

**Remedial Investigation Report
Sites 9, 13, 19, 22, and 23
Operable Unit 2A (OU-2A)**

**Alameda Point
Alameda, California**



DS.B010.20039

FINAL

**Volume I of III
Sections 1 through 11**

April 1, 2005



**Department of the Navy
Base Realignment and Closure
Program Management Office West
1230 Columbia Street, Suite 1100
San Diego, California 92101-8571**

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DRAFT FINAL REMEDIAL INVESTIGATION REPORT
SITES 9, 13, 19, 22, AND 23
Operable Unit 2A (OU-2A)
ALAMEDA POINT
VOLUME I OF III

March 3, 2005



Prepared for

DEPARTMENT OF THE NAVY
Base Realignment and Closure
Program Management Office West
San Diego, California

Prepared by



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March 2, 2005

Ms. Anna Marie Cook
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Dear Ms. Cook:

Subj: DRAFT FINAL REMEDIAL INVESTIGATION REPORT SITES 9, 13, 19, 22, AND 23,
OPERABLE UNIT 2A, ALAMEDA POINT, ALAMEDA, CALIFORNIA

Enclosed for your review the Draft Final Remedial Investigation Report, Sites 9, 13, 19, 22, and 23, Operable Unit 2A, Alameda Point, Alameda, California [March 3, 2005]. This document incorporates the Navy's responses to agency comments that were issued on the Draft Remedial Investigation Report of February 26, 2004.

Based on the Site Management Plan, of February 15, 2005, the OU-2A, Sites 9, 13, 19, 22, and 23 Draft Final RI, was scheduled for submittal on January 31, 2005. Due to an unforeseen incident of the temporary loss of the primary author of this document, this submittal extended 30-days beyond the delivery date. The BRAC Cleanup Team (BCT) was notified of this extenuating circumstance in the January 18, 2005 BCT meeting. In accordance with the Federal Facility Agreement (FFA), the draft final will become final in 30 days from issuance. All due dates of future OU-2A documents would also be extended by 30-days.

If you have any questions or comments, please call Ms. Claudia Domingo at (619) 532-0935, or call me at (619) 532-0907.

Sincerely,

THOMAS L. MACCHIARELLA
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By direction of the Director

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**Subject: Replacement Pages for Final Remedial Investigation Report
Operable Unit-2A, Sites 9, 13, 19, 22, and 23
Alameda Point, Alameda, CA**

Dear Ms. Cook:

Enclosed are replacement cover, back, spine, and title pages for the Final Remedial Investigation Report that were sent out on April 1, 2005. The pages sent previously had the incorrect Navy contract number and document control number. These pages reflect the proper contract number and document control number.

Please call if you have any questions.

Sincerely,



Craig R. Hunter, Ph.D.
Project Manager

Enclosures – (1) set of covers/back, spines, and title page

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- F Total Petroleum Hydrocarbon Screening
- G Solid Waste Management Unit Evaluation for OU-2A
- H Human Health Risk Assessment
- I Ecological Risk Assessment
- J Response to Comments
- K Agency List of Data Gaps

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ACRONYMS AND ABBREVIATIONS

µg/kg	Microgram per kilogram
µg/dL	Microgram per deciliter
µg/L	Microgram per liter
µmhos/cm	Micromhos per centimeter
AIMD	Aircraft Intermediate Maintenance Department
AOC	Area of concern
ARAR	Applicable or relevant and appropriate requirement
Army	U.S. Army
ARRA	Alameda Reuse and Redevelopment Authority
AS	Air sparging
AST	Aboveground storage tank
ATSDR	Agency for Toxic Substances and Disease Registry
BaP	Benzo(a)pyrene
Bay Area	San Francisco Bay Area
BCT	Base Realignment and Closure Cleanup Team
BERC	Berkeley Environmental Restoration Center
bgs	Below ground surface
BRAC	Base Realignment and Closure
BSU	Bay sediment unit
BTAG	Biological Technical Advisory Group
BTEX	Benzene, toluene, ethylbenzene, and total xylenes
CAA	Corrective action area
Cal/EPA	California Environmental Protection Agency
Canonie	Canonie Environmental Services
CAP	Corrective action plan
CBU	Construction Battalion Unit
CCC	Criterion continuous concentration
CDI	Chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action Navy
CLEAN II	Comprehensive Long-term Environmental Action Navy II
CLP	Contract Laboratory Program
CMC	Criteria maximum concentration
COC	Chemicals of concern
COD	Chemical oxygen demand
COE	U.S. Army Corps of Engineers

ACRONYMS AND ABBREVIATIONS (Continued)

COPC	Chemical of potential concern
COPEC	Chemical of potential ecological concern
CPT	Cone penetrometer testing
CSF	Carcinogenic slope factor
CSM	Conceptual site model
CTE	Central tendency exposure
CWA	Clean Water Act
DCA	Dichloroethane
DCE	Dichloroethene
DCN	Document control number
DCP	1,2-Dichloropropane
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethene
DDT	Dichlorodiphenyltrichloroethane
DDTt	Total DDD, DDE, and DDT
DoD	U.S. Department of Defense
DQO	Data quality objective
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
DW	Dry weight
DVE	Dual-phase vacuum extraction
E&E	Ecology and Environment, Inc.
EBS	Environmental Baseline Survey
EDB	Ethylene dibromide
EBMUD	East Bay Municipal Utilities District
EDAW	EDAW, Inc.
EFA West	Naval Facilities Engineering Command, Engineering Field Activity West
EPA	U.S. Environmental Protection Agency
EOD	Explosive ordnance disposal
EPC	Exposure point concentration
ERA	Ecological risk assessment
ERM-West	Environmental Resources Management-West, Inc.
ERV	Ecological reference value
FID	Flame ionization detector
FISC	Fleet and Industrial Supply Center
FOD	Frequency of detection
Foss	Foss Environmental

ACRONYMS AND ABBREVIATIONS (Continued)

FS	Feasibility study
FSP	Field sampling plan
ft ²	Square foot
FW	Fresh weight
FWBZ	First water-bearing zone
FWBZL	Lower first water-bearing zone
FWBZU	Upper first water bearing zone
FWS	U.S. Fish and Wildlife Service
GAP	Generator accumulation point
GI	Gastrointestinal
gpd	Gallons per day
gpm	Gallons per minute
GT	Gehan-Wilcoxon tests
HI	Hazard index
HLA	Harding Lawson Associates
HMW	High molecular weight
HQ	Hazard quotient
HHRA	Human health risk assessment
HSI	Hydro-Search, Inc.
IAS	Initial assessment study
IMF	Intermediate maintenance facility
IR	Installation restoration
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IT	International Technology Corporation
IWTP	Industrial waste treatment plant
JETC	Jet engine test cell
JMM	James M. Montgomery
JP	Jet propellant
kg	Kilogram
K	Hydraulic conductivity
KLI	Kinnetic Laboratories, Inc
K _{ow}	Octanol-water partition coefficient
LMW	Low molecular weight

ACRONYMS AND ABBREVIATIONS (Continued)

MCL	Maximum contaminant level
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
mg/L	Milligram per liter
MLLW	Mean lower low water
msl	Mean sea level
MTBE	Methyl tertiary butyl ether
MW	Montgomery Watson Consulting Engineers
N/A	Not applicable
NA	Not analyzed
NACIP	Navy Assessment and Control of Installation Pollutants
NADEP	Naval Aviation Depot Alameda
NARF	Naval Air Rework Facility
NAS	Naval Air Station
Navy	U.S. Department of the Navy
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	Not detected
NEESA	Naval Energy and Environmental Support Activity
NFA	No further action
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
OEHHA	California Office of Environmental Health Hazard Assessment
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response
OU	Operable unit
OU-2	Operable Unit 2
OWS	Oil water separator
PACFLTAVFAC	Pacific Fleet Audio-Visual Facility
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethylene (tetrachloroethene, perchloroethylene)
PCP	Pentachlorophenol
PIC	Paved invert corrugated iron
PID	Photoionization detector
POL	Petroleum, oil, and lubricant compounds
ppm	Parts per million

ACRONYMS AND ABBREVIATIONS (Continued)

PRC	Preliminary remediation criteria
PRC EMI	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
PVC	Polyvinyl chloride
PWC	Public Works Center
QC	Quality control
QE	Qualitative evaluation
RAB	Restoration Advisory Board
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act
REL	Reference exposure levels
RFA	Resource Conservation and Recovery Act facility assessment
RfC	Reference concentration
RfD	Reference dose
RFI	Resource Conservation and Recovery Act facility investigation
RI	Remedial investigation
RME	Reasonable maximum exposure
RV	Recreational vehicle
RWQCB	San Francisco Bay Regional Water Quality Control Board
Sanborn	Sanborn-Ferris Map Company
SARA	Superfund Amendments and Reauthorization Act
SCAPS	Site Characterization Analysis Penetrometer System
Shaw	Shaw Environmental Inc.
SIMA	Shore Intermediate Maintenance
SQL	Sample quantitation limit
SQUIRTS	Screening Quick Reference Tables
STLC	Soluble threshold limit concentration
SUF	Site use factor
SVE	Soil vapor extraction
SVOC	Semivolatile organic compound
SWBZ	Second water-bearing zone
SWMU	Solid waste management unit
SWRCB	California State Water Resources Control Board
TCA	Trichloroethane (1,1,1-trichloroethane)
TCE	Trichloroethylene (trichloroethene)

ACRONYMS AND ABBREVIATIONS (Continued)

TCLP	Toxicity characteristic leaching procedure
TCP	1,2,3-trichloropropane
TDS	Total dissolved solids
Tetra Tech	Tetra Tech EM Inc.
TOC	Total organic carbon
TPH	Total petroleum hydrocarbons
TPH-d	TPH quantified as diesel
TPH-g	TPH quantified as gasoline
TPH-mo	TPH quantified as motor oil
TRPH	Total recoverable petroleum hydrocarbons
TRV	Toxicity reference value
TRW	Tarry refinery waste
TTPH	Total TPH (sum of all TPH fractions)
U&A	Uribe and Associates, Inc.
UCB	University of California at Berkeley
UCL ₉₅	95 th percentile upper confidence limit on the arithmetic mean
URF	Unit risk factor
UST	Underground storage tank
VOC	Volatile organic compound
WET	Waste extraction test
WRS	Wilcoxon rank sum

EXECUTIVE SUMMARY

In July 1999, Alameda Point was identified as a National Priorities List (NPL) site (U.S. Environmental Protection Agency [EPA] 1999a). As a result, the U.S. Department of the Navy (Navy) is conducting investigations in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Title 42 *United States Code* 9601-9675) at a number of sites at Alameda Point (formerly Naval Air Station [NAS] Alameda), located in Alameda, California. This report presents the approach, results, conclusions, and recommendations of the remedial investigation (RI) conducted for CERCLA Sites 9, 13, 19, 22, and 23, which are a portion of Operable Unit (OU)-2A. EPA Region 9, the California Environmental Protection Agency Department of Toxic Substances Control, and the San Francisco Bay Regional Water Quality Control Board provide regulatory oversight.

Because Alameda Point is listed as a NPL site, CERCLA provides the framework for the RI approach. The approach used to conduct the RI includes the following steps: (1) scoping, (2) environmental investigations, (3) data evaluation, and (4) conclusions and recommendations. During the initial scoping stage of the RI, site histories and available data were used to identify potential sources of contamination, potentially affected media, and data needs at each site. Field investigation methods were selected to meet the data needs established in the scoping process of the RI. An initial conceptual site model (CSM) was refined through an iterative process that involved identifying areas of known or potential releases of chemicals to the environment, conducting environmental investigations, and filling data gaps until the quality and quantity of data for characterization of the nature and extent of contamination and evaluating risk at each site was judged to be sufficient. Overall, the data for Sites 9, 13, 19, 22, and 23 were collected using a biased sampling approach that was phased. With the phased approach, stakeholders were afforded opportunities to provide feedback on the suitability or adequacy of the collected data and the need to collect additional data to identify releases and complete this RI report.

The Navy conducted environmental investigations at Alameda Point in conformance with investigation work plans prepared by the Navy and reviewed by federal and state regulatory agencies. Environmental investigations were conducted under the Installation Restoration Program to meet the data needs established in the scoping process of the RI and identified to address other regulatory requirements (base closure, total petroleum hydrocarbon [TPH], and the Resource Conservation Recovery Act [RCRA]). The investigations are grouped according to four types: CERCLA, environmental baseline survey, TPH, RCRA. Investigation activities consisted of collection of soil, groundwater, and soil gas samples at and around Sites 9, 13, 19, 22, and 23. Data were reviewed to ensure that they met data quality objectives identified for the RI and that adequate data were collected to characterize the nature and extent of contamination and to evaluate risk to human health and the environment at Sites 9, 13, 19, 22, and 23. There is a low potential that a site would be recommended for no further action if it poses a potential risk to human health or the environment.

The process used to evaluate the data in support of the CERCLA risk management process included (1) a site-specific CSM, (2) data quality assessment, (3) a background comparison, (4) a nature and extent evaluation, (5) a fate and transport evaluation, (6) a human health risk assessment (HHRA), and (7) an ecological risk assessment (ERA). The site-specific CSM is a result of refining the initial CSM through an iterative process that involved identifying areas of

known or potential releases of chemicals to the environment, conducting environmental investigations, and filling data gaps. The site-specific CSM is a flow chart that presents the physical features and historical site activities considered the primary sources of contamination; primary, secondary, and tertiary release mechanisms; pathways; exposure pathways; and current and potential future receptors. The background comparison is a statistical process used to determine which metals in soil and groundwater are present at naturally occurring concentrations. The objectives of the evaluation of nature and extent are to characterize the site and present the nature and extent of contamination as defined by the risk assessments. The evaluation is composed of the following components: (1) a presentation of TPH detected at the site, (2) a presentation of the types and concentrations of CERCLA chemicals believed to have been used at the site, and (3) detailed descriptions of those chemicals that demonstrate significant risk to human health or the environment (risk drivers). The objective of the fate and transport evaluation is to determine whether the chemicals driving risk at the sites have migrated or degraded, whether there is a continuing source of contamination, and the likelihood that groundwater or other potential pathways will distribute the contaminants. The fate and transport evaluation also focuses on the risk drivers. The HHRA and ERA estimate potential risks to human health and the environment associated with exposure to chemicals at the site and identify those chemicals associated with the risk.

Human health risk was evaluated for residential, commercial/industrial, and construction worker exposures. According to reuse plans for Alameda Point, commercial/industrial exposure is the most likely future scenario. The residential exposure scenario was evaluated to allow flexibility in implementing the reuse plan (or modifications) at Alameda Point, and because EPA risk assessment guidance (1989) includes a strong preference for evaluation of the residential pathway. Chemicals in soil or groundwater were excluded as chemicals of potential concern (COPC) using the following screening criteria: (1) essential nutrient status, (2) frequency of detection, and (3) the EPA Region 9 residential preliminary remediation goal (PRG) or California-modified PRG. Chemicals considered background were not excluded on this basis, were noted as a part of the COPC selection process to underscore the contribution of background inorganic chemicals to a receptor's incremental risk.

Currently, ecological habitat capable of supporting significant wildlife is not present at the sites; however, exposure pathways for terrestrial receptors were considered potentially complete to provide a conservative estimate of risk. Exposure pathways for aquatic receptors were considered incomplete for the sites because groundwater plumes were not migrating toward or discharging to the San Francisco Bay or Seaplane Lagoon and broken storm-sewer lines were not discharging to surface water. Because these sites have limited habitat, site-specific ecological sampling to support a baseline ERA is not feasible; therefore, a modified screening-level ERA was conducted for the sites. This modified ERA is intended to be a conservative estimate using more realistic exposure parameters for the ecological endpoints defined than would typically be used for a screening ERA. This modified screening-level ERA methodology is consistent with EPA guidance for screening-level and baseline ERAs as well as Navy ERA guidance (EPA 1999d; Navy 1999c). Assessment endpoints included small mammals, passerines, and raptors.

The decision as to whether a feasibility study (FS) is required at any of the OU-2A sites is based primarily on a determination as to whether any CERCLA chemicals are present in soil or groundwater at concentrations that pose a potential risk to human health or the environment.

Potential risk is posed and an FS is necessary if (1) human health risk estimates for chemicals related to site activity exceed risk levels defined in the NCP or (2) chemicals related to site activity are present at levels that would pose significant risk to ecological receptors. The NCP presents a range of "excess upper-bound lifetime cancer risk to an individual of between 1E-06 and 1E-04", which is known as the "risk management range."

For the purposes of this RI, the Navy and the regulatory authorities have agreed that an FS is necessary at any OU-2A site where the total cancer risk exceeds a threshold level of 1E-06, or where the total noncancer hazard index (HI) exceeds 1 and further evaluation indicates that one or more chemicals pose a significant noncancer risk. The decision to require an FS at such sites applies even if such risk is attributed to background concentrations of chemicals such as arsenic, or to polynuclear aromatic hydrocarbons (PAHs) that reside in the dredged materials that were used to construct much of Alameda Point. Also for the purposes of this RI, all individual chemicals that exceed the above risk thresholds or that pose significant risk to the environment are defined as "risk drivers," and they are also defined as chemicals of concern (COC) unless they were found to be present at concentrations that are consistent with background.

Recommendations and conclusions site-specific to Sites 9, 13, 19, 22, and 23 are presented below.

SITE 9

Soil and groundwater at Site 9 are recommended for further evaluation in an FS, as defined under CERCLA, to address risks to residential receptors under the residential (unrestricted reuse) scenario. Total carcinogenic site risk from soil and groundwater to residential receptors (including background) is above the risk management range and an HI of 1. However, carcinogenic risks to residential receptors from exposures to soil are within the risk management range and the noncancer HI from soil is less than 1.

An evaluation of TPH in soil and groundwater also was conducted based on the TPH strategy for Alameda Point (Navy 2001a) (see Appendix F). Based on this evaluation, no further action is warranted under the TPH program for soil at Site 9; further action is warranted for groundwater at Site 9. TPH in groundwater is commingled with other CERCLA contaminants and should be further evaluated under the CERCLA program after the floating petroleum product is removed from the site.

The nature and extent evaluation concluded that most of the chemicals detected across Site 9 are consistent with historical activities (such as paint stripping and defueling) known to occur at the site. The following physical features and site activities were considered likely sources at Site 9:

- Paint stripping within Building 410
- Releases of petroleum fuel from storage and defueling activities near Building 410
- Fill material containing PAHs

Although numerous chemicals were detected at Site 9, some of these chemicals do not pose significant risk as defined by the risk assessments. For the commercial/industrial and construction worker scenarios, the HHRA indicated that the most conservative cancer risks for soil and groundwater (including background) are within the risk management range of 1E-06 and 1E-04. The most conservative HIs were less than 1 for soil and groundwater.

For the residential (unrestricted reuse) scenario, carcinogenic risk from exposure to soil (including background) is within the risk management range, and noncancer risk from soil is less than 1. In addition, the carcinogenic risk from exposure to soil is driven by arsenic, which is attributed to background; therefore, no chemicals of concern (COC) are identified for soil. The carcinogenic risk for groundwater exceeds the risk management range, and the noncancer HI is greater than 1. COCs identified for groundwater are:

- 1,2- Dichloroethene (DCE) (total)
- 1,2- dichloropropane (DCP)
- 1,3-DCP
- 2-Methylnaphthalene
- 1,2,3-Trichloropropane
- 4-Methylphenol
- Antimony
- Arsenic
- Benzo(a)pyrene(BaP)
- Benzene
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Ethylbenzene
- Indeno(1,2,3-cd)pyrene
- Manganese
- Naphthalene
- Pentachlorophenol
- Tetrachloroethene
- Trichloroethene
- Vinyl chloride

Although antimony and arsenic were identified as groundwater risk drivers, they are not COCs because they are attributed to background.

Results of the hazard quotient (HQ) calculations and qualitative evaluations indicate that residual chemicals at Site 9 have very limited potential to affect terrestrial ecological receptors. Based on the HQ calculations and qualitative evaluations and the planned future use of the site, no risks to ecological receptors have been identified that require further evaluation or mitigation.

SITE 13

Soil and groundwater at Site 13 are recommended for further evaluation in an FS, as defined under CERCLA, to address risks to residential receptors under the residential (unrestricted reuse) scenario. Total carcinogenic site risk from soil and groundwater to residential receptors (including background) is above the risk management range and an HI of 1. However, carcinogenic risks to residential receptors from exposures to soil are within the risk management range and the noncancer HI from soil is less than 1. In addition, significant risks from exposures to soil and groundwater are posed by a tarry refinery waste (TRW), which was not addressed in the HHRA, but is known to be present within a portion of Site 13.

An evaluation of TPH in soil and groundwater also was conducted based on the TPH strategy for Alameda Point (Navy 2001a) (see Appendix F). Based on this evaluation, further action is

recommended for TTPH and TPH-associated chemicals present in soil and groundwater within Plume 1 of Site 13 under the TPH program. Further action is recommended for total-TPH and TPH-associated chemicals present in soil and groundwater within Plume 2 of Site 13 under the CERCLA program for commingled contaminants.

The nature and extent evaluation concluded that most chemicals detected at Site 13 are consistent with historical activities known to occur at the site, which included the former oil refinery and aircraft storage, overhaul, and defueling. The following physical features and site activities were considered likely sources at Site 13:

- Former oil refinery activities
- Aboveground storage tanks (AST) 324 through 328
- Building 397 and associated oil water separators (OWS) 397A, 397B, 397D, and 397D
- Fill material containing PAHs

Although numerous chemicals were detected at Site 13, some of these chemicals do not pose significant risk as defined by the risk assessments. For the commercial/industrial and construction worker scenarios, the HHRA indicated that the most conservative cancer risks for soil and groundwater are within the risk management range. The most conservative HIs were less than 1 for soil and groundwater.

For the residential scenario, carcinogenic risk from exposure to soil is within the risk management range and the noncancer HI from soil is less than 1. Benzo(a)pyrene (BaP) is identified as the only COC for soil. Arsenic in soil was identified as a risk driver, but is attributed to background. The carcinogenic risk for groundwater exceeds the risk management range, and the noncancer HI is greater than 1. COCs identified for groundwater are benzene, manganese, PCP, and TCE. Although thallium was identified as a risk driver in groundwater, it is not a COC, because it is attributed to background.

Results of the HQ calculations and qualitative evaluations indicate potential risk to small mammals from zinc. No significant risk to passerines and raptors occurs from exposure to Site 13 soils. However, based on the lack of habitat at Site 13 and the planned future use of the site, no risks to ecological receptors have been identified that require further evaluation or mitigation.

SITE 19

Soil and groundwater at Site 19 are recommended for further evaluation in an FS, as defined under CERCLA, to address risks to residential receptors under the residential (unrestricted reuse) scenario. Total carcinogenic site risk from soil and groundwater to residential receptors (including background) is above the risk management range and an HI of 1. However, carcinogenic risks to residential receptors from exposures to soil are within the risk management range and the noncancer HI from soil is less than 1.

An evaluation of TPH in soil and groundwater was conducted based on the TPH strategy for Alameda Point (Navy 2001a) (see Appendix F). Based on this evaluation, no further action is recommended at Site 19 under the TPH program for TPH-fractions and TPH-associated constituents.

The nature and extent evaluation concluded that most of the chemicals detected across Site 19 are consistent with historical activities known to occur at the site, which included hazardous material storage at Building 616 and Yard D-13. The following physical features and site activities were considered likely sources at Site 19:

- Yard D-13 (hazardous waste storage yard)
- Building 616 (hazardous materials storage area)
- Fill material containing PAHs

Although numerous chemicals were detected at Site 19, some of the chemicals do not pose significant risk as defined by the risk assessments. For the commercial/industrial and construction worker scenarios, the HHRA indicated that the most conservative carcinogenic risks for soil and groundwater are within the risk management range. The highest HIs calculated for these pathways were less than 1 for soil. The pathway for exposure to groundwater was incomplete.

For the residential scenario, carcinogenic risk from exposure to soil is within the risk management range and the noncancer HI from soil is less than 1. Arsenic and BaP in soil were identified as risk drivers, but arsenic is not a COC because it is attributed to background. BaP also is not recommended as a COC, because it most likely resulted from the use of sediments to construct Alameda Point; these sediments contain ambient concentrations of PAHs (including BaP). In addition some of the BaP at Site 19 most likely is attributed to the Marsh Crust; therefore, the Marsh Crust ROD is applicable. The carcinogenic risk for groundwater exceeds the risk management range and the noncancer HI is greater than 1. COCs identified for groundwater at Site 19 are 1,2-DCP, manganese, PCE, and TCE. Although arsenic was identified as a risk driver in groundwater, it is not a COC, because it is attributed to background.

Results of the HQ calculations and qualitative evaluations indicated potential risk to small mammals from copper and potential risk to raptors from barium and lead. No significant risk is posed to passerines from exposure to Site 19 soils. However, based on the lack of habitat at Site 19 and the planned future use of the site, no risks to ecological receptors have been identified that require further evaluation or mitigation.

SITE 22

Soil and groundwater at Site 22 are recommended for further evaluation in an FS, as defined under CERCLA, to address risks to residential receptors under the residential (unrestricted reuse) scenario. Total carcinogenic site risk from soil and groundwater to residential receptors (including background) is above the risk management range and a noncancer HI of 1. However,

risks to residential receptors from exposures to soil are within the risk management range, and the noncancer HI is less than 1.

An evaluation of TPH in soil and groundwater also was conducted based on the TPH strategy for Alameda Point (Navy 2001a) (see Appendix F). Based on this evaluation, further action is not warranted for soil at Site 22. Further action is warranted for groundwater at Site 22. However, because Site 22 was considered significantly impacted by TPH, corrective action for free TPH product in soil and groundwater is currently underway using a combination of dual vapor extraction and biosparging.

Recommendations for further action under CERCLA will be based only on CERCLA contaminants; TPH-related chemicals are being addressed under a Corrective action plan (CAP).

The nature and extent evaluation concluded that most of the chemicals detected across Site 22 are consistent with the historical activities known to occur at the site, which included a gasoline station and car wash. Site 22 was a gasoline station and there were no documented uses of CERCLA contaminants during the site's history. Of the potential sources the following physical features and site activities were considered likely sources at Site 22:

- Former gas station and associated underground storage tanks (UST) 547-1 through 547-3 and fuel lines
- OWS 547 associated with the car wash
- Fill material containing PAHs

Although numerous chemicals were detected at Site 22, some of these chemicals do not pose significant risk as defined by the risk assessments. For the commercial/industrial and construction worker scenarios, the HHRA indicated that the most conservative carcinogenic risks for soil and groundwater are within the risk management range. The most conservative HIs are less than 1 for soil and groundwater.

For the residential scenario, carcinogenic risk from exposure to soil is within the risk management range, and the noncancer HI from soil is less than 1. Arsenic, BaP, benzene, ethylbenzene, lead, and xylene are identified as COCs for soil. The carcinogenic risk for groundwater exceeds the risk management range, and the noncancer HI is above 1. Carcinogenic risk posed by groundwater exceeds the risk management range, and the noncancer HI is above 1. COCs identified for groundwater are 1,2-DCA, benzene, chloroform, ethylbenzene, manganese, naphthalene, PCE, thallium, TCE, and xylene. Arsenic is a risk driver in soil and groundwater; it is not identified as a COC because it is attributed to background.

Results of the HQ calculations and qualitative evaluations indicate potential risk to small mammals, passerines, and raptors from lead. However, based on the lack of habitat at Site 13 and the planned future use of the site, no risks to ecological receptors have been identified that require further evaluation or mitigation.

SITE 23

Soil and groundwater at Site 23 are recommended for further evaluation in an FS, as defined under CERCLA, to address risks to residential receptors under the residential (unrestricted reuse) scenario. Total carcinogenic site risk from soil and groundwater to residential receptors (including background) is above the risk management range, and the noncancer HI is above 1. However, carcinogenic risk to residential receptors from exposure to soil is within the risk management range, and the noncancer HI is less than 1.

An evaluation of TPH in soil and groundwater also was conducted based on the TPH strategy for Alameda Point (Navy 2001a) (see Appendix F). Based on this evaluation, further action is recommended for TPH and TPH-associated chemical concentrations present in soil and groundwater at Site 23. Site 23 was considered significantly impacted by TPH, and corrective action for free TPH product in soil and groundwater was conducted using dual-phase vacuum extraction (DVE) and biosparging.

Recommendations for further action under CERCLA will be based only on CERCLA contaminants; TPH-related chemicals are being addressed under a CAP.

The nature and extent evaluation concluded that most of the chemicals detected across Site 23 are consistent with historical activities known to occur at the site, which included plane defueling and the former oil refinery. In addition, the petroleum plume at Site 13 is another likely source of petroleum contamination at Site 23. The following physical features and site activities were considered likely sources at Site 23:

- Defueling area and associated OWSs 529 and 530 and ASTs 530A, 530B, and 530C
- Former oil refinery activities

Although numerous chemicals were detected at Site 23, some of these chemicals do not pose significant risk as defined by the risk assessments. For the commercial/industrial and construction worker scenarios, the HHRA indicated that the most conservative carcinogenic risk for soil for these two scenarios is within the risk management range. The most conservative HI is less than 1 for soil. The most conservative carcinogenic risk for groundwater for these two scenarios is below the risk management range.

For the residential scenario, carcinogenic risk from exposure to soil is within the risk management range, and the noncancer HI from soil is less than 1. BaP and dibenzo(a,h)anthracene are identified as COCs for soil. Arsenic in soil is identified as risk driver but is attributed to background. BaP and dibenzo(a,h)anthracene in soil are attributed to the presence of petroleum contamination. 1,2,4-Trimethylbenzene, BaP, benzo(b)fluoranthene, ethylbenzene, naphthalene, and sec-butylbenzene are identified as COCs for groundwater. BaP and benzo(b)fluoranthene are attributed to the presence of soil particles in groundwater and the remaining groundwater COCs are attributed to petroleum contamination. Although arsenic and thallium were identified as groundwater risk drivers, they are attributed to background and are not identified as COCs.

Results of the HQ calculations and qualitative evaluations indicated potential risk to small mammals and raptors from cadmium. Based on the low magnitude of the low HQ, the limited habitat at Site 23, and the planned future use of the site, no risks to ecological receptors were identified that require further evaluation or mitigation.

Based on the data and risks for the sites, the following recommendations were made for Sites 9, 13, 19, 22, and 23:

Site	Media	Further Evaluation in FS (yes/no)	Chemicals of Concern	Further Action for TPH (yes/no)	Data Gaps (yes/no)
9	Soil	Yes	NA ¹	No	Yes
	Groundwater	Yes	1,2-DCP; 1,3 DCP; 1,2 DCE; 2-methylnaphthalene, 4-methylphenol, 1,2,3-TCP) benzene; ethylbenzene; manganese; naphthalene; PAHs; PCE; PCP; TCE; vinyl chloride, arsenic ² , and antimony ²	Yes	Yes
13	Soil	Yes	BaP and Dibenzo(a,h)anthracene	Yes	Yes
	Groundwater	Yes	Benzene, manganese, PCP, and TCE	Yes	Yes
19	Soil	Yes	NA ^{3,4}	No	Yes
	Groundwater	Yes	Manganese, PCE, TCE, and 1,2 DCP	No	Yes
22	Soil	Yes	BaP, benzene, ethylbenzene, lead, and xylene ¹	No	Yes
	Groundwater	Yes	1,2-DCA, benzene, chloroform, ethylbenzene, manganese, naphthalene, PCE, thallium, TCE, and xylene ²	Yes	Yes
23	Soil	Yes	BaP and dibenzo(a,h)anthracene ¹	Yes	Yes
	Groundwater	Yes	1,2,4-Trimethylbenzene, BaP, benzo(b)fluoranthene, ethylbenzene, naphthalene, and sec-butylbenzene ²	Yes ⁵	Yes

Notes:

- 1 Arsenic in soil was identified as a risk driver but is attributed to background
- 2 Arsenic, antimony, and thallium were identified as risk drivers in groundwater, but they are attributed to background
- 3 Arsenic and BaP in soil were identified as risk drivers, but arsenic is attributed to background. BaP at Site 19 is attributed to the Marsh Crust; therefore, the Marsh Crust ROD is applicable, and BaP is not recommended as a COC for further evaluation in the FS.
- 4 Copper and Lead are identified as ecologic risk drivers
- 5 Further action is continuing under the TPH Program.

1.0 INTRODUCTION

The U.S. Department of the Navy (Navy) has completed this remedial investigation (RI) at Alameda Point (formerly Naval Air Station [NAS] Alameda), in Alameda County, California, (see Figure 1-1) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (U.S. Environmental Protection Agency [EPA] 1988a). The California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC), San Francisco Bay Regional Water Quality Control Board (RWQCB), and EPA Region 9 provided regulatory oversight of this RI. RI activities have been conducted from 1988 to 2003 at Alameda Point.

This RI report presents the results, conclusions, and recommendations of the RI conducted for the southeastern area of Operable Unit (OU)-2, referred to as OU-2A at Alameda Point (see Figure 1-2). The CERCLA sites that comprise OU-2A are included in this report as Sites 9, 13, 19, 22, and 23.

1.1 PURPOSE AND OBJECTIVES

This report presents the results of the RI conducted to assess site characteristics and the nature and extent of chemical contamination. The data and site information gathered during the RI were used to complete a risk assessment for each site to assess potential risks to human health and the environment. The results of the risk assessment also are included with this RI report and will be evaluated in combination with the RI results as necessary to develop risk-based cleanup goals for use in evaluating remedial alternatives as part of the feasibility studies (FS) for the OU-2A CERCLA sites. Specific OU-2A RI objectives are as follow:

- Characterize site conditions
- Assess the nature and extent of chemical contamination at each site
- Identify potential pathways for contaminant migration at each site
- Assess risk to human health and the environment

1.2 REPORT ORGANIZATION

This report is divided into 10 sections and 8 appendices. The remainder of Section 1 provides historical background for Alameda Point, describes the OU-2A sites considered in this report, and discusses future land uses. Section 2 discusses the physical setting, geology, hydrogeology, ecology, and soil and groundwater at Alameda Point. Section 3 describes the RI approach including the initial conceptual site model (CSM), data quality objectives (DQO), previous investigations, criteria used to evaluate data, and the methods used to determine background concentrations and assess risks to human health and ecological resources. Section 4 describes the OU-wide geology and hydrogeology. Sections 5 through 9 each address one of the OU-2A

sites, covering a number of topic areas including history and background, nature and extent of contamination, risk assessment results, and RI conclusions. Section 10 summarizes the conclusions and recommendations for each site.

Appendices A through K provide supporting documentation and calculations for the RI report. Tables and figures cited within this report can be found at the end of the section in which they are first mentioned and are numbered consecutively in the order in which they appear in the text of this document. The document is presented in four volumes. The contents of each volume are as follows:

- Volume I: Executive summary and Sections 1 through 5
- Volume II: Sections 6 through 11
- Volume III: Appendices A through E
- Volume IV: Appendices F through K

1.3 ALAMEDA POINT BACKGROUND

This section provides a brief summary of the history of Alameda Point, describes the operational history of the former installation, explains OU designations, and provides general descriptions and operational histories for each site in OU-2A.

1.3.1 Installation History

Originally a peninsula, Alameda Island was detached from the mainland in 1876 when a channel was cut to link San Leandro Bay with the San Francisco Bay (the Bay). The northern portion of Alameda Island was formerly tidal areas, marshlands, and sloughs adjacent to the historical San Antonio Channel, now known as the Oakland Inner Harbor. During the late 1800s the eastern portion of the base was used for industrial purposes, specifically the Pacific Coast Oil Company operated a refinery along the western shore of the island. The U.S. Department of the Army (Army) acquired the installation property from the City of Alameda in 1930 and began construction activities in 1931. In 1936, the Navy acquired title to the land from the Army and began building the air station in response to the military buildup in Europe before World War II. Construction of the base included several iterations of filling the existing tidelands, marshlands, and sloughs with dredge materials from the Bay (Navy 2001a) (see Figure 1-3).

After the end of the war in 1945, the installation continued its primary mission of providing facilities and support for fleet aviation activities. During its operations as an active naval base, the installation provided berthing for Pacific Fleet ships and was a major center of naval aviation. Over 120 years of military and industrial operations have resulted in soil and groundwater contamination at various locations on Alameda Point.

The Navy began site investigations at Alameda Point under the Navy Assessment and Control of Installation Pollutants (NACIP) program in 1982. On June 6, 1988, the Navy received a Remedial Action Order from the California Department of Health Services (now referred to as DTSC) that identified a total of 20 sites as needing an RI/FS in conformance with the requirements of CERCLA. In 1988, the Navy converted its NACIP program into the Installation Restoration (IR) program to be more consistent with CERCLA. Military activities at Alameda Point were identified for closure in September 1993, and all naval operations ceased in April 1997. In July 1999, Alameda Point was identified as a National Priority List (NPL) site (EPA 1999a). Between 1998 and 2003, additional CERCLA sites were identified as requiring RI/FS activities. The Navy currently is conducting investigations in accordance with CERCLA (EPA 1988a) at 34 CERCLA sites shown on Figure 1-2.

1.3.2 Operational Unit Designations

As a management tool to accelerate site investigation, cleanup, and reuse, the Base Realignment and Closure (BRAC) Cleanup Team (BCT) at Alameda Point developed a comprehensive OU strategy that separates the 29 of the 34 CERCLA sites into a total of 10 OUs (OU-1, OU-2A, OU-2B, OU-2C, OU-3, OU-4A, OU-4B, OU-4C, OU-5, and OU-6). Figure 1-2 identifies the CERCLA sites that are within each OU. Site 18, the storm sewer system, was previously considered a separate CERCLA site. The site was reconfigured, and the storm sewer system is now being addressed within the individual CERCLA sites where it is located.

The designation of OUs was based on grouping sites with similar characteristics and reuse potential. OU-1 consists of CERCLA Sites 6, 7, 8, 14, 15, and 16. These sites are relatively small with low levels of contamination related to historical petroleum, oil, and lubricant use. Because OU-1 sites are anticipated to be closed with minimal effort and cost, they have potential for early conveyance to the community for reuse. OU-2 (A, B, and C) sites are identified as those sites with high reuse potential in their current configuration of primary industrial and office buildings, and existing manufacturing, maintenance, and infrastructure repair facilities. OU-3 consists of CERCLA Site 1, the former disposal area (1943 through 1956). OU-4 (A, B, and C) consists of CERCLA Site 2, and the wetlands and aquatic environments at CERCLA Sites 17, 20, 24, and 29, as shown in Figure 1-2. OU-5 consists of CERCLA Site 25, which includes Estuary Park and the Coast Guard Housing area located at the northeast corner of the installation. OU-6 consists of Sites 26, 27 and 28, called the Western Hangar Zone, Dock Zone, and Todd Shipyards, respectively. CERCLA Sites 30 through 35 are newly identified sites that have not yet been given an OU designation.

OU-2 consists of 12 CERCLA sites divided into the following three sub-OUs:

OU-2A Southeastern Area

CERCLA Site 9: Building 410 - Paint Stripping Facility

CERCLA Site 13: Former Oil Refinery

CERCLA Site 19: Yard D-13 - Hazardous Waste Storage

CERCLA Site 22: Building 547 - Former Service Station

CERCLA Site 23: Building 530 - Missile Rework Operations/Former Plane Defueling

OU-2B Eastern Area

CERCLA Site 3: Area 97 – Abandoned Fuel Storage Area

CERCLA Site 4: Building 360 – Aircraft Engine Facility and Plating Shop

CERCLA Site 11: Building 14 – Engine Test Cell

CERCLA Site 21: Building 162 – Ship Fitting and Engine Repair

OU-2C Central Area

CERCLA Site 5: Building 5 – Naval Air Rework Facility

CERCLA Site 10: Building 400 – Missile Rework Facility

CERCLA Site 12: Building 10 – NAS Alameda Power Plant

1.3 ALAMEDA POINT BACKGROUND

This section provides a brief summary of the history of Alameda Point, describes the operational history of the former installation, explains OU designations, and provides general descriptions and operational histories for each site in OU-2A.

1.3.1 Installation History

Originally a peninsula, Alameda Island was detached from the mainland in 1876 when a channel was cut to link San Leandro Bay with the San Francisco Bay (the Bay). The northern portion of Alameda Island was formerly tidal areas, marshlands, and sloughs adjacent to the historical San Antonio Channel, now known as the Oakland Inner Harbor. During the late 1800s the eastern portion of the base was used for industrial purposes, specifically the Pacific Coast Oil Company operated a refinery along the western shore of the island. The U.S. Department of the Army (Army) acquired the installation property from the City of Alameda in 1930 and began construction activities in 1931. In 1936, the Navy acquired title to the land from the Army and began building the air station in response to the military buildup in Europe before World War II. Construction of the base included several iterations of filling the existing tidelands, marshlands, and sloughs with dredge materials from the Bay (Navy 2001a) (see Figure 1-3).

After the end of the war in 1945, the installation continued its primary mission of providing facilities and support for fleet aviation activities. During its operations as an active naval base, the installation provided berthing for Pacific Fleet ships and was a major center of naval aviation.

Over 120 years of military and industrial operations have resulted in soil and groundwater contamination at various locations on Alameda Point.

The Navy began site investigations at Alameda Point under the Navy Assessment and Control of Installation Pollutants (NACIP) program in 1982. On June 6, 1988, the Navy received a Remedial Action Order from the California Department of Health Services (now referred to as DTSC) that identified a total of 20 sites as needing an RI/FS in conformance with the requirements of CERCLA. In 1988, the Navy converted its NACIP program into the Installation Restoration (IR) program to be more consistent with CERCLA. Military activities at Alameda Point were identified for closure in September 1993, and all naval operations ceased in April 1997. In July 1999, Alameda Point was identified as a National Priority List (NPL) site (EPA 1999a). Between 1998 and 2003, additional CERCLA sites were identified as requiring RI/FS activities. The Navy currently is conducting investigations in accordance with CERCLA (EPA 1988a) at 34 CERCLA sites shown on Figure 1-2.

1.3.2 Operational Unit Designations

As a management tool to accelerate site investigation, cleanup, and reuse, the Base Realignment and Closure (BRAC) Cleanup Team (BCT) at Alameda Point developed a comprehensive OU strategy that separates the 29 of the 34 CERCLA sites into a total of 10 OUs (OU-1, OU-2A, OU-2B, OU-2C, OU-3, OU-4A, OU-4B, OU-4C, OU-5, and OU-6). Figure 1-2 identifies the CERCLA sites that are within each OU. Site 18, the storm sewer system, was previously considered a separate CERCLA site. The site was reconfigured, and the storm sewer system is now being addressed within the individual CERCLA sites where it is located.

The designation of OUs was based on grouping sites with similar characteristics and reuse potential. OU-1 consists of CERCLA Sites 6, 7, 8, 14, 15, and 16. These sites are relatively small with low levels of contamination related to historical petroleum, oil, and lubricant use. Because OU-1 sites are anticipated to be closed with minimal effort and cost, they have potential for early conveyance to the community for reuse. OU-2 (A, B, and C) sites are identified as those sites with high reuse potential in their current configuration of primary industrial and office buildings, and existing manufacturing, maintenance, and infrastructure repair facilities. OU-3 consists of CERCLA Site 1, the former disposal area (1943 through 1956). OU-4 (A, B, and C) consists of CERCLA Site 2, and the wetlands and aquatic environments at CERCLA Sites 17, 20, 24, and 29, as shown in Figure 1-2. OU-5 consists of CERCLA Site 25, which includes Estuary Park and the Coast Guard Housing area located at the northeast corner of the installation. OU-6 consists of Sites 26, 27 and 28, called the Western Hangar Zone, Dock Zone, and Todd Shipyards, respectively. CERCLA Sites 30 through 35 are newly identified sites that have not yet been given an OU designation.

OU-2 consists of 12 CERCLA sites divided into the following three sub-OUs:

OU-2A Southeastern Area

CERCLA Site 9: Building 410 - Paint Stripping Facility

CERCLA Site 13: Former Oil Refinery

CERCLA Site 19: Yard D-13 - Hazardous Waste Storage

CERCLA Site 22: Building 547 - Former Service Station

CERCLA Site 23: Building 530 - Missile Rework Operations/Former Plane Defueling

OU-2B Eastern Area

CERCLA Site 3: Area 97 – Abandoned Fuel Storage Area

CERCLA Site 4: Building 360 – Aircraft Engine Facility and Plating Shop

CERCLA Site 11: Building 14 – Engine Test Cell

CERCLA Site 21: Building 162 – Ship Fitting and Engine Repair

OU-2C Central Area

CERCLA Site 5: Building 5 – Naval Air Rework Facility

CERCLA Site 10: Building 400 – Missile Rework Facility

CERCLA Site 12: Building 10 – NAS Alameda Power Plant

1.3.3 Historical Operations and General Site Descriptions for OU-2A

Activities performed at the installation by the Navy and former tenants include the following:

- **Aircraft Intermediate Maintenance Department (AIMD).** AIMD was responsible for the intermediate repair of aircraft components for transient and tenant aircraft. AIMD used substances such as fuel products and cleaning solvents.
- **Air Operations.** The Navy Public Works Center (PWC) and Naval Aviation Depot Alameda (NADEP) supported a wide variety of air operations across the installation. These operations used substances such as fuel products and cleaning solvents.
- **Navy Exchange Service Stations.** Two service stations were operated on the installation. At both stations, waste oils were stored in underground tanks and pumped out as needed by a local contractor (Ecology and Environment Inc. [E&E] 1983).
- **Weapons Department.** The Weapons Department was responsible for receiving, issuing, storing, and shipping ammunition, ammunition components, and explosives. The department also operated a small arms firing range and saluting battery and coordinated ordnance disposal with the explosive ordnance disposal (EOD) detachment.

- **Supply Department.** The Supply Department was responsible for providing fueling support activities. Fuel products were distributed throughout the installation by a complex of underground storage tanks (UST), aboveground storage tanks (AST), and underground piping systems.

The installation and its two largest tenants, PWC and NADEP, supported several activities involving use of substances such as industrial solvents, acids, paint strippers, degreasers, caustic cleaners, and metals from plating operations. Oils, fuels, and asbestos also were used at the installation. Several other tenants and support units may have used minor amounts of fuel products, pesticides, PCBs, and cleaning solvents. General descriptions of each site in OU-2A are presented in the following text. The site features are included as figures in Sections 5 through 9.

1.3.3.1 Site 9 – Paint Stripping Facility

Site 9 covers approximately 2.9 acres in the southwestern corner of OU-2A. Two buildings (Buildings 410 and 351) covering approximately 37,000 square feet are still present at Site 9. Building 410 was constructed in 1958 as an aircraft paint stripping facility run by Naval Area Rework Facility (NARF), and has been used for storage since the early 1990s. Building 351, located immediately north of Building 410, was a support building that served as a lunch room/locker room for Building 410 staff. Both buildings are inactive and scheduled for demolition. The Industrial Waste Treatment Plant (IWTP) 410, known as Structure 588, was located east of Building 351 and treated paint stripping wastes under a Resource Conservation and Recovery Act (RCRA) permit. This facility and 11 associated ASTs have been removed from Site 9, and the permit has been closed under RCRA.

AST 410A was a 10,000-gallon methylene chloride tank. AST 410B was a 10,000-gallon phenol tank, and AST 410C was a 1,500 gallon surfactant tank. The remaining eight ASTs were directly associated with industrial waste treatment processes at IWTP 410. Acids, bases, coagulants, and other IWTP-related chemicals were stored in these tanks until their removal. One oil water separator (OWS) was also associated with IWTP 410 and closed under RCRA. Two additional OWSs were operated by NARF. There is no historical evidence of USTs at Site 9.

1.3.3.2 Site 13 – Former Oil Refinery

An oil refinery operated from 1879 to 1903 at the location of Site 13 before Navy operations at Alameda Point. Site 13 covers approximately 17.5 acres in the northern half of OU-2A. Site 13 includes Building 397, a 17,400-square-foot aircraft overhaul plant and engine test facility constructed in 1958 and operated by NARF. A self-storage facility occupies the southeastern corner of the site. The majority of the rest of the site is paved or open space.

Five ASTs (324 through 328), of unknown capacity, were located on the eastern portion of the site. These tanks held fuel and were removed in 1990. There is no historical record of USTs at

Site 13. In addition, four OWSs and a waste generator accumulation point (GAP) (NADEP GAP 62) were operated by NADEP at Site 13.

1.3.3.3 Site 19 – Hazardous Waste Storage

Site 19 covers approximately 2.3 acres in the northwestern corner of OU-2A. There are two structures on the site, Building 616 and Yard D-13. Building 616 is a 1,800-square-foot office and materials storage unit constructed in 1982. Yard D-13 is a 30,000-square-foot hazardous waste storage area with a steel roof and secondary containment berms.

Two USTs, 616-1 and 616-2, (5,000 and 10,000 gallon capacity) are located at Site 19. The USTs were constructed for spill control but were never used. There is no historical record of ASTs at Site 19. Yard D-13 was a permitted hazardous waste storage area (D-13).

1.3.3.4 Site 22 – Former Service Station

Site 22 covers approximately 2.1 acres in the northeastern corner of OU-2A. This site was formerly a gasoline distribution and service station from 1971 to 1980. All buildings associated with the service station (Building 547, 547A, and Structure 547) have been demolished.

Three USTs (547-1 through 547-3) associated with the service station were removed. These tanks each held a 12,000-gallon capacity of gasoline. One OWS is located south of the car wash pad. There is no historical evidence of ASTs at Site 22.

1.3.3.5 Site 23 – Missile Rework Operations/Formal Plane Defueling

Site 23 covers approximately 14.3 acres at the southern half of OU-2A. This area was used for plane defueling between 1953 and the early 1970s. The main structure located at Site 23 is Building 530. Building 530 was constructed in 1973 for missile rework operations and was run by NARF. Two smaller buildings on the site, Buildings 529 and 600, provided operational support for Building 530. The eastern third of the site is used currently as a self-storage facility.

Three ASTs have been removed from Site 23. ASTs 530A and 530B each had a capacity of 10,000 gallons. AST 530C was a 15,000 gallon capacity jet fuel tank. These ASTs were associated with a defueling facility that also was removed. There is no historical evidence of USTs at Site 23. Within Building 530, three GAPs were used to manage wastes generated by the operations in the building, NADEP GAP 64, NADEP GAP 63, and NADEP GAP 63A. Two OWSs associated with a plane defueling area are located within Site 23.

1.3.4 Future Land Use

Land use categories define the types of activities that are anticipated to be carried out in a specific geographical area (defined as "land use area" in the reuse plan) at Alameda Point. The

following 10 land use categories have been identified in the NAS Alameda community reuse plan (EDAW, Inc. [EDAW] 1996):

- Residential
- Business Park/Light Industry
- Office
- Research and Development/Industrial Flex
- Civic/Institutional
- Commercial
- Mixed-use
- Parks
- Open Space/Habitat
- Commercial Recreation/Marina

Under the land use plan (EDAW 1996), Alameda Point has been divided into the following seven geographical areas, presented on Figure 1-4, which are associated with one or more of the 10 land use categories described above:

- Civic Core
- Main Street Neighborhoods
- Inner Harbor
- North Waterfront
- Marina District
- Northwest Territories
- Wildlife Refuge

Sites 9, 13, 19, 22, and 23 are located in the Inner Harbor reuse area. Planned land use in this reuse area can be characterized as a combination of business park/light industrial, open space, and civic/institutional support uses. Even though the most prominent land use features at OU-2A are large-scale industrial buildings and the reuse plan does not identify residential redevelopment for OU-2A, this RI report evaluates the human health risks for residential future use. It also evaluates impacts on ecological species.



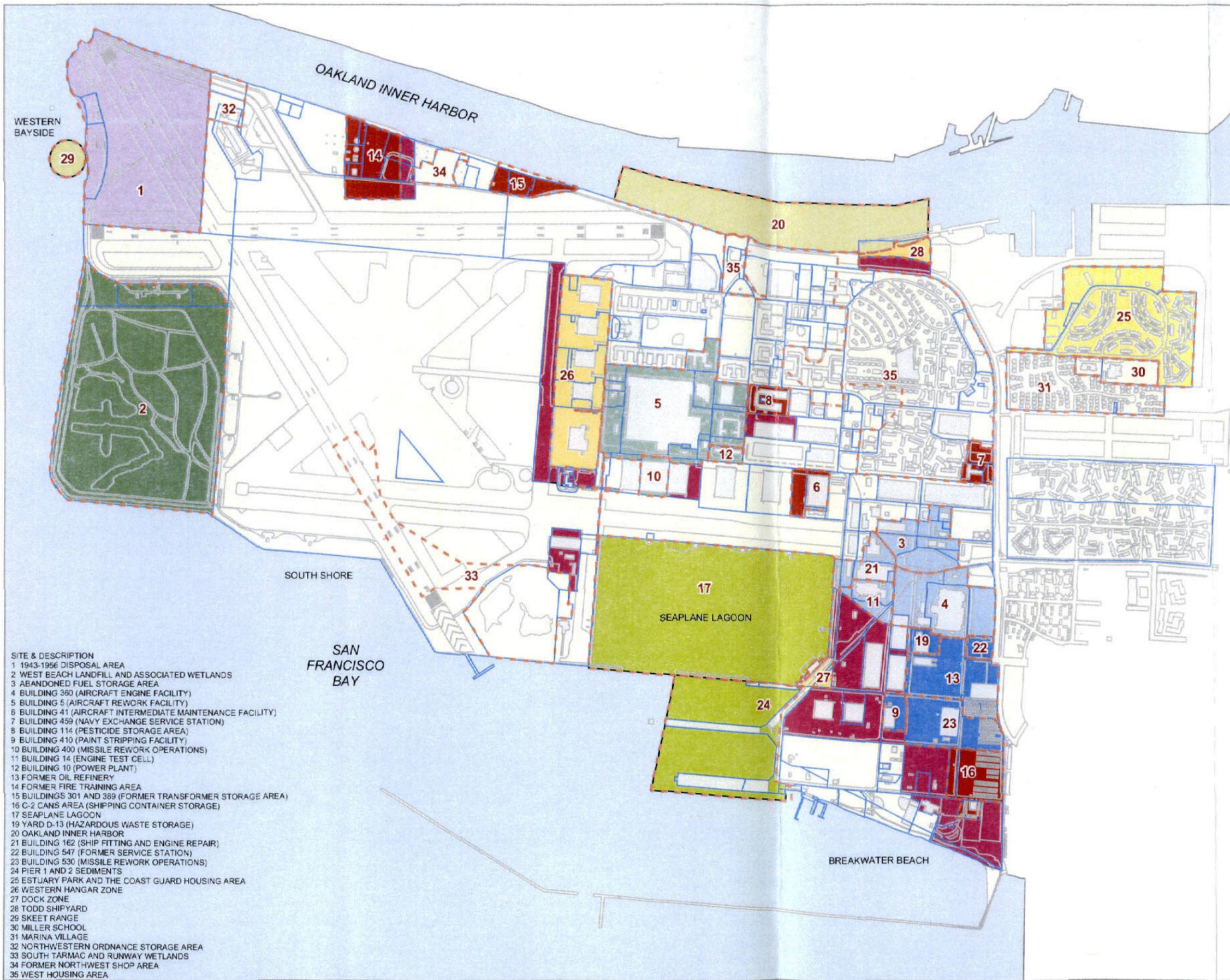
Tetra Tech EM Inc.

Alameda Point
 U.S. Navy Southwest Division, NAVFAC, San Diego

**FIGURE 1-1
 ALAMEDA POINT LOCATION MAP**

Operable Unit 2A
 Remedial Investigation Report

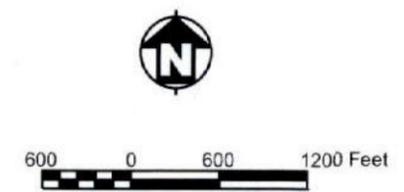
- CITY
- HIGHWAY
- COUNTY BORDER



- CERCLA SITE BOUNDARY
- BUFFER ZONE
- OPERABLE UNIT 1
- OPERABLE UNIT 2A
- OPERABLE UNIT 2B
- OPERABLE UNIT 2C
- OPERABLE UNIT 3
- OPERABLE UNIT 4A
- OPERABLE UNIT 4B
- OPERABLE UNIT 4C
- OPERABLE UNIT 5
- OPERABLE UNIT 6
- BUILDING
- LAND COVER
- OPEN WATER

Notes:
 CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980

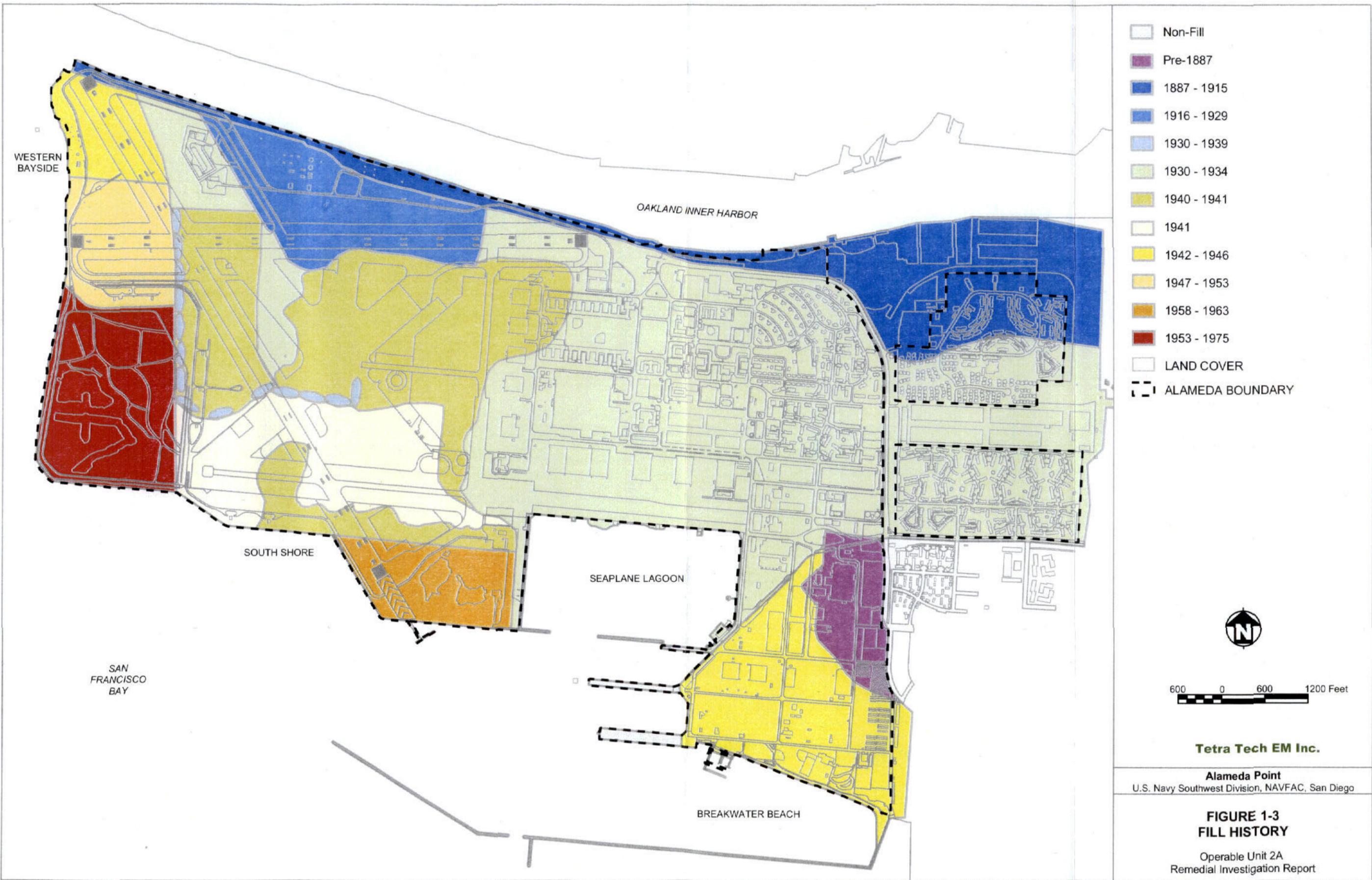
- SITE & DESCRIPTION**
- 1 1943-1956 DISPOSAL AREA
 - 2 WEST BEACH LANDFILL AND ASSOCIATED WETLANDS
 - 3 ABANDONED FUEL STORAGE AREA
 - 4 BUILDING 360 (AIRCRAFT ENGINE FACILITY)
 - 5 BUILDING 5 (AIRCRAFT REWORK FACILITY)
 - 6 BUILDING 41 (AIRCRAFT INTERMEDIATE MAINTENANCE FACILITY)
 - 7 BUILDING 459 (NAVY EXCHANGE SERVICE STATION)
 - 8 BUILDING 114 (PESTICIDE STORAGE AREA)
 - 9 BUILDING 410 (PAINT STRIPPING FACILITY)
 - 10 BUILDING 400 (MISSILE REWORK OPERATIONS)
 - 11 BUILDING 14 (ENGINE TEST CELL)
 - 12 BUILDING 10 (POWER PLANT)
 - 13 FORMER OIL REFINERY
 - 14 FORMER FIRE TRAINING AREA
 - 15 BUILDINGS 301 AND 389 (FORMER TRANSFORMER STORAGE AREA)
 - 16 C-2 CANS AREA (SHIPPING CONTAINER STORAGE)
 - 17 SEAPLANE LAGOON
 - 19 YARD D-13 (HAZARDOUS WASTE STORAGE)
 - 20 OAKLAND INNER HARBOR
 - 21 BUILDING 162 (SHIP FITTING AND ENGINE REPAIR)
 - 22 BUILDING 547 (FORMER SERVICE STATION)
 - 23 BUILDING 530 (MISSILE REWORK OPERATIONS)
 - 24 PIER 1 AND 2 SEDIMENTS
 - 25 ESTUARY PARK AND THE COAST GUARD HOUSING AREA
 - 26 WESTERN HANGAR ZONE
 - 27 DOCK ZONE
 - 28 TODD SHIPYARD
 - 29 SKEET RANGE
 - 30 MILLER SCHOOL
 - 31 MARINA VILLAGE
 - 32 NORTHWESTERN ORDNANCE STORAGE AREA
 - 33 SOUTH TARMAC AND RUNWAY WETLANDS
 - 34 FORMER NORTHWEST SHOP AREA
 - 35 WEST HOUSING AREA

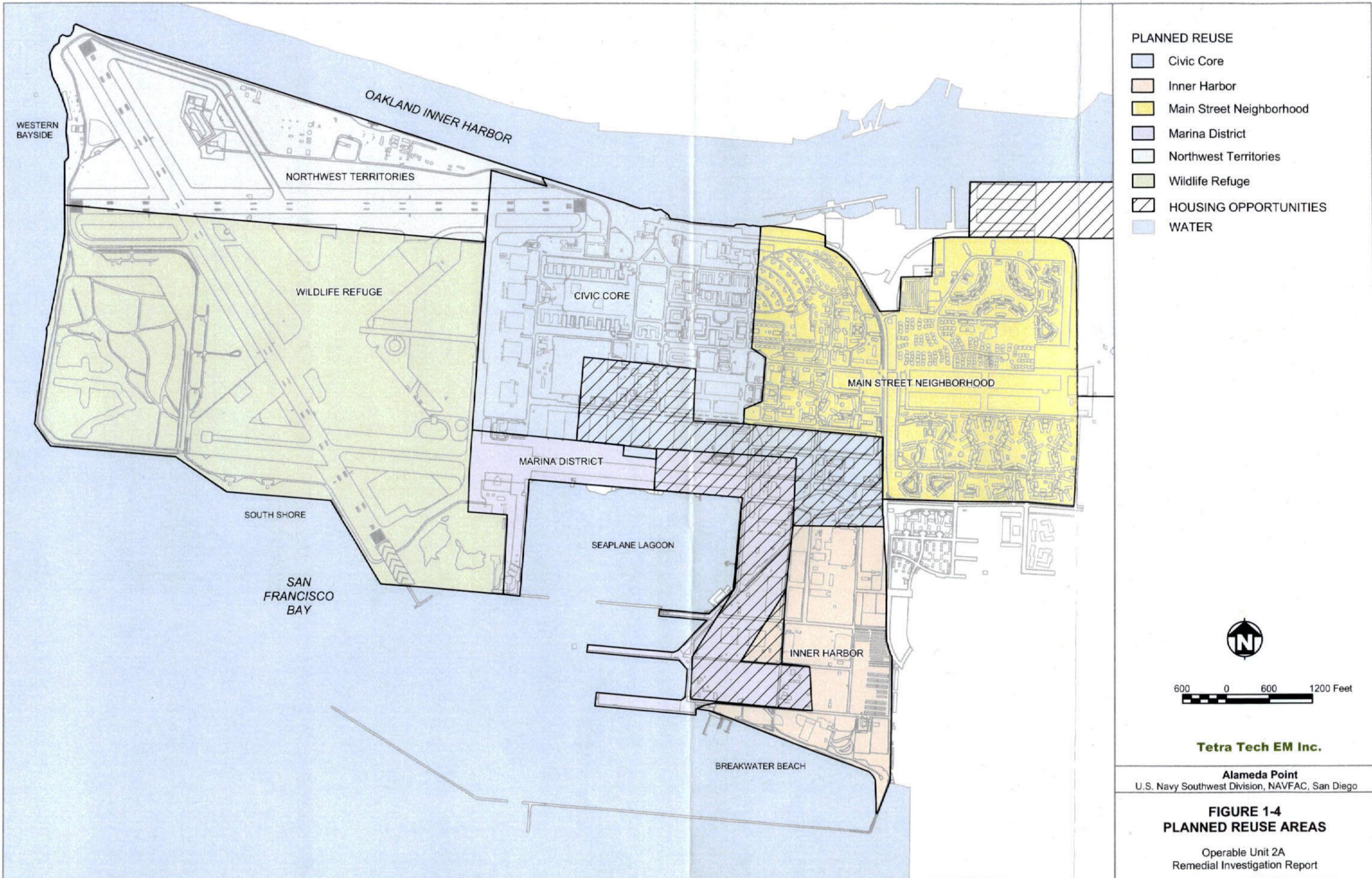


Tetra Tech EM Inc.

Alameda Point
 U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 1-2
OPERABLE UNITS, CERCLA SITES
AND BUFFER ZONES
 Operable Unit 2A
 Remedial Investigation Report





2.0 GENERAL ENVIRONMENTAL SETTING AND HISTORY

This section describes the physical setting of the former naval installation as well as the regional and base-wide geology, hydrogeology, and ecology.

2.1 PHYSICAL SETTING

Alameda Point is located at the west end of Alameda Island, which lies at the base of a gently westward-sloping plain that extends from the Oakland-Berkeley hills on the east to the shore of the Bay on the west (see Figure 1-1). The Bay also borders the island to the south and the Oakland Inner Harbor borders the island to the north.

The San Francisco Bay Area experiences a maritime climate with mild summer and winter temperatures. Prevailing winds in the Bay Area are from the west. Because of the varied topography of the Bay Area, climatic conditions vary considerably throughout the region. Heavy fog occurs at Alameda Point an average of 21 days per year. Rainfall occurs primarily during the months of October through April. The installation averages approximately 18 inches of rainfall a year (Air Traffic Control, NAS Alameda 1992). There are no naturally occurring surface streams or ponds on the installation, so precipitation either returns to the atmosphere by evapotranspiration, runs off in the storm drain system that discharges to the Bay, or infiltrates to groundwater (Tetra Tech EM Inc. [Tetra Tech] 2000a).

Physical features at Alameda Point include runways, streets, buildings, fuel lines, USTs, ASTs, and utility lines (sanitary sewer, storm sewer, water, steam, telephone, and power lines). Some fuel lines, USTs, and ASTs have been removed and others have been closed in place.

As mentioned in Section 1.3.2, the storm sewer system was previously considered a separate CERCLA Site 18. The site was reconfigured, and the storm sewer system is now being addressed within the individual CERCLA sites in which it is located. This installation feature warrants special concern because it is considered a possible preferential pathway for the discharge of groundwater contaminant plumes into the Oakland Inner Harbor or the Bay. The storm sewer system lies within the fill material and consists of storm sewer lines, access ways, manholes, catch basins, and outfalls on the base and in the outlying base housing area. Much of the system is below the water table. It initially was constructed by the Navy to collect base-wide surface water runoff from streets, tarmac and runways, landscaped areas, and building roof drains. Before 1972, it also was used for industrial waste disposal. The storm sewer system transported runoff to the Oakland Inner Harbor, Seaplane Lagoon, or the Bay through 36 outfalls (Tetra Tech 2000b).

2.2 GEOLOGY

The following sections provide an overview of the Bay regional and installation geology. The description of the Bay regional geology and the installation geology is based on the work of Trask and Ralston (1951), Treasher (1963), Radbruch (1957, 1969), Atwater and others (1977),

Atwater (1979), Helley and others (1979), Rogers and Figuers (1991), and Sloan (1990, 1992), which was generally regional in nature and based on a limited number of borings in and around Alameda Point. A discussion of the geology at OU-2A is presented in Section 4.1.

2.2.1 Regional Geology

Alameda Point is located along the eastern shore of the central Bay, directly west of the City of Oakland. The Bay and the area surrounding it occupy a large, regional trough that extends northwest-southeast across the California Coast Ranges. In the subsurface, the Bay is approximately coincident with the axis of a broad bedrock trough, which was formed by crustal movements associated with two active faults, the Hayward Fault to the east and the San Andreas Fault west of San Francisco (Figuers 1998).

Both the Hayward and San Andreas Faults, which are major regional tectonic features, are right-lateral strike slip faults. Extensional fault movement created a trough beginning 1 million to 500,000 years ago in the area that now is the Bay (Rogers and Figuers 1991). As subsidence continued, the depression was filled with a sequence of coalescing alluvial fans consisting of lenses of sand, silt, and gravel eroded from the surrounding hills. During interglacial periods, the Pacific Ocean entered the basin and widely deposited estuarine muds (Figuers 1998).

Today, regional geologic conditions in the Bay Area reflect this depositional history and consist of up to approximately 1,000 feet of interbedded and alternating alluvial and estuarine deposits overlying crystalline bedrock of the Franciscan Complex. The major formations underlying the Bay Area from oldest to youngest are (1) Franciscan Complex, (2) Alameda Formation, (3) Yerba Buena Mud, (4) San Antonio Formation, (5) Posey Formation, (6) Merritt Sand Formation, (7) Young Bay Mud, and (8) artificial fill. The stratigraphy of the Bay Area has been interpreted by several authors; these interpretations are presented as stratigraphic columns in Figure 2-1.

Franciscan Complex. The Franciscan Complex was formed from deep-sea fans and trench deposits that were later subjected to metamorphism related to subduction. This metamorphism created a highly deformed and structurally complex melange composed predominantly of greywacke and argillite, with lesser amounts of submarine basalt (greenstone), radiolarian chert, serpentinite and high pressure/high temperature metamorphic rocks. The age of the Franciscan Complex is Late Jurassic to Early Cretaceous, or approximately 160 to 120 million years ago (Wahrhaftig and Sloan 1989).

The first sediments to be deposited onto the surface of the Franciscan Complex were that of the Alameda Formation. The earliest Alameda deposition, which filled the initial Franciscan trough (1 million to 500,000 years ago), was continental in nature and included a variety of depositional environments such as alluvial fans, lakes, flood plains, streams and swamps (Rogers and Figuers 1991).

Between 400,000 and 500,000 years ago, the basin was first flooded by the ancestral Pacific Ocean and the deposits changed from continental (alluvial) to a mixture of alluvial, brackish (estuarine), and marine sediments. The upper, marine portion of the Alameda Formation provides evidence of up to four rises of sea level or transgressions during interglacial periods (Rogers and Figuers 1991). Since that time, the valley has experienced a number of episodes of estuarine deposition followed by erosional periods during the Quaternary (Sloan 1992); these episodes have occurred in response to glacially controlled fluctuations in sea level. The earliest-known estuarine deposit in the trough is 450,000 years old, and the youngest is 115,000 years old (Wahrhaftig and Sloan 1989).

Alameda Formation. The Alameda Formation was deposited onto the top of the Franciscan Complex bedrock. The most extensive of all the late Pleistocene-aged deposits in the Bay Area, the Alameda Formation is divided into a lower continental unit 300 to 600 feet thick and an upper marine unit 200 to 400 feet thick. Limited information is available regarding the nature of the older, basal unit; the individual layers of this unit are typically thin and discontinuous and are difficult to correlate. The upper Alameda Formation consists of estuarine layers that are similar to the blue-gray clay and silt that are being deposited in the Bay today (Rogers and Figuers 1991).

The deposition of the Alameda Formation ended approximately 200,000 years ago (Rogers and Figuers 1991). Deposition of the next unit, the Yerba Buena Mud, occurred after a short erosional period that created the unconformable contact between the two units. The Yerba Buena Mud is the lower member of the San Antonio Formation and comprises the youngest estuarine sediments below the Bay.

Yerba Buena Mud. The Yerba Buena Mud, formerly referred to as the Old Bay Mud, consists primarily of olive to dark greenish gray silty clay with minor amounts of sandy silty clay, sand, and gravel. The mineralogy of the unit includes pyrite, secondary gypsum, and mica; volcanic glass is present in the top half of the formation. The thickness of the Yerba Buena Mud ranges from approximately 85 to 105 feet in the central Bay (Sloan 1992) and from 25 to 50 feet at the eastern Bay margin (Figuers 1998). A thin (10- to 15-foot thick) sandy, shell-rich zone is commonly found near the middle of the unit and may represent a temporary, slightly lower sea level (Rogers and Figuers 1991).

The Yerba Buena Mud represents the last interglacial (Sangamon) period, which was followed by the Wisconsin glacial stage beginning about 90,000 years ago. The Yerba Buena Mud is unconformably overlain by continental (alluvial) sediments deposited at the same time during the Wisconsin glacial period. These deposits include the San Antonio (upper member) Formation, the Posey Formation, and the Merritt Sands Formation, described in the following text.

San Antonio Formation (upper member). The San Antonio Formation is a sequence of continental (alluvial fan) deposits that reach a maximum thickness of 120 feet (Figuers 1998). The San Antonio Formation sediments were deposited in a complex and dynamic depositional environment ranging from alluvial fans to flood plain, lakes, swamps, and beaches. The

individual units in the San Antonio are generally discontinuous and difficult to correlate (Rogers and Figuers 1991).

Posey Sand. The Posey Sand Formation is predominantly a sand deposit that fills broad stream channels that were cut into the uppermost part of the San Antonio Formation (Rogers and Figuers 1991).

Merritt Sand. The Merritt Sand is a fine-grained, well sorted, Aeolian (wind-deposited) sand that occurs locally on Alameda Island and in western Oakland. The Merritt Sand reaches a maximum thickness of approximately 60 feet (Figuers 1998). Deposition layers of the Merritt Sand reflect drier weather patterns in the late Pleistocene during which wind-blown sands accumulated. The Merritt Sand most likely consists of reworked portions of the Posey Sand (Rogers and Figuers 1991).

Between 11,000 and 8,000 years ago, after the end of the Wisconsin glacial period, sea level rose sharply and deposition of another estuarine mud began, unconformably filling stream valleys that had been incised into the San Antonio, Posey, and Merritt Sand Formations during glaciation. Deposition of this estuarine mud, the Young Bay Mud, continues in the Bay in the present day (Rogers and Figuers 1991).

Young Bay Mud. The Young Bay Mud is a black, unconsolidated, saturated, organic-rich clay, containing occasional gravel and sand layers, shell fragments/layers, peat, and organic debris. It generally ranges in thickness between 50 and 75 feet but can reach as much as 150 feet in channels cut into the San Antonio/Posey/Merritt Sand during the late Wisconsin glacial stage (Figuers 1998).

In the mid-19th century, development of the greater Oakland area resulted in the progressive filling of natural Bay margins. A network of brackish sloughs along the Oakland waterfront was choked with sediment and the eastern Bay was shallow, no more than 6 feet deep. Around the turn of the century, a number of the sloughs had been filled to create commercial zones west of the downtown area. At roughly the same time, creation of a continuous channel between Fruitvale (then known as "the Alameda Annex") and Alameda was completed, thereby making Alameda an island. In 1936, the Navy began construction of NAS Alameda. The majority of the western half of Alameda is constructed on artificial fill, as shown on Figure 1-3.

Artificial fill. Most of the filled ground came from hydraulic dredging of the Merritt Sand and Young Bay Mud just under the waters of the Bay, short distances from the areas to be filled. Rock fill for sea walls was imported by barge from quarries in San Rafael. Crushed volcanic rock, specifically rhyolite, from nearby quarries also was used in the fill materials.

By the mid-1950s, the shorelines of the Oakland area were changed to how they appear today (Rogers and Figuers 1991).

2.2.2 Installation Geology

This section provides a description of the Alameda Point installation geology based on interpretation of the occurrence of unconsolidated, Quaternary-aged units encountered in subsurface investigations completed to date. The installation geology is described beginning with the uppermost units encountered at the surface down to bedrock.

Artificial Fill. The artificial fill is the uppermost lithologic unit and underlies most of Alameda Point, ranging in thickness from 0 to 30 feet. The artificial fill is thickest in the western portion of Alameda Point and generally thins eastward across Alameda Point. The artificial fill is thinnest in the locations of former tidal flats. The varying thickness of the artificial fill results from natural variations in the surface topography of the estuary before artificial filling activities began in the late 1800s.

The artificial fill at Alameda Point consists of sediments dredged from the surrounding Bay and the Oakland Inner Harbor. Although the composition of the artificial fill varies, it generally consists of silty sand or sand with minor inclusions of clay or gravel or both. The composition of the artificial fill most likely consists of dredged portions of the Merritt Sand Unit and the Bay Sediment Unit (BSU) (Rogers and Figuers 1991). The installation fill history is shown on Figure 1-3.

Bay Sediment Unit. The BSU, which consists of Holocene-aged estuarine (tidal flat) deposits, is the youngest, naturally occurring unit in the vicinity of Alameda Point. The BSU is equivalent to the Young Bay Mud discussed in Section 2.2.1. The BSU is about 40 feet thick in the western portion of Alameda Point, thinning and pinching out in the southeastern region at the former shoreline of Alameda Island (Figure 2-2). The BSU is encountered at a depth of about 25 feet below ground surface (bgs) in the western portion of Alameda Point and at a depth of about 5 feet bgs in the eastern portion of the installation. The BSU is made up of tidal flat deposits consisting of varying degrees of fine- and coarse-grained material that grade westward, away from the former shoreline, into finer grained subtidal deposits. The BSU consists of gray to black silt and clay with discontinuous, poorly graded, silty and clayey sand layers. In some parts of the western region of Alameda Point, the lower portion of the BSU is composed predominantly of gray to black sand.

A layer with high organic content, called the “marsh crust,” typically marks the top of the BSU throughout the eastern portion of the installation. The marsh crust is a layer of contaminated sediment that was formed by the discharge of petroleum wastes into the former tidal flats from two gas plants and an oil refinery before Navy acquisition of the property. After deposition in the tidal flats, this waste migrated over much of the surface of the surrounding marshlands and was dispersed and deposited through tidal actions in subtidal areas that later were filled to become Alameda Annex and the eastern portion of Alameda Point. Fill materials were placed in these areas from as early as 1887 to as recently as 1975 (see Figure 1-3). The marsh crust is encountered at depths of 10 to 20 feet bgs in the eastern half of the installation (Navy 2001a) (see Figure 2-2). Areas where the marsh crust is known to exist are subject to excavation restrictions

known as the Marsh Crust Ordinance (City of Alameda 2000) that limits the extent of excavations to designated threshold depths.

Merritt Sand. Over most of the installation, the Merritt Sand underlies the BSU. The Merritt Sand is encountered at depths ranging from 40 feet bgs in the western portion of the installation to surface outcrops in the southeastern portion of the installation. At Alameda Point, the Merritt Sand is composed of brown, fine- to medium-grained, poorly graded sand. Bivalve shells and shell hash are observed in parts of the Merritt Sand, indicating some marine reworking during the most recent sea level rise. The thickness of the Merritt Sand ranges from 8 feet to 60 feet across Alameda Point.

San Antonio Formation (upper member). At Alameda Point, the upper member of the San Antonio Formation generally unconformably underlies the Merritt Sand and consists of interbedded layers of gray sand and clay ranging in thickness from 10 to 40 feet in the eastern portion and from 7 to 70 feet in the central portion of the installation. A persistent layer containing shells and sand is present near the top of the formation. The San Antonio Formation is present over most of the installation but is absent where a paleochannel crosses the northern half of the central and western portions of the installation. Greenish-gray clay layers within the upper member of the San Antonio Formation may not be regionally continuous. An organic-rich layer containing plant debris or peat is occasionally present at the base of the formation.

A paleochannel (former stream channel cut through existing sediments then filled with younger sediments) underlying Alameda Point is located along an east-west trending axis through the middle of the installation. The paleochannel was cut through the Merritt Sand and into the upper unit of the San Antonio Formation. Then it was filled with the encroaching BSU, which consisted of low-permeability silts and clays with discontinuous layers of poorly graded sands. Those poorly graded sands become continuous and thicker in the western region of the installation. Although the southern bank of the east-west trending paleochannel is located more than 1,000 feet north of OU-2A, tributaries of this ancient stream created north-south trending channels that may have caused localized depositional variability at OU-2A.

Yerba Buena Mud (Lower San Antonio). Yerba Buena Mud at Alameda Point reaches a maximum thickness of 50 feet at the west end and thins to the east but does not pinch out. The top of the Yerba Buena Mud occurs at elevations of 50 to 100 feet below mean sea level (msl). The top of the Yerba Buena Mud dips approximately 2 degrees to the southwest under the installation (Rogers and Figuers 1991). In borings conducted at OU-2A, it is described as a stiff, plastic, dark gray to blue fat clay. The presence of organic matter and changes in sand or silt content vary locally.

Alameda Formation. The Alameda Formation underlying Alameda Point ranges in thickness from approximately 250 feet at the western edge of the installation to approximately 850 feet at the eastern end of the installation. In the central portion of the installation, the formation is about 600 feet thick (Rogers and Figuers 1991).

Franciscan Complex. Most of the installation overlies the western side of the trough that was described in Section 2.2.1. Bedrock of the Franciscan Complex underlies Alameda Point at elevations ranging from approximately 400 to 950 feet below msl. The bedrock surface under Alameda Point dips to the east-southeast at an angle of approximately 1 degree (Rogers and Figuers 1991). The axis of the bedrock depression in the Bay Area is oriented northwest-southeast and is coincident with the eastern part of the installation.

2.3 HYDROGEOLOGY

The following sections provide a description of the regional and installation hydrogeology of Alameda Point. A discussion of the hydrogeology at OU-2A is included in Section 4.2.

2.3.1 Regional Hydrogeology

Alameda Point is near the center of the San Francisco Basin, one of three groundwater basins beneath the greater Bay Area. The groundwater basins are elongated, sediment-filled troughs oriented in a northwest-southeast direction, parallel to the trend of regional geologic structural features. The lower half of the San Francisco Basin is filled with continental units; the upper part of the San Francisco Basin is filled with an alternating sequence of marine and continental units.

Regional aquifers and aquitards in the San Francisco Basin, described in the following text, were identified and named in the 1950s. Generally, the aquifers correlate with the continental/alluvial fan deposits and the aquitards correspond to estuarine mud deposits such as the Young Bay Mud and the Yerba Buena Mud. Aquifers in the east Bay extend east to the Hayward Fault, where they merge into a vertically continuous, coarse-grained alluvial fan sequence.

The aquifers are nonhomogeneous, and the aquifer materials generally become finer from east to west, but they can exhibit significant lateral and vertical variations, which reflect changes in the natural localized depositional environments.

Three primary aquifers in the east Bay Area consist of (from upper to lower) the Newark, Centerville, and Fremont aquifers. The Newark Aquifer is contained within sediments of the San Antonio, Merritt Sand, and Posey Sand Formations, and is generally 100 to 150 feet thick in the region. It is confined in the areas where the Merritt Sand is overlain by the Young Bay Mud, which is called the Newark Aquitard in these areas. The Newark Aquifer is unconfined in areas where the Young Bay Mud is absent.

The Newark Aquifer is confined below by the Irvington Aquitard. The Irvington Aquitard is contained in fine-grained sediments of the Yerba Buena Mud. The Irvington Aquitard acts as a confining unit for the Centerville Aquifer, which underlies the Irvington and is contained in the upper part of the Alameda Formation.

Below the Centerville Aquifer, is the Fremont Aquifer, which corresponds to continental sediments deposited at an earlier time. This deeper aquifer is confined by estuarine sediments in the upper portion of the Alameda Formation (Figuers 1998).

2.3.2 Installation Hydrogeology

Unconfined groundwater occurs within the artificial and natural unconsolidated deposits underlying Alameda Point at depths ranging from approximately 6 feet bgs in the southeastern portion of the installation to approximately 10 feet bgs in the central and western portions. Groundwater also occurs under semiconfined conditions at Alameda Point in areas where the BSU functions as an aquitard.

The following section describes the hydrostratigraphy or system of aquifers and intervening aquitards underlying Alameda Point. The water-bearing units encountered at Alameda Point have been named based on their sequence in the subsurface; the aquitards are named based on the formation they are in. The local hydrostratigraphic units at Alameda Point correlate with regional hydrostratigraphic units described in Section 2.3.1, as shown in parentheses below.

2.3.2.1 Hydrostratigraphy

Five local hydrostratigraphic units are identified at Alameda Point. Water-bearing units include the first water-bearing zone (FWBZ) (Newark Aquifer) and the second water-bearing zone (SWBZ) (confined Newark Aquifer). The FWBZ and the SWBZ are separated by the BSU (Newark Aquitard); the occurrence of the SWBZ depends on the presence of the BSU, which acts as an aquitard separating the FWBZ and the SWBZ. The water-bearing units are underlain by the Yerba Buena Aquitard (Irvington Aquitard). The hydrostratigraphic units at Alameda Point are described (beginning at the top) below.

First Water Bearing Zone

The FWBZ is an unconfined aquifer that occurs within the uppermost permeable units at Alameda Point, primarily the artificial fill materials, if present, or the Merritt Sand and the Upper San Antonio Formation in areas where the artificial fill and BSU are absent. Groundwater in most of the FWBZ at Alameda Point is fresh, although the FWBZ is sometimes brackish (slightly saline) in areas near the Bay shoreline.

The FWBZ in the artificial fill occurs mainly in the western and central parts of the installation and in a portion of the southeastern area. The FWBZ in the artificial fill extends vertically to the base of the fill, except in localized zones where more permeable materials occur in the upper part of the underlying BSU. In that case, the permeable part of the BSU functions as part of the FWBZ. In other areas where the BSU consists of low permeability materials, it acts as a confining layer below the FWBZ in the artificial fill.

The FWBZ is subdivided into upper and lower units in areas where the BSU functions as part of the FWBZ. The portion of the FWBZ in the artificial fill is referred to as the upper first-water bearing zone (FWBZU), and the portion in the BSU is referred to as the lower first water-bearing zone (FWBZL).

In portions of the southeastern part of the installation, where the BSU does not occur in a continuous layer, the FWBZ occurs primarily in the artificial fill (where present), the Merritt Sand Formation, and the underlying Upper San Antonio Formation. In those areas, the FWBZ extends vertically to the top of the Yerba Buena Mud (Lower San Antonio Formation), which acts as a confining layer below the FWBZ.

The FWBZ may also be subdivided into the FWBZU, consisting of a thin layer of artificial fill and the upper portion of the Merritt Sand, and the FWBZL, consisting of the lower portion of the Merritt Sand and the upper San Antonio Formation.

There is no connection between the shallow aquifer systems in artificial fill materials on Alameda Island and the Oakland mainland because Oakland Inner Harbor bisects the Merritt Sand unit. The Merritt Sand unit on Alameda Island is hydraulically isolated from mainland aquifers.

Bay Sediment Unit Aquitard

The BSU functions as an aquitard in areas where it is present and consists of fine-grained, low permeability materials. In other areas, where it consists of higher permeability materials, the BSU forms the lower portion of the FWBZ.

Second Water Bearing Zone

The SWBZ is a semiconfined, brackish to saline aquifer that occurs within the Merritt Sand and the Upper San Antonio Formation. The SWBZ is found only in portions of the installation where the overlying BSU is both present and consists of low permeability materials, such that it acts as a confining unit for the SWBZ (see Figure 2-3). The SWBZ extends to the top of the Yerba Buena Mud, which functions as a confining unit below the SWBZ. The SWBZ is present near the shoreline in the southeastern portion of the base.

Yerba Buena Mud Aquitard

The Yerba Buena Mud functions as an aquitard that underlies the installation. The top of the Yerba Buena Mud has been encountered in some borings drilled at the installation, but no borings advanced during the RI have drilled through the entire unit. Based on available data, the thickness of the Yerba Buena Mud Aquitard underlying the installation is approximately 50 to 90 feet. As such, the Yerba Buena Mud Aquitard most likely is continuous beneath the installation, which limits or prevents hydraulic communication between the first and second water-bearing units and the underlying Alameda Aquifer.

The thickness of the Yerba Buena Mud Aquitard underlying the Oakland Inner Harbor is approximately 50 to 110 feet. The presence of the aquitard prevents mixing of fresh water in the Alameda Formation with saline water in the more shallow aquifers (Subsurface Consultants Inc. 1998).

Alameda Aquifer

The Alameda Aquifer is a confined, regional drinking water aquifer that occurs in the Alameda Formation (Tetra Tech 2000a). This aquifer is also known as the regional Centerville Aquifer (Section 2.3.1). The Alameda Aquifer is confined by the overlying Yerba Buena Mud Aquitard. The Alameda Formation yields fresh water (Hickbottom 1998) and most likely is isolated hydraulically from overlying saline aquifers based on pumping tests conducted in the Alameda during which no response was measured in overlying units (Hydro-Search, Inc. [HSI] 1977).

Three wells on or near Alameda Point are screened in the confined Alameda Formation. Two of the wells are in operation, and one of the wells has been closed. Of the two operational wells, one is near the intersection of what is now Pan Am Way and West Red Line Avenue on Alameda Point, and the other is near the intersection of 5th Street and Pacific Avenue, east of Alameda Point. Both of these wells are used for irrigation (Tetra Tech 2000a).

2.3.2.2 Installation Regional Subdivisions

Alameda Point has been divided into three regions based on geologic and hydrogeologic similarities: the southeastern, western, and central regions (see Figure 2-3). The boundary between the central and southeastern regions has been drawn historically along an east-west line north of OU-2A, which coincides with the change of the BSU from an aquitard to an aquifer. In the area south of the line, the BSU's thickness and lithology allow it to function as a part of the FWBZ. The hydrostratigraphy of each of these regions is described in the following sub-sections.

Southeastern Region Hydrostratigraphy

In the southeastern region of Alameda Point, the BSU is discontinuous, thin, or is not present at all. The BSU does not occur east of the former shoreline (see Figure 2-2). The BSU Aquitard is present only in the southwestern portion of OU-2A. Where the BSU Aquitard occurs, the FWBZ is within a thin layer of artificial fill, and the SWBZ is in the Merritt Sand and the Upper San Antonio Formation. Where the BSU Aquitard does not occur, the FWBZ is within a thin layer of artificial fill, but primarily in the Merritt Sand and the Upper San Antonio Formation, which together reach a thickness of approximately 65 to 80 feet. The correlations of installation geologic and hydrogeologic units are illustrated on Figure 2-3; it is discussed in greater detail in Section 4.2.

Western Region and Central Region Hydrostratigraphy

The western region and central region of Alameda Point are north and west of OU-2A (see Figure 2-3).

The FWBZ occurs primarily in the artificial fill materials in the western region and the central region. The saturated thickness of the FWBZ ranges from less than 10 feet in the central regions to over 30 feet in the western region. In the western region, the upper portion of the BSU consists entirely of silt and clay; however, in the southern part of the central region, the upper portion of the BSU contains interbedded silt and sand that cause that portion of the BSU to be included in the FWBZ.

The SWBZ occurs within the Merritt Sand and the Upper San Antonio Formation in the western region and the central region. The SWBZ in these regions are confined locally and contained in the lower portion of the BSU, the Merritt Sand Formation (where present), and the Upper San Antonio Formation.

The SWBZ is underlain by the Yerba Buena Mud aquitard, which is approximately 60 feet thick in the western region and the central region of the installation.

2.3.2.3 Groundwater Flow

The shallow groundwater at Alameda Point flows in a radial pattern toward the Bay, Oakland Inner Harbor, or Seaplane Lagoon in the FWBZ. Groundwater flow directions vary locally as a result of seasonal changes in precipitation rates and diurnal variations related to tidal cycles. Groundwater in the southeast region of the base generally flows from the east or northeast inland areas to the west towards the Seaplane Lagoon and the Bay. A sheet pile wall located along the eastern edge of the Seaplane Lagoon has resulted in mounding of groundwater to the east of the Seaplane Lagoon. Groundwater is recharged by vertical infiltration of precipitation, horticultural irrigation, leaking water supplies, and from sanitary or storm sewer pipes. Tidal inundation of storm water conveyance lines also may contribute to recharge of the FWBZ.

Groundwater in the FWBZ within the central and western regions of Alameda Point generally flows in a radial pattern toward the Bay, the Oakland Inner Harbor, and the Seaplane Lagoon. A sheet pile wall located along the northern edge of the Seaplane Lagoon has resulted in mounding of groundwater to the north of the Seaplane Lagoon. Groundwater flow is affected locally near industrial buildings by preferential flow paths such as storm water drains and underground utility conveyance structures. The FWBZ is tidally influenced on the northern, western, and southern sides of Alameda Point. Tidal influence studies indicate the region of influence extends about 250 to 300 feet inland on the northern and southern sides of Alameda Island and about 1,000 to 1,500 feet inland on the west side. Diurnal tidal fluctuations measured in the FWBZ range from 0.1 to 4 feet (PRC Environmental Management, Inc. [PRC EMI] 1997a).

The SWBZ appears to be a semiconfined aquifer and is composed of the silty sands within the lower portion of the BSU, the Merritt Sand Unit, and the upper unit of the San Antonio formation. The potentiometric elevation of the SWBZ ranges from 3 to 9 feet mean lower low water (MLLW).

The upper and lower units of the San Antonio Formation underlie the Merritt Sand. The lower unit, the Yerba Buena Mud, is believed to be both locally and regionally continuous and a significant barrier to potential contaminant migration. This observation is supported by numerous local and regional boring logs showing an extensive, coherent stratigraphic unit; by the fact that the underlying Alameda Formation yields fresh water while the overlying Merritt Sand and upper unit of the San Antonio Formation yield saline to hypersaline water (Hickbottom 1988); and by pumping tests performed in the Alameda Formation during which no drawdown was observed in the overlying Merritt Sand or upper unit of the San Antonio Formation (Hydrosearch Inc. [HSI] 1977).

The SWBZ is recharged mainly by lateral flow (through the Merritt Sand) from upgradient areas on Alameda Island. Another source of recharge may be the upper unit of the San Antonio Formation, although the thickness and discontinuity of the water-bearing zones within the upper unit of the San Antonio Formation would preclude a significant contribution. The sources of recharge for the Merritt Sand unit are precipitation; irrigation; and pipe leakages from water supply, sanitary sewer, and storm sewer systems. The SWBZ is believed to discharge through lateral groundwater flow to the Bay, the Oakland Inner Harbor, and the Seaplane Lagoon.

2.3.3 Existing Uses of Groundwater

Groundwater beneath Alameda Point was evaluated for potential beneficial uses in 2000 (Tetra Tech 2000a). EPA's Guidelines for Groundwater Classification under the EPA Groundwater Protection Strategy (EPA 1988b) are used to classify groundwater as Class I, II, or III. A Class I groundwater is an irreplaceable source of drinking water or is ecologically vital. A Class II groundwater is a current or potential source of drinking water and a water that has other beneficial uses. A Class III groundwater is not a potential source of drinking water and is of limited beneficial use. EPA classifies groundwater having an existing or potential use as a drinking water supply (Class I or II) using the following criteria: a total dissolved solids (TDS) concentration less than 10,000 milligrams per liter (mg/L) and a minimum well yield of 150 gallons per day (gpd) or 0.104 gallons per minute (gpm). Under California State Water Resources Control Board (SWRCB) Resolution No. 88-63 (SWRCB 1988), all groundwater is considered potentially suitable for municipal or domestic supply, unless the TDS content exceeds 3,000 mg/L or a well cannot provide a sustainable yield of 200 gpd or 0.139 gpm. The state identifies other potential beneficial uses of groundwater, including industrial service and industrial supply, agricultural supply, and freshwater replenishment (RWQCB 1995). For the purposes of CERCLA response actions, EPA's guidelines are used to classify groundwater, because (1) EPA guidelines for TDS and well yield are more protective than state criteria and (2) the State of California does not have an EPA-approved comprehensive state groundwater protection plan.

Based on federal TDS and yield criteria, the FWBZ in the southeastern portion of Alameda Point beneath Sites 3, 4, 9, 11, 13, 16, 19, 21, 22, and 23 is a Class II aquifer.

The FWBZ in the southeastern region of Alameda Point is connected to another Class II groundwater (Merritt Sand) that is a drinking water source for off-base wells on Alameda Island. Sixty upgradient wells are screened in the Merritt Sand immediately east (up to 1 mile) of Alameda Point, and an additional 113 upgradient wells are screened in the Merritt Sand, between 1 and 2 miles east-southeast of Alameda Point. The majority of the wells were installed during the 1970s to provide a supplemental source of irrigation water for homeowners on Alameda Island. During a recent backflow prevention device field survey, the East Bay Municipal Utilities District (EBMUD) found that many of the wells are no longer in use; however, some of them are still used for backyard irrigation. No restrictions exist on the type of well use (domestic supply, industrial supply, or irrigation).

The EPA Well Head Protection Area model was used to determine whether an off-base well could capture a groundwater contaminant plume from the southeastern region of Alameda Point. The model indicated that plume capture from Sites 22 and 23 was possible at pumping rates of 3 gpm. The existence of these wells in addition to the classification of the aquifer as Class II, indicates that the groundwater in this area is a potential, and possibly current, source of drinking water. Maximum contaminant levels (MCL) will most likely be considered for evaluating remedial alternatives to address contaminated groundwater beneath Sites 3, 4, 9, 11, 13, 16, 19, 21, 22, and 23. Reuse plans (EDAW 1996) by the City of Alameda call for mixed use, which could involve residential consumption of groundwater. Other possible uses for groundwater below OU-2A would be for watering livestock and crop irrigation. Industrial uses would require pretreatment for TDS. It is highly unlikely that water below Alameda Point will be used for watering livestock based upon the proposed land uses.

2.4 ECOLOGY

The following sections summarize the ecology of the Bay Area and Alameda Point. They include a description of the ecological regions, soil types, habitats, and dominant species as well as special status species found in the Bay Area and at Alameda Point.

2.4.1 Regional Ecology

The Bay Area is situated in the California coastal chaparral forest and scrub province of the Mediterranean division and includes the discontinuous coastal plains. The coastal province has a more moderate climate than the interior and receives some moisture from fog in the summer. These coastal plains are characterized by sagebrush and grassland communities. Exposed coastal areas support desert-like shrub communities called coastal scrub, dominated by coyote bush, California sagebrush, and bush lupine. Most of the coastal plains in the Bay Area have been converted to urban use; however, the area continues to be a major resource and migration route for both aquatic and terrestrial birds (Bailey 1995).

2.4.2 Habitat Types and Dominant Species

The following six major terrestrial and aquatic wildlife habitats were identified at Alameda Point in the Final Environmental Impact Statement (Naval Facilities Engineering Command, Field Activity West [EFA West] 1999):

- Open Water Area
- Grassland
- Landscaped or Developed
- Intensively Developed
- Airfield (Paved) Area
- Rock Breakwaters and Rip Rap

Figure 2-4 shows that a portion of the grassland was surveyed and determined not to be a jurisdictional wetland and that three areas at Alameda Point have been delineated as wetlands. Two of the wetland areas (West Beach Wetland and Runway Wetland) can be classified as salt marsh or brackish tidal marsh and were delineated using U.S. Army Corps of Engineers (COE) criteria (PRC EMI and Kinnetic Laboratories, Inc. [KLI] 1993) (International Technology Corporation [IT] 2001). The third wetland north of CERCLA Site 15 was delineated using COE criteria as part of the OU-1 RI for Sites 14 and 15.

OU-2A sites are considered intensively developed areas and are bordered by other intensively developed areas (see Figure 2-4). The intensively developed areas consist primarily of buildings, roads, and parking lots and have little vegetation (EFA West 1999). These areas are primarily in the eastern end of the installation. Typical urban wildlife, such as California ground squirrels, scrub jays, and American robins, may be observed in the intensively developed areas but to a lesser extent than in the landscaped/developed areas because less foraging habitat is available in these areas. Feral cats also are found in the intensively developed area.

2.4.3 Special Status Species

Special status species that occur or are expected to occur at Alameda Point were identified by the U.S. Fish and Wildlife Service (FWS) and are summarized in Table 2-1 (FWS 1993). The species are federal- or state-designated threatened or endangered species. Some species do not receive legal status under federal or state endangered species acts, but are identified by the state as "Species of Special Concern."

Trask and Rolston
(1951)

Radbruch
(1957, 1969)

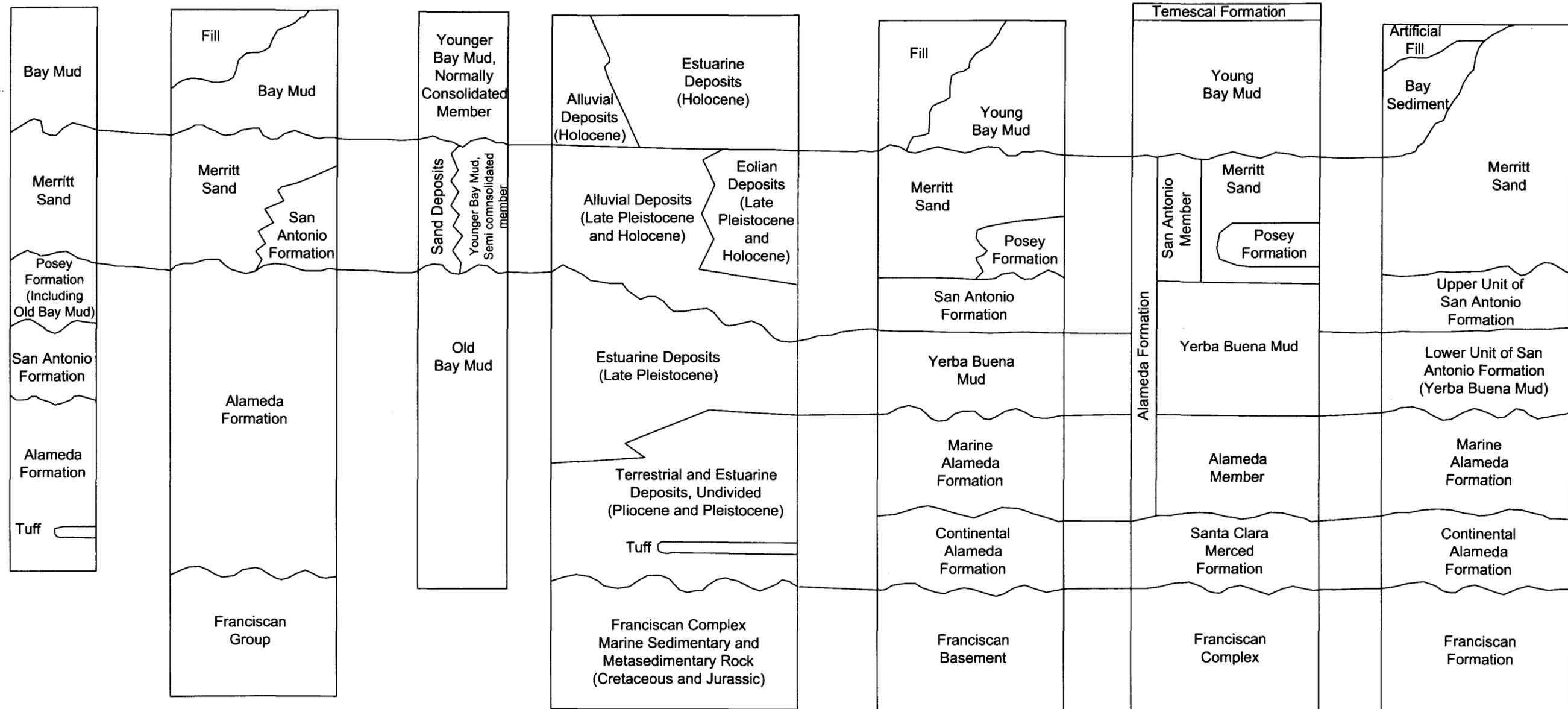
Treasher
(1963)

Atwater and others
(1977)

Rogers and
Figuers
(1991)

Figuers
(1998)

This Report



Notes:

1. Zig-Zag lines indicate inter-fingering of time equivalent units
2. Wavy lines indicate unconformities

 Tetra Tech EM Inc.

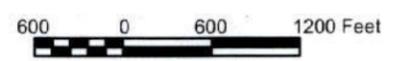
Alameda Point
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-1
CORRELATION OF STRATIGRAPHIC
INTERPRETATIONS OF PREVIOUS
INVESTIGATIONS
Operable Unit 2A
Remedial Investigation Report



- EXTENT OF BAY SEDIMENT UNIT
- AREA SUBJECT TO MARSH CRUST RESTRICTIONS
- EXTENT OF FORMER ISLAND 1865 (RADBRUCH 1957)
- - - CERCLA SITE
- LAND COVER
- WATER

Notes:
 Source: NAVY 2001a
 CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980

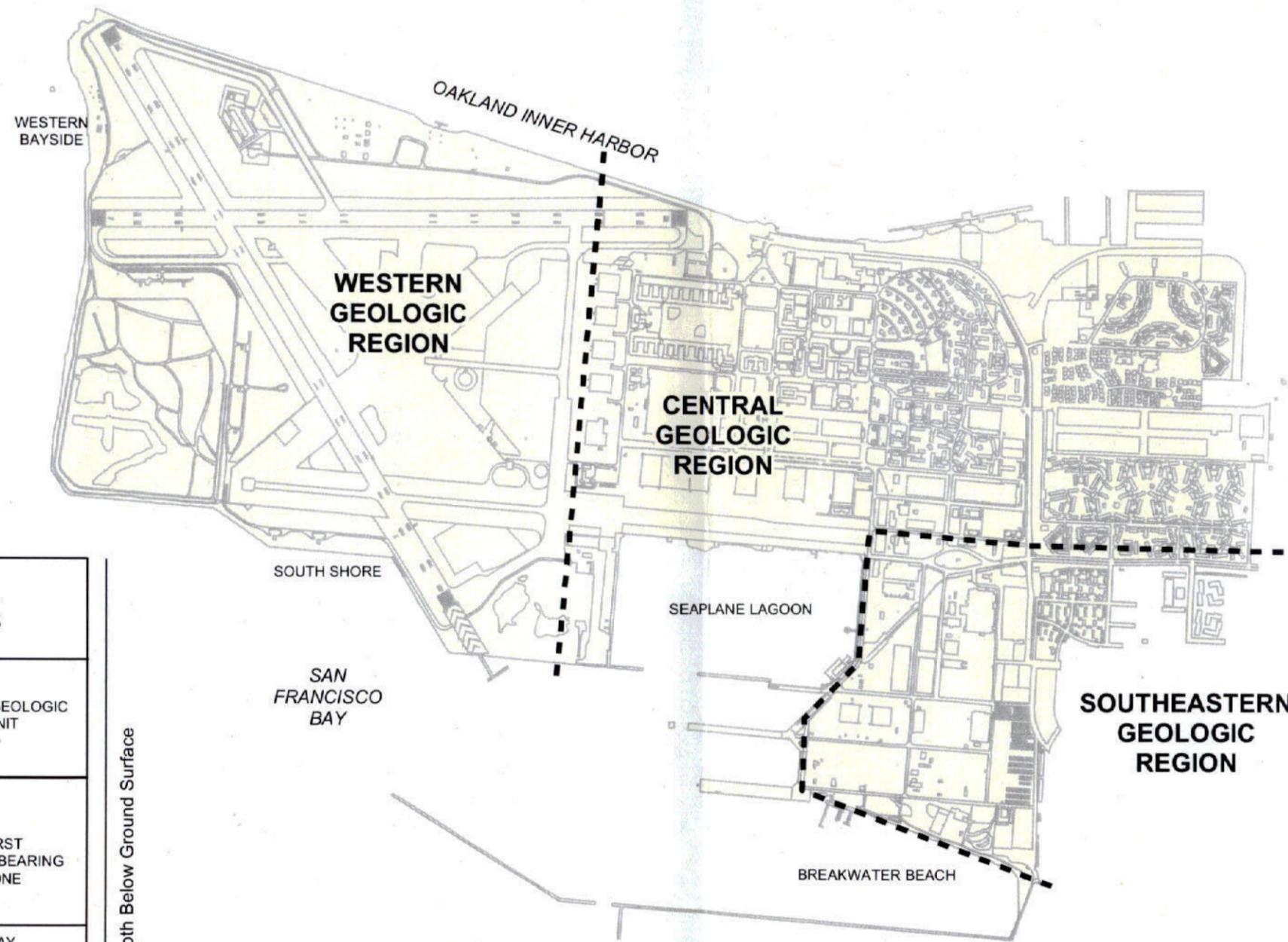


Tetra Tech EM Inc.

Alameda Point
 U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-2
EXTENT OF BAY SEDIMENT UNIT
AND MARSH CRUST AREA

Operable Unit 2A
 Remedial Investigation Report



LITHOSTRATIGRAPHIC UNIT		HYDROGEOLOGIC UNIT
FILL		FIRST WATER-BEARING ZONE
BAY SEDIMENTS		BAY SEDIMENT UNIT
MERRIT SAND		SECOND WATER-BEARING ZONE
SAN ANTONIO FORMATION	UPPER SAN ANTONIO UNIT	YERBA BUENA AQUITARD
	YERBA BUENA MUD	

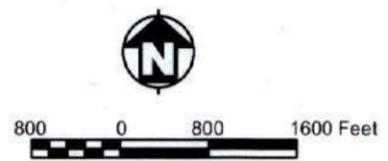
Increasing Depth Below Ground Surface

SOUTHEASTERN GEOLOGIC REGIONS		
LITHOSTRATIGRAPHIC UNIT	HYDROGEOLOGIC UNIT	
FILL	FWBZ	FWBZU
BAY SEDIMENTS	BAY SEDIMENTS	
MERRIT SAND	SWBZ	FWBZL
SAN ANTONIO FORMATION	UPPER SAN ANTONIO UNIT	YERBA BUENA AQUITARD
	YERBA BUENA MUD	

Increasing Depth Below Ground Surface

Notes:
 The FWBZU in the Southeastern Geologic Region communicates with the FWBZU in the Central Geologic Region where the Bay Sediment Unit pinches out near CERCLA Site 3. The FWBZL in the Southwestern Geologic Region becomes and communicates with the SWBZ in the Central Geologic Region north and west of CERCLA Site 3.

FWBZ = First Water-Bearing Zone
 FWBZU = Upper First Water-Bearing Zone
 FWBZL = Lower First Water-Bearing Zone
 SWBZ = Second Water-Bearing Zone



Tetra Tech EM Inc.

Alameda Point
 U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 2-3
INSTALLATION GEOLOGIC AND
HYDROGEOLOGIC DIVISIONS

Operable Unit 2A
 Remedial Investigation Report

SECTION 2 – GENERAL ENVIRONMENTAL
SETTING AND HISTORY

FIGURE 2-4
ECOLOGICAL HABITAT MAP

AS PER RPM, THIS FIGURE CANNOT BE
RECOVERED.

FINAL REMEDIAL INVESTIGATION REPORT
SITES 9, 13, 19, 22, AND 23
OPERABLE UNIT 2A (OU-2A)

QUESTIONS MAY BE DIRECTED TO:

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TABLE 2-1: SPECIAL STATUS SPECIES

Remedial Investigation Report for Sites 9, 13, 19, 22, and 23, Alameda Point, Alameda, California

	COMMON NAME	SCIENTIFIC NAME	STATUS
PLANTS	Alkali milk-vetch	<i>Astragalus tener var. tener</i>	SC
	Beach layia	<i>Layia carnosa</i>	FE, SE
	Bent-flowered fiddleneck	<i>Amsinckia lunaris</i>	SC
	Knot grass (Kellogg's horkelia)	<i>Horkelia cuneata ssp. sericea</i>	SC
	Robust spinflower	<i>Chorizanthe robusta var. robusta</i>	FE
	Rose linanthus	<i>Linanthus rosaceus</i>	SC
	Round-leaved filaree	<i>Erodium macrophyllum</i>	Not listed
	Saline clover	<i>Trifolium depauperatum var. hydrophilum</i>	SC
	San Francisco Bay spineflower	<i>Chorizanthe cuspidate var. cuspidate</i>	SC
	Santa Cruz tarplant	<i>Holocarpha macradenia</i>	FT, SE
	Kellogg's horkelia	<i>Horkelia cuneata sericea</i>	SC
	Point Reyes bird's beak	<i>Cordylanthus maritimus palustris</i>	FE
BIRDS	California least tern ¹	<i>Sterna antillarum browni</i>	FE, SE
	White-tailed kite	<i>Elanus leucurus</i>	SC
	Double-crested cormorant, rookery sites	<i>Phalacrocorax auritus</i>	C
	California black rail	<i>Laterallus jamaicensis coturniculus</i>	SC
	California clapper rail	<i>Rallus longirostris obsoletus</i>	FE, SE
	Northern harrier	<i>Circus cyaneus</i>	C
REPTILE	California tiger salamander	<i>Ambystoma californiense</i>	FE
FISH	Tidewater goby	<i>Eucyclogobius newberryi</i>	FE, C
MAMMALS	Saltmarsh harvest mouse ²	<i>Reithrodonomys raviventris</i>	FE, SE

Notes:

C State Species of Concern

SC Federal species of concern

FE Federally endangered

SE State endangered

FT Federally threatened

1 Nesting colonies within Alameda Point, west of the sites.

2 In 1995, a survey for the saltmarsh harvest mouse was conducted in the West Beach Landfill and the Runway Area Wetlands to identify potential receptors for evaluation in ecological risk assessments being conducted by the Navy for the Installation Restoration Program. No individuals were captured during these surveys of the West Beach Landfill and Runway Area Wetlands.

Source: California Department of Fish and Game Natural Diversity Data Base, Oakland West Quadrangle, October 21, 2003.

3.0 REMEDIAL INVESTIGATION APPROACH

This section describes the general RI approach used at Sites 9, 13, 19, 22, and 23. The regulatory status of Alameda Point, and specifically of the sites under CERCLA, provides the framework for this approach and is presented in Section 3.1. The approach used to conduct the RI includes the following steps: (1) scoping, (2) environmental investigations, (3) data evaluation, and (4) conclusions and recommendations. The approach used to scope the RI is presented in Section 3.2, which describes the process used to identify potential sources at each site, the media potentially affected, the data needs, and development of an initial CSM. Environmental investigations conducted at Alameda Point in support of the Installation Restoration (IR) Program and to verify the initial CSM are described in Section 3.3. These investigations were conducted under CERCLA, the Resource Conservation Recovery Act [RCRA], the environmental baseline survey [EBS], and the total petroleum hydrocarbon [TPH] program. Section 3.4 summarizes the methods that were used to evaluate the data from those investigations. This section presents the process used to evaluate the data in support of the CERCLA risk management process, which included preparation of site-specific CSMs, data quality assessments, background comparisons, evaluations of the nature and extent and fate and transport of contamination, an HHRA, and an ERA. Section 3.5 presents the approach used to draw conclusions and make recommendations about the types and amounts of contamination at the sites.

The results of this RI approach are presented in a similar order in the site-specific sections (Section 5 through 9).

3.1 REGULATORY STATUS

One of the consequences of the operations that occurred at Alameda Point during its years of operation was the release of contamination to soil, sediments, and water. The Navy began investigations of contaminated sites in 1982 under the auspices of the Navy Assessment and Control of Installation Pollutants (NACIP) Program. Under the NACIP Program, 12 sites were evaluated during an initial assessment study (IAS); additional study was recommended at seven of these sites, which included Site 13 (Naval Energy and Environmental Support Activity [by Ecology and Environment [E&E] 1983). In 1988, the Navy received a Remedial Action Order from the California Department of Health Services (now known as DTSC) that identified an additional 16 sites for evaluation.

In 1986, the Superfund Amendment and Reauthorization Act (SARA) formally established the authority and funding for the Defense Environmental Restoration Program to guide U.S. Department of Defense (DoD) cleanups. Section 2701 of Title 10 of the *United States Code* codified the Defense Environmental Restoration Program. SARA also accomplished the following:

- Established CERCLA as a statutory requirement for DoD
- Modified terminology and procedures to match those provided in the National Oil and Hazardous Substances Contingency Plan (NCP)
- Provided EPA and states broad power to review, comment, and, in some instances, approve documents and decisions
- Established specific reporting requirements
- Subjected federal facilities to listing on the NPL
- Mandated interagency agreements between EPA and federal facilities on the NPL

In 1987, Executive Order 12580 delegated CERCLA authority to DoD. CERCLA, commonly known as Superfund, (1) established prohibitions and requirements concerning closed and abandoned hazardous waste sites, (2) provided for liability of persons responsible for releases of hazardous substances at these sites, and (3) established a trust fund to provide for cleanup when no responsible party could be identified.

Congress directed that DoD environmental cleanup efforts be consistent with CERCLA. Additionally, CERCLA itself requires that cleanup efforts at federal facilities be conducted under CERCLA. Due to these reasons, and in order to have a common framework for managing a national cleanup program, DoD uses CERCLA as the primary legislative authority for managing cleanup of DoD sites. As the lead agency for cleanup under CERCLA, DoD can also take advantage of existing CERCLA authorities (such as removal actions) to expedite cleanup.

In 1988, Congress passed the Base Closure and Realignment Act. This act (together with subsequent base closure laws) established the basic requirements for identifying and implementing domestic military base closures and realignments, including the transfer of surplus property from DoD to other entities. One element of the act was to require that all transfers of property must be conducted in accordance with Section 120(h) of CERCLA. In 1992, the Community Environmental Response Facilitation Act amended Section 120(h) of CERCLA. This amendment added the requirement that DoD identify and document all uncontaminated real property, or parcels thereof, at installations undergoing closure or realignment. The mechanism identified for this documentation was an EBS.

When NAS Alameda was listed for closure in 1993, responsibility for the environmental cleanup program at Alameda Point passed to the BCT. At Alameda Point, the BCT comprises representatives from Navy, EPA, RWQCB, and DTSC, and the City of Alameda. The BCT provides oversight of investigations. In addition to the BCT, a Restoration Advisory Board (RAB) provides community involvement in the cleanup program.

After NAS Alameda was identified for closure, the following occurred: (1) an EBS identified the environmental condition of all property affected by base closure, (2) a program to decommission all USTs began, and (3) ongoing environmental cleanup programs were coordinated with property conversion and reuse. As a part of the program to decommission all USTs, TPH contamination was evaluated under the TPH Program, and Corrective Action Areas (CAA) were developed. The corrective action program for these petroleum-contaminated areas is overseen by RWQCB, in cooperation with DTSC and EPA.

In July 1999, NAS Alameda was listed as an NPL site (EPA 1999a). This listing included all of Alameda Point except for those parcels that have received regulatory agency concurrence pursuant to Section 120(h) of CERCLA. The identified Navy Parcel Numbers 39, 60, 63, 93, 101, and 194 as uncontaminated pursuant to CERCLA Section 120(h)(4)(a) and received concurrence from the regulatory agencies pursuant to Section 120(h)(4)(b). Therefore, these parcels are not part of the NAS Alameda NPL site. If additional uncontaminated property is identified in the future and receives appropriate regulatory agency concurrence, that property will not be considered part of the NPL site. The listing of NAS Alameda on the NPL invokes the remedial requirements of the NCP and requires EPA concurrence with uncontaminated property designations. The Navy is also required to negotiate and sign an interagency agreement with EPA. Navy and EPA signed the Federal Facility Agreement in 2001.

In addition to CERCLA, hazardous waste management at Alameda Point (formerly NAS Alameda) has also been regulated under RCRA. RCRA regulations provide for cradle-to-grave tracking of hazardous wastes by establishing record-keeping requirements for hazardous waste generation, transportation, storage, and disposal. Alameda Point was listed in the May 1992 RCRA database as a large-quantity hazardous waste generator as well as a treatment, storage, and disposal facility.

DTSC regulated storage and treatment of RCRA hazardous waste at Alameda Point through two operating permits (RCRA Part A and RCRA Part B). In November 1980, the Navy originally applied to DTSC for a RCRA Part A permit (also known as an interim status document); the application covered four hazardous waste storage tanks (Tetra Tech 2003b). In March 1981, DTSC issued an interim status document for the waste container storage facility at Alameda Point (DTSC 1992a). Throughout the rest of the 1980s and into the early 1990s, DTSC approved several revisions to the RCRA Part A interim status permit (Tetra Tech 2003b). In 1992, DTSC conducted a RCRA facility assessment (RFA) at Alameda Point (DTSC 1992a). Its primary purpose was to identify solid waste management units (SWMU) and areas of concern (AOC) and to collect preliminary information on all actual or potential contaminant releases to evaluate the need and scope of a RCRA facility investigation (RFI). The 1992 RFA identified a number of RCRA facilities that were already being evaluated under the Navy's IRP. DTSC recommended a low priority for these sites in the RFI to avoid duplication with CERCLA investigations (DTSC 1992a). In July 1993, DTSC issued a RCRA Part B permit for seven hazardous waste facilities at Alameda Point (Tetra Tech 2003b). DTSC has concurred with findings of no further action (NFA) for several of the facilities formerly operating under either the Part A or the Part B permits.

Although CERCLA and RCRA are separate legislative authorities, each environmental cleanup program should operate consistently with the other and should yield similar environmental solutions when faced with similar circumstances. Any procedural differences between CERCLA and RCRA should not substantively affect the outcome of remediation.

3.2 SCOPING OF THE REMEDIAL INVESTIGATION

The Navy began environmental investigations at Alameda Point under the NACIP program in 1982. Under the NACIP program, an Initial Assessment Study (IAS) assessed the entire base for potential areas where chemicals may have affected soil and/or groundwater (E&E 1983). A verification step/characterization study was then performed in 1985 at sites that were identified for further study in the IAS (Wahler Associates 1985). In 1988, the Navy converted its NACIP program into the IRP to be more consistent with CERCLA, and investigations were conducted at Sites 9, 13, 19, 22, and 23 in a phased approach.

During the initial scoping stage of the RI, site histories and data collected during these earlier investigations were used to identify potential sources at each site, media potentially affected, and data needs. Field investigation methods were selected to meet the data needs established in the scoping process of the RI.

The following types of physical features and historical site activities were considered potential sources of contamination:

- Buildings associated with nonadministrative functions
- USTs and ASTs
- Generator accumulation point (GAP)
- Oil water separators (OWS)
- Washdown areas
- Disposal and storage practices associated with hazardous waste

The site-specific sections describe the physical features and historical activities conducted at each site in addition to the types of chemicals (for example, solvents, PCBs, and metals) associated with these potential sources.

Media potentially contaminated from these physical features and historical activities and possible exposure pathways and receptors identified during the scoping stage of the RI are presented in an initial CSM (see Figure 3-1). Soil and groundwater were expected to be the primary exposure media through ingestion, direct contact, and inhalation exposure routes. Both current and

potential future receptors were identified, including human receptors (residential, commercial/industrial, and construction workers) and ecological receptors.

The storm sewer system was not evaluated as a primary source of contamination, but it was investigated in as a potential secondary contamination source wherever it exhibited the potential to transport contamination from primary sources of contamination to soil or groundwater. In addition, the storm sewers were considered to be a possible preferential pathway for the discharge of contaminant plumes into the Oakland Inner Harbor or San Francisco Bay. The storm sewer system lies within the fill material and consists of storm sewer lines, accessways, manholes, catch basins, and outfalls on the base and in the outlying base housing area. Much of the system is below the water table. It was initially constructed by the Navy to collect basewide surface runoff from streets, runways, the tarmac, landscaped areas, and building roof drains. Before 1972, the Navy also used it for industrial waste disposal. The storm sewer system conveys stormwater to the Oakland Inner Harbor, Seaplane Lagoon, or the Bay through 36 outfalls (Tetra Tech 2000b).

The initial CSM was refined through an iterative process that involved identifying areas of known or potential releases of chemicals to the environment, conducting environmental investigations, and filling data gaps until the quality and quantity of data for characterization of the nature and extent of contamination and evaluating risk at each site was judged to be sufficient. Consequently, environmental investigations at OU-2A sites focused mainly on known or potential releases and data gaps. Overall, data for OU-2A were collected using a phased biased sampling approach. With the phased approach, stakeholders were afforded opportunities to provide feedback on the suitability or adequacy of the collected data and the need to collect additional data to identify releases and complete this RI report.

The environmental investigations that were conducted at Sites 9, 13, 19, 22, and 23 to meet the data needs established in the scoping process of the RI and to address other regulatory requirements (base closure, TPH, and RCRA) are presented in the following text.

3.3 ENVIRONMENTAL INVESTIGATIONS CONDUCTED AT OU-2A

DoD established the IRP to investigate, assess, characterize, and remediate hazardous waste sites caused by historical disposal activities at military installations. The fundamental goal of the IRP is to protect human health and the environment. This section briefly describes each of the environmental investigations that were conducted at Alameda Point under the IRP. The IAS is briefly discussed because it was used to assist in scoping some of the later investigations at Alameda Point. The investigations are grouped according to the four types conducted, CERCLA, EBS, TPH, and RCRA, which are defined previously in Section 3.1. Activities specific to a site and the results of the environmental investigations are presented in the site-specific sections (Sections 5.0 through 9.0). Sampling location figures and tabular summaries of the results are provided in the site-specific sections for each of the environmental investigations. (The figures and tabular summaries for the TPH program summarize all the data collected at the site to characterize TPH and related components, which may include data collected by TPH,

EBS, or CERCLA investigations.) Summaries are provided by media, are organized according to analytical group, and include the following: (1) the number and percent of detections of chemicals; (2) the average, minimum, and maximum detected concentrations; (3) the minimum and maximum detection limits for nondetected samples; and (4) an indication of whether the maximum detected concentrations exceed EPA Region 9 residential PRGs (EPA 2002a).

3.3.1 Environmental Investigations Conducted before the Installation Restoration Program

The Navy initiated the NACIP to identify, assess, and control contamination of the environment resulting from base activities. In 1983, an IAS (E&E 1983) was completed and identified several areas for additional investigation. In addition, the assessment collected information from several active portions of the base and documented the findings in the report. Site 13, the former oil refinery previously designated as Site 11 in the IAS, was evaluated during the IAS but was not recommended for further study. Other portions of OU-2A also were evaluated during the IAS as part of the assessment.

A verification step/characterization study was performed in 1985 at sites that were identified for further study in the IAS (Wahler Associates 1985). Sites 9, 13, 19, 22, and 23 were not identified in the IAS as areas needing further study.

On June 6, 1988, the Navy received a Remedial Action Order from the California Department of Health Services (now the DTSC) that identified Sites 9, 13, 19, and 22 as needing an RI/FS in conformance with the requirements of CERCLA. In 1988, the Navy converted its NACIP program into the IRP to be more consistent with CERCLA, and investigations were conducted at the CERCLA sites in a phased approach.

3.3.2 Environmental Investigations Conducted Under the Installation Restoration Program

DoD established the IRP to investigate, assess, characterize, and remediate hazardous waste sites caused by historical disposal activities at military installations. The fundamental goal of the IRP is to protect human health and the environment. This section briefly describes each of the environmental investigations that were conducted at Alameda Point under the IRP. The investigations are grouped according to the four types of investigations conducted in conformance with CERCLA, the EBS, the TPH Program, and RCRA, which are defined previously in Section 3.1. Activities specific to a site and the results of the environmental investigations are presented in the site-specific sections (Sections 5.0 through 9.0). Within the site-specific sections, sampling location figures and tabular summaries of the results are provided for each of the CERCLA, EBS, and TPH environmental investigations. (The TPH tabular summaries summarize all the data collected at the site to characterize TPH and related components, which included data collected under TPH, EBS, and CERCLA investigations. Summaries are provided by media, are organized according to analytical group, and include the following: (1) the number and percent of detections of chemicals; (2) the average, minimum, and

maximum detected concentrations; (3) the minimum and maximum detection limits for non-detected samples; and (4) an indication of whether the maximum detected concentrations exceed Region 9 residential PRGs (EPA 2002a) Table 3-1 provides a historical summary of these investigations.

3.3.2.1 Comprehensive Environmental Response, Compensation, and Liability Act Investigations

The Navy is conducting investigations in accordance with CERCLA (EPA 1988a) at 34 sites. As a management tool to accelerate site investigation, cleanup, and reuse, the BCT at Alameda Point developed a comprehensive OU strategy, which separates 29 of the 34 CERCLA sites into a total of 10 OUs (OU-1, OU-2A, OU-2B, OU-2C, OU-3, OU-4A, OU-4B, OU-4C, OU-5, and OU-6). Site 18, the storm sewer system, was previously considered a separate CERCLA site. The site was reconfigured and the storm sewer system is now being addressed within the individual CERCLA site in which it is located.

Sites 9, 13, 19, 22, and 23, designated as OU-2A sites (see Figure 1-2), are identified as those sites with high reuse potential in their current configuration of primary industrial and office buildings, and existing manufacturing, maintenance, and infrastructure repair facilities. In October 2000, the boundaries for Site 13 and Site 23 were redefined to the current boundaries based on locations of groundwater plumes. This section briefly describes each of the environmental investigations performed at Sites 9, 13, 19, 22, and 23 under CERCLA. Activities specific to Sites 9, 13, 19, 22, and 23 are presented in site-specific Sections 5 through 9.

Sites 9, 10B (now known as 23), 13, and 19 were investigated in Phases 1 and 2A of the IRP. The Navy also investigated Site 22 during Phases 1 and 2A of the IRP (see Table 3-1). Other sites on the base were investigated in Phases 2B and 3. Investigations for Phases 1, 2A, 2B, and 3 were conducted initially to evaluate the potential impacts of site operations on soil and groundwater. The investigations were performed as described in the work plans prepared by Canonie Environmental Services (Canonie), Volumes 1-8, (Canonie 1989 and 1990) and addenda to these plans prepared by the PRC EMI team (PRC EMI and James M. Montgomery [JMM] 1991). Results for Sites 9, 13, 19, 22, and 23 investigations were summarized in the Phases 1 and 2A report (PRC EMI and Montgomery Watson Consulting Engineers [MW] 1993).

During 1994 and 1995, two follow-on investigations were conducted to collect data to fill the gaps from the Phases 1, 2A, 2B, and 3 investigations (see Table 3-1). The investigations were conducted under the follow-on field sampling plan (FSP), RI/FS, Phases 2B and 3 (PRC EMI and JMM 1994, 1996b).

The storm sewers have not been used for industrial waste disposal since 1972, and two phases of storm sewer cleaning were completed at OU-2A. In 1991, the storm sewer system at Alameda Point was cleaned and inspected, and portions of the system were replaced with new polyvinyl chloride piping. Additional portions of the storm sewer system were cleaned and inspected in 1997.

In 2000, a basewide storm sewer investigation evaluated the physical conditions of storm sewers and the places where storm sewers were submerged below groundwater; identified locations where contaminated groundwater intercepts submerged, damaged sections of storm sewers; and identified significant data gaps for further evaluation. Results were summarized in the draft final storm sewer study report (Tetra Tech 2000b)

In 2001, supplemental RI data gap sampling was conducted at OU-2A under the final FSP supplemental RI data gap sampling for OUs 1 and 2 (Tetra Tech 2001b). Results were summarized in the data summary report supplemental RI data gap sampling for OU-1 and OU-2 (Tetra Tech 2002a). The overall objectives of the supplemental data gap sampling were (1) delineation of contaminant plumes in groundwater, (2) investigation of storm sewer pathways, and (3) characterization of soil gas to evaluate the risk from the vapor inhalation pathway (Tetra Tech 2002a).

In 2001, all transformer pads were investigated to identify transformers with concentrations of PCBs greater than 50 parts per million (ppm) for replacement. In addition, wipe samples were collected at stained transformer pads. The pads were remediated (pressure washed) if PCBs were detected. Results were summarized in the final PCB report (Innovative Technical Solutions Inc. 2002).

A basewide groundwater monitoring effort was conducted during 2002 and 2003. The specific objectives of this investigation were to monitor the status of contaminant plumes in groundwater, and determine the main constituents of concern. Selected wells located within OU-2A were identified for quarterly or semiannual monitoring. The first round of sampling was conducted in June 2002. Samples were analyzed for volatile organic compounds (VOC), TPH, dissolved metals, and general chemistry.

During 2003, samples were collected and analyzed from all CERCLA sites at Alameda Point to provide data needed to calculate exposure point concentrations (EPC) for polynuclear aromatic hydrocarbons (PAH) to be used in risk assessments. At OU-2A, 175 soil borings were advanced using direct-push sampling methods. Separate samples were collected between the ground surface and 0.5 feet bgs, 0.5 feet and 2 feet bgs, 2 feet and 4 feet bgs, and 4 feet and 8 feet bgs. Results are discussed by site in Section 5 through Section 9.

Removal actions under CERCLA were conducted previously at Sites 9, 13, and at former CERCLA Site 18, the storm sewers throughout the operable unit.

An interim removal action is under way at Site 9 as a non-time-critical removal action under CERCLA. A pilot test completed in 2002 demonstrated that in situ chemical oxidation is an effective means of destroying VOCs in groundwater at Site 9. The Navy is currently conducting full-scale removal activities to reduce concentrations of VOCs at Site 9 (Shaw Environmental Inc. [Shaw] 2003a).

A removal action was conducted during 1993 and 1994 at Site 13 to address elevated concentrations of lead associated with refinery waste. The results of the removal action were documented by PRC EMI and MW (1995) in the "Remedial Investigation/Feasibility Study Data Transmittal Memorandum Sites 1, 2, 3, Runway Area, 6, 7A, 7B, 7C, 9, 10B, 11, 13, 15, 16, and 19."

3.3.2.2 Environmental Baseline Survey

After Alameda Point was identified for closure in September 1993, ongoing environmental restoration and compliance programs were coordinated with property conversion and reuse activities. As mandated under BRAC, an EBS was performed to identify the environmental condition of all property affected by base closure. As part of the EBS, all Alameda Point on-shore property was divided into parcels and grouped into 23 zones based on geographic location and expected land use. Site-specific information gathered during the EBS was used to determine each parcel's suitability for leasing or transfer based upon the intended use and the Defense Authorization Act of 1997 (enacted in September 1996).

The EBS process included a series of basewide investigations. The EBS Phase 1 investigation was conducted by ERM-West and included site visits, employee interviews, and historical research (ERM-West 1994). In addition, recommendations for additional investigations (EBS Phase 2A) were prepared and presented in the zone analysis plans and parcel evaluation plans (ERM-West 1995a and 1995b). In conjunction with the EBS Phase 2A investigation, a basewide EBS sewer investigation was conducted in accordance with the work plan for storm, industrial, and sanitary sewer sampling (IT 1994). EBS Phases 2A and 2B and the sewer investigation results are presented in the final EBS data evaluation summaries (IT 2001).

3.3.2.3 Total Petroleum Hydrocarbon Program

A program that addressed TPH contamination at Alameda Point began in August 1994 and included decommissioning of USTs and identifying 25 Corrective Action Areas (CAAs), 3 of which are related to fuel lines. The corrective action program for these petroleum-impacted areas is overseen by RWQCB, in cooperation with DTSC and EPA. No sampling has been conducted at Site 9 or Site 19 under the TPH program. Sites 13 and 23 are known as CAA 13, and Site 22 is known as CAA 4C. Several investigations, removal actions, and studies conducted within OU-2A under the TPH program are listed below:

- During 1993, the Navy responded to a release of between 3,500 to 17,000 gallons of jet propellant (JP)-5 at Building 397 within Site 13. Approximately 1,320 tons of impacted soil was excavated and removed from the site. Floating product and contaminated water were pumped into tanks before testing and disposal. Numerous underground structures and piping systems were removed during this activity. This removal action was conducted with DTSC approval.
- During November 1994, three USTs were removed from Site 22.

- A basewide removal action was conducted in 1998 to address active and inactive fuel lines across the installation (Tetra Tech 2002b). During October 1998, one fuel line that conveyed JP-5 to Building 397 was removed from Site 13. Although no removal was conducted at Site 19, one inactive fuel line was sampled and filled with grout.
- In August 1998, a metal detector survey was conducted at Site 22 to locate two USTs that were not found in 1994. The site was searched on a 5-foot grid. No metal anomalies were identified.
- In October 1999, the Navy investigated the possible presence of floating product at selected UST sites at Alameda Point. Seven monitoring wells at Site 22 were investigated for floating product. Floating product was present at Site 22.
- In April 2000, the Navy conducted a data gap investigation at Site 22/CAA 4C to determine whether methyl tertiary butyl ether (MTBE) and chlorinated hydrocarbons were present in groundwater.
- A dual-phase vacuum extraction (DVE) pilot test was conducted in 2001 to evaluate the capability of the DVE technology to recover free product from the groundwater surface and to capture hydrocarbon vapors from the soil at Site 13. The pilot test indicated that the DVE system was successfully removing the hydrocarbon contaminants from the soil. In 2002, the pilot scale DVE system was expanded to a full-scale DVE system on the east end of Building 397. During 2002, the DVE system piping was extended to Site 23 to recover free product located west of Building 530.
- During 2001, 15 soil and groundwater samples were collected to investigate the source area beneath the storage units located in the southeastern corner of Site 13.

In addition to these investigations, corrective actions have been completed from 2002 through 2003 to remove petroleum fuel contamination at Sites 13 and 23. These corrective actions addressed a spill of jet fuel at Building 397 in Site 13, and contamination by aviation gasoline and jet fuel at the former aircraft defueling area at Site 23. A third corrective action has begun to address gasoline contamination at Site 22.

3.3.2.4 Resource Conservation and Recovery Act Investigations

Storage and treatment of hazardous waste at Alameda Point was regulated through two operating permits issued by DTSC (RCRA Part A and RCRA Part B). In November of 1980, the Navy originally applied to DTSC for a RCRA Part A permit (also known as an interim status document); the application covered four hazardous waste storage tanks (Tetra Tech 2003a). In March 1981, an interim status document was issued by DTSC for the waste container storage facility at Alameda Point (DTSC 1992a). Throughout the rest of the 1980s and into the early 1990s, several revisions to the RCRA Part A interim status permit were approved by DTSC (Tetra Tech 2003a).

An RFA was conducted at Alameda Point in 1992 (DTSC 1992a). Its primary purpose was to identify solid waste management units (SWMU) and AOCs and to collect preliminary information on all actual or potential contaminant releases from these SWMUs and AOCs to evaluate the need and scope of a RCRA facility investigation (RFI). The SWMUs and AOCs identified in the RFA were divided into the following six categories:

- GAPs
- USTs
- CERCLA Program Sites
- Hazardous Waste Permit Facilities
- Miscellaneous Sites
- Tiered Permit Facilities

An RFI for Alameda Point was implemented through the coordination of existing environmental programs, namely the CERCLA program, the TPH program, and the EBS program. DTSC recommended a low priority for RCRA units located on CERCLA sites in the RFI to avoid duplication with CERCLA investigations (DTSC 1992a). Functional equivalents of RFI documents (such as RFI work plans and RFI reports) have been and continue to be issued for various SWMUs and AOCs under each of these programs. These programs have and will continue to result in the full characterization of the nature, extent, and rate of migration of hazardous waste releases at all SWMUs and AOCs at Alameda Point. Many of the results of the RFA- and RFI-related activities at Alameda Point are summarized in the 2001 EBS (IT 2001).

The status and evaluation of RCRA-nonpermitted units at Alameda Point are shown in Appendix G. The following SWMUs or AOCs were identified at Sites 9, 13, 19, 22, and 23:

- ASTs 410-A through 410-C – Site 9
- OWS 410-A and 410-B – Site 9
- AOC 009 (ASTs 324-328) – Site 13
- AOC 397 (Building 397) – Site 13
- NADEP GAP 62 (storage area on the first floor of Building 397) – Site 13
- OWS 397-A through 397-D – Site 13
- AOC 616 (Building 616 and USTs 616-1 and 616-2) - Site 19
- UST(R)-17 (USTs 547-1 through 547-3) – Site 22

- OWS 547 – Site 22
- NADEP GAPS 63, 63A and 64 (storage area on the first floor of Building 530) – Site 23
- ASTs 530A through 530C – Site 23
- OWS 529 and 530 – Site 23

Data have been collected in the areas mentioned previously under the CERCLA, EBS, and TPH investigations and are discussed further in the site-specific sections.

3.4 DATA EVALUATION METHODS

This section presents the information available about the sites and identifies the process used to evaluate the data in support of the CERCLA risk management process and to meet TPH and RCRA closure requirements. Data generated during the environmental investigations (see Section 3.3) are presented in Appendix D.

The process used to evaluate the data in support of the CERCLA risk management process included (1) a site-specific CSM, (2) data quality assessment, (3) a background comparison, (4) a nature and extent evaluation, (5) a fate and transport evaluation, (6) an HHRA, and (7) an ERA. The site-specific CSM is a result of refining the initial CSM through an iterative process that involved identifying areas of known or potential releases of chemicals to the environment, conducting environmental investigations, and filling data gaps. The site-specific CSM is a flow chart that presents the physical features and historical site activities considered the primary sources of contamination; primary, secondary, and tertiary release mechanisms; exposure pathways; and current and potential future receptors.

The data quality assessment summarizes the objective and results of the environmental investigations, defines the most appropriate use for data, and establishes the quantity and quality of data needed to support decision-making. The results of the CERCLA and EBS environmental investigations are summarized for each medium (soil, soil gas, and groundwater) in the site-specific sections (Sections 5.0 through 9.0). The summaries are organized according to analytical group and include the following: (1) the number and percent of detections of chemicals; (2) the average, minimum, and maximum detected concentrations; (3) the minimum and maximum detection limits for nondetected samples; and (4) whether the maximum detected concentrations exceed EPA Region 9 residential PRGs (EPA 2002a).

The background comparison is a statistical process used to identify the metals in soil and groundwater that are present at naturally occurring concentrations. A data set representative of ambient conditions is compared with the data sets for each site.

The objectives of the nature and extent evaluations are to: (1) present TPH and related components (benzene, toluene, ethylbenzene, and total xylenes [BTEX] and lead) detected at the site, (2) present the concentrations of chemicals believed to be used at the site, and (3) provide detailed evaluations of those chemicals that demonstrate significant risk to human health or the environment (risk drivers). Risk drivers are defined as those chemicals that pose a carcinogenic risk above 1E-06, a hazard index (HI) above 1, or that pose potential risk to ecological receptors.

The objective of the fate and transport evaluation is to determine whether the chemicals driving risk at the sites have migrated or degraded, whether there is a continuing source of contamination, and the likelihood that groundwater or other potential pathways will distribute the contaminants. The fate and transport evaluation also focuses on the risk drivers.

The HHRA and ERA estimate potential risks to human health and the environment associated with exposure to chemicals at the site from CERCLA releases and identify the chemicals associated with the risk. The HHRA and ERA identify chemicals of potential concern (COPC) and chemicals of potential ecological concern (COPEC) and evaluate the risk from these chemicals. COPCs are considered risk drivers if they pose a carcinogenic risk above 1E-06 or an HI above 1. COPECs are considered risk drivers if they pose potential risk to ecological receptors.

Because TPH is not a CERCLA chemical, separate evaluations were conducted for areas of soil and groundwater in which TPH contamination was present but not commingled with CERCLA chemicals. These separate evaluations were conducted using the "Preliminary Remediation Criteria and Closure Strategy for Petroleum-Contaminated Sites at Alameda Point" dated May 16, 2001 (the Alameda Point TPH strategy) (Navy 2001a) and is presented in Appendix F. The HHRA and ERA are presented in Appendices G and H.

A RCRA evaluation of the SWMUs in Sites 9, 13, 19, 22, and 23 is presented in Appendix I. The SWMUs addressed in this report were evaluated using the requirements stipulated in the final hazardous waste facility permit for former NAS Alameda (EPA Identification Number CA 2170023236) to support further corrective action decisions at Alameda Point. Recommendations for NFA or further action are based on the analytical results presented in Appendix I. Any corrective action required will be conducted under the CERCLA program as part of the remedial actions to be evaluated in the FS.

3.4.1 Site-specific Conceptual Site Model

The initial CSM was refined in an iterative process that involved conducting environmental investigations, identifying areas of known or potential releases of chemicals to the environment, and filling data gaps. This iterative process resulted in site-specific CSMs.

The site-specific CSMs include the following components: (1) primary source of contamination; (2) primary, secondary, and tertiary release mechanisms; (3) pathways; (4) exposure routes; and (5) current and future receptors. Physical features and site-related activities (former and

remaining) at the sites are identified as likely primary sources of contamination. Release mechanisms include spills and leaks, suspension of air particles, plant uptake, infiltration to groundwater, and emissions of volatile compounds. Current and potential future receptors include human receptors (residential, commercial/industrial, and construction workers) and ecological receptors. The site-specific CSMs also indicate which exposure pathways are considered complete for each receptor. According to EPA guidance (EPA 1989), an exposure pathway consists of four elements:

- A source and mechanism of chemical release
- A retention or transport medium (or media in cases involving transfer of chemicals)
- A point of potential contact with the contaminated medium (referred to as the exposure point)
- An exposure route (such as ingestion) at the contact point

Eliminating any of these elements (except in a case where the source itself is the point of exposure) results in an incomplete exposure pathway. Therefore, if no receptors exist that would contact the source or transport medium, the exposure pathway is incomplete and is not evaluated. Similarly, if contact with a medium is not possible, the exposure pathway is considered incomplete.

The site-specific CSMs were used to support the risk assessment and nature and extent evaluations

3.4.2 Data Quality Objectives

This section presents the seven-step process used to develop DQOs and summarizes the quality of data collected during the environmental investigations of OU-2A. A specific discussion of the quality and quantity of data collected at each site is presented in the site-specific sections.

DQOs are qualitative and quantitative statements developed through the seven-step DQO process outlined in EPA guidance documents (EPA 1993, 1994, 1999b, 2000a). DQOs clarify objectives, define the most appropriate use for data, and specify tolerable limits on decision errors used as the basis for establishing the quantity and quality of data needed to support decision-making. The following subsections summarize the results of applying each of the seven steps in the DQO process to the RI for OU-2A. DQOs for the RI for Sites 9, 13, 19, 22, and 23 and a specific discussion of the quality and quantity of data collected at each site are presented in the site-specific data quality assessment sections (Sections 5.0 through 9.0)

3.4.2.1 State the Problem

Step 1 of the DQO process identifies the following specific problem to be solved: Past activities at Sites 9, 13, 19, 22, and 23 were suspected of causing releases of VOCs, semivolatile organic compounds (SVOC), pesticides, PCBs, TPH, and metals to soil and groundwater. These constituents were suspected of posing a threat to human and ecological receptors.

3.4.2.2 Identify the Decision

Step 2 of the DQO process identifies three decisions that must be supported in the RI for Sites 9, 13, 19, 22, and 23. These decisions, which are presented in the following text, were formulated based on the overall problems presented in Step 1.

The first decision is to determine whether sufficient quality and quantity of data are available to conduct a risk assessment. Sufficient data are necessary to ensure confidence in nature and extent and risk assessment conclusions.

The second decision is to determine whether site contamination is appropriately addressed under CERCLA or is best addressed by another Navy program, such as the TPH (corrective action program) or RCRA Programs). This is necessary to provide the appropriate regulatory context for corrective action.

The third decision is to determine whether any CERCLA constituents present at the sites as a result of site-related activities pose a potential risk to human health or the environment, thus requiring an FS. An FS provides a regulatory context for corrective action under CERCLA.

3.4.2.3 Identify Inputs to the Decision

Step 3 of the DQO process describes the information needed to resolve the decision statements identified in Step 2. The decision to determine whether sufficient data have been collected during previous investigations to characterize the site and conduct a risk assessment was based on several factors. They included knowledge of the history of the sites, an initial CSM, the spatial distribution of samples collected, the quantity and quality of data for each analytical group, professional judgment, and consensus among stakeholders (Navy, the regulatory agencies, and the RAB).

Both screening and definitive data were generated during the environmental investigations using a wide range of field and laboratory methodologies. For this report, screening data are defined as the results of sample analyzes either (1) performed in the field (for example, mobile laboratories) or (2) samples analyzed in a "fixed laboratory" and unvalidated. Although the quality control requirements specified for the mobile laboratory analyses were less stringent than those that would be expected from a fixed laboratory, the resulting data underwent cursory validation to ensure that their quality were adequate for their intended purpose of characterizing the sites.

Definitive data are defined as the results of samples analyzed in a "fixed laboratory" and are also validated. Typically, definitive quality data could be used for risk assessment and background comparisons in addition to nature and extent evaluations, fate and transport evaluations, evaluation of alternatives, and/or engineering design.

In general, the definitive quality data were collected and analyzed in accordance with EPA's Contract Laboratory Program (CLP) procedures, and detection limits (sample quantitation limits [SQL]) were sufficiently low to permit identification of potential health risks. Samples in each sample delivery group received a cursory validation review, and a minimum of 10 percent of the samples for each of the analysis received a full validation review by independent validators. The majority of data were validated with respect to laboratory blanks, quality control samples, and qualifiers. In general, data quality is consistent with EPA Analytical Level III, as specified in EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (1988a). Data qualified "R" (rejected) during data validation were not used in this RI.

Detection limits may be elevated over current residential PRGs (EPA 2002a) and may be the consequence of the following: (1) data collected over a period of longer than 10 years and the evolution of lower detection limits as technology improves, (2) the revision of PRGs over time (which are not always technologically feasible), (3) and matrix interference. Of these, only matrix interference should raise concern that there would be a possibility that a chemical contaminant might be disregarded.

It is an unavoidable consequence that at least some detection limits will be elevated over current residential PRGs (EPA 2002a) whenever data are collected over long periods, as they were for the OU-2 sites. During the more than 10 years of sampling at these sites, lower detection limits were established for a number of chemicals as technology improved, and the PRGs for some of those chemicals were also reduced based on new toxicological information. Therefore, the original detection limits that prevailed before the new PRGs exceed many of the new PRGs. In addition, current analytical methods do not achieve the detection limits necessary to support a number of the current PRGs. Furthermore, matrix interferences in specific samples often prevent analytical methods from achieving the expected detection limits that normally can be attained under more ideal matrix conditions. Therefore, the detection limits necessary to support some PRGs are never achieved with modern analytical methods, and others cannot be attained at sites where the sample media contain recalcitrant matrix interferences.

In addition, not all detection limits for the investigations were set to be below PRGs. For example, reporting limits were compared against MCLs for groundwater data collected during the basewide groundwater monitoring investigations, and reporting limits for soil gas samples collected during supplemental RI data gap sampling were not compared against PRGs (Tetra Tech 2001a).

Additional samples for analysis of PAHs at the CERCLA sites were collected in 2003 because detection limits were elevated because of matrix interference in some historical data for PAHs in

soil at Alameda Point. These data achieved detection limits below EPA Region 9 PRGs, however, so the PAH data are of sufficient quality to characterize the sites and conduct risk assessments. Only data for PAHs from the 2003 sampling event, rather than historical data, are evaluated in the RI.

Data for soil and groundwater collected as part of the EBS or TPH program typically were not used to evaluate risk in this RI because (1) they were not collected under the IRP with the objective of characterizing CERCLA releases. The general, the DQO for the EBS is to identify the environmental condition of all property affected by base closure and more of these data are a screening nature. Inclusion of these data could add more uncertainty to the risk assessments and potentially over or underestimate the risk from CERCLA releases. The general DQO for the TPH Program is to decommission all USTs and evaluate TPH contamination. Risk from TPH was assessed separately for soil and groundwater that is not commingled with a plume containing CERCLA contaminants using the Alameda Point TPH Strategy (Navy 2001a) and is presented in Appendix F.

The following information was used to determine whether a site is eligible for closure under CERCLA or is best addressed by another Navy program: site activities, chemical data associated with soil and groundwater samples, results of a TPH screening, and regulatory guidance.

The following information was used to determine whether CERCLA chemicals from site-related activities are present at levels that pose a potential risk to human health or the environment, and thus require an FS: background, human health and ecological risk assessment results, site-specific CSMs, future land use, and professional judgment.

3.4.2.4 Define the Study Boundary

Step 4 of the DQO process describes the spatial boundaries of the sites. Site boundaries were used to evaluate soil and were based on physical features (such as roads and buildings), knowledge of site activities, and results of previous investigations. Plume boundaries were used to evaluate groundwater. Temporal boundaries were established to include all site activities and extend to the future based on anticipated uses of the site. Section 1.3 describes the physical boundaries of the sites, site activities, and future land use.

3.4.2.5 Develop Decision Rules

Step 5 essentially delineates the consequences of study results and provides direction for the next stage of problem resolution. The first decision, are sufficient data available to conduct a risk assessment and an FS, is a yes/no decision based on inputs identified in Step 3 and consensus among stakeholders (Navy, regulatory agencies, and the RAB).

The second decision is to determine whether site contamination is appropriately addressed and eligible for closure under CERCLA or is best addressed by another Navy program. If no further

action is required under CERCLA and it is necessary to address TPH or RCRA further, the site will be recommended for transfer to another Navy program. If further action is required under CERCLA, site contamination (including commingled CERCLA and TPH plumes) will be addressed under CERCLA. Further action for noncommingled TPH plumes and RCRA contamination will be recommended to another Navy program.

The third decision is to determine whether any constituents present at the sites pose a potential risk to human health or the environment, thus requiring an FS. The results of risk assessments for human health and ecological receptors were used to determine whether risk is adequately defined at Sites 9, 13, 19, 22, and 23. An FS is necessary if (1) human health risk estimates exceed risk levels identified in the NCP as a carcinogenic risk management range of 1E-04 to 1E-06 or a noncarcinogenic hazard quotient (HQ) of 1 or (2) chemicals are present at levels that would pose a risk to ecological receptors. An FS is not necessary if (1) human health risk estimates do not exceed risks identified in the NCP and (2) chemicals are not present at levels that would pose a risk to ecological receptors.

3.4.2.6 Specify Tolerable Decision Errors

The decision as to whether Sites 9, 13, 19, 22, and 23 have been adequately characterized during this RI is a yes/no decision that is based on a series of professional judgments made by representatives from the Navy and regulatory agencies. The types and numbers of samples collected from each potential source of contamination are considered sufficient based upon professional judgment, so there is a low potential of any source at any of the sites not being adequately evaluated or of a no further action recommendation if contamination poses a potential risk to human health or the environment.

The decision to address contamination at Sites 9, 13, 19, 22, and 23 under CERCLA or to transfer the sites to another Navy program is a yes/no decision based upon the requirements of CERCLA-, TPH-, and RCRA-regulated chemicals and a series of professional judgments made by representatives from the Navy, EPA, DTSC, and RWQCB.

The decision as to whether any constituents present at the sites pose a potential risk to human health or the environment, thus requiring an FS at Sites 9, 13, 19, 22, and 23 is a yes/no decision and is based on human health and ecological risk assessment results. Risk assessment methods were established by the regulatory agencies and adapted by the Navy to site-specific conditions, in cooperation with the regulatory agencies. The risk assessment defines the uncertainty in the risk characterization; however, EPA guidance and professional judgment determine the tolerable limits on decision error. Because risk assessment methods used are intentionally designed to be biased toward the overestimation of risks to account for unavoidable uncertainties inherent in any risk assessment process, the error rate for this decision is low. Some uncertainties, however, have the potential to be under accounted for in risk assessments, so stakeholders applied guidance and professional judgment to ensure that tolerable limits on decision errors were maintained.

3.4.2.7 Optimize Sampling Design

Soil, grab groundwater, and monitoring well groundwater samples were collected during previous investigations and removal actions. The Navy and regulatory agencies reviewed the data from these investigations to identify data gaps before completion of the RI and risk assessments. Additional data gap sampling was proposed and conducted in accordance with regulatory agency review and recommendations.

3.4.3 Approach to Background Comparison

Data for soil and groundwater at Alameda Point that were considered to be naturally occurring and not related to historical site activities were compared with analytical results for samples considered representative of current conditions at OU-2A. This comparison identified metals in soil and groundwater at the sites that potentially resulted from historical site activities and metals in the soil and groundwater that are naturally occurring or background.

The methodology used to establish background concentrations of naturally occurring metals in soil and groundwater at Alameda Point is briefly described in the following text, along with a summary of the methodology used to compare the background data set with data for samples considered to represent current conditions at the sites.

3.4.3.1 Selection of Background Data Sets

The data sets considered to represent naturally occurring metals or background conditions for Alameda Point were selected using a series of statistical tests conducted on data sets for each medium. Details of the construction of the ambient soil and groundwater data sets are provided in Samples for Use as Background (Tetra Tech 1997) and the Technical Memorandum for Estimation of Ambient Metal Concentrations in Shallow Groundwater (Tetra Tech 1998), which are provided in Appendix A.

As presented in the background comparisons report for soil (PRC EMI 1997b), areas of the installation with geologically similar soils that represent a single background data set were designated as the pink, blue, or yellow areas. These areas correspond with a specific fill event, provided as follows and shown on Figure 3-2.

- Pink Area: Runway area and central portion of the installation (Fill Area 1)
- Blue Area: Southeast portion of the installation (Fill Area 2)
- Yellow Area: Far west portion of the installation (Fill Area 3)

Sites 9, 13, 19, 22, and 23 are located in the blue area. The statistical summary results that define the background data sets for metals in the blue area are provided in Appendix A of this report.

As presented in the "Technical Memorandum for Estimation of Ambient Metal Concentrations in Shallow Groundwater" (Tetra Tech 1998), 35 wells were identified as being unaffected by site-related groundwater contamination, and data for metals based on filtered samples, analyzed using CLP methodology, were used to constitute the ambient metals data set. Each of the 35 wells was sampled at least four times during quarterly sampling. The statistical summary results that define the background data set for metals in groundwater are provided in Appendix A.

3.4.3.2 Background Soil and Groundwater Comparison

The background soil comparison consisted of comparing the background data set (blue area) for soil with analytical results that represent Sites 9, 13, 19, 22, and 23 to identify the metals that are present at concentrations above naturally occurring levels. The background groundwater comparison consisted of comparing the background data set for groundwater at Alameda Point with analytical results that represent Sites 9, 13, 19, 22, and 23. The methodology for the background comparison is presented in Appendix A and is summarized in the following text.

Two-population statistical tests were used to compare metal concentrations in site data with ambient concentrations established for Alameda Point. All of the following methods were used to conduct two-population comparison tests, as appropriate, depending on the relative frequency of detection and sample size for each population:

- Wilcoxon rank sum (WRS) and Gehan-Wilcoxon (GT) tests
- Test of proportions
- Quantile test

One-sided statistical tests were used in all cases and employed a Type I error rate of 0.05. WRS and GT tests were used for metals with at least 60-percent detected data and single detection-limits in both the site and ambient populations. Testing was performed using the nonparametric WRS test. For chemicals with fewer than 60 percent detected data, the detection frequencies in the site and ambient populations were compared using the test of proportions. The quantile test (Johnson and others 1987; EPA 1994b; Navy 1999b) was conducted for all chemicals with less than 60 percent detected data and for all cases where either the WRS or GT test did not reject the null hypothesis (that is, when it was concluded that the median concentrations in the site and ambient concentrations were not significantly different).

3.4.4 Approach to Evaluation of Nature and Extent

The objectives of the evaluation of nature and extent are to characterize the site and present the nature and extent of contamination as defined by the risk assessments. The evaluation is composed of the following components: (1) a presentation of TPH detected at the site, (2) a presentation of the types and concentrations of CERCLA chemicals believed to have been used at the site, and (3) detailed descriptions of those chemicals that demonstrate significant risk to human health or the environment (risk drivers). The Navy focused on the chemicals used at the site to provide additional information about the nature and extent of the chemicals at the site beyond the risk drivers. This additional evaluation assisted the Navy in determining whether contamination "hot spots" were present at the sites. Data tables for soil and groundwater are provided in Sections 5 through 9 for chemicals that were used at the site. The tables include the residential PRG (EPA 2002), range of concentrations detected in soil and groundwater, and the sampling locations for the maximum concentrations detected. PRGs are provided for comparison purposes only; risks are quantified by the risk assessments.

Chemicals that demonstrate significant risk to human health or the environment (risk drivers) which is based on the results of the risk assessments are evaluated in more detail. Risk drivers are defined as the chemicals that pose a carcinogenic risk above $1E-06$ or an HI above 1. In addition, the risk based contamination level of 0.62 mg/kg for PAHs in soil that was agreed to by the Navy and agencies was also used to evaluate PAHs in more detail (Navy 2001d). These detailed evaluations primarily include the following:

- Preparing site-specific figures to assess the spatial distribution and concentration patterns of the contaminants
- Reviewing the figures, data, and site hydrology to identify the boundaries of the contamination, the volume of the affected media, and identification, if possible, of the suspected source of these chemicals

PAHs are evaluated relative to benzo(a)pyrene (BaP) equivalents. BaP equivalents are calculated by multiplying the detected concentrations of the carcinogenic PAHs by appropriate toxicity equivalency factors. The toxicity equivalency factors are based on the carcinogenic potency of each compound relative to BaP (EPA 1993). The seven carcinogenic PAH compounds and their toxicity equivalency factors are as follows.

CARCINOGENIC PAHS AND TOXICITY EQUIVALENCY FACTORS

Compound	Toxicity Equivalency Factor
Benzo(a)pyrene	1.0
Benz(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h)anthracene	1.0
Indeno(1,2,3-c,d)pyrene	0.1

3.4.5 Fate and Transport Evaluation Approach

Evaluations of the fate and transport of contaminants at each OU-2A site determines whether the chemicals driving risk at the sites are likely to migrate off site or have a tendency to attenuate, whether there is a continuing source of contamination, and the likelihood that groundwater or other potential pathways will distribute the contaminants. The evaluation primarily included the following:

- Identifying soil and groundwater sampling locations with the maximum concentrations of the contaminants that drive risk
- Identifying the presence of breakdown or parent products for these contaminants
- Preparing trend graphs for monitoring wells with the highest concentrations of these contaminants
- Evaluating the effect of groundwater flow or other potential pathways on the distribution of the contaminants.

3.4.6 Human Health Risk Assessment Approach

Site-specific HHRAs were conducted as part of the RI for OU-2A to estimate potential human health risks associated with possible exposure to site-related chemicals. The HHRAs were conducted using chemical concentrations that reflect data collected through April 2003 in combination with current and potential future uses of the sites. These baseline HHRAs were conducted without regard to future remediation or any future attempt to control or mitigate chemical releases; however, reductions in chemical concentrations associated with past removal activities have been included. Risk estimates presented in the HHRA will be used to support informed risk management decisions on the need for remedial action and selection of the most appropriate remedial alternative, if necessary.

The methods and assumptions used to evaluate human health risks were selected or developed to be consistent with Navy, EPA, and DTSC guidelines for baseline risk assessments and agreements reached during meetings with EPA and DTSC. The Navy is a federal agency and, as such, primarily followed federal guidance for risk assessment, as required by Section 120 of CERCLA. Additional information was obtained from the primary literature or was developed from key EPA and DTSC reference documents, including published reports or unpublished memoranda. The primary risk assessment guidance documents used as the basis for the HHRAs include the "U.S. Navy Human Health Risk Assessment Guidance" (Pioneer Technologies Corporation 2001); "Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part A), Interim Final" (EPA 1989); and the "Preliminary Endangerment Assessment Guidance Manual" (DTSC 1994). The standard RAGS Part D table format was used.

In addition, some alternative agency risk assessment methods were used in lieu of or in addition to the parallel EPA method. The DTSC lead risk model, LeadSpread 7 (DTSC 2003), was used to assess lead health risks for children if site concentrations exceed the California modified (Cal-modified) residential PRG (EPA 2002a).

Following the risk assessment model in EPA guidance (EPA 1989), the HHRA are composed of the following four components:

- **Data Evaluation and Selection of COPCs.** This step consists of evaluating data and selecting COPCs in site media
- **Exposure Assessment.** This step involves evaluating potential exposure pathways to the COPCs and human populations
- **Toxicity Assessment.** This step consists of compiling toxicity values that characterize potential adverse health effects from exposure to COPCs
- **Risk Characterization.** This step quantitatively characterizes potential human health risks associated with exposure to COPCs

These components, along with general uncertainty factors, are summarized in the following text. Greater detail is provided in Appendix H, and summaries of the site-specific results are provided in Sections 5.6, 6.6, 7.6, 8.6, and 9.6 of this report.

3.4.6.1 Data Evaluation

The first step of the HHRA process consisted of reviewing and evaluating available data and identifying COPCs in the environmental media (such as groundwater and soil). Data for soil and groundwater were collected within and near Sites 9, 13, 19, 22, and 23 through several sampling efforts. The data were considered appropriate for use in the HHRA if they (1) were validated, (2) could be used to characterize CERCLA releases, and (3) represented current site conditions. Only definitive-quality data were used in the HHRA; therefore, screening-level data were not used (see Section 3.4). Data collected with the objective of characterizing noncommingled TPH releases were evaluated by the TPH strategy. Data for soil no longer present at the sites because of removal actions or for groundwater that were later replaced with more current data were not included in the HHRA because they do not reflect the current conditions at the sites. Only data collected under the IRP with the objective of characterizing CERCLA activities were used in the HHRA.

Data for Soil

The HHRA for Sites 9, 13, 19, 22, and 23 used the site boundaries to define the soil exposure area. Data for soil at each site were aggregated in depth intervals of 0 to 2 feet bgs and 0 to 8 feet bgs. The depth intervals evaluate potential exposures associated with site use. The 0 to

2 feet bgs depth interval (surface soil) assumes little or no disturbance of deeper soils, and the 0 to 8 feet bgs depth interval (subsurface soils) assumes disturbance of deeper soils, which may be associated with future grading or excavation. Although the DTSC standard depth interval of 0 to 10 feet bgs is typically evaluated for residential and construction worker receptors, the groundwater table lies at about 8 feet bgs throughout Alameda Point; therefore, subsurface soils were characterized and evaluated only to a depth of 8 feet bgs.

Additional samples for analysis of PAHs were collected at the CERCLA sites in 2003 because detection limits were elevated in some historical data for PAHs in soil at Alameda Point. These data achieved detection limits that meet the DQOs for the RI (that is, detection limits below EPA Region 9 PRGs), so the HHRA includes only the PAH data from the 2003 sampling event, rather than historical data.

Chromium speciation also was performed; results showed that chromium was trivalent.

Data for Groundwater

Field and screening-level data were typically not used; however, in some site-specific cases, results for groundwater grab samples obtained using direct-push methods were included if data from a permanent monitoring well were lacking. Data for groundwater obtained using direct-push methods were used when necessary because a lack of data from monitoring wells in the concentrated plume areas could have resulted in a data set that does not represent “reasonable maximum” conditions. In addition, samples collected from the SWBZ were excluded from the risk assessment because it is considered Class III groundwater, which is not a potential source of drinking water.

With the exception of Sites 13 and 19, groundwater data were aggregated by contaminant plume rather than by site. Based on current groundwater monitoring data, chemicals have been identified at sporadic points at Site 13 and do not exist as a groundwater plume. Site 19 is relatively small with sporadic, low concentrations of VOCs. Therefore, the site boundaries were used to define the exposure area for groundwater at Sites 13 and 19.

When possible, at least four quarters of groundwater data were used; trend analyses of historical data were completed as needed to assess the appropriate data set that accounts for seasonal variability as well as most accurately characterizes the plume.

3.4.6.2 Identification of Chemicals of Potential Concern

Following the data evaluation, a number of chemicals were identified as COPCs. COPCs are chemicals that are carried through the quantitative exposure and risk analysis portions of the HHRA. These chemicals are assumed to account for the majority of any estimated health effects at a site.

Soil and Groundwater

Chemicals in soil or groundwater were excluded as COPCs using the following screening criteria: (1) status as an essential nutrient, (2) frequency of detection, and (3) the EPA Region 9 residential PRG. Chemicals attributed to background were selected as COPCs if they were not excluded by these screening criteria; the risks posed by background chemicals were used to evaluate their relative contributions to total site risk. Figure 3-3 presents a flow chart that describes the COPC selection process used for the sites. These criteria were applied provided the chemical is not detected in any other media at the site, the chemical is not historically related to site operations, and detection limits for that analyte are not elevated.

The essential human nutrients that were excluded are calcium, iron, magnesium, potassium, and sodium. The frequency of detection criterion was used because chemicals detected infrequently may be sampling and analytical artifacts or spurious data (EPA 1989). If an analyte was detected in less than 5 percent of the samples (minimum of 20 samples), it was excluded as a COPC.

The final screening step consisted of comparing the maximum detected concentrations of soil and groundwater to the EPA Region 9 residential PRG or the Cal-modified PRG (EPA 2002a) for soil and tap water, respectively. A COPC was excluded if the maximum detected concentration is below the PRG. Consistent with EPA (EPA 1989) and Navy guidance (Navy 2001b), the PRG screen (conservatively set to the risk level of one in one million or a "safe" noncancer-based level equal to an HQ of 1) is considered conservative.

Soil Gas

Soil gas data were evaluated for potential vapor intrusion, as vapors can emanate from the subsurface, where there is the potential for migration upward into indoor air. All detected volatile chemicals that exceeded EPA's subsurface vapor intrusion guidance risk-based levels (EPA 2002b) were retained as COPCs. An additional Tier 1 evaluation was conducted to incorporate additional screening criteria provided by (RWQCB 2001, 2003). Finally, an advanced Tier 1 weight of evidence evaluation was conducted to incorporate soil gas and groundwater concentrations in conjunction with the RI CSM and other site data to determine whether the vapor intrusion pathway is of potential concern and should be considered in the HHRA.

3.4.6.3 Exposure Assessment

An exposure assessment includes an evaluation of potential human receptors that could come in contact with site-related COPCs as well as routes, magnitude, frequency, and duration of exposure. An evaluation of all possible human exposures is necessary to identify receptors in current contact with or that could come in contact with constituents at Sites 9, 13, 19, 22, or 23.

The exposure assessment involves the following steps:

- Characterization of the exposure setting(s) and identification of potential future human receptors
- Identification of exposure pathways and exposure routes
- Estimation of exposure point concentration (EPC)
- Quantification of chemical intake for pathway specific exposures for each potential receptor

Exposure Scenarios and Receptor Populations

To estimate human exposure to chemicals, assumptions must be made regarding how and with what frequency an individual will contact the subject chemicals. These exposure patterns are collectively referred to as an “exposure scenario.” Exposure scenarios depend on whether a child or adult receptor is exposed and on the current and future uses of the property (residential, commercial/industrial, recreational, or construction worker). All four uses might be applicable at a single site.

Residential, commercial/industrial, and construction worker exposure scenarios were evaluated for each site. According to reuse plans for Alameda Point the commercial/industrial exposure scenario is the most likely future exposure at Sites 9, 13, 19, 22, and 23. The recreational exposure scenario was not evaluated because each site was evaluated for exposure scenarios (residential and commercial/industrial) that were more protective to human health. In addition, current reuse plans show that future recreational reuse is not contemplated in reuse plans for Alameda Point at OU-2A sites. Both an adult and child are considered potential future receptors for the residential scenario. The residential scenario was evaluated to allow flexibility in implementing the reuse plan at Alameda Point and because EPA risk assessment guidance (1989) includes a strong preference for evaluation of the residential pathway.

Exposure Pathways and Exposure Routes

All relevant exposure pathways were evaluated for future commercial/industrial, construction worker, and residential exposure scenarios.

According to EPA guidance (1989), an exposure pathway consists of four elements:

- A source and mechanism of chemical release
- A retention or transport medium (or media in cases involving transfer of chemicals)

- A point of potential human contact with the contaminated medium (referred to as the exposure point)
- An exposure route (such as ingestion) at the contact point

Eliminating any of these elements (except in a case where the source itself is the point of exposure) results in an incomplete exposure pathway. If no receptors exist that would contact the source or transport medium, the exposure pathway is incomplete and is, therefore, not evaluated. Similarly, if human contact with a medium is not possible, the exposure pathway is considered incomplete and is not evaluated.

The exposure scenarios were evaluated for the following pathways:

- **Residential** - incidental soil ingestion, dermal contact with soil, inhalation of particulates from soil (nonvolatile), ingestion of homegrown produce, inhalation of vapors in ambient air, inhalation of vapors in indoor air, and domestic use of groundwater (ingestion, dermal contact, and inhalation of vapors)
- **Commercial/Industrial** - soil ingestion, dermal contact with soil, inhalation of particulates from soil (nonvolatile), inhalation of VOCs in ambient air, and inhalation of VOCs in indoor air
- **Construction Worker** - soil ingestion, dermal contact with soil, inhalation of particulates from soil (nonvolatile), and inhalation of VOCs in ambient air

Because these pathways are based on future exposures, they are considered potentially complete and are evaluated to provide a conservative estimate of risk. Inhalation of only non-volatile chemicals bound to airborne soil particulates was evaluated for consistency with EPA Region 9 PRGs. Groundwater was evaluated for domestic use (ingestion, dermal contact, and inhalation of vapors during whole-house use) because it has been established as a potential drinking source using EPA's "Guidelines for Groundwater Classification" (EPA 1988b). Although construction workers may have transient dermal contact with groundwater, this exposure was considered insignificant due to the very short duration and limited extent expected, and it is not assessed. CSMs and tables that indicate which exposure pathways are complete for each scenario are provided in Appendix H.

It is unlikely that residential gardening would occur at Alameda Point in existing (unamended) in situ soils (which largely consist of San Francisco Bay dredge and fill soils that are naturally highly unsuitable for crop production). In addition, exposures from future, hypothetical homegrown produce ingestion are highly variable, and a long list of exposure assumptions and extrapolations are necessary to predict risk. Further, because of the pathway's inherent uncertainty, it can result in unrealistic elevated risk estimates or insignificant exposures compared to other pathways, such as incidental ingestion of soil.

Volatilization of chemicals (vapors) to ambient or indoor air was included in the HHRA when volatile chemicals were detected in soil, soil gas, or groundwater. Soil data were used to calculate risk from volatilization of chemicals (vapors) to ambient air. Soil gas data or groundwater data in the absence of soil gas data were used to calculate risk from volatilization of chemicals (vapors) to indoor air in accordance with EPA's Supplemental Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway (EPA 2001a).

Exposure Point Concentrations

EPCs are the concentrations of chemicals in a media (soil, water, or air) used to calculate human health risks. EPCs were calculated for surface soils (0 to 2 feet bgs), subsurface soils (0 to 8 feet bgs), groundwater, and soil gas.

Following previous guidance (EPA 1989, 1992), the EPC for a chemical has generally been the lesser of the 95 percent upper confidence limit of the mean (UCL₉₅) or the maximum concentration of the various sample concentrations (EPA 1989). The UCL₉₅ of the arithmetic mean is defined as a value that, when calculated repeatedly for randomly drawn subsets of site data, equals or exceeds the true mean 95 percent of the time (EPA 1992). The UCL₉₅ is a better predictor of actual chronic exposure conditions because it is based on the probability of long-term random contact with contaminated areas. While the latter statement still holds, EPA has updated its approach to calculating the concentration term to avoid cases where the maximum concentration must be used (EPA 2002c); therefore, these improved methodologies (EPA 2002c supersedes EPA 1992) were implemented, as appropriate. The latest statistical guidance for calculating EPCs was used. This approach effectively treats nondetected data as random variables that can assume any value between zero and the reporting limit and calculates a distribution of all potential values for the UCL₉₅. See Appendices H and I for a complete description of how the EPCs were calculated.

Generally data were included from samples that contained petroleum constituents (benzene toluene, ethylbenzene, and xylenes) in the EPC calculation, even when the samples were collected from TPH plumes that were not contaminated with any CERCLA hazardous substances.

Estimating Chemical Intake

Chemical intake rates were estimated for all complete exposure pathways based on the EPCs and on the estimated magnitude of exposure to contaminated media. Exposure is based on "intake," which is defined as the mass of a substance taken into the body per unit body weight per unit time. Intake from a contaminated medium is determined by the amount of the chemical in the medium, the frequency and duration of exposure, body weight, the contact rate, and the averaging time. The following is a generic algorithm that is used to calculate chemical intake:

$$I = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

where

- I = intake (milligram per kilogram body weight-day [mg/kg-day])
- C = chemical concentration in contaminated medium (milligram per kilogram [mg/kg] or mg/L)
- CR = contact or ingestion rate (milligrams soil per day or liters per day)
- EF = exposure frequency; how often exposure occurs (days per year)
- ED = exposure duration; how long exposure occurs (years)
- BW = body weight (kilogram [kg])
- AT = averaging time; period over which exposure is averaged (days)

EPA (1992) requires that exposure parameters used to determine contaminant intakes for a given pathway should be selected so that the estimated intake represents the average (central tendency exposure [CTE]) and reasonable maximum exposure (RME). Specific values for the exposure parameters were obtained from EPA or DTSC guidance, where available; otherwise, exposure parameters were developed from the primary literature or other EPA and DTSC reference documents. Both RME and CTE intakes for future receptors (residential, commercial/industrial, and construction worker) were calculated.

The intake equations and exposure parameters used to estimate chemical intake associated with exposure to soil and groundwater for residential, occupational, and construction worker receptors are provided in Appendix H.

3.4.6.4 Toxicity Assessment

Standard toxicological methodologies for assessing the toxicity of chemicals involve quantifying the dose-response relationships for adverse human health effects associated with exposure to specific chemicals. There are two categories of toxic chemicals, noncarcinogenic and carcinogenic. While not all chemicals have carcinogenic potential, all are assumed to have some noncarcinogenic effect at a high dose. Carcinogenic chemicals' potency was evaluated and presented separately from noncarcinogenic chemical potency.

The toxicity assessment identifies the reference doses (RfD) and cancer slope factors (CSF) used to evaluate adverse noncancer health effects and cancer risks. The major toxicological effects associated with the COPCs also are presented. The following are the sources of toxicity values used for the HHRAs, in order of preference:

- EPA's Integrated Risk Information System (IRIS), which is summarized in the Region 9 table of PRGs (2002a). IRIS is an on-line database that contains EPA-approved RfDs and oral slope factors as well as inhalation reference concentrations (RfC) and inhalation unit risk factors (URF) (EPA 2003). The RfDs/RfCs and CSFs/URFs have undergone extensive review and are recognized as high-quality, agencywide consensus information.
- Values recommended by the EPA National Center for Environmental Assessment (NCEA), either listed in the Region 9 table of PRGs (EPA 2002a) as NCEA source values or as recommended by the Superfund Technical Support Center within EPA NCEA.
- EPA's Health Effects Assessment Summary Tables (HEAST 1997a)

3.4.6.5 Risk Characterization

Risk characterization combines the exposure and toxicity assessment to produce quantitative estimates of health effects from COPCs. The health effects of a chemical are quantified in terms of noncarcinogenic health effects (all other adverse health effects besides cancer) as well as carcinogenic risk if the chemical is considered to be a carcinogen. Chemicals might present noncancer health effects in addition to cancer risks; therefore, the potential for both types of effects will be evaluated.

Characterization of Noncancer Risks

The potential for exposure to result in adverse health effects other than cancer is evaluated by comparing the chronic daily intake (CDI) with an RfD. When calculated for a single chemical, the comparison yields a ratio termed the HQ, as shown in the following equation:

$$HQ = \frac{CDI}{RfD}$$

Where:

CDI = Chronic daily intake
 RfD = Reference dose

To evaluate the potential for adverse health effects from simultaneous exposure to multiple chemicals, the HQs for all chemicals are summed, yielding a HI. Pathway-specific HIs are then summed to estimate a total HI for each receptor. If the resulting HI is less than 1, it is assumed that there is no significant potential for noncarcinogenic health effects due to cumulative effects. If the total HI exceeds 1, a more refined analysis is required. This analysis is referred to by EPA as "segregation of hazard indices" (EPA 1989). In this procedure, chemicals that have similar

mechanisms of toxic action, or more conservatively, similar target organs, are grouped together, and an HI is calculated for each group.

It is important to note that the noncancer HI is estimated differently than cancer risk; specifically, a child's exposure is not cumulatively additive to the projected adult exposure. Noncancer effects manifest over a specific period, and once the exposure period is over, the hazard has also passed (that is, no latency is assumed). Therefore, because a child's exposure is much larger compared to its body weight, risk management decisions for chemicals with noncancer health effects are based on the HI for a child (the receptor with the highest potential risk) for the residential and recreational scenarios. The total HI that includes background chemicals is presented for all scenarios, and an incremental HI (which does not include background) is also presented for the residential scenario.

Characterization of Cancer Risks

Unlike noncancer health effects, which assume that there is no significant potential for noncarcinogenic health effects if the HI is below 1, carcinogenic risks associated with exposure to chemicals classified as carcinogens are estimated as the incremental probability that an individual will develop cancer over a lifetime as a direct result of an exposure. The estimated risk is expressed as a unitless probability. To aid in the interpretation of the results of the risk assessment, EPA guidance presents a range of goals for incremental carcinogenic risk, which is "an excess upper-bound lifetime cancer risk to an individual of between 1 in 1,000,000 to 1 in 10,000" or between 1E-06 and 1E-04. The range between 1E-06 and 1E-04 is referred to as the "risk management range" in the HHRA results.

Three steps are used in estimating cancer risks. First, to derive a cancer risk estimate for a single chemical and pathway, the CDI is multiplied by the chemical-specific CSF, as follows:

$$\text{Cancer Risk} = \text{CDI} \times \text{CSF}$$

where

CSF = Cancer slope factor
CDI = Chronic daily intake

Second, to estimate the cancer risk associated with exposure to multiple carcinogens for a single exposure pathway, the individual chemical cancer risks are assumed to be additive. Third, pathway-specific risks are summed to estimate the total cancer risk for a receptor. Risk management decisions for chemicals with carcinogenic effects are based on lifetime or total risk; therefore, risks for adult and child receptors are summed to obtain a total carcinogenic risk.

The total site cancer risk that includes background chemicals is presented for all scenarios, and an incremental site cancer risk (which does not include background) is also presented for the residential scenario.

Health Effects Associated with Exposure to Lead

Lead is not evaluated in the same manner as other human health COPCs because the nature of the toxicological data for lead differs for assessment of health effects; therefore, lead is not included in the noncancer HI or cancer risk. Where lead EPCs exceed the Cal-modified PRG, lead health risks were measured based on the expected blood lead concentration that will result from exposure. DTSC has developed a special model called "LeadSpread" to predict blood-lead concentrations and to assess health risks associated with them. LeadSpread 7 (DTSC 2003) was used to assess lead health risks to a child. Acceptable lead levels are defined as those that produce a blood-lead concentration greater than 10 micrograms per deciliter ($\mu\text{g}/\text{dL}$) in no more than 5 percent (the 95th percentile) of the exposed child population. LeadSpread was used to assess risk from ingestion of site soil and groundwater.

3.4.6.4 Uncertainty

Uncertainty can be introduced into each stage of the HHRA because of the assumptions made in the risk assessment and the limitations of the data used to calculate risk estimates. Uncertainty and variability are inherent in the exposure assessment, toxicity assessment, and risk characterization.

EPA categorizes uncertainty into three types: (1) parameter, (2) model, and (3) scenario (or decision) (EPA 1997b). Variability is often used synonymously with uncertainty. However, uncertainty describes imperfect knowledge and can usually be reduced through additional data collection. Variability is defined as "observed differences attributable to true heterogeneity or diversity in a population or exposure parameter" (EPA 1997b). Unlike uncertainty, variability cannot be reduced with additional data collection, although it may be known more accurately.

Parameter uncertainty includes measurement errors, sampling errors, and systematic errors. This type of uncertainty occurs when variables that appear in equations cannot be measured precisely or accurately. Reasons can include equipment limitations or spatial or temporal variances between the quantities measured. Parameter uncertainty can either be random (sampling errors) or systemic (experimental design).

Model uncertainty is associated with all models used during all phases of the risk assessment, including the animal models used as surrogates for testing chemical carcinogenicity, the dose-response models used to extrapolate the level of adverse effects, and the analytical models used predict the fate and transport of chemicals in the environment. The uncertainty arises because of the necessary simplification of real-world processes, misspecification of the model structure, misuse of the model, and use of inappropriate surrogate variables.

Scenario uncertainty describes the uncertainty that occurs as a result of incomplete analysis, or errors in problem description, aggregation, and professional judgment. Scenario uncertainty can have the largest impact on the risk managers' decision-making role because it directly relates to the balance among societal concerns when establishing acceptable levels of risk. Constituents evaluated in the HHRA are identified using a process that involves professional judgment and regulatory guidance. This process could exclude some constituents that might contribute to risk. The calculation of risk in the HHRA involves the use of default values typically defined by regulatory guidance. These default values do not necessarily reflect site-specific conditions; thus, risk estimates may not reflect actual conditions. Consequently, the HHRA process uses many conservative factors to generate risk estimates that likely overstates actual risk (Hattis and Burmaster 1994).

The HHRA calculated for OU 2A was based on a series of assumptions, most intended to be conservative, that are expected to yield an estimate of risks that is biased toward protecting exposed populations. The following identifies potential sources of uncertainty for the OU-2A HHRA.

Parameter Uncertainty

Although a number of constituents were not detected, the detection limits of some of the constituents were higher than concentrations that would equate to a minimal risk level of $1E-06$. This uncertainty was accommodated by using a robust approach to calculating the exposure point concentration where the chemical was detected for the HHRA. In addition, there was a bias to using more recent data (especially for groundwater) to better present current conditions in the HHRA. The impact on the overall uncertainty caused by measurement errors on the HHRA was probably neutral.

Samples were collected in areas suspected or known to be a source of contamination. Samples were not collected systematically or randomly across a site. Therefore, no samples were collected in some areas within a site. However, the impact of errors in either sampling or sampling design is likely biased toward overestimation of risk because of the bias toward areas of known or potential releases.

Model Uncertainty

The uncertainty related to the choice of animal models for evaluating carcinogenicity or the dose-response model is common to many, if not all, risk assessments conducted for hazardous wastes sites in the United States. The desire to be protective of potentially exposed individuals has led to a conservative bias in evaluating potential effects caused by chemical exposure. The overall effect on the HHRA is to bias the risk estimates high for any identified potential exposure.

The HHRA for OU-2A used two models to evaluate potential exposure to chemicals in soil or groundwater. One was the Johnson-Ettinger model for estimating indoor air concentrations for

an inhalation exposure pathway caused by vapor intrusion for volatile organic compounds. The other was a soil-uptake model to evaluate plant uptake of contaminants in soil to evaluate a consumption exposure pathway for garden produce. Both of these models should be considered screening and likely overestimate exposure and, consequently, risk. Neither model was adjusted for site-specific conditions. The conservative nature of the model likely balances potential issues with sample design for soil gas, and the impact on the HHRA risk estimates for indoor air inhalation is neutral. However, the input parameters for the garden produce pathway likely lead to an overestimation of risk for this pathway.

Scenario Uncertainty

A contributor to the scenario uncertainty for the OU-2A HHRA is the process used to select the chemical constituents for evaluation. Detected constituents for OU-2A were screened against the EPA Region 9 PRGs, which equate to a 1E-06 risk for the residential scenario. The assumption for applying this screen was that a maximum concentration less than the PRG demonstrates that a chemical would not be a significant contributor to overall risk. However, the Navy recognizes that the screened chemicals would have contributed a small additional risk; therefore, the risk estimate is slightly lower than it would have been without the PRG screen.

As discussed above, results for samples that contained petroleum constituents were included in the EPC calculation and risk assessments even when they were collected from TPH-only (and not commingled) plumes. The result of including samples that contain petroleum constituents is an overestimation of the risk posed by releases of CERCLA contaminants.

As discussed above, results for samples that contained saturation levels of TPH were excluded from the EPC calculations. Because these samples generally contained high concentrations of petroleum constituents, excluding them from the EPC resulted in a lower total risk estimate for the sites where those samples were collected. However, the impact of excluding those samples on the overall uncertainty is considered low because TPH and TPH constituents are investigated under the Navy's TPH program.

Default exposure factors were not adjusted to relate to site-specific conditions. Because of the bias to protect potentially exposed individuals, the effect of using the default exposure parameters is to bias the risk estimate to higher values.

Although aspects of the HHRA process at OU-2A were not always the most conservative, the overall effect on the HHRA was likely neutral. It is expected that nonconservative assumptions were balanced by the use of other, more conservative, elements, and that the resulting risk estimates adequately reflect the risk to potentially exposed individuals

3.4.7 Ecological Risk Assessment Approach

OU-2A has limited habitat; therefore, site-specific ecological sampling to support a baseline ERA was not feasible. A modified ERA was conducted for the sites. This modified ERA was designed to provide a conservative estimate of ecological risk using higher exposure parameters

than typically would be used for a screening-level ERA. This modified ERA methodology is consistent with EPA guidance for screening-level and baseline ERAs as well as Navy ERA guidance (EPA 1997b; Navy 1999).

Current and reasonable future uses of the sites were evaluated to determine the presence and potential future formation of habitat in these areas and to identify complete exposure pathways that might exist at the site. Ecological habitat at OU-2A sites is not currently capable of supporting significant wildlife; however, exposure pathways for terrestrial receptors were considered complete to provide a conservative estimate of risk as required by the BCT. (A complete exposure pathway is one in which the chemical can be traced or expected to travel from the source to a receptor.) An exposure pathway for aquatic receptors is considered complete for sites with groundwater plumes that are migrating toward the San Francisco Bay (including Oakland Inner Harbor and Seaplane Lagoon) or with broken storm-sewer lines that discharge to the San Francisco Bay. However, in the case of OU-2A all groundwater plumes are more than 500 feet from the Bay and are stable in terms of movement. None of the storm sewers crossing plumes within OU-2A is damaged and causing short-circuiting to the Bay. Therefore, the aquatic receptor pathway was not considered complete for OU-2A sites.

The process used to conduct the modified ERA is composed of the following components:

- Screening for chemicals of potential ecological concern (COPECs)
- Problem formulation
- Exposure estimates and risk evaluation
- Evaluation of assessment results

These components, along with uncertainty factors, are summarized in the following text.

3.4.7.1 Screening for Chemicals of Potential Ecological Concern

COPECs are organic and inorganic chemicals defined as potentially related to site activity and potentially causing adverse effects to ecological receptors. Evaluating site-specific data and selecting COPECs is the first step in quantifying risks and identifying potential hazards at each site. Since OU-2A is not located near Seaplane Lagoon or the Bay, the aquatic receptor pathway is not complete, and groundwater data are not evaluated for ecological impacts. Based on previous investigations, terrestrial receptor pathways were considered complete for direct exposure to soil and food chain exposure pathways (as discussed in Section 3.4.7.1); therefore, soil COPECs were screened in the following manner.

As mentioned in Section 3.4, soil data were collected within and near OU-2A through several sampling efforts and were used to characterize the sites. EBS data were not considered for use in estimating ecological risks in the modified ERA because they are regarded as lower quality data.

Soil data for each site were aggregated at a depth interval of 0 to 4 feet bgs. The soil data summaries for each site are presented in Appendix I. These data were used as follows to develop COPECs for OU-2A sites.

Chemicals detected in soil were subjected to a screening process to focus the ERA on chemicals, related to site activity, that pose the greatest potential risk to ecological receptors. The screening was a sequential process that considered factors such as frequency of detection, spatial distribution of detected chemicals, statistical comparison to background concentrations for inorganic chemicals, and chemical properties such as bioaccumulation and toxicity. The following are the steps involved in the chemical screening process.

Step 1: The first step in the COPEC screening process was to calculate the frequency of detection for all detected chemicals. Chemicals with a frequency of detection greater than 5 percent were further screened in Step 3. Chemicals with a frequency of detection 5 percent or less were further screened in Step 2.

Step 2: Chemicals that did not have a 5 percent frequency of detection were then screened based on their bioaccumulation potential and toxicity. Octanol-water partition coefficient (K_{ow}) values for a chemical are correlated with the bioaccumulation potential because K_{ow} values measure the tendency of a chemical to partition into lipids (fat tissues). Chemicals detected in the soils with K_{ow} values greater than 3 were considered to have significant bioaccumulation potential. Chemical toxicity was evaluated by literature review. If the chemical was associated with significant bioaccumulation or high toxicity (to a specific receptor), it was retained as a COPEC.

Step 3: Certain inorganic chemicals are essential nutrients that may be eliminated as COPECs, according to guidance documents issued by EPA and DTSC. These chemicals, calcium, iron, magnesium, potassium, and sodium, were excluded as COPECs. If the chemical was not an essential nutrient, it was further screened by the criteria in Step 4.

Step 4: If the frequency of detection was greater than 5 percent and the chemical was inorganic but not an essential nutrient, the concentration was statistically compared to background levels established for Alameda Point, consistent with the methodology identified in the document "Procedural Guidance for Statistically Analyzing Environmental Background Data" (Navy 1998a). Any inorganic chemical detected at levels determined to be statistically similar to or less than background was removed from consideration as a COPEC.

3.4.7.2 Problem Formulation

Problem formulation represents the stage of the ERA process where the goals, breadth, and focus of the assessment are determined. The major goal of the problem formulation component is to develop an ecological CSM that addresses the following five issues:

- Environmental setting and chemicals known or suspected to exist at the site
- Chemical fate and transport mechanisms that might exist at the site
- Mechanisms of ecotoxicity associated with chemicals and likely categories of receptors that could be affected
- Complete exposure pathways that might exist at the site (a complete exposure pathway is one in which the chemical can be traced or expected to travel from the source to a receptor)
- Selection of assessment and measurement endpoints to screen for ecological risk

To begin the problem formulation stage, information on the environmental setting and a list of chemicals known to exist at the site was obtained. For these chemicals, physical, and chemical characteristics were obtained. The first step to compiling environmental setting information was to obtain information about the site: (1) history, (2) habitats, and (3) animal and plant species, including special status species. OU-2A sites are located in industrial areas with limited habitat for ecological receptors. Ecological habitat capable of supporting significant wildlife is neither present nor expected based on future reuse; therefore, inclusion of exposure pathways for terrestrial receptors provides a conservative estimate of risk.

Using a fully exposed soil scenario, the following complete exposure pathways for the OU-2A sites were selected:

- Direct exposure to soil
- Food chain exposure

An assessment endpoint defines both valuable ecological resources at the site and a characteristic of that resource to protect such as reproductive success or production per unit area. Unlike human health risk assessment, which evaluates only one species, the ERA involves multiple species with different degrees of exposure and toxicological responses. An assessment endpoint is defined by EPA as an “explicit expression of an environmental value to be protected” (EPA 1997b). Ecological resources may be considered valuable when (1) their absence would significantly impair ecosystem function; (2) they provide critical resources, such as habitat or fisheries; and (3) they are perceived by humans as being valuable, such as endangered species.

Assessment endpoints are usually not amenable to direct measurement. Instead, measurement endpoints related to assessment endpoints must be developed. Selected assessment and measurement endpoints are presented in Table 3-2. EPA defines measurement endpoints as “a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint and is a measure of biological effects (such as mortality, reproduction, and growth)” (EPA 1997b). Measurement endpoints can include measures of exposure or effect.

They are frequently numerical expressions of observations that can be compared statistically to a control or reference site or scientific study to detect adverse responses to a site-specific COPEC. Each measurement endpoint correlates directly with one of the defined assessment endpoints and was based on available literature mechanisms of toxicity.

Additional information regarding problem formulation is provided in Appendix I.

3.4.7.3 Exposure Estimates and Risk Evaluation

The exposure estimate and risk calculation step results in a conservative estimate of potential risk to the selected measurement endpoints. For each measurement endpoint and COPEC, a conservative estimate of the dose to an organism was developed using soil concentrations and either site-specific or literature-derived exposure parameters. The urban nature of the sites precluded the collection of site-specific tissue samples that could be used to reduce the uncertainty in the baseline ERA. In the absence of site- or species-specific tissue data, instead of using the most conservative exposure parameters, as in a traditional screening-level ERA, more average exposure parameters were deemed appropriate. These average exposure parameters were used to provide a more realistic view of potential risks to ecological receptors from exposure to residual chemicals at the OU-2A sites. The following equations were used to estimate daily doses to various receptors in the ERA. Values for the exposure factors for each vertebrate receptor are presented in Appendix I.

$$\text{Ground squirrel dose (milligrams per kilogram per day [mg/kg-day])} = \frac{(\text{SUF}) [(C_{\text{soil}})(\text{IR}_{\text{soil}}) + (C_{\text{invert}})(\text{IR}_{\text{invert}}) + (C_{\text{plant}})(\text{IR}_{\text{plant}})]}{\text{BW}}$$

$$\text{Alameda song sparrow dose (mg/kg-day)} = \frac{(\text{SUF}) [(C_{\text{soil}})(\text{IR}_{\text{soil}}) + (C_{\text{invert}})(\text{IR}_{\text{invert}}) + (C_{\text{plant}})(\text{IR}_{\text{plant}})]}{\text{BW}}$$

$$\text{American robin dose (mg/kg-day)} = \frac{(\text{SUF}) [(C_{\text{soil}})(\text{IR}_{\text{soil}}) + (C_{\text{invert}})(\text{IR}_{\text{invert}}) + (C_{\text{plant}})(\text{IR}_{\text{plant}})]}{\text{BW}}$$

$$\text{Red-tailed hawk dose (mg/kg-day)} = \frac{(\text{SUF}) [(C_{\text{ground squirrel}})(\text{IR}_{\text{ground squirrel}}) + (C_{\text{soil}})(\text{IR}_{\text{soil}})]}{\text{BW}}$$

where BW = Body weight

C_{soil} = EPC of chemical in soil (mg/kg)

$$C_{\text{invert}} = (C_{\text{soil}})(BCF_{\text{soil-to-invert}}) \text{ (mg/kg-Fresh Weight[FW]) (EPA 1999d)}$$

$$C_{\text{plant}} = (C_{\text{soil}})(BCF_{\text{soil-to-plant}}) (0.12) \text{ (mg/kg-FW) (EPA 1999d)}$$

(0.12 is a default value to convert the plant concentration from dry weight to fresh weight and is presented by EPA (1999d). This value is an average based on 80 to 95 percent water content in herbaceous plants and non-woody plant parts.)

$BCF_{\text{soil-to-invertebrate}}$ = Bioconcentration factor for uptake of constituent from soil to invertebrate tissue

$BCF_{\text{soil-to-plant}}$ = Bioconcentration factor for uptake of constituent from soil to plant tissue

$$C_{\text{ground squirrel}} = [(C_{\text{invert}})(FCM^3/FCM^2)(F_i) + (C_{\text{plant}})(BCF_{\text{plant-to-mammals}})(F_p) (0.12) + (C_{\text{soil}})(BCF_{\text{soil-to-mammal}})(\text{mg/kg})] \text{ (EPA 1999d)}$$

$BCF_{\text{soil-to mammal}}$ = Bioconcentration factor for uptake of constituent from soil to mammal tissue (based on mg/kg-Dry Weight[DW]) soil to mg/kg-FW mammal tissue (unitless) (EPA 1999d)

$BCF_{\text{plant-to-mammal}}$ = Bioconcentration factor for uptake of constituent from plant tissues to mammal tissues (based on mg/kg-DW soil to mg/kg-DW plant tissue (unitless)

FCM^3/FCM^2 = Food chain multiplier (FCM), which models a COPC concentration in a predator item (FCM^3), such as the California ground squirrel, from the ingestion of a prey item (FCM^2), such as a soil invertebrate (unitless).

Table I-15 presents the FCMs as presented in EPA 1999d.

F_i = The fraction of the ground squirrel diet that consists of invertebrates

F_p = The fraction of the ground squirrel diet that consists of plants

IR = Ingestion rate (the amount of prey items and soil ingested per day) (mg/kg-day)

SUF = Site use factor

Using risk calculations, doses were then compared to toxicity reference values (TRV) or ecological reference values (ERV) to evaluate potential risks to each ecological receptor. A TRV or ERV is a concentration or daily dose at which a particular biological effect may occur in an organism, based on laboratory toxicological investigations. TRVs were developed as a result of an ecological effect evaluation for mammalian and avian receptors that was conducted by the Navy, the EPA Region 9 Biological Technical Advisory Group, and Tetra Tech (Navy 1998b). If a Navy TRV was not available for a COPEC or endpoint, ERVs previously developed for other Navy facilities in California were used if available. If no ERVs for Navy facilities were available, other sources of conservative ERVs, such as toxicological benchmarks for wildlife (Sample and others 1996), were used. The entire exposure estimate and risk calculations are presented in Appendix I.

Chemicals detected in groundwater and retained as COPECs were further compared to valid saltwater screening values that have been published for the COPECs (see Section 3.4.7.1). HQs were calculated by dividing the EPC by a factor of 10, to account for mixing of groundwater and surface water, and then dividing the resulting concentration by the saltwater screening criteria. If no saltwater screening values have been published for the retained COPECs, impacts of these chemicals to marine receptors were qualitatively assessed.

3.4.7.4 Evaluation of Assessment Results

Using the high and low TRVs to evaluate ecological endpoints provides a bounding estimate of risk to each endpoint. The high TRV represents an upper bounding limit, which is the lowest concentration at which adverse effects are known to occur. The low TRV represents the lower bounding limit, which is the highest concentration an endpoint can be exposed to which adverse effects are known not to occur. Based on this, HQ results for soil using the high and low TRVs, were evaluated. If both HQ values for a chemical were below 1, then no potential risk to the ecological endpoint from soil was deemed to be appropriate. If one or both bounding limit HQs for metals exceeded 1, however, then the chemical was further compared to calculated background HQs for metals in soil. Additionally, chemicals with HQs above 1 and above background concentrations were further evaluated based on each chemical's frequency of detection and distribution at the site, the range of concentrations detected, and its absorption potential and toxicity to each ecological receptor. This type of analysis provides additional weight-of-evidence data to support risk management decisions for the sites.

3.4.7.5 Uncertainty

The ERA process involves a large number of uncertainties and extrapolations to evaluate potential risk to ecological receptors. Many of the assumptions in the ERA process are conservative and result in overestimates of site-specific parameters. Uncertainties associated with the ERA conducted for OU-2A are identified as follows:

- **Area Use Factors** - The risk calculations assumed that all receptors live and feed at the sites at all times
- **Dietary Composition** - The percent composition and type of prey ingested by various receptors were based on literature studies that were not site-specific. Additionally, the models were simplified to assume a limited diet, consistent with the literature data
- **Bioavailability** - All ecological COPCs were assumed to be 100 percent bioavailable to all receptors
- **Development of TRVs** - TRVs and ERVs used in risk calculations were derived from literature studies. These studies were not conducted on the receptors used in this assessment. TRVs and ERVs were extrapolated using uncertainty factors to account for differences between species
- **Qualitative Evaluations of COPECs** - Studies were not available to develop TRVs for a number of the measurement endpoints. The potential effects of these ecological COPCs were evaluated on a qualitative basis, relying heavily on professional judgment
- **Surrogate TRVs** - Surrogate TRV values were used for some compounds, such as the use of the 4,4'-Dichlorodiphenyltrichloroethane (DDT) TRV for other chlorinated pesticides
- **Bioconcentration Factors** - The use of the octanol-water partition coefficient (K_{ow}) to calculate the biotransfer factor of chemicals into mammal tissue and the BCFs for receptors and food items can overestimate the uptake of organic compounds into the tissues of organisms and plants
- **Background Levels of Metals and Ambient Concentrations of Pesticides** - To place site-specific risks in the proper context, the risks associated with background and ambient concentrations of chemicals were considered

Overall, many of the assumptions in the ERA process are conservative and result in overestimates of site-specific parameters. For further discussion on uncertainty refer to the ERA in Appendix I.

3.5 APPROACH TO CONCLUSIONS

The decision as to whether an FS is required at any of the OU-2 sites is based primarily on a determination as to whether any CERCLA chemicals are present at concentrations that pose a potential risk to human health or the environment. That determination is based on the following information:

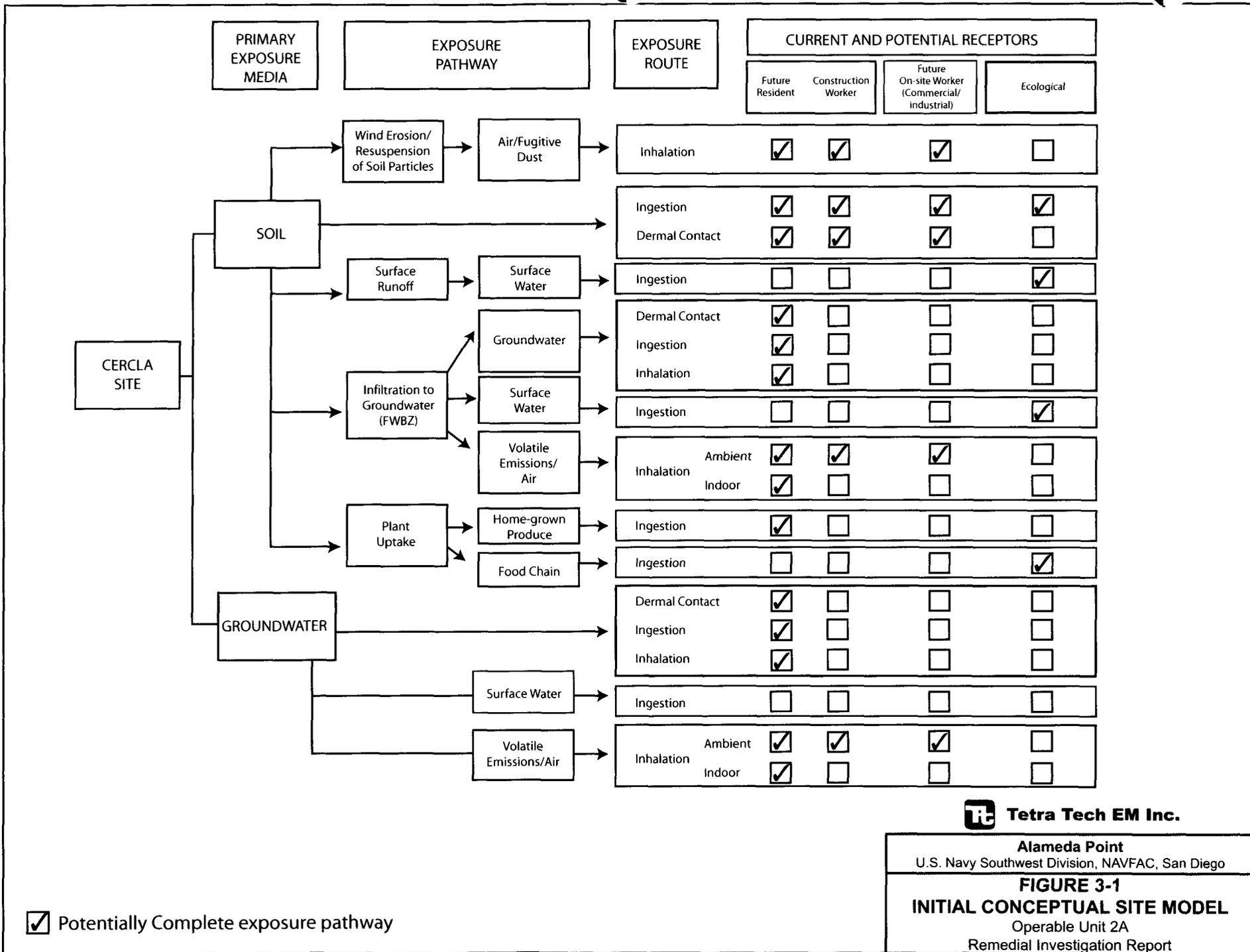
- Site-specific CSM
- Background comparison results
- HHRA results
- ERA results
- Future land use
- Professional judgment

Potential risk is posed and an FS is necessary if (1) human health risk estimates for chemicals related to site activity exceed risk levels defined in the NCP or (2) chemicals related to site activity are present at levels that would pose significant risk to ecological receptors.

The NCP presents a range of "excess upper-bound lifetime cancer risk to an individual of between 1E-06 and 1E-04", which is known as the "risk management range." If the cancer risk exceeds 1E-06, risk is posed and an FS is necessary. If the total HI exceeds 1, further evaluation in the form of a segregation of HI analysis may be performed to determine whether the noncancer HIs are a concern. If the noncancer HIs are considered a concern, risk is posed, and an FS is necessary.

Acceptable ecological risk from soil is defined as HQ values below 1 for chemicals in soil. If HQ values exceed 1, further evaluation of background and a chemical's frequency of detection and distribution at the site, the range of concentrations detected, and its absorption potential and toxicity may be performed to make a determination of no or limited potential risk. Acceptable ecological risk from groundwater is defined as the groundwater screening indicating no or limited potential risk.

Chemicals that demonstrate significant risk to human health or the environment (risk drivers), as defined by the risk assessments, and that are not considered background are identified as chemicals of concern (COC) requiring further evaluation in an FS. Conclusions and recommendations regarding further action are provided in the site-specific sections (Sections 5 through 9). The conclusions and recommendations of all five OU-2A sites are summarized in Section 10.

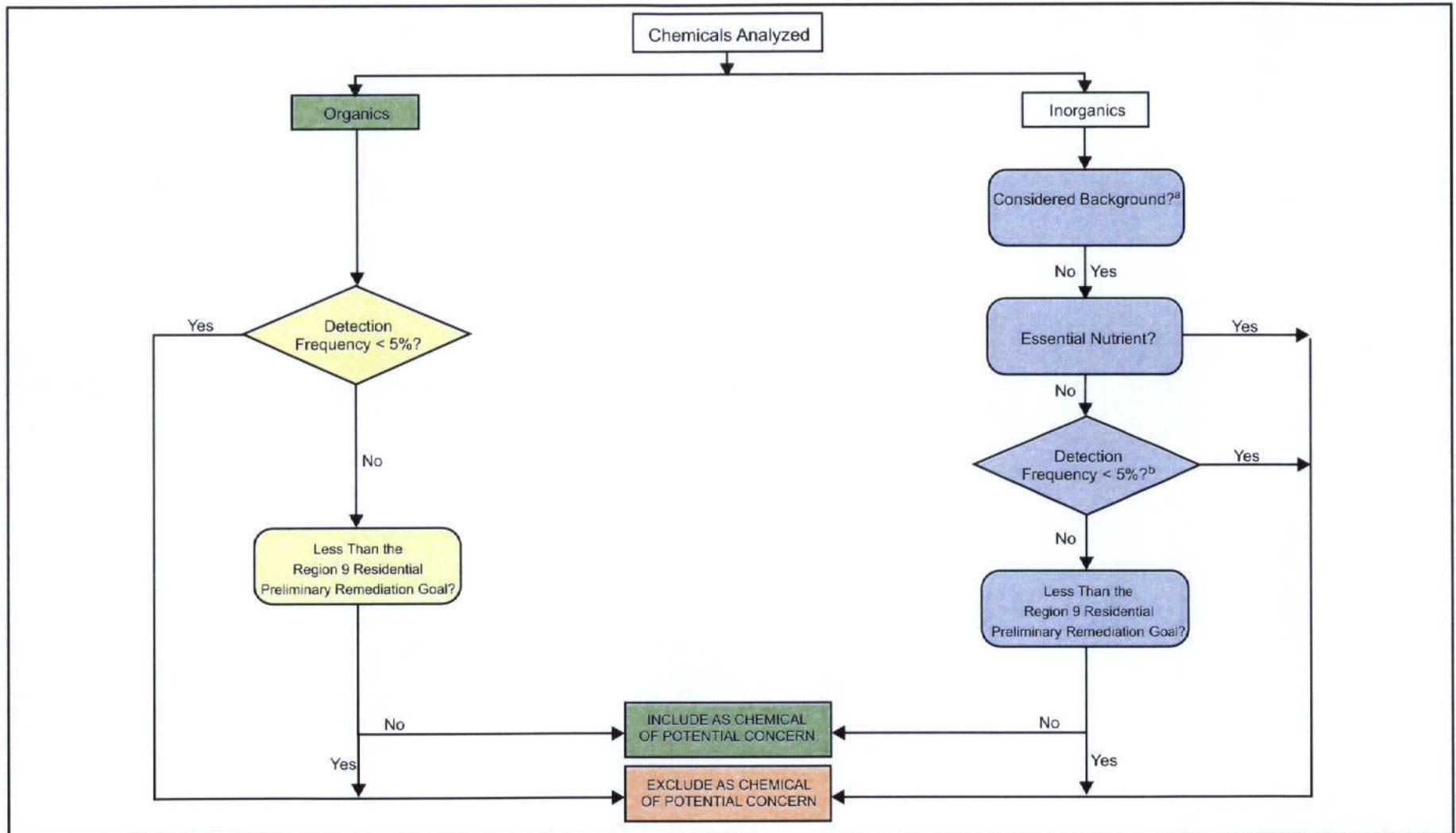


Potentially Complete exposure pathway

Tetra Tech EM Inc.

Alameda Point
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 3-1
INITIAL CONCEPTUAL SITE MODEL
Operable Unit 2A
Remedial Investigation Report



a Consistent with U.S. Department of the Navy guidance, metals data will be statistically compared with the background (ambient) data set. Chemicals considered to be background will not be removed from further consideration in the human health risk assessment; rather, any chemicals considered to be background will be noted as such.

b Will only occur if at least one of the following criteria is met:

- 1) at least 20 samples have been collected from that medium;
- 2) the chemical is not historically related to site operations or suspected releases (for example, a single chlordane detection would be eliminated from a data set of 20 results, whereas a single cis-1,2-dichloroethene detection would be retained for a site with a known solvent release);
- 3) the chemical is not closely related to others detected or a degradation product;
- 4) detection limits for some or all analyses for that chemical are elevated.

Tt Tetra Tech EM Inc.

Alameda Point
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 3-3
FLOW CHART OF CHEMICAL OF
POTENTIAL CONCERN
SELECTION PROCESS

Operable Unit 2A
Remedial Investigation Report

TABLE 3-1: HISTORICAL SUMMARY OF ENVIRONMENTAL INVESTIGATIONS
 Remedial Investigation Report for Sites 9, 13, 19, 22, and 23, Alameda Point, Alameda, California

Environmental Investigation		Site 9	Site 13	Site 19	Site 22	Site 23
Prior to IR Program	Initial assessment study (IAS)		√			
RCRA	multiple	√	√	√	√	√
CERCLA	Phases 1A & 2A Investigation, 1991	√	√	√	√	√
	Follow-on Investigation, 1994	√	√	√	√	√
	Follow-on Investigation, 1998	√	√	√	√	√
	Groundwater Sampling and Tidal Influence	√	√	√	√	√
	Supplemental RI Data Gap Sampling, 2001	√	√	√	√	√
	Basewide Groundwater Monitoring, 2002	√	√	√	√	√
	PAH Investigation	√	√	√	√	√
EBS	Phase IIA EBS	√		√	√	√
	Phase IIB EBS			√		√
TPH	Fuel Lines and UST Investigations		√	√	√	√
Removal Actions	Intermediate Maintenance Facility Removal Action		√			
	Basewide Fuel Line Removal Action Confirmation Sampling		√	√		
	Duel Vapor Extraction		√			√
	Chemical Oxidation Removal Action	√				

Notes:
 EBS Environmental baseline survey
 IR Installation restoration
 PAH Polynuclear aromatic hydrocarbons
 RCRA Resource Conservation and Recovery Act
 RI Remedial Investigation
 TPH Total petroleum hydrocarbon
 UST Underground storage tank

TABLE 3-2: ECOLOGICAL RISK ASSESSMENT AND MEASUREMENT ENDPOINTS

Remedial Investigation Report for Sites 9, 13, 19, 22, and 23, Alameda Point, Alameda, California

ASSESSMENT ENDPOINTS	MEASUREMENT ENDPOINTS
Sufficient rates of survival, growth, and reproduction to sustain small mammal populations typical to the area	Reproductive or physiological impacts to the California ground squirrel (<i>Citellus beecheyi</i>), as indicated by HQs developed based on both high (LOAEL-based) and low (NOAEL-based) TRVs
Sufficient rates of survival, growth, and reproduction to sustain passerine populations typical to the area	Reproductive or physiological impacts to the Alameda song sparrow (<i>Melospiza melodia pusillula</i>) and American robin (<i>Turdus migratorius</i>), as indicated by HQs developed based on both high (LOAEL-based) and low (NOAEL-based) TRVs
Sufficient rates of survival, growth, and reproduction to sustain raptor populations typical to the area	Reproductive or physiological impacts to the red-tailed hawk (<i>Buteo jamaicensis</i>), as indicated by HQs developed based on both high (LOAEL-based) and low (NOAEL-based) TRVs
Sufficient rates of survival, growth, and reproduction to sustain marine populations typical to the area	Direct comparison with published water quality criteria to assess risk to marine receptors ⁽¹⁾

Notes:

⁽¹⁾ Published criteria were obtained from either the California Toxics Rule Criteria (U.S. EPA) for Enclosed Bays and Estuaries, Saltwater Aquatic Life Protection, or if not available, the U.S. EPA National AWQC, Saltwater Aquatic Life Protection, as presented in the NOAA SQUIRT Tables. See full references below.

- AWQC = Aquatic Water Quality Criteria
- HQ = Hazard quotient
- LOAEL = Lowest observed adverse effects level
- NOAA = National Oceanic and Atmospheric Administration
- NOAEL = No observed adverse effects level
- SQUIRT = Screening Quick Reference Tables
- TRV = Toxicity reference value
- U.S. EPA = U.S. Environmental Protection Agency

Source :

California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. 2000. A Compilation of Water Quality Goals. August.
 U.S. Department of Commerce, NOAA. 1999. NOAA SQUIRT. Hazmat Report 99-1. Updated September.

4.0 RESULTS OF GEOLOGICAL AND HYDROGEOLOGICAL INVESTIGATIONS

The following sections describe the results of geologic and hydrogeologic investigation activities at OU-2A, which encompasses Sites 9, 13, 19, 22, and 23. Because these five sites are contiguous, the geologic and hydrogeologic conditions at the sites are similar and interrelated; therefore, they are discussed together in the following sections. The site-specific geology of OU-2A is described in Section 4.1, followed by a discussion of the site-specific hydrogeology presented in Section 4.2.

4.1 OPERABLE UNIT 2A GEOLOGY

The OU-2A geology, investigated in the RI, includes four upper Quaternary units (as described in Section 2.2), plus a surficial layer of artificial fill material. The OU was characterized by reviewing logs from 178 soil borings and cone penetrometer tests conducted at the sites. Conceptual geologic cross sections showing the idealized geology of OU-2A are presented as Figure 4-1. Detailed geologic cross sections, two per site (see Figures 4-2 through 4-11), were developed based on information collected during exploration activities, including:

- Information from the boring logs
- Stratigraphic contacts that were determined using changes in lithology
- Color of the lithologic matrix
- Grain features (such as frosting, angular, subangular, and rounded)
- Presence of debris, oxidized root channels, and oxide staining
- Presence of key shell marker beds, buried vegetative surfaces, roots, stems, leaves, old soil surfaces, peat layers, and shell hash
- Degree of consolidation
- Changes in cone penetrometer testing (CPT) tip resistance and blow counts

Geologic logs are presented in Appendix B.

Artificial Fill. The artificial fill is the uppermost unit that underlies most of OU-2A, ranging in thickness from 0 to 15 feet bgs. The artificial fill is thickest in the western portion of Site 9 and decreases in thickness until it pinches out at Site 22 and the northeast corner of Site 13. The fill at OU-2A mainly comprises dense to medium density brown silty sand. Local variations in the fill include the presence of discontinuous clay and gravel lenses. Construction debris (such as concrete, asphalt, and wood debris) has been encountered in borings at numerous locations in OU-2A.

Holocene Estuarine Deposits (Bay Sediment Unit). At OU-2A, the BSU underlies the artificial fill material at Site 9 and the western portions of Sites 13, 19, and 23, where it pinches out along the former shoreline of Alameda Island (see Figure 2-2). Northeast of the former shoreline, the BSU is not present. The BSU reaches a maximum thickness of 9 feet at Sites 9 and 13. The BSU at OU-2A comprises subtidal deposits because the tidal flat sediments are located to the north.

At OU-2A, the BSU consists of loose silt and soft gray to black clay with laterally discontinuous, poorly graded, silty and clayey sand layers associated with subtidal deposits. The marsh crust (see Section 2.2.2) is found on top of the BSU at Sites 9, 13, 19, and 23.

Late Pleistocene/Holocene Eolian Deposits (Merritt Sand). At OU-2A, the Merritt Sand is present at the ground surface in the eastern portion of Site 22 and in the northeast portion of Site 13. In the western portion of Site 22, and the central portions of Sites 13, 19, and 23, the Merritt Sand underlies the artificial fill, as shown in Figures 4-4 through 4-7 and 4-10 through 4-11. At Site 9 and the western portions of Site 13, 19, and 23, the Merritt Sand Formation underlies the Bay Sediments, as shown in Figures 4-2 through 4-7 and 4-10 through 4-11. At OU-2A, the Merritt Sand ranges in thickness from 55 feet at Site 9 to 80 feet at Sites 13 and 23.

The Merritt Sand at OU-2A is composed of brown, dense to medium dense, fine- to medium-grained, poorly graded sand. Thin, continuous clayey or silty sand layers are common, as shown in Figures 4-3 and 4-11. Bivalve shells and shell hash are observed in parts of the Merritt Sand, indicating some marine reworking during the most recent sea level rise.

Late Pleistocene/Holocene Alluvial Deposits (Upper San Antonio Formation). At OU-2A, the upper unit of the San Antonio Formation was encountered in nine borings. The depth of the top of the upper unit of the San Antonio Formation is between 68 feet bgs at Site 19 (see Figure 4-6) and 84 feet bgs at Site 23 as shown in Figure 4-10. The thickness of the upper unit of the San Antonio Formation, seen in eight of the nine borings, ranges from 3 to 8 feet at Site 9 (see Figure 4-2) and from 15 to 28 feet at Site 13 (see Figure 4-5). The Upper San Antonio Formation at OU-2A consists of medium-grained dark gray to olive brown sand containing varying amounts of silt and clay. Bedding planes were found in several borings at Sites 19 and 13.

Late Pleistocene Estuarine Deposits (Yerba Buena Mud). At OU-2A, the lower unit of the San Antonio Formation (Yerba Buena Mud) was encountered in seven borings. The depth of the top of the Yerba Buena Mud occurs between 79 feet bgs at Site 9 (see Figure 4-2) to 100 feet bgs at Sites 13 and 23 (see Figures 4-5 and 4-10). Borings advanced at OU-2A penetrated the unit a maximum of 5 feet; the total thickness of this unit was not explored during RI activities. The Yerba Buena Mud encountered at OU-2A is described as a bluish gray, stiff silty clay or fat clay with some organic matter present.

Alameda Formation/Franciscan Complex. Geologic units underlying the Yerba Buena Mud, the Alameda Formation and the Franciscan Complex, were not encountered in borings conducted during the RI program.

4.2 OPERABLE UNIT 2A HYDROGEOLOGY

The following sections provide a description of the hydrogeology of OU-2A at Alameda Point.

4.2.1 Hydrostratigraphy

As discussed in Section 2.3.2.1, there are five hydrostratigraphic units at Alameda Point, each of which is represented in OU-2A. Hydrostratigraphic units occurring within OU-2A include the FWBZ, the BSU Aquitard, the SWBZ, the Yerba Buena Aquitard, and the Alameda Aquifer. Figure 4-12 shows the conceptual site model of the hydrostratigraphic features at OU-2A. The FWBZ occurs in all of OU-2A. The SWBZ occurs only in the southwestern portion of OU-2A, where the BSU Aquitard is present and separates the FWBZ from the SWBZ. The lithologic BSU Aquitard pinches out beneath OU-2A, approximately coincident with the former Alameda Point shoreline; the approximate eastern extent of the BSU in OU-2A is shown on Figure 2-2. The SWBZ does not occur in the eastern part of OU-2A, where the BSU Aquitard is absent.

The SWBZ in OU-2A is confined by the overlying BSU Aquitard. The regional aquitard (Yerba Buena Mud) separates the FWBZ and, where present, the SWBZ from the underlying Alameda Formation. Detailed descriptions of the hydrostratigraphic units were provided in Section 2.3.2.1; the occurrence of these hydrostratigraphic units within OU-2A is described as follows:

FWBZ. The FWBZ is the uppermost water-bearing zone at OU-2A and occurs throughout the OU as a water table aquifer. At OU-2A, the FWBZ occurs within both the artificial fill deposits in the western portion of OU-2A and in the Merritt Sand in the eastern portion of OU-2A. Artificial fill was placed in most areas of OU-2A at thicknesses up to 15 feet. The artificial fill was placed on top of native materials including the Merritt Sand and the BSU. Where the BSU Aquitard is present, the FWBZ is approximately 15 feet thick and is comprised primarily of artificial fill.

Where the BSU Aquitard is absent, the FWBZ reaches a maximum thickness of at least 55 feet and is comprised of either artificial fill and the Merritt Sand or only the Merritt Sand in the northeastern part of OU-2A (Site 22). In this part of OU-2A, the FWBZ is subdivided vertically into the FWBZU and the FWBZL. In general, the FWBZU is coincident with the artificial fill deposits where present and the upper part of the Merritt Sand. The FWBZL occurs only in the Merritt Sand in the eastern portion of OU-2A.

Bay Sediment Unit Aquitard. The BSU Aquitard occurs only in the southwestern portion of OU-2A. The BSU Aquitard underlies the artificial fill material at Site 9 and occurs in the

western portions of Sites 13, 19, and 23. The aquitard discontinues along an approximate northwest-southeast trending line, as determined from boring logs, and is illustrated in Figure 2-2. The BSU Aquitard consists of silty to clayey fine or very fine sand and reaches a maximum thickness of approximately 5 feet at the western edge of Site 19 and approximately 9 feet at the western edge of Site 9.

SWBZ. The SWBZ occurs in the southwestern part of OU-2A in Sites 9, 13, 19 and 23, coincident with the occurrence of the BSU Aquitard. The SWBZ is in the Merritt Sand and the Upper San Antonio Formation. The maximum thickness of the SWBZ in OU-2A is estimated to be 60 feet in the western part of Site 9.

Yerba Buena Aquitard. The Yerba Buena Aquitard occurs at depths of 79 to 100 feet below the ground surface at OU-2A. No OU-2A monitoring wells are screened in or below this unit.

Alameda Aquifer. The Alameda Aquifer occurs below the Yerba Buena Aquitard at OU-2A. No OU-2A monitoring wells are screened in or below this unit.

4.2.2 Groundwater Flow

Groundwater flow in the FWBZ and the SWBZ in OU-2A is described in this section.

4.2.2.1 Groundwater Flow in the FWBZ

Groundwater elevations measured in the FWBZ in OU-2A in 2002 and 2003 range from approximately 6 to 9 feet above the MLLW. Groundwater in the FWBZ at OU-2A generally flows from northeast to southwest.

Groundwater elevation measurements were collected during quarterly groundwater monitoring during the June, September, December 2002 and April 2003 sampling events. Data collected during the first three quarterly events were collected over periods of several days to weeks, and therefore cannot be used to estimate flow direction. With the exception of two wells at the eastern edge of Site 13, MWOR-4 and M13-09, the April 2003 data set was collected on April 7, 2003. MWOR-4 and M13-09 were measured on April 8, 2003.

Groundwater elevation data collected in OU-2A monitoring wells on April 7 and 8, 2003, are presented in Figure 4-13. Groundwater elevation contours from those data indicate that groundwater flow patterns in OU-2A are similar to those interpreted from the June and December 2002 data. Groundwater elevations are highest at Site 22 and lowest in the western portion of Site 23. A general northeast to southwest groundwater flow direction is indicated. There is also localized groundwater flow in the western portion of Site 23 from the southeast to the northwest.

4.2.2.2 Groundwater Flow in SWBZ

Groundwater elevations in the SWBZ in OU-2A range from approximately 4 to 7 feet above MLLW. Based on two groundwater elevation contour maps of data collected in June 2002 and April 2003, the groundwater flow direction in the SWBZ at OU-2A is from east to west. A groundwater elevation contour map generated from the June 2002 data is shown on Figure 4-14. The tidally corrected April 2003 groundwater elevation data, which were collected on April 7, 2003, are shown on the Figure 4-15 contour map.

4.2.3 Aquifer Hydraulic Parameters

Table 4-1 presents estimates of aquifer hydraulic parameters for Sites 9 and 13, based on data collected from slug tests and pumping tests that were conducted in 2003 (Shaw 2003a). The hydraulic conductivity (K) of the FWBZ at Site 9, as determined from slug testing, is estimated at 1.7 feet per day. K values for Site 13 ranged from 3.4 to 5.3 feet per day, as interpreted from pumping test data.

The hydraulic conductivity of the SWBZ at Site 9, as determined from pumping test data, is 2.3 feet per day. The estimated transmissivity and storativity of the SWBZ at Site 9, as determined from pumping test data, are 52 square feet per day and 0.0023 (dimensionless).

4.2.4 Hydraulic Gradients

A description of horizontal and vertical hydraulic gradients is provided in this section.

4.2.4.1 Horizontal Hydraulic Gradients

The horizontal hydraulic gradient in the FWBZ, as estimated from groundwater elevation data collected in December 2003, ranges from 0.0038 in the vicinity of Sites 13, 19, and 22 to 0.01 in the southern portion of Site 23. In the northeastern part of Site 23, the horizontal hydraulic gradient in December 2002 was approximately 0.003.

On April 7, 2003, the horizontal hydraulic gradient in the FWBZ ranged from 0.002 in the vicinity of Sites 13, 19, and 22 to 0.004 in the southern portion of Site 23.

Horizontal hydraulic gradients in the SWBZ in June 2002 ranged from 0.0035 in the northern part of OU-2A to 0.0048 in the southern part of OU-2A. In April 2003, the horizontal hydraulic gradient ranged from 0.0015 in the northern portion of OU-2A to 0.0015 in the southern portion of OU-2A.

4.2.4.2 Vertical Hydraulic Gradients

Vertical hydraulic gradients within the FWBZ and between the FWBZ and the SWBZ were estimated using groundwater elevation data from six monitoring well pairs. The well pairs consist of adjacent or closely spaced wells screened in multiple hydrostratigraphic zones. Vertical hydraulic gradients in OU-2A were estimated using groundwater elevation data collected over a period of weeks from June and December 2002 and are considered approximate; vertical hydraulic gradients for OU-2A were also calculated from tidally corrected groundwater elevation data collected on April 7, 2003.

Vertical hydraulic gradients were calculated by dividing the difference in hydraulic heads between two adjacent wells by the difference in the midpoint elevations of the screened intervals. Vertical hydraulic gradients are indicative of the magnitude and direction of the vertical component of groundwater flow. Vertical hydraulic gradients calculated using the groundwater elevation data were generally downward, suggesting that groundwater in the FWBZ moves horizontally towards the Seaplane Lagoon and the Bay with some component of flow downward to recharge the lower FWBZ and the SWBZ. The low permeability materials of the BSU function as an aquitard, most likely preventing the downward flow of groundwater from the FWBZ to the SWBZ.

In the eastern portion of OU-2A, where the BSU Aquitard is absent, slight (0.001 to 0.006) downward vertical gradients between the upper and lower FWBZ were present in June 2002 in two monitoring well pairs. A low vertical hydraulic gradient (0.002) calculated at one monitoring well pair using the December 2002 data was upward, indicating a small component of upward flow from the lower FWBZ to the upper FWBZ. Vertical hydraulic gradients calculated using the April 7, 2003, data are both downward and are greater than those calculated using previous, nonsynchronized data. These results suggest that the primary component of groundwater flow in the FWBZ in the eastern part of OU-2A is horizontal but that some downward movement of groundwater occurs between the upper FWBZ and lower FWBZ.

In the western part of OU-2A, where the BSU is present, downward vertical gradients between the FWBZ and the SWBZ (ranging from 0.023 to 0.063) were generally present according to the June 2002 and the April 2003 groundwater elevation data. The slightly greater vertical gradients between the FWBZ and the SWBZ are most likely caused by the BSU functioning as an aquitard, acting to slow the vertical component of groundwater flow from the FWBZ to the SWBZ. At one location in Site 23, a localized low upward vertical hydraulic gradient was noted in each of the three rounds of groundwater elevation data.

Example vertical gradient calculations for the June 2002 dataset are provided on Table 4-2.

4.2.5 Tidal Influence

Aquifers located adjacent to tidal water bodies are subject to short-term fluctuations in water levels in response to the tides. Water levels in monitoring wells near tidal bodies demonstrate

fluctuations in hydraulic head that parallel the rise and fall of the tide. The amplitude of the fluctuation is generally greatest at the coast and diminishes inland. At Alameda Point, water level fluctuations in the Bay cause groundwater levels near the coast to respond hydraulically, moving up and down according to the tidal cycle; groundwater affected in this way is said to be "tidally influenced." Groundwater levels in tidally influenced monitoring wells move up and down after the corresponding high and low tides occur. The length of time required for the water in a well to respond to the ocean tidal cycle is known as the "tidal time lag" (Fetter 1994). The ratio of the tidal amplitude in a well to that of the ocean is termed the "tidal efficiency."

The FWBZ is tidally influenced on the northern, southern, and western sides of Alameda Point. Tidal influence studies indicate the region of influence extends about 250 to 300 feet inland on the northern and southern sides of Alameda Island and about 1,000 to 1,500 feet inland on the west side. Groundwater that is tidally influenced in OU-2A occurs at the western and southwestern edges in Sites 9, 13, 19, and 23, as determined during tidal studies performed at Alameda Point. Diurnal tidal fluctuations measured in the FWBZ range from 0.1 to 4 feet (PRC 1997a).

In the FWBZ, tidally influenced groundwater occurs at monitoring wells MWOR-2, MW410-1, M10B-01, and MW530-1. Groundwater in the SWBZ at the western and southwestern edges of OU-2A is tidally influenced, as indicated by data from monitoring wells D19-01, D09-01, and D10B-01.

Estimated lag time for tidal response in monitoring well D09-01 was about 1 to 1.5 hours during the study conducted in 1997. The gradient near this well was approximately 0.0019 feet/foot at high tide and 0.0025 feet/foot at low tide (PRC 1997a).

4.2.6 Seawater Intrusion

In aquifers near the coast, fresh water generally grades into saline water with a steady increase in the dissolved solids content. Because of the difference in the concentration of dissolved solids, the density of the saline water is greater than that of fresh water. As a result, along seacoasts there is a salt water-freshwater contact zone or interface in aquifers that extends under the sea. At coastal locations, the fresh groundwater beneath the ground surface is discharging across the fresh water-salt water interface and mixing with saline groundwater under the sea floor (Fetter 1994).

Normally, freshwater moves seaward continuously at a rate that is related to the hydraulic head above mean sea level in a freshwater aquifer (Hem 1989); this natural flow of fresh water toward the sea limits the landward encroachment of sea water (Domenico and Schwartz 1990).

The shape and position of the interface between saline groundwater and fresh groundwater is a function of the volume of fresh water discharging from the aquifer. Any action that changes the volume of fresh water discharge results in a consequent change in the salt water-fresh water boundary. Minor fluctuations in the boundary position occur with tidal actions and seasonal and

annual changes in the amount of fresh water discharge (Fetter 1994). With development of groundwater supplies and subsequent lowering of the water table or piezometric surface, the dynamic balance between fresh and sea water is disturbed, permitting seawater to intrude into usable parts of the aquifer above the coastline (Domenico and Schwartz 1990). This phenomenon is referred to as "salt water intrusion" or "saline-water encroachment."

Specific conductance is a measure of the ability of a solution to carry an electric current and depends on the total concentration of ionized substances dissolved in the water. Although all ions contribute to conductivity, their valences and mobilities differ, so their actual and relative concentrations affect conductivity. When the concentration of ions is high, conductivity is elevated. The approximate specific conductance of seawater is 50,000 micromhos per centimeter ($\mu\text{mhos/cm}$) (Hem 1989). The California Secondary MCL recommended for the specific conductance of drinking water is less than 900 $\mu\text{mhos/cm}$.

At Alameda Point, fresh groundwater occurs in the FWBZ; the SWBZ primarily consists of water that is fresh to brackish, with specific conductance readings ranging from less than 500 $\mu\text{mhos/cm}$ to greater than 3,000 $\mu\text{mhos/cm}$. Specific conductance values measured in monitoring wells in OU-2A were measured in 1990 and 1994, and more data points were measured in 1994. In 1990, specific conductance readings from 20 monitoring wells screened in the FWBZ ranged from approximately 380 to 2,000 $\mu\text{mhos/cm}$ with slightly higher conductivities at two monitoring wells occurring at 2,580 and 4,020 $\mu\text{mhos/cm}$. In 1994, specific conductance measured in 32 monitoring wells screened in the FWBZ ranged from approximately 300 to 2,000 $\mu\text{mhos/cm}$ with several isolated data points ranging from 5,160 to 14,600 $\mu\text{mhos/cm}$.

In monitoring wells in the SWBZ, where conductivities were measured only in 1994, the values were 1 to 2 orders of magnitude higher than those in the FWBZ, ranging from 2,600 to 37,000 $\mu\text{mhos/cm}$. The highest conductivities were measured in wells in the SWBZ at the southern and western edges of OU-2A, including 20,000 $\mu\text{mhos/cm}$ at D19-01, 34,000 $\mu\text{mhos/cm}$ at D10B-01, and 37,000 $\mu\text{mhos/cm}$ at D09-01. These monitoring well locations are closest to the coast; the higher conductivities may indicate the location of the top of the salt water-fresh water interface.

Overpumping of groundwater extraction wells drilled into the Merritt Sand on Alameda Island before the turn of the century resulted in salt water intrusion and closure of these production wells. Only minor pumping of groundwater from the aquifer underlying Alameda Island has occurred since 1990 (Figuers 1998).

4.2.7 Existing Uses of Groundwater

A technical memorandum has been prepared on the quality and beneficial uses of groundwater at Alameda Point (Tetra Tech 2000a). The memorandum focuses on applicable water quality policies and regulations, the rationale for and assessment of groundwater quality, the feasibility of using the groundwater resource, and the determination of the probable beneficial use of the

groundwater resource at Alameda Point. The technical memorandum is currently being revised to reflect EPA groundwater classification and use scenarios.

Nine state-registered wells are screened in the unconfined Merritt Sand unit east of Alameda Point. These wells are located in the neighborhood south of Atlantic Avenue and west of Webster Street. In addition, there are several unregistered, private irrigation wells screened in the unconfined Merritt Sand unit and the Alameda Formation. All the neighborhood wells are located upgradient of Alameda Point. Many of the unregistered wells screened in the Merritt Sand aquifer were installed by private landowners to obtain water for lawn and horticultural irrigation during periods of drought. The irrigation wells are known to be in current use for lawn irrigation within the community. The irrigation wells were installed in accordance with historical well construction standards before the enactment of current Alameda County well construction standards. Current Alameda County standards prohibit screening of municipal or domestic water supply wells in the unconfined Merritt Sand unit.

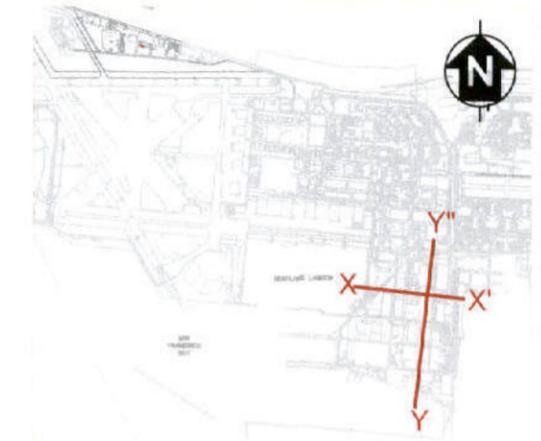
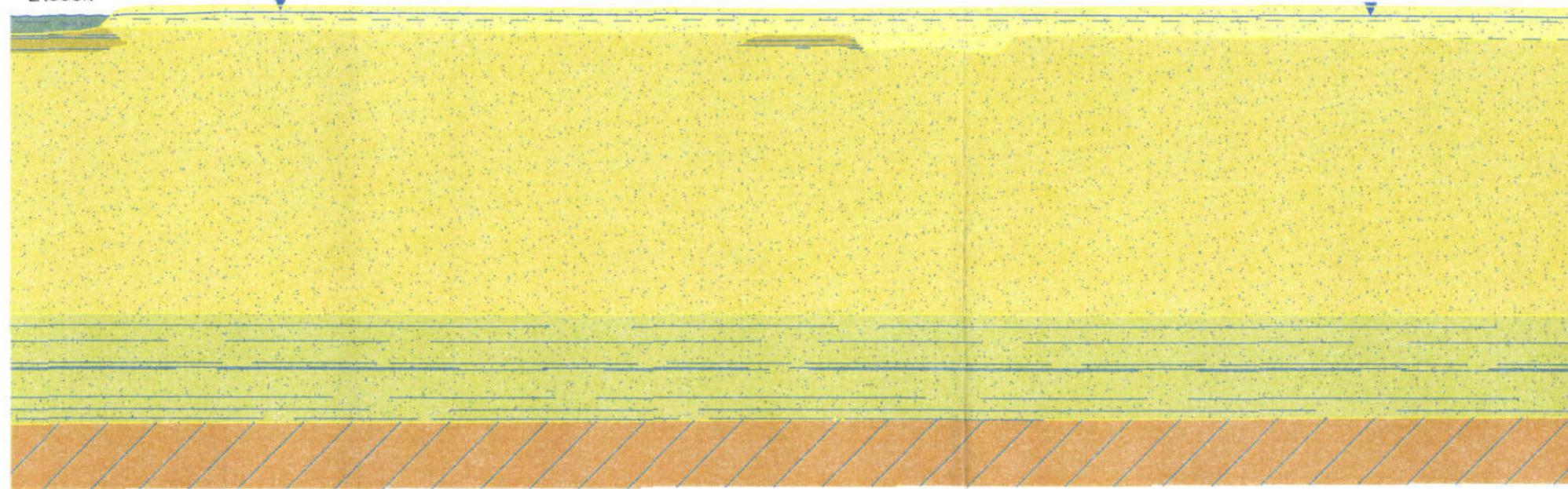
Three wells on or near Alameda Point are screened in the confined Alameda Formation. Two of the wells are in operation, and one of the wells has been closed. Of the two operational wells, one is near the intersection of Pan Am Way and West Red Line Avenue on Alameda Point, and the other is near the intersection of 5th Street and Pacific Avenue east of Alameda Point. Both of these wells are used for irrigation.

Groundwater wells to be used for domestic consumption could be installed in the Alameda Formation (a confined aquifer), because of the regional aquitard that protects it from contamination. However, the pumping rates of any new wells in this aquifer must be controlled to prevent significant drawdown that would adversely affect the current domestic groundwater wells in the area.

WEST
X

SEAPLANE
LAGOON

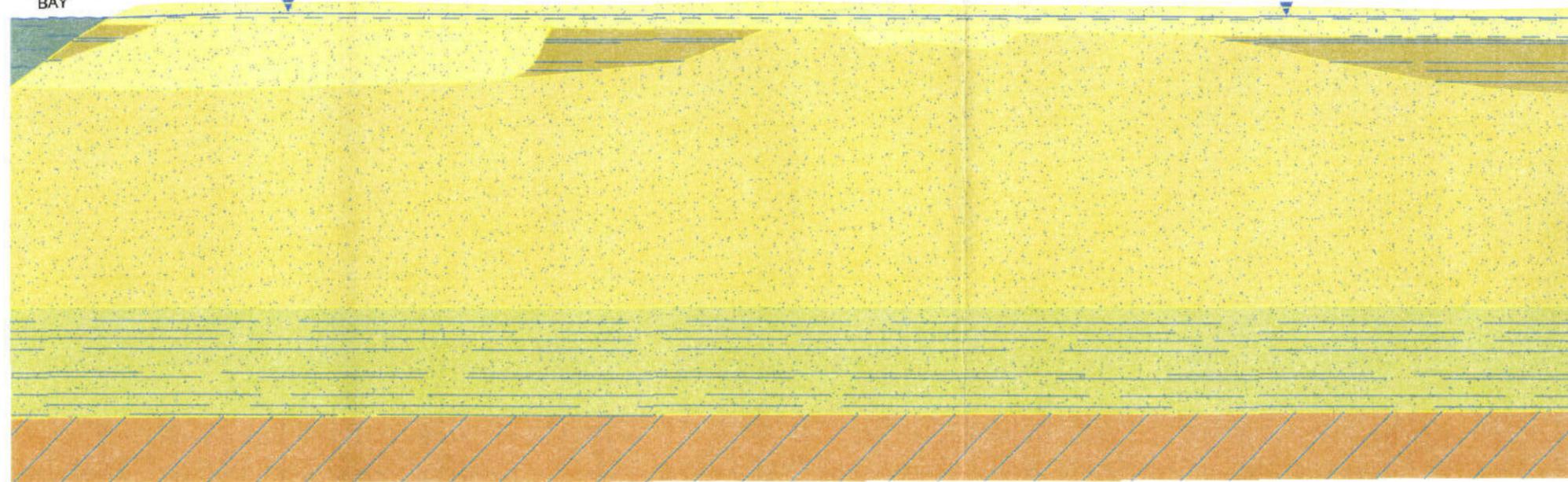
EAST
X'



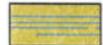
SOUTH
Y

SAN FRANCISCO
BAY

NORTH
Y'



LEGEND

-  WATER BODIES
-  FILL
-  BAY SEDIMENTS CLAY
-  BAY SEDIMENTS SAND

-  MERRITT SAND
-  SAN ANTONIO INTERBEDDED SAND AND CLAY
-  YERBA BUENA MUD

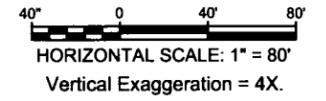
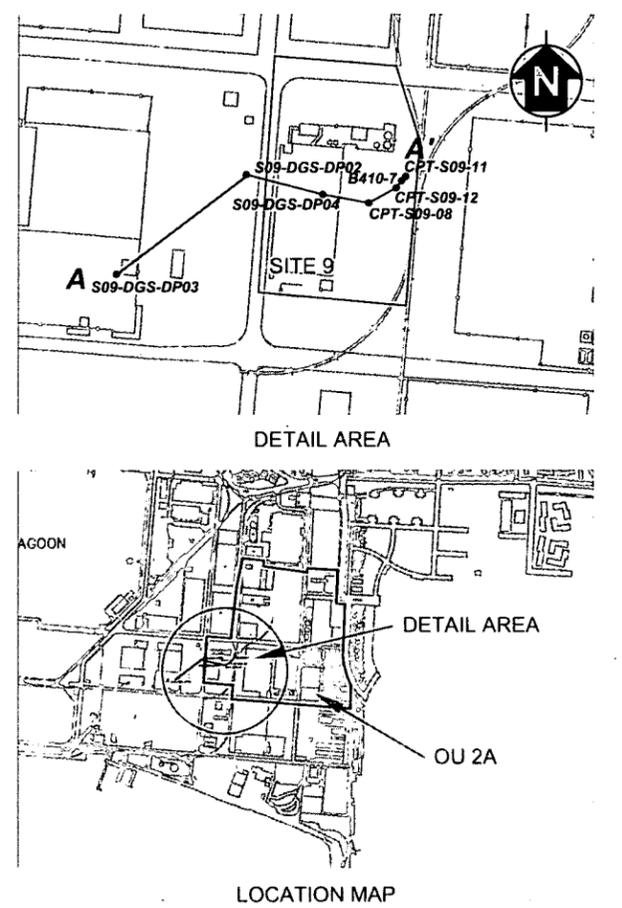
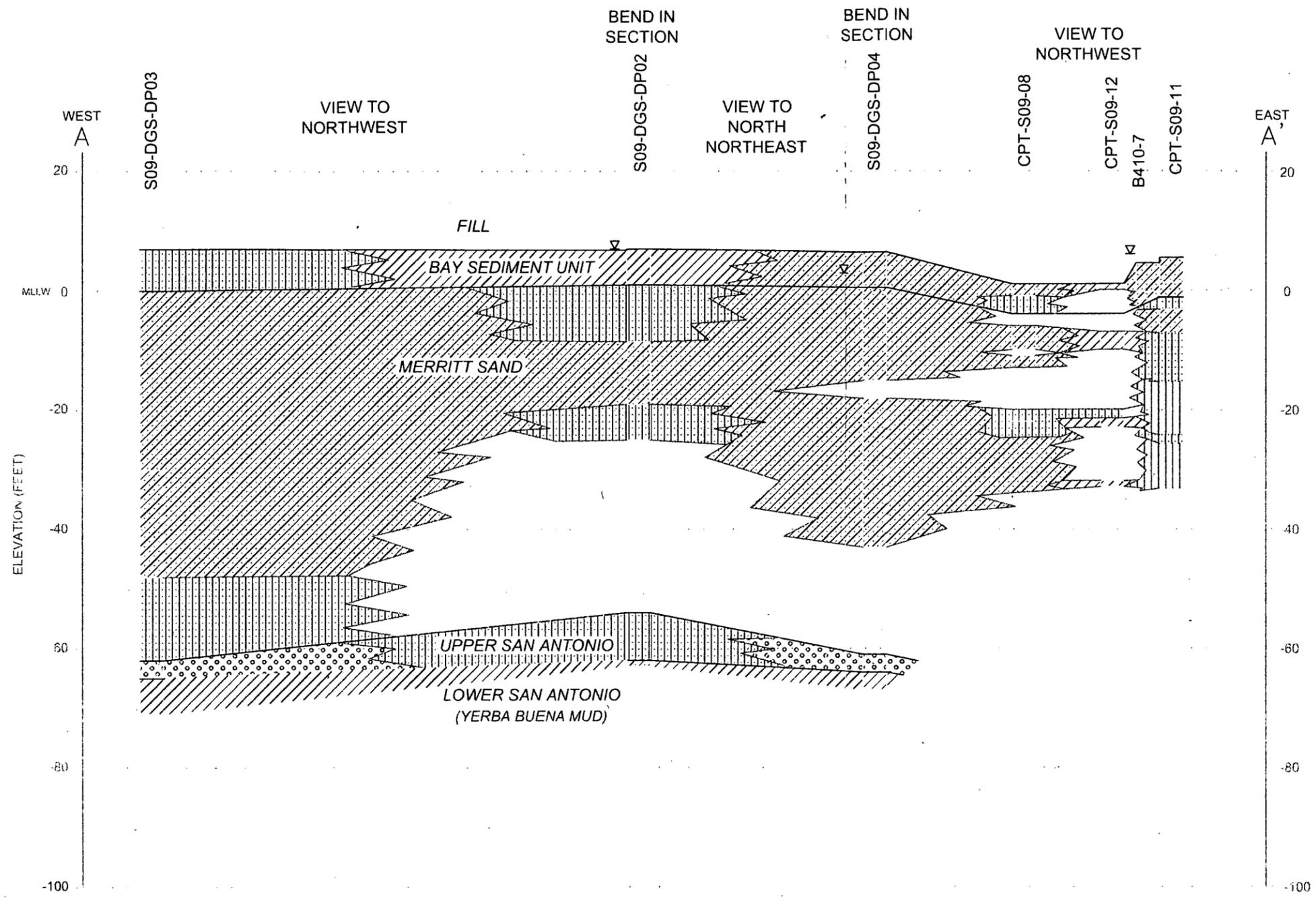
-  CONTACT OF LITHOLOGIC UNITS
-  CONTACT OF FINE AND COARSE MATERIAL WITHIN BAY SEDIMENTS
-  SHALLOW WATER-BEARING ZONE WATER TABLE

NOT TO SCALE

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U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 4-1
CONCEPTUAL GEOLOGIC CROSS SECTIONS
Operable Unit 2A
Remedial Investigation Report



LEGEND

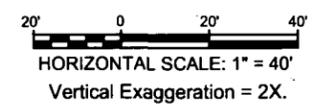
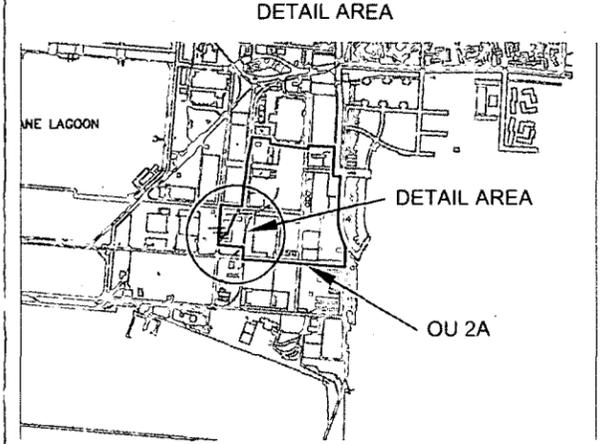
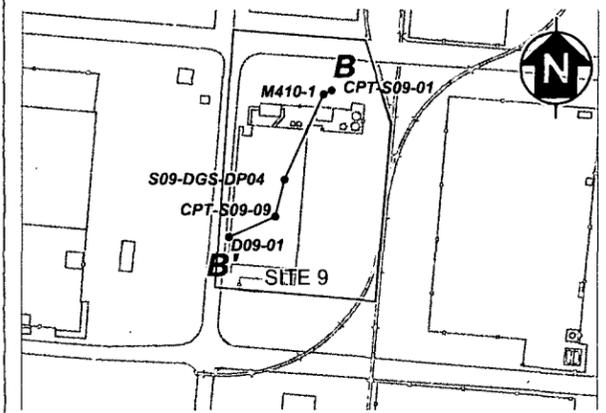
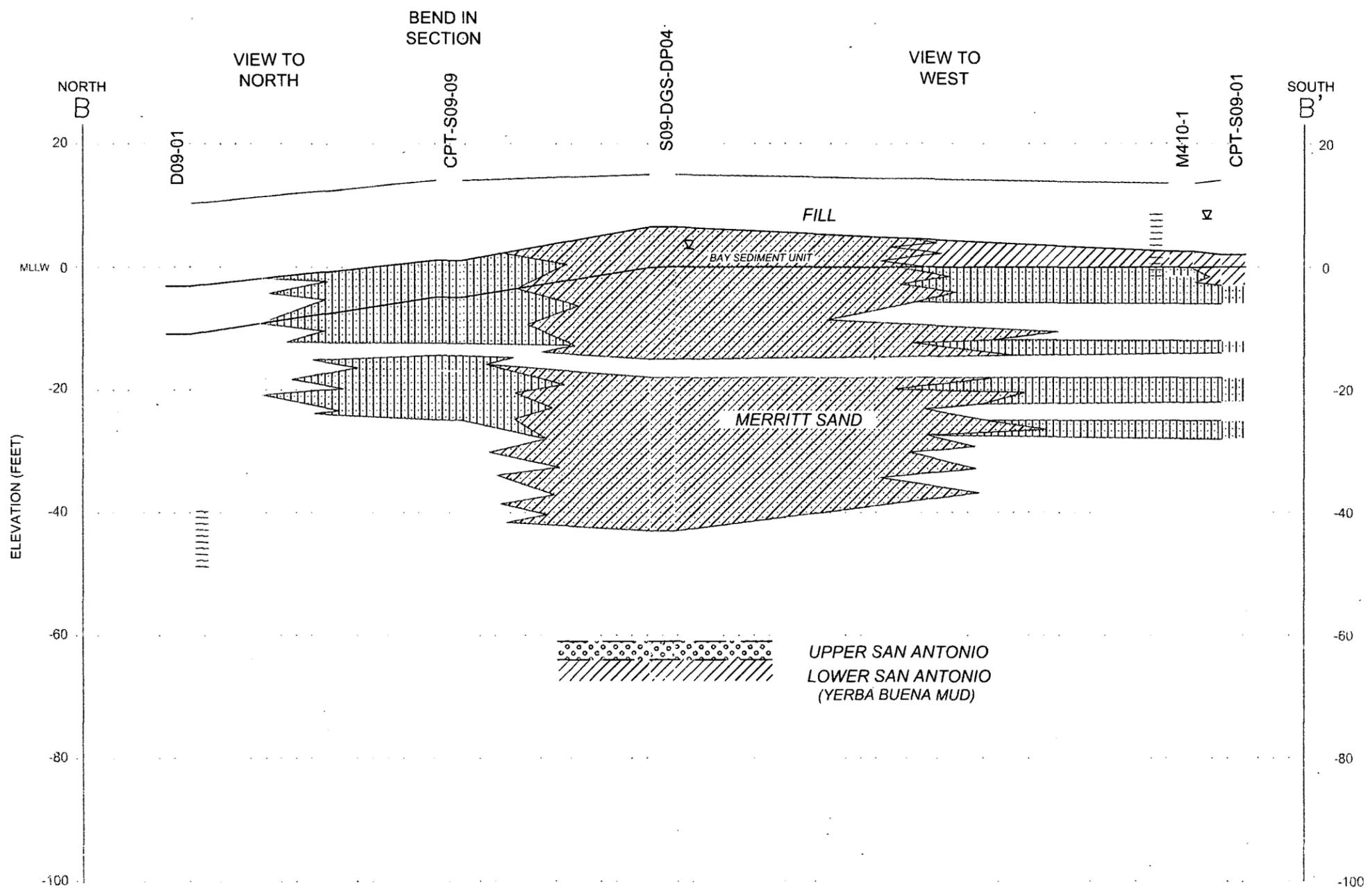
- | | | | | | |
|--|--------------------------|--|-------------------------------------|--|-----------------------------------|
| | FILL | | SC - CLAYEY SANDS | | MH - INORGANIC SILTS |
| | SM - SILTY SANDS | | ML - SANDY SILTS | | LITHOLOGIC CONTACT |
| | SW - WELL GRADED SANDS | | CL - SANDY CLAYS | | FORMATION CONTACT |
| | SP - POORLY GRADED SANDS | | CH - ORGANIC CLAYS, HIGH PLASTICITY | | MLLW |
| | | | | | WATER ENCOUNTERED DURING DRILLING |

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ALAMEDA POINT
U.S. Navy Southwest Division, NAVFAC, San Diego

**FIGURE 4-2
GEOLOGICAL CROSS SECTION A-A'
SITE 9**

Operable Unit 2A
Remedial Investigation Report



LEGEND

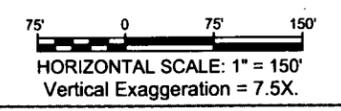
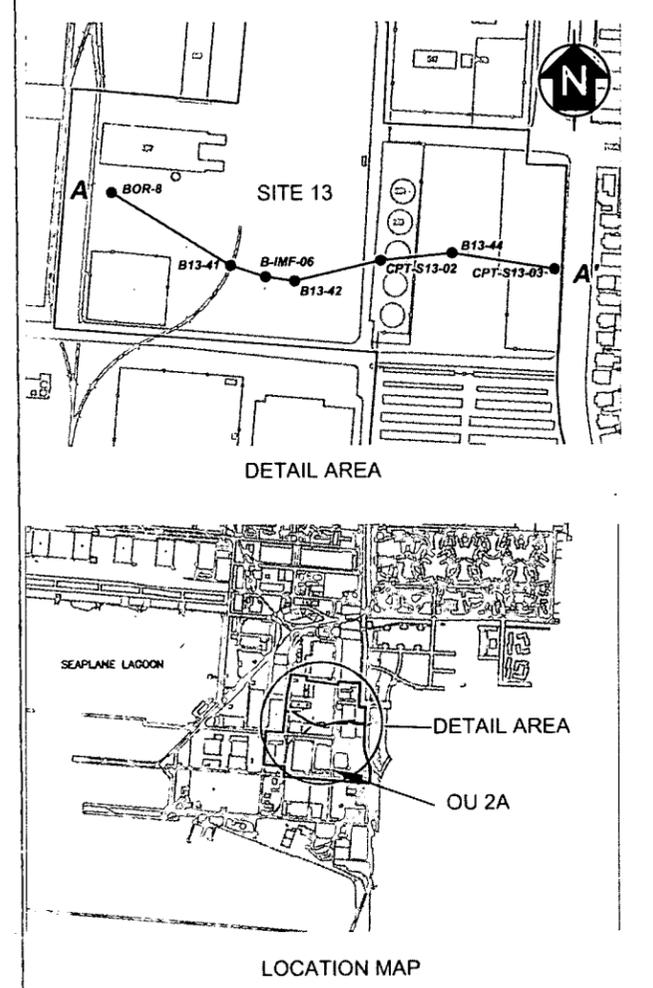
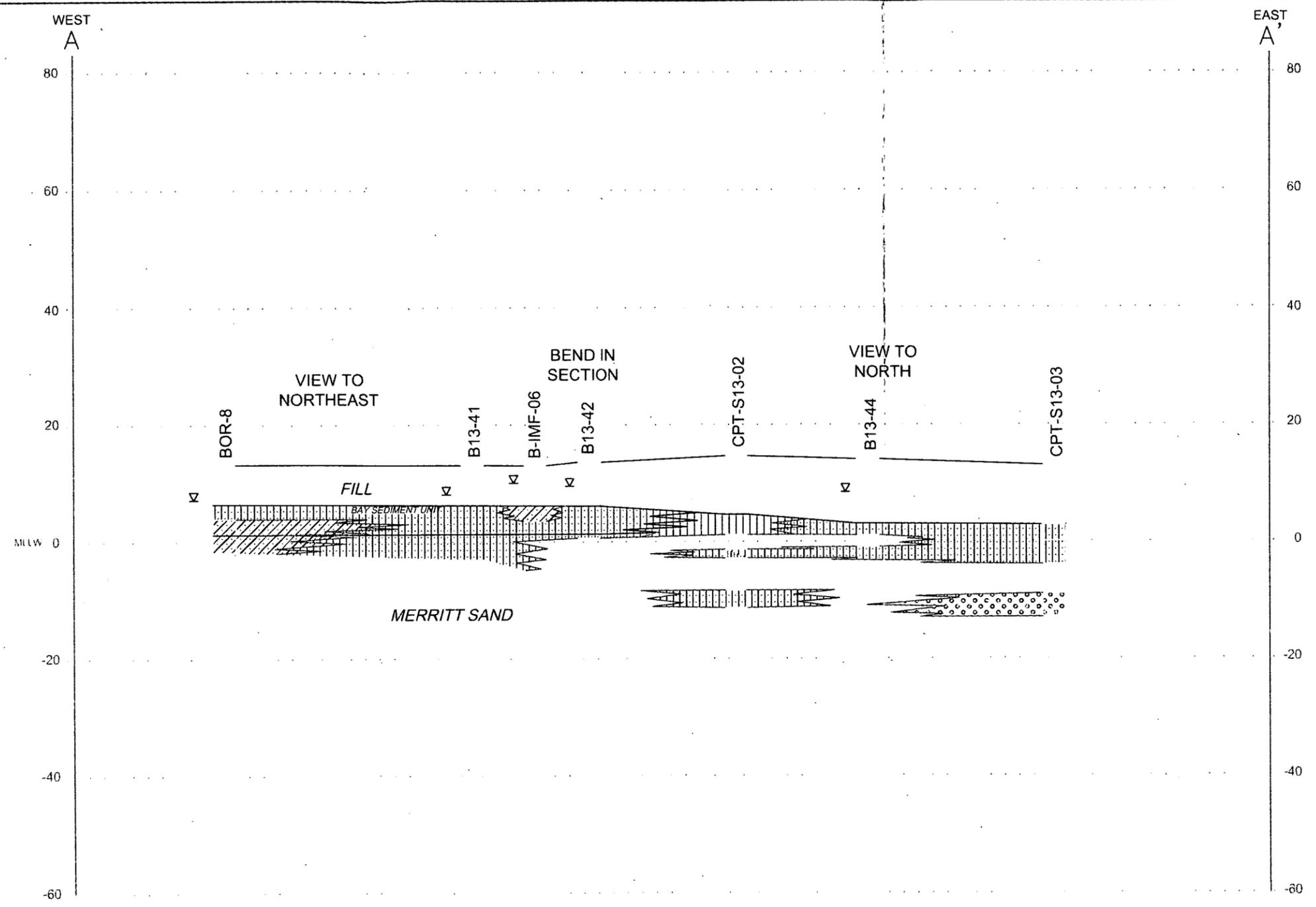
- | | | | | | |
|--|--------------------------|--|-------------------------------------|--|---|
| | FILL | | SC - CLAYEY SANDS | | LITHOLOGIC CONTACT |
| | SW - WELL GRADED SANDS | | ML - SANDY SILTS | | FORMATION CONTACT (DASHED WHERE INFERRED) |
| | SP - POORLY GRADED SANDS | | CL - SANDY CLAYS | | MONITORING WELL SCREENED INTERVAL |
| | SM - SILTY SANDS | | CH - ORGANIC CLAYS, HIGH PLASTICITY | | MLLW |
| | | | | | WATER ENCOUNTERED DURING DRILLING |

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U.S. Navy Southwest Division, NAVFAC, San Diego

**FIGURE 4-3
GEOLOGICAL CROSS SECTION B-B'
SITE 9**

Operable Unit 2A
Remedial Investigation Report



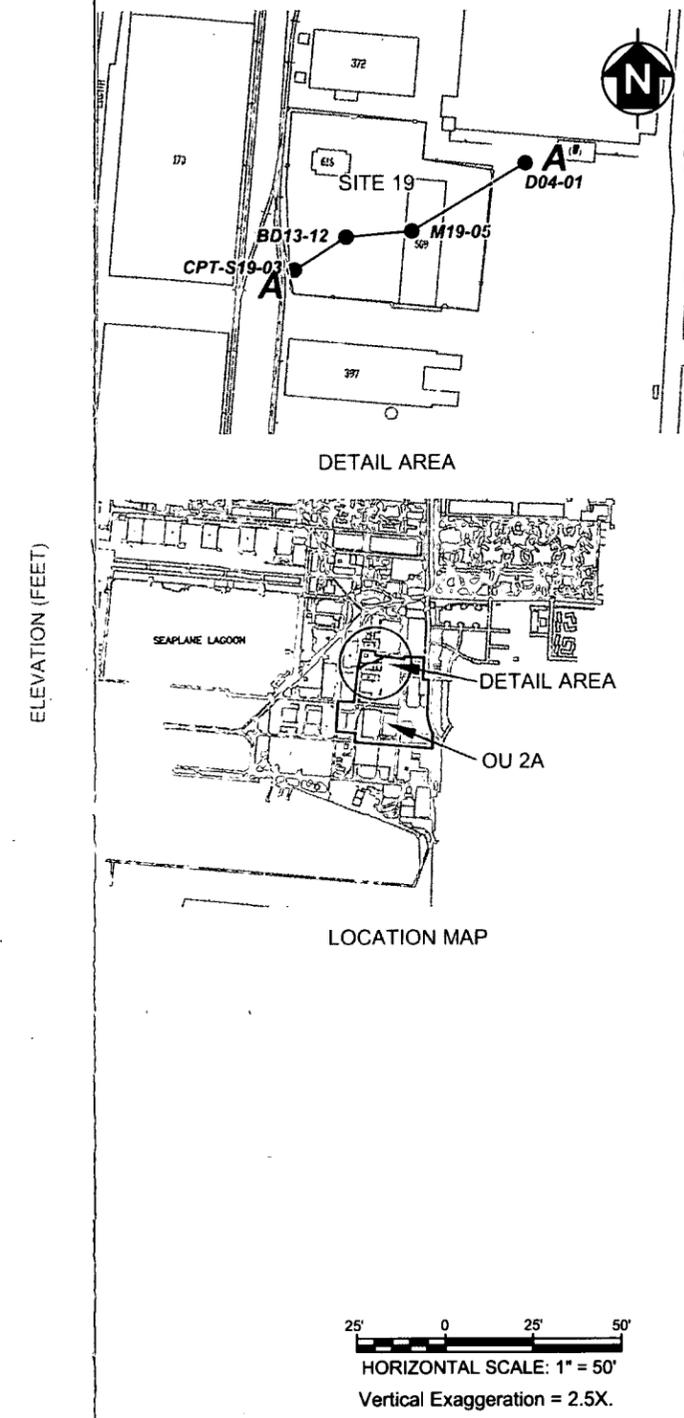
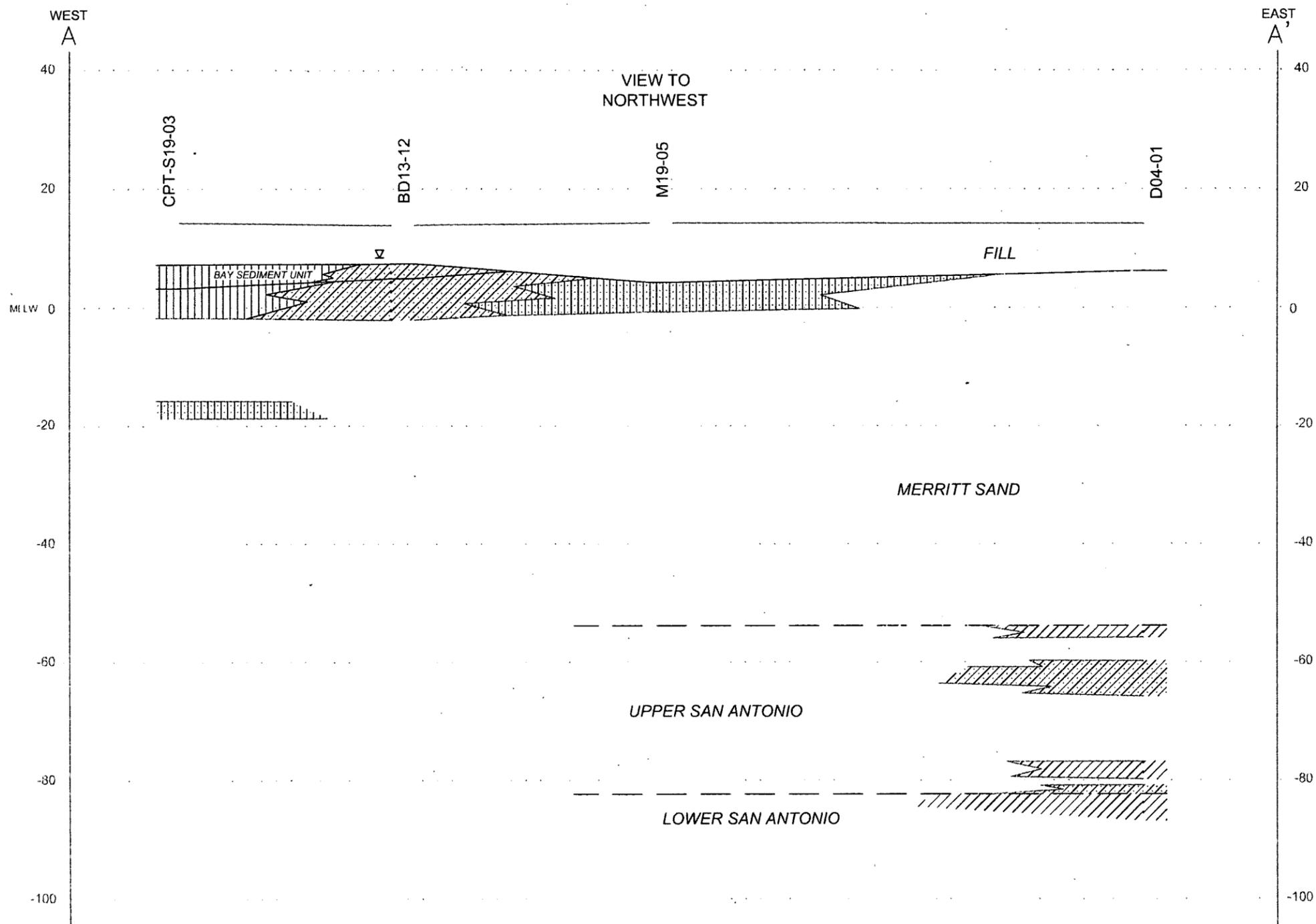
LEGEND					
	FILL		CL - SANDY CLAYS		LITHOLOGIC CONTACT
	SW - WELL GRADED SANDS		SC - CLAYEY SANDS		FORMATION CONTACT
	SP - POORLY GRADED SANDS		ML - SANDY SILTS		MONITORING WELL SCREENED INTERVAL
	SM - SILTY SANDS				MLLW
					MEAN LOWER LOW WATER
					WATER ENCOUNTERED DURING DRILLING

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FIGURE 4-4
GEOLOGICAL CROSS SECTION A-A'
SITE 13

Operable Unit 2A
Remedial Investigation Report



- LEGEND**
- FILL
 - SP - POORLY GRADED SANDS
 - SM - SILTY SANDS
 - SC - CLAYEY SANDS
 - ML - SANDY SILTS
 - CL - SANDY CLAYS, SILTY CLAYS

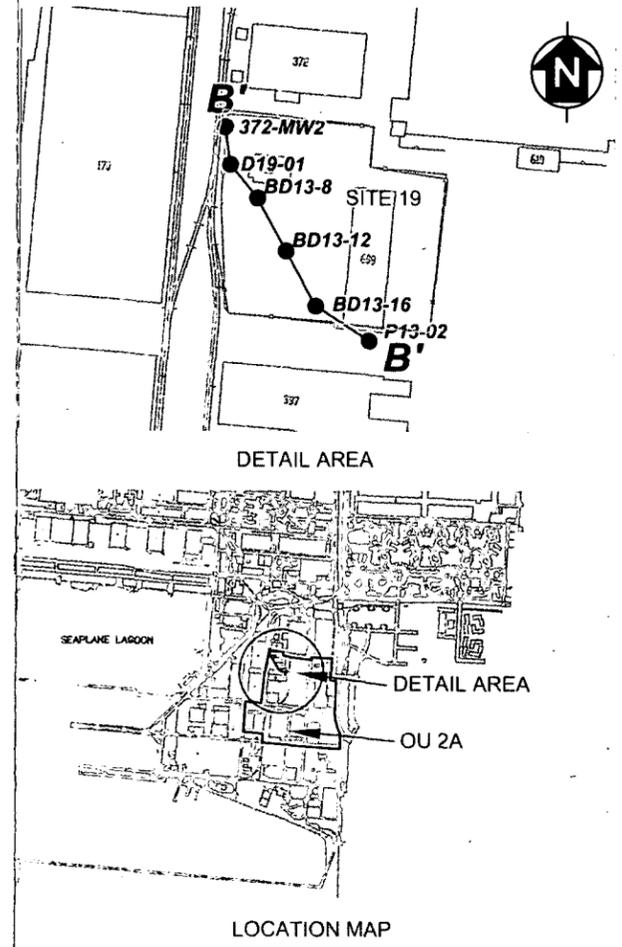
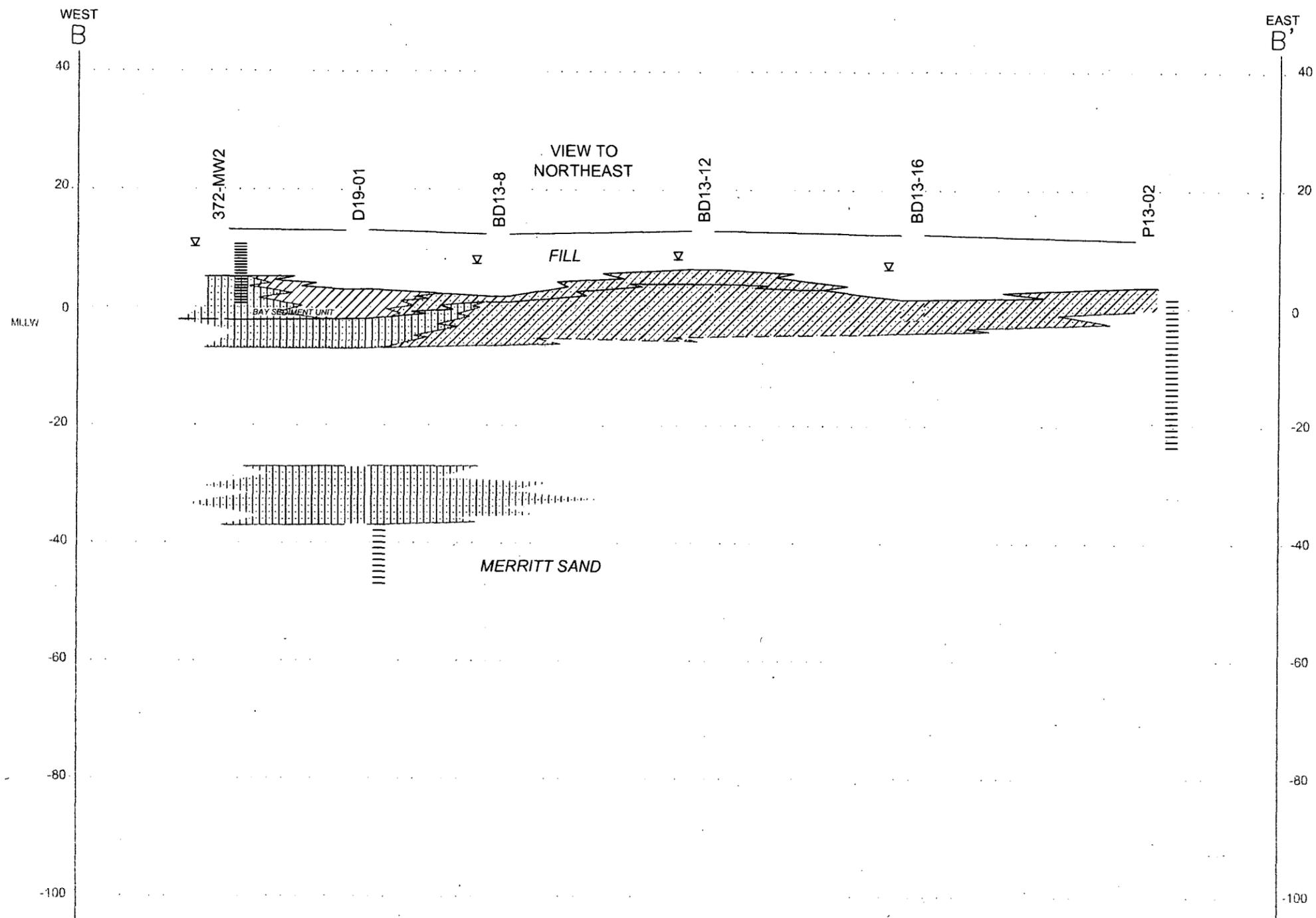
- LITHOLOGIC CONTACT
- FORMATION CONTACT (DASHED WHERE INFERRED)
- MONITORING WELL SCREENED INTERVAL
- MLLW MEAN LOWER LOW WATER
- WATER ENCOUNTERED DURING DRILLING

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FIGURE 4-6
GEOLOGICAL CROSS SECTION A-A'
SITE 19

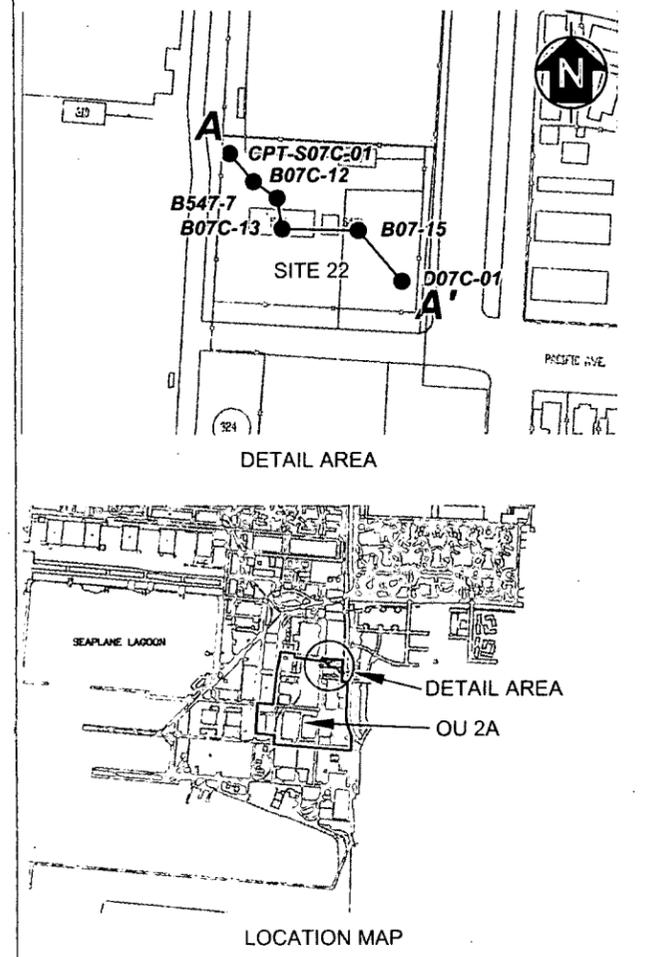
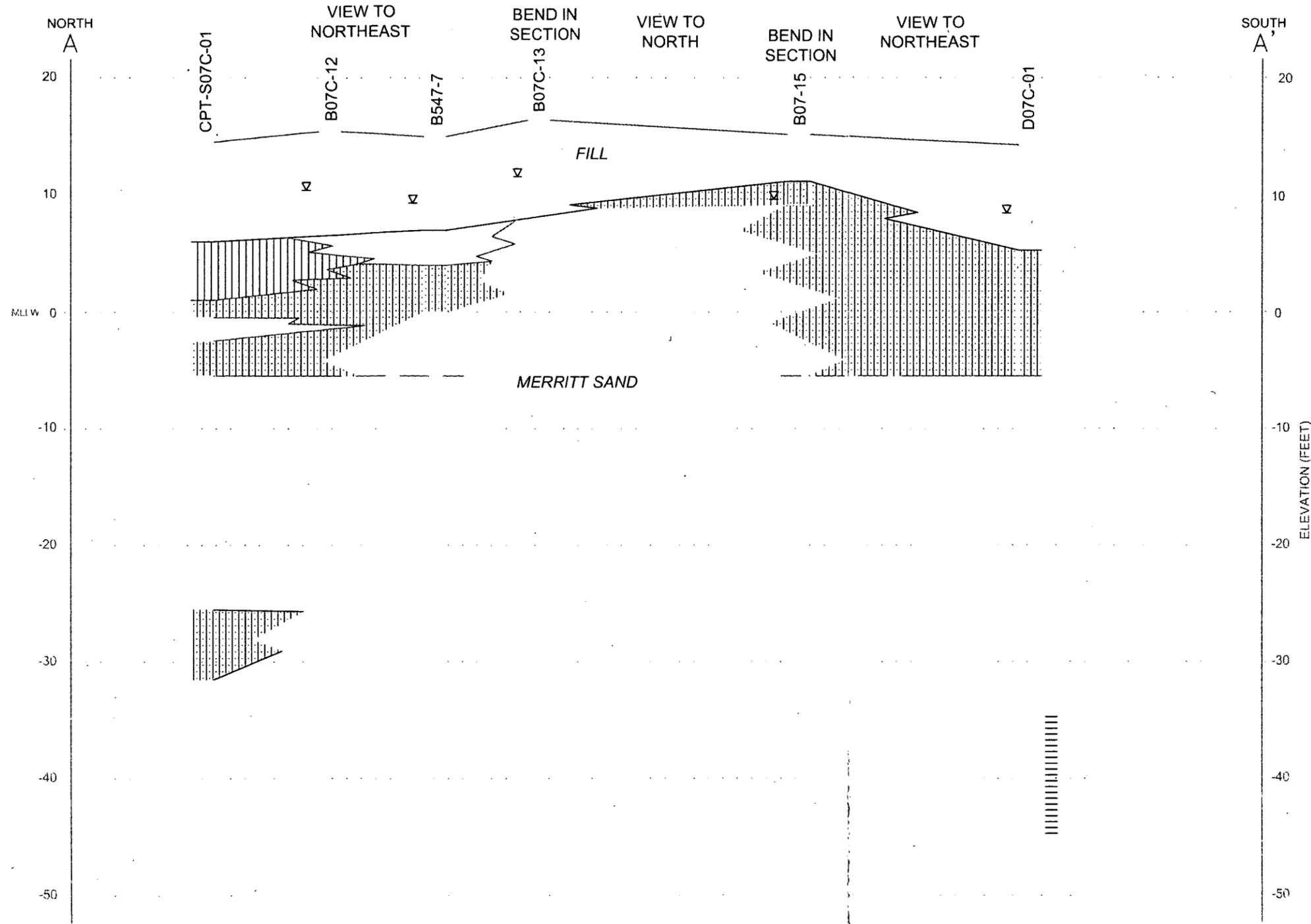
Operable Unit 2A
Remedial Investigation Report



25' 0 25' 50'
 HORIZONTAL SCALE: 1" = 50'
 Vertical Exaggeration = 2.5X.

- LEGEND**
- | | | |
|--------------------------|-------------------------------|--|
| FILL | SM - SILTY SANDS | LITHOLOGIC CONTACT (DASHED WHERE INFERRED) |
| GM - SILTY GRAVELS | SC - CLAYEY SANDS | FORMATION CONTACT |
| SP - POORLY GRADED SANDS | CL - SANDY CLAYS, SILTY CLAYS | MONITORING WELL SCREENED INTERVAL |
| | | MLLW |
| | | WATER ENCOUNTERED DURING DRILLING |

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FIGURE 4-7
GEOLOGICAL CROSS SECTION B-B'
SITE 19
 Operable Unit 2A
 Remedial Investigation Report



25' 0 25' 50'
 HORIZONTAL SCALE: 1" = 50'
 Vertical Exaggeration = 5X.

- LEGEND**
- FILL
 - ML - SANDY SILTS
 - SP - POORLY GRADED SANDS
 - SM - SILTY SANDS
 - SC - CLAYEY SANDS
 - CL - SANDY CLAYS, SILTY CLAYS

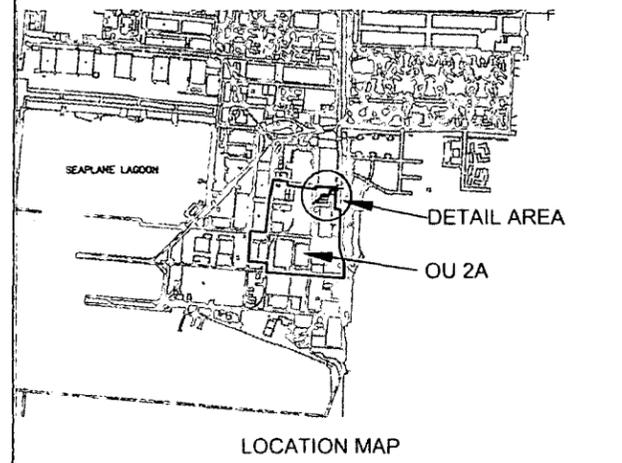
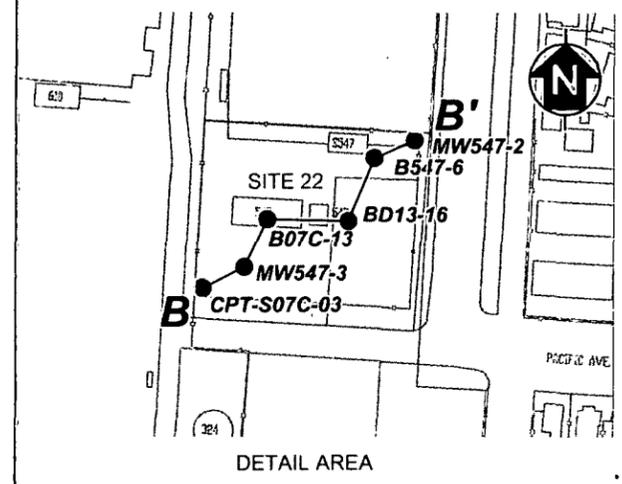
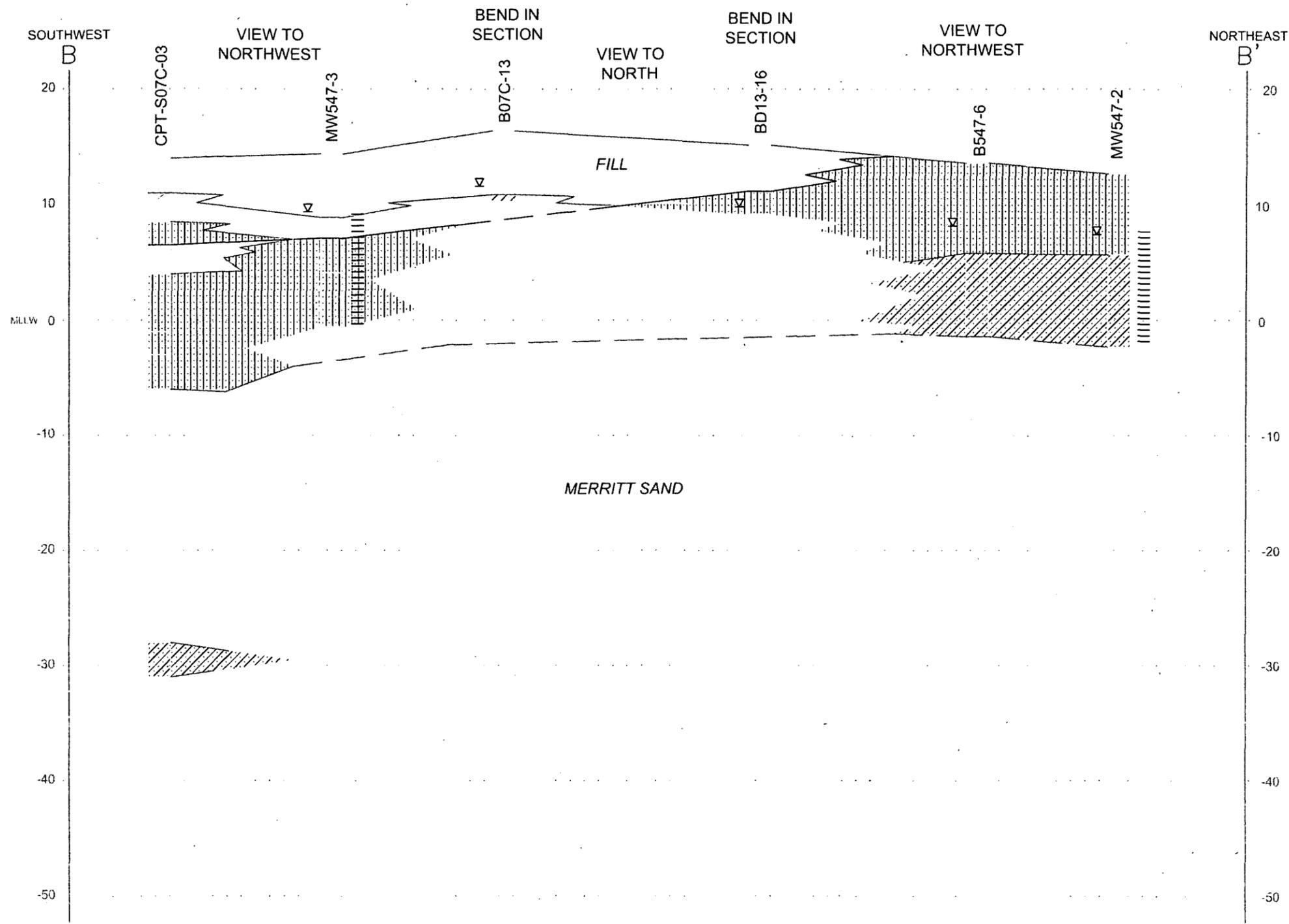
- LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
- FORMATION CONTACT
- MONITORING WELL SCREENED INTERVAL
- MLLW MEAN LOWER LOW WATER
- WATER ENCOUNTERED DURING DRILLING

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FIGURE 4-8
GEOLOGICAL CROSS SECTION A-A'
SITE 22

Operable Unit 2A
 Remedial Investigation Report



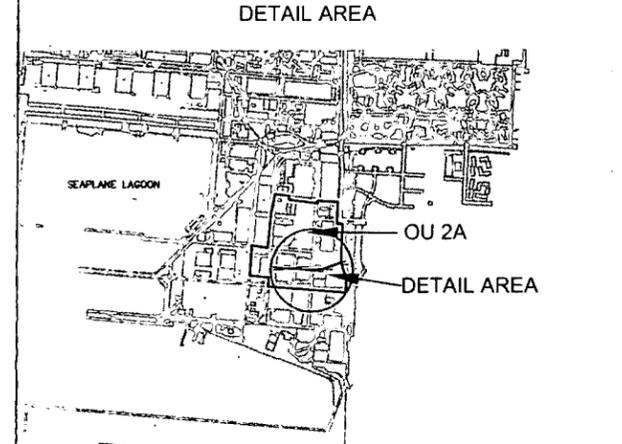
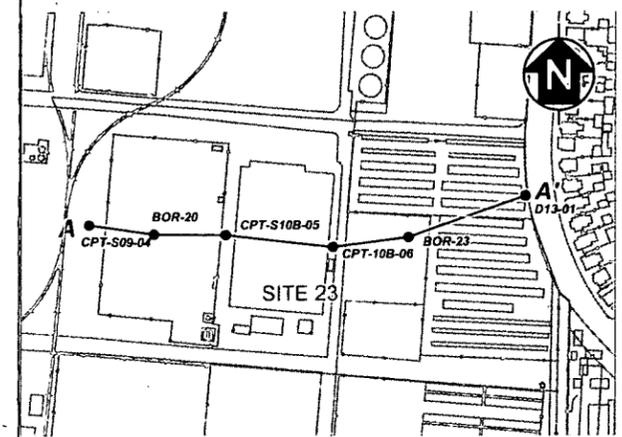
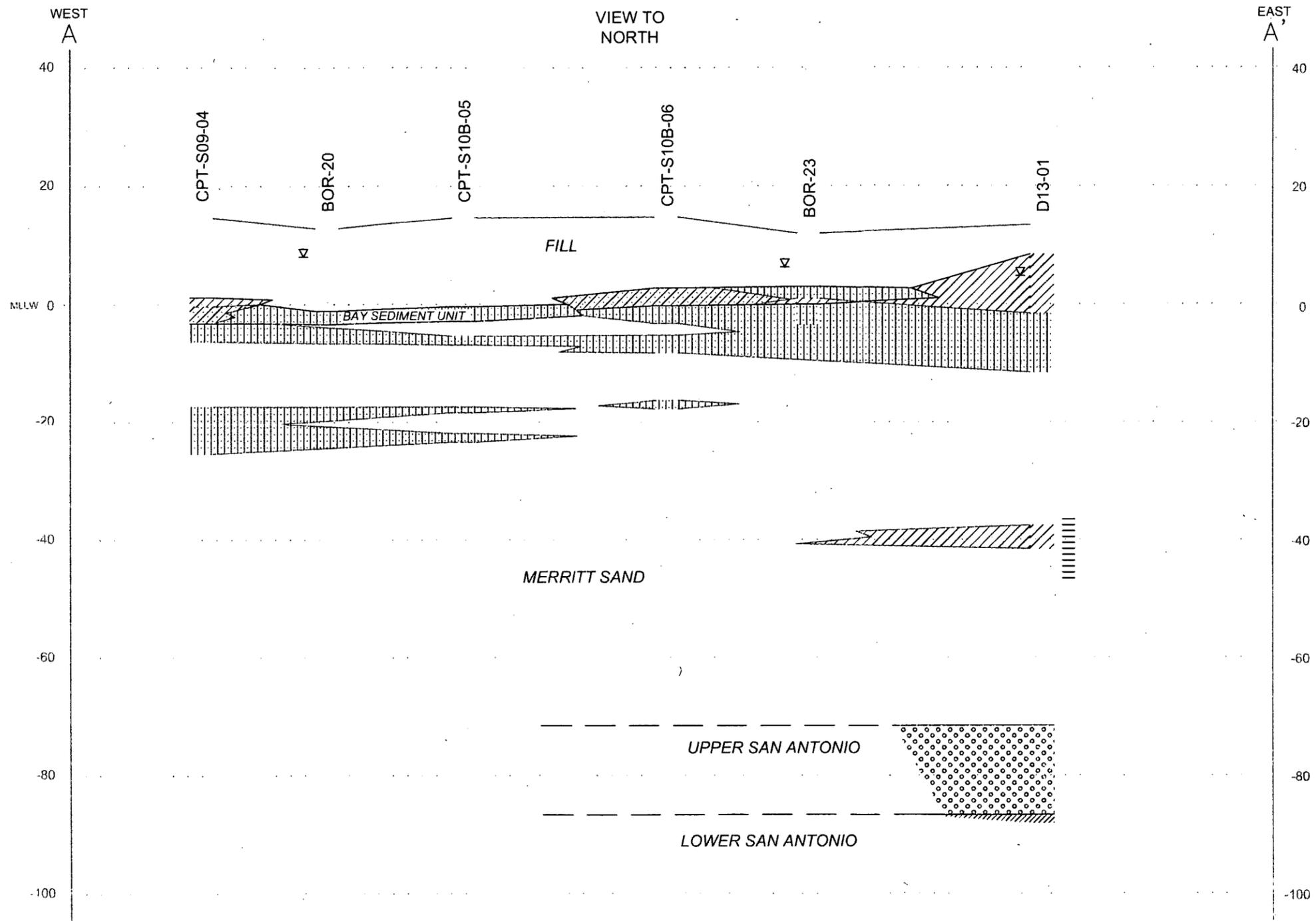
25' 0 25' 50'
 HORIZONTAL SCALE: 1" = 50'
 Vertical Exaggeration is 2.5X.

LEGEND			
	SW - WELL GRADED SANDS		LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
	SP - POORLY GRADED SANDS		FORMATION CONTACT
	SM - SILTY SANDS		MONITORING WELL SCREENED INTERVAL
	SC - CLAYEY SANDS		MLLW MEAN LOWER LOW WATER
	ML - SANDY SILTS		WATER ENCOUNTERED DURING DRILLING
	CL - SANDY CLAYS, SILTY CLAYS		

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FIGURE 4-9
GEOLOGICAL CROSS SECTION B-B'
SITE 22

Operable Unit 2A
 Remedial Investigation Report



75' 0 75' 150'
 HORIZONTAL SCALE: 1" = 150'
 Vertical Exaggeration is 7.5X.

LEGEND

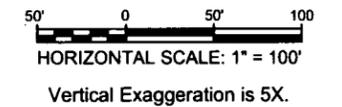
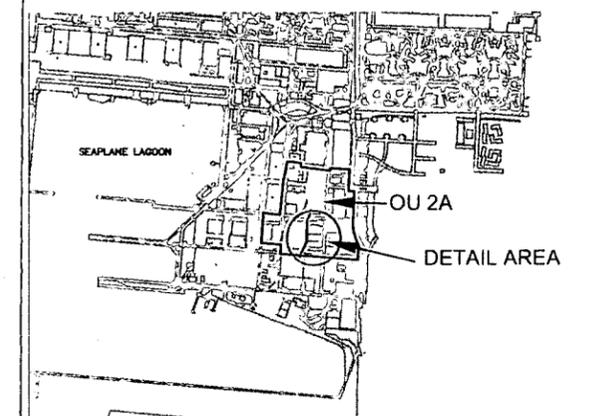
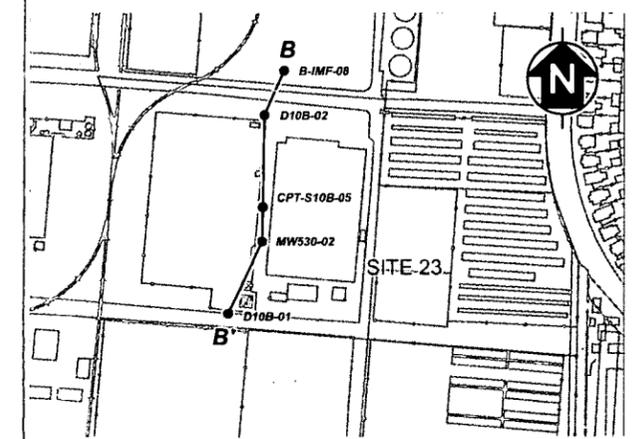
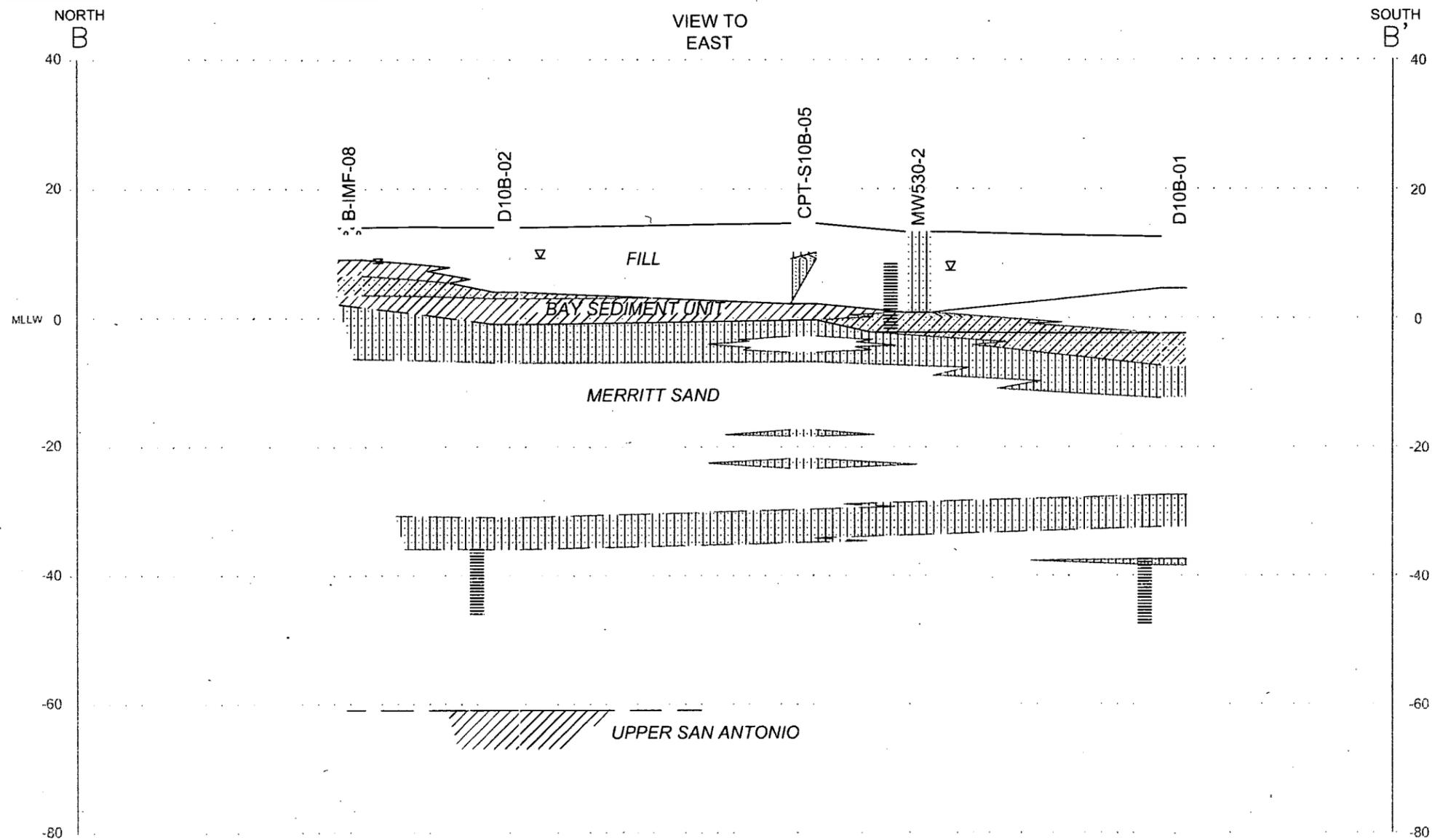
- | | | | |
|--|----------------------------|--|---|
| | GP - POORLY GRADED GRAVELS | | CL - SANDY CLAYS, SILTY CLAYS |
| | SW - WELL GRADED SANDS | | CH - ORGANIC CLAYS, HIGH PLASTICITY |
| | SP - POORLY GRADED SANDS | | LITHOLOGIC CONTACT |
| | SM - SILTY SANDS | | FORMATION CONTACT (DASHED WHERE INFERRED) |
| | SC - CLAYEY SANDS | | MONITORING WELL SCREENED INTERVAL |
| | ML - SANDY SILTS | | MEAN LOWER LOW WATER |
| | | | WATER ENCOUNTERED DURING DRILLING |

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FIGURE 4-10
GEOLOGICAL CROSS SECTION A-A'
SITE 23

Operable Unit 2A
 Remedial Investigation Report



LEGEND

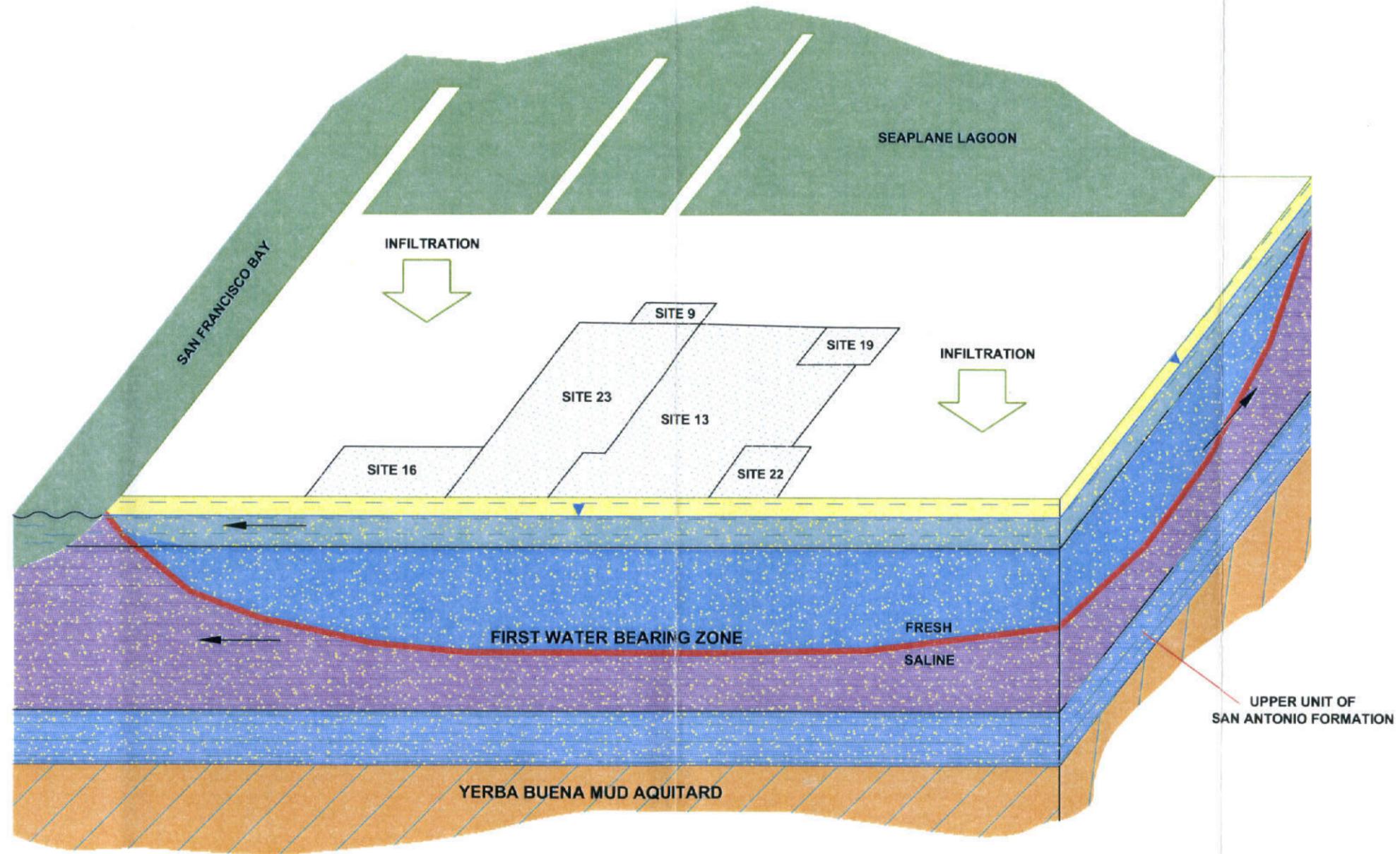
- | | | |
|---|--|--|
| <ul style="list-style-type: none"> SW - WELL GRADED SANDS SP - POORLY GRADED SANDS SM - SILTY SANDS | <ul style="list-style-type: none"> SC - CLAYEY SANDS ML - SANDY SILTS CL - SANDY CLAYS CH - ORGANIC CLAYS, HIGH PLASTICITY | <ul style="list-style-type: none"> LITHOLOGIC CONTACT (DASHED WHERE INFERRED) FORMATION CONTACT (DASHED WHERE INFERRED) MONITORING WELL SCREENED INTERVAL MLLW WATER ENCOUNTERED DURING DRILLING |
|---|--|--|

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FIGURE 4-11
GEOLOGICAL CROSS SECTION B-B'
SITE 23

Operable Unit 2A
Remedial Investigation Report



LEGEND

-  INSTALLATION RESTORATION SITE
-  SEAWATER
-  ARTIFICIAL FILL WITH FRESH WATER
-  MERRITT SAND WITH FRESH WATER

-  MERRITT SAND WITH SALINE WATER
-  UPPER UNIT OF SAN ANTONIO FORMATION WITH SALINE WATER
-  YERBA BUENA MUD AQUITARD

-  CONTACT OF LITHOLOGIC UNITS
-  FIRST WATER-BEARING ZONE WATER TABLE
-  GROUNDWATER FLOW DIRECTION
-  FRESHWATER/SALTWATER INTERFACE (TOTAL DISSOLVED SOLIDS [TDS] > 10,000 MILLIGRAMS PER LITER [mg/L])

NOT TO SCALE

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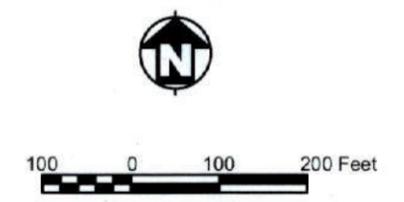
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FIGURE 4-12
CONCEPTUAL HYDROGEOLOGIC MODEL
FOR THE SOUTHEASTERN REGION

Operable Unit 2A
Remedial Investigation Report



MONITORING WELL AND GROUNDWATER ELEVATION (FEET MLLW) APRIL 2003
 8.11
 GROUNDWATER ELEVATION CONTOUR LINE (FEET MLLW) (DASHED WHERE INFERRED)
 CERCLA SITE BOUNDARY
BUILDING
 Present
 Removed
 LAND COVER
 Note:
 CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
 MLLW = Mean Lower Low Water



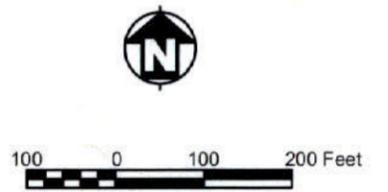
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Alameda Point
 U.S. Navy Southwest Division, NAVFAC, San Diego
FIGURE 4-13
GROUNDWATER LEVEL ELEVATIONS
WITHOUT TIDAL CORRECTIONS
APRIL 2003
 Operable Unit 2A
 Remedial Investigation Report



- MONITORING WELL AND GROUNDWATER ELEVATION (FEET MLLW) JUNE 2002
- POTENTIOMETRIC SURFACE CONTOUR LINE (FEET MLLW) (DASHED WHERE INFERRED)

- CERCLA SITE BOUNDARY
- BUILDING**
- Present
- Removed
- LAND COVER

Note:
 CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
 MLLW = Mean Lower Low Water



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FIGURE 4-14
POTENTIOMETRIC SURFACE MAP
SECOND WATER BEARING ZONE
JUNE 2002

Operable Unit 2A
 Remedial Investigation Report



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Alameda Point
U.S. Navy Southwest Division, NAVFAC, San Diego

FIGURE 4-15
POTENTIOMETRIC SURFACE MAP
SECOND WATER BEARING ZONE
APRIL 2003

Operable Unit 2A
Remedial Investigation Report

TABLE 4-1: ESTIMATED VALUES OF AQUIFER HYDRAULIC PARAMETERS

Remedial Investigation Report for Sites 9, 13, 19, 22, and 23, Alameda Point, Alameda, California

OU-2A Site	Test Method	Method of Analysis	Transmissivity (ft ² /min)	Hydraulic Conductivity (ft/min)	Hydraulic Conductivity (ft/day)	Storage Coefficient ¹ S	Specific Yield ¹ S _y	Source
FIRST WATER BEARING ZONE								
Site 9	soil (lab)	unknown		0.0019	2.74			TtEMI 1998
	slug test	Bouwer and Rice			1.70			Shaw 2003
Site 13	pumping test	Theis	0.1170	0.0037	5.265	0.0009	NA	PRC 1996
		Neuman	0.0763	0.0024	3.431	0.0007	0.12	PRC 1996
		Cooper-Jacob	0.1418	0.0035	5.103	0.0033	NA	PRC 1996
		Hantush ²	0.1100	0.0034	4.950			PRC 1996
SECOND WATER BEARING ZONE								
Site 9	pumping test	Hantush-Jacob	0.036	0.0016	2.3	0.0023		Shaw 2003

Notes:

- ¹ Dimensionless
- ² Method without storage
- ft/day Feet per day
- ft/min Feet per minute
- ft²/min Square feet per minute

TABLE 4-2: EXAMPLE VERTICAL HYDRAULIC GRADIENT CALCULATIONS, JUNE 2002

Remedial Investigation Report for Sites 9, 13, 19, 22, and 23, Alameda Point, Alameda, California

Page 1 of 1

Well	OU-2A Site	Hydrostratigraphic Unit	Well Elevation (feet MLLW)	Screened Interval Depth (feet bgs)	Screened Interval Depth (feet MLLW)	Screen Midpoint Depth (feet bgs)	Screen Midpoint Depth (feet MLLW)	Groundwater Elevation (6/02) (feet MLLW)	Vertical Hydraulic Gradient (6/02) (feet/feet)	Vertical Hydraulic Gradient Direction (6/02)
MWOR-4	23	FWBZU	11.76	5 - 15	6.76 to -3.24	7.5	4.26	8.40		
D13-01	23	FWBZL	11.9	50 - 60	-38.1 to -48.1	55	-43.1	8.11	0.006	downward
M07C-08	22	FWBZU	12.68	3.5 - 13.5	9.18 to -.082	8.5	4.18	8.46		
D07C-01	22	FWBZL	13.04	49 - 59	-35.96 to -45.96	54	-40.96	8.40	0.001	downward
MW410-2	9	FWBZ	13.44	5 - 15	8.44 to -1.56	7.5	5.94	7.01		
D09-01	9	SWBZ	13.79	50 - 60	-36.21 to -46.21	55	-41.21	4.19	0.060	downward
MW360-3	19	FWBZ	12.67	5 - 15	7.67 to -2.33	7.5	5.17	8.21		
D04-01	19	SWBZ	12.74	86 - 96	-73.26 to -83.26	91	-78.26	6.38	0.022	downward
MWD13-3	19	FWBZ	12.79	5 - 15	7.79 to -2.21	7.5	5.29	8.08		
D19-01	19	SWBZ	12.14	50 - 60	-37.86 to -47.86	55	-42.86	6.44	0.034	downward
M10B-01	23	FWBZ	12.95	3 - 11	9.95 to 1.95	7	5.95	6.69		
D10B-02	23	SWBZ	12.67	50 - 60	-37.33 to -47.33	55	-42.33	7.12	-0.009	upward

Notes:

- bgs below ground surface
- FWBZU First Water Bearing Zone Upper
- FWBZL First Water Bearing Zone Lower
- MLLW Mean Low Low Water

Example Calculation:

$$\begin{aligned}
 \text{Vertical Hydraulic Gradient} &= \frac{\text{Groundwater Elevation FWBZU} - \text{Groundwater Elevation FWBZL}}{\text{Screen Midpoint Depth FWBZU} - \text{Screen Midpoint Depth FWBZL}} \\
 \text{Vertical Hydraulic Gradient} &= \frac{(8.40 - 8.11)}{(4.26 - -43.1)} = \frac{0.26}{47.36} = 0.00612
 \end{aligned}$$

A positive gradient indicates downward movement while a negative gradient indicates upward movement

5.0 BACKGROUND AND RI RESULTS FOR CERCLA SITE 9 BUILDING 410 (PAINT STRIPPING FACILITY)

This section provides a comprehensive site summary and analysis of contamination located at CERCLA Site 9. The physical features and history of the site are presented in Section 5.1. The environmental investigations conducted at Site 9 are presented in Section 5.2. The initial data evaluation, which includes the site-specific conceptual site model, data quality assessment, and background evaluation, is presented in Section 5.3. The nature and extent evaluation is presented in Section 5.4, and the fate and transport analysis is included in Section 5.5. The human health and ecological risk assessments are summarized in Sections 5.6 and 5.7, respectively. Conclusions and recommendations for Site 9 are identified in Section 5.8.

5.1 PHYSICAL FEATURES AND SITE HISTORY

This section summarizes the physical features and history of Site 9. The physical features of Site 9 are described in Section 5.1.1. The history and activities conducted at Site 9, including generation of hazardous wastes and past disposal and storage practices associated with these wastes, are summarized in Section 5.1.2. The Site 9 regulatory history is provided in

5.1.1 Site 9 Physical Features

Site 9 is located approximately 900 feet east of the Seaplane Lagoon, in the southeast portion of NAS Alameda (see Figure 1-2). Site 9 is approximately 3 acres in size, relatively flat, mostly paved, and is composed primarily of open space surrounding Building 410. Before the construction of Building 410 in 1958, Site 9 was used for aircraft storage. Site features include Buildings 351 and 410; former IWTP 410, which consisted of former Building 588, and eight former ASTs and OWS-588 associated with the RCRA Part A permitted IWTP; and three ASTs associated with Building 410 (410A, B, and C) (see Figure 5-1). All ASTs have been removed (EFA West 1999). Storm and industrial wastewater sewer lines run from Building 410 to the area previously occupied by Building 588 and extend to the Seaplane Lagoon. Two OWSs (410A and 410B) were located south of Building 410; both remain in place. During site investigations, these OWSs were observed to be clean and to contain groundwater. No USTs or underground fuel lines were identified at Site 9.

Seventy percent of Site 9 consists of open space that is extensively covered with asphalt and concrete. These areas were primarily used for aircraft storage, roadways, vehicle and equipment parking, materials storage, and as washdown areas for maintenance, gear, and equipment. Minor landscaped areas are also present at the site.

5.1.2 Site 9 History

The area of Site 9 was part of the Bay before the Navy established NAS Alameda. Between 1942 and 1946, the area was filled by dredging sand from the floor of the Bay and pumping it onto the area.

Until 1958, the area of Site 9 was open space used for aircraft storage (IT 2001). Aerial photographs from 1949 and 1953 show that planes were parked in open spaces that probably were surfaced with compacted soil or pavement. During 1958, the Navy constructed Building 410 in the western portion of Site 9 and added storm sewers, which conveyed runoff and industrial wastes to the Seaplane Lagoon.

Building 410 is the primary structure at Site 9 and housed the corrosion control facility, which included aircraft cleaning and paint stripping activities. According to the initial assessment study (IAS) conducted at NAS Alameda in 1983, paint stripping and aircraft cleaning activities included the use of phenol, methylene chloride, trichloroethane (TCA), chromium, detergents, wipe-down solvents, and parts cleaners (E&E 1983). The building has concrete floors, metal walls and ceilings, and is approximately 35,000 square feet (ft²) in size. Anecdotal evidence suggests that numerous undocumented releases of aircraft fuel have occurred inside Building 410 (IT 2001). Based on activities performed inside Building 410, other industrial solvents likely included naphthalene and tetrachloroethylene (PCE). Wastes generated at this site were discharged to the Seaplane Lagoon from 1958 until 1972.

Floor drains within Building 410 drained to storm sewer laterals extending from Building 410 toward the east and north to a storm sewer main line located parallel to the northern edge of Site 9 (see Figure 5-1). This sewer main line flows from east to west and empties at Outfall J in the Seaplane Lagoon. Industrial wastes were discharged into these lines from 1958 until 1972. A catch basin (5-0A) for a second storm sewer line is located south of the southwest corner of Building 410. This second storm sewer line is oriented north-south and runs south to Outfall O and the Bay.

Building 351, constructed between 1953 and 1969, served as an office and break room for staff that worked in the Building 410 corrosion control facility until 1990. The building covers an area of about 900 ft² and has a concrete floor and metal walls. The building is no longer in use.

In 1973, the Navy constructed IWTP 410; a RCRA Part A permitted facility located north of Building 410, which included Building 588, OWS-588, and eight associated ASTs. Acids, bases, coagulants, and other IWTP chemicals were stored and used in this area (IT 2001). Former Building 588 and the eight associated ASTs occupied about 4,500 ft² and were removed between 1997 and 2002 during decommissioning of IWTP 410. Figure 5-1 depicts the former locations of the three largest ASTs removed and the general location of IWTP 410. From 1973 until operations ceased in 1990, IWTP 410 received wastewater laden with oil, paint, paint skins, detergents, and paint stripper at a rate of about 16,000 gallons per day (gpd) (IT 2001).

The Navy prepared a closure plan for IWTP Building 410 and associated ASTs in April 1988. In February 1997, a closure summary report was prepared by E&E (1997). The Navy provided certification for the IWTP 410 closure summary report on April 1, 1997. The Navy received a letter from DTSC regarding approval of the IWTP 410 closure certification report on November 9, 1998 (DTSC 1998). This facility is a separate administrative unit within Site 9 and received NFA closure under RCRA. No further evaluation of this IWTP is needed.

In 1990, the Navy ceased paint stripping and aircraft cleaning operations at Building 410. The building was used to temporarily store investigation-derived soil waste and was used as a garbage transfer station between 1990 and 1996. Nelson's Marine, a boat storage facility, currently occupies Building 410. Nelson's Marine stores boats, trailers, and recreational vehicles (RV) inside and outside of Building 410. Private parties are allowed to access their boats and conduct repair activities. The Navy's review of site activity suggested that engine repair is conducted on site.

ASTs 410A, B, and C were located east of Building 410. ASTs 410A and 410B had capacities of about 10,000 gallons each, and AST 410C had a capacity of 1,500 gallons. It is unclear when these ASTs were installed. These ASTs stored methylene chloride, phenol, and surfactant, respectively. These compounds were used extensively within Building 410. All three ASTs were removed before 2001 (IT 2001), and NFA recommendations are included in SWMU Appendix (Appendix G).

In 1991, the Navy inspected, cleaned, or replaced much of the storm sewer system at Alameda Point. At Site 9, the entire length of storm drain line that discharged to Outfall J, in the Seaplane Lagoon, was inspected and cleaned, and the entire length of the storm drain line that discharged to Outfall O, in the Seaplane Lagoon, was replaced with PVC piping (IT 1997).

The Navy conducted an inspection of OWSs 410A and 410B, south of Building 410. The OWSs appear to have been cleaned and contain clear water. OWS-410A is located west of a wash rack and was at one time connected to a drain within the wash rack area. The wash rack is no longer in use and is currently used for the storage of equipment. OWS-410B collected storm water runoff from the concrete open space on the east side of Building 410.

5.1.3 Site 9 Regulatory History

Several facilities and areas within Site 9 are regulated by different programs. These programs include the CERCLA program and the RCRA program. No investigations have been conducted under the TPH program at Site 9. The following subsections briefly describe the history of involvement of each of these programs at Site 9.

5.1.3.1 CERCLA Program

Site 9 was originally identified as Parcel 152 and selected for evaluation under CERCLA during the 1983 IAS investigation (E&E 1983).

On June 6, 1988, the California Department of Health Services (currently known as DTSC) issued a Remedial Action Order requiring the Navy to investigate Site 9 (DTSC 1988).

In July 2000, Site 9 was expanded under the CERCLA program to include Parcel 153A because investigation results indicated that Parcel 153A was impacted by Building 410 activities.

5.1.3.2 RCRA Program

Several facilities or activities within Site 9 had separate regulatory involvement. IWTP 410 was a RCRA Part A permitted facility. The Navy received a letter from DTSC regarding approval of the IWTP 410 closure certification report on November 9, 1998 (DTSC 1998).

Three ASTs (410A, B, and C) were removed before 2001 (IT 2001),. NFA is recommended in the SWMU appendix (Appendix G).

5.2 SITE 9 ENVIRONMENTAL INVESTIGATIONS

This section describes the environmental investigations conducted at Site 9, which include investigations conducted before the IRP, under CERCLA, under the EBS, and during removal actions. No investigations were conducted under the TPH program at Site 9.

Tables 5-1 and 5-2 summarize the soil and groundwater samples collected under each environmental investigation at Site 9 and the types of analyses conducted. Sampling locations are shown on Figure 5-2 and are categorized by investigation. Results for each of the investigations are presented in Tables 5-3 through 5-13. The tables are organized by analytical group and detail the number and percent of detections; the minimum, average, and maximum detected concentration; the minimum and maximum detection limit; the number of detections exceeding either the residential (for soil) or tap water (for groundwater) PRGs (EPA 2002a); the number of detection limits for nondetected samples exceeding the PRG; and the PRG.

The following subsections summarize investigations conducted at Site 9 prior to the IRP (Section 5.2.1), under the CERCLA (Section 5.2.2), EBS (Section 5.2.3), and TPH programs (Section 5.2.4), and as a part of removal actions and treatability studies (Sections 5.2.5 and 5.2.6, respectively).

5.2.1 Investigations Conducted Before the IRP

In 1982, the Navy initiated the NACIP to identify, assess, and control contamination of the environment resulting from base activities. The IAS, completed in 1983 (E&E 1983), identified several areas for additional investigation. In addition, information from several active portions of NAS Alameda was documented in the IAS. The IAS discussed activities conducted in Building 410 as part of the NARF. Until 1972, Building 410 discharged wastewater laden with oil, paint, detergents, and paint strippers directly to the Seaplane Lagoon. After 1972, the wastewater was discharged to the industrial wastewater treatment system (IWTP 410).

5.2.2 CERCLA Investigations

The following subsections summarize investigations conducted at Site 9 under CERCLA. These investigations included the Phase 1 and 2A investigation performed in 1991, the follow-on investigations conducted in 1994 and 1998, the storm sewer investigation in 2000, the

supplemental RI data gaps sampling event performed in 2001, the basewide groundwater monitoring conducted in 2002 and 2003, and the PAH study in 2003.

5.2.2.1 Phase 1 and 2A Investigation, 1991

The Navy contracted with Canonie to determine whether contamination from surface spills or leaks in the subsurface sewer system at Building 410 had affected soils and groundwater (Canonie 1989). Canonie field notes did not indicate any visual evidence of surface spills.

Soil

Seven soil borings were drilled (B410-1 through B410-7), and four of the seven borings were completed and renamed as monitoring wells (MW410-1, MW410-2, MW410-3, and MW410-4). Figure 5-2 presents the sampling locations. Borings B410-6 and MW410-4 were advanced upgradient on Site 23 and were not considered part of the Site 9 investigation for this report. Seventy soil samples were collected at Site 9. To evaluate if compounds were present in the areas investigated, 30 samples were analyzed for VOCs, 38 for SVOCs, 38 for metals, and 6 each for total organic carbon (TOC) and other general chemistry parameters (PRC and MW 1993a) (see Table 5-3). The table below summarizes chemicals detected at concentrations greater than the PRG and the sampling location with the highest detected result for each chemical.

Site 9 1991 Phase 1 and 2A Investigation Soil Summary		
Analytical Group	Detected Chemical Exceeding 2002 Residential PRG	Location of Highest Concentration Exceeding PRG
VOC	None	Not Applicable
SVOC	Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene	B410-7
Metals	Arsenic and iron	B410-5
	Thallium	MW410-1

Note:

PAH data collected for soil during this investigation were not used in this RI because of high detection limits; data from additional PAH sampling conducted in 2003 were used.

No VOCs were detected in soil above their respective PRGs. The investigation report concluded that 2-butanone was detected in some of the laboratory blanks and was suspect as a laboratory contaminant (PRC Environmental Management Inc. [PRC EMI] and James M. Montgomery, Consulting Engineers, Inc. [JMM] 1992).

PAHs were detected exceeding the PRGs for samples from boring B410-7, collected from 14.5 to 15 feet bgs; no other SVOC exceeded PRGs. It was noted in the investigation report that PAH compounds were typically detected from 11.5 feet bgs to 15.0 feet bgs (PRC EMI and JMM 1992). The investigation report concluded that n-nitroso-di-n-propylamine and

pentachlorophenol were detected in some of the laboratory blanks and were suspected as laboratory contaminants (PRC EMI and JMM 1992).

Groundwater

Three groundwater samples, one from each monitoring well (MW410-1, MW410-2, and MW410-3), were analyzed for VOCs, SVOCs, metals, and general groundwater properties (see Figure 5-2). The table below summarizes chemicals detected at concentrations greater than the PRG and the sampling location with the highest detected result for each chemical.

Site 9 1991 Phase 1 and 2A Investigation Groundwater Summary		
Analytical Group	Detected Chemical Exceeding 2002 Tap Water PRG	Location of Highest Concentration Exceeding PRG
VOC	None	None
SVOC	None	None
Metals	Aluminum, arsenic, iron, manganese, and vanadium	MW410-3

No VOCs, SVOCs, or PAHs were detected in groundwater, although detection limits for select compounds exceeded PRGs (see Table 5-4). Aluminum, arsenic, iron, manganese, and vanadium from monitoring well MW410-3 exceeded the 2002 residential PRG.

Analytical detection limits of numerous VOC, SVOC, and metal compounds, in soil and groundwater, exceeded the 2002 residential PRGs (see Table 5-4). Furthermore, quality assurance/quality control (QA/QC) information was not available for data validation during preparation of the investigation report. Therefore, the groundwater and soil data from the 1991 Phase 1 and 2A investigation at Site 9 were used for qualitative purposes only in the investigation report.

Recommendations for future work included the collection of additional groundwater samples to; evaluate tidal influence on the shallow and deeper water-bearing zone, to verify that the groundwater has not been impacted by VOCs, to better characterize metals in groundwater, and to evaluate whether groundwater beneath the site was considered a potential drinking water source.

The investigation report concluded that based on the samples collected, sufficient VOC, SVOC, and metals data had been collected in soil for the RI/FS investigation and that compounds detected at Site 9 would be addressed during the risk assessment (PRC and JMM 1992).

5.2.2.2 Follow-On Investigation, 1994

Based on the recommendations of the 1991 investigation, and discussions with the regulatory agencies, PRC and MW conducted a follow-on field investigation to provide additional lithologic, chemical, and hydrogeologic information (PRC and MW 1995). Data collection

focused on areas around Building 410 and industrial waste sewer lines associated with the building.

During the 1994 follow-on investigation, an industrial drain line connected to a floor drain in Building 410 was inspected using a video camera. The purpose of the inspection was to determine whether cracks or leaks in the drain line could have served as source areas for chemical migration to groundwater and to assist in determining locations for six shallow Hydropunch sampling locations along the drain line beneath the building (PRC and MW 1995).

The video survey did not indicate cracking or leaking along the portions of the drain line that were accessible by the camera. Some portions of the drain line were inaccessible because of obstructions in the line and were not inspected (PRC and MW 1995). Several soil and groundwater sampling locations were based on areas of obstruction noted during the video survey.

Activities conducted under the 1994 follow-on investigation consisted of soil sampling as well as shallow and deep groundwater sampling activity at 12 locations. Several borings were advanced at each location to evaluate concentrations of chemicals in shallow groundwater, deep groundwater, and soil. In addition, four quarters of groundwater sampling data were collected at all Site 9 wells. This phase of investigation evaluated soil and groundwater beneath Building 410 and around the storm sewer and industrial waste collection systems east of the building. The vertical extent of groundwater contamination was evaluated by collecting deeper groundwater samples and installing a deep monitoring well (D09-01) near the southwestern corner of Building 410. Two nonpoint samples from storm drains were also collected in 1994.

Soil

At 7 of 12 locations (M09-06, CPT-S09-05, CPT-S09-06, CPT-S09-07, CPT-S09-08, CPT-S09-09, and CPT-S09-10), soil samples were collected at three depths (2.5, 5.5, and 8.5 feet bgs) (see Figure 5-2). Twenty-one soil samples were collected and analyzed for VOCs, total metals, and general chemistry (see Table 5-5). Two of these samples were analyzed for TOC. No soil samples were analyzed for SVOCs or PAHs.

No VOCs were detected in soil above their respective PRGs. These findings support those of the 1991 investigation.

Various metals were detected in soil (PRC EMI and MW 1994), but only arsenic concentrations exceeded the PRG in samples from CPT-S09-05. The table below summarizes chemicals detected at concentrations exceeding the PRG and the sampling location with the highest detected result for each chemical.

Site 9 1994 Follow-On Investigation Soil Summary

Analytical Group	Detected Chemical Exceeding 2002 Residential PRG	Location of Highest Concentration Exceeding PRG
VOC	None	Not Applicable
SVOC	None	Not Applicable
Metals	Arsenic	CPT-S09-05

Groundwater

At 8 of 12 locations (SHP-S09-05, SHP-S09-07, SHP-S09-08, SHP-S09-09, SHP-S09-10, SHP-S09-11, SHP-S09-12, and DHP-S09-06), grab groundwater samples were collected from less than 15 feet bgs using Hydropunch borings. At 9 of the 12 locations (DHP-S09-02, DHP-S09-03, DHP-S09-05, DHP-S09-07, DHP-S09-08, DHP-S09-09, DHP-S09-10, DHP-S09-11, and DHP-S09-12), grab groundwater samples were collected from between 20 and 30 feet bgs using Hydropunch borings. Sampling locations are presented on Figure 5-2. Boring logs were prepared to evaluate the lithology of the site. Eighteen groundwater samples collected using Hydropunch methodologies were analyzed for VOCs, SVOCs, dissolved metals, and general chemistry (see Table 5-6). The table below summarizes chemicals detected at concentrations exceeding the PRG and the sampling location with the highest detected result for each chemical.

Site 9 1994 Follow-on Investigation Groundwater Summary

Analytical Group	Detected Chemical Exceeding 2002 Tap Water PRG	Location of Highest Concentration Exceeding PRG
VOC	1,1-DCA and TCE	SHP-S09-09
	1,2-DCA and 1,2-DCP	DHP-S09-09
	1,2-DCE, ethylbenzene, and total xylenes	SHP-S09-10
	Benzene	SHP-S09-07
	Chloroform	D09-01
	PCE	MW410-3
	Vinyl chloride	DHP-S09-06
SVOC	4-Methylphenol	SHP-S09-07
	Pentachlorophenol	SHP-S09-09
	Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene	SHP-S09-11
	Naphthalene	SHP-S09-10
Metals	Unfiltered arsenic	MW410-1
	Filtered antimony	DHP-S09-05
	Filtered arsenic	SHP-S09-07
	Filtered cadmium	D09-01

DCA Dichloroethane
DCE Dichloroethene

VOCs were detected in groundwater above their respective tap water PRGs in samples from SHP-S09-07, SHP-S09-09, SHP-S09-10, DHP-S09-06, DHP-S09-09, D09-01, and MW410-3.

SVOCs were detected in groundwater above their respective tap water PRGs in samples from SHP-S09-07 and SHP-S09-09.

PAHs were detected in groundwater above their respective tap water PRGs in samples from SHP-S09-11 and SHP-S09-10.

Filtered and unfiltered metals were detected in groundwater above their respective tap water PRGs in samples from 280-S09-028, DHP-S09-05, SHP-S09-07, and D09-01.

Based on elevated concentrations of 1,2-DCE detected at location SHP-S09-10, two shallow monitoring wells were installed, M09-05 and M09-06. Well M09-05 is located east and upgradient of Site 9; therefore, it is not discussed for Site 9. Well locations are presented on Figure 5-2. One deep monitoring well (D09-01) was also installed at Site 9. Five monitoring wells (M09-06, D09-01, MW410-1, MW410-2, and MW-410-3) were sampled as part of the 1994 investigation. All of the wells were sampled during the fourth quarter of 1994. Samples from four wells were collected in February 1995, and all wells were sampled in June and August 1995.

Nonpoint Source Samples

One sediment sample was collected from a catch basin east of Building 410 to assess the potential for the utilities to act as conduits for transporting chemicals off site. The sample was analyzed for VOCs, SVOCs, TPH-P, TPH-E, and metals. Chemicals from all analytical groups were detected in the sample. Chemicals found at concentrations greater than residential PRGs included benzo(a)pyrene, antimony, arsenic, cadmium, chromium, iron, lead, and nickel.

In general, few VOCs were detected in soil during the 1994 investigation, but elevated VOCs were detected in groundwater adjacent to former industrial wastewater and storm sewer systems beneath and east of Building 410.

The investigation report concluded that chemicals detected in soil and groundwater varied from those found during the previous (1991) investigation due to the close proximity of sample collection points to the industrial drain lines (PRC and MW 1995). The report also indicated that additional soil or groundwater data were not required for further characterization of the site, but that additional data may be necessary for or human health risk assessment.

5.2.2.3 Follow-On Investigation, 1998

The 1998 investigation consisted of 1 year of basewide quarterly groundwater monitoring to assess and monitor the status of plumes at various sites at Alameda Point. Both filtered and

unfiltered groundwater samples were collected. Two wells (D09-01 and M09-06) located within Site 9 were included in the monitoring program to assess the migration of chlorinated hydrocarbons detected in 1994. In general, these wells monitored the upgradient and vertical extent of the groundwater contamination plumes at Site 9. Groundwater samples collected from these wells were analyzed for VOCs, dissolved metals, and general groundwater chemistry (Tetra Tech and Uribe and Associates, Inc. [U&A] 1998) (see Table 5-7). Data from the latter two analyses were used in the basewide analysis of ambient water quality (Tetra Tech 1998) and in the evaluation of beneficial uses of groundwater (Tetra Tech 2000a). Samples from the first quarter of groundwater monitoring were also analyzed for TOC to help evaluate the biodegradation potential for petroleum hydrocarbons. Sampling locations are presented on Figure 5-2. The table below summarizes chemicals detected at concentrations exceeding the PRG and the sampling location with the highest detected result for each chemical.

Site 9 1998 Follow-On Investigation Groundwater Summary		
Analytical Group	Detected Chemical Exceeding 2002 Tap Water PRG	Location of Highest Concentration Exceeding PRG
VOC	Chloroform	D09-01
Metals	Manganese	D09-01

During quarter four, the VOC chloroform was detected in groundwater above the 2002 tap water PRG in monitoring well D09-01. This result was also found in the duplicate sample.

Various metals were detected in filtered and unfiltered groundwater samples; however, manganese was detected above the 2002 tap water PRG in unfiltered and filtered samples collected from monitoring well D09-01.

5.2.2.4 Storm Sewer Investigation, 2000

This basewide storm sewer investigation evaluated the physical conditions of storm sewers and the places where storm sewers were submerged below groundwater; identified locations where contaminated groundwater intercepts submerged, damaged sections of storm sewers; and identified significant data gaps for further evaluation.

The 2000 storm sewer investigation noted that the east-west oriented storm sewer main line (to Outfall J) is submerged, but does not intercept the groundwater contamination plumes at Site 9 (see Figure 5-4). The storm sewer report recommended that samples be collected from catch basin 3-J during the following phase of investigation (Tetra Tech 2000b). A second storm sewer line, oriented north-south, has one catch basin (5-OA) line near the southwestern corner of Building 410 that runs south to Outfall O. In 1991, this storm sewer line was replaced with an 8-inch diameter polyvinyl chloride (PVC) line that enters a 20-inch diameter PVC line located south of West Ticonderoga Avenue. This storm sewer does not intercept groundwater contamination plumes and was not identified for further evaluation.

5.2.2.5 Supplemental Data Gaps Sampling Investigation, 2001

Based on identified data gaps, a supplemental data gap sampling effort was conducted at OU-2A to address two primary data gaps categories: (1) the status of groundwater contaminant plumes and (2) preferential flow paths associated with the storm sewer system (Tetra Tech 2002a). This sampling effort included sampling of groundwater monitoring wells and bedding material at the storm sewers.

Five groundwater monitoring wells (MW410-1, MW410-2, MW410-3, M09-06, and D09-02) at Site 9 were sampled to monitor the status of groundwater contaminant plumes. Direct-push grab groundwater sampling was conducted to delineate the horizontal and vertical extent of chlorinated hydrocarbon contamination in groundwater. Vacuum extraction location S09-DGS-VE01, soil gas sampling location S09-DGS-SG03, sampling locations S09-GGS-DP-01 through S09-DGS-DP-12, and the monitoring wells are presented on Figure 5-2. Twelve direct-push borings were advanced, and 44 groundwater samples were collected. One water sample was collected from storm sewer catch basin 3-J. Every groundwater sample was analyzed for VOCs (totaling 44 samples), and 27 samples were selected for SVOC analysis (see Table 5-8).

Groundwater contaminant plumes were delineated to establish current site conditions, identify point-of-compliance wells for long-term monitoring, and approximate exposure areas for risk assessment (Tetra Tech 2002a). Water level elevations were also collected to provide local conditions of groundwater flow. The table below summarizes chemicals detected at concentrations greater than the PRG and the sampling location with the highest detected result for each chemical.

Site 9 2001 Supplemental Data Gaps Sampling Investigation		
Analytical Group	Detected Chemical Exceeding 2002 Tap Water PRG	Location of Highest Concentration Exceeding PRG
VOC	1,1-DCA and vinyl chloride	S09-DGS-DP02
	1,2-DCA	S09-DGS-DP01
	Benzene and ethylbenzene	S09-DGS-DP05
	MTBE	S09-DGS-DP08
	PCE and TCE	MW410-3
SVOC	Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene	D09-DGS-DP04
PAH	Naphthalene	S09-DGS-DP05

VOCs were detected in groundwater above their respective tap water PRGs in samples from S09-DGS-DP01, S09-DGS-DP02, S09-DGS-DP05, S09-DGS-DP08, P-9-IWS-01, and MW410-3.

No SVOCs (aside from PAHs) were detected in groundwater above their respective tap water PRGs.

PAHs were detected in groundwater above their respective tap water PRGs in samples from S09-DGS-DP04 and S09-DGS-DP05.

VOCs and PAHs were detected in groundwater above their respective MCLs. No SVOCs were detected above the MCLs.

To determine whether storm sewer bedding materials were acting as a preferential pathway for contaminant migration, soil and groundwater samples were collected from along storm sewer lines at Site 9 (Tetra Tech 2002a). Vacuum excavation borings were advanced immediately adjacent to storm sewer lines, and undisturbed samples of the bedding material were collected. For comparison purposes, samples of native soil were collected at the approximate depth of the storm sewer, 10 feet away from the vacuum excavation locations. Soil samples were analyzed for geotechnical parameters. Groundwater samples were collected from the vacuum extraction locations and analyzed for TPH-P and TPH-E and VOCs. TPH in the diesel, gasoline, and motor oil ranges were detected in samples collected from Site 9. No PRGs or MCLs are associated with TPH.

One vacuum excavation boring was advanced within the storm drain bedding material, and water samples collected from catch basin 3-J were tested for VOCs and SVOCs as part of a storm sewer evaluation (five additional VOC samples) (Tetra Tech 2002a). The data gaps sampling investigation determined that VOCs were not being transported through the storm sewer line that discharges to Outfall J and that storm drain bedding material was not a preferential pathway for contaminant migration (Tetra Tech 2002a).

One boring was advanced for soil gas sampling at a location selected with assistance from the BCT (see Figure 5-2) for use in a future human health risk assessment. At the soil gas sampling location, two continuous core soil borings were completed to determine specific groundwater depths and evaluate physical soil parameters required for the indoor vapor intrusion risk assessment model. Samples were collected at depths of 1.5 and 4.0 feet bgs. Chlorinated hydrocarbons and BTEX compounds were detected in the soil gas samples. (Tetra Tech 2002a)

The data gaps sampling investigation defined the horizontal and vertical extent of chlorinated hydrocarbons in groundwater west of Building 410. Sampling was conducted in accordance with the field sampling plan (FSP) and accompanying quality assurance project plan (QAPP) and the project-specific data quality objectives (DQO) (Tetra Tech 2001a). Analytical detection limits goals were established based on MCLs, rather than 2002 residential PRGs.

5.2.2.6 Basewide Groundwater Monitoring, 2002 and 2003

The specific objectives of the 2002 and 2003 basewide groundwater monitoring investigation were to (1) evaluate contaminant plumes in groundwater and (2) determine the main chemicals of concern (Shaw 2003a). The monitoring scheme for OU-2A included 23 of the 46 wells located within the five sites (Sites 9, 13, 19, 22, and 23) of OU-2A. Three wells (D09-01, MW410-01, and MW410-02) were sampled in June, September, and December 2002, and in

April 2003 (Shaw 2003a, 2003b) (see Table 5-9). Sampling locations are presented on Figure 5-2.

The table below summarizes chemicals detected at concentrations exceeding the tap water PRG and sampling locations with the highest detected result for each chemical.

Site 9 2002 and 2003 Basewide Groundwater Monitoring Investigation		
Analytical Group	Detected Chemical Exceeding the 2002 Tap Water PRG	Location of Highest Concentration Exceeding PRG
VOC	1,1-DCA, benzene, 1,2,3-Trichloropropane, ethylbenzene, MTBE, TCE, and vinyl chloride	MW410-2
Metals	Arsenic	MW410-2
	Manganese	D09-01

VOCs were detected in groundwater above their respective tap water PRGs in samples from MW410-2.

Various filtered metals were detected in groundwater above their respective tap water PRGs in samples from MW410-2 and D09-01.

VOCs and metals were detected in groundwater above their respective MCLs in samples from MW410-2 and D09-01.

TPH in the diesel, gasoline, and JP-5 ranges were detected in samples collected from Site 9.

5.2.2.7 Basewide PAH Study, 2003

The primary objective of the 2003 PAH study was to collect sufficient PAH data to calculate exposure point concentrations (EPC) for ecological and human health risk assessments at CERCLA sites (Bechtel 2003). The historical PAH data collected at each CERCLA site were used to estimate the mean and standard deviation of BaP concentrations to identify the appropriate number of PAH samples to collect at each site. At Site 9, 13 soil borings were advanced north, south, and east of Building 410 using direct-push sampling methods. Samples were collected from each of the following four depth intervals: 0 to 0.5, 0.5 to 2, 2 to 4, and 4 to 8 feet bgs. This investigation detected PAHs at concentrations less than PRGs (EPA 2002a) and the site-specific action level of 0.62 mg/kg for BaP equivalents (Navy 2001d). Sampling locations for this investigation are presented on Figure 5-2. Table 5-10 provides a statistical summary of analytical results.

The table below summarizes chemicals detected at concentrations exceeding the residential PRG and sampling locations with the highest detected result for each chemical.

Site 9 2003 Basewide PAH Soil Study			
Analytical Group	Detected Chemical Exceeding the 2002 Tap Water PRG	Location of Highest Concentration Exceeding PRG	Chemical Detected Below 2002 Residential PRG*
PAHs	None	Not Applicable	Numerous

Note:

* Includes compounds with no PRG

5.2.3 EBS Investigations

The EBS was performed to identify the environmental condition of all base property and structures to facilitate transfer to the community as quickly as possible. Two phases of the EBS were conducted at the installation. Tables 5-11 and 5-12 provide a statistical summary of analytical results for Phases 2A and 2B of the EBS.

Phase 1. The first phase of investigation comprised an examination of aerial photographs and historical records as well as the performance of site inspections and interviews with current and former employees involved in operations. The Phase 1 EBS found that many parcels could not be classified as transferable because of insufficient information; therefore, recommendations for additional investigations were prepared and presented in the zone analysis and parcel evaluation plans (ERM-West 1995a, 1995b).

Phase 2A. As recommended by the IAS (E&E 1983), Phase 2 investigations did not focus on areas already under evaluation. No EBS samples were collected at Parcel 152 because it was being evaluated under the IRP. Other Navy land uses or areas that may impact transfer were the subjects of the investigations. Site 9 lies within Zone 22 and comprises Parcels 152 and 153A (see Figure 5-1). Parcel 153A was sampled in January and May 1995 as part of the EBS Phase 2A (IT 2001) (see Figure 5-2). Seven soil borings were advanced on Parcel 153A. Nine soil samples from six of these borings were tested for VOCs. Six samples from three borings were tested for metals, and four samples were tested for pesticides and SVOCs. Six of the seven borings were located in or around the footprint of IWTP-410. EBS soil samples were collected to depths of 3.5, 7.0, 8.0, 8.5, and 10.0 feet bgs from Parcel 153A. Only estimated concentrations of two VOCs and seven SVOCs were detected during the January and May 1995 EBS sampling events (see Tables 5-11 and 5-12). As a result, no further investigation of Parcel 153A was deemed necessary (IT 2001).

Phase 2B. Parcel 154, immediately west and downgradient of Site 9, also was sampled in October 1995 as part of the EBS Phase 2B (IT 2001). Four direct-push groundwater samples were collected and analyzed for VOCs and TPH. One sample was analyzed for SVOCs and dissolved metals. All samples were collected from less than 9.5 feet bgs. No VOCs or SVOCs were detected in the samples. The only chemicals detected were diesel and motor oil-range petroleum hydrocarbons in sample 154-SN-007. These hydrocarbons did not resemble the laboratory standards, suggesting that areas west of Building 410 are not source areas for VOCs.

5.2.4 TPH Investigations

As defined under the Alameda TPH program, Site 9 is not within a CAA. No TPH program sampling activity has taken place on Site 9.

5.2.5 Removal Actions

The Navy sought to conduct a full-scale groundwater removal action at CERCLA Sites 9, 11, 16, and 21 beginning in March 2002; this removal action was expected to last approximately 1 year, and a draft action memorandum was issued June 17, 2002 (Tetra Tech 2002d). This removal action was a non-time-critical removal action for dissolved phase chlorinated solvents in groundwater. The removal action was designed to remove chlorinated solvents from soil and groundwater by injection of chemical oxidation agents such as permanganate, Fenton's reagent, or hydrogen peroxide into the subsurface, transforming the chemicals into less toxic chemical compounds. The removal action, while substantially reducing the potential for exposure to chemicals by potential receptors, was anticipated to be an interim action, requiring subsequent investigation and response. From June to December 2002, the Navy conducted a pilot scale test to evaluate the best oxidizing agent for the transformation of the chemicals present at Site 9.

The purpose of the pilot test was to evaluate the radial effects associated with application of the oxidant (Fenton's reagent) and to evaluate the effectiveness of the oxidant in destroying chlorinated hydrocarbons at Site 9. The pilot test included collecting hydrogeologic data from a slug test and a pump test conducted at Site 9, collecting pretest groundwater contamination data, injecting the chemical oxidant into shallow (less than 15 feet bgs) and deeper (between 22 and 45 feet bgs) groundwater, and collecting post-test groundwater contamination data.

The shallow pilot test was conducted east of Building 410, and the deeper pilot test was conducted west of Building 410 (see Figure 5-3). Results of the shallow pilot test indicated that concentrations of trimethylbenzene, vinyl chloride, benzene, 1,1-DCA, and 1,2-DCE in shallow groundwater were effectively reduced and that the radius of influence was approximately 20 feet from each injection point. The deeper pilot test experienced short-circuiting and did not evaluate the radius of influence or effectiveness of the oxidant in destroying groundwater contamination west of Building 410; therefore, the field summary report for the pilot test (IT 2003) recommended additional pilot testing to measure the efficacy of this technology for deeper groundwater.

The draft action memorandum issued in June 17, 2002 (Tetra Tech 2002d), discussed the Navy's plans to conduct additional pilot test activity and full-scale remediation of chlorinated solvents dissolved in groundwater starting in 2003 (Tetra Tech 2002d). Full-scale removal operations were scheduled to begin in the shallow zone in October 2003, and additional pilot testing was planned for the deeper water zone. Construction plans in the shallow zone have been delayed by the discovery of floating petroleum product (Shaw 2003c). Table 5-13 presents statistical summaries of the analytical results.

5.2.6 Treatability Studies

No treatability studies were conducted at Site 9.

5.3 INITIAL DATA EVALUATION

Based on the investigations described in Section 5.2, the Navy completed an initial data evaluation for Site 9. This evaluation included (1) a site-specific CSM, (2) a data quality assessment, and (3) a background comparison. The complete background comparison is provided in Appendix A.

5.3.1 Site 9 CSM

The initial CSM was refined in an iterative process that involved conducting environmental investigations, identifying areas of known or potential releases of chemicals to the environment, and filling data gaps. This iterative process resulted in a CSM specific to Site 9. This site-specific CSM was used to support the nature and extent evaluations and risk assessments by identifying potential sources of contamination, media affected, exposure pathways, and future receptors. The CSM for Site 9 is described in the following text and presented on Figure 5-5.

Through environmental investigations and literature searches for Site 9, physical features and activities at Site 9 that might have generated hazardous waste or released chemicals to the environment were identified. The following physical features and activities were identified as potential sources of contamination:

- Building 410 (Paint Stripping Facility) – Chemicals used included 1,1,1-TCA, naphthalene, methylene chloride, phenol, chromium, detergents, wipe down solvents (such as PCE), and parts cleaners; paint stripping process may have potentially released metals.
- ASTs 410A, 410B, and 410C – Located east of Building 410; contained methylene chloride, phenol, and surfactant.
- OWS-410A – Located south of the southwestern corner of Building 410; received water from a nearby wash rack; no sampling locations are located near this OWS. Because data gaps are associated with this OWS, it is considered a potential source of contamination.
- OWS-410B – Located southeast of the southeastern corner of Building 410 and is associated with former plane washing activities; ; no sampling locations are located near this OWS. Because data gaps are associated with this OWS, it is considered a potential source of contamination.
- Historical aircraft storage and fueling activities – Associated with numerous releases of petroleum.

- Placement of dredged fill material used to build the island – Potential source of PAHs.

Building 351 and IWTP 410 were not considered potential sources because (1) Building 351 served as an office and break room until 1990 for staff that worked in Building 410 and (2) IWTP 410 included Building 588, OWS-588, and eight associated ASTs. The Navy received a letter from DTSC approving the IWTP 410 closure certification report on November 9, 1998 (DTSC 1998). This concurrence states that no VOCs, SVOCs, or metals were present at concentrations greater than PRGs. This concurrence indicates that the IWTP is not a source of contamination at Site 9 and will not be discussed further in this document.

Of the potential sources, (1) paint stripping within Building 410, (2) releases of petroleum fuel from storage and defueling activities near Building 410, and (3) fill material containing PAHs were identified as likely sources of contaminants in soil and groundwater at Site 9. The exposure pathways and primary and secondary release mechanisms may include the following (see Figure 5-5):

- Direct release of chlorinated solvents, petroleum distillates, and petroleum fuels to groundwater from activities conducted within Building 410. These compounds were discharged to floor drains connected to storm sewers and industrial waste discharge sewers extending east of Building 410. Industrial waste sewer piping extending east from Building 410 is located below the depth of groundwater. It is likely that underground industrial waste sewer pipes east of Building 410 leaked, and chemicals used in Building 410 entered groundwater directly from these leaks.
- Direct release of petroleum products to soil and groundwater from spills around and within Building 410.
- Placement of fill material that contained PAHs.
- Secondary release from soil to air through volatilization or resuspension of particulates.
- Secondary release from soil into the food chain from plant uptake.
- Secondary release from soil to groundwater through infiltration.
- Secondary release from groundwater to air through volatilization.
- Secondary release from groundwater into domestic use through a well.

As shown in the CSM for Site 9 (see Figure 5-5), residential, commercial/industrial, and construction worker receptors were identified as potential human receptors. Exposure scenarios that include ingestion of homegrown produce and ingestion, dermal contact, and inhalation of soil and groundwater are evaluated in the HHRA (see Appendix H). Exposure of potential

ecological receptors to contaminants through direct contact with soil and the food chain were also evaluated in the ERA (see Appendix I).

Exposure of potential ecological receptors to groundwater from migration to surface water was considered an incomplete pathway. Tidal influence studies indicated that only two wells (MW410-1 and D09-01) at Site 9 are tidally influenced (PRC 1997a), groundwater is not expected to migrate to San Francisco Bay, and the storm sewer system at Site 9 is not considered a preferential pathway for contaminant migration. In addition, based on the results of the supplemental RI data gaps sampling conducted in 2001, the bedding material was not considered a preferential pathway.

The storm sewer line (sewer line J) that runs across the northern portion of Site 9 with lateral lines leading to Building 410 was determined to be in sound condition between Site 9 and the outfall (Outfall J); it also is submerged in groundwater. The line (sewer line O) that extends close to the southern portion of the site is submerged in groundwater and in sound condition (Tetra Tech 2000b) (see Figure 5-4). Because data show that the groundwater contamination plumes do not intersect sewer line J, it is unlikely that the sewer line will create a preferential migration pathway to San Francisco Bay. Data collected from storm drain manhole 3J indicate that very low concentrations of VOCs are present in storm water. Samples collected from the storm drain bedding did not contain VOCs at concentrations that exceed detection limits. Data suggest that the groundwater contamination plumes do not intersect sewer line O; however, limited data are available to complete this evaluation.

5.3.2 Site 9 Data Quality Assessment

As discussed in Section 5.2, several environmental investigations were conducted at Site 9 as a part of CERCLA and EBS programs to identify and assess the extent of contamination in soil and groundwater and to determine risk. Data were collected over a period of approximately 13 years, from 1990 through 2003, using a biased and phased sampling approach. Sampling focused on the following:

- Industrial, sanitary, and storm sewers;
- Building 410 to assess the presence of VOCs, SVOCs, metals, and petroleum products in soil and groundwater;
- Fill material and native sediments to assess the presence of PAHs; and
- Groundwater to assess and delineate VOCs.

These data, through an iterative process, were used to construct and refine the site-specific CSM presented in Section 5.3.1. They also were used to identify and fill data gaps until the quantity and quality of the data at Site 9 were judged to be adequate to complete the RI, as determined by applying the DQOs presented in Section 3.4.

Detection limits for some of the data used to evaluate Site 9 are elevated over residential PRGs (EPA 2002a); these elevated detection limits are the consequence of one or more of the following circumstances: (1) the evolution of lower detection limits as technology improves, (2) the revision of PRGs over time (which are not always technologically feasible), (3) and matrix interference. The first two of these circumstances generally do not result in significantly elevated detection limits. However, matrix interferences sometimes cause significant elevations in the detection limits for a chemical contaminant, which leads to uncertainty as to whether that undetected compound could be present in significant concentrations at a site. Although some detection limits (SQL) were elevated above 2002 residential PRGs, detection limits for nondetected chemicals were typically sufficiently low to permit identification of potential health risks. However, because detection limits were elevated in both soil and groundwater for some non-detected SVOCs (excluding PAHs) and VOCs, the need for further sampling and analysis of soil and groundwater for SVOCs (excluding PAHs) and VOCs were identified to confirm that these chemicals are not present in soil or groundwater. A data gap for soil and groundwater associated with OWS-410A was also identified.

Although soil and groundwater data gaps were identified, it was determined that the types and numbers of samples collected at the site (see Figures 5-6A through 5-6L) and the analytical suite (see Tables 5-1 and 5-2) were adequate to characterize Site 9 and to conduct risk assessments because data collection at Site 9 focused mainly on potential sources and was conducted in phases. This phased approach afforded stakeholders opportunities to provide feedback on the suitability or adequacy of the data collected and the need for additional data to identify releases and complete the RI report. It is unlikely that the RI would recommend NFA if the site poses a potential significant risk to human health or the environment.

Both definitive and screening-level data were generated. Screening data were considered appropriate for use only in evaluations of nature and extent and fate and transport of chemicals. Section 3.4.2 provides further detail on the assessment of data quality and the use of definitive and screening-level data.

Data generated during the environmental investigations that were considered to be of sufficient quality for use in the RI report are presented in Appendix D and in the subsections below. Tables 5-14 through 5-16 summarize results of the CERCLA and EBS investigations for soil, groundwater, and soil gas. No data were collected at Site 9 under the TPH investigations. The summaries are organized according to analytical group and include the following: (1) the number and percent of detections of chemicals; (2) the average, minimum, and maximum detected concentrations; (3) minimum and maximum detection limits for nondetected samples; and (4) whether the maximum detected concentrations or detection limits exceed Region 9 residential PRGs or Cal-modified PRGs (EPA 2002a). Cal-modified PRGs are used for some chemicals if the California EPA PRG is more protective than the federal EPA value. PRGs and MCLs are provided in the tables for comparison only.

5.3.2.1 Soil

Soil samples collected under the environmental investigations at Site 9 were analyzed for VOCs, SVOCs, pesticides and PCBs, PAHs, and metals as well as selected physical parameters (organic metals, pH, TPH, total organic carbon, and percent moisture) (see Table 5-1). Of the samples collected and analyzed, results for 63 samples analyzed for VOCs and 42 samples for SVOCs were considered acceptable for use in this RI report. Results for one sample analyzed for PCBs, which were nondetected, and 63 samples analyzed for metals were also considered acceptable for use in this RI report. Three soil samples were analyzed for pesticides. Pesticide and PCB data were collected at depths below 7 feet bgs. The minimal pesticide and PCB data were not perceived as a data gap because the site is mostly paved and use of pesticides and PCBs was not identified at Site 9.

Results for 52 samples were considered acceptable from the additional PAH sampling conducted in 2003. Data for PAHs in soil samples collected during previous investigations were not evaluated because of the high detection limits. Laboratory detection limits for some other chemicals exceeded residential PRGs (EPA 2002a) and are noted in Table 5-14. Detection limits for some of the nondetected SVOCs and nondetected thallium in soil were also elevated above residential PRGs (EPA 2002a), and detection limits for these chemicals in groundwater were also elevated. However, Site 9 was not identified as a source of thallium (see Section 5.3.1), and detected concentrations are similar to concentrations detected in ambient soil.

A subset of these data was selected for use in the risk assessments (see table below). Data were considered to be appropriate for use if they (1) were validated, (2) could be used to characterize CERCLA releases, and (3) reflected current site conditions. Only data collected with the objective of characterizing CERCLA activities were used. Data collected as part of the EBS program are more of a screening nature, and inclusion of these data could add more uncertainty to the risk assessments.

Data for soil from each site were aggregated in depth intervals of 0 to 2, 0 to 4, and 0 to 8 feet bgs. The depth intervals evaluate potential exposures associated with site use. The 0-to-2-foot and 0-to-8-foot-bgs depth intervals evaluate potential human health exposures, and the 0-to-4-foot-bgs depth interval evaluates potential ecological exposures. The total number of samples for each analytical group included in the data set for each of these depth intervals is presented in the table below.

Numbers of Suitable Soil Data for Site 9 Risk Assessments			
Analytical Group	0 to 2 feet bgs	0 to 4 feet bgs	0 to 8 feet bgs
VOCs	8	21	37
SVOCs	6	13	22
PAHs	26	39	52
Pesticides and PCBs	0	0	0
Metals	13	26	42

The minimal data for VOCs in soil from 0 to 2 feet bgs are not perceived as a data gap because Site 9 is mostly paved and VOCs in surface soil would likely volatilize and no longer be present in soil at the site. Data for 2 to 8 feet bgs are sufficient to evaluate the nature and extent and risk from VOCs at Site 9.

The minimal data for SVOCs in soil from 0 to 2 feet bgs are not perceived as a data gap because data for 2 to 8 feet bgs are sufficient to evaluate the nature and extent and risk from SVOCs at Site 9. In addition, the release mechanism for SVOCs (through storm and industrial waste sewers) is likely to include soil at depth rather than at the surface. However, detection limits for some of the nondetected SVOCs in soil were elevated above residential PRGs (see Table 5-14) (EPA 2002a), and detection limits for these SVOCs in groundwater were also elevated (see Table 5-15).

Only one soil sample, which was collected in 1995 at a depth of 10 to 11 feet bgs, was analyzed for PCBs; the result was not validated. PCBs were not detected in this sample. Only three soil samples were analyzed for pesticides, which were EBS samples collected at depths greater than 7 feet bgs. The lack of PCB and pesticide data was not perceived as a data gap because Site 9 is mostly paved and the use of pesticides and PCBs was not identified at Site 9.

The quantity of data for metals in soil was considered sufficient to evaluate risk; however, thallium was nondetected in soil with detection limits elevated above residential PRGs (EPA 2002a).

5.3.2.2 Groundwater

Groundwater samples collected at Site 9 were analyzed for VOCs, SVOCs, PAHs, and metals (see Table 5-2). Of the samples collected and analyzed, results for 159 samples for VOCs and 70 samples for SVOCs were considered acceptable for use in this RI report. Results for 32 samples for PAHs and 52 filtered samples for metals also were considered acceptable for use in this RI report. No samples were analyzed for pesticides and PCBs. The lack of PCB and pesticide data was not perceived as a data gap because use of pesticides and PCBs was not identified at Site 9. Laboratory detection limits for some chemicals in groundwater exceeded residential PRGs (EPA 2002a); these exceedances are noted in Table 5-15. Detection limits for

some PAHs and VOCs detected in groundwater at a low frequency were significantly elevated over tap water PRGs and MCLs. Detection limits for some nondetected SVOCs and for nondetected thallium in groundwater also were elevated; detection limits for these chemicals were elevated in soil.

A subset of these groundwater data was selected for use in the risk assessments (see table below). Data were considered appropriate for use if they (1) were validated, (2) could be used to characterize CERCLA releases, and (3) reflected current site conditions. Data for groundwater were aggregated by contaminant plume rather than site. Data for groundwater later replaced with more current data were not included because they do not reflect current conditions at Site 9. Only data collected under the IRP with the objective of characterizing CERCLA activities were used. Data collected as part of the EBS were not used to evaluate risk because they were collected with DQOs that differ from the CERCLA investigations. At least four quarters of groundwater data from monitoring wells were used. However, if data were lacking for an analytical group, older data were included for all analytical groups. Groundwater data included samples collected from 1994 to 2003. Field and screening-level data typically were not used; however, data obtained using direct-push methods were used because of a lack of data from monitoring wells in the concentrated plume areas.

Numbers of Suitable Groundwater Data for Site 9 Risk Assessments		
Analytical Group	Suitable for RI Report	Used in Risk Assessments
VOCs	159	44
SVOCs	70	37
PAHs	32	0
Pesticides and PCBs	0	0
Metals	52	30

As shown in the table above, large percentages of the data collected for each analytical group were excluded from the risk assessments based on criteria described in the paragraph prior to the table. For example, only 44 of the 159 samples for VOCs in groundwater were included, and 115 of these samples were excluded from the risk assessments. Of the 115 samples excluded, 83 were not validated; therefore, only 32 validated samples were excluded from the risk assessments. Sixteen of the 32 excluded validated samples represented old data that were replaced by more recent, representative data from monitoring wells. Another four of these samples were excluded because they were collected for the EBS from areas outside the contaminant plume identified in groundwater. The remaining 12 samples were excluded either because they were collected outside of the contaminant plume or were from grab groundwater samples that were less representative than data from nearby monitoring wells.

There is no perceived data gap for pesticides and PCBs because Site 9 is mostly paved and use of pesticides and PCBs was not identified at Site 9.

5.3.2.3 Soil Gas

Data for soil gas were collected to evaluate indoor air risk in the HHRA. Two soil gas samples were collected at Site 9 near the sampling location where maximum VOC concentrations were detected in groundwater at depths of 1.5 and 3.5 to 4 feet bgs. These samples were analyzed for VOCs and SVOCs (see Table 5-16). Detection limits for some of the nondetected chemicals exceeded PRGs for ambient air; however, SQLs were not set to meet the PRGs.

5.3.3 Site 9 Background Comparison

A background comparison was conducted for Site 9 by comparing a background data set with analytical results for metals in samples representative of Site 9. This comparison was used to determine if metals in soil and groundwater are statistically similar to background and could be considered to be either naturally occurring (background) or potentially resulting from historical site activities. The complete approach is presented in Appendix A and summarized previously in Section 3.4.3.

Metals that exceeded background in soil included barium, beryllium, and lead.

The statistical evaluation of lead in soil determined that lead at Site 9 is not background based on frequency of detection using the test of proportions. However, comparison of detection frequencies using only the test of proportions cannot be used to evaluate whether the distribution of concentrations measured at the site exceeds background. An important assumption of the test of proportions is that the censoring mechanism is the same for five of the highest eight measurements in the pooled site and that the background data set would need to come from the site data set for site concentrations of lead to be statistically elevated relative to background. In this case, only two of the highest eight measurements come from Site 9, and the maximum detected background concentration (41 mg/kg) is almost double the level measured at the site (22.2 mg/kg). Side-by-side outlier box plots and quantile tables (see Appendix A) were also used to show that the distribution of lead at Site 9 is well within ambient limits. In this case, the available evidence (that is, results of the quantile test, comparison of box plots and quantiles) suggests that concentrations of lead at Site 9 are below background.

Aluminum, barium, chromium, copper, iron, manganese, selenium, and vanadium exceeded background in groundwater at Site 9.

The statistical evaluation of manganese in groundwater determined that manganese concentrations at Site 9 are not background. A review of the range of concentrations shows that manganese concentrations at Site 9 are greater than manganese in the background data set. These elevated manganese concentrations may be attributable to reducing conditions associated with organic material present in the BSU and the marsh crust. With the exception of higher concentrations present in deeper groundwater at Site 9, there is no discernable pattern to the distribution of elevated manganese in groundwater. Manganese is not associated with site

activity, but its relatively high concentrations in deeper groundwater at Site 9 are likely due to reducing conditions at Site 9 and saltwater intrusion.

5.4 NATURE AND EXTENT OF CHEMICALS IN SOIL AND GROUNDWATER

This section summarizes the nature and extent of contamination in soil and groundwater at Site 9. The nature and extent evaluation summarizes (1) TPH detected at the site, (2) types and concentrations of CERCLA chemicals that most likely were used at the site, and (3) CERCLA chemicals that demonstrate significant risk to human health or the environment (also known as "risk drivers"). Only chemicals that pose risk to human health or the environment (see Appendices H and I) or relate to past site activity are discussed in the sections below. Section 5.4.2, Chemicals Used at Site 9, assisted the Navy in determining whether contamination "hot spots" were present at Site 9. The nature and extent of risk drivers, excluding those that may occur naturally at the site, are evaluated in Section 5.4.3. Risk drivers are those chemicals that pose a cancer risk above $1E-06$ or an HI above 1 to human receptors or pose significant risk to ecological receptors. The evaluation of risk drivers includes (1) site-specific figures to assess the spatial distribution and concentration patterns of risk drivers and (2) a review of the figures, data, and site hydrology to identify the boundaries of the contamination, the volume of the affected media, and, if possible, the suspected source of the risk drivers at the site.

5.4.1 TPH

Although TPH is not a CERCLA contaminant, soil and groundwater were sampled at various locations across Site 9 and analyzed for TTPH, which includes all TPH-fractions (TPH as diesel, gasoline, jet fuel, or motor oil) and TPH-associated constituents (BTEX, lead, and MTBE) (see Figure 5-2). An evaluation of TPH in soil and groundwater at Site 9 was conducted based on the TPH strategy for Alameda Point (see Appendix F) to assess contamination and possible risk at the site. On the basis of this evaluation, further action is not warranted for soil at Site 9. Further action is warranted for groundwater at Site 9. TPH in groundwater is commingled with other CERCLA contaminants and should be further evaluated under the CERCLA program after the floating petroleum product is removed from Site 9.

Potential sources of TPH contamination at Site 9 include plane defueling inside and around Building 410; engine repair and vehicle and boat storage inside and outside of Building 410 by current lessee Nelson's Marine; IWTP 410, which received wastewater laden with oil from Building 410; the OWS-588; and eight associated ASTs that were used during IWTP processes and were located directly east of Building 588. IWTP 410 and associated ASTs and OWS were investigated and closed under RCRA in 1998. Other potential sources include OWS-410A and OWS-410B located south of Building 410.

Floating petroleum product was detected in four remedial action wells during November 2003. Wells P-9-MWS-04, F9SMW04, F9SMW-05, and 9-2 were installed as part of an interim remedial action to reduce concentrations of chlorinated hydrocarbons in groundwater at Site 9. Each of the four wells contained measurable floating petroleum product (see Figure 5-3). Concentrations of benzene detected in groundwater at 12 sampling locations (MW410-2,

SHP-S09-07, S09-DGS-DP04, S09-DGS-DP05, 9S-CH1, 9S-CH2, 9S-CH3, 9S-CH-4, P-9-IWSI-01, P-9MWS-01, P-9MWS-03, and P-9MWS-04) ranged from 1 to 5.6 µg/L. Toluene was detected at concentrations of 230 and 220 µg/L in groundwater samples from locations DHP-S09-06 and SHP-S09-10, respectively. Maximum concentrations of MTBE ranged from 6.8 to 40 µg/L in groundwater samples from locations MW410-2 and S09-DGS-DP08. Finally, lead was detected at concentrations of 88, 90, and 28.9 µg/L in groundwater samples from three sampling locations MW410-1, MW410-2, and SHP-S09-10, respectively.

5.4.2 Chemicals Used at Site 9

This section focuses on chemicals detected in soil and groundwater that were used historically at Site 9. Chemicals that most likely were used at Site 9 and their breakdown products include methylene chloride, phenol, 1,1,1-TCA, naphthalene, and other solvents such as PCE. Numerous releases of petroleum fuels likely associated with historical aircraft defueling were reported during interviews with site personnel during the EBS (IT 2001). These chemical concentrations and a general description of their extent are presented below by medium. Most of the chemicals detected across Site 9 are consistent with historical activities known to have occurred at the site, which included paint stripping and defueling. Statistical summaries of all results for soil, groundwater, and soil gas are presented in Tables 5-14, 5-15, and 5-16.

Soil

The table below lists the chemicals that most likely were used at Site 9 (or their breakdown components), the residential PRG (EPA 2002a), the range of concentrations detected in soil at the site, and the sampling locations where the maximum concentration of each chemical was detected. It also lists chemicals not detected in soil but detected in groundwater at Site 9. Figure 5-2 shows the sampling locations.

Soil Analytical Results for Chemicals Used at Site 9			
Chemical	Residential PRG (mg/kg)	Range of Concentrations (mg/kg)	Sampling Location of Maximum Detected Concentration
1,1,1-TCA	1,200	Not Detected	Not applicable
1,1-DCA	2.8*	Not Detected	Not applicable
1,2-DCA	0.28	Not Detected	Not applicable
PCE	1.5	0.001 to 0.002	153-IW-002
Trichloroethylene	0.053	Not Detected	Not applicable
1,2-DCE (total)	43 (as cis-)	0.001 to 0.130	CPT-S09-10
Vinyl Chloride	0.079	Not Detected	Not applicable
1,2-Dichloropropane	0.34	Not Detected	Not applicable
1,2,3-Trichloropropane	120	Not Detected	Not applicable
Benzene	0.6	Not Detected	Not applicable
Ethylbenzene	8.9	0.002 to 0.200	B410-8
Toluene	520	0.002 to 0.730	B410-7
Xylene	270	0.002 to 3.100	CPT-S09-10

Soil Analytical Results for Chemicals Used at Site 9

Chemical	Residential PRG (mg/kg)	Range of Concentrations (mg/kg)	Sampling Location of Maximum Detected Concentration
Chromium	210	0.019 to 0.178	CPT-S09-07
Naphthalene	56	0.035 to 0.170	9S-CH3
Methylene chloride	9.1	0.002 to 0.007.7	9S-CH3
Phenol	37,000	0.042	B410-5

Note: Residential PRG is provided for reference only. Risks are quantified in the HHRA section of this document.

* Denotes California-modified PRG

The maximum concentration of PCE was detected in a soil sample collected near former IWTP 410 that was located in the northeastern portion of Site 9 (see Figure 5-4). The maximum concentration of 1,2-DCE was detected in soil collected from the southeastern portion of the site near storm sewer and industrial wastewater lines connected to IWTP 410 (see Figure 5-2). Concentrations of PCE and the breakdown component 1,2-DCE (total) were detected only in these areas. No other detections were reported for these chemicals, and vinyl chloride and TCE were not detected in soil at Site 9.

Maximum concentrations of BTEX were detected in soil in the eastern portion of Site 9. Benzene was not detected in soil at the site. The maximum concentration of toluene was collected east of the eastern storm sewer line, and the maximum concentrations of ethylbenzene and xylene were collected to the west of the eastern storm sewer line (see Figure 5-2).

Although phenol and chromium were used during site operations, concentrations of these chemicals were detected in soil at Site 9 significantly below their PRGs. The maximum concentration of chromium was detected in a sample collected near a floor drain within Building 410. Phenol was detected in a sample collected near a storm sewer line located to the north of Building 410; this storm sewer line is connected to the building.

Groundwater

The table below lists the chemicals that were most likely used at Site 9, the tap water PRG (EPA 2002a), the range of concentrations detected in groundwater at the site, and the sampling location of the maximum concentration detected. Figures 5-2 and 5-3 show the groundwater sampling locations at Site 9. Chlorinated hydrocarbon plumes in groundwater are presented on Figure 5-7.

Groundwater Analytical Results for Chemicals Used at Site 9

Chemical	Tap Water PRG (µg/L)	Range of Concentrations (µg/L)	Sampling Location of Maximum Detected Concentration
1,1,1-TCA	3,200	0.7 to 3	D09-01
1,1-DCA	2.0*	0.5 to 1,200	S09-DGS-DP02
1,2-DCA	0.12	0.5 to 0.7	S09-DGS-DP01

Groundwater Analytical Results for Chemicals Used at Site 9

Chemical	Tap Water PRG (µg/L)	Range of Concentrations (µg/L)	Sampling Location of Maximum Detected Concentration
PCE	0.66	0.7 to 3	MW410-3
TCE	0.028	0.7 to 22	SHP-S09-09
1,2-DCE (total)	61 (as cis-)	0.5 to 2,400	SHP-S09-10
Vinyl chloride	0.02	0.5 to 280	9-1
DCP	0.16	2	DHP-S09-09
1,2,3-TCP	30	0.3	MW410-2
Benzene	0.34	0.58 to 5.6	P-9-MWS-04
Ethylbenzene	2.9	0.5 to 150	9S-CH3
Toluene	720	0.2 to 230	DHP-S09-06
Xylene	210	2 to 1,200	SHP-S09-10
Chromium	110	0.51 to 350	MW410-3
Naphthalene	6.2	0.9 to 29,000	SHP-S09-10
Methylene chloride	4.3	0.58 to 7.3	9-3
Phenol	22,000	7 to 59	S09-DGS-DP05

Note: Residential PRGs are provided for reference only. Risks are quantified in the HHRA section of this document.

DCP 1,2-dichloropropane

TCP 1,2,3-trichloropropane

Although 1,1,1-TCA was historically used in large quantities inside of Building 410, it was detected in only 2 of 159 groundwater samples at D09-01 and storm sewer sample 3J in 1995. It is likely that this compound chemically degraded into 1,1-DCA and 1,1-DCE. Of the 159 samples analyzed for 1,1,1-TCA, 133 contained less than the laboratory detection limit of 1 µg/L or lower. The detection limit for 22 of the 159 samples was 5 µg/L or lower.

1,1-DCA, a breakdown component of TCA, likely entered groundwater between 1958 and 1990 through leaks in the storm sewer and sanitary sewer lines, which were connected to Building 410. Groundwater samples from beneath Site 9 contained concentrations of 1,1-DCA (see Figure 5-8 and Table 5-17), suggesting that parent products that were discharged to shallow groundwater through the storm sewer and sanitary sewer lines east of Building 410 transformed to 1,1-DCA as the contaminants migrated downward and southwest with groundwater.

Concentrations of 1,1-DCA appear highest in groundwater between 30 and 45 feet bgs, west of Building 410 as shown on Figure 5-9. Shallow groundwater west of Building 410 contains lower concentrations of 1,1-DCA, suggesting no sources of groundwater contamination west of Building 410. The highest concentration (1,200 µg/L) was detected in a sample collected at 35 feet bgs from Hydropunch location S09-DGS-DP02. Concentrations of 1,1-DCA decrease with depth to below the laboratory reporting limit of 1 µg/L at 78 feet bgs. This location is approximately 80 feet west of Building 410. Samples collected farther west and southwest have decreasing but detectable concentrations within the depth interval of 30 to 40 feet bgs. The downgradient limit of this contamination plume is defined by location S09-DGS-DP03, which is approximately 250 feet west-southwest of Building 410. In addition, 1,1-DCA was not detected

in samples collected from the storm drain bedding material downgradient from the suspected source area at Site 9 (S09-DGS-VE01). Planned remedial action by chemical injection is expected to reduce concentrations of 1,1-DCA in groundwater at Site 9 by chemically destroying the compound. Of the 158 samples analyzed for 1,1-DCA, 101 contained less than the laboratory detection limit of 1 µg/L or lower. Nine additional samples contained less than the laboratory detection limit of 5 µg/L or lower.

The maximum concentrations of PCE, TCE, 1,2-DCE (total), and vinyl chloride were detected in groundwater in the area beneath or east of Building 410, adjacent to the storm sewer systems. The maximum concentrations of 1,1-DCA were detected within groundwater in the area west of and downgradient from Building 410. The compounds TCE, 1,2-DCE, and 1,1-DCA are likely breakdown components of 1,1,1-TCA and PCE, which were used in Building 410.

Groundwater samples from beneath Building 410 and west of the building contained concentrations of 1,1-DCE. This suggests that parent products discharged to shallow groundwater through the storm sewer and sanitary sewer lines east of Building 410 transformed to 1,1-DCE as the contaminants migrated downward and southwest with groundwater. This compound was detected at concentrations below the tap water PRG (EPA 2002a); however, its breakdown compound, vinyl chloride, is present at the same locations as 1,1-DCE, indicating that natural attenuation is occurring. Of the 159 samples analyzed for 1,1-DCE, 117 contained less than the laboratory detection limit of 1 µg/L or lower. Twenty-three additional samples contained less than the laboratory detection limit of 10 µg/L or lower.

DCP and TCP were detected in only one sample. DCP was detected east of Building 410 and TCP beneath Building 410. TCP was detected at a concentration below the PRG.

BTEX in groundwater may be the result of paint stripping activities at Building 410, petroleum releases associated with aircraft defueling, or the current tenant. The maximum concentrations of benzene, toluene, and xylene were detected in groundwater samples collected in the area beneath or east of Building 410, near the storm sewer systems. Of the 63 samples analyzed for toluene, 57 contained less than the laboratory detection limit of 5 µg/L or lower.

Dissolved chromium was detected at concentrations above the PRG of 110 µg/L for total chromium in groundwater collected near a storm sewer in the northern portion of the site.

Phenol was detected in groundwater beneath Building 410 at concentrations below the PRG of 22,000 µg/L.

Methylene chloride was detected at concentrations that exceed the PRG; however, there is no discernable pattern in the distribution and concentrations. Methylene chloride was detected in 40 of the 159 groundwater samples analyzed for methylene chloride; however, it was also present in the method blank ("B" qualified) for all of these samples. Only two of these samples (design data points 9-3 and 9S-CH2) contained methylene chloride at concentrations greater than the PRG. Design data points were not validated and therefore not included in the risk assessments.

Of the groundwater samples not detected for methylene chloride, only 15 had laboratory detection limits greater than the PRG of 4.3 µg/L. Of these 15 elevated detection limits, 11 were at 10 µg/L or less and 8 were 5 µg/L or less.

Remedial efforts under a CERCLA non-time-critical removal action are addressing dissolved phase chlorinated solvents in groundwater. The results of the shallow pilot test indicated that concentrations of trimethylbenzene, vinyl chloride, benzene, 1,1-DCA, and 1,2-DCE in shallow groundwater were effectively reduced.

5.4.3 Risk Drivers

Although numerous chemicals were detected at Site 9, most of the chemicals do not pose significant risk as defined by the risk assessments. As a result, the purpose of this section is to further characterize the nature and extent of CERCLA chemicals driving risk at Site 9 that are not background. Selection of these chemicals was based on the background comparison for metals and results of the HHRA and ERA. Based on the HHRA, arsenic was identified as a risk driver in soil and 1,2-DCP, 2-methylnaphthalene, 4-methylphenol, 1,2,3-trichloropropane, antimony, arsenic, benzene, manganese, naphthalene, PAHs, PCE, PCP, TCE, and vinyl chloride were identified as risk drivers in groundwater. No chemicals were determined to pose risk to terrestrial ecological receptors. Arsenic in soil and antimony and arsenic in groundwater are attributed to background, so the nature and extent of these metals was not evaluated further.

5.4.3.1 Risk Drivers in Soil

No risk drivers were identified for soil.

5.4.3.2 Risk Drivers in Groundwater

The following discussions focus on the nature and extent of 1,2-DCP; 2-methylnaphthalene, 4-methylphenol, 1,2,3-trichloropropane; benzene; manganese; naphthalene; PAHs; PCE; PCP; TCE; and vinyl chloride in groundwater. 1,2 DCE is discussed because it is a breakdown component of the chemicals identified as risk drivers. TCA is discussed because it is a parent compound of risk drivers.

PAHs

The following five PAH compounds were detected in grab groundwater samples collected from borings (S09-DPS-01 through S09-DPS-05) at Site 9:

- BaP (between 0.3 to 2.5µg/L)
- Benzo(a)anthracene (0.1 to 1 µg/L)
- Benzo(b)fluoranthene (0.2 to 2 µg/L)

- Benzo(k)fluoranthene (0.1 to 0.8 µg/L)
- Indeno(1,2,3-cd)pyrene (0.2 to 1 µg/L)

Their detections in groundwater possibly are attributable to the Hydropunch sampling methodology that was used at Site 9 because they are almost insoluble in water. These compounds could also be associated with releases of fuel because they are within a larger groundwater contamination plume of VOCs.

TCA

Several chlorinated hydrocarbons were detected in groundwater at Site 9. TCA was detected only in one sample collected in 1995; however, its breakdown components, 1,1-DCA, DCE, and vinyl chloride, were detected in a number of groundwater samples. The presence of these breakdown components suggests that groundwater contamination releases occurred in the past. The location of the 1,1-DCA, 1,2-DCE, and vinyl chloride groundwater plumes is shown on Figure 5-7.

PCE

PCE was historically used in Building 410 (see Figure 5-12). This compound entered groundwater through leaks in the storm sewer and sanitary sewer lateral lines. PCE was detected in 2 of 159 samples at Site 9. The highest concentration of PCE was detected in a sample collected south of Building 410 at well MW410-3 in 2001. PCE was detected in one other groundwater sample collected at this location in 1995. Of the 159 samples analyzed for PCE, 12 contained less than the laboratory detection limit of 0.5 µg/L and 120 contained less than the laboratory detection limit of 1.0 µg/L. Twenty-six additional samples had laboratory detection limits of 2.0 µg/L or greater.

TCE

TCE was not detected in samples collected from the storm sewer line bedding downgradient from the suspected source area at Site 9. TCE was detected in four of 159 samples at Site 9. The highest concentration of TCE was detected in a sample collected beneath Building 410 (SHP-S09-09). Detectable concentrations of TCE were present in samples from wells MW410-2 and MW410-3 in 2002 and 2001. Planned remedial actions by chemical injection are expected to reduce concentrations of TCE in groundwater at Site 9. Of the 159 samples analyzed for TCE, 136 contained less than the laboratory detection limit of 1.0 µg/L. Seventeen additional samples contained less than the laboratory detection limit of 2.0 µg/L.

1,2-DCE

1,2-DCE is a breakdown component of other chlorinated solvents, such as PCE and TCE, that historically were used in Building 410 that entered the groundwater through leaks in the storm

sewer and sanitary sewer lines. In 1994, the compound was detected in two grab groundwater samples collected near storm sewer lateral lines east of the building at concentrations of 400 and 2,400 µg/L. Monitoring well data from MW410-2, located west of the building, show that concentrations of 1,2-DCE are increasing as the groundwater moves west beneath the building (see Table 5-18). 1,2-DCE was not detected in grab groundwater samples collected during the 2001 data gaps sampling effort down gradient from Building 410. In addition, 1,2-DCE was not detected in samples collected from the storm drain bedding material downgradient from the suspected source area at Site 9 (S09-DGS-VE01). The groundwater plume appears to be delineated as shown on Figure 5-10 and on Figure 5-11. Planned remedial actions by chemical injection are expected to reduce concentrations of 1,2-DCE in groundwater at Site 9. Of the 159 samples analyzed for 1,2-DCE, 117 contained less than the laboratory detection limit of 1 µg/L or lower. Twenty additional samples contained less than the laboratory detection limit of 5 µg/L or lower.

Vinyl Chloride

Vinyl chloride is a breakdown component of 1,1-DCE, 1,2-DCE, and other chlorinated solvents such as TCA, TCE, and PCE, that historically were used in Building 410 that entered groundwater through leaks in the storm sewer and sanitary sewer lines. Vinyl chloride was not detected in samples collected from the storm sewer line bedding downgradient from the suspected source area at Site 9. The highest concentrations of vinyl chloride were detected near storm sewer lateral lines east of Building 410 (see Table 5-19). The plume extends toward the west and is detectable at location S09-DGS-DP09 at depths between 30 and 45 feet bgs (coincident with detected concentrations of 1,1-DCE). Farther west, the plume is defined horizontally at locations S09-DGS-DP10, DP11, and S09-DGS-DP03 (see Figure 5-12) and is defined vertically in deeper samples at location S09-DGS-DP09, as shown Figure 5-13. Planned remedial actions by chemical injection are expected to reduce concentrations of vinyl chloride in groundwater at Site 9. Of the 159 samples analyzed for vinyl chloride, 59 contained less than the laboratory detection limit of 0.5 µg/L. Fifty-one additional samples contained less than the laboratory detection limit of 1 µg/L.

1,2,3-TCP

The solvent 1,2,3-TCP was likely used during paint stripping and other activities at Building 410. It has been detected above the laboratory reporting limit only in 1 of 56 groundwater samples collected at Site 9 at a concentration of 0.3 µg/L. This sample was collected from monitoring well MW410-2 in 2002 (see Figure 5-2). The 55 other groundwater samples had laboratory detection limits of 5 µg/L or less.

Naphthalene and 2-Methylnaphthalene

Naphthalene was detected in groundwater in the vicinity of Building 410 and the associated storm sewers. Naphthalene was likely used as paint stripper or parts cleaner inside Building 410 and entered the groundwater through leaks in the storm sewer and sanitary sewer lines.

Concentrations of naphthalene are highest east of Building 410, in the vicinity of the storm drain lateral system (see Figure 5-14). Concentrations of naphthalene are below laboratory detection limits west of Building 410 (see Table 5-20). The extent of naphthalene contamination in groundwater is defined (see Figure 5-14). Samples collected from the storm drain bedding material downgradient (S09-DGS-VE01) from the suspected source area are below detection limits. Planned remedial actions by chemical injection are expected to reduce concentrations of naphthalene in groundwater at Site 9 under a CERCLA non-time critical removal action. Of the 96 samples analyzed for naphthalene as a VOC, 62 contained less than the laboratory detection limit of 5 µg/L or lower. Detection limits for naphthalene as an SVOCs were higher, with 28 of 102 samples containing less than the laboratory detection limit of 5 µg/L and an additional 57 samples containing less than the laboratory detection limit of 10 µg/L.

Of a total of 70 groundwater samples, 2-methylnaphthalene was detected in only four samples (SHP-S09-08, SHP-S09-09, SHP-S09-10 and DHP-S09-06) (see Figure 5-2). This compound is collocated with naphthalene and was detected in only a few samples.

4-Methylphenol

Of a total of 70 groundwater samples, 4-methylphenol was detected in one sample (SHP-S09-07), and was collocated with naphthalene.

PCP

In addition to the risk drivers discussed above, PCP was identified as a risk driver in groundwater in the HHRA but was detected only in 2 of 70 groundwater samples (SHP-S09-09 and DHP-S09-10) collected at Site 9 (see Figure 5-2). The laboratory detection limits for PCP were greater than the PRGs but were consistent with CLP standards. PCP is used in pesticides and as a wood preservative. There are no documented uses of PCP at Site 9.

1,2-Dichloropropane

The solvent 1,2-DCP was detected in 1 of 119 groundwater samples collected at Site 9 at a concentration of 2 µg/L. 1,2-DCP was present in grab groundwater samples from location DHP-S09-09 (see Figure 5-2). Of the 119 samples analyzed for 1,2-DCP, 86 contained less than the laboratory detection limit of 1.0 µg/L. An additional 38 samples contained less than the laboratory detection limit of 2 µg/L. 1,2-DCP is mainly used in production of polystyrene and latex.

Benzene

Several compounds associated with petroleum fuels (BTEX and trimethylbenzenes) have been detected in groundwater around Building 410 and the associated storm sewers. These compounds may be associated with paint stripping and historical aircraft defueling activities and may have entered into the groundwater through storm sewers.

Low concentrations of benzene have been detected east of and beneath Building 410 in the vicinity of the storm sewer systems (see Figure 5-15). The extent of benzene is limited to the area east and beneath the building or immediately adjacent to the storm sewer lateral lines west of the building. Samples collected from the storm drain bedding material downgradient (S09-DGS-VE01) from the suspected source area are below detection limits. Planned remedial actions by chemical injection are expected to reduce the benzene plume at Site 9 under a CERCLA non-time-critical removal action. Of the 159 samples analyzed for benzene, 45 contained less than the laboratory detection limit of 0.6 µg/L or lower. Eighty additional samples contained less than the laboratory detection limit of 1 µg/L.

Manganese

Although no documented use of manganese at Site 9 exists, the presence of reducing conditions at the site may contribute to the elevated presence of manganese. Manganese has been detected at concentrations above laboratory detection limits in 68 of 71 groundwater samples collected at Site 9. Detected concentrations range from 4.8 to 18,600 µg/L. Twenty-seven of the samples contained concentrations of manganese greater than the tap water PRG of 880 µg/L (EPA 2002a).

5.5 FATE AND TRANSPORT

The objective of this evaluation is to assess whether chemicals driving risk at Site 9 (1) have migrated or degraded, (2) are being released from a continuing source of contamination, and (3) are likely to be distributed by groundwater or along other potential pathways. No chemicals were identified as driving risk in soil. PAHs, PCE, TCE, vinyl chloride, 1,2,3-trichloropropane, naphthalene, 2-methylnaphthalene, 2-methylphenol, PCP, 1,2-DCP, benzene, and manganese are driving risk in groundwater.

Groundwater flows west-southwest at Site 9 at gradients between 0.0015 and 0.0035. Hydraulic conductivity has been measured using several methods at Site 9 and ranges from 0.14 feet per day and 2.7 feet per day. Of all the groundwater plumes discussed below, the VOC 1,1-DCA has migrated the farthest west in groundwater and is approximately 550 feet southwest of the storm and sanitary sewer lines from which it was most likely released.

5.5.1 PAHs in Groundwater

Five PAH compounds with low solubility in groundwater (BaP, benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-cd]pyrene) may be present in groundwater at Site 9. Their detections possibly are attributable to the Hydropunch sampling methodology that was used at Site 9 because they are almost insoluble in water. The PAHs may also be associated with petroleum fuels or the marsh crust. PAHs degrade extremely slowly in the environment and bind to organic matter in soil. In addition, they are almost insoluble in water; therefore, they exhibit low potential for migration. The PAHs found at Site 9 likely will

remain in their present state (Agency for Toxic Substances and Disease Registry [ATSDR] 1995a).

5.5.2 VOCs in Groundwater

The primary source of groundwater contamination at Site 9 has been removed with the cessation of paint stripping activities at Building 410. Chlorinated hydrocarbons released at Site 9 can degrade according to one of the pathways depicted on Figure 5-16. Historical records show that 1,1,1-TCA used in Building 410 during the paint stripping activities was discharged to storm sewer lines and later to the sanitary sewer lines to IWTP 410. No TCA has been detected in soil or groundwater at the site; however, compounds known to be “daughter” or breakdown components of TCA have been detected. When TCA degrades, it transforms into 1,1-DCA and to a lesser extent, 1,1-DCE. The primary daughter product, 1,1-DCA, is found both in the release area east of Building 410 and extending toward the west with groundwater flow. Concentrations of 1,1-DCA are increasing slightly at MW410-2 on the west side of Building 410, signifying that it is migrating west from the release area east of Building 410. This compound will eventually transform into chloroethane, acetic acid, carbon dioxide, and water. The other daughter compound from degradation of TCA is 1,1-DCE, which is detected in concentrations below the PRG only in points west of Building 410. This indicates that TCA has transformed in an abiotic fashion as it migrated westward with groundwater. This compound, 1,1-DCE, will continue to transform to vinyl chloride, which is also present west of Building 410. The Navy is currently conducting an interim removal action to address chlorinated hydrocarbons at Site 9.

Other compounds previously used at Site 9 for paint stripping or parts cleaning purposes include PCE and TCE, although no records specifically discuss their use at the site. Under anaerobic degradation conditions, PCE and TCE can transform into 1,2-DCE and vinyl chloride. Concentrations of 1,2-DCE and vinyl chloride are present in groundwater beneath Building 410, extending toward the west with groundwater flow. The source of this groundwater contamination has been removed with the cessation of paint stripping activities at Building 410. The Navy is conducting an interim removal action to address chlorinated hydrocarbons at Site 9.

5.5.3 Naphthalene in Groundwater

Naphthalene has relatively low mobility and is present near the storm sewer piping east of Building 410 and below Building 410. Naphthalene is not present downgradient of Building 410. Planned remedial actions for Site 9 should significantly reduce the remaining concentrations of naphthalene. Residual naphthalene concentrations are expected to decrease further by natural degradation processes.

5.5.4 PCP in Groundwater

The presence of PCP is uncertain based on detection frequency and laboratory detection limits. There are no known sources of this compound at Site 9. PCP can be found in two forms: PCP itself, or as the sodium salt of PCP. The sodium salt dissolves easily in water, but PCP does not.

The physical and chemical properties of the compound suggest it likely will not evaporate into the atmosphere and that most PCP will move with water and generally adhere to soil particles. Movement of PCP in soils depends on the soil's acidity. PCP lasts for hours to days in air, soil, and surface water. The compound is broken down by microorganisms in soil and surface water to other compounds, some of which may be harmful to humans (ATSDR 1995a).

5.5.5 Benzene in Groundwater

Benzene, along with other TPH components ethylbenzene, xylene, and trimethylbenzene, is present in the area east of Building 410 near the storm drain piping. These compounds may have entered groundwater as a result of paint stripping activities within the building, or they may be the result of petroleum releases associated with aircraft defueling or the current tenant. Planned remedial actions by chemical injection are expected to reduce concentrations of chemicals at Site 9 or transform chemicals to compounds less toxic in nature. It is likely that this planned remediation will reduce the concentrations of these compounds or destroy them completely. Any remaining residual concentrations will be addressed by natural attenuation.

5.6 HHRA

A summary of the HHRA methodology is presented in Section 3.4.6. The summary includes details pertaining to selection of the data set, selection of COPCs, the exposure assessment, the toxicity assessment, and the risk characterization. Additional detailed information is provided in the HHRA (see Appendix H).

Various data were used to characterize risk at Site 9. These data included soil samples, groundwater samples from wells, grab groundwater samples where necessary, and soil gas samples. Grab groundwater samples collected from 1994 to 2001 were the only groundwater data available in the area of the suspected source (the storm and sanitary sewer lines). The Navy is currently conducting an interim removal action to reduce the concentrations of chlorinated hydrocarbons in the area of the sewer lines.

Noncancer health hazards and cancer risks calculated for Site 9 media are summarized in this section on a media-by-media basis, including surface soil, subsurface soil, soil gas and groundwater (vapor intrusion pathways), and groundwater (domestic use pathways). As noted in Section 3.4.6, the following receptors were evaluated in the HHRA: current/future commercial/industrial worker, future construction worker, future hypothetical resident, future construction worker intrusive exposure scenario (deep soil 0 to 8 feet bgs), and future hypothetical resident intrusive exposure scenario.

The total RME carcinogenic risks and noncancer HIs for Site 9 are summarized in Table 5-21. The total CTE cancer risks and noncancer HIs for Site 9 are summarized in Table 5-22. Risk for each media and pathway is presented in the tables.

5.6.1 Risks from Soil

Commercial/industrial and construction worker scenarios are considered the most likely exposure scenarios. For soil, all results are based on the current/future industrial worker scenario. The highest total RME carcinogenic risk (including background) is below **4E-06**, which is within the risk management range of 1E-06 to 1E-04. The total RME HI (including background) is **0.07**, which is less than the risk management HI of 1 for noncarcinogens. The RME risk results are summarized on Table 5-21 and detailed in Appendix H. The highest total CTE carcinogenic risk (including background) is below **1E-07**, which is less than the risk management range of 1E-06 to 1E-04. The total CTE HI (including background) is **0.004**, which is less than the risk management HI of 1. The CTE risk results are summarized on Table 5-22 and detailed in Appendix H.

The residential scenario is considered the most conservative estimate of risk. Soil data were aggregated in depth intervals of 0 to 2 feet bgs (surface soil) and 0 to 8 feet bgs (subsurface soil). For surface soil, using the residential scenario, the total RME carcinogenic risk (including background) is **3E-05**, which is within the risk management range of 1E-06 to 1E-04. The total RME HI (including background) is **0.4**, which is less than the risk management HI of 1 (see Table 5-21). Compound-specific risk values are presented in a table in Section 5.6.3. Arsenic is the only risk driver identified for surface soil under the residential scenario. No noncancer risk drivers were identified for surface soil under the residential scenario.

For surface soil, using the residential scenario, the total CTE carcinogenic risk (including background) is **3E-06**, which is within the risk management range of 1E-06 to 1E-04. The total CTE HI (including background) is **0.06**, which is less than the risk management HI of 1 (see Table 5-22).

For subsurface soil (0 to 8 feet bgs), using the intrusive residential scenario, the total RME carcinogenic risk (including background) is **3E-05**, which is within the risk management range of 1E-06 to 1E-04. The total RME HI (including background) is **0.3**, which is less than the risk management HI of 1. Arsenic is the only risk driver identified for subsurface soil under the residential scenario. No noncancer risk drivers were identified for subsurface soil under the residential scenario.

The total CTE carcinogenic risk (including background) for subsurface soil is **4E-06**, which is within the risk management range of 1E-06 to 1E-04. The total CTE HI (including background) is **0.07**, which is less than the risk management HI of 1. Tables 5-21 and 5-22 present the RME and CTE risks for each subsurface soil pathway.

Soil risks are primarily attributed to arsenic. Arsenic at Site 9 is attributed to background. Concentrations of arsenic at the site are similar to concentrations of arsenic in the background soil data set.

Lead was not selected as a COPC in soil at Site 9. The maximum detected concentration of lead in surface and subsurface soil at Site 9 is 10.4 mg/kg, which is less than the California-modified residential PRG for lead of 150 mg/kg (EPA 2002a). This suggests that no receptor would have unacceptable blood lead levels due to exposure to soils (that is, there is a low potential for unacceptable effects).

5.6.2 Risks from Groundwater

The groundwater pathway for construction worker receptors was not considered complete; therefore, groundwater was not evaluated for this scenario. Groundwater was evaluated for the commercial/industrial and residential scenarios.

Only inhalation of vapors from groundwater in indoor air was evaluated for the commercial/industrial scenario. The total RME carcinogenic risk (including background) for the commercial/industrial scenario is **5E-06**, which is within the risk management range. The total RME HI (including background) is **0.03**, which is less than the risk management HI of 1 for noncarcinogens. The total CTE carcinogenic risk (including background) for the commercial/industrial scenario is **2E-08**, which is less than the risk management range. The total CTE HIs (including background) is **0.0009**, which is less than the risk management HI of 1.

For groundwater, using the residential scenario, the total RME carcinogenic risk (including background) is **3E-03**, which exceeds the risk management range. The total RME HI (including background) is **130**, which is significantly higher than the risk management HI of 1. Compound-specific risk values are presented in a table in Section 5.6.3. Carcinogenic and noncancer drivers for groundwater are as follows:

- 1,2,3-Trichloropropane
- 1,3-DCP
- Antimony
- Benzene
- Benzo(k)fluoranthene
- Manganese
- Tetrachloroethene
- 1,2-DCE (total)
- 2-Methylnaphthalene
- Arsenic
- BaP
- Ethylbenzene
- Naphthalene
- Trichloroethene
- 1,2-DCP
- 4-Methylphenol
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Indeno(1,2,3-cd)pyrene
- Pentachlorophenol
- Vinyl chloride

The total CTE carcinogenic risk (including background) is **7E-04**, which exceeds the risk management range. The total CTE HI (including background) is **15**, which exceeds the risk management HI of 1 for noncarcinogens.

Table 5-21 presents the specific RME risk attributed to each groundwater pathway. Groundwater risk from arsenic is partially attributable to background concentrations of arsenic in groundwater. Carcinogenic risk from exposure to ambient arsenic concentrations from ingestion of groundwater was 4E-04; therefore, roughly one-half of the potential carcinogenic risk from

ingestion of arsenic in groundwater (8E-04) is attributable to ambient concentrations. Nevertheless, the total cancer risk not attributable to ambient arsenic concentrations is approximately 3E-03, which is greater than the risk management range of 1E-04 to 1E-06 for carcinogens. The HI from exposure to groundwater by domestic use is 130, which is greater than the risk management HI of 1 for noncarcinogens. Most of the HI (110) reflects ingestion and inhalation of 2-methylnaphthalene, naphthalene, and 4-methylphenol.

Lead was a groundwater (domestic use) COPC for Site 9, with a maximum concentration of 28.9 µg/L. The EPC derived for lead in groundwater was 5.8 µg/L, which is less than the EPA's treatment technique action limit (15 µg/L) for lead (EPA 2003b). Therefore, lead in groundwater at Site 9 will not be included in the FS.

5.6.3 HHRA Conclusions

Commercial/industrial and construction worker scenarios are considered the most likely exposure scenarios. The most conservative cancer risks for these two scenarios for soil and groundwater are within the risk management range. The most conservative HIs were less than 1 for soil and groundwater.

The tables below summarize the HHRA results for carcinogenic and noncancer risks under the residential scenario. The tables also list the risk drivers and their relative contributions to carcinogenic risk and the noncancer HI for exposure to soil and groundwater under the RME residential exposure scenario.

Site 9 Carcinogenic Risk, Residential Scenario Receptor: Potential Future Adult/Child		
Medium	Risk Drivers	RME Carcinogenic Risk
Surface Soil	Arsenic ^a	3E-05
Groundwater		
Vapor Intrusion	Vinyl Chloride	2E-04
	Benzene	3E-06
Domestic Use	BaP	1E-03
	Arsenic ^a	8E-04
	Vinyl chloride	7E-04
	Benzo(b)fluoranthene	1E-04
	TCE	9E-05
	PCP	1E-05
	Indeno(1,2,3-cd)pyrene	7E-05
	Benzo(a)anthracene	4E-05
	1,2,3-trichloropropane	1E-05
	PCE	3E-06
	1,2-dichloropropane (DCP)	2E-06
	Benzo(k)fluoranthene	2E-06
	Benzene	2E-06
	Ethylbenzene	2E-06

Site 9 Carcinogenic Risk, Residential Scenario Receptor: Potential Future Adult/Child		
Medium	Risk Drivers	RME Carcinogenic Risk
	1,3-Dichloropropane	1E-06
	Subtotal Risk (risk drivers only)^b:	3E-03
	Total Site Cancer Risk (all chemicals):	3E-03

Notes

- a Background, as discussed in Section 5.3.4 and Appendix A
b Risk drivers are compounds that individually pose greater than 1E-06 risk

Site 9 Noncancer Risk, Residential Scenario Receptor Potential: Future Adult/Child		
Medium	Risk Drivers	Noncancer HI
Soil	None	0.4
Groundwater	Naphthalene	66
	2-methylnaphthalene	23
	4-methyphenol	16
	Arsenic ^a	8
	Manganese	6
	TCE	3
	1,2-DCE compared to (Cis-)	3
	Antimony ^a	2
	Vinyl chloride	2
		Subtotal Risk (risk drivers only)^b:
	Total Site Noncancer Risk (all chemicals):	130

Notes:

- a Background, as discussed in Section 5.3.4 and Appendix A
b Risk drivers are compounds that individually have HI values greater than 1.0

The HHRA indicated that carcinogenic risk from exposure to soil is within the risk management range and that noncancer risk from soil is less than 1; furthermore, risk from soil is attributable to background concentrations of arsenic. The carcinogenic and noncancer risks for groundwater exceed the risk management range.

5.7 ERA

This section summarizes the results of the modified screening-level ERA conducted for Site 9 (see Appendix I). This modified screening-level ERA was conducted because this site has limited habitat and because site-specific ecological sampling to support a baseline ERA is not feasible. This ERA is intended to provide conservative estimates that incorporate more realistic exposure parameters for the ecological endpoints defined than would typically be used for a screening-level ERA.

The process used to conduct the modified screening-level ERA comprises the following components:

- Screening for COPECs
- Problem formulation
- Exposure estimates and risk evaluation
- Evaluation of assessment results

These components are summarized in the following sections.

5.7.1 Screening for COPECs

COPECs are organic and inorganic chemicals defined as potentially related to site activity and potentially causing adverse effects to ecological receptors. Evaluating site-specific data is the first step in quantifying risks and identifying potential hazards at each site. Data for the ERA were selected using the approach described in Section 3.4.7. Soil data for each site were aggregated at a depth interval of 0 to 4 feet bgs. Summaries of the soil data used for Site 9 are presented in Appendix I.

Groundwater at Site 9 was not assessed for the following two reasons: (1) groundwater was not expected to discharge to surface water, and (2) groundwater occurs at depths such that exposure to burrowing animals is expected to be minimal. The storm sewers at Site 9 were surveyed and contained concentrations of VOCs at least 2 orders of magnitude below the ecological risk values (Tetra Tech 2002a). For aquatic receptors, it is unlikely that contaminants in groundwater at Site 9 will reach surface water and affect ecological receptors because the site is approximately 900 feet from the Bay and the Seaplane Lagoon. Therefore, an exposure pathway for aquatic receptors was not considered complete.

Table 5-23 presents the data used to develop COPECs for Site 9. Chemicals detected in soil were subjected to a screening process to focus the ERA on chemicals related to site activity and that pose the greatest potential risk to ecological receptors. The screening was a sequential process that considered factors such as frequency of detection, spatial distribution of detected chemicals, statistical comparison to background concentrations for inorganic chemicals, and chemical properties such as bioaccumulation and toxicity. The COPEC approach is described in further detail in the approach Section 3.4.7.

5.7.2 Problem Formulation

Problem formulation represents the stage of the ERA process where the goals, breadth, and focus of the assessment are determined. The major goal of the problem formulation component is to develop an ecological CSM.

Current and reasonable future uses of the site were evaluated to determine the presence and potential future formation of habitat and to identify complete exposure pathways that might exist at the site. Ecological habitat capable of supporting significant wildlife is not currently present at Site 9; however, exposure pathways for terrestrial receptors were considered complete to provide a conservative estimate of risk. Using a fully exposed soil scenario, the following complete exposure pathways for Site 9 were evaluated:

- Direct exposure to soil
- Food chain exposure

Selected assessment and measurement endpoints for soil are presented in Section 3.4.7.

5.7.3 Exposure Estimates and Risk Evaluation

The exposure estimate and risk calculation step results in a conservative estimate of potential risk to the selected measurement endpoints. Using risk calculations, soil doses were compared to TRVs or ERVs to evaluate potential risks to each ecological receptor, and an HQ (a ratio that is indicative of potential risks to ecological receptors) was derived. HQ results for soil, using high and low TRVs, are presented in Table 5-24 and presented in detail in Appendix I.

5.7.4 Evaluation of ERA Results

High and low TRVs were used to provide a bounding estimate of risk to each endpoint. The high TRV represents an upper bounding limit, which is the lowest concentration where adverse effects are known to occur. The low TRV represents the lower bounding limit, which is the highest concentration an endpoint can be exposed to where adverse effects are known not to occur. If both HQ values for a chemical in soil were below 1.0, then the chemical is not considered to pose a potential for risk to ecological receptors. Metals with one or both bounding limit HQs exceeding 1.0 were further compared to calculate background HQs for metals in soil (see Table 5-25). Chemicals with HQs above 1.0 and above background concentrations were further evaluated based on each chemical's frequency of detection and distribution at the site, the range of concentrations detected, and its absorption potential and toxicity to each ecological receptor. This type of analysis provides additional weight-of-evidence data to support risk management decisions for each site.

5.7.4.1 Risk to Small Mammals

All soil COPECs were evaluated at Site 9 for small mammal populations (California ground squirrel is the measurement endpoint). Literature data were not adequate to develop an ERV for n-nitrosodiphenylamine and ethylbenzene for small mammals; therefore, these chemicals were evaluated qualitatively. This section briefly discusses the evaluation of risk to small mammals from COPECs that exceeded HQs of 1.0 as well as those that were qualitatively evaluated.

PCP and xylene had HQs above 1.0 using both the high and low TRVs. The high TRV HQ and low TRV HQ for PCP were 10.1 and 101, respectively. For xylene the high TRV HQ and low TRV HQ were 2.76 and 3.4, respectively. PCP was detected in only 1 of 13 samples considered for the ERA at a concentration of 0.43 mg/kg, which was below the maximum laboratory-reporting limit of 3.5 mg/kg. Xylene was detected in 5 of 21 samples at an EPC of 0.43 mg/kg, which was more than 3 times above the maximum laboratory reporting limit of 0.12 mg/kg. The toxicity of these compounds is generally seen only when receptors are exposed to high concentrations over a short time period. Long-term exposure to low concentrations is not well studied. However, the relatively high HQ values for these compounds are directly attributable to the conservative bioconcentration factors of the compound from the soil and into invertebrate receptors ($BCF_{\text{soil-to-invertebrate}}$) (EPA 1999d). These values were 1,034 and 29.84, respectively, for PCP and xylene and were calculated using the K_{ow} coefficient (EPA 1999d). This is a conservative method of calculating BCFs. Although the ecological risk of PCP and xylenes to small mammals cannot be discounted, it is expected to be low based on the low frequency of detection and low concentration of the compounds in soils at Site 9.

The qualitative evaluation of risk to small mammals from exposure to n-nitrosodiphenylamine and ethylbenzene involved assessing the weight-of-evidence parameters discussed in Section 3.4.7. Impact to small mammals from these chemicals is expected to be low based on the low detection of frequency and relatively low concentrations detected at Site 9 and because SVOCs and VOCs generally have toxic effects at higher doses.

5.7.4.2 Risk to Passerines

All soil COPECs were evaluated at Site 9 for passerine populations (Alameda song sparrow and the American robin are the measurement endpoints). Literature data were not adequate to develop avian ERVs for beryllium, high-molecular-weight (HMW) and low-molecular-weight (LMW) PAHs, n-nitrosodiphenylamine, PCP, 1,2-DCE, ethylbenzene, PCE, toluene, and xylene; therefore, these chemicals were evaluated qualitatively. This section briefly discusses the evaluation of risk to passerines from COPECs with HQs above 1.0 as well as those that were qualitatively evaluated.

Lead HQs for the Alameda song sparrow and the American robin using the high TRV for lead were below 1.0; however, the low TRV HQs for lead were 1.87 and 6.25, respectively. The HQ for the Alameda song sparrow and the American robin did not exceed the background low HQs of 2.71 and 9.07, respectively. Additionally, these HQ values may be driven by an overly conservative low TRV of 0.014 mg/kg-day, developed by the Navy and the EPA Region 9 BTAG and based on a study by Edens and others (1976). The study found measurable physiological effects on birds, but those effects may not be ecologically significant. When the HQ was calculated using an alternative TRV of 3.85 mg/kg-day developed by Oak Ridge National Laboratory (ORNL) for the U.S. Department of Energy (DOE), the lead HQ value was reduced significantly. This TRV was established based on a study by Pattee (1984), which administered inorganic lead to the avian receptor. Using an allometrically converted TRV of 36.6 mg/kg-day for song sparrows and 6.79 mg/kg-day for robins, reevaluation of the lead HQ at Site 9 was calculated as 0.00516 for the song sparrow, with a background HQ of 0.00748, and an

HQ of 0.0172 for the robin, with a background HQ of 0.025. Based on this information, lead at Site 9 does not appear to pose a significant potential for risk to passerines.

Literature data were not adequate to develop an ERV for avians for HMW and LMW PAHs, n-nitrosodiphenylamine, PCP, 1,2-DCE, ethylbenzene, PCE, toluene, and xylene. Studies indicated that PAH chemicals do not appear to bioaccumulate in mammals and birds (Eisler 1987a). Additionally, based on the relatively low frequency of detection and low concentration of PAHs and the SVOCs n-nitrosodiphenylamine and PCP, risk posed to passerines from these ecological COPECs is expected to be low. Residual levels of only 1,2-DCE, ethylbenzene, PCE, toluene, and xylene are present in soils at Site 9.

5.7.4.3 Risk to Raptors

All soil COPECs were evaluated at Site 9 for raptor populations (the red-tailed hawk is the measurement endpoint). Literature data were not adequate to develop avian ERVs for beryllium, HMW and LMW PAHs, n-nitrosodiphenylamine, PCP, 1,2-DCE, ethylbenzene, PCE, toluene, and xylene. All other COPECs evaluated at Site 9 were determined to pose no significant risk based on an HQ less than 1.0, using both the low and high TRVs. This section briefly discusses the evaluation of risk to raptors from COPECs with HQs above 1.0 as well as those that were qualitatively evaluated.

The high HQ value for lead was less than 1.0. The low HQ value was 15.1, which was less than the background HQ value of 21.9. Additionally, as discussed previously, the Navy believes that this HQ value may be driven by an inappropriately conservative low TRV. When HQs were calculated using the alternate allometrically converted TRV of 0.287, the HQ for lead at Site 9 was 0.0416, with a background HQ of 0.0603. Based on this information, lead at Site 9 poses no significant risk to raptors.

Literature data were not adequate to develop an ERV for raptors for HMW and LMW PAHs, n-nitrosodiphenylamine, PCP, 1,2-DCE, ethylbenzene, PCE, toluene, and xylene. Studies indicated that PAH chemicals do not appear to bioaccumulate in mammals and birds (Eisler 1987a). Additionally, based on the relatively low frequency of detection and low concentration of PAHs and the SVOCs n-nitroso-diphenylamine and PCP, risk posed to raptors from these ecological COPECs is expected to be low. Residual levels of only 1,2-DCE, ethylbenzene, PCE, toluene, and xylene are present in soils at Site 9.

5.7.5 Uncertainty

The screening-level ERA process involves a large number of uncertainties and extrapolations to evaluate potential risk to ecological receptors. Many of the assumptions in the screening-level ERA process are conservative and result in overestimates of site-specific parameters. Uncertainties associated with the ERA are identified in Section 3.4.7.5.

5.7.6 ERA Conclusions

Results of the HQ calculations and qualitative evaluations indicate that residual chemicals at Site 9 have very limited potential to impact terrestrial ecological receptors. Based on the HQ calculations and qualitative evaluations and the planned future use of the site, no risks to ecological receptors have been identified that require further evaluation or mitigation.

5.8 CONCLUSIONS AND RECOMMENDATIONS

The conclusions of the evaluations conducted in support of the CERCLA risk management process are presented in Sections 5.8.1 (nature and extent) and 5.8.2 (risk assessment), and the overall recommendations for Site 9 are presented in Section 5.8.3.

5.8.1 Nature and Extent Conclusions

The nature and extent evaluation concluded that most of the chemicals detected across Site 9 are consistent with historical activities (such as paint stripping and defueling) known to occur at the site. Physical features of Site 9, along with specific details on the hazardous waste generated and past disposal and storage practices associated with these wastes, were used to identify potential sources of CERCLA chemicals. Environmental investigations were conducted in these areas to identify and assess the extent of CERCLA chemicals in soil and groundwater, and the analytical results were evaluated. Of the potential sources the following physical features and site activities were considered likely sources at Site 9:

- Paint stripping within Building 410
- Releases of petroleum fuel from storage and defueling activities near Building 410
- Fill material containing PAHs

Most of the maximum detected concentrations of those chemicals related to paint stripping use (PCE and 1,2-DCE;) were located in soil near storm sewer and industrial wastewater connected to IWTP 410. BTEX components (toluene, ethylbenzene, and xylene) in soil were likely related to releases of petroleum fuel associated with defueling activities near Building 410. Maximum concentrations of toluene, ethylbenzene, and xylene were detected in soil in the eastern portion of the site; benzene was not detected in soil at the site.

Leaks in storm sewer and sanitary sewer lines around Building 410 are believed to be the source of solvents and VOCs (1,2,3-TCP; naphthalene; 2-methylnaphthalene; 1,1,1-TCA; 1,1-DCA; PCE, TCE, 1,2-DCE, and vinyl chloride) in groundwater at Site 9. Maximum concentrations in groundwater were detected beneath Building 410 and near storm and sanitary sewer lines, which were connected to Building 410. Storm sewer bedding material is not believed to be a source or pathway for contamination.

BTEX in groundwater may be the result of paint stripping activities at Building 410, petroleum releases associated with aircraft defueling, or the current tenant. The maximum concentrations of benzene, toluene, and xylene were detected in groundwater samples collected in the area beneath or east of Building 410, ancillary to the storm sewer systems.

The following five PAH compounds with low solubility were detected in direct-push groundwater samples at Site 9.

- BaP
- Benzo(a)anthracene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Indeno(1,2,3-cd)pyrene

Detections are within a larger groundwater VOC plume, and a discernable pattern is not present. Their presence in groundwater is likely attributed to the sampling methodology used or could also be associated with releases of fuel.

Although numerous chemicals were detected at Site 9, some of these chemicals do not pose significant risk as defined by the risk assessments. Significant risk to human health is potentially posed by arsenic in soil and by 1,2-DCP, 2-methylnaphthalene, 4-methylphenol, 1,2,3-TCP, antimony, arsenic, benzene, manganese, naphthalene, PAHs, PCE, PCP, TCE, and vinyl chloride in groundwater. No chemicals were determined to pose risk to terrestrial ecological receptors. Arsenic in soil and antimony and arsenic in groundwater are attributed to background concentrations that exist in the environment.

Data gaps for PCP, 1,2,3-TCP, and 1,2-DCP in groundwater were identified. PCP was detected in only 1 of 42 SVOC samples collected in soil at Site 9. The single result that identified PCP was qualified, indicating that PCP was present in the sample blank. Laboratory detection limits in nine of the samples analyzed for PCP exceeded the tap water PRG (EPA 2002a). 1,2,3-TCP was detected in 1 of 56 groundwater samples collected at the site at a concentration of 0.3 µg/L. The 55 other groundwater samples had laboratory detection limits of 5 µg/L or less. 1,2-DCP was detected in 1 of 119 groundwater samples at a concentration of 2 µg/L. Of the 119 samples, 86 samples contained less than the laboratory detection limit of 1.0 µg/L. An additional 38 samples contained less than the laboratory detection limit of 2 µg/L.

In addition, because detection limits were elevated in both soil and groundwater for some non-detected SVOCs, further sampling and analysis of soil and groundwater may be needed to confirm that these chemicals are not present in soil or groundwater. Because of elevated detection limits for some non-detected PAHs and VOCs in groundwater, further sampling and analysis of groundwater may be needed to confirm that these chemicals are not present in groundwater. A data gap for soil and groundwater associated with OWS-410A was identified. Although these data gaps were identified, it was determined that the types and numbers of

samples collected at Site 9 and the analytical suite were adequate to characterize the site and to conduct risk assessments because data collection at the site focused mainly on potential sources and was conducted in phases. This phased approach afforded stakeholders opportunities to provide feedback on the suitability or adequacy of the data collected and the need for additional data to identify releases and complete the RI report. There is a low potential that any source at Site 9 was not adequately evaluated or that NFA would be recommended if it poses a potential risk to human health or the environment.

5.8.2 Risk Assessment Conclusions

An HHRA and modified screening-level ERA were conducted to evaluate risk from chemicals detected at Site 9. The sections below present the conclusions for the HHRA and ERA, respectively.

5.8.2.1 HHRA Conclusions

According to reuse plans for Alameda Point (EDAW 1996), commercial/industrial and construction worker exposures are the most likely future exposures at Site 9. Human health risk was evaluated for commercial/industrial and construction worker exposures, along with residential exposures. The residential exposure scenario was evaluated to allow for flexibility in implementing the reuse plan (or modifications thereto) at Alameda Point, and because EPA risk assessment guidance (EPA 1989) includes a strong preference for evaluation of the residential pathway.

For the commercial/industrial and construction worker scenarios, the most conservative cancer risks for soil and groundwater are within the risk management range. The most conservative HIs were less than 1 for soil and groundwater.

The tables in Section 5.6.3 summarized the HHRA results for carcinogenic and noncancer risks under the residential scenario. Those tables also list risk drivers and their relative contributions to carcinogenic risk and the noncancer HI for exposure to soil and groundwater under the RME residential exposure scenario. For the residential scenario, the HHRA indicated that carcinogenic risk from exposure to soil is within the risk management range and that noncancer risk from soil is less than 1; furthermore, risk from soil is attributable to background concentrations of arsenic. The carcinogenic and noncancer risks for groundwater exceed the risk management range and are attributable to the following:

1,2,3-Trichloropropane	1,2-DCE (total)	1,2-DCP
1,3-DCP	2-Methylnaphthalene	4-Methylphenol
Antimony	Arsenic	Benzo(a)anthracene
Benzene	Benzo(a)pyrene	Benzo(b)fluoranthene
Benzo(k)fluoranthene	Ethylbenzene	Indeno(1,2,3-cd)pyrene
Manganese	Naphthalene	Pentachlorophenol
Tetrachloroethene	Trichloroethene	Vinyl chloride

Lead was not selected as a COPC in soil at Site 9. The maximum detected concentration of lead in surface and subsurface soil at Site 9 is 10.4 mg/kg, which is less than the California-modified residential PRG for lead of 150 mg/kg (EPA 2002a). This suggests that no receptor would have unacceptable blood lead levels due to exposure to soils (that is, there is a low potential for unacceptable effects).

5.8.2.2 ERA Conclusions

A site-specific ERA was conducted for Site 9 to estimate potential risks to the environment. Currently, ecological habitat capable of supporting significant wildlife is not present at Site 9; therefore, exposure pathways for terrestrial receptors were considered potentially complete to provide a conservative estimate of risk. Risk to marine receptors was not evaluated because exposure pathways for aquatic receptors were considered incomplete (see Section 5.3.1). Assessment endpoints include small mammals, passerines, and raptors.

Results of the HQ calculations and qualitative evaluations indicate that residual chemicals at Site 9 have very limited potential to affect terrestrial ecological receptors. Based on the HQ calculations and qualitative evaluations and the planned future use of the site, no risks to ecological receptors have been identified that require further evaluation or mitigation.

5.8.3 Recommendations

Based on the data and risk assessments discussed previously, soil and groundwater at Site 9 are recommended for further evaluation in an FS, as defined under CERCLA, to address risks to residential receptors under the unrestricted reuse scenario. Total site risk to residential receptors (including background) is above the risk management range. Arsenic in soil was identified as the only risk driver but is attributed to background; therefore, no chemicals of concern (COC) are identified for soil. COCs identified for groundwater are 1,2-DCP; 2-methylnaphthalene, 4-methylphenol, 1,2,3-TCP) benzene; manganese; naphthalene; PAHs; PCE; PCP; TCE; and vinyl chloride. Although antimony and arsenic were identified as groundwater risk drivers, they are attributed to background.

An evaluation of TPH in soil and groundwater also was conducted based on the TPH strategy for Alameda Point (Navy 2001a) (see Appendix F). Based on this evaluation, further action is not warranted under the TPH program for soil at Site 9; further action is warranted for groundwater at Site 9. TPH in groundwater is commingled with other CERCLA contaminants and should be further evaluated under the CERCLA program after the floating petroleum product is removed from the site.