours; 500 to 900 ppm causes eye, nose, and throat irritation, and dizziness in 1 hr; and 2000 ppm produces mild anesthesia in 30 min. Higher concentrations are intoxicating in 4 to 10 minutes. If large areas of skin are exposed to gasoline, toxic amounts may be absorbed. Repeated or prolonged skin exposure causes dermatitis. Certain individuals may develop hypersensitivity. Ingestion can cause CNS depression. Pulmonary aspiration after ingestion can cause severe pneumonitis. In adults, ingestion of 20 to 50 g gasoline may produce severe symptoms of poisoning.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eye, respiratory and central nervous systems.
Primary Entry Routes: Inhalation, ingestion, skin contact.
Acute Effects: Acute inhalation produces intense nose, throat, and lung irritation; headaches; blurred vision; conjunctivitis; flushing of the face; mental confusion; staggering gait; slurred speech; and unconsciousness, sometimes with convulsions. Ingestion causes inebriation (drunkenness), vomiting, dizziness, fever, drowsiness, confusion, and cyanosis (a blue to dark purplish coloration of skin and mucous membrane caused by lack of oxygen). Aspiration causes choking, cough, shortness of breath, increased rate of respiration, excessively rapid heartbeat, fever, bronchitis, and pneumonitis. Other symptoms following acute exposure include acute hemorrhage of the pancreas, fatty degeneration of the liver and kidneys, and passive congestion of spleen.
Chronic Effects: Chronic inhalation results in appetite loss, nausea, weight loss, insomnia, and unusual sensitivity (hyperesthesia) of the distal extremities followed by motor weakness, muscular degeneration, and diminished tendon reflexes and coordination. Repeated skin exposure can cause blistering, drying, and lesions.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Give conscious victim a mixture of 2 tablespoons of activated charcoal mixed in 8 oz of water to drink. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Use nonsparking tools. Take up small spills with sand or other noncombustible adsorbent. Dike storage areas to control leaks and spills. Follow applicable OSHA regulations (29 CFR 1910.120).
Aquatic Toxicity: Bluegill, freshwater, LC_{50}, 8 ppm/96 hr.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. There are no specific NIOSH recommendations. However, for vapor concentrations not immediately dangerous to life or health, use chemical cartridge respirator equipped with organic vapor cartridge(s), or a supplied-air respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Materials such as neoprene or polyvinyl alcohol provide excellent/good resistance for protective clothing. **Note:** Resistance of specific materials can vary from product to product.
Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. Avoid direct sunlight. Storage must meet requirements of OSHA Class IB liquid. Outside or detached storage preferred.
Engineering Controls: Avoid vapor inhalation and skin or eye contact. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Indoor use of this material requires explosion-proof exhaust ventilation to remove vapors. Only use gasoline as a fuel source due to its volatility and flammable/explosive nature. Practice good personal hygiene and housekeeping procedures. Wear clean work clothing daily.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Gasoline (*including casing-head and natural*)
DOT Hazard Class: Flammable liquid
ID No.: UN1203
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Gasoline
IMO Hazard Class: 3.1
ID No.: UN1203
IMO Label: Flammable liquid
IMDG Packaging Group: II

***MSDS Collection* References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146, 153, 159
Prepared by: M Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

32

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.

Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

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Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 µg/m³
Action Level TWA*: 30 µg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 µg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 µg/m³

1988 NIOSH REL
10-hr TWA: <100 µg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 µg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)

Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*

Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system. The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

***MSDS Collection* References:** 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 440
Methane

Issued: 7/80 Revision: A, 8/89

Section 1. Material Identification

29

Methane Description: Widely distributed in nature, methane comprises 0.00022% by volume of the earth's atmosphere. American natural gas is mostly methane (85%). At temperatures greater than 2012 °F (1100 °C), pure carbon combines with pure hydrogen to form methane. Above 2732 °F (1500 °C), the amount of methane produced increases with temperature. Obtained from sodium acetate and sodium hydroxide or from aluminum carbide and water. Commercially prepared from natural gas or by fermentation of cellulose and sewage sludge. Constituent of illuminating and cooking gas. Used in the manufacture of hydrogen, hydrogen cyanide, ammonia, acetylene, formaldehyde, and many other organics.
Other Designations: Fire damp; marsh gas; methyl hydride; CH_4; CAS No. 0074-82-8.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

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Section 2. Ingredients and Occupational Exposure Limits

Methane, ca 100%*

OSHA PEL	ACGIH TLV, 1988-89	NIOSH REL	Toxicity Data†
None established	None established	None established	Not listed

* Check with your supplier to determine the exact composition of the purchased methane. Possible contaminants are ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), higher molecular weight alkanes, carbon dioxide (CO_2), nitrogen (N_2), and oxygen(O_2).
† Monitor NIOSH, *RTECS* (PA1490000), for future toxicity data.

Section 3. Physical Data

Boiling Point: -259 °F (161.6 °C)
Vapor Density (Air = 1): 0.544 at 32 °F (0 °C)
Molecular Weight: 16 g/mol
Water Solubility: Slight*
Melting Point: -296.5 °F (-182.5 °C)

Appearance and Odor: A colorless, odorless, tasteless, extremely flammable gas. Commercial methane's trace amounts of a suitable mercaptan compound give it natural gas's familiar rotten egg smell.

*Soluble in alcohol and ether.

Section 4. Fire and Explosion Data

Flash Point: -213 °F (-136.11 °C)	Autoignition Temperature: 999 °F (537 °C)	LEL: 5% v/v*	UEL: 15% v/v*

Extinguishing Media: Methane's extreme flammability, extensive explosibility range, and very low flash point represent dangerous fire and explosion risks. *Treat any fire situation involving rapidly escaping and burning methane gas as an emergency.* Extinguish methane fires by shutting off the source of the gas. Use water sprays to cool fire-exposed containers and to protect the personnel attempting to seal the source of the escaping gas.
Unusual Fire or Explosion Hazards: Methane gas is very flammable with an extensive explosibility range. The best fire-fighting technique may be simply to let the burning gas escape from the pressurized cylinder, tank car, or pipelines. Never extinguish the burning gas without first locating and sealing its source. Otherwise, the still leaking gas could explosively re-ignite without warning and cause more damage than if it burned itself out.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* The loudest methane-air explosions occur when 1 volume of methane is mixed with 10 volumes of air (or 2 volumes of oxygen). **Warning:** Air with more than 14% by volume methane burns *noiselessly*. Methane burns with a pale, faintly luminous, not always easily detected flame.

Section 5. Reactivity Data

Stability/Polymerization: Methane is stable at room temperature in closed, pressurized containers during routine operations. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Genium reference 84 reports that methane can react violently with bromine pentafluoride, chlorine, chlorine dioxide, nitrogen trifluoride, liquid oxygen, and oxygen difluoride.
Conditions to Avoid: Never expose methane to ignition sources such as open flame, lighted cigarettes or pipes, uninsulated heating elements, or electrical or mechanical sparks. Prevent any accidental or uncontrollably rapid release of methane gas from high-pressure cylinders, tank cars, or pipelines.
Hazardous Products of Decomposition: Thermal oxidative degradation of methane can produce carbon dioxide and toxic carbon monoxide (CO).

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists methane as a carcinogen. **Summary of Risks**: As a simple asphyxiant, methane does not cause significant physiological responses, but it can displace the minimum required atmospheric oxygen level. Significant displacement results in an oxygen-deficient atmosphere with no adequate warning properties. Asphyxiation can occur especially in confined, poorly ventilated, undisturbed spaces infrequently entered by workers. Frostbite (cryogenic damage) can result from contact with liquid methane's extremely low temperature. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** None reported. **Primary Entry:** Inhalation. **Acute Effects:** The initial symptoms of simple asphyxiant gases's effects are rapid respiration and air hunger, diminished mental alertness, and impaired muscular coordination. Continuing lack of oxygen causes faulty judgement, depression of all sensations, rapid fatique, emotional instability, nausea, vomiting, prostration, unconsciousness, and finally, convulsions, coma, and death. **Chronic Effects:** None reported.

FIRST AID

Skin: (Liquid methane): Promptly flush the affected area with lots of tepid/lukewarm water to reduce freezing of tissues. Never apply direct heat to frostbitten areas. Loosely apply dry, bulky dressings to protect the area from further injury. Get treatment from qualified medical personnel. **Inhalation:** Rescuers must consider their own safety when entering confined, poorly ventilated, oxygen-deficient areas. Self-contained breathing equipment must be readily available. Rescuers must use nonsparking tools and equipment; e.g., floodlights lowered into any incident area must be electrically grounded and bonded, shatter-resistant, and sparkproof. **After first aid, get appropriate in-plant, paramedic, or community medical attention and support for inhalation exposures in oxygen-deficient atmospheres.** Seek prompt medical assistance for further observation and treatment.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a methane spill control and countermeasure plan (SCCP).* When a leak occurs, notify safety personnel, eliminate heat and ignition sources, evacuate unnecessary personnel, provide maximum explosion-proof ventilation, and implement the SCCP. Use only nonsparking tools and equipment. Locate and seal the source of the leaking gas. Use water sprays to protect the personnel attempting this shutoff. Large methane releases can result in spectacular explosions. If attempts to shut off the leaking gas are unsuccessful, evacuate the likely explosion area. **Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations. Remove leaking or defective cylinders to a safe, outside, posted, discharge location. Let the methane gas discharge at a moderate rate. When it is empty, return the cylinder to the supplier after it is properly tagged, labelled, or stenciled MT (empty) or defective.

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Gloves:** To prevent skin contact, workers handling liquid methane should wear appropriate insulating gloves, safety glasses, and splash aprons, as required by the particular work conditions. **Respirator:** Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres; use self-contained breathing equipment there. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the 5% v/v LEL (Sec. 4). Local exhaust ventilation is preferred since it prevents methane dispersion into the work area by eliminating it at its source (Genium ref. 103). Give special attention to proper ventilation of enclosed areas. **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, washing facilities, fire extinguishers, and oxygen bottles for emergency first-aid. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Other:** If appropriate, consider installing automatic sensing equipment that warns workers of oxygen-deficient atmospheres or of potentially explosive air-gas mixtures. All engineering systems in any methane gas storage, handling, or processing area must be explosion-proof so they have no spark potential or hot spots. Pressurized systems must use only approved valves, manifolds, flanges, and flame arrestors. **Comments:** Methane gas presents dangerous fire, explosion, and reactivity risks. Regularly inspect and service all the piping systems which transport methane gas in production and storage areas. Before use, thoroughly test methane lines with nitrogen gas for leaking, especially in enclosed areas.

Section 9. Special Precautions and Comments

Storage Requirements: Store methane in closed, pressurized cylinders, tank cars, pipelines, or other containers in a cool, dry, well-ventilated, fireproof area away from heat and ignition sources and incompatible chemicals (Sec. 5). Protect these containers from physical damage and heat. Shield them from direct sunlight. **Special Handling/Storage:** Electrically ground and bond all containers, tanks, cylinders, tank cars and pipelines used in methane shipping, receiving, or transferring operations. Never smoke in any work area where the possibility of exposure to methane gas (fire hazard) exits. Recommended storage containers include steel.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Methane
DOT Hazard Class: Flammable gas
DOT ID No. : UN1971
DOT Label: Flammable gas
DOT Packaging Requirements: 49 CFR 173.302
DOT Packaging Exceptions: 49 CFR 173.306

IMO Shipping Name: Methane, compressed
IMO Hazard Class: 2.1
IMO Label: Flammable gas

***MSDS Collection* References:** 1, 6, 7, 84-94, 100, 116, 117, 119, 120, 122

Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

F8

MACE SECURITY INTERNATIONAL -- CS MACE

MATERIAL SAFETY DATA SHEET

Part No. Indicator: A

Part Number/Trade Name: CS MACE

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General Information

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Company's Name: MACE SECURITY INTERNATIONAL

Company's Street: 160 BENMONT AVE

Company's City: BENNINGTON

Company's State: VT

Company's Country: US

Company's Zip Code: 05201-5000

Company's Emerg Ph #: 802-447-1503

Company's Info Ph #: 802-447-1503

Record No. For Safety Entry: 001

Tot Safety Entries This Stk#: 001

Status: SE

Date MSDS Prepared: 25FEB94

Safety Data Review Date: 06OCT94

MSDS Preparer's Name: BERNIE GRANEY

Preparer's Company: MACE SECURITY INTERNATIONAL

Preparer's St Or P. O. Box: 160 BENMONT AVE

Preparer's City: BENNINGTON

Preparer's State: VT

Preparer's Zip Code: 05201-5000

MSDS Serial Number: BVSKV

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Ingredients/Identity Information

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Proprietary: NO

Ingredient: O-CHLOROBENZYLIDENE MALONONITRILE

Ingredient Sequence Number: 01

Percent: 2

NIOSH (RTECS) Number: OO3675000

CAS Number: 2698-41-1

OSHA PEL: 0.05 PPM

ACGIH TLV: C 0.39 MG/CUM

Other Recommended Limit: 0.05 PPM

Proprietary: NO

Ingredient: SEC-BUTANOL ALCOHOL

Ingredient Sequence Number: 02

Percent: 20

NIOSH (RTECS) Number: EO1750000

CAS Number: 78-92-2

OSHA PEL: 100 PPM

ACGIH TLV: 100 PPM

Other Recommended Limit: 100 PPM

Proprietary: NO

Ingredient: 1,2-PROPANEDIOL (PROPYLENE GLYCOL)

Ingredient Sequence Number: 03

Percent: 20

NIOSH (RTECS) Number: TY2000000

CAS Number: 57-55-6

Proprietary: NO

Ingredient: CARVENE; CYCLOHEXENE, 1-METHYL-4-(1-METHYLETHENYL), CITRUS TERPENE, D-LIMONENE, P-MENTHADIENE

Ingredient Sequence Number: 04

Percent: 20

NIOSH (RTECS) Number: GW6360000

CAS Number: 5989-27-5

Proprietary: NO

Ingredient: DIPROPYLENE GLYCOL METHYL ETHER, DOWANOL DPM, DIPROPYLENE GLYCOL MONOMETHYL ETHER

Ingredient Sequence Number: 05

Percent: 30

NIOSH (RTECS) Number: JM1575000

CAS Number: 34590-94-8

OSHA PEL: 100 PPM SKIN

ACGIH TLV: 100 PPM

Other Recommended Limit: 100 PPM

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Physical/Chemical Characteristics

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Appearance And Odor: CLEAR AMBER LIQUID W/AROMATIC ODOR.

Boiling Point: 211-370F

Specific Gravity: 1.07

Solubility In Water: SLIGHT

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Fire and Explosion Hazard Data

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Flash Point: 110F

Flash Point Method: CC

Extinguishing Media: DRY CHEMICAL, CO2/WATER SPRAY

Special Fire Fighting Proc: COOL CONTAINERS IF EXPOSED TO FIRE/HIGH HEAT.

Unusual Fire And Expl Hazrds: PRODUCT PACKAGED IN AEROSOL FORM MAY CAUSE CONTAINERS TO BURST WHEN EXPOSED TO EXTREME HEAT. VAPORS ARE >AIR & MAY TRAVEL ALONG GROUND & BE IGNITED BY IGNITION.

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Reactivity Data

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Stability: YES

Cond To Avoid (Stability): EXTREME HEAT, TEMPS >175F

Hazardous Decomp Products: CO2, CO, VARIOUS HYDROCARBONS, SMALL AMOUNTS OF PHOSGENE.

Hazardous Poly Occur: NO

Conditions To Avoid (Poly): EXTREME HEAT, TEMPS >175F.

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Health Hazard Data

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Route Of Entry - Inhalation: YES

Route Of Entry - Skin: YES

Route Of Entry - Ingestion: YES

Health Haz Acute And Chronic: INHALATION: IRRITATION/BURNING SENSATION TO LUNGS & RESPIRATORY SYSTEM. EYES: IRRITATION/BURNING SENSATION. MAY CAUSE SUPERFICIAL KERATITIS & CONJUNCTIVITIS. SKIN: LIQUID CAN CAUSE IRRITATION/ ABSORPTION. INGESTION: LIQUID MAY CAUSE IRRITATION/BURNING SENSATION TO DIGESTIVE SYSTEM.

Carcinogenicity - NTP: NO

Carcinogenicity - IARC: NO

Carcinogenicity - OSHA: NO

Explanation Carcinogenicity: NONE

Signs/Symptoms Of Overexp: IRRITATION, BURNING SENSATION, DIZZINESS, NAUSEA

Emergency/First Aid Proc: INHALATION: REMOVE TO FRESH AIR. IF BREATHING IS DIFFICULT, ADMINISTER OXYGEN/CPR IF NECESSARY. EYES: FLUSH W/ COOL WATER FOR 15 MINS. SKIN: WASH W/COOL WATER & SOAP. INGESTION: DRINK A GLASS OF WATER & INDUCE VOMITING. OBTAIN MEDICAL ATTENTION IN ALL CASES.

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Precautions for Safe Handling and Use

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Steps If Matl Released/Spill: EXTINGUISH ALL FLAMES, THEN SOAK UP MATERIAL IN ABSORBANT MATERIAL & SHOVEL INTO WASTE CONTAINER.

Waste Disposal Method: DISPOSE OF IN ACCORDANCE W/LOCAL, STATE & FEDERAL REGULATIONS. UN1950.

Precautions-Handling/Storing: PACKAGED PRODUCT IS UNDER PRESSURE. DON'T PUNCTURE, INCINERATE/STORE AT TEMPERATURES >130F.

Other Precautions: STRONGLY IRRITATING TO EYES, NOSE & SKIN. AVOID INHALING VAPORS & CONTACT W/SKIN. AVOID ABSORPTION OF PRODUCT ON CLOTHING.

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Control Measures

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Respiratory Protection: CHEMICAL RESPIRATOR, NIOSH APPROVED.

Protective Gloves: SOLVENT RESISTANT RUBBER

Eye Protection: CHEMICAL RESISTANT GOGGLES

Other Protective Equipment: SOLVENT RESISTANT TYPE CLOTHING W/FULL JACKET.

RADIONUCLIDES

FACT SHEET

See related Fact Sheets: Acronyms & Abbreviations; Glossary of Terms; Cost Assumptions; Raw Water Composition; Total Plant Costs; and WaTER Program.

1. CONTAMINANT DATA

A. Chemical Data: Radioactive elements are often called radioactive isotopes or radionuclides. Radionuclides emit radiant atomic energy caused by the spontaneous disintegration of the nuclei of their atoms, resulting in radioactive particles or decay products that are members of the radioactive elements. As radionuclides decay, they emit ionizing radiation in the form of alpha (α) or beta (β) particles and gamma (γ) photons. Alpha particles are relatively massive and easy to stop. They typically travel 100 μm into tissue while beta particles may travel several centimeters. Gamma rays, having no charge or mass, are simply a form of electromagnetic radiation, that travel at the speed of light. Gamma rays have short wavelengths and therefore are capable of causing ionizations; as such they are biologically damaging. Generally, the soluble radionuclides of concern in water include: Radon (Rn), atomic number 86, atomic weight 222, a gas; Uranium (U), atomic number 92, atomic weight 238.03, a metal; and combined Radium-226/228 (Radium (Ra), atomic number 88, atomic weight 226.03, a metal). The three forms of radioactivity, α, β, and γ are also a concern.

B. Source in Nature: Radionuclides are both natural and man-made and are found in air, water, soil, plants, and the human body. Rn gas is especially widespread in soils, rocks, and granite, and is created by the decay of the U and Ra series. Several small sources of radiation exist in the home and persons in many occupations encounter radiation. Medical uses for radiation include therapy and diagnosis. This Fact Sheet is concerned with the soluble natural radionuclides found in water. Radionuclides in water are ingested by either drinking contaminated water or eating food that has been washed in the water. In the case of Rn, exposure occurs from inhalation of the gas or decay products released from water during household use. Higher levels of Rn are generally found in groundwater rather than surface water.

C. SDWA Limits (currently under review): Current or proposed limits include: Rn=300 pCi/L; U=0.02 pCi/L; Alpha Emitters (including Radium-226 but excluding Rn and U)=15 pCi/L; Beta/Photon Emitters=4 mrem/yr; and combined Radium-226/228=5 pCi/L. When finalized, the Radionuclide Rule will exclude Rn and U, which will have their own individual standards.

USEPA is scheduled to propose revised standard for Rn by 8/1/1999 and promulgate final rule by 8/1/2001; and promulgate final rules for U and the complete Radionuclides Rule by 8/1/2000.

D. Health Effects of Contamination: Radionuclides are known human carcinogens. All three forms of radiation are dangerous to living things. Rn is associated with lung cancer; Radium-226 is associated with bone sarcomas and head carcinomas; and Radium-228 is associated with bone sarcomas. Other health effects include kidney damage and birth defects. Low level exposures can cause somatic and/or genetic defects. Somatic defects may include a higher risk of cancer, sterility, cataracts, or reduced life span. Genetic defects may include chromosome damage.

Protection against the three forms of radiation differ significantly. Our skin is sufficient protection for α emitters external to the body, however taken internally, such as inhalation, α particles can be extremely dangerous. Beta particles can be stopped with shielding (i.e. 1 cm of aluminum). Gamma rays may require several centimeters of lead to provide adequate shielding.

Bureau of Reclamation, Technical Service Center
Water Treatment Engineering and Research Group, D-8230
PO Box 25007, Denver CO 80225 (303) 445-2260

Revision Date: 9/21/01

2. REMOVAL TECHNIQUES

A. USEPA BAT (currently under review):

BAT / Radionuclide	AS	GAC	IX	RO	Lime softening	Coagulation & filtration
Rn	X	X				
U			anion	X	X	X
α				X		
β			mixed bed	X		
Ra			cation	X	X	

! AS use towers filled with material, whereby water enters the top of the tower, is sprayed over the material exposing a thin layer of water to countercurrent air being blown in at the bottom. The process allows for mass transfer of the Rn from water into air. AS off-gas is either discharged to the atmosphere or treated by vapor phase GAC. Benefits: removal efficiencies greater than 99.9%; best suited large installations. Limitations: risks associated with off-gassed Rn; requires ample space; requires careful monitoring.

! GAC uses extremely porous carbon media in a process known as adsorption. As water passes through the media, the dissolved contaminants are attracted and held (adsorbed) on the solid surface. Benefits: well established; suitable for home use. Limitations: too expensive for large systems; less effective than aeration; requires careful monitoring. GAC cost curves will be included in a future revision.

! IX uses selectively charged resins to exchange acceptable ions from the resin for radionuclides in the water. Benefits: effective; well developed. Limitations: restocking of salt supply; regular regeneration; concentrate disposal.

! RO uses a semipermeable membrane, and the application of pressure to a concentrated solution which causes water, but not suspended or dissolved solids (radionuclides), to pass through the membrane. Benefits: produces high quality water. Limitations: cost; pretreatment/feed pump requirements; concentrate disposal.

! Lime softening uses $Ca(OH)_2$ in sufficient quantity to raise the pH to about 10 to precipitate carbonate hardness and heavy metals, like Ra. Benefits: lower capital costs; proven and reliable. Limitations: operator care required with chemical usage; sludge disposal.

! Coagulation and filtration uses the conventional treatment processes of chemical addition, coagulation, and dual media filtration. Benefits: low capital costs for proven, reliable process. Limitations: operator care required with chemical usage; sludge disposal.

B. Alternative Methods of Treatment: Distillation heats water until it turns to steam. The steam travels through a condenser coil where it is cooled and returned to liquid. The dissolved solids (radionuclides) remain in the boiler section. Distillation is not effective for Rn gas.

C. Safety and Health Requirements for Treatment Processes: Personnel involved with demineralization treatment processes should be aware of the chemicals being used (MSDS information), the electrical shock hazards, and the hydraulic pressures required to operate the equipment. General industry safety, health, and self protection practices should be followed, including proper use of tools.

3. BAT PROCESS DESCRIPTION AND COST DATA

General Assumptions: Refer to: Raw Water Composition Fact Sheet for ionic concentrations; and Cost Assumptions Fact Sheet for cost index data and process assumptions. All costs are based on *ENR*, PPI, and BLS cost indices for March 2001. General sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal are not included.

3A. Air Stripping for Rn Removal:

Process - AS is a physical separation process. Packed tower AS may use a tall, cylindrical tower filled with packing material. Water enters the top of the tower and is sprayed over the packing material exposing a thin layer of water to the countercurrent air being blown in at the bottom of the tower. The process maximizes the surface area of the water and allows for mass transfer of the Rn from water into air. Maximum volatilization occurs when the water is evenly distributed and the countercurrent air is evenly applied, even when a load change occurs. Treated water exits the bottom of the tower, while air containing the volatilized contaminants is vented to atmosphere or treated by vapor phase GAC. Air emissions above Clean Air Act standards must be treated prior to release. A variety of packing materials are available, or plastic elements may be used in place of packing material. Auxiliary equipment can include: automated controls and level switches or safety features such as differential pressure monitors. Alternate types of ASs include: aeration tanks, spray aeration, shallow trays, columns filled with chemical resistant ellipsoids, or cascade-type internal components.

Vapor phase GAC is similar to liquid phase GAC. It uses extremely porous carbon media in a process known as adsorption. As air passes through the highly porous media which has an extremely high surface area for adsorption, the volatilized contaminants adsorb on the solid surface. The treated air is discharged directly to the atmosphere. Careful selection of type of carbon to be used is based on the contaminants in the air, and manufacturer's recommendations.

Pretreatment - Chlorination and dechlorination for routine cleaning of scale, slime, and clogging may be required. With high TSS waters, prefiltration may be required.

Posttreatment - Postdisinfection of AS effluent may be required. Polishing of AS off-gas may be required.

Maintenance - Careful monitoring and testing to ensure contaminant removal. Packed tower ASs are subject to chemical/physical scaling of the equipment as a result of hardness or sliming of the packing material due biological growth. Regular replacement of vapor phase carbon media is required and is based on contaminant type, concentration, rate of water usage, and type of carbon used.

Waste Disposal - When large amounts of raw water with high levels of radioactive materials are treated for sufficiently long periods of time, the waste products can become radioactive enough to cause concern about safe and legal disposal. Waste products (i.e. GAC and cleaning solutions) require disposal in accordance with local or state regulations. The USEPA guidance entitled *Suggested Guidelines for Disposal of Drinking Water Treatment Wastes Containing Radioactivity*, dated June 1994, provides disposal information. Costs associated with waste disposal should be considered significant.

Advantages -

- ! Well established.
- ! Rn readily escapes from water into air.
- ! Low air/water ratios are sufficient which leads to lower O&M requirements and costs.
- ! Packed towers are more effective, but tray configurations are less susceptible to fouling and are easier to clean.

Disadvantages -

- ! Requires design by knowledgeable, experienced individual with specifics on water flow rate, air-to-water ratio, influent concentrations, water temperature, and atmospheric pressure. Design is based on Henry's Law Constant, which describes the relation between the distribution of a substance in the liquid and the gas phases where ideal conditions exist. Computer programs are available to assist with modeling, and most manufacturer's have programs for modeling their specific equipment.
- ! Risks associated with the off-gassed Rn.
- ! Fouling potential from the precipitation of Mn and Fe oxides.
- ! Risks of increases of Pb and Cu in some tap water due to increases in corrosivity of treated water.

Costs - The application of AS is extremely site specific. The costs of the equipment and operation and maintenance are based on the site specific organics and Rn concentrations. Because the organics and Rn concentrations vary greatly from location to location, a typical raw water analysis on which to base generic costs is impractical. For these reasons generic costs are not provided.

3B. Granular Activated Carbon for Rn Removal:

Process - GAC uses extremely porous carbon media in a process known as adsorption. As water passes through the highly porous media which has an extremely high surface area for adsorption, the dissolved contaminants adsorb on the solid surface. GAC is made of tiny clusters of carbon atoms stacked upon one another. The carbon media is produced by heating the carbon source (generally activated charcoal) in the absence of air to produce a high carbon material. The carbon media is activated by passing oxidizing gases through the material at extremely high temperatures. The activation process produces the pores that result in such high adsorption properties. The adsorption process depends on the following factors: 1) physical properties of the GAC, such as type of raw carbon, method of activation, pore size distribution, and surface area; 2) the chemical/electrical nature of the carbon source or method of activation, and the amount of oxygen and hydrogen associated with them, such that as the carbon surfaces become filled the more actively adsorbed contaminants will displace the less actively adsorbed ones; 3) chemical composition and concentration of contaminants, such as size, similarity, and concentration; 4) the temperature and pH of the water, adsorption usually increases as temperature and pH decrease; and 5) the flowrate and exposure time to the GAC, in that low contaminant concentration and flowrate with extended contact times increase the carbon's life. GAC devices include: pour-through for treating small volumes; faucet-mounted (with or without by-pass) for single point use; in-line (with or without by-pass) for treating large volumes at several faucets; and high-volume commercial units for treating community water supply systems. Careful selection of type of carbon to be used is based on the contaminants in the water, and manufacturer's recommendations.

Pretreatment - With bacterially unstable waters, filtration and disinfection prior to carbon treatment may be required. With high TSS waters, prefiltration may be required.

Maintenance - Careful monitoring and testing to ensure contaminant removal is required. Regular replacement of carbon media is required and is based on contaminant type, concentration, rate of water usage, and type of carbon used. The manufacturer's recommendations for media replacement should be consulted. Recharging by backwashing or flushing with hot water (145°F) may release the adsorbed Rn gas and any organic chemicals. With bacterially unstable waters, monitoring for bacterial growth is required because the adsorbed organic chemicals are a food source for some bacteria. Flushing is required if the carbon filter is not used for several days, and regular backwashing may be required to prevent bacterial growth. Perform system pressure and flowrate checks to verify backwashing capabilities. Perform routine maintenance checks of valves, pipes, and pumps.

Waste Disposal - When large amounts of raw water with high levels of radioactive materials are treated for sufficiently long periods of time, the waste products can become radioactive enough to cause concern about safe and legal disposal. Waste products (i.e. GAC, backwash water, and cleaning solutions) require disposal in accordance with local or state regulations. The USEPA guidance entitled *Suggested Guidelines for Disposal of Drinking Water Treatment Wastes Containing Radioactivity*, dated June 1994, provides disposal information. As a result of the wide variances in local and state laws, the costs presented below do not address waste disposal. However, costs associated with waste disposal should be considered significant. Disposal of spent GAC may be offered by the contractor providing the media replacement services.

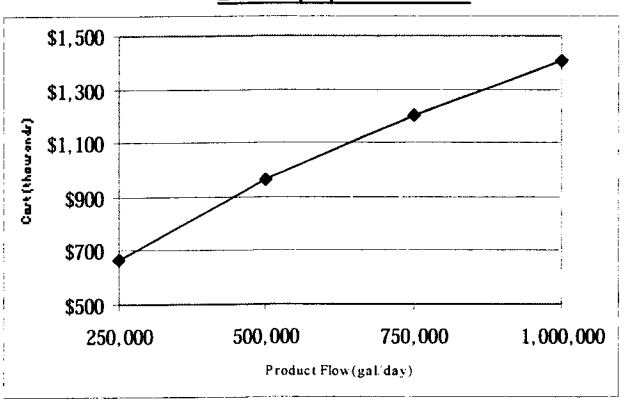
Advantages -

- ! Well established.
- ! Suitable for small systems, or even home use, providing disposal of spent carbon can be addressed.
- ! Typically inexpensive, with simple filter replacement requirements.
- ! Improves taste and smell; removes chlorine.

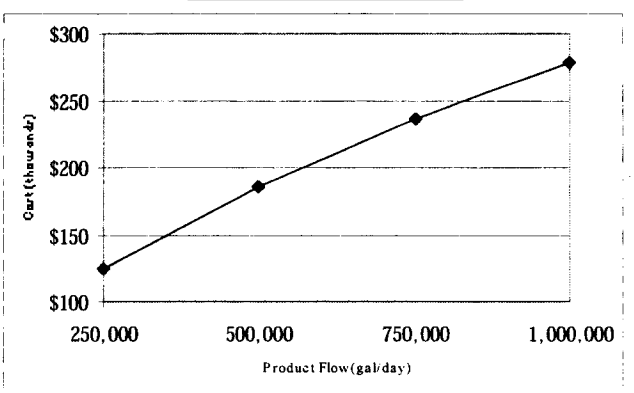
Disadvantages -

- ! Too expensive for large systems.
- ! Susceptible to sudden removal-efficiency drop-offs.
- ! Bacteria may grow on carbon surface.
- ! Adequate water flow and pressure required for backwashing/flushing.
- ! Requires careful monitoring and disposal of spent carbon.
- ! Less effective than aeration.

BAT Equipment Cost*



BAT Annual O&M Cost*



*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal.

3C-a. Anion Ion Exchange for U Removal:

Process - Anion IX is a reversible chemical process in which ions from an insoluble, permanent, solid resin bed are exchanged for ions in water. The process relies on the fact that water solutions must be electrically neutral, therefore ions in the resin bed are exchanged with ions of similar charge in the water. As a result of the exchange process, no reduction in ions is obtained. IX operation for U removal begins with a fully recharged resin bed, having enough Cl^- or OH^- ions to carry out the anion exchange. Usually a polymer resin bed is composed of millions of medium sand grain size, spherical beads. As water passes through the resin bed, the negatively charged Cl^- or OH^- ions are released into the water, being substituted or replaced with the soluble, negatively charged U compounds in the water (ion exchange). When the resin becomes exhausted of Cl^- ions, the bed must be regenerated by passing a strong, usually NaCl (or KCl), solution over the resin bed, displacing the negatively charged U compounds with Cl^- ions. Current resins are not compound selective and may remove other anions before removing negatively charged U compounds. Therefore IX requires careful consideration of the raw water characteristics. Typically, IX for negatively charged U compounds utilizes a Cl^- or OH^- strongly basic anion resin bed.

Pretreatment - Guidelines are available on accepted limits for pH, organics, turbidity, and other raw water characteristics. Pretreatment may be required to reduce excessive amounts of TSS which could plug the resin bed, and typically includes media or carbon filtration.

Maintenance - The IX resin requires regular regeneration, the frequency of which depends on raw water characteristics and the U concentration. Preparation of the NaCl solution is required. If utilized, filter replacement and backwashing will be required.

Waste Disposal - When large amounts of raw water with high levels of radioactive materials are treated for sufficiently long periods of time, the waste products can become radioactive enough to cause concern about safe and legal disposal. Waste products (i.e. resin, backwash water, and cleaning solutions) require disposal in accordance with local or state regulations. The USEPA guidance entitled *Suggested Guidelines for Disposal of Drinking Water Treatment Wastes Containing Radioactivity*, dated June 1994, provides disposal information. As a result of the wide variances in local and state laws, the costs presented below do not address waste disposal. However, costs associated with waste disposal should be considered significant.

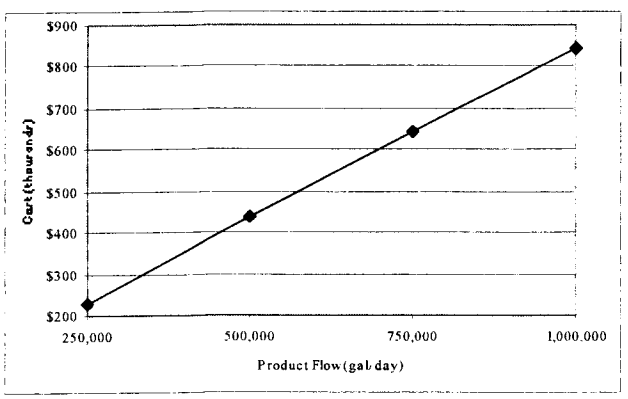
Advantages -

- ! Ease of operation; highly reliable.
- ! Lower initial cost; resins will not wear out with regular regeneration.
- ! Effective; widely used.
- ! Suitable for small and large installations.
- ! Variety of specific resins are available for removing specific contaminants.

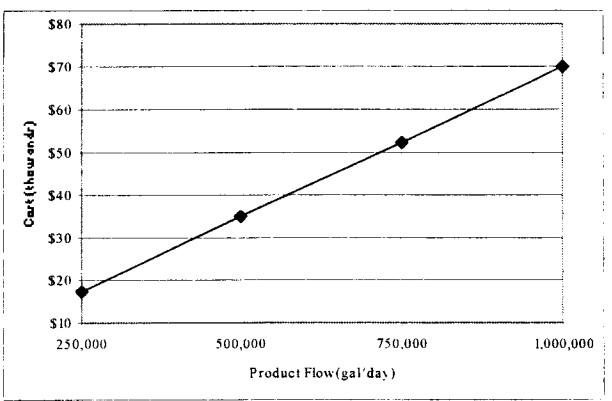
Disadvantages -

- ! Requires salt storage.
- ! Strongly basic anion resins are susceptible to organic fouling; reduced life; thermodynamically unstable.
- ! Usually not feasible with high levels of TDS.
- ! Resins are sensitive to the presence of competing ions.

BAT Equipment Cost*



BAT Annual O&M Cost*



*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal.

3C-b. Cation Ion Exchange for Ra Removal:

Process - Cation IX is a reversible chemical process in which ions from an insoluble, permanent, solid resin bed are exchanged for ions in water. The process relies on the fact that water solutions must be electrically neutral, therefore ions in the resin bed are exchanged with ions of similar charge in the water. As a result of the exchange process, no reduction in ions is obtained. IX operation for Ra removal begins with a fully recharged resin bed, having enough Na^+ or K^+ ions to carry out the cation exchange. Usually a polymer resin bed is composed of millions of medium sand grain size, spherical beads. As water passes through the resin bed, the negatively charged Na^+ ions are released into the water, being substituted or replaced with the soluble, positively charged Ra compounds in the water (ion exchange). When the resin becomes exhausted of Na^+ ions, the bed must be regenerated by passing a strong, usually NaCl (or KCl), solution over the resin bed, displacing the positively charged Ra compounds with Na^+ ions. Current resins are not compound selective and may remove other cations before removing positively charged Ra compounds. Therefore IX requires careful consideration of the raw water characteristics. Typically, IX for positively charged Ra compounds utilizes a Cl^- or OH^- strongly acid cation resin bed.

Pretreatment - Guidelines are available on accepted limits for pH, organics, turbidity, and other raw water characteristics. Pretreatment may be required to reduce excessive amounts of TSS which could plug the resin bed, and typically includes media or carbon filtration.

Maintenance - Depending on raw water characteristics and Ra concentration, the resin will require regular regeneration with a NaCl solution. Preparation of the NaCl solution is required. If utilized, filter replacement and backwashing will be required.

Waste Disposal - When large amounts of raw water with high levels of radioactive materials are treated for sufficiently long periods of time, the waste products can become radioactive enough to cause concern about safe and legal disposal. Waste products (i.e. resin, backwash water, and cleaning solutions) require disposal in accordance with local or state regulations. The USEPA guidance entitled *Suggested Guidelines for Disposal of Drinking Water Treatment Wastes Containing Radioactivity*, dated June 1994, provides disposal information. As a result of the wide variances in local and state laws, the costs presented below do not address waste disposal. However, costs associated with waste disposal should be considered significant.

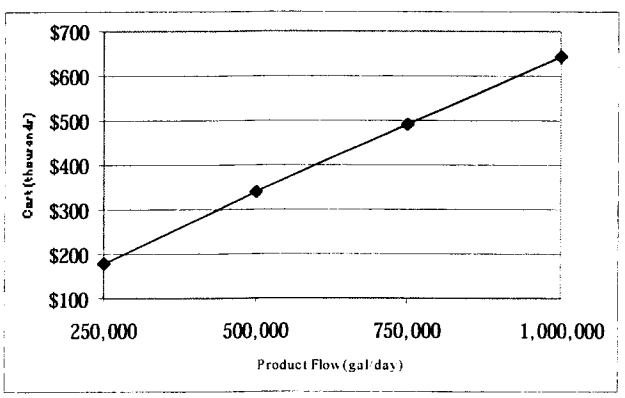
Advantages -

- ! Ease of operation; highly reliable.
- ! Lower initial cost; resins will not wear out with regular regeneration.
- ! Effective; widely used.
- ! Suitable for small and large installations.
- ! Variety of specific resins are available for removing specific contaminants.

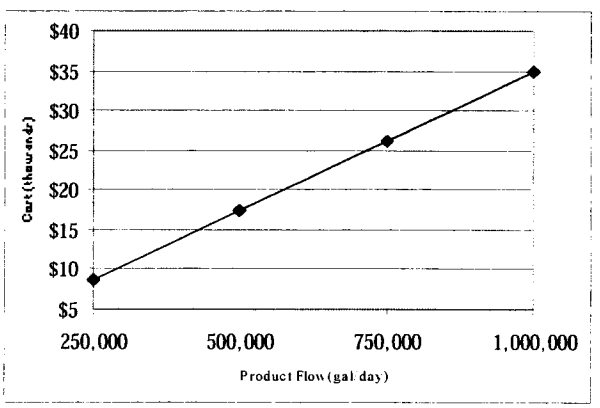
Disadvantages -

- ! Requires salt storage.
- ! Usually not feasible with high levels of TDS.
- ! Resins are sensitive to the presence of competing ions.

BAT Equipment Cost*



BAT Annual O&M Cost*



*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal.

3C-c. Mixed Bed Ion Exchange for β Removal:

Process - Mixed bed IX is a reversible chemical process in which ions from an insoluble, permanent, solid resin bed are exchanged for ions in water. The process relies on the fact that water solutions must be electrically neutral, therefore ions in the resin bed are exchanged with ions of similar charge in the water. As a result of the exchange process, no reduction in ions is obtained. IX operation for Gross Beta (β) Particle Activity and Photon Emitter removal begins with a fully recharged resin bed, having enough positive and negative ions to carry out the cation and anion exchange. Usually a polymer resin bed is composed of millions of medium sand grain size, spherical beads. As water passes through the resin bed, the negatively charged Na^+ or Cl^- ions are released into the water, being substituted or replaced with the soluble, positively or negatively charged β compounds in the water (ion exchange). When the resin becomes exhausted of Na^+ or Cl^- ions, the bed must be regenerated by passing a strong, usually NaCl (or KCl), solution over the resin bed, displacing the positively or negatively charged β compounds with Na^+ or Cl^- ions. Current resins are not compound selective and may remove other cations/anions before removing positively/negatively charged β compounds. Therefore IX requires careful consideration of the raw water characteristics. Typically, IX for β compounds utilizes a mixed Na^+ and Cl^- strongly acid/basic cation/anion resin bed.

Pretreatment - Guidelines are available on accepted limits for pH, organics, turbidity, and other raw water characteristics. Pretreatment may be required to reduce excessive amounts of TSS which could plug the resin bed, and typically includes media or carbon filtration.

Maintenance - Depending on raw water characteristics and β concentration, the resin will require regular regeneration with a NaCl solution. Preparation of the NaCl solution is required. If utilized, filter replacement and backwashing will be required.

Waste Disposal - When large amounts of raw water with high levels of radioactive materials are treated for sufficiently long periods of time, the waste products can become radioactive enough to cause concern about safe and legal disposal. Waste products (i.e. resin, backwash water, and cleaning solutions) require disposal in accordance with local or state regulations. The USEPA guidance entitled *Suggested Guidelines for Disposal of Drinking Water Treatment Wastes Containing Radioactivity*, dated June 1994, provides disposal information. As a result of the wide variances in local and state laws, the costs presented below do not address waste disposal. However, costs associated with waste disposal should be considered significant.

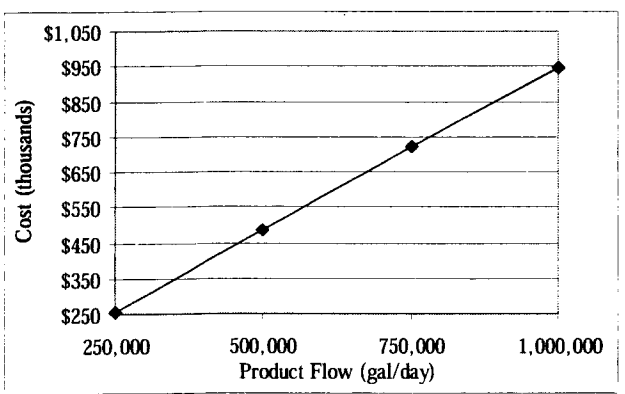
Advantages -

- ! Ease of operation; highly reliable.
- ! Lower initial cost; resins will not wear out with regular regeneration.
- ! Effective; widely used.
- ! Suitable for small and large installations.
- ! Variety of specific resins are available for removing specific contaminants.

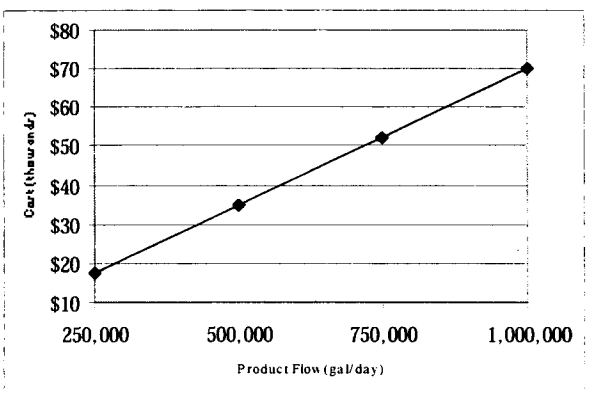
Disadvantages -

- ! Requires salt storage.
- ! Usually not feasible with high levels of TDS.
- ! Resins are sensitive to the presence of competing ions.

BAT Equipment Cost*



BAT Annual O&M Cost*



*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal.

3D. Reverse Osmosis for U, α, β, and Ra Removal:

Process - RO is a physical process in which contaminants are removed by applying pressure on the feed water to direct it through a semipermeable membrane. The process is the "reverse" of natural osmosis (water diffusion from dilute to concentrated through a semipermeable membrane to equalize ion concentration) as a result of the applied pressure to the concentrated side of the membrane, which overcomes the natural osmotic pressure. RO membranes reject ions based on size and electrical charge. The raw water is typically called feed; the product water is called permeate; and the concentrated reject is called concentrate. Common RO membrane materials include asymmetric cellulose acetate or polyamide thin film composite. Common membrane construction includes spiral wound or hollow fine fiber. Each material and construction method has specific benefits and limitations depending upon the raw water characteristics and pretreatment. A typical large RO installation includes a high pressure feed pump, parallel 1st and 2nd stage membrane elements (in pressure vessels); valving; and feed, permeate, and concentrate piping. All materials and construction methods require regular maintenance. Factors influencing membrane selection are cost, recovery, rejection, raw water characteristics, and pretreatment. Factors influencing performance are raw water characteristics, pressure, temperature, and regular monitoring and maintenance.

Pretreatment - RO requires a careful review of raw water characteristics and pretreatment needs to prevent membranes from fouling, scaling, or other membrane degradation. Removal of suspended solids is necessary to prevent colloidal and bio-fouling, and removal of dissolved solids is necessary to prevent scaling and chemical attack. Large installation pretreatment can include media filters to remove suspended particles; ion exchange softening or antiscalant to remove hardness; temperature and pH adjustment to maintain efficiency; acid to prevent scaling and membrane damage; activated carbon or bisulfite to remove chlorine (postdisinfection may be required); and cartridge (micro) filters to remove some dissolved particles and any remaining suspended particles.

Maintenance - Monitor rejection percentage to ensure U and Ra removal below MCL. Regular monitoring of membrane performance is necessary to determine fouling, scaling, or other membrane degradation. Use of monitoring equations to track membrane performance is recommended. Acidic or caustic solutions are regularly flushed through the system at high volume/low pressure with a cleaning agent to remove fouling and scaling. The system is flushed and returned to service. $NaHSO_3$ is a typical caustic cleaner. RO stages are cleaned sequentially. Frequency of membrane replacement dependent on raw water characteristics, pretreatment, and maintenance.

Waste Disposal - When large amounts of raw water with high levels of radioactive materials are treated for sufficiently long periods of time, the waste products can become radioactive enough to cause concern about safe and legal disposal. Waste products (i.e. filters, elements, backwash water, and cleaning solutions) require disposal in accordance with local or state regulations. The USEPA guidance entitled *Suggested Guidelines for Disposal of Drinking Water Treatment Wastes Containing Radioactivity*, dated June 1994, provides disposal information. As a result of the wide variances in local and state laws, the costs presented below do not address waste disposal. However, costs associated with waste disposal should be considered significant.

Advantages -

! Produces highest water quality.

! Can effectively treat wide range of dissolved salts and minerals, turbidity, health and aesthetic contaminants, and certain organics; some highly-maintained units are capable of treating biological contaminants.

! Low pressure (<100 psi), compact, self-contained, single membrane units are available for small installations.

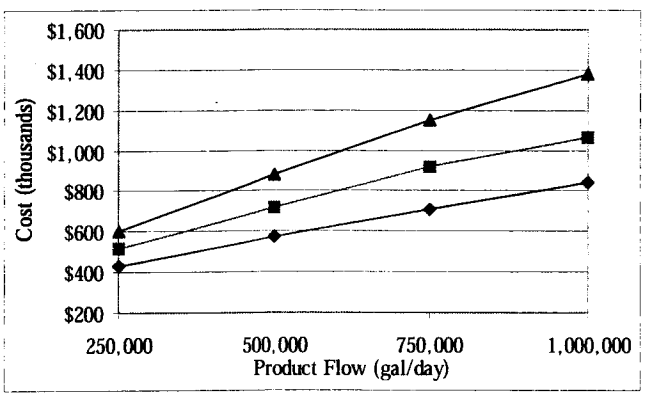
Disadvantages -

! Relatively expensive to install and operate.

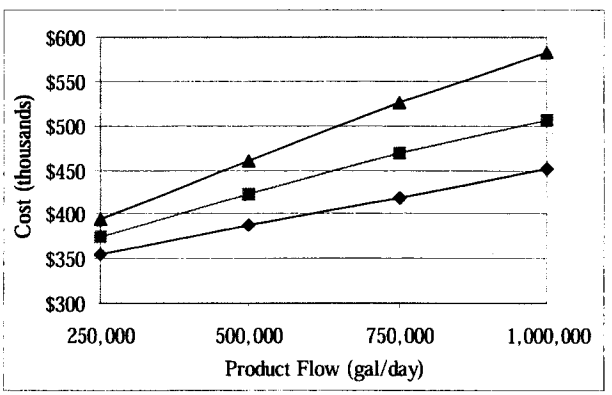
! Frequent membrane monitoring and maintenance; monitoring of rejection percentage for U and Ra removal.

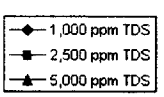
! Pressure, temperature, and pH requirements to meet membrane tolerances. May be chemically sensitive.

BAT Equipment Cost*



BAT Annual O&M Cost*





*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal.

3E. Lime Softening for U and Ra Removal:

Process - Lime softening uses chemical additions followed by an upflow SCC to accomplish coagulation, flocculation, and clarification. Chemical additions include $Ca(OH)_2$ to precipitate carbonate and Na_2CO_3 to precipitate noncarbonate hardness. In the upflow SCC, coagulation, flocculation (agglomeration of the suspended material, including U and Ra, into larger particles), and final clarification occur. In the upflow SCC, the clarified water flows up and over the weirs, while the settled particles are removed by pumping or other collection mechanisms (i.e. filtration).

Pretreatment - Jar tests to determine optimum pH for coagulation, and resulting pH adjustment, may be required. Optimum pH is about 10.5 or higher.

Maintenance - A routine check of chemical feed equipment is necessary several times during each work period to prevent clogging and equipment wear, and to ensure adequate chemical supply. All pumps, valves, and piping must be regularly checked and cleaned to prevent buildup of carbonate scale, which can cause plugging and malfunction. Similar procedures also apply to the sludge disposal return system, which takes the settled sludge from the bottom of the clarifier and conveys it to the dewatering and disposal processes.

Waste Disposal - When large amounts of raw water with high levels of radioactive materials are treated for sufficiently long periods of time, the waste products can become radioactive enough to cause concern about safe and legal disposal. Waste products (i.e. sludge and cleaning solutions) require disposal in accordance with local or state regulations. The USEPA guidance entitled *Suggested Guidelines for Disposal of Drinking Water Treatment Wastes Containing Radioactivity*, dated June 1994, provides disposal information. As a result of the wide variances in local and state laws, the costs presented below do not address waste disposal. However, costs associated with waste disposal should be considered significant.

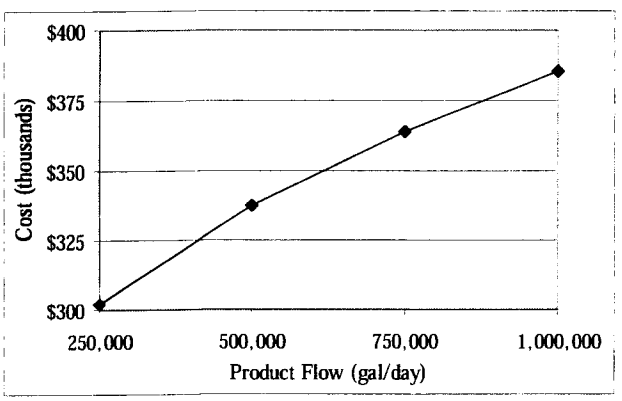
Advantages -

- ! Other heavy metals are also precipitated; reduces corrosion of pipes.
- ! Proven and reliable.
- ! Low pretreatment requirements.

Disadvantages -

- ! Operator care required with chemical handling.
- ! Produces high U and Ra-contaminated sludge volume.
- ! Sulfate may cause significant interference with removal efficiencies.

BAT Equipment Cost*



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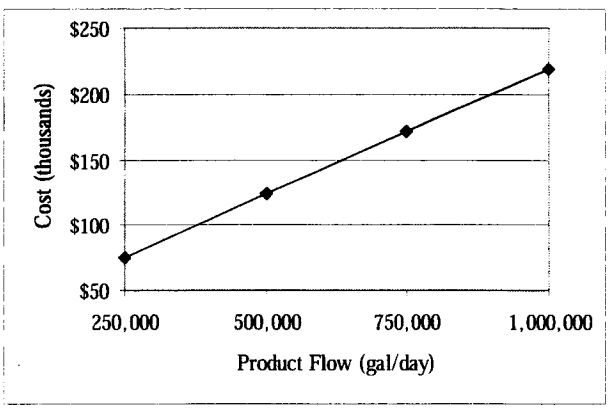


*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal.

3F. Coagulation and Filtration for U Removal:

Process - Coagulation and filtration for uses the conventional chemical and physical treatment processes of chemical addition, rapid mix, coagulation with dry alum, flocculation, and dual media filtration. Chemical coagulation and flocculation consists of adding a chemical coagulant combined with mechanical flocculation to allow fine suspended and some dissolved solids to clump together (floc). $Al_2(SO_4)_3$ has been proven to be the most effective coagulant for U removal. Filtration provides final removal by dual media filtering of all floc and suspended solids.

Pretreatment - Jar tests to determine optimum pH for coagulation, and resulting pH adjustment, may be required.

Maintenance - A routine check of chemical feed equipment is necessary several times during each work period to prevent clogging and equipment wear, and to ensure adequate chemical supply. All pumps, valves, and piping must be regularly checked and cleaned to prevent buildup of carbonate scale, which can cause plugging and malfunction. Routine checks of contaminant buildup in the filter is required, as well as filter backwash. Recharging or clean installation of media is periodically required.

Waste Disposal - When large amounts of raw water with high levels of radioactive materials are treated for sufficiently long periods of time, the waste products can become radioactive enough to cause concern about safe and legal disposal. Waste products (i.e. media, backwash water, and cleaning solutions) require disposal in accordance with local or state regulations. The USEPA guidance entitled *Suggested Guidelines for Disposal of Drinking Water Treatment Wastes Containing Radioactivity*, dated June 1994, provides disposal information. As a result of the wide variances in local and state laws, the costs presented below do not address waste disposal. However, costs associated with waste disposal should be considered significant.

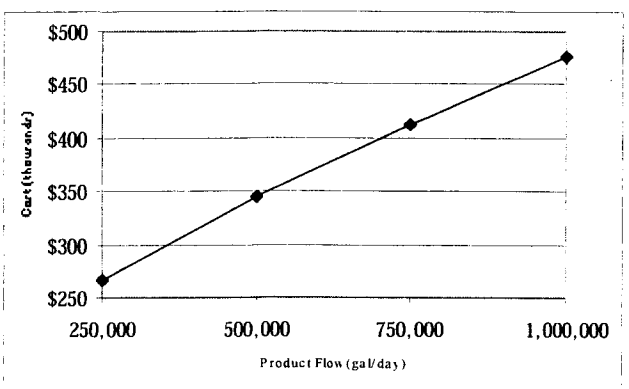
Advantages -

- ! Lowest capital costs.
- ! Lowest overall operating costs.
- ! Proven and reliable.
- ! Low pretreatment requirements.

Disadvantages -

- ! Operator care required with chemical handling.
- ! Produces high sludge volume.
- ! Sulfate may cause significant interference with removal efficiencies.

BAT Equipment Cost*



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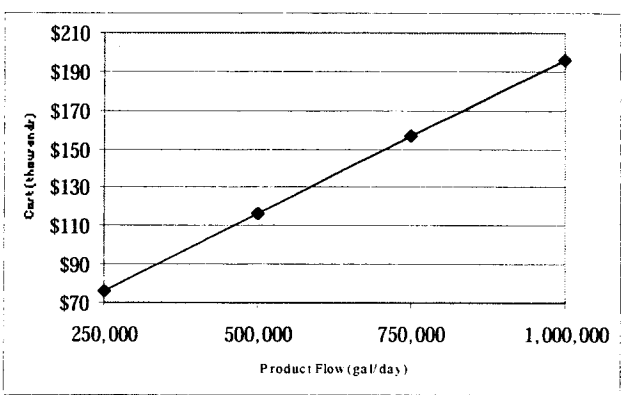

*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal. Costs are presented for direct filtration (coagulation and flocculation plus filtration). Costs for coagulation and filtration would be less since flocculation is omitted.

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Material Safety Data Sheets Collection:
Sheet No. 317
Toluene
Issued: 8/79 Revision: E, 9/92 Errata: 2/94

Section 1. Material Identification

Toluene ($C_6H_5CH_3$) Description: Derived from petroleum i.e., dehydrogenation of cycloparaffin fractions followed by the aromatization of saturated aromatic hydrocarbons or by fractional distillation of coal-tar light oil and purified by rectification. Used widely as a solvent (replacing benzene in many cases) for oils, resins, adhesives, natural rubber, coal tar, asphalt, pitch, acetyl celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharine, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solution for navigational instruments.

R 1
I 3
S 2*
K 3
* Skin absorption

NFPA

Other Designations: CAS No. 108-88-3, Methacide, methylbenzene, methylbenzol, phenylmethane, toluol, Tolu-sol.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

HMIS
H 2- Chronic effects
F 3
R 0
PPE-Sec. 8

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high centrations. Liver and kidney damage has occurred. Pregnant women chronically exposed to toluene have shown teratogenic effects. Toluene is highly flammable.

Section 2. Ingredients and Occupational Exposure Limits

Toluene, < 100%; may contain a small amount of benzene (~ 1%), xylene, and nonaromatic hydrocarbons.

1991 OSHA PELs
8-hr TWA: 100 ppm (375 mg/m^3)
15-min STEL: 150 ppm (560 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH RELs
TWA: 100 ppm (375 mg/m^3)
STEL: 150 ppm (560 mg/m^3)

1992-93 ACGIH TLV (Skin)
TWA: 50 ppm (188 mg/m^3)

1990 DFG (Germany) MAK*
TWA: 100 ppm (380 mg/m^3)
Half-life: 2 hr to end of shift
Category II: Substances with systemic effects
Peak Exposure Limit: 500 ppm, 30 min average value, 2/shift

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: 100 ppm caused hallucinations, and changes in motor activity and changes in psychophysiological tests.
Human, oral, LD_{Lo}: 50 mg/kg; toxic effects not yet reviewed
Human, eye: 300 ppm caused irritation.
Rat, oral, LD_{50}: 5000 mg/kg
Rat, liver: 30 µmol/L caused DNA damage.

* Available information suggests damage to the developing fetus is probable.
†See NIOSH, *RTECS* (XS5250000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 232 °F (110.6 °C)
Melting Point: -139 °F (-95 °C)
Molecular Weight: 92.15
Density: 0.866 at 68 °F (20/4 °C)
Surface Tension: 29 dyne/cm at 68 °F (20 °C)
Viscosity: 0.59 cP at 68 °F (20 °C)
Refraction Index: 1.4967 at 20 °C/D

Water Solubility: Very slightly soluble, 0.6 mg/L at 68 °F (20 °C)
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.
Vapor Pressure: 22 mm Hg at 68 °F (20 °C); 36.7 mm Hg at 86 °F (30 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0797 lb/ft^3 or 1.2755 kg/m^3
Odor Threshold (range of all referenced values): 0.021 to 69 ppm

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

Flash Point: 40 °F (4.4 °C) CC	**Autoignition Temperature:** 896 °F (480 °C)	**LEL:** 1.27% v/v	**UEL:** 7.0% v/v

Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Water spray may be ineffective as toluene floats on water and may actually spread fire. **Unusual Fire or Explosion Hazards:** Concentrated vapors are heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toluenes' burning rate = 5.7 mm/min and its flame speed = 37 cm/sec. Vapor poses an explosion hazard indoors, outdoors, and in sewers. May accumulate static electricity. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Apply cooling water to sides of tanks until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Toluene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can't occur. **Chemical Incompatibilities:** Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetroxide, silver perchlorate, bromine trifluoride, tetranitromethane, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione. **Conditions to Avoid:** Contact with heat, ignition sources, or incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of toluene can produce carbon dioxide, and acrid, irritating smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list toluene as a carcinogen. **Summary of Risks**: Toluene is irritating to the eyes, nose, and respiratory tract. Inhalation of high concentrations produces a narcotic effect sometimes leading to coma as well as liver and kidney damage. 93% of inhaled toluene is retained in the body of which 80% is metabolized to benzoic acid, then to hippuric acid and excreted in urine. The remainder is metabolized to *o*-cresol and excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is synergistic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 mg/cm^2/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due to its lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leucopenia with biopsy showing bone marrow hypo-plasia. These reports are few and some authorities argue that the effects may have been due to benzene contaminants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction, attentional deficits, developmental delay + language impairment, growth retardation, and physical defects including a small midface, short palpebral fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that toluene causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on next page

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** CNS, liver, kidney, skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Acute Effects:** Vapor inhalation causes respiratory tract irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, parasthesis, and vertigo progressing to narcotic coma. Death may result from cardiac arrest due to ventricular fibrillation with catecholamines loss. Liquid splashed in the eye causes conjunctival irritation, transient corneal damage and possible burns. Prolonged skin contact leads to drying and fissured dermatitis. Ingestion causes GI tract irritation and symptoms associated with inhalation. **Chronic Effects:** Symptoms include mucous membrane irritation, headache, vertigo, nausea, appetite loss and alcohol intolerance. Repeated heavy exposure may result in encephalopathies (cerebellar ataxia and cognitive dysfunction), liver enlargement, and kidney dystrophy (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend. **FIRST AID Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of danger of aspiration into the lungs. Gastric lavage may be indicated if large amounts are swallowed; potential toxicity needs to be weighed against aspiration risk when deciding for or against gastric lavage. **Note to Physicians:** Monitor cardiac function. If indicated, use epinephrine and other catecholamines carefully, because of the possibility of a lowered myocardial threshold to the arrhythmogenic effects of such substances. Obtain CBC, electrolytes, and urinalysis. Monitor arterial blood gases. If toluene has > 0.02% (200 ppm) benzene, evaluate for potential benzene toxicity. BEI: hippuric acid in urine, sample at shift end (2.5 g/g creatinine); Toluene in venous blood, sample at shift end (1.0 mg/L).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel protect against inhalation and skin/eye contact. Use water spray to cool and disperse vapors but it may not prevent ignition in closed spaces. Cellosolve, hycar absorbent materials, and fluorocarbon water can also be used for vapor suppression/containment. Take up small spill with earth, sand, vermiculite, or other absorbent, noncombustible material. Dike far ahead of large spills for later reclamation or disposal. For water spills, (10 ppm or greater) apply activated carbon at 10X the spilled amount and remove trapped material with suction hoses or use mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo fluidized bed incineration at 842 to 1796 °F (450 to 980 °C), rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C), or liquid injection incineration at 1202 to 2912 °F (650 to 1600 °C). Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Blue gill, LC_{50} = 17 mg/L/24 hr; shrimp (*Crangonfracis coron*), LC_{50} = 4.3 ppm/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 36.2 mg/L/96 hr. **Environmental Degradation:** If released to land, toluene evaporates and undergoes microbial degradation. In water, toluene volatilizes and biodegrades with a half-life of days to several weeks. In air, toluene degrades by reaction with photochemically produced hydroxyl radicals. **Disposal:** Treat contaminated water by gravity separation of solids, followed by skimming of surface. Pass through dual media filtration and carbon absorption units (carbon ratio 1 kg to 10 kg soluble material). Return waste water from backwash to gravity separator. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U220
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
[* per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307 (a)]
Listed as a SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses with shatter-resistant glass and side-shields or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use any chemical cartridge respirator with appropriate organic vapor cartridges, any supplied-air respirator (SAR), or SCBA. For < 2000 ppm, use any SAR operated in continuous-flow mode, any SAR or SCBA with a full facepiece, or any air-purifying respirator with a full facepiece having a chin-style, front or back mounted organic vapor canister. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol with a breakthrough time of > 8 hr, Teflon and Viton are recommended as suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove toluene from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles. Outside or detached storage is preferred. If stored inside, use a standard flammable liquids warehouse, room, or cabinet. To prevent static sparks, electrically ground and bond all equipment used with toluene. Do not use open lights in toluene areas. Install Class 1, Group D electrical equipment. Check that toluene is free of or contains < 1% benzene before use. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (holes, wells, storage tanks). Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, liver, kidney, and skin. Include hemocytometric and thrombocyte count in cases where benzene is a contaminant of toluene. Monitor air at regular intervals to ensure effective ventilation.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Toluene
DOT Hazard Class: 3
ID No.: UN1294
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 150
b) Non-bulk Packaging: 202
c) Bulk Packaging: 242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
Vessel Stowage: B
Other: --

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 140, 148, 153, 159, 163, 164, 167, 169, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, CIH, MPH; **Medical Review:** AC Darlington, MD, MPH

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Material Safety Data Sheets Collection:

Sheet No. 318
Xylene *(Mixed Isomers)*

Issued: 11/80 Revision: E, 9/92 Errata: 12/94

Section 1. Material Identification

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Xylene (Mixed Isomers) (C_8H_{10}) Description: The commercial product is a blend of the three isomers [*ortho*-(*o*-), *meta*-(*m*-), *para*-(*p*-)] with the largest proportion being *m*- xylene. Xylene is obtained from coal tar, toluene by transalkylation, and pseudocumene. Used in the manufacture of dyes, resins, paints, varnishes, and other organics; as a general solvent for adhesives, a cleaning agent in microscope technique; as a solvent for Canada balsam microscopy; as a fuel component; in aviation gasoline, protective coatings, sterilizing catgut, hydrogen peroxide, perfumes, insect repellants, pharmaceuticals, and the leather industry; in the production of phthalic anhydride, isophthalic, and terephthalic acids and their dimethyl esters which are used in the manufacture of polyester fibers; and as an indirect food additive as a component of adhesives. Around the home, xylene is found as vehicles in paints, paint removers, degreasing cleaners, lacquers, glues and cements and as solvent/vehicles for pesticides.

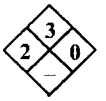
Other Designations: CAS No. 1330-20-7 [95-47-6; 108-38-3; 106-42-3 (*o*-, *m*-, *p*-isomers)], dimethylbenzene, methyltoluene, NCI-C55232, Violet 3, xylol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Xylene is an eye, skin, and mucous membrane irritant and may be narcotic in high concentrations. It is a dangerous fire hazard.

R	1
I	2
S	2
K	3

NFPA



HMIS
H 2†
F 3
R 0
PPE ‡
† Chronic Effects
‡ Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Xylene (mixed isomers): the commercial product generally contains ~ 40% *m*-xylene; 20% each of *o*-xylene, *p*-xylene, and ethylbenzene; and small quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m^3)
15-min STEL: 150 ppm (655 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 100 ppm (435 mg/m^3)
STEL: 150 ppm (655 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 150 ppm (651 mg/m^3)
BEI (Biological Exposure Index): Methylhippuric acids in urine at end of shift: 1.5 g/g creatinine

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category II: Substances with systemic effects
Half-life: < 2 hr
Peak Exposure: 200 ppm, 30 min, average value, 4 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 200 ppm produced olfaction effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.
Man, inhalation, LC_{Lo}: 10000 ppm/6 hr; toxic effects not yet reviewed.
Human, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted.
Rat, oral, LD_{50}: 4300 mg/kg; toxic effect not yet reviewed.
Rat, inhalation, LC_{50}: 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH, *RTECS* (XE2100000), for additional toxicity data.

Section 3. Physical Data

Boiling Point Range: 279 to 284 °F (137 to 140 °C)*
Boiling Point: *ortho:* 291 °F (144 °C); *meta:* 281.8 °F (138.8 °C); *para:* 281.3 °F (138.5 °C)
Freezing Point/Melting Point: *ortho:* -13 °F (-25 °C); *meta:* -53.3 °F (- 47.4 °C); *para:* 55 to 57 °F (13 to 14 °C)
Vapor Pressure: 6.72 mm Hg at 70 °F (21 °C)
Saturated Vapor Density (Air = 1.2 kg/m^3): 1.23 kg/m^3, 0.077 lbs/ft^3
Appearance and Odor: Clear, sweet-smelling liquid.
* Materials with wider and narrower boiling ranges are commercially available.

Molecular Weight: 106.16
Specific Gravity: 0.864 at 20 °C/4 °C
Water Solubility: Practically insoluble
Other Solubilities: Miscible with absolute alcohol, ether, and many other organic liquids.
Octanol/Water Partition Coefficient: logKow = 3.12-3.20
Odor Threshold: 1 ppm
Viscosity: <32.6 SUS

Section 4. Fire and Explosion Data

Flash Point: 63 to 77 °F (17 to 25 °C) CC	**Autoignition Temperature:** 982 °F (527 °C) (*m*-)	**LEL:** 1.1 (*m*-, *p*-); 0.9 (*o*-)	**UEL:** 7.0 (*m*-, *p*-); 6.7 (*o*-)

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective. Use water spray to cool fire-exposed containers. **Unusual Fire or Explosion Hazards:** Xylene vapors or liquid (which floats on water) may travel to an ignition source and flash back. The heat of fire may cause containers to explode and/or produce irritating or poisonous decomposition products. Xylene may present a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may occur from vapor or liquid flow sufficient to cause ignition. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide limited protection. If feasible and without risk, move containers from fire area. Otherwise, cool fire-exposed containers until well after fire is extinguished. Stay clear of tank ends. Use unmanned hose holder or monitor nozzles for massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Xylene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Xylene is easily chlorinated, sulfonated, or nitrated. **Chemical Incompatibilities:** Incompatibilities include strong acids and oxidizers and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidindione (dichlorohydrantoin). Xylene attacks some forms of plastics, rubber, and coatings. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of xylene can produce carbon dioxide, carbon monoxide, and various hydrocarbon products.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list xylene as a carcinogen. **Summary of Risks**: Xylene is an eye, mucous membrane, and respiratory tract irritant. Irritation starts at 200 ppm; severe breathing difficulties which may be delayed in onset can occur at high concentrations. It is a central nervous system (CNS) depressant and at high concentrations can cause coma. Kidney and liver damage can occur with xylene exposure. With prolonged or repeated cutaneous exposure, xylene produces a defatting dermatitis. Chronic toxicity is not well defined, but it is less toxic than benzene. Prior to the 1950s, benzene was often found as a contaminant of xylene and the effects attributed to xylene such as blood dyscrasias are questionable. Since the late 1950s, xylenes have been virtually benzene-free and blood dyscrasias have not been associated with xylenes. Chronic exposure to high concentrations of xylene in animal studies have demonstrated mild reversible decrease in red and white cell counts as well as increases in platelet counts.

Continue on next page

Section 6. Health Hazard Data, *continued*

Menstrual irregularity was reported in association with workplace exposure to xylene perhaps due to effects on liver metabolism. Xylene crosses the human placenta, but does not appear to be teratogenic under conditions tested to date. **Medical Conditions Aggravated by Long-Term Exposure:** CNS, respiratory, eye, skin, gastrointestinal (GI) , liver and kidney disorders. **Target Organs:** CNS, eyes, GI tract, liver, kidneys, and skin. **Primary Entry Routes:** Inhalation, skin absorption (slight), eye contact, ingestion. **Acute Effects:** Inhalation of high xylene concentrations may cause dizziness; nausea, vomiting, and abdominal pain; eye, nose, and throat irritation; respiratory tract irritation leading to pulmonary edema (fluid in lung); drowsiness; and unconsciousness. Direct eye contact can result in conjunctivitis and corneal burns. Ingestion may cause a burning sensation in the oropharynx and stomach and transient CNS depression. **Chronic Effects:** Repeated or prolonged skin contact may cause drying and defatting of the skin leading to dermatitis. Repeated eye exposure to high vapor concentrations may cause reversible eye damage, peripheral and central neuropathy, and liver damage. Other symptoms of chronic exposure include headache, fatigue, irritability, chronic bronchitis, and GI disturbances such as nausea, loss of appetite, and gas.

FIRST AID *Emergency personnel should protect against exposure.* **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and.continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing as it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Monitor exposed person for respiratory distress. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, *do not induce vomiting!* If spontaneous vomiting should occur, keep exposed person's head below the hips to prevent aspiration (breathing liquid xylene into the lungs). *Aspiration of a few millimeters of xylene can cause chemical pneumonitis, pulmonary edema, and hemorrhage.* **Note to Physicians:** Hippuric acid or the ether glucuronide of *ortho*-toluic acid may be useful in diagnosis of *meta-*, *para-* and *ortho*-xylene exposure, respectively. Consider gastric lavage if a large quantity of xylene was ingested. Proceed gastric lavage with protection of the airway from aspiration; consider endotracheal intubation with inflated cuff.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate spill area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If feasible and without undue risk, stop leak. Use appropriate foam to blanket release and suppress vapors. Water spray may reduce vapor, but does not prevent ignition in closed spaces. For small spills, absorb on paper and evaporate in appropriate exhaust hood or absorb with sand or some non-combustible absorbent and place in containers for later disposal. For large spills dike far ahead of liquid to contain. Do not allow xylene to enter a confined space such as sewers or drains. On land, dike to contain or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material with pumps or vacuum equipment. On water, contain material with natural barriers, booms, or weirs; apply universal gelling agent; and use suction hoses to remove spilled material. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** Little bioconcentration is expected. Biological oxygen demand 5 (after 5 days at 20 °C): 0.64 (no stated isomer). **Ecotoxicity values:** LD_{50}, Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer. **Environmental Degradation:** In the atmosphere, xylenes degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1-1.7 hr. in the summer to 10-18 hr in winter or a typical loss of 67-86% per day. Xylenes are resistant to hydrolysis. **Soil Absorption/Mobility:** Xylenes have low to moderate adsorption to soil and when spilled on land, will volatilize and leach into groundwater. **Disposal:** As a hydrocarbon, xylene is a good candidate for controlled incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U239, F003 (spent solvent)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4); per RCRA, Sec. 3001]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations >1000 ppm, use any chemical cartridge respirator with organic vapor cartridges; any powered, air-purifying respirator with organic vapor cartridges; any supplied-air respirator; or any self-contained breathing apparatus. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. With breakthrough times > 8 hr, consider polyvinyl alcohol and fluorocarbon rubber (Viton) as materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in clearly labelled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources. During transferring operations, electrically ground and bond metal containers. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Use hermetically sealed equipment, transfer xylene in enclosed systems, avoid processes associated with open evaporating surfaces, and provide sources of gas release with enclosures and local exhaust ventilation. Use Class I, Group D electrical equipment. **Administrative Controls:** Establish air and biological monitoring programs and evaluate regularly. Consider preplacement and periodic medical examinations including a complete blood count, a routine urinalysis, and liver function tests. Consider hematologic studies if there is any significant contamination of the solvent with benzene. If feasible, consider the replacement of xylene by less toxic solvents such as petrol (motor fuel) or white spirit. Before carrying out maintenance and repair work, steam and flush all equipment to remove any xylene residues.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Xylenes	**Packaging Authorizations**	**Quantity Limitations**	**Vessel Stowage Requirements**
DOT Hazard Class: 3	a) Exceptions: 173.150	a) Passenger, Aircraft, or Railcar: 5L	a) Vessel Stowage: B
ID No.: UN1307	b) Nonbulk Packaging : 173.202	b) Cargo Aircraft Only: 60L	b) Other: –
DOT Packing Group: II	c) Bulk Packaging: 173.242		
DOT Label: Flammable Liquid			
Special Provisions (172.102): T1			

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 176, 180.
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD