

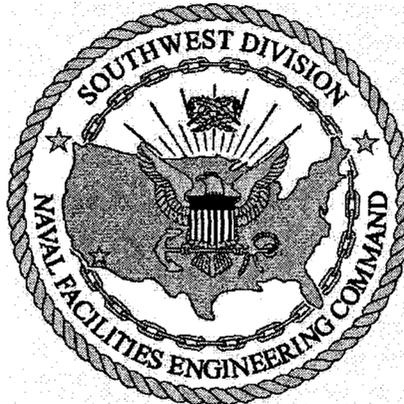
N00236.000307
ALAMEDA POINT
SSIC NO. 5090.3

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order No. 0386

Southwest Division
Naval Facilities Engineering Command
1220 Pacific Highway
San Diego, California 92132-5190

FINAL
INSTALLATION RESTORATION SITES 4 AND 5
DNAPL AND DISSOLVED SOURCE
NON-TIME CRITICAL REMOVAL ACTION
ACTION MEMORANDUM
ALAMEDA POINT, ALAMEDA, CALIFORNIA

December 7, 2001





TRANSMITTAL/DELIVERABLE RECEIPT

Contract No. N62474-94-D-7609

Document Control No. DS . 0386 . 15782

TO: Mr. Ron Fuller, Code 02R1.RF
Contracting Officer
Naval Facilities Engineering Command
Southwest Division
1230 Columbia Street, Suite 1100
San Diego, CA 92101-8517

DATE: 12/10/01
CTO: 0386
LOCATION: Alameda Point, California

FROM: Daniel Chow, Program Manager

DOCUMENT TITLE AND DATE:

Final Installation Restoration Sites 4 and 5, DNAPL and Dissolved Source
Non-Time Critical Removal Action, Action Memorandum
December 7, 2001

TYPE: [] Contractual Deliverable [x] Technical Deliverable (DS) [] Other (TC)

VERSION: Final REVISION #: NA
(e.g., Draft, Draft Final, Final)

ADMIN RECORD: Yes [x] No [] CATEGORY: Confidential []

SCHEDULED DELIVERY DATE: 12/07/01 ACTUAL DELIVERY DATE: 12/10/01

NUMBER OF COPIES SUBMITTED TO NAVY: O/5C/5E
O = original transmittal form
C = copy of transmittal form
E = enclosure

COPIES TO: (Include Name, Navy Mail Code, and Number of Copies)

Table with columns: NAVY, TtEMI, OTHER. Rows include G. Clark (06CAGC), Diane Silva (05G.DS)*, M. McClelland (06CAMM).

Date/Time Received

CONTENTS

<u>Section</u>	<u>Page</u>
LIST OF APPENDICES, FIGURES AND TABLES	iii
ABBREVIATIONS, ACRONYMS, AND SYMBOLS	iv
1.0 PURPOSE	1
2.0 SITE CONDITIONS AND BACKGROUND INFORMATION	2
2.1 SITE DESCRIPTION	2
2.1.1 Removal Site Evaluation	2
2.1.2 Physical Location	2
2.1.3 Site Characteristics	9
2.1.4 Release or Threatened Release into the Environment of Contaminants of Concern	11
2.1.5 National Priorities List Status	13
2.2 ACTIONS CONDUCTED TO DATE	13
2.2.1 Previous Actions	13
2.2.2 Current Activities	14
2.3 NAVY, FEDERAL, STATE, AND LOCAL AUTHORITIES ROLES	15
2.3.1 Navy Role	15
2.3.2 Federal, State, and Local Authority Role	15
3.0 THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT AND STATUTORY AND REGULATORY AUTHORITIES	16
3.1 THREATS TO PUBLIC HEALTH OR WELFARE	16
3.2 THREATS TO THE ENVIRONMENT	17
4.0 ENDANGERMENT DETERMINATION	19
5.0 PROPOSED ACTION AND ESTIMATED COSTS	21
5.1 PROPOSED REMOVAL ACTION	21
5.1.1 Proposed Removal Action Description	21
5.1.2 Contribution to Remedial Performance	22
5.1.3 Description of Alternatives	23
5.1.4 Engineering Evaluation and Cost Analysis	23
5.1.5 Applicable or Relevant and Appropriate Requirements	24
5.1.6 Project Schedule	31
5.2 ESTIMATED COSTS	32

CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
6.0 EXPECTED CHANGE SHOULD REMOVAL ACTION BE DELAYED OR NOT TAKEN....	34
7.0 PUBLIC INVOLVEMENT.....	35
8.0 OUTSTANDING POLICY ISSUES	36
9.0 RECOMMENDATIONS	37
REFERENCES.....	38

APPENDICES

- A Engineering Evaluation/Cost Analysis
- B Administrative Record Leading up to the Removal Action
- C Exposure to Volatilized Chemicals in Groundwater - IR Site 5 Risk Calculations
- D ARAR Correspondence
- E Response to Comments

FIGURES

Figure

- 2-1 OPERABLE UNITS AND INSTALLATION RESTORATION SITES
- 2-2 INSTALLATION RESTORATION SITE 4 FEATURES
- 2-3 INSTALLATION RESTORATION SITE 5 FEATURES
- 2-4 INSTALLATION RESTORATION SITE 4 POTENTIAL DNAPL AND SOURCE REMOVAL ACTION AREAS
- 2-5 INSTALLATION RESTORATION SITE 5 POTENTIAL DNAPL AND SOURCE REMOVAL ACTION AREAS

TABLES

Table

- 2-1 INSTALLATION RESTORATION SITE 4 HISTORICAL OPERATIONS
- 2-2 INSTALLATION RESTORATION SITE 5 HISTORICAL OPERATIONS
- 2-3 GROUNDWATER TREATMENT AREAS ADDRESSED FOR INTERIM REMOVAL ACTION
- 2-4 INSTALLATION RESTORATION SITE 4 PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
- 2-5 INSTALLATION RESTORATION SITE 5 PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
- 4-1 RISKS ASSOCIATED WITH INSTALLATION RESTORATION SITES 4 AND 5
- 5-1 INSTALLATION RESTORATION SITES 4 AND 5 COMPARATIVE ANALYSIS OF ALTERNATIVES
- 5-2 INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
- 5-3 INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
- 5-4 INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

µg/L	Microgram per liter
AM	Action memorandum
ARRA	Alameda Reuse and Redevelopment Authority
ARAR	Applicable or relevant and appropriate requirement
BAAQMD	Bay Area Air Quality Management District
Bay Area	The San Francisco Bay Area
Bay Plan	San Francisco Bay Plan
BCDC	San Francisco Bay Conservation and Development Commission
BCT	Base Realignment and Closure Cleanup Team
BERC	Berkeley Environmental Restoration Center
bgs	Below ground surface
BRAC	Base Realignment and Closure
CAA	Clean Air Act
Ca-HSC	California Health and Safety Code
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	Chemical of concern
CZMA	Coastal Zone Management Act
DCA	Dichloroethane
DCE	Dichloroethene
DNAPL	Dense nonaqueous phase liquid
DTSC	California Environmental Protection Agency Department of Toxic Substances Control
EE/CA	Engineering evaluation and cost analysis
EBS	Environmental baseline survey
EFW	Einarson, Fowler, and Watson
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FS	Feasibility study
IR	Installation restoration
IT	International Technology Corporation
LDR	Land disposal restriction
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
NAAQS	National Ambient Air Quality Standards
NAS	Naval Air Station
Navy	Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
O&M	Operations and maintenance
OU	Operable unit
POTW	Publicly owned treatment works
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation

ABBREVIATIONS, ACRONYMS, AND SYMBOLS (Continued)

ROD	Record of decision
RWQCB	San Francisco Bay Regional Water Quality Control Board
SDWA	Safe Drinking Water Act
SIP	State implementation plan
SPH	Six-phase heating
SVE	Soil vapor extraction
SWDIV	Southwest Division, Naval Facilities Engineering Command
TBC	To be considered
TCA	Trichloroethane
TCE	Trichloroethene
TCLP	Toxicity characteristic leaching procedure
TtEMI	Tetra Tech EM Inc.
USC	U.S. Code

1.0 PURPOSE

The purpose of this action memorandum (AM) is to document, for the Administrative Record, the Department of the Navy's (Navy) decision to undertake a non-time-critical removal action (NTCRA) for chemicals of concern (COCs) in groundwater at Installation Restoration (IR) Sites 4 and 5, Alameda Point, Alameda, California. The COCs at IR Sites 4 and 5 are chlorinated solvents, which are dissolved in groundwater at concentrations high enough to indicate that they may be present as a dense nonaqueous phase liquid (DNAPL). The Department of Defense has the authority to undertake Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions, including removal actions, under 42 U.S.C. Section 9604, 10 U.S.C. Section 2705 and federal Executive Order (EO) 12580. Further, this removal action is consistent, to the maximum extent possible, with Chapter 6.8 of the California Health and Safety Code (Ca-HSC).

The proposed removal action will remove COCs from the subsurface by heating the soil and groundwater with electricity, causing the COCs to vaporize, which will then be collected using a soil-vapor extraction (SVE) system. The proposed action will substantially eliminate the identified pathways of exposure to COCs for potential receptors, including future residents, site and construction workers, base personnel, and ecological receptors. The proposed action is not anticipated to be a final remedy for IR Sites 4 and 5; further investigation and responses are expected at both of these sites.

The proposed removal action is deemed consistent with: (1) the factors set forth within the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) 40 Code of Federal Regulations [CFR], Part 300, and (2) Chapter 6.8 Ca-HSC.

2.0 SITE CONDITIONS AND BACKGROUND INFORMATION

This section describe IR Sites 4 and 5, the actions conducted at these sites to date, and the respective roles of the Navy and Federal, state, and local authorities. The information presented in this section was derived from various sources, including the draft Operable Unit (OU) -2, Remedial Investigation (RI) report (TtEMI 1999) and the Environmental Baseline Survey (EBS) (International Technology Corporation [IT] 1998). Tables cited appear at the end of this section.

2.1 SITE DESCRIPTION

The following sections summarize the (1) removal site evaluation, (2) physical location, (3) site characteristics, (4) release or threatened release into the environment of contaminants of concern, and (5) National Priorities List (NPL) status of IR Sites 4 and 5.

2.1.1 Removal Site Evaluation

The Navy received a Remedial Action Order (RAO) on June 6, 1998, from the California Environmental Protection Agency Department of Toxic Substances Control (DTSC). IR Sites 4 and 5 were identified, along with 21 other sites, as needing a remedial investigation/feasibility study (RI/FS) in conformance with the requirements of CERCLA. In a July 6, 2000 meeting, the Navy and regulatory agencies agreed that a non-time-critical removal action should be conducted for DNAPL at IR Sites 4 and 5. An index of documents from the Administrative Record leading to the decision to conduct removal actions at IR Sites 4 and 5 is included in Appendix B. Minutes from meetings between the Navy and regulatory agencies relevant to this decision are also included in Appendix B.

2.1.2 Physical Location

IR Sites 4 and 5 are located at Alameda Point (formerly Naval Air Station [NAS] Alameda), part of the City and island of Alameda, located in the central portion of the eastern side of the San Francisco Bay (Bay), California. IR Site 4 is located within OU-2B, near the eastern perimeter of Alameda Point, and IR Site 5 is located within OU-2C, in the central industrial portion of Alameda Point (Figure 2-1). The following sections describe the meteorology, ecology, geology, and hydrogeology for Alameda Point.

2.1.2.1 Meteorology

The San Francisco Bay area (Bay area) experiences a maritime climate with mild summer and winter temperatures. Prevailing winds are from the west. Because of the varied topography of the Bay area, climatic conditions vary considerably throughout the region. Heavy fog occurs on an average of 21 days per year. Rainfall occurs primarily during the months of October through April. The Alameda Point Installation averages at least 18 inches of rainfall per year (U.S. Navy 1992). No naturally occurring surface streams or ponds occur on the installation; precipitation returns to the atmosphere by evapotranspiration, run off in the storm sewer system that discharges to San Francisco Bay, or infiltration to groundwater.

2.1.2.2 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 summer. The coastal plains are characterized by sagebrush and grassland communities. Exposed coastal areas support desert-like shrub communities called coastal scrub; such communities are dominated by coyote bush, California sagebrush, and bush lupine. The area continues to be a major resource and migration route for both aquatic and terrestrial birds (Bailey 1995). Alameda Point, including contiguous and noncontiguous properties, contains the following terrestrial and aquatic wildlife habitats: open water areas, estuarine intertidal emergent wetlands, non-native grassland, ruderal upland vegetation, disturbed areas, beach, and urban and ornamental landscapes. Detailed descriptions of the wildlife habitats, soil types, and special status species encountered at Alameda Point are presented in the OU-2 RI report (TtEMI 1999a).

2.1.2.3 Geology

This section provides an overview of the geology of the San Francisco Bay region and Alameda Point, and is based on the work of Trask and Rolston (1951), Treasher (1963), Radbruch (1957, 1969), Atwater and others (1977), Atwater (1979), Helley and others (1979), Rogers and Figuers (1991), and Sloan (1990, 1992). The Bay occupies a depression between two uplifted areas; the Berkeley Hills on the east and the Montara Mountains on the west. The depression and uplifted areas are formed by two sub-parallel, active faults: the San Andreas Fault to the west of the Bay and the Hayward Fault to the east. The Bay is underlain by a series of Quaternary age unconsolidated sediments, which include, in the order of youngest to oldest (top to bottom): Artificial Fill; the Holocene age Bay Sediment Unit; the

Holocene/Late Pleistocene age Merritt Sand; the Holocene/Late Pleistocene San Antonio Formation, Upper Unit; the Late Pleistocene San Antonio Formation, Lower Unit (Yerba Buena Mud), and the Late Pleistocene/Pliocene Alameda Formation. These sediments are underlain by Jurassic age bedrock of the Franciscan Formation. The sedimentary units overlying the Alameda Formation are relevant to groundwater flow and contaminant migration at Alameda Point, and are described in further detail below.

Artificial Fill. Artificial fill is present over most of Alameda Point and consists of sediments that were dredged from the surrounding San Francisco Bay and the Oakland Inner Harbor in the late 1800s. The composition of the fill varies, but it is generally silty sand or sand with minor inclusions of clay and/or gravel. Much of the fill is similar in composition to the Merritt Sand, which in most cases served as the source for the fill. The fill ranges in thickness from 0 to 30 feet, which is a result of the natural topography of the estuary prior to filling activities. The fill is thinnest in the 1856 tidal flat area in the eastern region, and generally thickens westward across Alameda Point.

Bay Sediment Unit. The Holocene estuarine or tidal flat deposits of the Bay Sediment Unit (BSU, or Young Bay Mud) are the youngest naturally occurring sediments at Alameda Point. The BSU consists of silt and gray to black clay with laterally discontinuous, poorly graded, silty and clayey sand and gravel layers. The gravel layers contain relatively large amounts of shell fragments. A coherent clay member is present in the upper portion of the BSU, and a layer with high organic content, called the "marsh crust" typically marks the top of the unit throughout most of the installation. The BSU is approximately 40 feet thick in the western region of Alameda Point, and pinches out to the east. The unit is discontinuous in the eastern region, and absent in the extreme southeastern region. The BSU is encountered at approximately 25 feet below ground surface (bgs) in the western region of Alameda Point and approximately 5 feet bgs in the eastern region.

Merritt Sand. Over most of the installation, the Holocene/Late Pleistocene eolian deposits of the Merritt Sand Formation underlie the BSU; where the BSU is absent, the Merritt Sand directly underlies the artificial fill. The Merritt Sand in the vicinity of Alameda Point consists of fine-grained orange-brown, silty, clayey sand with inclusions of gray, medium-grained 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 is 8.5 to 56 feet in the southeastern region, 19 to 60 feet in the central region, and 9.5 to 48 feet in the western region of Alameda Point. It is encountered at a depth of about 45 feet bgs in the western and central regions of Alameda Point, and outcrops in, or underlies the artificial fill layer in the southeastern region. A paleo-stream system cut an east-west trending channel

through the Merritt Sand. This paleochannel was subsequently filled with low-permeability silts and clays, with discontinuous layers of poorly graded sands associated with the BSU.

San Antonio Formation, Upper Unit. The Holocene/Late Pleistocene alluvial deposits of the upper unit of the San Antonio Formation underlie the Merritt Sand. These sediments were deposited in environments ranging from alluvial fans to flood plains, lakes, and beaches, and consist of interbedded layers of medium-grained sand with varying amounts of silt and clay. A persistent layer containing shells and sand is present near the top of the formation, and a layer containing organic material (plant debris or peat) is present at the base of the formation. Greenish-gray clay layers within the unit may be locally confining. The unit ranges in thickness from 10 to 40 feet in the eastern region and 7 to at least 72 feet in the central region of Alameda Point. The unit is present over most of the installation but is absent where the paleochannel crosses the central and western regions of the installation.

San Antonio Formation, Lower Unit (Yerba Buena Mud). The Late Pleistocene estuarine deposits of the lower unit of the San Antonio Formation (Yerba Buena Mud, or Old Bay Mud) underlie the continental alluvial deposits of the upper unit of the San Antonio Formation. The Yerba Buena Mud in the vicinity of Alameda Point consists of a dark greenish-gray, silty clay. The unit ranges in thickness from 0 feet in Hayward to 125 feet on Yerba Buena Island. The unit is 55 to 90 feet thick at Alameda Point (Atwater and others, 1977; Rogers and Figuers, 1991). The Yerba Buena Mud marks the erosional surface of the Alameda Formation, and is believed to be regional, underlying the San Francisco Bay and bay margins, including Alameda Point (Rogers and Figuers, 1991). The paleochannel that crosses Alameda Point has partially eroded into the Yerba Buena Mud but does not bisect the unit.

2.1.2.4 Hydrogeology

The artificial fill and four naturally occurring geologic units described above form four hydrogeologic units at Alameda. These units include from top to bottom, the first water-bearing zone (FWBZ), the BSU Semi-Confining Layer, the second water-bearing zone (SWBZ), and the Yerba Buena Mud Aquitard. These units are described below.

FWBZ. The FWBZ is unconfined, and ranges in thickness from less than 10 feet in the central region, to over 30 feet in the western region, and up to 100 feet in the southeastern region. In the western and central regions the FWBZ is restricted to the artificial fill overlying the BSU. The BSU pinches out from east to west and is not present in the southeastern region. In the absence of the BSU, both the artificial fill and

the entire Merritt Sand unit are identified as the FWBZ. Because of a difference in the measured elevation of the piezometric surface, and the absence of a discernible confining layer, the FWBZ has been informally divided into two separate hydrogeologic intervals: the FWBZ upper (FWBZU) and the FWBZ lower (FWBZL).

Groundwater in the FWBZ is encountered from about 2 to 8 feet bgs, and generally flows radially, from the center of Alameda Island toward San Francisco Bay, the Oakland Inner Harbor, and the Seaplane Lagoon. The northeast to west-trending paleochannel does not appear to influence groundwater flow within the FWBZ. Groundwater recharge to the FWBZ is attributed to vertical infiltration from precipitation; horticultural irrigation; and leaking water supply, sanitary sewer, and storm sewer pipes. Tidal inundation of wetland areas and storm water conveyance lines may also contribute recharge to the FWBZ. The FWBZ is tidally influenced on the northern, western, and southern sides of Alameda Point. Tidal influence studies indicate the region of influence extends approximately 250 to 300 feet inland on the northern and southern sides of Alameda Island and approximately 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], 1997a). Local horizontal gradients calculated at similar locations throughout the year ranged from 0.001 to 0.003 ft/ft in the FWBZ. Hydraulic conductivity values for the FWBZ determined using aquifer tests are on the order of 6.3×10^{-3} ft/min.

BSU Semi-confining Layer. The upper portion of the BSU contains a coherent clay member that locally acts as an aquitard or confining layer, and is termed here a “semi-confining layer”. Vertical hydraulic communication through the BSU (where present) appears to be minimal. This observation is supported by the presence of the coherent clay member in the upper portion of the BSU, the lack of observed drawdown in the underlying Merritt Sand (SWBZ) when pumping tests were performed in the artificial fill (FWBZ), the lack of migration of saline water from the SWBZ into the fresh to brackish water of the FWBZ, and the lack of migration of contaminants from the base of the artificial fill into the BSU and underlying Merritt Sand. Hydraulic conductivity values for the silty clays of the BSU determined using slug tests are on the order of 6.1×10^{-5} ft/min.

SWBZ. The SWBZ is present in the western and central regions of Alameda Island, where the BSU is substantive enough to retard flow to/from the overlying FWBZ. The SWBZ appears to be semi-confined, and occupies the silty sands within the lower portion of the BSU, the Merritt Sand Formation (where present), and the upper unit of the San Antonio Formation. The potentiometric elevation of the SWBZ ranges from 3 to 9 feet MLLW. In the western region, the Merritt Sand Formation and the upper unit of

the San Antonio Formation are not laterally continuous, and the SWBZ is restricted to the lower portion of the BSU, which consists mainly of poorly graded sand. The SWBZ has also been divided into two separate hydrogeologic intervals: the SWBZ upper (SWBZU) and the SWBZ lower (SWBZL). Most of the SWBZ is in the Merritt Sand unit, while the SWBZL extends into the interbedded silty and clayey sands of the upper San Antonio Formation.

Recharge of the SWBZ is 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 SWBZ is believed to discharge through lateral groundwater flow to San Francisco Bay, the Oakland Inner Harbor, and the Seaplane Lagoon. The northeast to west-trending paleochannel is believed to be a potential barrier to groundwater flow and contaminant migration within the SWBZ between the northern and southern portions of the central region of the installation. Local horizontal gradients calculated at similar locations throughout the year ranged from 0.001 to 0.003 ft/ft in the SWBZ. Slug test data indicate that the hydraulic conductivity of the SWBZ in the western region ranges from 1.22×10^{-3} to 3.7×10^{-3} ft/min.

Yerba Buena Mud Aquitard. The Yerba Buena Mud (San Antonio Formation, Lower Unit) is a regionally continuous clay layer, forming a regional aquitard. Beneath the southeastern region of Alameda Point, it is approximately 55 to 80 feet thick, and is encountered at 90 to 115 feet bgs. The aquitard is believed to be an effective hydraulic barrier between the SWBZ and the underlying Alameda Formation. This observation is supported 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 (Hickenbottom, 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 (Hydro-Search, Inc. [HSI], 1977).

2.1.2.5 Site-Specific Geology and Hydrogeology

The geology and hydrogeology specific to IR Sites 4 and 5 are discussed below.

IR Site 4

Artificial fill is present at the surface at IR Site 4, and consists of silty, fine-grained sand with trace amounts of gravel and brick fragments. The artificial fill makes up the upper portion of the FWBZ and is encountered from the ground surface to about 10 feet bgs. The BSU is not present at IR Site 4. A 1-to 5-foot-thick layer of dense to well-consolidated, low-permeability clayey sand separates the artificial fill from the underlying Merritt Sand at about 10 feet bgs. The Merritt Sand consists of orange-brown, silty, fine sand and clayey, fine sand. The Merritt Sand makes up the middle portion of the FWBZ and extends from about 10 to 70 feet bgs. A 5- to 15-foot-thick layer of dense to well-consolidated, low-permeability clayey sand occurs between the eolian and alluvial sections of the Merritt Sand Formation, at about 30 feet bgs. The Upper Unit of the San Antonio Formation underlies the Merritt Sand and consists of sand, sandy clay, and silty clay. The Upper San Antonio Formation makes up the lower portion of the FWBZ and extends from about 70 to 90 feet bgs. The Yerba Buena Mud underlies the Upper San Antonio Formation, preventing downward migration from the FWBZ to the underlying Alameda Formation.

Groundwater at IR Site 4 is first encountered between approximately 2 and 8 feet bgs. Groundwater generally flows from the east and northeast inland areas to the west and southwest, towards the Seaplane Lagoon and San Francisco Bay, and is affected locally near industrial buildings by preferential flow paths such as storm drains and underground utility trenches. Water levels in the vicinity of industrial buildings indicate localized regions of groundwater mounding or groundwater sinks. The storm water conveyance pipes may contribute to groundwater recharge or act as potential groundwater sinks, depending on pipe integrity and whether they are located above or below the groundwater table, respectively. At high tide, water from the Bay may enter the shallow upper reaches of the storm water drainage system, causing localized mounding of groundwater; at low tide, shallow pipes may act as groundwater sinks. The hydraulic conductivity for the FWBZ (including the artificial fill and the Merritt Sand) within this region of the site ranged from 9.69×10^{-4} centimeters per second (cm/sec) to 3.01×10^{-3} cm/sec.

IR Site 5

Artificial fill is also present at the surface of IR Site 5, and consists of unconsolidated fine- to medium-grained sand with lenses of silty sand, gravelly sand, or sandy gravel. The artificial fill makes up the FWBZ and is encountered from the ground surface to a depth of 12 to more than 15 feet bgs. The hydraulic conductivity estimated in the FWBZ within this region of the site ranged from 3.21×10^{-3}

cm/sec to 7.65×10^{-3} cm/sec. The Bay Sediment unit (BSU) underlies the artificial fill and consists of three sediment types: stiff, moist clay; sand and clay with some shell fragments; and silty sand with interbedded layers of fine sand. These sediment layers are discontinuous and begin at depths of about 12 to 15 feet bgs. The BSU layers vary from 20 to 25 feet in thickness and may restrict flow between the FWBZ and the second water-bearing zone. The hydraulic conductivities estimated in the BSU ranged from 3.22×10^{-8} cm/sec to 3.9×10^{-5} cm/sec.

Groundwater at IR Site 5 is first encountered between approximately 4 and 7 feet bgs. Local recharge from precipitation, seasonal variation in groundwater elevations, and tidal influences at IR Site 5 impact groundwater flow directions. During the rainy season, groundwater flow is generally north, towards the Oakland Inner Harbor. During dry periods, the hydraulic gradient can change directions, resulting in flow away from the harbor. Two storm drain lines in the northwestern corner of the site discharge to the harbor and may also influence local groundwater elevations and flow directions. These storm drain lines may also influence local flow velocities by acting as preferential flow paths.

2.1.3 Site Characteristics

This section describes the buildings and activities associated with IR Sites 4 and 5. The current status of these sites is also discussed in this section.

IR Site 4

IR Site 4 is part of the Inner Harbor land use area defined in the community reuse plan (Alameda Reuse and Redevelopment Authority [ARRA] 1996). Potential reuse may include industrial, research and development facilities, mixed use (including residential), and parks. IR Site 4 consists of about 21 acres and the following EBS parcels: 133, 143, 144, 164A, and a portion of 134A. Figure 2-2 shows the EBS parcels and site features associated with IR Site 4.

IR Site 4 includes buildings 163, 170, 360, 372, 414, 552, and 610. Activities associated with the buildings of IR Site 4 include aircraft testing and maintenance, hazardous materials storage, and aviation equipment storage. Vehicle parking, hazardous waste and materials storage was conducted in the open space of IR Site 4. The historical operations associated with IR Site 4 are summarized in Table 2-1.

Historical operations at Building 360 (currently vacant) included aircraft maintenance, engine testing, hazardous materials storage, paint stripping, plating, metal grinding, and machining. The building housed specialized production shops for repair and testing of both jet-turbine and piston engines for aircraft. These aircraft engine repair operations began at the site in 1954 (Canonie, 1990). A paint shop, a part cleaning shop, a plating shop, and machine shops were also contained in Building 360. Shop operations included paint stripping by blasting; chrome, nickel, and silver stripping; etching; and chrome, copper, nickel, and silver plating. The cleaning and blasting processes used baths of phenol-based cleaners, alkaline-type cleaners, rust removers, descaling compounds, and caustics. Chemicals mixtures used in the cleaning process included trichloroethene (TCE), sodium hydroxide, and/or varying amounts of dichlorobenzene, methylene chloride, and toluene. Industrial wastewater generated in Building 360 was treated at the wastewater treatment facility formerly located north of Building 163. Plating operations were discontinued and the plating shop was dismantled and removed in 1991. The machine shops, stripping and painting shops, and parts assembly areas within Building 360 were active until 1996.

IR Site 5

IR Site 5 is part of the Central Industrial Territories defined in the community reuse plan (ARRA 1996). Potential reuse may include industrial, research and development, mixed use (including residential), and parks. IR Site 5 consists of about 47 acres, and the following EBS parcels: 23C, 28A, 29A, 30A, 45A, 46-49, 50A, 50B, 51A, 51B, 53A, 54-59, 66-68, and 186. Figure 2-3 shows the EBS parcels and site features associated with IR Site 5.

IR Site 5 includes buildings 2, 5, 6, 32, 34, 42-44, 62, 102, 194, 261, 282, 346-348, 405, 500, 614, and 615. Activities associated with the buildings of IR Site 5 include fuel and electronics testing, ordnance storage, aircraft repair and maintenance, and hazardous waste and materials storage. Vehicle parking, wash down activities, and chemical storage were conducted in the open space of IR Site 5. The historical operations associated with IR Site 5 are summarized in Table 2-2.

Building 5 (currently vacant), the Aircraft Rework facility, was the largest facility at Alameda. Beginning in 1942, Building 5 housed specialty shops for aircraft component repair and maintenance, a plating shop and a "selective" plating shop that was used to plate small items by hand; these facilities were closed in 1990 and 1993, respectively. Shops within Building 5 were used for the cleaning, reworking, and manufacturing of metal parts; tool maintenance; plating operations; and painting operations. The paint shop contained two paint bays and several smaller paint spray booths. Processes in the plating shop

included degreasing; caustic and acid etching; metal stripping and cleaning; and cadmium, chrome, copper, nickel, and silver plating. Within Building 5, past operations required a hazardous waste storage area, which was closed in 1988. The former hazardous waste storage area was located outside of Building 5 in the southeastern corner of IR Site 5. Drummed wastes formerly stored in the hazardous waste storage area included spent solvents, waste paints, waste oils, hydraulic fluid, and lubricating oils. The former hazardous waste storage area is currently fenced and access is restricted.

2.1.4 Release or Threatened Release into the Environment of Contaminants of Concern

For the purposes of this removal action, the Alameda Point Base Realignment and Closure (BRAC) Closure Team (BCT) agreed that DNAPL should be considered present in areas where chlorinated solvent concentrations exceed one percent of their solubility in water. Three such areas were identified at IR Site 4, and four at IR Site 5 and are demarcated in yellow on Figures 2-4 and 2-5 respectively. Because of their high solvent concentrations, and proximity to former industrial facilities, these areas are considered to be probable sources of contamination, and will be treated as part of the planned removal action. The source, nature and extent of DNAPL at these areas are summarized below, and discussed in further detail in the IR Sites 4 and 5 engineering evaluation and cost analysis (EE/CA) report (TtEMI 2001). In addition, Table 2-3 presents the approximate area and depth to be treated under this interim removal action based on the one percent solubility criteria, and on information obtained from previous investigations (TtEMI and Einarson, Fowler, and Watson [EFW] 1998; TtEMI 1999b; Berkeley Environmental Restoration Center [BERC] 2000).

IR Site 4

The three areas at IR Site 4 were selected for treatment based on the aqueous concentrations of TCE northwest of Building 360, 1,1-dichloroethene (DCE) southwest of Building 360, and TCE east of Building 360 exceeding one percent solubility in water (Figure 2-4).

TCE concentrations of 11,000 micrograms per liter ($\mu\text{g/L}$), indicative of DNAPL, were present at a depth of 30 to 35 feet bgs northwest of Building 360. Deeper samples at this location did not have concentrations indicating DNAPL.

Concentrations of 1,1-DCE at 16,000 to 84,000 $\mu\text{g/L}$, indicative of DNAPL, are present at a depth of 20 to 30 feet bgs at the southwestern side of Building 360. Concentrations of 1,1-DCE in deeper samples were not indicative of DNAPL.

The area east of Building 360 was included as a potential DNAPL location because high concentrations of TCE were measured in a monitoring well. The concentration of 5,000 $\mu\text{g/L}$ was lower than the 11,000- $\mu\text{g/L}$ DNAPL indicator; however, the sample was collected from a monitoring well, and dilution from the entire well screen was taken into account.

As part of the ongoing RI for IR Site 4, DNAPL characterization was performed at locations east of Building 360 during data gap sampling, which was conducted between June 2001 and August 2001.

IR Site 5

Four areas at IR Site 5 have been selected for treatment based on aqueous concentrations of TCE, 1,1-dichloroethane (DCA), 1,1-DCE, and 1,1,1-trichloroethane (TCA)(Figure 2-5).

Maximum concentrations of 1,1,1-TCA (200,000 $\mu\text{g/L}$), 1,1-DCA (57,000 $\mu\text{g/L}$), TCE (36,000 $\mu\text{g/L}$), and 1,2-DCA (73,000 $\mu\text{g/L}$), indicative of DNAPL, are present at a depth of about 15 feet bgs, east of the northeast corner of Building 5 (TtEMI 1999b). Deeper samples at this location did not have concentrations indicating DNAPL.

A concentration of TCE (72,500 $\mu\text{g/L}$), indicative of DNAPL, was present at about 10 feet bgs east of the central portion of Building 5 (Figure 2-5). Concentrations of TCE in deeper samples at this location were not indicative of DNAPL.

Concentrations of 1,1,1-TCA (20,000 to 100,000 $\mu\text{g/L}$) and 1,1-DCE (22,000 to 65,000 $\mu\text{g/L}$) indicative of DNAPL and high concentrations of 1,1-DCA (24,000 $\mu\text{g/L}$) are present between 5 and 10 feet bgs near the southeastern corner of Building 5. Deeper samples at this location did not have concentrations indicating DNAPL.

Concentrations of 1,1,1-TCA (790,000 $\mu\text{g/L}$) indicative of DNAPL and high concentrations of 1,1-DCA (13,000 $\mu\text{g/L}$) are present at a depth of 10 to 15 feet bgs northwest of the former plating shop inside Building 5. Deeper samples at this location did not have concentrations indicating DNAPL.

2.1.5 National Priorities List Status

NAS Alameda, including IR Sites 4 and 5, was placed on the U.S. Environmental Protection Agency (EPA's) National Priorities List in July 1999. The sites addressed in this AM are currently being investigated as part of the OU-2 RI and FS efforts.

2.2 ACTIONS CONDUCTED TO DATE

This section summarizes investigations and removal actions previously conducted, and other decisions taken at IR Sites 4 and 5 leading up to the removal action described in this AM. A copy of the administrative record index listing all decisions taken at IR Sites 4 and 5 is included in Appendix B.

2.2.1 Previous Actions

IR Site 4

Nineteen investigations have been conducted at IR Site 4. Table 2-4 summarizes the approximate timeframe, the type of activity performed, and the results of each investigation conducted at IR Site 4. The specific activities conducted during the previous investigations and their findings are listed and summarized in Table 2-4. Previous sampling locations, the resultant isoconcentration contours, and the proposed DNAPL removal areas are indicated on Figure 2-4. Analytical data for groundwater samples collected from IR Site 4 are presented in Appendix A of the IR Site 4 and 5 EE/CA report (TtEMI 2001).

IR Site 5

Eighteen investigations have been conducted at IR Site 5. Table 2-5 summarizes approximate timeframe, the type of activity performed, and the results of each investigation and removal action conducted at IR Site 5. The specific activities conducted during the previous investigations and their findings are listed and summarized in Table 2-5. Previous sampling locations and resultant isoconcentration contours, as well as the proposed DNAPL removal areas are indicated on Figure 2-5. Analytical data for groundwater samples collected from IR Site 5 are presented in Appendix A of the IR Site 4 and 5 EE/CA report (TtEMI 2001a).

2.2.2 Current Activities

Currently, the Navy is conducting data gap sampling to confirm the presence of DNAPL and delineate the extent of the plume at IR Sites 4 and 5. Fieldwork associated with the data gap sampling was initiated on May 20, 2001, and is expected to be completed in August 2001. Results of the data gap sampling will be incorporated in the final AM. The following section describes the data gap sampling objectives and protocol for this investigation.

Data Gap Sampling

Aqueous concentrations of a COC exceeding 1 percent of its solubility limit may indicate the presence of DNAPL. The data gap sampling investigation will be performed adjacent to historical sampling locations where DNAPL is suspected to be present, based on previously collected soil and groundwater data and field observations.

Prior to performing the DNAPL investigation at the specified locations, groundwater in nearby monitoring wells will be vertically profiled for COC concentrations at 2-foot intervals using passive diffusion bag (PDB) samplers to identify depth intervals of potential DNAPL contamination. In support of data evaluation, water levels will be measured from existing monitoring well pairs, adjacent shallow (first WBZ) and deep (second WBZ) wells to estimate the potential impact of vertical gradients on COC concentrations.

Following monitoring well profile sampling, ribbon NAPL samplers (RNS) will be employed at suspected DNAPL locations for determining (qualitatively) the extent of DNAPL contamination. Proposed sampling locations are based on previous soil and groundwater data. A Minimum of four RNSs will be installed at each DNAPL investigation area; one RNS will be installed at the center of the suspect area and three RNSs will be installed in a triangular configuration around the first. If DNAPL is detected in any of the initial four RNS locations, as many as two step-out locations will be sampled based on the step-out strategy described in Appendix B-2 of the Field Sampling Plan (TtEMI 2001b).

At the outermost RNS sampling locations, co-located groundwater samples will be collected at specified depths (the depth at which NAPL is detected in the previous RNS location) to confirm that the RNS results do not represent false negative interpretation and to confirm the extent of DNAPL contamination. Groundwater samples will be analyzed for COCs using an on-site mobile laboratory.

2.3 NAVY, FEDERAL, STATE, AND LOCAL AUTHORITIES ROLES

This section describes current and future environmental management roles of Navy and federal, state, and local authorities at IR Sites 4 and 5.

2.3.1 Navy Role

Federal EO 12580 delegates to the Department of Defense the President's authority to undertake CERCLA response actions. Congress further outlines this authority in its Defense Environmental Restoration Program Amendments (10 USC Sections 2701 through 2705). Both 42 USC Section 9620(f) and 10 USC Section 2705 require Naval facilities to ensure that state and local officials are given timely opportunity to review and comment on Navy response actions. In addition, 42 USC, Section 9620(a)(4), requires the Navy to comply with state removal action requirements at its facilities; which is consistent with CERCLA and 1990 NCP requirements.

The Navy, with federal and state regulatory support, is the lead agency for the removal action. The Navy has approval authority over the recommended alternative and all public participation activities.

Southwest Division, Naval Facilities Engineering Command (SWDIV), is the regional manager for Navy's CERCLA program.

2.3.2 Federal, State, and Local Authority Role

The EPA, DTSC, and San Francisco Bay Regional Water Quality Control Board (RWQCB) provide oversight during all phases of the execution of the recommended alternative. DTSC, RWQCB, EPA, and Navy representatives make up the BCT. The BCT provides technical advice, oversight, and assistance during this removal action and will continue to do so throughout the IR program.

TABLE 2-1
INSTALLATION RESTORATION SITE 4
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA CALIFORNIA
(Page 1 of 1)

Parcel	Building	Operations Conducted	Hazardous Materials Stored or Used
133	552	The electrical substation was constructed in 1975.	None
134A	163	This was part of Pacific Coast Borax Works constructed in 1939. It was an aircraft maintenance facility after the late 1940s. Machine and welding shops are still present.	Metals, corrosives, petroleum products, paint, halogenated and nonhalogenated organic compounds
	372	The engine test facility was constructed in 1953. Two test cells and an operation gallery were included. Fuel and lubricant supply systems serviced the engine test cells. An oil-water separator is located west of the building. Fuel releases at the building are documented.	Fuels and lubricants
	414	The hazardous materials storage area was constructed in 1957. An industrial waste treatment plant, used to treat wastewater from Building 360, is located west of Building 414.	Metals, corrosives, petroleum products, fuels, paints, and organic compounds
143	360	The aircraft engine and airframe overhaul facility was constructed in 1953. Shop operations included paint stripping by blasting; chrome, silver, and nickel stripping; etching; and chrome, copper, nickel, and silver plating. The plating shop was dismantled and removed in 1991. The machine shops, stripping and painting shops, and parts assembly areas were active until 1996. Currently, the building is vacant.	Phenolic-based cleaners, alkaline-type cleaners, rust removers, descaling compounds, caustics, chemical mixtures containing 55 percent tetrachloroethene, dichlorobenzene, methylene chloride, toluene, and 30 to 70 percent solutions of sodium hydroxide
	610	The metal grinding and machining facility was constructed in 1979.	Metals
144	No Buildings Present	The recreational area consists of unpaved open space.	None
164A	170	The warehouse was constructed in 1976.	None

TABLE 2-2
INSTALLATION RESTORATION SITE 5
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 1 of 4)

Parcel	Building	Operations Conducted	Hazardous Materials Stored/Used
45A	2	The enlisted personnel barracks were constructed in 1947.	None
46	42	The engineering laboratory was constructed in 1941.	None
	102	An ordnance storage area was constructed in 1943.	Paint, nonhalogenated organic compounds, and petroleum products
47	43	An ammunition overhaul and rework shop was constructed in 1941.	Petroleum products and solvents
48	44	Engineering laboratory and administrative offices were constructed in 1941.	None
	346	This engineering laboratory and administrative office were constructed in 1949.	None
49	405	This storage area for hazardous materials and wastes and non-chemical shipping area was constructed in 1958. Two aboveground storage tanks used for storing lubricating oil are located north of Building 405.	Trichlorofluoroethane, tricresyl phosphate, petroleum products, solvents, halogenated and nonhalogenated organic compounds, fuel, paint, lubricating oils, hydraulic fluids, and asbestos
	614	This paint storage facility was constructed in 1981. This fenced area outside of Building 614 was used for chemical storage.	Polyurethane and urethane paints, paint thinner, solvents, organic compounds, corrosives, petroleum products, lubricating oils, and naphtha
51A	No Buildings Present	This open space is north of Hangar 11.	None
53A	No Buildings Present	This open space is entirely paved, used for aircraft and vehicle parking.	None

TABLE 2-2
INSTALLATION RESTORATION SITE 5
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 2 of 4)

Parcel	Building	Operations Conducted	Hazardous Materials Stored/Used
54	5	<p>The aircraft component repair and maintenance facility was constructed in 1940. Shops within Building 5 were used for the cleaning, reworking, and manufacturing of metal parts, tool maintenance, plating operations, and painting operations. The paint shop contained two paint bays and several smaller paint spray booths. Processes in the plating shop included degreasing; caustic and acid etching; metal stripping and cleaning; and chrome, nickel, silver, cadmium, and copper plating. From 1940 through the early 1960s, radioluminescent aircraft instrument dials were refurbished with radium-226 on the second floor of Building 5. Radium paint from the process was washed down sink drains into the storm sewer system leading from Building 5 into the Seaplane Lagoon. Lead-acid and nickel-cadmium batteries were serviced in the battery storage area in the northeastern portion of Building 5. Two industrial waste water treatment plants, one of which is abandoned, are located near the southwestern corner of Building 5. The hazardous waste storage area at Building 5 was closed in 1988. The plating shop was closed in 1990. The building is currently vacant.</p>	<p>Zinc chromate, sulfuric acid, potassium hydroxide, heavy metals, methyl ethyl ketone, halogenated and nonhalogenated organics, corrosives, solvents, paints, radium-containing paints, waste oils, hydraulic fluid, antifreeze, beryllium, and mercury</p>
	347	<p>This general-purpose manufacturing and repair facility was constructed in 1946.</p>	<p>Information unknown</p>
55	261	<p>This building was constructed in 1943. No information on activities conducted there is available.</p>	<p>Information unknown</p>
56	500	<p>An office space, a chemical and equipment storage area, and a woodworking shop were constructed between 1958 and 1963.</p>	<p>Oils, stains, paints, solvents, and glues</p>

TABLE 2-2
INSTALLATION RESTORATION SITE 5
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 3 of 4)

Parcel	Building	Operations Conducted	Hazardous Materials Stored/Used
57	348	The corrosion control shop was constructed in 1960. Activities included steam cleaning of aircraft outer surfaces and parts.	Methylene chloride
	415	The storage shed and hazardous waste accumulation area were constructed in 1956.	Petroleum products, resins, solvents, oils, and lubricants
	615	The electrical equipment and parts storage facility were constructed in 1982. This building is currently used for hazardous materials storage.	Resins and adhesives
58	34	An electrical substation was constructed between 1975 and 1981.	Transformer oils
59	62	The cafeteria and credit union were constructed prior to 1947.	Corrosives, paint, and battery water
66	32	This is a metal treatment shop	Information unknown
67	No Buildings Present	This open space is entirely paved.	None
68	6	This includes a repair shop, steam cleaning facility, electromotor shop, storage area, and fire station	Information unknown
69	10	The Public Works Center power plant was constructed in the late 1930s. Activities included steam generation and air compression. Nine aboveground storage tanks used for fuel are located on the southern side of the building. Five abandoned underground storage tanks are associated with Building 10.	Petroleum products, laboratory chemicals, plant water treatment chemicals, microbicide, morpholine, and corrosives
186	194	The maintenance storage structure is for equipment and drums.	None

TABLE 2-2
INSTALLATION RESTORATION SITE 5
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 4 of 4)

Parcel	Building	Operations Conducted	Hazardous Materials Stored/Used
186	282	A diesel motor gasoline station was constructed in 1944. Two active underground storage tanks containing unleaded gasoline and diesel fuel are located east of Building 282.	Petroleum products

TABLE 2-3
GROUNDWATER TREATMENT AREAS ADDRESSED
FOR INTERIM REMOVAL ACTION
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 1 of 1)

Installation Restoration Site	Chemicals of Concern Targeted	Approximate Treatment Area
IR Site 4	1,1-DCE and TCE	Area = 32,138 ft ² Depth = 20-30 ft
IR Site 5	1,1,1-TCA, 1,1-DCA, 1,1-DCE, 1,2-DCE, and TCE	Area = 32,676 ft ² Depth = 15 ft

Notes:

DCE Dichloroethene
ft Foot
ft² Square foot
IR Installation Restoration
TCA Trichloroethane
TCE Trichloroethene

TABLE 2-4
INSTALLATION RESTORATION SITE 4
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 1 of 5)

Investigation Name	Contractor	Date	Analytes	Field Activities
RI (CTO 121) Phase 1 and 2A	CES	1990	VOCs, SVOCs, TOC, TRPH, metals, cyanide, pH, and general chemical parameters	<ul style="list-style-type: none"> • 9 Soil borings drilled • 4 Monitoring wells installed • 108 Soil samples collected • 9 Wipe samples collected • Groundwater sampling conducted
RI (CTO 121) Phase 2B and 3	PRC and JMM	1991-1992	metals, hexavalent chromium, and cyanide	<ul style="list-style-type: none"> • 12 Surface soil samples in plating shop area collected
RI (CTO 260)	PRC and JMM	1994	VOCs, SVOCs, pesticide and PCBs, TPPH, TEPH, metals, cyanide, and general chemical parameters	<ul style="list-style-type: none"> • 3 CPTs conducted • 9 Shallow and deep Hydropunch® samples collected • Soil borings drilled and 65 soil samples collected • Non-point-source sampling conducted • 3 Shallow monitoring wells installed • 3 Deep monitoring wells installed • Quarterly groundwater sampling conducted
RI (CTO 280)	PRC and JMM	1994	VOCs, SVOCs, pesticide and PCBs, TPPH, TEPH, metals, cyanide, and general chemical parameters	<ul style="list-style-type: none"> • 3 Surface soil samples collected • 3 Shallow soil borings drilled • 6 CPTs conducted

TABLE 2-4
INSTALLATION RESTORATION SITE 4
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 2 of 5)

Investigation Name	Contractor	Date	Analyses	Field Activities
UST 163-1 Removal	PWC	1995	VOCs, SVOCs, TEPH, TPPH, and TRPH	<ul style="list-style-type: none"> • 5 Soil samples collected • 1 Groundwater sample collected • Exposed soil in the excavation not visibly contaminated • No observable sheen on the groundwater encountered at 4 feet bgs • Over-excavation performed on the eastern side of the UST excavation
UST 372-1 Removal	PWC	1995	VOCs, TPPH, and TEPH	<ul style="list-style-type: none"> • 2 Soil samples collected • 1 Groundwater sample collected • UST 372-1 reported to be in good condition with no holes • Soil staining not observed in the excavation sidewalls • Floating product and petroleum hydrocarbon odors noted in the UST excavation
Phase I	ERM West	1995	VOCs, TEPH, and TPPH	<ul style="list-style-type: none"> • 18 Soil samples field screened, of which 4 analyzed • 20 Groundwater samples collected

TABLE 2-4
INSTALLATION RESTORATION SITE 4
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 3 of 5)

Investigation Name	Contractor	Date	Analyses	Field Activities
Phase II	ERM West	1995	VOCs, TPH, TEPH, metals, and SVOCs	<ul style="list-style-type: none"> • 3 Monitoring wells installed • 3 Soil samples collected • 3 Groundwater samples collected • 1 Soil sample collected below water table tested for permeability
EBS Phase IIa	IT	1995	TPPH, VOCs, SVOCs, Pesticides and PCBs, herbicides, reactivity, and metals	<u>Parcel 134</u> <ul style="list-style-type: none"> • 19 Surface soil samples • 27 Subsurface soil samples <u>Parcel 144</u> <ul style="list-style-type: none"> • Surface soil samples • Subsurface soil samples • Soil gas samples • 1 Subsurface (sanitary sewer)
EBS Phase IIb	IT	1995	TPPH, VOCs, SVOCs, Pesticides and PCBs, and metals	<u>Parcel 134B</u> <ul style="list-style-type: none"> • 6 Surface soil samples • 18 Subsurface soil samples • 12 Groundwater samples
RI (CTO 107)	OGISO Environmental	1997	VOCs	<ul style="list-style-type: none"> • Groundwater grab sampling conducted for plume definition
Phase I	Moju	1997	MTBE, BTEX, TPH-g, TPH-d, TPH-mo, and JP5, selected for chlorinated hydrocarbons	<ul style="list-style-type: none"> • 15 soil samples • 15 groundwater samples

TABLE 2-4
INSTALLATION RESTORATION SITE 4
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 4 of 5)

Investigation Name	Contractor	Date	Analyses	Field Activities
RI (CTO 108)	TtEMI	1997-1998	VOCs, SVOCs, TOC, TPH, metals, cyanide, and general chemical parameters	<ul style="list-style-type: none"> • Quarterly groundwater sampling conducted • Tidal influence study performed
Phase III	Moju	1997-1999	VOCs, SVOCs, BTEX and TTPH, selected for chlorinated hydrocarbons	<ul style="list-style-type: none"> • 11 Groundwater samples
RI (CTO 122)	TtEMI and EFW	1998	VOCs	<ul style="list-style-type: none"> • Plume definition: groundwater grab samples collected
UST 372-2	ITSI	1998	VOCs, SVOCs, TPPH, TEPH, and metals	<ul style="list-style-type: none"> • 2 Soil samples collected • Groundwater with a sheen observable at 3.5 feet bgs • UST with visible corrosion, but no holes • A tar-like product observable in the soil at the eastern end of the excavation
Fuel Line Removal	IT	1998	VOCs, SVOCs, TPPH, TEPH, and metals	<ul style="list-style-type: none"> • 17 soil and 1 groundwater sample collected
Floating Product Investigation	TtEMI	1999	Floating product	<ul style="list-style-type: none"> • Monitoring wells checked with dual-phase probe • No floating product found
MTBE Investigation	TtEMI	1999	BTEX and MTBE	<ul style="list-style-type: none"> • 1 groundwater sample collected near UST 163-1

Notes:

BTEX Benzene, toluene, ethylbenzene, and xylenes
 CES Canone Environmental Services
 CPT Cone penetrometer testing
 CTO Contract task order
 EFW Einarson, Fowler, and Watson

TABLE 2-4
INSTALLATION RESTORATION SITE 4
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 5 of 5)

Notes (Continued):

ERM	Environmental Resources Management
IT	International Technology Corporation
ITSI	Innovative Technical Solution, Inc.
JMM	James M. Montgomery
JP5	Jet Propulsion Fuel 5
Moju	Moju Environmental Technologies
MTBE	Methyl-tert-butyl ether
PCB	Polychlorinated biphenyl
PRC	PRC Environmental Management, Inc.
PWC	Navy Public Works Center
RI	Remedial investigation
SVOC	Semivolatile organic compound
TEPH	Total extractable petroleum hydrocarbons
TOC	Total organic compound
TPH	Total petroleum hydrocarbons
TPH-d	Total petroleum hydrocarbons as diesel
TPH-g	Total petroleum hydrocarbons as gasoline
TPH-mo	Total petroleum hydrocarbons as motor oil
TPPH	Total purgeable petroleum hydrocarbons
TRPH	Total recoverable petroleum hydrocarbons
TtEMI	Tetra Tech EM Inc.
UST	Underground storage tank
VOC	Volatile organic compound

TABLE 2-5
INSTALLATION RESTORATION SITE 5
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 1 of 5)

Investigation Name	Contractor	Date	Analyses	Field Activities
RI (CTO 121) Phase 2B and 3	PRC and JMM	1991-1992	Hexavalent chromium, cyanide, and metals	<ul style="list-style-type: none"> • 19 Surface soil samples collected • 56 Subsurface soil samples collected • 5 Shallow monitoring wells installed • 2 Monitoring wells installed • Geophysical survey conducted
RI (CTO 260)	PRC and JMM	1994	Pesticides and PCBs, SVOCs, TPPH, TEPH, VOCs, metals, cyanide, and general chemical parameters	<ul style="list-style-type: none"> • 6 CPT performed • Hydropunch[®] samples collected • 11 Soil borings drilled • 26 Soil samples collected • Non-point-source sampling conducted • 5 Shallow monitoring wells installed • Reference boring drilled • Deep monitoring wells installed • Quarterly groundwater sampling conducted

TABLE 2-5
INSTALLATION RESTORATION SITE 5
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 2 of 5)

Investigation Name	Contractor	Date	Analyses	Field Activities
UST 261-1 and 261-2 Removal	PWC	1994	Metals, TEPH, TPPH, and VOCs	<ul style="list-style-type: none"> • USTs 261-1 and 261-2 contained within a concrete vault; therefore, no soil or groundwater samples collected • 10 Soil samples collected from the product-line removal trench associated with UST 261-1 and 261-2
UST 261-3 Removal	PWC	1994	Metals, TEPH, TPPH, and VOCs	<ul style="list-style-type: none"> • 4 Soil samples and 1 groundwater sample collected • Brown foam and a greenish sheen observable on the groundwater surface in the excavation • 1 Soil sample collected from the pipeline removal trench between UST 263-3 and Building 261
UST 615-3 Removal	PWC	1994	TEPH, TPPH, and VOCs	<ul style="list-style-type: none"> • 1 Soil sample collected from the UST excavation

TABLE 2-5
INSTALLATION RESTORATION SITE 5
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 3 of 5)

Investigation Name	Contractor	Date	Analyses	Field Activities
EBS Phase IIa	IT	1995	Metals, and pesticides and PCBs, TPPH, and VOCs	<ul style="list-style-type: none"> • 11 Surface soil samples • 16 Subsurface soil samples
EBS Phase IIb	IT	1995	Metals, Pesticides and PCBs, TPH, and VOCs	<ul style="list-style-type: none"> • 4 Soil samples • 2 Groundwater samples
RI (CTO 316)	PRC	1996	Aquifer test parameters	<ul style="list-style-type: none"> • Pumping well and 3 observation wells installed
SCAPS	PWC	1996-1998	DNAPL, LNAPL, SVOCs, TEPH, TPPH, VOCs, and metals	<ul style="list-style-type: none"> • 33 SCAPS pushes using SCAPS with LIF to measure free product in the groundwater • 21 SCAPS borings • 14 Membrane interface probe vertical profiles • 13 Soil borings
RI (CTO 107)	PRC and OGISO Environmental	1997	VOCs	<ul style="list-style-type: none"> • Groundwater grab sampling conducted for plume definition
USTs 5-2 and 5-3 Removal	TtEMI	1997	TEPH, TPPH, and VOCs	<ul style="list-style-type: none"> • 6 Soil samples • 1 Groundwater sample • An oily sheen observable on the groundwater surface in the excavation of UST 5-2 • Stained soil observable in the excavation of UST 5-3 Groundwater not encountered during removal
RI (CTO 108)	PRC	1997-1998	Cyanide, metals, SVOCs, TEPH, TPPH, VOCs, and general chemical parameters	<ul style="list-style-type: none"> • Quarterly groundwater sampling conducted • Tidal influence study performed

TABLE 2-5
INSTALLATION RESTORATION SITE 5
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 4 of 5)

Investigation Name	Contractor	Date	Analyses	Field Activities
RI (CTO 122)	TtEMI and EFW	1998	VOCs	<ul style="list-style-type: none"> • Groundwater grab sampling conducted for plume definition
UST 615-4 Removal	TtEMI	1998	TEPH, TPH, and VOCs	<ul style="list-style-type: none"> • 1 Soil sample collected in UST excavation • Soil staining was observed in the excavation
EBS Phase IIc	IT	1999	TPH and VOCs	<ul style="list-style-type: none"> • 3 Soil and groundwater samples collected along former product lines
MTBE Investigation	TtEMI	1999	VOCs	<ul style="list-style-type: none"> • 1 Groundwater sample collected near UST 615-3 to obtain site closure
Floating Product Investigation	TtEMI	1999	Floating product	<ul style="list-style-type: none"> • 1 Monitoring well checked with interface probe.
SEE	BERC	2000	VOCs, SVOCs, and TEPH	<ul style="list-style-type: none"> • SEE system was installed. • Steam was injected via injection wells. • Injections and extractions occurred cyclically.
SESR	TtEMI	1999	VOCs	<ul style="list-style-type: none"> • Surfactant solution was injected via 2 injection wells. • 4 Extraction wells recovered water. • Organic chemicals were stripped from the water.

TABLE 2-5
INSTALLATION RESTORATION SITE 5
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 5 of 5)

Notes:

CPT	Cone penetrometer testing
CTO	Contract task order
DNAPL	Dense nonaqueous phase liquids
EBS	Environmental baseline survey
EFW	Einarson, Fowler, and Watson
IT	International Technology Corporation
JMM	James M. Montgomery
LIF	Laser-induced fluorescence
LNAPL	Light nonaqueous phase liquids
MTBE	Methyl-tert-butyl ether
PCB	Polychlorinated biphenyl
PRC	PRC Environmental Management, Inc.
PWC	Public Works Center
RI	Remedial investigation
SCAPS	Site Characterization Analysis Penetrometer System
SEE	Steam-enhanced Extraction treatability study
SESR	Surfactant-enhanced Subsurface Remediation DNAPL Removal treatability study
SVOC	Semivolatile organic compound
TEPH	Total extractable petroleum hydrocarbons
TPH	Total petroleum hydrocarbons
TPPH	Total purgeable petroleum hydrocarbons
TtEMI	Tetra Tech EM Inc.
UST	Underground storage tank
VOC	Volatile organic compound

LEGEND

BOUNDARIES

-  ENVIRONMENTAL BASELINE SURVEY PARCEL
-  INSTALLATION RESTORATION SITE BOUNDARY

-  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

SITE FEATURE

-  LAND COVER

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

SEE FIGURES 2-3 AND 2-5

SEE FIGURES 2-2 AND 2-4



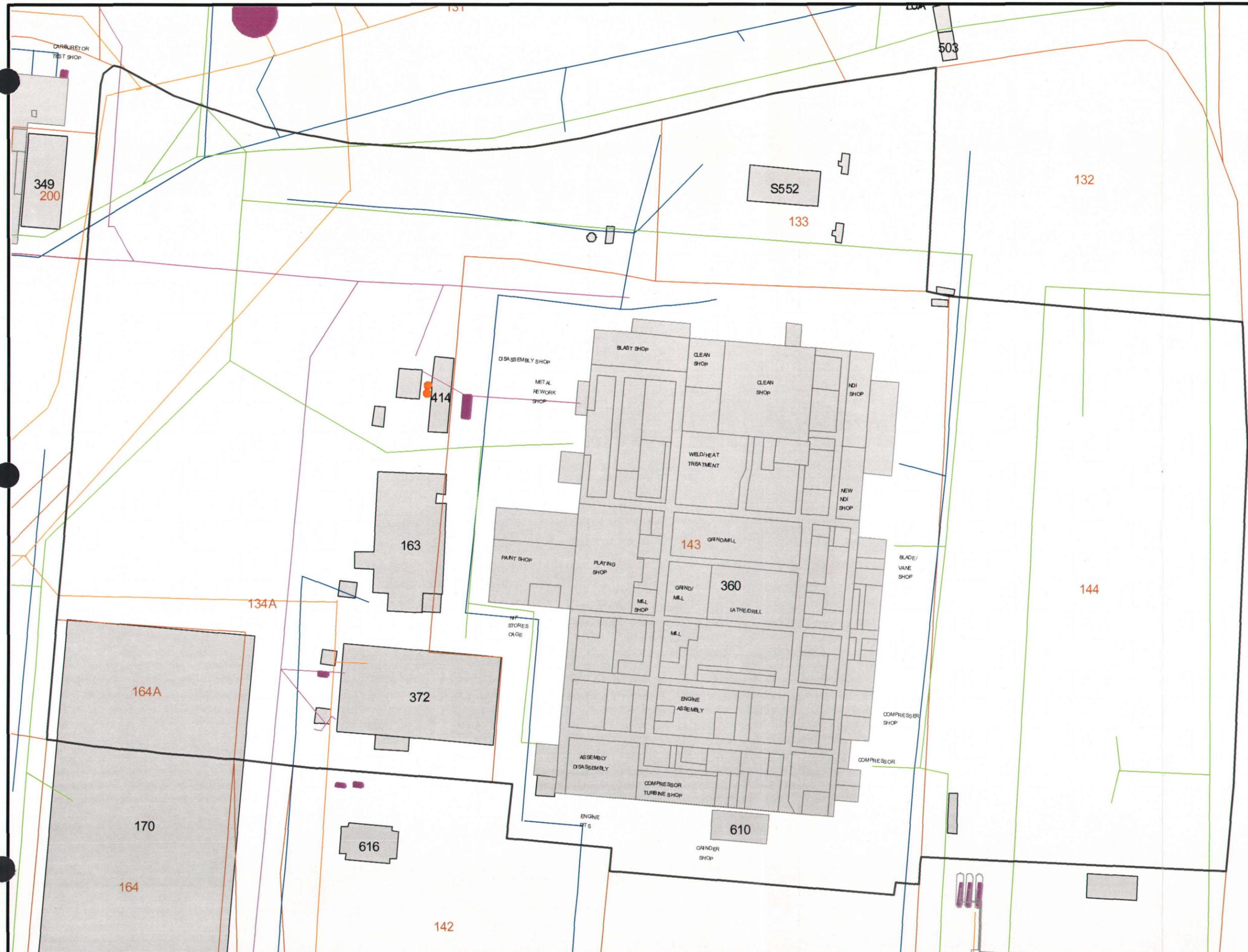
600 0 600 1200

SCALE: 1" = 1200'

**FIGURE 2-1
OPERABLE UNITS AND
INSTALLATION RESTORATION SITES**

ALAMEDA POINT
ALAMEDA, CALIFORNIA
AUGUST 24, 2001





- LEGEND**
- BOUNDARIES**
- ENVIRONMENTAL BASELINE
 - SURVEY PARCEL (EBS)
 - LAND COVER
 - IR SITE BOUNDARY
 - BUILDING
- SITE FEATURES**
- INDUSTRIAL WASTE LINE
 - FUEL LINE
 - SANITARY SEWER LINE
 - STORM SEWER LINE
 - ABOVEGROUND STORAGE TANKS
 - UNDERGROUND STORAGE TANKS

NOTE:
IR = INSTALLATION RESTORATION

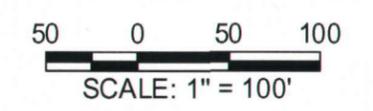


FIGURE 2-2
IR SITE 4 FEATURES

ALAMEDA POINT
ALAMEDA, CALIFORNIA
AUGUST 24, 2001





- LEGEND**
- BOUNDARIES**
- ENVIRONMENTAL BASELINE
 - SURVEY PARCEL (EBS)
 - LAND COVER
 - IR SITE BOUNDARY
 - BUILDING
- SITE FEATURES**
- INDUSTRIAL WASTE LINE
 - FUEL LINE
 - SANITARY SEWER LINE
 - STORM SEWER LINE
 - ABOVEGROUND STORAGE TANKS
 - UNDERGROUND STORAGE TANKS

NOTE:
IR = INSTALLATION RESTORATION

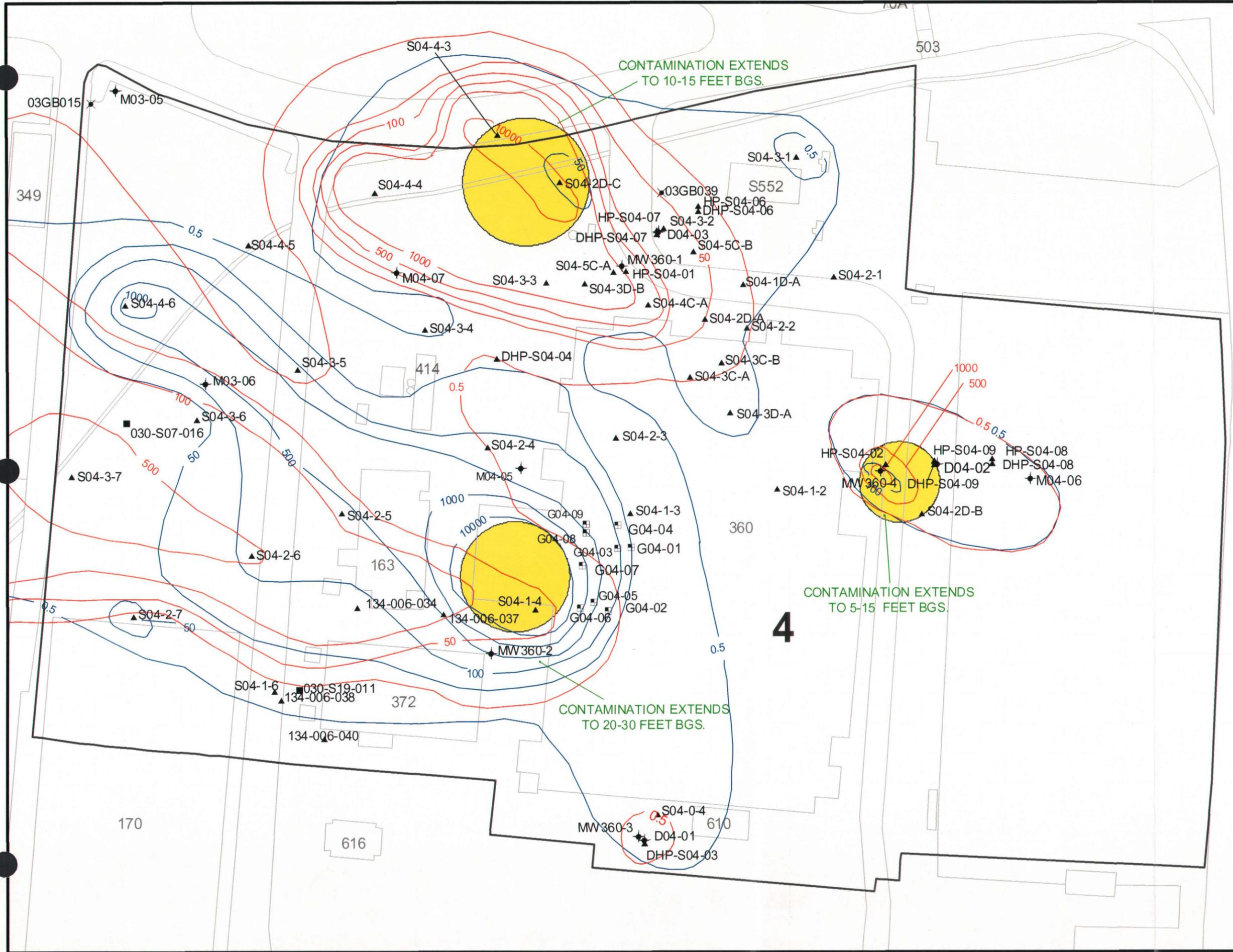


SCALE: 1" = 200'

FIGURE 2-3
IR SITE 5 FEATURES

ALAMEDA POINT
ALAMEDA, CALIFORNIA
AUGUST 24, 2001





LEGEND

BOUNDARIES

- BUILDING AND LAND COVER
- DNAPL REMOVAL AREAS
- IR SITE 4 BOUNDARY

POINT TYPES

- EXCAVATION
- ✕ GEOPROBE
- ▲ HYDROPUNCH
- ◆ MONITORING WELL
- SURFACE LOCATION

GROUNDWATER CONCENTRATION CONTOURS

- ▲ TRICHLOROETHENE PLUME (UG/L)
- ▲ 1,1-DICHLOROETHENE PLUME (UG/L)

NOTE:

- BGS = BELOW GROUND SURFACE
- DNAPL = DENSE NON-AQUEOUS PHASE LIQUID
- IR = INSTALLATION RESTORATION
- µg/L = MICROGRAM PER LITER

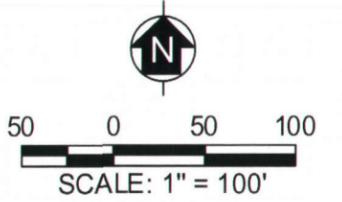
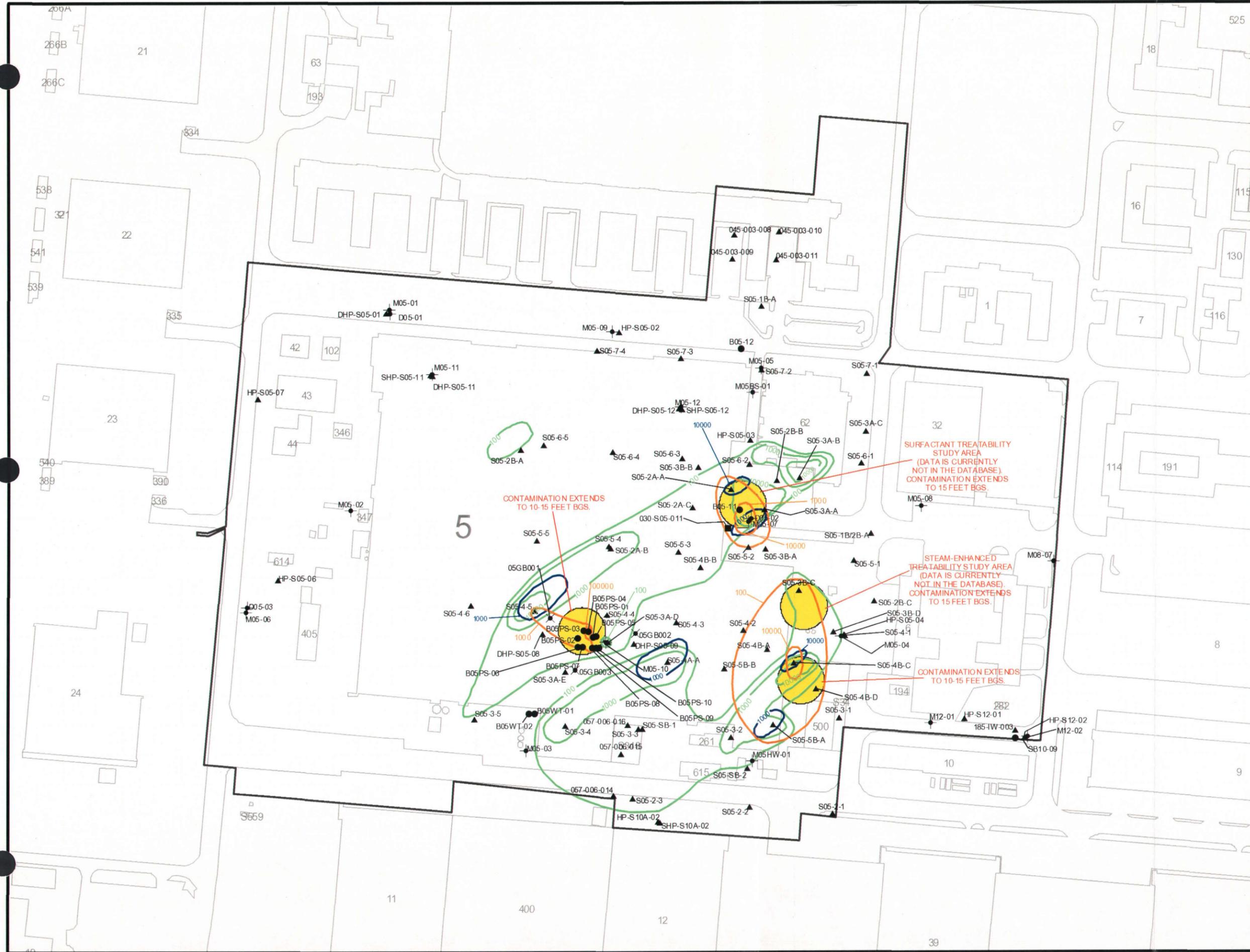


FIGURE 2-4
IR SITE 4
POTENTIAL DNAPL AND SOURCE
REMOVAL ACTION AREAS

ALAMEDA POINT
 ALAMEDA, CALIFORNIA
 AUGUST 24, 2001





LEGEND

BOUNDARIES

- BUILDING AND LAND COVER
- DNAPL REMOVAL AREAS
- IR SITE 5 BOUNDARY

POINT TYPES

- EXCAVATION
- GEOPROBE
- HYDROPUNCH
- MONITORING WELL
- SURFACE LOCATION

GROUNDWATER CONCENTRATION CONTOURS

- 1,1-DICHLOROETHENE PLUME (UG/L)
- 1,1-DICHLOROETHENE PLUME (UG/L)
- 1,1,1 TRICHLOROETHANE PLUME (UG/L)

NOTE:

- BGS = BELOW GROUND SURFACE
- DNAPL = DENSE NON-AQUEOUS PHASE LIQUID
- IR = INSTALLATION RESTORATION
- µg/L = MICROGRAM PER LITER

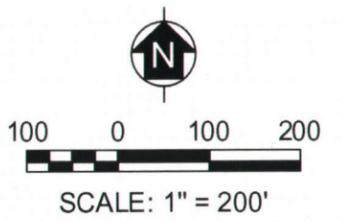


FIGURE 2-5
IR SITE 5
POTENTIAL DNAPL AND SOURCE
REMOVAL ACTION AREAS

ALAMEDA POINT
 ALAMEDA, CALIFORNIA
 AUGUST 24, 2001



3.0 THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT AND STATUTORY AND REGULATORY AUTHORITIES

In accordance with the NCP, 40 CFR, Section 300.415(b)(2), the Navy evaluated the potential for the following threats to determine the appropriateness of a removal action:

- (1) Actual or potential exposure to hazardous substances, pollutants, or contaminants of nearby populations, animals, and food chains
- (2) Actual or potential contamination of drinking water supplies and sensitive ecosystems
- (3) Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, and other bulk storage containers that may pose a threat of release
- (4) High levels of hazardous substances or pollutants or contaminants in soils largely at, or near, the surface, that may migrate
- (3) Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released
- (4) Threat of fire or explosion
- (7) Other situations or factors that may pose threats to human health or the environment

3.1 THREATS TO PUBLIC HEALTH OR WELFARE

IR Site 4

Two of the above threats apply to public health or welfare at IR Site 4.

- (1) **Actual or potential exposure to hazardous substances, pollutants, or contaminants of nearby populations, animals, and food chains**

There is a potential for exposure of human populations, animals, and food chains through volatilization and inhalation to DNAPL contaminants 1,1-DCE and TCE.

- (2) **Actual or potential contamination of drinking water supplies and sensitive ecosystems**

Groundwater at IR Site 4 is a potential drinking water source (TtEMI 2000). Whether nearby human populations, animals, or vegetation have been exposed to contaminants has

not been determined. However, there is a potential for exposure of human populations through ingestion and inhalation to potential DNAPL contaminants 1,1-DCE and TCE.

IR Site 5

Since groundwater at IR Site 5 is not a potential drinking water source (TtEMI 2000), only the following threat applies to public health or welfare at IR Site 5:

- (1) **Actual or potential exposure to hazardous substances, pollutants, or contaminants of nearby populations, animals, and food chains**

There is a potential for exposure of human populations through volatilization and inhalation to potential DNAPL contaminants TCE, 1,1-DCA, 1,1-DCE, 1,2-DCA, and 1,1,1-TCA.

3.2 THREATS TO THE ENVIRONMENT

IR Site 4

Two of the threats listed above apply to the environment at IR Site 4.

- (1) **Actual or potential exposure to hazardous substances, pollutants, or contaminants of nearby populations, animals, and food chains**

There is a potential for exposure of animal populations through volatilization and inhalation to potential DNAPL contaminants 1,1-DCE and TCE.

- (2) **Actual or potential contamination of drinking water supplies and sensitive ecosystems**

Groundwater at IR Site 4 is a potential drinking water source (TtEMI 2000). Whether nearby animal populations or vegetation have been exposed to contaminants has not been determined. However, there is a potential for exposure of animal populations through ingestion and inhalation to potential DNAPL contaminants 1,1-DCE and TCE.

IR Site 5

Since groundwater at IR Site 5 is not a potential drinking water source (TtEMI 2000), only the following threat factor listed applies to IR Site 5:

- (1) **Actual or potential exposure to hazardous substances, pollutants, or contaminants of nearby populations, animals, and food chains**

There is a potential for exposure of animal populations through volatilization and inhalation to potential DNAPL contaminants TCE, 1,1-DCA, 1,1-DCE, 1,2-DCA, and 1,1,1-TCA.

4.0 ENDANGERMENT DETERMINATION

Chlorinated solvents are present in groundwater at IR Sites 4 and 5 at concentrations high enough to indicate the presence of DNAPL and are recognized by the BCT as presenting a potential risk to public health, welfare, and the environment.

The NCP, 40 CFR Section 300.430(e)(2)(i)(A)(2), states "For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response. The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure".

Concentrations of COCs in groundwater beneath IR Site 4 are several orders of magnitude above the preliminary remediation goals (PRGs) published by the U.S. EPA, Region IX for tap water (Table 4-1). They are also several orders of magnitude greater than the concentrations that equate to a risk of 10^{-4} (also shown in the table). The concentrations that equate to a risk of 10^{-4} were estimated by multiplying the PRG by a factor of 100 (Table 4-1 first paragraph).

IR Site 5 is not a potential drinking water source, and risks associated with the COCs at the site are inhalation of the COC vapors that enter buildings. Therefore, the bottom half of Table 4-1 presents both the maximum concentrations of COCs in groundwater beneath IR Site 5, and the risk levels associated with those concentrations (Risks were calculated for exposure to volatilized chemicals from groundwater using the California-modified Johnson and Ettinger model. Model output and constants used in the calculation are included in Appendix C.) The table shows that the concentrations of COCs in the groundwater beneath Site 5 result in risks that are significantly higher than the NCP guidance from inhalation of the COCs in indoor air.

The COCs at IR Sites 4 and 5 were detected at concentrations up to four (4) orders of magnitude higher than the NCP, 40 CFR Section 300.430(e)(2)(i)(A)(2) upper end of the risk management range. If the removal action described in this AM is delayed or not implemented, actual or threatened releases of 1,1-DCE and TCE from IR Site 4 and 1,1,1-TCA, 1,1-DCA, 1,1-DCE, 1,2-DCA, and TCE from IR Site 5

may present an imminent and substantial danger to public health, welfare, or the environment through volatilization and inhalation.

TABLE 4-1

**RISKS ASSOCIATED WITH INGESTION OF GROUNDWATER
AT IR SITE 4
ALAMEDA POINT, ALAMEDA CALIFORNIA**

Chemical of Concern	Effect	Maximum Concentration Detected (µg/L)	Region IX PRG (µg/L)	10 ⁻⁴ Risk Concentration (µg/L)
1,1-Dichloroethene (1,1-DCE)	Carcinogenic	84,000	0.046	4.6
Trichloroethene (TCE)	Carcinogenic	11,000	1.60	160

**RISKS ASSOCIATED WITH INHALATION OF INDOOR AIR
AT IR SITE 5
ALAMEDA POINT, ALAMEDA CALIFORNIA**

Chemical of Concern	Effect	Maximum Concentration Detected (µg/L)	Calculated Risk Based on the Maximum Concentration Detected ¹	Hazard Index ¹
1,1-Dichloroethane (1,1-DCA)	Carcinogenic	57,000	2.8 x 10 ⁻⁵	-
1,1-Dichloroethene (1,1-DCE)	Carcinogenic	65,000	4.1 x 10 ⁻³	-
1,2-Dichloroethane (1,2-DCA)	Carcinogenic	73,000	1.4 x 10 ⁻⁴	-
1,1,1-Trichloroethane (1,1,1-TCA)	Non-carcinogenic	790,000	NC	1.3
Trichloroethene (TCE)	Carcinogenic	72,500	6.7 x 10 ⁻⁵	0.13

1. Reported values are groundwater concentrations associated with risks from inhalation of indoor vapors; calculated using the California-modified Johnson and Ettinger model.

Notes:

µg/L Micrograms per liter
 IR Installation Restoration
 NC Not calculated
 PRG Preliminary remediation goal

5.0 PROPOSED ACTION AND ESTIMATED COSTS

This following sections describe (1) the proposed removal action, (2) the contribution of the selected alternative to remedial performance, (3) alternatives evaluated, (4) the EE/CA report, (5) applicable or relevant and appropriate requirements (ARAR), (6) the removal action schedule, and (7) estimated costs.

5.1 PROPOSED REMOVAL ACTION

The following sections describe the proposed removal action, the contribution this removal action is expected to make toward remediation of the site, the alternatives that were evaluated during the EE/CA process, the EE/CA, ARARs, and the project schedule.

5.1.1 Proposed Removal Action Description

The goal of the removal action is to reduce chlorinated solvent concentrations beneath IR Sites 4 and 5 to 10,000 μ g/L, or to the extent technically and economically feasible. Source areas were defined for this removal action as chlorinated solvent concentrations exceeding 10,000 micrograms per liter (μ g/L), based on the 1 percent solubility concentration for each potential DNAPL constituent (see Table 1-1 in Appendix A). The 1 percent solubility for six of the contaminants is near or exceeds 10,000 μ g/L.

The proposed removal action for all treatment areas (Figures 2-4 and 2-5) is electrical heating with SVE. Six-phase electrical heating will be used to raise the temperature of soil and groundwater within the saturated zone. A central neutral electrode surrounded by six charged electrodes will be installed to promote an even distribution of heat throughout each treatment zone. Within each treatment zone, the heat will vaporize the groundwater creating an in situ source of steam, which will strip the COCs from saturated soil and groundwater. Vapor pressures of the COCs will increase by as much as 100 times as a result of these elevated temperatures, causing them to migrate into the unsaturated zone. An SVE system will be constructed to remove the volatilized COCs from the unsaturated zone. Vapors extracted by the SVE system will be treated using a condenser, knock-out drum, oil-water separator, with activated carbon units, and/or a thermal/catalytic-oxidizer.

The site-specific geology at IR Sites 4 and 5 is well suited to the proposed removal actions. The unsaturated zone at IR Site 4 consists of artificial fill composed of fine silty-sand with traces of gravel and brick fragments. These soil materials have an estimated effective porosity of nearly 40 percent and a moderate permeability that does not appear to be a limiting factor on the vapor extraction processes with the exception that there may be some groundwater mounding during the initial phases of vacuum startup, however, as the groundwater is heated to boiling, the mounding should be reduced, increasing the achievable air flow through the SVE well.

The unsaturated zone at IR Site 5 is also composed of artificial fill materials. These materials are somewhat coarser than the fill materials at IR Site 4 with fine-to-medium sand, with lenses of silty sand, gravelly sand, or sandy gravel. These materials have an estimated effective porosity of more than 30 percent and a relatively good permeability that should not pose any limiting factors for the vapor extraction process.

Three treatment areas have been identified at IR Site 4 for treatment and four areas at IR Site 5. The goal of the removal action is to reduce the concentration of COCs dissolved in groundwater to less than 10,000 ug/L. Currently, the Navy estimates that 4 to 6 weeks will be required for the six-phase electrical heating system to reduce the concentrations at each site to this level. A pilot study will be conducted prior to full implementation of the system, and will provide data that will allow the Navy to refine its estimate of the cleanup time. The system will be operated at each of the targeted cleanup areas for the time period derived from the pilot study data. The system will be shut down after the specified time period, and after two weeks, monitoring wells will be sampled to determine the concentrations of COCs dissolved in groundwater. If the concentrations still exceed 10,000 ug/L, the system will resume operation. If the concentrations are below 10,000 ug/L, the site will remain idle for 90 days, at which time the wells will be re-sampled to confirm that the cleanup goal has been met. If concentrations rebound to greater than 10,000 ug/L, the site will require further treatment. A closure report will be prepared following the completion of field activities. Further discussion and analysis of this alternative are presented in Sections 4.0 through 6.0 of the EE/CA report, included as Appendix A.

5.1.2 Contribution to Remedial Performance

The proposed removal action should decrease COC concentrations and reduce risks of human and ecological exposure. The removal action is intended to be an interim measure and not the final remedy

for groundwater at these sites. This removal action will be followed by further risk evaluation and possible risk reduction pursuant to a FS and final record of decision (ROD) for the sites.

5.1.3 Description of Alternatives

Four removal alternatives were developed and evaluated for their effectiveness, implementability and cost, based on the removal action objectives for IR Sites 4 and 5. These alternatives were (1) no action, (2) in situ chemical oxidation, (3) steam injection with SVE, and (4) electrical heating with SVE. The evaluations of the four alternatives are summarized in Table 5-1. The table highlights the effectiveness, implementability, and cost of each alternative. More detailed descriptions, analysis, and comparison of the removal action alternatives are provided in Sections 4.0 and 5.0 of the EE/CA report, included as Appendix A.

5.1.4 Engineering Evaluation and Cost Analysis

A draft EE/CA report, dated January 5, 2001, was prepared in accordance with current EPA and U.S. Navy guidance documents for a non-time-critical removal action under CERCLA and Chapter 6.8 of the Ca-HSC. The EE/CA has been included as Appendix A. The purpose of the EE/CA was to identify and analyze removal action alternatives and recommend the best alternative for the removal of contaminants in the areas suspected to be sources of DNAPL. The scope of potential removal actions evaluated in the EE/CA were limited to the removal of DNAPL and the reduction of high concentrations of dissolved phase chlorinated solvents.

The following alternatives were evaluated:

Alternative 1: No action

Alternative 2: In situ chemical oxidation

Alternative 3: Steam injection and soil vapor extraction (SVE)

Alternative 4: Electrical heating with SVE

A comparative analysis of these alternatives was conducted according to the SWDIV guidance for preparing EE/CAs. The Navy analyzed these alternatives based on general principles of effectiveness, implementability and cost, and the specific evaluation criteria set forth in 40 CFR 300.430(e)(9). Based on the evaluation of the alternatives contained within the EE/CA, the Navy recommended Alternative 4,

electrical heating with soil vapor extraction, for the removal of DNAPL and elevated concentrations of chlorinated solvents in groundwater at IR Sites 4 and 5.

5.1.5 Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA (42 United States Code [U.S.C.] Section [§] 9621[d]), as amended, states that remedial actions at CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations determined to be legally applicable or relevant and appropriate. Although Section 121 of CERCLA does not itself expressly require that CERCLA removal actions comply with ARARs, EPA has promulgated a requirement in the NCP mandating that CERCLA removal actions “. . . shall, to the extent practicable considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under federal environmental or state environmental or facility siting laws” (Title 40 C.F.R. § 300.415[j]). Certain specified waivers may be used for removal actions, as is the case with remedial actions.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. The requirement is applicable if the jurisdictional prerequisites of the standard show a direct correspondence when objectively compared to the conditions at the site. An applicable federal requirement is an ARAR. An applicable state requirement is an ARAR only if it is more stringent than federal ARARs.

If the requirement is not legally applicable, then the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations similar to the circumstances of the proposed response action and are well suited to the conditions of the site (U.S. EPA 1988a). A requirement must be determined to be both relevant and appropriate in order to be considered an ARAR.

The criteria for determining relevance and appropriateness are listed in 40 C.F.R. § 300.400(g)(2) and include the following:

- the purpose of the requirement and the purpose of the CERCLA action;

- the medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;
- the substances regulated by the requirement and the substances found at the CERCLA site;
- any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site;
- the type of place regulated and the type of place affected by the release or CERCLA action;
- the type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action; and
- any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site.

According to CERCLA ARARs guidance (U.S. EPA 1988a), a requirement may be “applicable” or “relevant and appropriate,” but not both. Identification of ARARs must be done on a site-specific basis and involve a two-part analysis: first, a determination whether a given requirement is applicable; then, if it is not applicable, a determination whether it is nevertheless both relevant and appropriate. It is important to explain that some regulations may be applicable or, if not applicable, may still be relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (U.S. EPA 1988b).

Tables 5-2, 5-3 and 5-4 present each potential ARAR with a determination of ARAR status (i.e., applicable, relevant and appropriate, or not an ARAR). For the determination of relevance and appropriateness, the pertinent criteria were examined to determine whether the requirements addressed problems or situations sufficiently similar to the circumstances of the release or response action contemplated, and whether the requirement was well suited to the site. A negative determination of relevance and appropriateness indicates that the requirement did not meet the pertinent criteria.

To qualify as a state ARAR under CERCLA and the NCP, a state requirement must be:

- a state law,
- an environmental or facility siting law,
- promulgated (of general applicability and legally enforceable),
- substantive (not procedural or administrative),
- more stringent than the federal requirement,

- identified in a timely manner, and
- consistently applied.

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered to be ARARs. Permits are considered to be procedural or administrative requirements. Provisions of generally relevant federal and state statutes and regulations that were determined to be procedural or non-environmental, including permit requirements, are not considered to be ARARs. CERCLA 121(e)(1), 42 U.S.C. § 9621(e)(1), states that “No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with this section.” The term “on-site” is defined for purposes of this ARARs discussion as “the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action” (40 C.F.R. § 300.5).

Nonpromulgated advisories or guidance issued by federal or state governments are not legally binding and do not have the status of ARARs. Such requirements may, however, be useful, and are “to be considered” (TBC). TBC (40 C.F.R. § 300.400[g][3]) requirements complement ARARs but do not override them. They are useful for guiding decisions regarding cleanup levels or methodologies when regulatory standards are not available.

Pursuant to U.S. EPA guidance (U.S. EPA 1988a), ARARs are generally divided into three categories: chemical-specific, location-specific, and action-specific requirements. Chemical-specific ARARs set limits on concentrations of specific hazardous substances, contaminants, and pollutants in the environment. Examples of this type of ARAR are ambient water quality criteria and drinking water standards. Location-specific requirements set restrictions on certain types of activities based on site characteristics. These include restrictions on activities in wetlands, floodplains, and historic sites.

Action-specific requirements are technology-based restrictions, which are triggered by the type of action under consideration. This classification was developed to aid in the identification of ARARs; some ARARs do not fall precisely into one group or another. ARARs must be identified on a site-specific basis from information about specific chemicals at the site, specific features of the site location, and actions that are being considered as removal actions.

As the lead federal agency, the Navy has primary responsibility for identifying federal ARARs for NAS Alameda IR Sites 4 and 5. The Navy has identified ARARs for the proposed removal action. State

ARARs were solicited by the Navy in a letter to DTSC on December 27, 2000. In a letter dated February 8, 2001, DTSC responded to the Navy, stating that DTSC was reviewing the original ARARs provided in 1996, and would provide any changes to the Navy (see Appendix D). The results of this analysis are pending. These ARARs and to be considered (TBC) criteria are presented in the discussion below and in the tables at the end of this section. Table 5-2 summarizes chemical-specific ARARs and TBC criteria, Table 5-3 highlights location-specific ARARs, and Table 5-4 describes action-specific ARARs. More detailed information on the ARARs is provided in Section 3.4 of the EE/CA report.

5.1.5.1 Chemical-Specific ARARs

The scope of this removal action is removal of DNAPL and chlorinated solvent source areas in the aquifer at IR Sites 4 and 5. Chemical-specific requirements exist as a guidance for classifying groundwater and surface water beneficial uses, groundwater concentration limits, and ambient surface water quality standards that may be affected by groundwater discharge to surface water. This removal action is an interim measure whose principal goal is site stabilization, and not long-range cleanup. Requirements that are outside the scope of the immediate action therefore are not ARARs but will be included as TBCs.

For this removal action, the only chemical-specific ARARs are those requirements under the Resource Conservation and Recovery Act (RCRA) relating to the identification of hazardous waste. Any waste generated as a result of the installation of the electrical heating and SVE system will be analyzed to determine if it is a hazardous waste. The applicability of RCRA hazardous waste management requirements depends on whether the activity generates a waste; whether the waste is a RCRA hazardous waste; whether the waste initially underwent treatment, storage, or disposal after the date of the particular RCRA requirement; and whether the activity at the site constitutes treatment, storage, or disposal as defined by RCRA. However, RCRA requirements may be relevant and appropriate even if they are not applicable. Examples include activities that are similar to the definition of RCRA treatment, storage, or disposal for waste that is similar to RCRA hazardous waste.

The determination of whether a waste is a RCRA hazardous waste can be made by comparing the site waste to the definition of RCRA hazardous waste. The RCRA requirements at 22 California Code of Regulations (CCR) § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1) and 66261.100 are ARARs because they define RCRA hazardous waste. In particular, a waste can meet the definition of hazardous waste if it has the toxicity characteristic of hazardous waste. This determination is made by using the toxicity characteristic leaching procedure (TCLP). The California regulation at 22 CCR

§66261.24(a)(1)(B) lists the maximum concentrations allowable for the TCLP and is a federal ARAR for determining whether the site has hazardous waste. If the site has concentrations exceeding these values, it is determined to be a characteristic RCRA hazardous waste.

All contaminated water generated as a result of the removal action will be treated and disposed of at a publicly owned treatment works (POTW). There will be no discharge to surface waters. Therefore the Clean Water Act surface water quality criteria and standards are not ARARs or TBCs.

One of the significant issues in identifying ARARs for groundwater under the Safe Drinking Water Act (SDWA) and RCRA is whether the groundwater at the site can be classified as a source of drinking water. Federal maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) developed by U.S. EPA under the SDWA are potential federal ARARs. The point of compliance for MCLGs and MCLs under the SDWA is at the tap. Therefore MCLs and MCLGs are not applicable ARARs at Navy sites. However, MCLs and MCLGs are often considered relevant and appropriate as remediation goals for current or potential drinking water sources. Although groundwater at Site 4 is a potential drinking water source, the removal action is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement. Groundwater is not a potential drinking water source at Site 5.

5.1.5.2 Location Specific ARARs

Location-specific ARARs are restrictions on the concentrations of hazardous substances or on the conduct of activities solely because they are in specific locations. Specific locations include flood plains, wetlands, historic places, and sensitive ecosystems or habitats. Several site conditions at Alameda Point are associated with location-specific ARARs. Requirements such as the Endangered Species Act, the National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA), the Migratory Bird Treaty Act, the National Historic Preservation Act, the Archeological Resources Protection Act, and the Coastal Zone Management Act (CZMA) were considered as potential location-specific ARARs. IR Sites 4 and 5 do not provide any habitat for threatened or endangered species, and no endangered species have been observed at the site, thus the Endangered Species Act is not an ARAR. Additionally, IR Sites 4 and 5 do not encompass any historic properties included or eligible for inclusion on the National Register of Historic Places. No scientific, prehistoric, or archeological data have been identified at the sites. Also, EPA and the Navy have determined that the requirements of NEPA and

CEQA are no more stringent than the requirements for environmental review under CERCLA and the NCP. Hence, NEPA and CEQA were not considered ARARs for CERCLA actions.

Section 307 (c)(1) of the CZMA (16 USC §1456(c)(1)) and the implementing regulations in 15 CFR §930 and 923.45 require that federal agencies conducting or supporting activities directly affecting the coastal zone conduct or support those activities in a manner that is consistent with the approved state coastal zone management programs. A state coastal zone management program (developed under state law and guided by the CZMA) sets forth objectives, policies, and standards to guide public and private uses of lands and water in the coastal zone.

California's approved coastal management program includes the San Francisco Bay Plan (Bay Plan) developed by the San Francisco Bay Conservation and Development Commission (BCDC). The BCDC was formed under authority of the McAteer-Petris Act (California Government Code §66600 and the following sections), which authorizes the BCDC to regulate activities within San Francisco Bay and the shoreline (100 feet landward from the shoreline) in conformity with the policies of the Bay Plan (BCDC, 1968). The Bay Plan's policies include limiting Bay filling, maintaining marshes and mudflats to the fullest extent possible to conserve wildlife and abate pollution, and protect the beneficial uses of the Bay. IR Sites 4 and 5 are located adjacent to the coastal zone such that this removal action could affect the coastal zone. Therefore, all removal action alternatives will be consistent with the goals of the Bay Plan and will conform to the substantive requirements of the state management program. This ARAR is summarized in Table 5-3.

5.1.5.3 Action-Specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations for activities conducted during remedial and removal actions. These requirements are triggered by the particular remedial activities selected and suggest how a selected removal alternative should be achieved. These action-specific requirements do not in themselves determine the removal alternative; rather, they indicate how a selected alternative must be conducted. Therefore, because action-specific ARARs depend on the action selected, they are identified after an alternative has been selected.

For the electrical heating and SVE system, as discussed below, the federal action-specific ARARs consist of RCRA hazardous waste classification requirements, RCRA hazardous waste accumulation requirements and Bay Area Air Quality Management District (BAAQMD) Rules 8-47-301 and 8-47-302.

California Regional Water Quality Control Board Resolution 88-160 and Title 23 CCR Section 2655 are state action-specific ARARs.

Soil cuttings and water generated in the course of installing and operating the electrical heating and SVE system are subject to the RCRA requirements identified as chemical-specific ARARs to determine whether such wastes would be classified as hazardous. Any hazardous waste accumulated on site, including soil cuttings and contaminated groundwater, must comply with the RCRA requirements set forth at 22 CCR §66262.34. This section permits on-site hazardous waste accumulation for up to 90 days as long as the waste is properly stored and labeled.

The federal Clean Air Act (CAA), 42 USC §§7401, and the following sections, establishes the National Ambient Air Quality Standards (NAAQS). NAAQS are not enforceable in and of themselves; they are translated into source-specific emission limitations by the state. Substantive requirements of the BAAQMD that have been approved by EPA as part of the state implementation plan (SIP) under the CAA are potential federal ARARs for air emissions (CAA Section 110). Off-gas from SVE operations will comply with Rules 8-47-301 and 8-47-302.

For hazardous waste sent off site for disposal at a disposal facility (such as excavated soil or dewatering water), the Navy will comply with the EPA Off-Site Disposal Policy. In addition, the following RCRA requirements are ARARs: the RCRA pre-transport regulations at 22 CCR §§ 66262.30(packaging), 66262.31(labeling), 66262.32 (marking) and 66262.33 (placarding); and RCRA manifest requirements at 22 CCR §§ 66262.20, 66262.21, 66252.22 and 66262.23. The regulations implementing the RCRA land disposal restrictions (LDR); including applicable LDR treatment standards at 22 CCR §66268.7 are also ARARs. Prior to sending any waste off-site, the Navy will determine whether the waste is subject to LDR and will provide the required notices and certifications of 22 CCR § 66268.7. In addition, the DOT hazardous materials regulations at 49 CFR 171-172 are also ARARs for transporting hazardous materials on-site.

Any contaminated groundwater generated as a result of the SVE system will be disposed of in accordance with California Regional Water Quality Control Board Resolution 88-160 which establishes priorities for the disposal of water extracted from groundwater cleanups and is a state ARAR. The first priority is reuse, the second is discharge to a municipal treatment plant, and if neither reclamation nor discharge to a municipal treatment plant is feasible, discharge pursuant to an National Pollution Discharge Elimination

System permit. It is expected that any contaminated groundwater generated will be treated and discharged to a POTW.

Title 23, CCR §2655, a California underground storage tank regulation, requires the removal of free product to the maximum extent practicable. This section also contains numerous administrative requirements including the preparation of a free product removal report. To the extent 23 CCR §2655 contains substantive requirements, it is a state ARAR if free product as a result of a release from an underground storage tank is encountered during removal activities.

5.1.6 Project Schedule

The AM, Removal Action Work Plan, and FSP/QAPP for the post-removal action confirmation sampling are scheduled for completion in August 2001, with the removal action itself scheduled to begin in September 2001. The removal action is scheduled to continue for one year, with a closeout report to be prepared by October 2002.

5.2

ESTIMATED COSTS

A present worth estimate has been developed for electrical heating with SVE at IR Sites 4 and 5. Vendor quotes for Six-phase heating (SPH) ranged from \$70 to \$120 per cubic yard treated. The estimated costs include direct and Operations and maintenance (O&M) costs. The following items are considered capital costs and O&M costs:

IR Site 4**Capital Costs:**

Design and Permit costs	\$ 69,000
Construction and Startup costs	\$ 784,000
Drill Cutting Disposal costs	\$ 8,000
Power Drop Fee	\$ 30,000
Demobilization and Report costs	\$ 194,000

O&M Costs

Operation and Maintenance (38-weeks)	\$ 258,000
Activated Carbon costs	\$ 71,000
Electricity costs	\$ 321,000
Condensate Disposal costs	\$ 5,000

Site 4 (29,757 cubic yards estimated)

Capital	\$ 1,085,000
O&M	\$ 655,000
Total Site 4:	\$ 1,740,000

IR Site 5

Capital Costs:

Design and Permit costs	\$ 48,000
Construction and Startup costs	\$ 550,000
Drill Cutting Disposal costs	\$ 5,000
Power Drop Fee	\$ 30,000
Demobilization and Report costs	\$ 136,000

O&M Costs

Operation and Maintenance (8-weeks)	\$ 180,000
Activated Carbon costs	\$ 49,000
Electricity costs	\$ 225,000
Condensate Disposal costs	\$ 14,000

Site 5 (12,102 cubic yards estimated)

Capital	\$ 769,000
O&M	\$ 468,000
Total Site 5:	\$ 1,237,000

Based on vendor estimates approximately 62% of the total cost will be capital costs and 38% will be O&M costs. The total estimated costs (including Removal Action Contractor (RAC) Markup) for the proposed action are as follows:

IR Site 4	\$ 1,740,000
+20% RAC Markup	\$ 348,000
IR Site 5	\$ 1,237,000
+20% RAC Markup	\$ 247,000

Removal Action Total for both Sites \$ 3,572,000

TABLE 5-1

INSTALLATION RESTORATION SITES 4 AND 5
 COMPARATIVE ANALYSIS OF ALTERNATIVES
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 1 of 4)

Criteria	Alternative 1: No Action		Alternative 2: In Situ Chemical Oxidation		Alternative 3: Steam Injection and Soil Vapor Extraction		Alternative 4: Electrical Heating and Soil Vapor Extraction	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score
EFFECTIVENESS								
1. Overall Protection of Human Health and the Environment	No protection is provided; and potential for exposure exists.	--	Contaminant concentration would decrease in a short period of time; it is more effective when DNAPL is not present; and there is a potential explosion hazard if free petroleum product is present.	6	The hot spot would decrease in a very short period of time; the DNAPL source would be removed; and short-circuiting could occur beneath buildings.	7	The hot spot would decrease in a very short period of time; the DNAPL source would be removed; and short-circuiting is minimized because heat is distributed by electrical conduction.	10
2. Compliance with ARARs	ARARs would not apply; ultimate remediation goals would not be met.	--	Construction ARARs would be met.	7	Construction ARARs would be met; air emission monitoring is required; and extracted groundwater disposal is necessary.	5	Construction ARARs would be met; air emission monitoring is required; and extracted groundwater disposal is necessary.	6
3. Short-term Effectiveness	This is highly because no action is taken.	--	Construction workers can be exposed to COCs; hexavalent chromium can be produced; and oxidizing chemicals require special handling.	4	Construction workers can be exposed to COCs; and exposure to steam can occur during operation.	6	Construction workers can be exposed to COCs; and electric safety hazard is present.	8

TABLE 5-1

INSTALLATION RESTORATION SITES 4 AND 5
 COMPARATIVE ANALYSIS OF ALTERNATIVES
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 2 of 4)

Criteria	Alternative 1: No Action		Alternative 2: In Situ Chemical Oxidation		Alternative 3: Steam Injection and Soil Vapor Extraction		Alternative 4: Electrical Heating and Soil Vapor Extraction	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score
4. Long-term Effectiveness and Permanence	Low effectiveness is provided for ecological receptors.	--	It would be effective in the long term if hydraulic short-circuiting and rebound do not occur.	6	It would be effective in the long term if hydraulic short-circuiting does not occur.	6	It offers the highest long-term effectiveness for DNAPL because hydraulic short-circuiting would not occur.	10
5. Reduction in Toxicity, Mobility, and Volume through Treatment	No treatment is proposed.	--	It would effectively reduce toxicity, mobility, and volume of COCs; and potential hexavalent chromium formation is reported to reduce back to trivalent chromium after oxidation ceases.	8	Reduction in mobility would be achieved; GAC would most likely be used for extracted groundwater and vapors; and reduction in COC volume and toxicity would ultimately be achieved during carbon regeneration.	7	Reduction in mobility would be achieved; GAC would most likely be used for extracted vapors; and reduction in COC volume and toxicity would ultimately be achieved during carbon regeneration.	7

TABLE 5-1

INSTALLATION RESTORATION SITES 4 AND 5
 COMPARATIVE ANALYSIS OF ALTERNATIVES
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 3 of 4)

Criteria	Alternative 1: No Action		Alternative 2: In Situ Chemical Oxidation		Alternative 3: Steam Injection and Soil Vapor Extraction		Alternative 4: Electrical Heating and Soil Vapor Extraction	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score
IMPLEMENTABILITY								
6. Technical Implementability	It is easy to implement.	--	It is moderately easy to implement; and pilot tests would be performed to optimize the system.	7	It is moderately easy to implement and technically capable of treating DNAPL; pilot tests would be performed to optimize the system; and vendors are available.	6	It is moderately easy to implement and technically capable of treating DNAPL; pilot tests would be performed to optimize the system; and vendors are available.	6
7. Community and Regulatory Acceptance	Regulators and the community are unlikely to accept no action.	--	Regulators and the community are most likely to accept it if light nonaqueous phase liquid and methane are not present.	7	Regulators and the community are likely to accept this technology because it has been demonstrated to be effective for nonaqueous phase liquid removal at IR Site 5.	9	Regulators and the community are likely to accept this technology because it has been demonstrated to be effective at similar areas.	9
8. Cost	\$0	--	\$726,120 for IR Site 5 \$ 1.2 Million for IR Site 4	6	\$1.8 Million for IR Site 5 \$ 3.0 Million for IR Site 4, including GAC	1	\$1.5 Million for IR Site 5 \$2.1 Million for IR Site 4	3
Overall Ranking	--	--	--	49	--	51	--	62

TABLE 5-1

INSTALLATION RESTORATION SITES 4 AND 5
 COMPARATIVE ANALYSIS OF ALTERNATIVES
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 4 of 4)

Criteria	Alternative 1: No Action		Alternative 2: In Situ Chemical Oxidation		Alternative 3: Steam Injection and Soil Vapor Extraction		Alternative 4: Electrical Heating and Soil Vapor Extraction	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score
<u>Effectiveness Criteria</u>	<u>Implementability Criteria</u>				<u>Cost</u>			
1 = ineffective	1 = implementable with difficulty				1 = high cost			
5 = moderately effective	5 = implementable				5 = moderate cost			
10 = highly effective	10 = easily implementable				10 = low cost			

Notes:

-- Not applicable
 ARAR Applicable or relevant and appropriate requirement
 COC Contaminant of concern

DNAPL Dense nonaqueous phase liquid
 GAC Granular activated carbon
 IR Installation Restoration

TABLE 5-2

INSTALLATION RESTORATION SITES 4 AND 5 CHEMICAL-SPECIFIC
 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 1 of 1)

Statutory Citation	Regulatory Citation	Medium	Description	ARAR Determination	Comments
Federal Requirements					
California State Drinking Water Act (California Health and Safety Code Section 116365)	26 CCR 22-64444	Water	Establishes MCL for public water systems	To be considered	To be considered criterion is used for IR Site 4 because groundwater is a potential drinking water source.
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 and the sections that follow)	22 CCR 66261.21 66262.22(a)(1) 66261.23 66261.24(a)(1) 66261.100	Water and Soil	Criteria for identifying characteristics of RCRA hazardous waste	Applicable	These requirements are applicable for determining whether excavated media contain hazardous waste.

Notes:

ARAR Applicable or relevant and appropriate requirement
 CCR California Code of Regulations
 IR Installation Restoration
 L-DR Land disposal restrictions

MCL Maximum contaminant level
 RCRA Resource Conservation and Recovery Act
 USC U.S. Code

TABLE 5-3

INSTALLATION RESTORATION SITES 4 AND 5 FEDERAL LOCATION AND LOCATION-SPECIFIC
 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
 AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 1 of 1)

Statutory Citation	Regulatory Citation	Medium	Description	ARAR Determination	Comments
Federal Requirements					
Coastal Zone Management Act (16 USC 1456(c)(1)) and McAteer-Petris Act (Government Code Section 66600 and the sections that follow)	15 CFR 930 and 923.45	Water and soil	Federal actions that affect land or water use in coastal zones should be conducted in a manner that is consistent with state coastal zone management programs. The state management program for San Francisco Bay is described in the BCDC San Francisco Bay Plan, enacted under authority of the McAteer-Petris Act of 1969.	Relevant and appropriate, neither site is within 100 feet of shoreline.	IR Sites 4 and 5 are located adjacent to the coastal zone. Removal action alternatives may affect the coastal zone. These alternatives will be implemented so that they are consistent with the San Francisco Bay Conservation and Development Commission's San Francisco Bay Plan.

Notes:

- ARAR Applicable or relevant and appropriate requirement
- BCDC San Francisco Bay Conservation and Development Commission
- CFR Code of Federal Regulations
- IR Installation Restoration
- USC U.S. Code

TABLE 5-4

**INSTALLATION RESTORATION SITES 4 AND 5 ACTION-SPECIFIC
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 1 of 5)**

Statutory Citation	Regulatory Citation	Medium	Description	ARAR Determination	Comments
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 et seq.)	22 CCR, Division 4.5, Chapter 14, §§ 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1) and 66261.100	Soil and water	Criteria for classifying excavated material	Applicable	The requirements of 22 CCR, Division 4.5, Chapter 14 are applicable for determining whether excavated material contains hazardous waste. These requirements may be relevant and appropriate to excavated material that is similar or identical to RCRA hazardous waste or non-RCRA hazardous waste
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 et seq.)	22 CCR, Division 4.5, Chapter 12 § 66262.34	Soil and water	Requirements for accumulation of hazardous waste	Applicable	These requirements are applicable if hazardous waste is generated and accumulated on-site before transport.
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 et seq.)	22 CCR, Division 4.5, Chapter 12 § 66262.30	Soil and water	Requires that hazardous waste be packaged in accordance with DOT regulations prior to transporting	Applicable	These requirements are applicable if hazardous waste is to be transported.
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 et seq.)	22 CCR, Division 4.5, Chapter 12 § 66262.31	Soil and water	Requires that hazardous waste be labeled in accordance with DOT regulations prior to transporting	Applicable	These requirements are applicable if hazardous waste is to be transported.

TABLE 5-4

INSTALLATION RESTORATION SITES 4 AND 5 ACTION-SPECIFIC
 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
 AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 2 of 5)

Statutory Citation	Regulatory Citation	Medium	Description	ARAR Determination	Comments
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 et seq.)	22 CCR, Division 4.5, Chapter 12 § 66262.32	Soil and water	Requires that hazardous waste be marked in accordance with DOT regulations prior to transporting	Applicable	These requirements are applicable if hazardous waste is to be transported.
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 et seq.)	22 CCR, Division 4.5, Chapter 12 § 66262.33	Soil and water	Requires transport vehicle be placarded in accordance with DOT regulations prior to transport of hazardous waste.	Applicable	These requirements are applicable if hazardous waste is to be transported.
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 et seq.)	22 CCR, Division 4.5, Chapter 12 § 66262.20-66262.23	Soil and water	Requires preparation of a manifest for transport of hazardous waste off-site.	Applicable	These requirements are applicable if hazardous waste is to be transported.

TABLE 5-4

INSTALLATION RESTORATION SITES 4 AND 5 ACTION-SPECIFIC
 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
 AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 3 of 5)

Statutory Citation	Regulatory Citation	Medium	Description	ARAR Determination	Comments
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 et seq.)	22 CCR, Division 4.5, Chapter 18 § 66268.7	Soil and water	Requires generators of hazardous waste to determine if waste has to be treated before it can be land disposed. Requires generators to notify treatment facility if a waste is subject to land disposal restrictions and does not meet applicable treatment standards. If the waste meets treatment standards, generators must sign a certification.	Applicable	These requirements are applicable if hazardous waste is to be land disposed.
Clean Air Act (42 USC §7401 et seq.)	Bay Area Air Quality Management District Regulations 8-47-301 and 302	Air	Sets forth emission control requirements for soil vapor extraction	Applicable	Applies to soil vapor extraction system.

TABLE 5-4

**INSTALLATION RESTORATION SITES 4 AND 5 ACTION-SPECIFIC
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 4 of 5)**

Statutory Citation	Regulatory Citation	Medium	Description	ARAR Determination	Comments
Transportation of hazardous material 49 U.S.C. §§ 5101-5127	49 C.F.R. § 171.2(f), 171.2(g), 172.300, 172.301, 172.302, 172.303, 172.304, 172.312, 172.400, 172.504	Soil and water	Sets forth requirements for transporting hazardous waste including representations that containers are safe, prohibitions on altering labels, marking requirements, labeling requirements and placarding requirements.	Relevant and appropriate	Relevant and appropriate for transporting hazardous materials on-site.
California Regional Water Quality Control Board Resolution 88-160		Water	Sets forth priority scheme for disposing of contaminated water during cleanup actions.	Applicable	All water generated as a result of the electrical heating system will be disposed of in accordance with Resolution 88-160.
California Underground Storage Tank Release Reporting and Initial Abatement Requirements	23 CCR Chapter 16, Div. 3 Article 5, § 2655	Water	Sets forth requirements for removal of free product from underground storage tanks.	Applicable	If free product from an underground storage tanks is discovered, this section is applicable to the extent it contains substantive requirements.

Notes:

- ARAR Applicable or relevant and appropriate requirement
- CAMU Corrective Action Management Unit
- CCR California Code of Regulations
- CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
- CFR Code of Federal Regulations

TABLE 5-4

**INSTALLATION RESTORATION SITES 4 AND 5 ACTION-SPECIFIC
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 5 of 5)**

DTSC	Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
HSC	Health and Safety Code
IR	Installation Restoration
MCL	Maximum contaminant level
USC	U.S. Code

6.0 EXPECTED CHANGE SHOULD REMOVAL ACTION BE DELAYED OR NOT TAKEN

If action should be delayed or not taken, exposure of human populations and ecological receptors to DNAPL and chlorinated solvents will continue from exposure to groundwater. Contamination will most likely spread from IR Sites 4 and 5 to nearby areas from groundwater migration. This spread of contamination would result in an increased health risk to the exposed population. Delayed action will also increase public health risks to the adjacent population through prolonged exposure to chlorinated solvents through ingestion, volatilization, and inhalation.

If the action should be delayed or not taken, contamination will be allowed to continue to migrate, thereby, potentially resulting in a greater volume of material to be remediated. This will result in an increase of treatment and/or disposal costs.

7.0 PUBLIC INVOLVEMENT

The results of the engineering evaluation and cost analysis were presented to the public and to the Alameda Point Restoration Advisory Board (RAB) at the February 6, 2001 RAB meeting. The Draft EE/CA report was completed on January 5, 2001 and placed in the Administrative Record. Minor revisions to the Draft EE/CA were completed on February 22, 2001 and also placed in the Administrative Record. A public notice announcing the availability of the Draft EE/CA for review was published in Alameda area newspapers on March 13, 2001, and a public comment period extended through April 13, 2001. No comments were received from the public. Comments received from the regulatory agencies and the Navy's response to those comments were completed on July 6, 2001 and included in the Administrative Record.

8.0 OUTSTANDING POLICY ISSUES

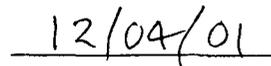
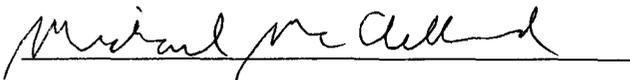
No outstanding policy issues exist for this removal action.

9.0 RECOMMENDATIONS

The AM was prepared in accordance with current EPA and Navy guidance documents for non-time critical removal actions under CERCLA. The purpose of this AM was to identify and analyze removal actions to address DNAPL contamination in groundwater at IR Sites 4 and 5, Alameda Point. Four alternatives were identified, evaluated, and ranked: no action, in-situ chemical oxidation, steam injection and soil vapor extraction, and electrical heating and soil vapor extraction.

Based on the comparative analysis of the removal action alternatives as summarized in Section 5.1.3 and Table 5-1, the recommended removal action is electrical heating and soil vapor extraction. This alternative is recommended because this alternative is feasible and cost effective, and will most effectively meet the removal action objective. The action will lower risks by reducing the potential for exposure of human and ecological receptors to COCs in groundwater. Treatment of contaminated groundwater will also reduce the potential for migration of COCs via storm sewer infiltration and groundwater flow. The cleanup goals have been established as an interim measure to reduce the total mass of contaminants and thereby reduce potential contaminant loading to groundwater. The recommended alternative is technically and administratively feasible.

This decision document represents the selected removal action for IR Sites 4 and 5, Alameda Point, Alameda, California developed in accordance with CERCLA as amended and is not inconsistent with the NCP. This decision is based on the Administrative Record for the site.



Michael E. McClelland, P.E.
Base Realignment and Closure Environmental Coordinator
Southwest Division, Naval Facilities Engineering Command

Date

REFERENCES

- 40 CFR 300, 47384 Federal Register/Vol. 59, No. 178/September 15, 1994.
- Alameda Reuse and Redevelopment Authority. 1996. "NAS Alameda Community Reuse Plan."
- Bailey, R. G. 1995. *Descriptions of Ecoregions of the United States*. Second edition. U.S. Department of Agriculture Forest Service.
- Berkeley Environmental Restoration Center. 2000. "Treatability Study Report, Steam Enhanced Extraction, Site 5, Alameda Point." Draft. March.
- Canonie, 1990 (for reference to Site 4 operations)
- Community Relations in Superfund: A Handbook, OERR Directive 9230.0-03C.
- Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA, OSWER Publication 9360.0-32, August 1993.
- Innovative Technical Solutions, Inc. (ITSI). 1998. "Technical Memorandum: Remove Underground Storage Tanks at Alameda Point." Draft. October.
- International Technology Corporation. (IT) 1998. "Environmental Baseline Studies, Data Evaluation Summaries Alameda Point, Alameda, California." Prepared for the Navy. Western Division Naval Facilities Engineering Command. San Bruno, California. December.
- IT. 1999. "Letter Sampling Plan – EBS Phase IIC (Part II)." August.
- Moju. 1998. "Groundwater Monitoring Reports at Select UST Sites/Buildings - 2nd Round (Mar 98). Draft. July.
- Moju. 1999a. "Groundwater Monitoring Reports at Selected UST Sites/Buildings - 3rd Round (Sep 98)." Draft. January.
- Moju. 1999b. "Groundwater Monitoring Reports at Selected UST Sites/Buildings – 4th Round (April 99)." Draft. June.
- Navy/Marine Corps Installation Restoration Manual, February 1992.
- Navy Public Works Center (PWC). 1996a. "Final Summary Report UST 163-1." December.
- PWC. 1996b. "Final Summary Report USTs 261-1 through 261-3." December.
- PWC. 1996c. "Final Summary Report UST 372-1." December.
- PWC. 1997. "Final Summary Report UST 615-3." January.

- OGISO Environmental (OGISO). 1997. Geochemical Profiling for Definition of Chlorinated Plumes, Sites 4 and 5, Alameda Naval Air Station, Alameda California. Prepared for PRC Environmental, Rancho Cordova, California.
- PRC Environmental Inc. (PRC). 1996. Draft Technical Memorandum Aquifer Test Data Analysis. NAS Alameda. Alameda, California. August.
- PRC. 1997. Tidal Influence Study Letter Report, NAS Alameda, California. June.
- PRC and James M Montgomery (PRC and JMM). 1992. "Data Summary Report RI/FS Phases 2B and 3 Quality Control Summary Report." Prepared for Department of Navy, Western Division Naval Facilities Engineering Command, San Bruno, California. February.
- PRC and JMM. 1993. "Data Summary Report RI/FS Phases 1 and 2A." Prepared for Department of Navy, Western Division Naval Facilities Engineering Command, San Bruno, California. August.
- PRC and Montgomery Watson (PRC and MW). 1994a. "Follow-on Field Sampling Plan, Remedial Investigation/Feasibility Study, Phase 2A." Naval Air Station Alameda, California. July.
- PRC and MW. 1994b. "Follow-on Field Sampling Plan, Remedial Investigation/Feasibility Study, Phase 2B and 3." Naval Air Station Alameda, California. August.
- Superfund Removal Procedures: Action Memorandum Guidance, OSWER Directive 9360.3-01, December 1990.
- Superfund Removal Procedures: Guidance on the Consideration of ARARs During Removal Actions, OSWER Directive 9360.3-02, August 1991.
- Superfund Removal Procedures: Public Participation Guidance for On-Scene Coordinators – Community Relations and the Administrative Record, OERR Publication 9360.3-05, July 1992.
- Tetra Tech EM Inc. TtEMI. 1997. "Tidal Influence Study Report." Alameda Point, California. June.
- TtEMI. 1999a. "Draft OU-2 Remedial Investigation Report." June 29.
- TtEMI. 1999b. "Surfactant Enhanced Subsurface Remediation Treatability Study Final Report at Alameda Point (Site 5)." October.
- TtEMI. 1999c. "Final Summary Report UST 5-3."
- TtEMI. 1999d. "Final Summary Report UST 615-4."
- TtEMI. 2000. "Final Determination of the Beneficial Uses of Groundwater at Alameda Point, Alameda, California." Prepared for the Naval Facilities Engineering Command, Southwest Division. July.
- TtEMI. 2001. "Installation Restoration Sites 4 and 5 Dense Nonaqueous Phase Liquid and Dissolved Source Removal Action Engineering Evaluation and Cost Analysis." Prepared for the Naval Facilities Engineering Command, Southwest Division. January.

REFERENCES
(Continued)

TtEMI and Einarson, Fowler, and Watson (TtEMI and EFW). 1998. Data Transmittal Memorandum for Sites 4 and 5 Chlorinated Solvent Plume Definition and Site 14 Sump Investigation at Alameda Point, Alameda, California. Prepared for Department of the Navy Western Division, Naval Facilities Engineering Command, San Bruno, California. June 26.

U.S. EPA, Guidance on Preparing Superfund Decision Documents: The Proposed Plan, The Record of Decision, Explanation of Significant Differences, The Record of Decision Amendment, 1989 EPA540/G-89/007.

U.S. Navy. 1992. International Station Meteorological Climate Summary - 1950 to 1985. Year/Month Total Precipitation (Inches) from Daily Observations. Prepared by Naval Air Station Alameda, Air Traffic Control, Division OPS, Building 19. NAS Alameda, California.

APPENDIX A
ENGINEERING EVALUATION/COST ANALYSIS

**COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order No. 0386**

Prepared For

**U.S. DEPARTMENT OF THE NAVY
Glenna Clark, Remedial Project Manager
Engineering Field Division, Southwest
Naval Facilities Engineering Command
San Diego, California**

**INSTALLATION RESTORATION SITES 4 AND 5
DENSE NONAQUEOUS PHASE LIQUID
AND DISSOLVED SOURCE
REMOVAL ACTION
ENGINEERING EVALUATION AND COST ANALYSIS
ALAMEDA POINT, ALAMEDA, CALIFORNIA**

DS.0386.15537

DRAFT

January 5, 2001

Prepared By

**TETRA TECH EM INC.
10670 White Rock Road, Suite 100
Rancho Cordova, California 95670
(916) 852-8300**


Alan Driscoll, Project Manager


Chris Fennessey, P.E.



DS.0386.15537

CONTENTS

<u>Section</u>	<u>Page</u>
LIST OF FIGURES AND TABLES	iii
ABBREVIATIONS, ACRONYMS, AND SYMBOLS.....	v
EXECUTIVE SUMMARY.....	1
1.0 INTRODUCTION.....	1-1
2.0 SITE CHARACTERIZATION.....	2-1
2.1 SITE DESCRIPTION AND BACKGROUND.....	2-1
2.1.1 Climate and Meteorology	2-1
2.1.2 Regional Ecology	2-1
2.1.3 Site Geology and Hydrogeology	2-2
2.1.4 Surrounding Land Use and Proposed Reuse	2-3
2.1.5 Site Location and Operations Conducted.....	2-4
2.2 HISTORY OF PREVIOUS REMOVAL ACTIONS, INVESTIGATIONS, AND ACTIVITIES.....	2-5
2.3 SOURCE, NATURE, AND EXTENT OF CONTAMINATION.....	2-9
2.4 ANALYTICAL DATA.....	2-12
3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES.....	3-1
3.1 STATUTORY LIMITS ON REMOVAL ACTIONS	3-1
3.2 DETERMINATION OF REMOVAL SCOPE.....	3-2
3.3 DETERMINATION OF REMOVAL SCHEDULE.....	3-2
3.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS.....	3-2
3.4.1 ARARS Overview.....	3-3
3.4.2 ARARS and TBCs Affecting Removal Action Objectives.....	3-4
3.4.2.1 Chemical-Specific ARARs and TBCs	3-4
3.4.2.2 Location-Specific ARARs and TBCs	3-6
3.4.2.3 Action-Specific ARARs and TBCs.....	3-7
3.5 REMOVAL ACTION OBJECTIVES	3-8
4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES.....	4-1
4.1 ALTERNATIVE 1: NO ACTION	4-2
4.1.1 Description.....	4-2
4.1.2 Effectiveness	4-2

CONTENTS (Continued)

<u>Section</u>		<u>Page</u>
	4.1.3 Implementability	4-3
	4.1.4 Cost.....	4-4
4.2	ALTERNATIVE 2: <i>IN SITU</i> CHEMICAL OXIDATION.....	4-4
	4.2.1 Effectiveness	4-5
	4.2.2 Implementability	4-8
	4.2.3 Cost.....	4-8
4.3	ALTERNATIVE 3: STEAM INJECTION AND SOIL VAPOR EXTRACTION.....	4-8
	4.3.1 Description	4-9
	4.3.2 Effectiveness	4-10
	4.3.3 Implementability	4-13
	4.3.4 Cost.....	4-13
4.4	ALTERNATIVE 4: ELECTRICAL HEATING WITH SOIL VAPOR EXTRACTION	4-14
	4.4.1 Description	4-14
	4.4.2 Effectiveness	4-14
	4.4.3 Implementability	4-16
	4.4.4 Cost.....	4-17
5.0	COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES.....	5-1
	5.1 EFFECTIVENESS	5-1
	5.2 IMPLEMENTABILITY.....	5-3
	5.3 COST.....	5-4
6.0	RECOMMENDED REMOVAL ACTION ALTERNATIVE	6-1
7.0	REFERENCES.....	7-1
 Appendix		
A	HISTORICAL DATA TABLES FOR INSTALLATION RESTORATION SITES 4 AND 5	

FIGURES

<u>Figure</u>		<u>Follows</u>
2-1	OPERABLE UNITS AND INSTALLATION RESTORATION SITES	2-1
2-2	INSTALLATION RESTORATION SITE 4 FEATURES	2-1
2-3	INSTALLATION RESTORATION SITE 5 FEATURES	2-1
2-4	INSTALLATION RESTORATION SITE 4 POTENTIAL DNAPL AND SOURCE REMOVAL ACTION AREAS	2-10
2-5	INSTALLATION RESTORATION SITE 5 POTENTIAL DNAPL AND SOURCE REMOVAL ACTION AREAS	2-11

TABLES

<u>Table</u>		<u>Follows</u>
1-1	SOLUBILITIES OF POTENTIAL DENSE NONAQUEOUS PHASE LIQUID CONTAMINANTS, ALAMEDA POINT	1-2
2-1	INSTALLATION RESTORATION SITE 4 HISTORICAL OPERATIONS, ALAMEDA POINT	2-4
2-2	INSTALLATION RESTORATION SITE 5 HISTORICAL OPERATIONS ALAMEDA POINT	2-5
2-3	INSTALLATION RESTORATION SITE 4 PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS, ALAMEDA POINT	2-5
2-4	INSTALLATION RESTORATION SITE 5 PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS, ALAMEDA POINT	2-6
2-5	GROUNDWATER TREATMENT AREAS ADDRESSED FOR INTERIM REMOVAL ACTION	2-12
3-1	INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL CHEMICAL-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS	3-5
3-2	INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL FEDERAL LOCATION AND LOCATION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS	3-7

TABLES (Conintued)

<u>Table</u>		<u>Follows</u>
3-3	INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS	3-7
5-1	RESULTS OF COMPARATIVE ANALYSIS FOR DNAPL REMOVAL ACTION ALTERNATIVES INSTALLATION RESTORATION SITES 4 AND 5, ALAMEDA POINT	5-1

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

%	Percent
µg/L	Microgram per liter
1,1,1-TCA	1,1,1-Trichloroethane
1,1-DCA	1,1-Dichloroethane
1,2-DCA	1,2-Dichloroethane
1,1-DCE	1,1-Dichloroethene
1,2-DCE	1,2-Dichloroethene
A1	No action alternative
A2	<i>In situ</i> chemical oxidation
A3	Steam injection and soil vapor extraction
A4	Electrical heating with soil vapor extraction
ARRA	Alameda Reuse and Redevelopment Authority
ARAR	Applicable or relevant and appropriate requirement
AWQC	Ambient water quality criterion
BAAQMD	Bay Area Air Quality Management District
Battelle	Battelle Memorial Institute
Bay Plan	San Francisco Bay Plan
BCDC	San Francisco Bay Conservation and Development Commission
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
BTEX	Benzene, toluene, ethyl benzene, and xylenes
CAA	Clean Air Act
Ca-HSC	California Health and Safety Code
Cal-EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CES	Canonie Environmental Services
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	Chemical of concern
cm/sec	Centimeters per second
CPT	Cone penetrometer testing
CTO	Contract task order
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DCA	Dichloroethane
DCE	Dichloroethene
DERP	Defense Environment Restoration Program
DNAPL	Dense nonaqueous phase liquid
DTSC	California Department of Toxic Substances Control
EBMUD	East Bay Municipal Utilities District
EBS	Environmental baseline survey
EE/CA	Engineering evaluation and cost analysis

ABBREVIATIONS, ACRONYMS, AND SYMBOLS (Continued)

EFW	Einarson, Fowler, and Watson
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERM	Environmental Resources Management
FS	Feasibility study
ft	Foot
ft ²	Square foot
ft ³	Cubic foot
FWBZ	First water-bearing zone
Gpm	Gallon per minute
IR	Installation restoration
IT	International Technology Corporation
ITSI	Innovative Technical Solutions, Inc.
JMM	James M. Montgomery
JP-5	Jet propulsion fuel 5
LDR	Land disposal restrictions
LIF	Laser induced fluorescence
LNAPL	Light nonaqueous phase liquid
MCL	Maximum contaminant level
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
MTBE	Methyl-tert-butyl ether
MW	Montgomery Watson
NA	Not available
NAAQS	National Ambient Air Quality Standards
NAPL	Nonaqueous phase liquid
NARA	National Archive and Records Administration
NAS	Naval Air Station
Navy	U.S. Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollution Discharge Elimination System
O&M	Operations and maintenance
OU	Operable unit
OU-1	Operable Unit 1
OU-2	Operable Unit 2
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
POTW	Publicly Owned Treatment Works
Post-PITT	Post-partitioning interwell tracer test
PRC	PRC Environmental Management, Inc.
Pre-PITT	Pre-partitioning interwell tracer test
PWC	Public Works Center
RACER/ 99	Remedial Action Cost Engineering and Requirements 99
RAO	Removal action objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial investigation
RME	Reasonable maximum exposure

ABBREVIATIONS, ACRONYMS, AND SYMBOLS (Continued)

ROD	Record of decision
RWQCB	San Francisco Bay Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act of 1986
SCAPS	Site Characterization Analysis Penetrometer System
SDWA	Safe Drinking Water Act
SEE	Steam-enhanced extraction
SESR	Surfactant-enhanced subsurface remediation
SIP	State implementation plan
SPH	Six-phase heating
SVE	Soil vapor extraction
SVOC	Semivolatile organic compound
TBC	To be considered
TCA	Trichloroethane
TCE	Trichloroethene
TCLP	Toxicity characteristic leaching procedure
TEPH	Total extractable petroleum hydrocarbons
TPH	Total petroleum hydrocarbons
TPH-d	Total petroleum hydrocarbons as diesel
TPH-g	Total petroleum hydrocarbons as gasoline
TPH-mo	Total petroleum hydrocarbons as motor oil
TPPH	Total purgeable petroleum hydrocarbons
TtEMI	Tetra Tech EM Inc.
UIC	Underground Injection Control
USC	<i>United States Code</i>
UST	Underground storage tank
VOC	Volatile organic compound
WWII	World War II

EXECUTIVE SUMMARY

This engineering evaluation and cost analysis (EE/CA) was performed in accordance with current U.S. Environmental Protection Agency (EPA) and U.S. Navy guidance documents for a non-time-critical removal action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Chapter 6.8 of the California Health and Safety Code (Ca-HSC). This EE/CA summarizes results of the EE/CA process, characterizes the site, identifies removal action objectives, describes removal action alternatives, contains an analysis of these alternatives, and describes the recommended removal action alternative.

CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Title 40 of the Code of Federal Regulations (CFR), Part 300) and Ca-HSC §25323 define removal actions as the cleanup or removal of released hazardous substances, actions to monitor the threat of release of hazardous substances, and actions to mitigate or prevent damage to public health or welfare or the environment. CERCLA (40 CFR, §300.5) defines a removal to include the following:

“ . . . the cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of release of hazardous substance into the environment, such action as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removal material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release.”

In 1936, the Navy began building Naval Air Station (NAS) Alameda in response to the military buildup in Europe before World War II (WWII). During WWII, NAS Alameda's primary mission was to provide facilities and support for fleet aviation activities and provide berthing for Pacific Fleet ships. The support activities involved the use of industrial chemicals, including fuels, cleaning solvents, acids, paint strippers, degreasers, caustic cleaners, and metals from plating operations.

In 1988, the Navy received a remedial action order from the California Department of Health Services, now overseen by the California Environmental Protection Agency's Department of Toxic Substances Control (DTSC). The remedial action order identified Installation Restoration (IR) sites within NAS Alameda to be targeted for remedial action. NAS Alameda was designated for closure in 1993. As part of the Base Realignment and Closure (BRAC) strategy for station-wide investigation and cleanup, the IR sites were grouped into operable units (OU). Building 5 (IR Site 5) located within OU-2C and Building

360 (IR Site 4) located within OU-2B contained aircraft maintenance and support facilities where plating operations were conducted. Chlorinated solvents were released as a result of the plating operations, and are present in groundwater at concentrations exceeding 10,000 micrograms per liter. These concentrations represent a potential risk to human health and the environment, and may indicate that solvents are present as a dense, nonaqueous phase liquid (DNAPL).

The purpose of this EE/CA is to identify and analyze removal action alternatives and to recommend the best alternative for the removal of contaminants in the areas suspected to be sources of DNAPL. The goal of the removal action is to reduce chlorinated solvent concentrations beneath IR Sites 4 and 5 to the extent technically and economically feasible within one year. During scoping meetings conducted between June and October 2000, the BRAC Cleanup Team (BCT) agreed that the scope of potential removal actions to be evaluated in this EE/CA should be limited to the removal of DNAPL, and the reduction of high concentrations of dissolved phase chlorinated solvents .

The BCT also agreed that the following alternatives should be evaluated:

Alternative 1: No action

Alternative 2: *In situ* chemical oxidation

Alternative 3: Steam injection and soil vapor extraction (SVE)

Alternative 4: Electrical heating with SVE

A comparative analysis of these alternatives was conducted according to the Navy's Southwest Division guidance for preparing EE/CAs. The Navy analyzed these alternatives based on general principles of effectiveness, implementability and cost, and the specific evaluation criteria set forth in 40 CFR 300.430(e)(9). Regulatory and community acceptance will be evaluated as comments on the EE/CA are received and will be discussed in an Action Memorandum documenting the removal action decision.

Based on the evaluation of the alternatives contained within this EE/CA, the Navy recommends Alternative 4, electrical heating with soil vapor extraction, for the removal of DNAPL and elevated concentrations of chlorinated solvents in groundwater at IR Sites 4 and 5.

1.0 INTRODUCTION

Tetra Tech EM Inc. (TtEMI) prepared this engineering evaluation and cost analysis (EE/CA) for the U.S. Navy (Navy) under Comprehensive Long-term Environmental Action Navy (CLEAN) contract N62474-94-D-7609, Contract Task Order (CTO) No. 386. This EE/CA identifies and evaluates removal action alternatives for suspected dense nonaqueous phase liquids (DNAPL) and source areas associated with contaminated groundwater at Installation Restoration (IR) Sites 4 and 5, Alameda Point, Alameda, California.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Title 40 of the Code of Federal Regulations [CFR], §300.5) defines a removal to include the following:

“... the cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of release of hazardous substance into the environment, such action as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removal material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release”.

CERCLA classifies removal actions into the following three types based on the circumstances surrounding the release or threat of release: emergency, time critical, and non-time critical. The removal actions for IR Sites 4 and 5 have been determined to be non-time critical, because on-site action will be taken more than 6 months after commencement of the planning period.

A data gap investigation will be conducted as part of the remedial investigation (RI) for Operable Unit 2 (OU-2) in June 2001. This investigation will involve seven areas where chlorinated solvents are present in groundwater at concentrations potentially indicating the presence of DNAPL. The investigation will focus on delineating the vertical and lateral extent of the DNAPL and groundwater contaminant plumes. The U.S. Navy and the Base Realignment and Closure (BRAC) Cleanup Team (BCT) have indicated that the scope of potential removal actions to be evaluated in this EE/CA should be limited to the removal of DNAPL, if confirmed to be present, or the reduction of high concentrations of dissolved phase chlorinated solvents in groundwater (source areas) if DNAPL is not confirmed. The BCT consists of the Navy environmental BRAC coordinator and a representative from the California Environmental Protection Agency's (Cal-EPA) Department of Toxic Substances Control (DTSC), the U.S. Environmental Protection Agency (EPA), and the Regional Water Quality Control Board (RWQCB).

The BCT also expressed preferences for treatment technologies with high short-term effectiveness; therefore, the BCT and the Navy agreed to limit the scope of this EE/CA to evaluate the following removal action alternatives:

Alternative 1: No action

Alternative 2: *In situ* chemical oxidation

Alternative 3: Steam injection and soil vapor extraction (SVE)

Alternative 4: Electrical heating with SVE

According to general rule of thumb, the potential presence of DNAPL is indicated by a chlorinated solvent concentration exceeding 1 percent of its solubility in water. The Navy and regulatory agencies used this approach in identifying potential DNAPL areas to be investigated during the upcoming data gap investigation and to be addressed in this EE/CA. DNAPL or source areas found during the data gap investigation at any of the seven areas will be removed using the technology recommended in this EE/CA. Source areas were defined for this removal action as chlorinated solvent concentrations exceeding 10,000 micrograms per liter ($\mu\text{g/L}$), based on the 1 percent solubility concentration for each potential DNAPL constituent (see Table 1-1). The 1 percent solubility for six of the contaminants is near or exceeds 10,000 $\mu\text{g/L}$. The 1 percent solubility of tetrachloroethene (PCE) is 1,500 $\mu\text{g/L}$; however, historical data for PCE at the potential DNAPL areas are significantly less than 1,500 $\mu\text{g/L}$; therefore, PCE is not expected to be present in DNAPL at any of the areas.

This EE/CA addresses the implementability, effectiveness, and cost for IR Sites 4 and 5 groundwater DNAPL or source area removal actions and addresses applicable regulatory requirements. This EE/CA will be used as the basis for a future CERCLA removal action. The Navy is the lead agency for the IR Sites 4 and 5 groundwater DNAPL removal actions. As the lead agency, the Navy has final approval authority of the recommended alternative selected and overall public participation activities. The Navy is working in cooperation with EPA, DTSC, and RWQCB in the implementation of this removal action.

This EE/CA is divided into seven sections, including this introduction. Section 2.0 includes the site description and background, a summary of previous removal actions and investigations, a treatability study summary, the source, nature, and extent of contamination, and analytical data a. Section 3.0 discusses the removal action limits, scope, schedule, objectives, areas, and applicable or relevant and

TABLE 1-1

SOLUBILITIES OF POTENTIAL DENSE NONAQUEOUS PHASE LIQUID CONTAMINANTS
ALAMEDA POINT, ALAMEDA, CALIFORNIA

(Page 1 of 1)

Characteristic	TCE	1,1-DCE	1,2-DCE	1,1-DCA	1,1,1-TCA
Solubility (mg/L)	1,100	2,250	800	5,060	1,495
1-% of Solubility (mg/L)	11	22.5	8	50.6	14.95
1-% of Solubility (µg/L)	11,000	22,500	8,000	50,600	14,950

Notes:

- a Data obtained from www.chemfinder.com
- % Percent
- µg/L Microgram per liter
- 1,1,1-TCA Trichloroethane
- 1,1-DCA 1,1-Dichloroethane
- 1,1-DCE 1,1-dichloroethene
- 1,2-DCE 1,2-dichloroethene (used the cis-1,2-DCE solubility; trans-1,2-DCE is 6,300 mg/L)
- mg/L Milligram per liter
- TCE Trichloroethene

appropriate requirements. Section 4.0 provides an identification and analysis of removal action alternatives. Section 5.0 describes the comparative analysis of removal action alternatives based on effectiveness, implementability, and cost. Section 6.0 presents the recommended removal action. Section 7.0 provides the report references. All tables and figures referenced throughout the text are located at the end of each section where first cited.

This EE/CA is being issued to facilitate public involvement in the decision-making process. The public is encouraged to review and comment on the proposed removal activities described in this EE/CA. To gain a more thorough understanding of the activities associated with this removal action, the public is encouraged to review the administrative record for this activity available at the following locations:

Alameda Public Library
2264 Santa Clara Avenue
Alameda, California

Alameda Point Information Repository
950 West Mall Square
Main Office Building (Building 1)
Alameda Point
Alameda, California

2.0 SITE CHARACTERIZATION

The information for this site characterization was taken from various sources, including the draft OU-2 remedial investigation (RI) report (TtEMI, 1999c) and the environmental baseline survey (EBS) (IT, 1998).

2.1 SITE DESCRIPTION AND BACKGROUND

This section summarizes (1) climate and meteorology, (2) regional ecology for IR Sites 4 and 5, (3) site geology and hydrogeology, (4) surrounding land use and proposed reuse, and (5) site location (see Figure 2-1) and operations conducted. Physical features of IR Sites 4 and 5 are shown on Figures 2-2 and 2-3, respectively. A more complete description of geological units, geologic cross sections, and soil boring and cone penetrometer test (CPT) logs are located in the OU-2 draft RI report (TtEMI, 1999c).

2.1.1 Climate and Meteorology

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. Rainfall occurs primarily during the months of October through April. The installation averages approximately 18 inches of rainfall per year (Navy, Air Traffic Control, 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 sewer system that discharges to San Francisco Bay, or infiltrates to groundwater.

2.1.2 Regional Ecology

Most of California's coastal plains have been converted to urban use, which is evident in the Bay Area. However, the Bay Area continues to be a major resource and migration route for both aquatic and terrestrial birds (Bailey, 1995). Alameda Point, including contiguous and noncontiguous properties, contains the following terrestrial and aquatic wildlife habitats: open water areas; estuarine intertidal emergent wetlands; paved runway areas; non-native grassland; ruderal upland vegetation; disturbed areas; beach, urban, and ornamental landscapes, and riprap. Detailed descriptions of the wildlife habitats, soil

LEGEND

BOUNDARIES

- OPERABLE UNIT 1
- OPERABLE UNIT 2A
- OPERABLE UNIT 2B
- OPERABLE UNIT 2C
- OPERABLE UNIT 3
- OPERABLE UNIT 4A
- OPERABLE UNIT 4B
- OPERABLE UNIT 5
- OPERABLE UNIT 6
- ENVIRONMENTAL BASELINE SURVEY PARCEL
- IR SITE BOUNDARY

SITE FEATURES

- LAND COVER

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	SKREET RANGE

SEE FIGURES
2-3 AND 2-5

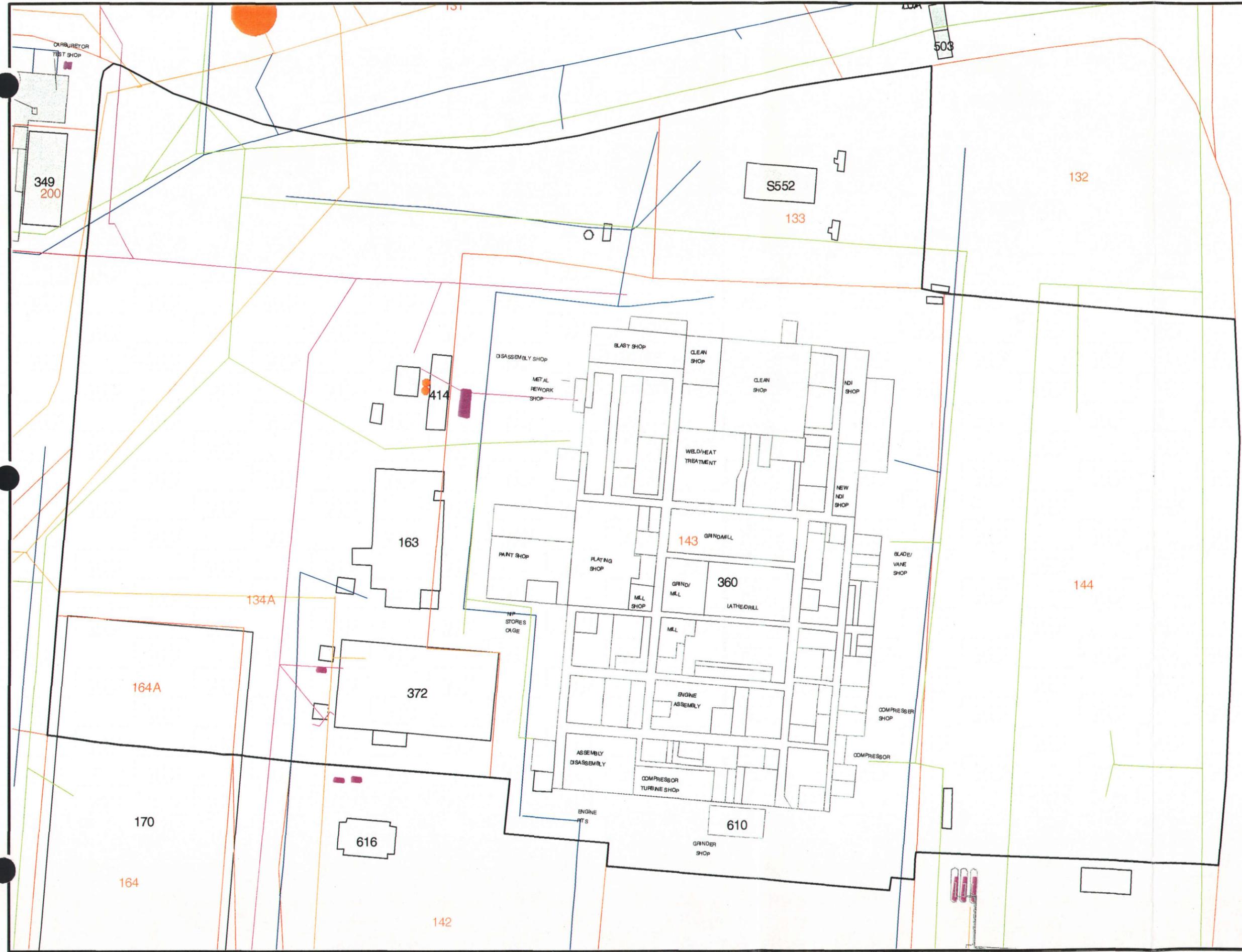
SEE FIGURES
2-2 AND 2-4



SCALE: 1" = 1200'

**FIGURE 2-1
OPERABLE UNITS AND
INSTALLATION RESTORATION SITES**

ALAMEDA POINT
ALAMEDA, CALIFORNIA
JANUARY 5, 2001



- LEGEND**
- BOUNDARIES**
- ENVIRONMENTAL BASELINE SURVEY PARCEL (EBS)
 - LAND COVER
 - IR SITE BOUNDARY
 - BUILDING
- SITE FEATURES**
- INDUSTRIAL WASTE LINE
 - FUEL LINE
 - SANITARY SEWER LINE
 - STORM SEWER LINE
 - ABOVEGROUND STORAGE TANKS
 - UNDERGROUND STORAGE TANKS

NOTE:
IR = INSTALLATION RESTORATION

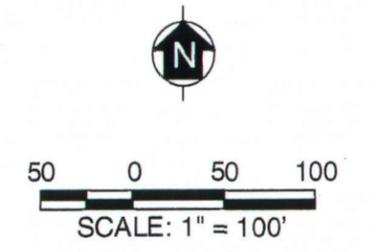


FIGURE 2-2
IR SITE 4 FEATURES
ALAMEDA POINT
ALAMEDA, CALIFORNIA
JANUARY 5, 2001



- LEGEND**
- BOUNDARIES**
- ENVIRONMENTAL BASELINE
 - SURVEY PARCEL (EBS)
 - LAND COVER
 - IR SITE BOUNDARY
 - BUILDING
- SITE FEATURES**
- INDUSTRIAL WASTE LINE
 - FUEL LINE
 - SANITARY SEWER LINE
 - STORM SEWER LINE
 - ABOVEGROUND STORAGE TANKS
 - UNDERGROUND STORAGE TANKS

NOTE:
IR = INSTALLATION RESTORATION



SCALE: 1" = 200'

FIGURE 2-3
IR SITE 5 FEATURES

ALAMEDA POINT
ALAMEDA, CALIFORNIA
JANUARY 5, 2001

types, and special status species encountered at Alameda Point are presented in the OU-2 draft RI report (TtEMI, 1999c).

2.1.3 Site Geology and Hydrogeology

This section summarizes site geology and hydrogeology at IR Sites 4 and 5.

IR Site 4

Four geologic units, relevant to the first water-bearing zone (FWBZ), were identified during the RI for OU-2B. The first geologic unit at IR Site 4 is artificial fill consisting of silty, fine-grained sand with trace amounts of gravel and brick fragments. The artificial fill makes up the upper portion of the FWBZ and is encountered from the ground surface to about 10 feet below ground surface (bgs). The Merritt Sand Formation underlies the artificial fill and consists of silty, fine sand and clayey, fine sand. The Merritt Sand Formation makes up the middle portion of the FWBZ and extends from about 10 to 70 feet bgs. The upper contact between the artificial fill and the Merritt Sand (at about 11 feet bgs) is composed of a 1-to 5-foot-thick layer of dense to well-consolidated, low-conductivity clayey sand. In addition, the contact between the eolian and alluvial Merritt Sand Formation (at about 30 feet bgs) is composed of a 5-to 15-foot-thick layer of dense to well-consolidated, low-conductivity clayey sand. The hydraulic conductivity for the FWBZ (including the artificial fill and the Merritt Sand) within this region of the site ranged from 9.69×10^{-4} centimeters per second (cm/sec) to 3.01×10^{-3} cm/sec. The Upper San Antonio Formation underlies the Merritt Sand and consists of sand, sandy clay, and silty clay. The Upper San Antonio Formation makes up the lower portion of the FWBZ and extends from about 70 to 90 feet bgs. The Lower San Antonio Formation (Yerba Buena Mud) underlies the Upper San Antonio Formation and consists of clay. The Lower San Antonio Formation forms a regionally continuous aquitard preventing downward migration from the FWBZ to the underlying Alameda Formation. The Lower San Antonio Formation extends from about 90 to 150 to 175 feet bgs.

Groundwater at IR Site 4 is first encountered between approximately 2 and 8 feet bgs. Local recharge from precipitation, seasonal variation in groundwater elevations, and tidal influences at IR Site 4 affect groundwater flow directions. Groundwater generally flows from the east and northeast inland areas to the west and southwest, towards the Seaplane Lagoon and San Francisco Bay, and is affected locally near industrial buildings by preferential flow paths such as storm drains and underground utility trenches.

Water levels in the vicinity of industrial buildings indicate localized regions of groundwater mounding or groundwater sinks. The storm water conveyance pipes act as potential groundwater sinks at low tide, when the groundwater hydraulic gradient is towards the lines.

IR Site 5

Two geologic units, relevant to the FWBZ, were identified during the RI for OU-2C. The first geologic unit at IR Site 5 is artificial fill consisting of unconsolidated fine to medium-grained sand with lenses of silty sand, gravelly sand, or sandy gravel. The artificial fill makes up the FWBZ and is encountered from the ground surface to about a depth of 12 to 15 feet bgs. The hydraulic conductivity estimated in the FWBZ within this region of the site ranged from 3.21×10^{-3} cm/sec to 7.65×10^{-3} cm/sec. The Bay Sediment unit (BSU) underlies the artificial fill and consists of three sediment types: stiff, moist clay; sand and clay with some shell fragments; and silty sand with interbedded layers of fine sand. These sediment layers are discontinuous and begin at depths of about 12 to 15 feet bgs. The BSU layers vary from 20 to 25 feet in thickness and act as a significant flow boundary between the FWBZ and the second water-bearing zone. The hydraulic conductivities estimated in the BSU ranged from 3.22×10^{-8} cm/sec to 3.9×10^{-5} cm/sec.

Groundwater at IR Site 5 is first encountered between approximately 4 and 7 feet bgs. Local recharge from precipitation, seasonal variation in groundwater elevations, and tidal influences at IR Site 5 impact groundwater flow directions. During the rainy season, groundwater flow is generally north, towards the Oakland Inner Harbor. During dry periods, the hydraulic gradient can change directions, resulting in flow away from the harbor. Two storm drain lines in the northwestern corner of the site discharge to the harbor and may also influence local groundwater elevations and flow directions. These storm drain lines may also influence local flow velocities by acting as preferential flow paths.

2.1.4 Surrounding Land Use and Proposed Reuse

This section summarizes the surrounding land use and the proposed reuse for IR Sites 4 and 5. The future land use categories are described in Chapter 2 of the OU-2 draft RI report (TtEMI, 1999c). The land use categories define the types of activities that are anticipated in a specific geographical area at Alameda Point (TtEMI, 1999c). The Alameda Reuse and Redevelopment Authority (ARRA) defines the specific geographical area as the "land use area" (ARRA, 1996).

IR Site 4

Parcels 127, 130 through 132, 134, 137, 138A, 140, 140A, 142, 143, 145, 146, 164, and 200 surround IR Site 4. IR Site 4 is part of the Inner Harbor land use area defined in the reuse plan (ARRA, 1996). Potential reuse may include industrial, research and development facilities, mixed use (including residential), and parks.

IR Site 5

Parcels 30, 32, 41, 44, 45, 51 through 53, 64, 65, 70, 74 through 76, 185, and 190 surround IR Site 5. IR Site 5 is part of the civic core land use area, as defined in the reuse plan (ARRA, 1996). Potential reuse may include industrial, research and development facilities; mixed use (including residential); and open space.

2.1.5 Site Location and Operations Conducted

This section presents site information and summarizes the operations historically conducted at IR Sites 4 and 5.

IR Site 4

IR Site 4 consists of about 21 acres and is located within OU-2B, in the northeastern portion of Alameda Point (see Figures 2-1 and 2-2). Groundwater in the shallow aquifer of OU-2B is considered to be a potential drinking water source (TtEMI, 2000a). IR Site 4 includes EBS Parcels 133, 134A, 143, 144, and 164A. General operations that were conducted at IR Site 4 include aircraft maintenance, engine testing, hazardous materials storage, paint stripping, plating, metal grinding, and machining. Buildings and operations conducted within IR Site 4 are summarized in Table 2-1.

IR Site 5

IR Site 5 consists of about 47 acres and is located within OU-2C, in the central industrial portion of Alameda Point (see Figures 2-1 and 2-3). Groundwater in the FWBZ of OU-2C is not considered to be a potential drinking water source (TtEMI, 2000a). IR Site 5 includes EBS Parcels 45A, 46 through 49,

TABLE 2-1
INSTALLATION RESTORATION SITE 4
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA CALIFORNIA
(Page 1 of 1)

Parcel	Building	Operations Conducted	Hazardous Materials Stored or Used
133	552	Electrical substation was constructed in 1975.	None
134A	163	It was part of Pacific Coast Borax Works constructed in 1939. It was aircraft maintenance facility after the late 1940s. Machine and welding shops are still present.	Metals, corrosives, petroleum products, paint, halogenated and nonhalogenated organic compounds
	372	Engine test facility was constructed in 1953. Two test cells and an operation gallery were included. Fuel and lubricant supply systems serviced the engine test cells. An oil-water separator is located west of the building. Fuel releases at the building are documented.	Fuels and lubricants
	414	Hazardous materials storage area was constructed in 1957. An industrial waste treatment plant, used to treat wastewater from Building 360, is located west of Building 414.	Metals, corrosives, petroleum products, fuels, paints, and organic compounds
143	360	Aircraft engine and airframe overhaul facility was constructed in 1953. Shop operations included paint stripping by blasting; chrome, silver, and nickel stripping; etching; and chrome, copper, nickel, and silver plating. The plating shop was dismantled and removed in 1991. The machine shops, stripping and painting shops, and parts assembly areas were active until 1996. Currently, the building is vacant.	Phenolic-based cleaners, alkaline-type cleaners, rust removers, descaling compounds, caustics, chemical mixtures containing 55 percent tetrachloroethene, dichlorobenzene, methylene chloride, toluene, and 30 to 70 percent solutions of sodium hydroxide
	610	Metal grinding and machining facility was constructed in 1979.	Metals
144	No Buildings Present	Recreational area consists of unpaved open space.	None
164A	170	Warehouse was constructed in 1976	None

51A, 53A, 54 through 59, 66 through 68, and 186. General operations that were conducted at IR Site 5 include ordnance storage, ammunition overhaul, hazardous materials storage, paint storage, aircraft maintenance and repair, plating operations, corrosion control, fuel storage, and chemical storage. Buildings located and operations conducted within IR Site 5 are summarized in Table 2-2.

2.2 HISTORY OF PREVIOUS REMOVAL ACTIONS, INVESTIGATIONS, AND ACTIVITIES

This section summarizes removal actions and investigations previously conducted at IR Sites 4 and 5. A discussion of treatability studies associated with DNAPL removals is included.

IR Site 4

Nineteen investigations or removal actions were conducted within IR Site 4: (1) a Phase 1 and 2A RI under CTO 121 (PRC Environmental Management, Inc. [PRC] and James M. Montgomery [JMM], 1993); (2) a Phase 2B and 3 RI under CTO 121 (PRC and JMM, 1992a, 1992b); (3) Phase I and II investigations (Environmental Resources Management, West [ERM-West], 1995); (4) an underground storage tank (UST) removal (Navy Public Works Center [PWC], 1996b); (5) an RI under CTO 260 (PRC and MW, 1996a); (6) an RI under CTO 107 (OGISO Environmental [OGISO], 1997); (7) a Phase I investigation (Moju, 1997), (8) an EBS Phase IIa and IIb investigation (IT, 1998); (9) an RI under CTO 122 (TtEMI and Einarson, Fowler, and Watson [EFW], 1998); (10) an UST removal (Innovative Technical Solutions, Inc. [ITSI], 1998); (11) a Phase III investigation (Moju, 1999); (12) an RI under CTO 108 (TtEMI, 1999c) (13) a fuel line removal (TtEMI, 1999a); (14) a floating product investigation (TtEMI, 2000b); (15) a methyl-tert-butyl ether (MTBE) investigation (TtEMI, 2000c); and (16) reductive anaerobic biological *in situ* treatment technology treatability testing (Battelle Memorial Institute [Battelle], 2000). The investigations conducted within IR Site 4 are summarized in Table 2-3.

IR Site 5

Fifteen investigations or removal actions were conducted within IR Site 5: (1) phase 2B and 3 follow-on RI investigations under CTO 121 (PRC and MW, 1994b); (2) an RI under CTO 260 (PRC and MW, 1996a); (3) an RI under CTO 316 (PRC, 1996b); (4) UST removals (Navy PWC, 1996b, 1997) (TtEMI, 1997, 1998); (5) an RI under CTO 107 (OGISO, 1997) (6) an RI under CTO 108 (PRC, 1997); (7) an EBS phase IIa and IIb investigation (IT, 1998); (8) an RI under CTO 122 (TtEMI and EFW, 1998); (9) a

TABLE 2-2
INSTALLATION RESTORATION SITE 5
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 1 of 4)

Parcel	Building	Operations Conducted	Hazardous Materials Stored/Used
45A	2	Enlisted personnel barracks were constructed in 1947.	None
46	42	Engineering laboratory was constructed in 1941.	None
	102	Ordnance storage area was constructed in 1943.	Paint, nonhalogenated organic compounds, and petroleum products
47	43	Ammunition overhaul and rework shop was constructed in 1941.	Petroleum products and solvents
48	44	Engineering laboratory and administrative offices were constructed in 1941.	None
	346	Engineering laboratory and administrative office were constructed in 1949.	None
49	405	Storage area for hazardous materials and wastes and non-chemical shipping area was constructed in 1958. Two aboveground storage tanks used for storing lubricating oil are located north of Building 405.	Trichlorofluoroethane, tricresyl phosphate, petroleum products, solvents, halogenated and nonhalogenated organic compounds, fuel, paint, lubricating oils, hydraulic fluids, and asbestos
	614	Paint storage facility was constructed in 1981. Fenced area outside of Building 614 was used for chemical storage.	Polyurethane and urethane paints, paint thinner, solvents, organic compounds, corrosives, petroleum products, lubricating oils, and naphtha
51A	No Buildings Present	Open space is north of Hangar 11.	None
53A	No Buildings Present	Open space is entirely paved, used for aircraft and vehicle parking.	None

TABLE 2-2
INSTALLATION RESTORATION SITE 5
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 2 of 4)

Parcel	Building	Operations Conducted	Hazardous Materials Stored/Used
54	5	<p>Aircraft component repair and maintenance facility was constructed in 1940. Shops within Building 5 were used for the cleaning, reworking, and manufacturing of metal parts, tool maintenance, plating operations, and painting operations. The paint shop contained two paint bays and several smaller paint spray booths. Processes in the plating shop included degreasing; caustic and acid etching; metal stripping and cleaning; and chrome, nickel, silver, cadmium, and copper plating. From 1940 through the early 1960s, radioluminescent aircraft instrument dials were refurbished with radium-226 on the second floor of Building 5. Radium paint from the process was washed down sink drains into the storm sewer system leading from Building 5 into the Seaplane Lagoon. Lead-acid and nickel-cadmium batteries were serviced in the battery storage area in the northeastern portion of Building 5. Two industrial waste water treatment plants, one of which is abandoned, are located near the southwestern corner of Building 5. The hazardous waste storage area at Building 5 was closed in 1988. The plating shop was closed in 1990. The building is currently vacant.</p>	<p>Zinc chromate, sulfuric acid, potassium hydroxide, heavy metals, methyl ethyl ketone, halogenated and nonhalogenated organics, corrosives, solvents, paints, radium-containing paints, waste oils, hydraulic fluid, antifreeze, beryllium, and mercury</p>
	347	<p>General-purpose manufacturing and repair facility was constructed in 1946.</p>	<p>Information unknown</p>
55	261	<p>This building was constructed in 1943. No information on activities conducted there is available.</p>	<p>Information unknown</p>
56	500	<p>Office space, chemical and equipment storage area, and woodworking shop were constructed between 1958 and 1963.</p>	<p>Oils, stains, paints, solvents, and glues</p>

TABLE 2-2
INSTALLATION RESTORATION SITE 5
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 3 of 4)

Parcel	Building	Operations Conducted	Hazardous Materials Stored/Used
57	348	Corrosion control shop was constructed in 1960. Activities included steam cleaning of aircraft outer surfaces and parts.	Methylene chloride
	415	Storage shed and hazardous waste accumulation area were constructed in 1956.	Petroleum products, resins, solvents, oils, and lubricants
	615	Electrical equipment and parts storage facility were constructed in 1982. Building is currently used for hazardous materials storage.	Resins and adhesives
58	34	Electrical substation was constructed between 1975 and 1981.	Transformer oils
59	62	Cafeteria and credit union were constructed prior to 1947.	Corrosives, paint, and battery water
66	32	This is a metal treatment shop.	Information unknown
67	No Buildings Present	Open space is entirely paved.	None
68	6	This includes a repair shop, steam cleaning facility, electromotor shop, storage area, and fire station	Information unknown
69	10	Public Works Center power plant was constructed in the late 1930s. Activities included steam generation and air compression. Nine aboveground storage tanks used for fuel are located on the southern side of the building. Five abandoned underground storage tanks are associated with Building 10.	Petroleum products, laboratory chemicals, plant water treatment chemicals, microbicide, morpholine, and corrosives
186	194	Maintenance storage structure is for equipment and drums.	None

TABLE 2-2
INSTALLATION RESTORATION SITE 5
HISTORICAL OPERATIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 4 of 4)

Parcel	Building	Operations Conducted	Hazardous Materials Stored/Used
186	282	Diesel motor gasoline station was constructed in 1944. Two active underground storage tanks containing unleaded gasoline and diesel fuel is located east of Building 282.	Petroleum products

TABLE 2-3
INSTALLATION RESTORATION SITE 4
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 1 of 4)

Investigation Name	Contractor	Date	Analyses	Field Activities
RI (CTO 121) Phase 1 and 2A	Canonie	1990	VOCs, SVOCs, TOC, TRPH, metals, cyanide, pH, and general chemical parameters	<ul style="list-style-type: none"> • 9 Soil borings drilled • 4 Monitoring wells installed • 108 Soil samples collected • 9 Wipe samples collected • Groundwater sampling conducted
RI (CTO 121) Phase 2B and 3	PRC and Montgomery Watson	1991-1992	metals, hexavalent chromium, and cyanide	<ul style="list-style-type: none"> • 12 Surface soil samples in plating shop area collected
RI (CTO 260)	PRC and Montgomery Watson	1994	VOCs, SVOCs, pesticide and PCBs, TPPH, TEPH, metals, cyanide, and general chemical parameters	<ul style="list-style-type: none"> • 3 CPTs conducted • 9 Shallow and deep Hydropunch[®] samples collected • Soil borings drilled and 65 soil samples collected • Non-point-source sampling conducted • 3 Shallow monitoring wells installed • 3 Deep monitoring wells installed • Quarterly groundwater sampling conducted
RI (CTO 280)	PRC and Montgomery Watson	1994	VOCs, SVOCs, pesticide and PCBs, TPPH, TEPH, metals, cyanide, and general chemical parameters	<ul style="list-style-type: none"> • 3 Surface soil samples collected • 3 Shallow soil borings drilled • 6 CPTs conducted

TABLE 2-3
INSTALLATION RESTORATION SITE 4
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 2 of 4)

Investigation Name	Contractor	Date	Analyses	Field Activities
UST 163-1 Removal	PWC	1995	VOCs, SVOCs, TEPH, TPPH, and TRPH	<ul style="list-style-type: none"> • 5 Soil samples collected • 1 Groundwater sample collected • Exposed soil in the excavation not visibly contaminated • No observable sheen on the groundwater encountered at 4 feet bgs • Over-excavation performed on the eastern side of the UST excavation
UST 372-1 Removal	PWC	1995	VOCs, TPPH, and TEPH	<ul style="list-style-type: none"> • 2 Soil samples collected • 1 Groundwater sample collected • UST 372-1 reported to be in good condition with no holes • Soil staining not observed in the excavation sidewalls • Floating product and petroleum hydrocarbon odors noted in the UST excavation
Phase I	ERM West	1995	VOCs, TEPH, and TPPH	<ul style="list-style-type: none"> • 18 Soil samples field screened, of which 4 analyzed • 20 Groundwater samples collected

TABLE 2-3
INSTALLATION RESTORATION SITE 4
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 3 of 4)

Investigation Name	Contractor	Date	Analyses	Field Activities
Phase II	ERM West	1995	VOCs, TPPH, TEPH, metals, and SVOCs	<ul style="list-style-type: none"> • 3 Monitoring wells installed • 3 Soil samples collected • 3 Groundwater samples collected • 1 Soil sample collected below water table tested for permeability
EBS Phase IIa	IT	1995	TPPH, VOCs, SVOCs, Pesticides and PCBs, herbicides, reactivity, and metals	<u>Parcel 134</u> <ul style="list-style-type: none"> • 19 Surface soil samples • 27 Subsurface soil samples <u>Parcel 144</u> <ul style="list-style-type: none"> • Surface soil samples • Subsurface soil samples • Soil gas samples • 1 Subsurface (sanitary sewer)
EBS Phase IIb	IT	1995	TPPH, VOCs, SVOCs, Pesticides and PCBs, and metals	<u>Parcel 134B</u> <ul style="list-style-type: none"> • 6 Surface soil samples • 18 Subsurface soil samples • 12 Groundwater samples
RI (CTO 107)	OGISO Environmental	1997	VOCs	<ul style="list-style-type: none"> • Groundwater grab sampling conducted for plume definition
Phase I	Moju	1997	MTBE, BTEX, TPH-g, TPH-d, TPH-mo, and JP5, selected for chlorinated hydrocarbons	<ul style="list-style-type: none"> • 15 soil samples • 15 groundwater samples

TABLE 2-3
INSTALLATION RESTORATION SITE 4
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 4 of 4)

Investigation Name	Contractor	Date	Analyses	Field Activities
RI (CTO 108)	TtEMI	1997-1998	VOCs, SVOCs, TOC, TPH, metals, cyanide, and general chemical parameters	<ul style="list-style-type: none"> Quarterly groundwater sampling conducted Tidal influence study performed
Phase III	Moju	1997-1999	VOCs, SVOCs, BTEX and TTPH, selected for chlorinated hydrocarbons	<ul style="list-style-type: none"> 11 Groundwater samples
RI (CTO 122)	TtEMI and EFW	1998	VOCs	<ul style="list-style-type: none"> Plume definition: groundwater grab samples collected
UST 372-2	ITSI	1998	VOCs, SVOCs, TPPH, TEPH, and metals	<ul style="list-style-type: none"> 2 Soil samples collected Groundwater with a sheen observable at 3.5 feet bgs UST with visible corrosion, but no holes A tar-like product observable in the soil at the eastern end of the excavation
Fuel Line Removal	IT	1998	VOCs, SVOCs, TPPH, TEPH, and metals	<ul style="list-style-type: none"> 17 soil and 1 groundwater sample collected
Floating Product Investigation	TtEMI	1999	Floating product	<ul style="list-style-type: none"> Monitoring wells checked with dual-phase probe No floating product found
MTBE Investigation	TtEMI	1999	BTEX and MTBE	<ul style="list-style-type: none"> 1 groundwater sample collected near UST 163-1

Notes:

BTEX Benzene, toluene, ethylbenzene, xylenes
 CES Canone Environmental Services
 CPT Cone penetrometer testing
 CTO Contract task order
 EFW Einarson, Fowler, and Watson
 ERM Environmental Resources Management
 IT International Technology Corporation
 ITSI Innovative Technical Solution, Inc.
 JMM James M. Montgomery
 JP5 Jet Propulsion Fuel 5
 MTBE Methyl-tert-butyl ether
 PCB Polychlorinated biphenyl
 PRC PRC Environmental Management, Inc.
 PWC Navy Public Works Center

RI Remedial investigation
 SVOC Semivolatile organic compound
 TEPH Total extractable petroleum hydrocarbons
 TOC Total organic compound
 TPH Total petroleum hydrocarbons
 TPH-d Total petroleum hydrocarbons as diesel
 TPH-g Total petroleum hydrocarbons as gasoline
 TPH-mo Total petroleum hydrocarbons as motor oil
 TPPH Total purgeable petroleum hydrocarbons
 TtEMI Tetra Tech EM Inc.
 UST Underground storage tank
 VOC Volatile organic compound

series of site characterization analysis penetrometer system (SCAPS) investigations (Navy PWC, 1999); (10) an EBS phase IIC investigation (IT, 1999); (11) a surfactant-enhanced subsurface remediation (SESR) treatability study (TtEMI, 1999d); (12) an UST removal (TtEMI, 1999e); (13) an MTBE investigation (TtEMI, 2000c); (14) a site characterization and steam-enhanced extraction treatability study (Berkeley Environmental Restoration Center [BERC], 2000); and (15) a floating product investigation (TtEMI, 2000b). The investigations conducted within IR Site 5 are summarized in Table 2-4 and the treatability studies are discussed below.

Steam-Enhanced Extraction Treatability Study

A pilot study of steam-enhanced extraction (SEE) to remove chlorinated and petroleum hydrocarbons from a suspected nonaqueous phase liquid (NAPL) waste oil source was conducted at IR Site 5, on the eastern side of Building 5 (BERC, 2000) near groundwater sample point S05-3B-C (a potential DNAPL area under this EE/CA). Using data collected during the August 1998 SCAPS investigation and subsequent BERC investigation conducted in September 1998, the extent of NAPL in this area was shown to be limited to depths between 6 and 9 feet bgs over an approximately 45-foot-diameter area. In general, the highest concentrations of each constituent were identified in soil samples located within the central portion of the NAPL zone in the area of the thickest accumulation of NAPL. Of the volatile organic compounds (VOC) analyzed, trichloroethene (TCE) was detected at the greatest concentration. The concentrations of TCE and total VOCs in soil ranged from non-detect to 2,200 milligrams per kilogram (mg/kg) and 3,635 mg/kg, respectively. Concentrations of total extractable petroleum hydrocarbons (TEPH) and total semivolatile organic compounds (SVOC) in soil ranged from non-detection to 13,000 mg/kg and from non-detection to 124 mg/kg, respectively (BERC, 2000).

Of the VOCs analyzed in groundwater prior to the application of SEE, TCE was detected at the greatest concentration. The concentrations of TCE and total VOCs in groundwater ranged from 12 to 71,200 $\mu\text{g/L}$ and from 34 to 115,962 $\mu\text{g/L}$, respectively. Concentrations of TEPH and total SVOCs in groundwater ranged from 63 to 15,000 $\mu\text{g/L}$ and from non-detection to 2,694 $\mu\text{g/L}$, respectively (BERC, 2000).

During the test, six injection well clusters with an average depth of 21 feet surrounded the suspected NAPL source zone, with separate completions in the vadose zone and in the saturated zone. A single extraction well with an average depth of 21 feet in the center of the injection wells was used to extract

TABLE 2-4

**INSTALLATION RESTORATION SITE 5
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA**

(Page 1 of 4)

Investigation Name	Contractor	Date	Analyses	Field Activities
RI (CTO 121) Phase 2B and 3	PRC and JMM	1991-1992	Metals, hexavalent chromium, and cyanide	<ul style="list-style-type: none"> • 19 Surface soil samples collected • 56 Subsurface soil samples collected • 5 Shallow monitoring wells installed • 2 Monitoring wells installed • Geophysical survey conducted
RI (CTO 260)	PRC and Montgomery Watson	1994	VOCs, SVOCs, pesticides and PCBs, TPPH, TEPH, metals, cyanide, and general chemical parameters	<ul style="list-style-type: none"> • 6 CPT performed • Hydropunch® samples collected • 11 Soil borings drilled • 26 Soil samples collected • Non-point-source sampling conducted • 5 Shallow monitoring wells installed • Reference boring drilled • Deep monitoring wells installed • Quarterly groundwater sampling conducted

TABLE 2-4
INSTALLATION RESTORATION SITE 5
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 2 of 4)

Investigation Name	Contractor	Date	Analyses	Field Activities
UST 261-1 and 261-2 Removal	PWC	1994	TPPH, TEPH, VOCs, and metals	<ul style="list-style-type: none"> • USTs 261-1 and 261-2 contained within a concrete vault; therefore, no soil or groundwater samples collected • 10 Soil samples collected from the product-line removal trench associated with UST 261-1 and 261-2
UST 261-3 Removal	PWC	1994	TPPH, TEPH, VOCs, and metals	<ul style="list-style-type: none"> • 4 Soil samples and 1 groundwater sample collected • Brown foam and a greenish sheen observable on the groundwater surface in the excavation • 1 Soil sample collected from the pipeline removal trench between UST 263-3 and Building 261
UST 615-3 Removal	PWC	1994	TPPH, TEPH, and VOCs	<ul style="list-style-type: none"> • 1 Soil sample collected from the UST excavation

TABLE 2-4
INSTALLATION RESTORATION SITE 5
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 3 of 4)

Investigation Name	Contractor	Date	Analyses	Field Activities
EBS Phase IIa	IT	1995	TPPH, VOCs, pesticides and PCBs, and metals	<ul style="list-style-type: none"> • 11 Surface soil samples • 16 Subsurface soil samples
EBS Phase IIb	IT	1995	VOCs, TPH, Pesticides and PCBs, and metals	<ul style="list-style-type: none"> • 4 Soil samples • 2 Groundwater samples
RI (CTO 316)	PRC	1996	Aquifer test parameters	<ul style="list-style-type: none"> • Pumping well and 3 observation wells installed
SCAPS	PWC	1996-1998	LNAPL, DNAPL, TPPH, TEPH, VOCs, SVOCs, and metals	<ul style="list-style-type: none"> • 33 SCAPS pushes using SCAPS with LIF to measure free product in the groundwater • 21 SCAPS borings • 14 Membrane interface probe vertical profiles • 13 Soil borings
RI (CTO 107)	PRC and OGISO Environmental	1997	VOCs	<ul style="list-style-type: none"> • Groundwater grab sampling conducted for plume definition
USTs 5-2 and 5-3 Removal	TtEMI	1997	VOCs, TPPH, and TEPH	<ul style="list-style-type: none"> • 6 Soil samples • 1 Groundwater sample • An oily sheen observable on the groundwater surface in the excavation of UST 5-2 • Stained soil observable in the excavation of UST 5-3 Groundwater not encountered during removal
RI (CTO 108)	PRC	1997-1998	VOCs, SVOCs, TPPH, TEPH, metals, cyanide, and general chemical parameters	<ul style="list-style-type: none"> • Quarterly groundwater sampling conducted • Tidal influence study performed

TABLE 2-4
INSTALLATION RESTORATION SITE 5
PREVIOUS INVESTIGATIONS AND REMOVAL ACTIONS
ALAMEDA POINT, ALAMEDA, CALIFORNIA
(Page 4 of 4)

Investigation Name	Contractor	Date	Analyses	Field Activities
RI (CTO 122)	TtEMI and EFW	1998	VOCs	<ul style="list-style-type: none"> • Groundwater grab sampling conducted for plume definition
UST 615-4 Removal	TtEMI	1998	TPPH, TEPH, and VOCs	<ul style="list-style-type: none"> • 1 Soil sample collected in UST excavation • Soil staining was observed in the excavation
EBS Phase IIc	IT	1999	TPH and VOCs	<ul style="list-style-type: none"> • 3 Soil and groundwater samples collected along former product lines
MTBE Investigation	TtEMI	1999	VOCs	<ul style="list-style-type: none"> • 1 Groundwater sample collected near UST 615-3 to obtain site closure
Floating Product Investigation	TtEMI	1999	Floating product	<ul style="list-style-type: none"> • 1 Monitoring well checked with interface probe.

Notes:

CPT Cone penetrometer testing
CTO Contract task order
DNAPL Dense nonaqueous phase liquids
EBS Environmental baseline survey
EFW Einarson, Fowler, and Watson
ERM Environmental Resources Management
IT International Technology Corporation
ITSI Innovative Technical Solutions, Inc.
JMM James M. Montgomery
LIF Laser-induced fluorescence
LNAPL Light nonaqueous phase liquids
MTBE Methyl-tert-butyl ether
PCB Polychlorinated biphenyl
PWC Public Works Center
RI Remedial investigation
SCAPS Site Characterization Analysis Penetrometer System

SVOC Semivolatile organic compound
TEPH Total extractable petroleum hydrocarbons
TOC Total organic compound
TPH Total petroleum hydrocarbons
TPPH Total purgeable petroleum hydrocarbons
TtEMI Tetra Tech EM Inc.
UST Underground storage tank
VOC Volatile organic compound

water, organic compounds, and hot vapor. The extracted fluids were then cooled, separated, and treated (BERC, 2000).

Steam was first injected into the vadose zone for 10 days until hot vapors were observed in the extracted flow stream. Steam was then injected into both the vadose and saturated zones at maximum rates for an additional 40 days until recovery rates dropped. Thereafter, and until the end of operations 20 days later, the injections and extractions occurred cyclically with a goal of inducing the maximum fluid pressure changes in the pores of the soil (BERC, 2000).

Approximately 603 gallons (1,943 kilograms) of chlorinated and petroleum hydrocarbon liquids were removed during the operation of SEE, the majority (530 gallons) of which was recovered as NAPL. Of that mass, 84 percent was collected and recycled, 2 percent was adsorbed on granular activated carbon in the water treatment system, and 14 percent was adsorbed on granular activated carbon in the vapor treatment line (BERC 2000). Approximately 192 kilograms of TCE were found in the gases exiting the last vapor-liquid separator, 22 kilograms of TCE were removed from the water stream entering the treatment carbon, and 18 kilograms of TCE were found in the recovered NAPL (BERC, 2000).

Post-SEE soil sample concentrations were significantly lower than the maximum concentrations detected in the pre-steaming soil samples. Post-SEE concentrations of TCE in soil were all less than 0.015 mg/kg except one sample that was reported as 20 mg/kg. Post-SEE concentrations of total VOCs and TEPH in soil ranged from non-detect to 166.19 mg/kg and non-detection to 3,300 mg/kg, respectively. In addition, total SVOC concentrations in soil ranged from non-detection to 3.12 mg/kg following SEE. Finally, microbial population counts in the steamed soil rebounded to pre-steaming levels upon cooling, indicating that natural bioattenuation processes will continue at the site (BERC, 2000).

Groundwater concentrations of petroleum hydrocarbons and chlorinated solvents in the treatment zone were generally reduced by about an order of magnitude lower than values found in upgradient groundwater. Post-SEE concentrations of TCE in groundwater ranged from non-detection to 17,040 µg/L. Post-SEE concentrations of total VOCs and TEPH in groundwater ranged from 4 µg/L to 31,119 µg/L and non-detection to 55,000 µg/L, respectively. In addition, total SVOC concentrations in groundwater ranged from 26 µg/L to 5,500 µg/L following SEE (BERC, 2000).

Surfactant Enhanced Subsurface Remediation DNAPL Removal Treatability Study

A SESR treatability study was performed on a 400-square-foot (20 feet by 20 feet) area within IR Site 5 on the northeastern side of Building 5 near groundwater sampling point S05-2A-A, (a potential DNAPL area under this EE/CA) (TtEMI, 1999d). DNAPL in this area consisted primarily of 1,1,1-trichloroethane (TCA), TCE, 1,1-dichloroethene (DCE), and 1,1-dichloroethane (DCA). Prior to the initiation of SESR, an estimated pretest DNAPL volume was calculated within the test area using soil coring and a pre-partitioning interwell tracer test (pre-PITT). Soil samples collected during the pretesting indicated the presence of DNAPL from 15 to 17 feet bgs in the central and southwestern portions of the study area extending out of the study area towards the southwest. Analytical results of soil samples collected during pretesting ranged from 2.1 to 32,000 mg/kg for 1,1,1-TCA and 0.82 to 17,000 mg/kg for TCE. Soil samples collected above 15 feet bgs and along the northern and eastern study area boundaries did not indicate the presence of DNAPL. Analytical results of groundwater samples collected prior to the initiation of SESR ranged from 5.0 to 580 mg/L for 1,1,1-TCA and 2.1 to 150 mg/L for TCE (TtEMI, 1999d).

Following pretesting, SESR was initiated using a surfactant solution. The surfactant solution was injected into two injection wells (depth to 17 feet bgs) at a rate of 2 gallons per minute (gpm). Four recovery wells were each pumped at a rate of 2 gpm (depth to 17 feet bgs). Recovered water was stripped of organic chemicals using a Macroporous Polymer Liquid-Liquid extraction system at removal efficiencies of 80 percent to 95 percent. The remaining surfactant solution passed through a Micellar Enhanced Ultrafiltration unit to concentrate surfactant for re-injection. During the test, approximately six pore volumes of surfactant solution were flushed through the aquifer in 18 days. The estimated combined volume of 1,1,1-TCA and TCE removed during SESR, based on samples collected during surfactant flushing, was approximately 70 gallons. The SESR flush was followed by 5 days of water flushing to remove sorbed surfactant from soil within the test area (TtEMI, 1999d).

Post-flush DNAPL concentrations were determined using soil coring results and by conducting a post-partitioning interwell tracer test (post-PITT). Soil cores were drilled within 2 feet of the pre-test soil sampling locations at depth intervals identical to the pre-test locations. Analytical results of soil samples collected after the conclusion of SESR ranged from non-detection to 1,500 mg/kg for 1,1,1-TCA and non-detection to 360 mg/kg for TCE. Soil samples collected from the clay aquitard beneath the aquifer were shown to yield anomalous data and, as a result, were not included in the above-mentioned analytical

ranges. Analytical results of groundwater samples collected almost 7 weeks after the conclusion of SESR ranged from 0.11 to 310 mg/L for 1,1,1-TCA and 0.13 to 170 mg/L for TCE. Based on a comparison of groundwater sample concentrations collected before and after the surfactant injection, the overall mass of 1,1,1-TCA and TCE in groundwater was reduced by 80 and 56 percent, respectively (TtEMI, 1999d).

2.3 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

Investigations of chlorinated solvent plumes at IR Sites 4 and 5 identified the potential for free-phase DNAPL in the subsurface (TtEMI and EFW, 1998). In addition, NAPL was found during the two treatability studies conducted at IR Site 5 described in Section 2.2. This section identifies the apparent sources of chlorinated solvent contamination and the extent of subsurface contamination at IR Sites 4 and 5.

IR Site 4

IR Site 4 contained the former plating shop in Building 360. Shop operations included paint stripping by blasting; chrome, nickel, and silver stripping; etching; and chrome, copper, nickel, and silver plating. The cleaning and blasting processes used baths of phenolic-based and alkaline-type cleaners, rust removers, descaling compounds, and caustics. Chemical mixtures used in the cleaning process historically included a mixture containing 55 percent PCE; several other mixtures containing dichlorobenzene, methylene chloride, and toluene; and 30 to 70 percent solutions of sodium hydroxide. Historical sources of VOCs at IR Site 4 included paints, adhesives, fuels, oils, solvents, and metal solutions that were stored and used in and around Building 360.

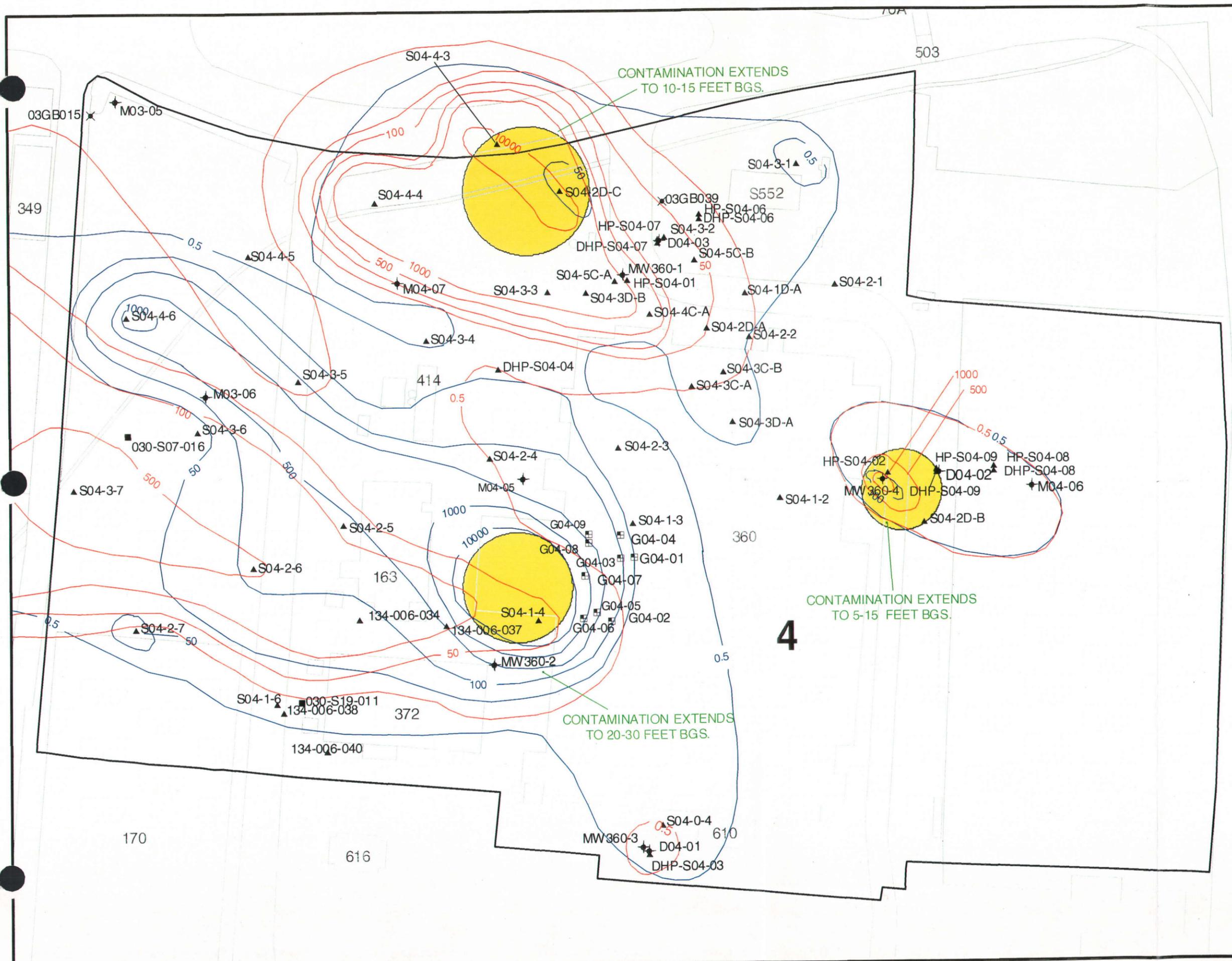
Chlorinated solvents were detected frequently in groundwater at IR Site 4 (TtEMI, 1999c). A focused groundwater investigation was conducted for IR Site 4 to evaluate the nature and extent of chlorinated solvent plumes caused by past releases at these sites (TtEMI and EFW, 1998). The investigation identified three distinct chlorinated solvent plumes at IR Site 4. Chlorinated solvent concentrations indicate that free-phase DNAPL may be present above less permeable layers between 11.5 and 30 feet bgs. Residual DNAPL may be present at shallower depths.

Potential DNAPL contamination or source areas are suspected to be present in three areas at IR Site 4 based on aqueous concentrations of TCE northwest of Building 360, 1,1-DCE southwest of Building 360, and TCE east of Building 360 (see Figure 2-4). The area east of Building 360 was included as a potential DNAPL location because high concentrations of TCE were measured in a monitoring well. The concentration of 5,000 µg/L was lower than the 11,000 µg/L DNAPL indicator; however, the sample was collected from a monitoring well, and dilution from the entire well screen was taken into account. TCE concentrations at 24,000 µg/L, indicative of DNAPL, were present at a depth of 10 to 15 feet bgs northwest of Building 360. Deeper samples at this location did not have concentrations indicating DNAPL. Concentrations of 1,1-DCE at 16,000 to 84,000 µg/L, indicative of DNAPL, are present at a depth of 20 to 30 feet bgs at the southwestern side of Building 360. Concentrations of 1,1-DCE in deeper samples were not indicative of DNAPL. DNAPL characterization will also be performed at locations east of Building 360 during data gap sampling scheduled for June 2001. The TCE concentrations in groundwater at these locations did not exceed the 1 percent solubility limit; however, separate chlorinated solvent releases are suspected.

IR Site 5

Shops within Building 5 were used for the cleaning, reworking, and manufacturing of metal parts; tool maintenance; plating operations; and painting operations. Processes in the plating shop included degreasing; caustic and acid etching; metal stripping and cleaning; and cadmium, chrome, copper, nickel, and silver plating.

Prior to 1972, wastewater from operations in Building 5 was discharged to the Seaplane Lagoon via the industrial waste sewer system. From 1972 until 1991, wastewater from the plating shops was sent to a pretreatment plant located near the southwestern corner of Building 5. A former hazardous waste storage area southeast of Building 5 was used to store spent solvents, waste paints, waste oils, hydraulic fluid, and lubricating oils. Lead-acid and nickel-cadmium batteries were serviced in the battery storage area northeast of Building 5. Battery fluids were discharged to a sink located in the storage area, and the sink discharged to the base industrial sewer system. Base personnel indicated that the corrosive fluids deteriorated the piping in the sink and drain that led to the sewer system (TtEMI, 1999c). Additionally, 10 USTs were previously located at Building 5 (TtEMI, 1999c). UST 5-3 (located on the eastern side of Building 5) was a leaking solvent tank that was removed in 1998.



LEGEND

BOUNDARIES

- BUILDING AND LAND COVER
- GROUNDWATER REMOVAL AREAS
- ▭ IR SITE 4 BOUNDARY

POINT TYPES

- EXCAVATION
- × GEOPROBE
- ▲ HYDROPUNCH
- ◆ MONITORING WELL
- SURFACE LOCATION

GROUNDWATER CONCENTRATION CONTOURS

- ▲ TRICHLOROETHENE PLUME (UG/L)
- ▲ 1,1-DICHLOROETHENE PLUME (UG/L)

NOTE:

- BGS = BELOW GROUND SURFACE
- DNAPL = DENSE NON-AQUEOUS PHASE LIQUID
- IR = INSTALLATION RESTORATION
- µg/L = MICROGRAM PER LITER

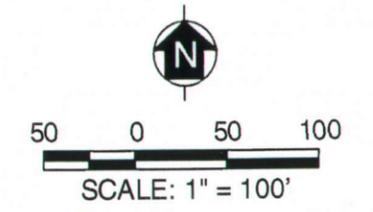


FIGURE 2-4
IR SITE 4
POTENTIAL DNAPL AND SOURCE
REMOVAL ACTION AREAS
 ALAMEDA POINT
 ALAMEDA, CALIFORNIA
 JANUARY 5, 2001

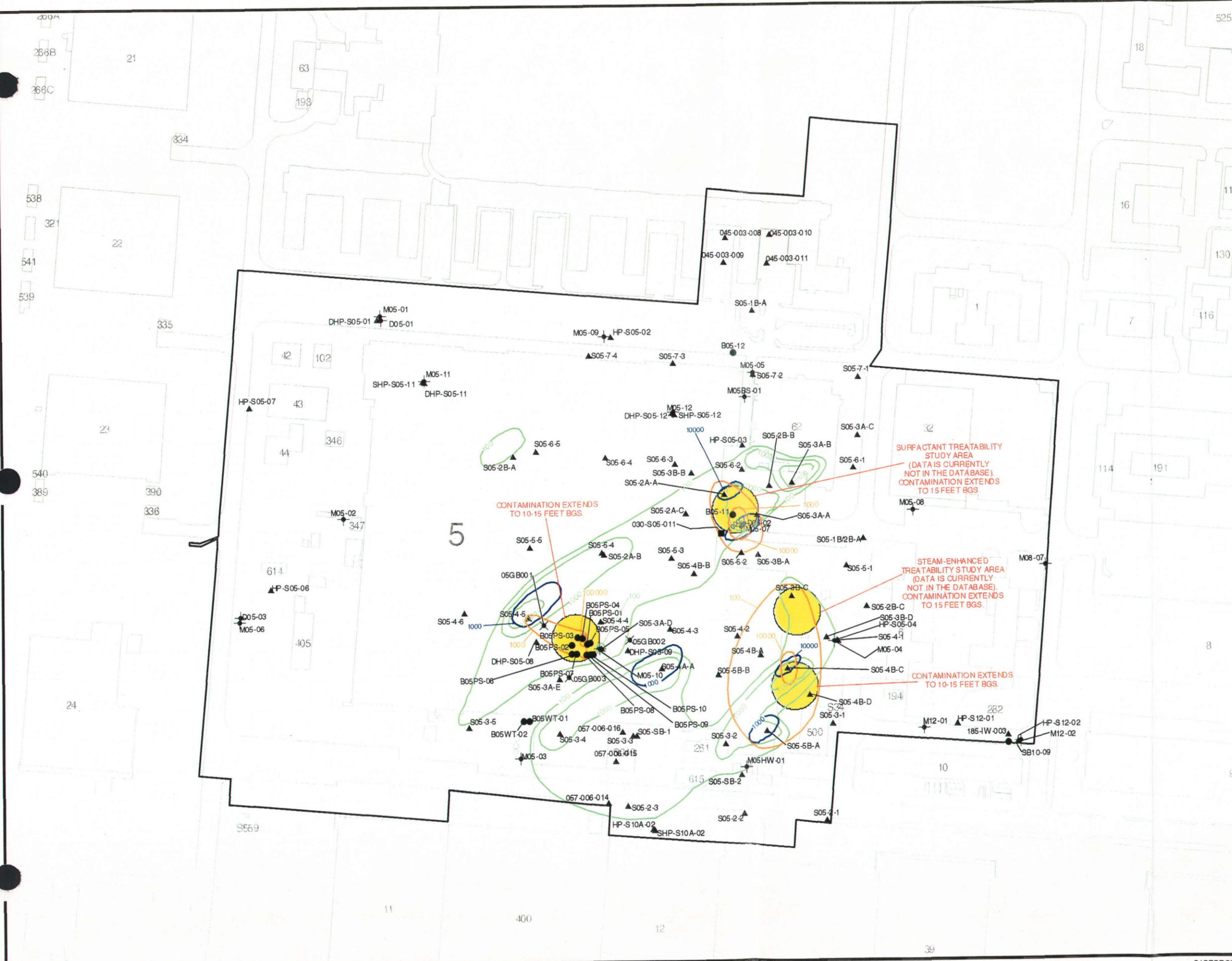
DS.0386.15537

Chlorinated solvents were detected frequently in groundwater at IR Site 5 (TtEMI, 1999c). Four distinct plumes were identified at IR Site 5 during the focused groundwater investigation conducted at IR Sites 4 and 5 (TtEMI and EFW, 1998). DNAPL contamination is suspected in four areas at IR Site 5. In fact, NAPL has been removed from IR Site 5 during two treatability tests conducted on the eastern side of Building 5 (see Section 2.2). The two treatability tests conducted at IR Site 5 located east and northeast of Building 5 reduced the DNAPL plumes at each of these areas. A SEE pilot study was conducted east of Building 5 and a SESR treatability study was conducted northeast of Building 5, as described in Section 2.2.

The study area for the SEE pilot study covered an area of about 1,600 square feet. The SEE removed about 603 gallons (1,943 kilograms) of chlorinated and petroleum hydrocarbon liquids from the study area, the majority (530 gallons) of which was recovered as NAPL. Samples collected following the application of SEE indicated a significant reduction of contaminants compared to samples collected prior to SEE.

The study area for the SESR pilot study covered an area of about 400 square feet at the northeastern portion of the DNAPL plume. Analytical results of soil samples collected following the application of SESR showed significant reduction (greater than 97 percent) of DNAPL constituent concentrations within the study area. It should be noted that analytical results presented in this report do not take into account the reduction of DNAPL by the two previously mentioned treatability studies. However, data gap sampling will be conducted in June 2001 to determine the current extent of contamination at these sites.

Aqueous concentrations of TCE, 1,1-DCA, 1,1-DCE, 1,2-DCE, and 1,1,1-TCA exceeding 1 percent of solubility (indicative of potential DNAPL) or exceeding 10,000 µg/L are present in four locations at IR Site 5 (see Figure 2-5). Maximum concentrations of 1,1,1-TCA (200,000 µg/L), 1,1-DCA (57,000 µg/L), TCE (36,000 µg/L) and 1,2-DCA (73,000 µg/L), indicative of DNAPL, are present at a depth of about 15 feet bgs, northeast of Building 5. The data for this determination can be found in the SESR report and is not included in the TtEMI database or shown as contours on Figure 2-3. Deeper samples at this location did not have concentrations indicating DNAPL. A concentration of TCE (72,500 µg/L), indicative of DNAPL, was present at about 10 feet bgs east of Building 5. The data for this determination can be found in the SEE report (BERC, 2000) and is not included in the TtEMI database or shown as contours on Figure 2-5. Concentrations of TCE in deeper samples at this location were not indicative of DNAPL. Concentrations of 1,1,1-TCA (20,000 to 100,000 µg/L) and 1,1-DCE (22,000 to 65,000 µg/L) indicative



- LEGEND**
- BOUNDARIES**
- BUILDING AND LAND COVER
 - GROUNDWATER REMOVAL AREAS
 - IR SITE 5 BOUNDARY
- POINT TYPES**
- EXCAVATION
 - ✕ GEOPROBE
 - ▲ HYDROPUNCH
 - ⊕ MONITORING WELL
 - SURFACE LOCATION
- GROUNDWATER CONCENTRATION CONTOURS**
- 1,1-DICHLOROETHENE PLUME (UG/L)
 - 1,1-DICHLOROETHANE PLUME (UG/L)
 - 1,1,1 TRICHLOROETHANE PLUME (UG/L)
- NOTE:**
- BGS = BELOW GROUND SURFACE
 - DNAPL = DENSE NON-AQUEOUS PHASE LIQUID
 - IR = INSTALLATION RESTORATION
 - µg/L = MICROGRAM PER LITER

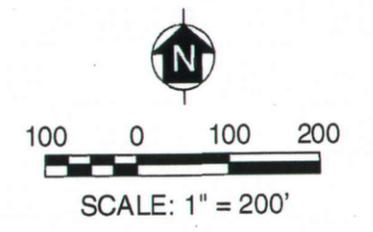


FIGURE 2-5
IR SITE 5
POTENTIAL DNAPL AND SOURCE
REMOVAL ACTION AREAS
 ALAMEDA POINT
 ALAMEDA CALIFORNIA
 JANUARY 5, 2001

DS.0386.15537

of DNAPL and high concentrations of 1,1-DCA (24,000 µg/L) are present between 5 and 10 feet bgs at the southeast corner of Building 5. Deeper samples at this location did not have concentrations indicating DNAPL. Concentrations of 1,1,1-TCA (790,000 µg/L) indicative of DNAPL and high concentrations of 1,1-DCA (13,000 µg/L) are present at a depth of 10 to 15 feet bgs northwest of the former plating shop inside Building 5. Deeper samples at this location did not have concentrations indicating DNAPL.

AREAS REQUIRING REMOVAL ACTIONS

Removal action areas were identified by the BCT during scoping meetings. Three potential source areas were identified and selected for treatment at IR Site 4, and four potential source areas were identified and selected for treatment at IR Site 5. These source areas were tentatively identified based on analytical data showing chlorinated solvent concentrations exceeding 1 percent of the solubility and areas suspected of having separate chlorinated solvent releases. These areas are recognized by the BCT to represent a potential risk, warranting the early removal action proposed in this EE/CA. Although the risk from these contaminants has not yet been quantified, complete risk assessments will be performed as part of the remedial investigation process, and risk numbers calculated at that time. Treatment areas were estimated in this EE/CA to facilitate cost estimates. Table 2-5 presents approximate area and depth to be treated under this interim removal action based on information obtained from previous investigations (TtEMI and EFW, 1998; TtEMI, 1999c; BERC, 2000). Data gap sampling will occur in June 2001 to further delineate removal action areas.

2.4 ANALYTICAL DATA

Appendix A presents the analytical data that were used to prepare this EE/CA. The database includes most IR Site 4 and 5 historical investigation analytical results. Tables in A-1 through A-8 list the sample point name, point type, date, depth, constituent and concentrations. Tables A-1 (IR Site 4) and A-5 (IR Site 5) include analytical data for all chemicals of concern (COC) to be addressed in this EE/CA. Supplemental data in Tables A-2 through A-4 (IR Site 4) and A-6 through A-8 (IR Site 5) present possible treatment parameters such as chromium concentrations, geochemical parameters, and carbon sources present in the groundwater treatment areas. A summary of the data was presented in the previous section.

TABLE 2-5
GROUNDWATER TREATMENT AREAS ADDRESSED FOR INTERIM REMOVAL ACTION
ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 1 of 1)

Installation Restoration Site	Chemicals of Concern Targeted	Approximate Treatment Area
IR Site 4	1,1-DCE and TCE	Area = 32,138 ft ² Depth = 20-30 ft
IR Site 5	1,1,1-TCA, 1,1-DCA, 1,1-DCE, 1,2-DCE, and TCE	Area = 32,676 ft ² Depth = 15 ft

Notes:

DCE Dichloroethene
 ft Foot
 ft² Square foot
 IR Installation Restoration
 TCA Trichloroethane
 TCE Trichloroethene

3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

The following sections provide information necessary to identify removal action objectives (RAO) for IR Sites 4 and 5. These objectives will be achieved while working within the statutory limits on removal actions. Section 3.1 presents statutory limits, Section 3.2 presents the removal scopes, Section 3.3 presents a removal schedule, Section 3.4 presents preliminary identification and screening of potential ARARs, and Section 3.5 presents RAOs.

3.1 STATUTORY LIMITS ON REMOVAL ACTIONS

The removal action will be taken pursuant to CERCLA and the NCP under the delegated authority of the Office of the President of the United States by Executive Order (EO) 12580. The EO provides the Navy with authorization to conduct and finance a removal action. The removal action is deemed non-time critical because more than a 6-month planning period was available between the time of the removal action was determined to be necessary and the initiation of removal action. The requirements for this EE/CA and its mandated public comment period provide opportunity for public input to the cleanup process.

The Navy is the lead agency for the removal action. As such, the Navy has final approval authority over the recommended alternative and all public participation activities. The Navy is working in cooperation with EPA, DTSC, and the RWQCB in the implementation of this removal action. The Southwest Division, Naval Facilities Engineering Command is the regional manager of the Navy's CERCLA program and is, therefore, providing technical expertise to conduct activities specific to the preparation of the EE/CA and the execution of the recommended removal action. This EE/CA complies with the requirements of CERCLA, Superfund Amendments and Reauthorization Act (SARA), the NCP at Title 40 of the Code of Federal Regulations (40 CFR) 300, Defense Environmental Restoration Program (DERP) at 10 U.S. Code (USC) §2701, et seq., and EO12580. Removal actions recommended under this EE/CA are being pursued under 40 CFR 300.415 (b)(2)(ii), (iii), and (viii). The \$2 million and 12 month statutory limits provided in CERCLA 104(c)(1) do not apply to this EE/CA because the removal action is not funded by the Superfund Trust Fund.

3.2 DETERMINATION OF REMOVAL SCOPE

The scope of these removal actions are limited to reduction of COCs in solvent source areas (defined as chlorinated solvent concentrations exceeding 10,000 µg/L) in groundwater at IR Sites 4 and 5. The goal of the removal action is to reduce chlorinated solvent concentrations beneath IR Sites 4 and 5 to the extent technically and economically feasible within 1 year. The purpose of the removal action is to reduce the total mass of contaminants and thereby reduce potential contaminant loading to groundwater. As such, the removal actions are an interim measure and not a final remedy for groundwater contamination at these sites. In addition to these removal actions, IR Sites 4 and 5 will undergo the full CERCLA RI/FS/ROD process. As explained below, the limited scope of the removal actions will affect the determination of applicable or relevant and appropriate requirements (ARAR).

3.3 DETERMINATION OF REMOVAL SCHEDULE

This EE/CA identifies, evaluates, and recommends removal actions. The EE/CA will be available for public review and comment for 30 days. The Navy will review the comments and direct the incorporation of public comments into the final EE/CA.

The removal actions are expected to be completed within 12 months after the award of the removal contract.

3.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The NCP states, "Removal actions . . . shall to the extent practicable considering the exigencies of the situation, attain applicable or relevant and appropriate requirements (ARARs) under Federal environmental or state environmental or facility citing laws" (40 CFR 300.415(i)). Three factors determine whether the attainment of ARARs is practicable in a given removal action: (1) the exigencies of the situation, (2) the scope of the removal action, and (3) the effect of ARAR attainment on statutory limits for removal action duration and cost.

The following sections provide an overview of the ARARs process and a discussion of the way potential ARARs may affect the development of RAOs.

3.4.1

ARARS Overview

Identification of ARARs is a site-specific determination that involves a two-part analysis: first, a determination of whether a given requirement is applicable, then, if it is not applicable, a determination of whether it is relevant and appropriate. A requirement is deemed applicable if the specific terms of the law or regulation directly address the COCs, remedial action, or area involved at the site. If the jurisdictional prerequisites of the law or regulation are not met, a legal requirement may nonetheless be relevant and appropriate if the site's circumstances are sufficiently similar to circumstances in which the law otherwise applies and it is well suited to the conditions of the site. The evaluation of a requirement's relevance and appropriateness is site specific and must be based on best professional judgment. A requirement may be relevant, but not appropriate, for the specific site. In 40 CFR 300.400(g)(2), the NCP lists factors to consider in evaluating relevance and appropriateness. Only requirements that are determined to be both relevant and appropriate in light of these factors must be considered. Portions of a requirement may be relevant and appropriate even if a requirement in its entirety is not.

A requirement must be substantive in order to constitute an ARAR for activities conducted onsite. Procedural or administrative requirements, such as permits, reporting requirements, and agency approvals, are not ARARs.

In addition to ARARs, the NCP provides that where ARARs do not exist, agency advisories, criteria, or guidance may be considered (termed "to-be-considered" [TBC] criteria) if useful "in helping to determine what is protective at a site or how to carry out certain actions or requirements" (55 Federal Register 8745). The NCP preamble states, however, that provisions in the TBC category "should not be required as cleanup standards because they are, by definition, generally neither promulgated nor enforceable, so they do not have the same status under CERCLA as do ARARs."

As the lead federal agency, the Navy has the primary responsibility for the identification of federal ARARs at Alameda Point. As the lead state agency, DTSC has the responsibility for identifying state ARARs. In a letter dated September 12, 1996, the Navy requested that DTSC identify State of California ARARs for the RI/FS of Naval Air Station (NAS) Alameda. DTSC identified these ARARs in a letter to the Navy dated November 13, 1996. However, since identification of ARARs must be site specific, the Navy will solicit state ARARs again concurrently with issuance of the draft EE/CA to the regulatory agencies. Accordingly, the Navy is listing only potential federal ARARs at this time.

3.4.2 ARARS and TBCs Affecting Removal Action Objectives

ARARS and TBCs are generally divided into three categories: chemical-specific, location-specific, and action-specific. ARARS and TBCs affecting the development of the RAOs are discussed in the following sections.

3.4.2.1 Chemical-Specific ARARS and TBCs

Chemical-specific ARARS are health- or risk-based numerical values or methodologies that, are applicable to the contaminants at a site and may result in the establishment of numerical cleanup values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

As discussed in Section 3.2 above, the scope of this removal action is removal of DNAPL and chlorinated solvent source areas in the aquifer at IR Sites 4 and 5. Chemical-specific requirements exist as a guidance for classifying groundwater and surface water beneficial uses, groundwater concentration limits, and ambient surface water quality standards that may be affected by groundwater discharge to surface water. Had the scope of those removal actions addressed a permanent restoration of beneficial uses of groundwater and surface water, these requirements would be evaluated under the principles stated in Section 3.4.1. However, this removal action is an interim measure; the principal goal of which is site stabilization, not long-range site cleanup. Requirements that are outside the scope of the immediate action, therefore, are not ARARS but will be included as TBCs (EPA, 1988, 1989, 1991)).

Moreover, even if certain groundwater and surface water requirements were found to be ARARS, the NCP only requires compliance with ARARS to the extent practicable. Among the factors to be considered in determining whether identifying and complying with ARARS is practical is the scope of the removal action under 40 CFR §300.415(i) (EPA, 1991). EPA guidance states the following in pertinent part:

[I]n some cases, compliance with ARARS is outside the scope of the removal action because the ARAR requires a degree of cleanup that would be inappropriate or inconsistent with the limited scope and purpose of the removal action, such as site stabilization and mitigation of near-term threats.

The goal of this removal action is reduction of contaminant mass in chlorinated solvent source areas and stabilization of the resultant plume.

The primary chemical-specific ARARs now identified are those requirements applicable to the identification and land disposal of hazardous waste. Whenever contaminated media is being excavated, activities may generate waste materials such as excavated soil and groundwater. The applicability of Resource Conservation and Recovery Act (RCRA) hazardous waste management requirements depends on whether the activity generates a waste; whether the waste is a RCRA hazardous waste; whether the waste initially underwent treatment, storage, or disposal after the effective date of the particular RCRA requirement; and whether the activity at the site constitutes treatment, storage, or disposal as defined by RCRA (EPA, 1998). If this removal action generates contaminated media that meet the definition of RCRA hazardous waste, then RCRA waste management requirements are potentially applicable. The RCRA requirements at 22 California Code of Regulations (CCR) §66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 are potential ARARs because they define RCRA hazardous waste. In particular, a waste can meet the definition of hazardous waste if it has the toxicity characteristic of hazardous waste. This determination is made by using the toxicity characteristic leaching procedure (TCLP). The California regulation at 22 CCR §66261.24(a)(1)(B) lists the maximum concentrations allowable for the TCLP and is a potential federal ARAR for determining whether the site has hazardous waste. If the site waste has concentrations exceeding these values, it is determined to be a characteristic RCRA hazardous waste. If site waste is found to contain hazardous waste, it will be managed in accordance with EPA's contained-in policy.

Additionally, site waste may also contain non-RCRA hazardous waste under California law. Therefore, non-RCRA, state-regulated waste definition requirements presented in 22 CCR §66261.24(a)(2) are potential state ARARs for determining whether other RCRA requirements are potential state ARARs.

RCRA land disposal restrictions (LDR) presented in 22 CCR §66268.1(f) are also potential federal ARARs for any removal alternatives that discharge hazardous waste to property on site. This requirement prohibits the disposal of hazardous waste to land unless the waste is treated in accordance with the treatment standards of §66268.40 and meets the Universal Treatment Standards of §66268.48 or meets the alternative treatment standards of §66268.49 or receives a treatability variance pursuant to §66268.44. These are potentially applicable federal ARARs because they are part of the state-approved RCRA program. ARARs are summarized in Table 3-1.

TABLE 3-1

INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL CHEMICAL-SPECIFIC
 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 1 of 1)

Statutory Citation	Regulatory Citation	Medium	Description	Preliminary ARAR Determination	Comments
Federal Requirements					
Clean Water Act (33 USC § 1314(a))		Water	Establishes surface water quality criteria protective of aquatic organisms	To be considered	To be considered for groundwater potentially discharging to surface water from IR Sites 4 and 5
California State Drinking Water Act (California Health and Safety Code § 116365)	26 CCR § 22-64444	Water	Establishes MCL for public water systems	To be considered	To be considered for IR Site 4 because groundwater is a potential drinking water source
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 <i>et seq.</i>)	22 CCR §§ 66261.21 66262.22(a)(1) 66261.23 66261.24(a)(1) 66261.100	Water and Soil	Criteria for identifying characteristics of RCRA hazardous waste	Applicable	These requirements would be applicable to Alternatives 2, 3, and 4 for determining whether excavated media contains hazardous waste.
Resource Conservation and Recovery Act (42 USC, Chapter 82, 6901 <i>et seq.</i>)	22 CCR §§ 66268.1(f) 66268.7(a) 66264.40 66268.44 66268.48 66268.49	Soil and Water	Prohibits disposal of hazardous waste through LDRs unless treatment standards are met	Applicable	Soil and water generated pursuant to Alternative 3 may not be disposed on-site unless LDR treatments standards are met, alternative treatment standards are met, or treatability variance is granted by the Department of Toxic Substance Control.

Notes:

ARAR Applicable or relevant and appropriate requirement
 CCR California Code of Regulations
 EPA Environmental Protection Agency
 IR Installation Restoration

MCL Maximum contaminant level
 RCRA Resource Conservation and Recovery Act
 USC U.S. Code

3.4.2.2 Location-Specific ARARs and TBCs

Location-specific ARARs are restrictions on the concentrations of hazardous substances or on the conduct of activities solely because they are in specific locations. Specific locations include flood plains, wetlands, historic places, and sensitive ecosystems or habitats. Several site conditions at Alameda Point are associated with location-specific ARARs. Requirements such as the Endangered Species Act, the National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA), the Migratory Bird Treaty Act, the National Historic Preservation Act, the Archeological Resources Protection Act, and the Coastal Zone Management Act (CZMA) were considered as potential location-specific ARARs. IR Sites 4 and 5 do not provide any habitat for threatened or endangered species, and no endangered species have been observed at the site, thus the Endangered Species Act was not identified. Additionally, IR Sites 4 and 5 do not encompass any historic properties included or eligible for inclusion on the National Register of Historic Places. No scientific, prehistoric, or archeological data have been identified at the sites. Also, EPA and the Navy have determined that the requirements of NEPA and CEQA are no more stringent than the requirements for environmental review under CERCLA and the NCP. Hence, NEPA and CEQA were not considered ARARs for CERCLA actions.

Section 307 (c)(1) of the CZMA (16 USC §1456(c)(1)) and the implementing regulations in 15 CFR §930 and 923.45 require that federal agencies conducting or supporting activities directly affecting the coastal zone conduct or support those activities in a manner that is consistent with the approved state coastal zone management programs. A state coastal zone management program (developed under state law and guided by the CZMA) sets forth objectives, policies, and standards to guide public and private uses of lands and water in the coastal zone.

California's approved coastal management program includes the San Francisco Bay Plan (Bay Plan) developed by the San Francisco Bay Conservation and Development Commission (BCDC). The BCDC was formed under authority of the McAteer-Petris Act (California Government Code §66600 *et seq.*), which authorizes the BCDC to regulate activities within San Francisco Bay and the shoreline (100 feet landward from the shoreline) in conformity with the policies of the Bay Plan (BCDC, 1968). The Bay Plan's policies include limiting Bay filling, maintaining marshes and mudflats to the fullest extent possible to conserve wildlife and abate pollution, and protect the beneficial uses of the Bay. IR Sites 4 and 5 are located adjacent to the coastal zone such that this removal action could affect the coastal zone.

Therefore, all removal action alternatives will be consistent with the goals of the Bay Plan and will conform to the substantive requirements of the state management program. This ARAR is summarized in Table 3-2.

3.4.2.3 Action-Specific ARARs and TBCs

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste. These requirements are triggered by the particular remedial activities selected. Removal actions often include a discharge, such as treated or untreated groundwater or air emissions. The requirements that are relevant and appropriate are determined by the media being discharged and the destination of the discharge. Action-specific ARARs do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be achieved. Therefore, because action-specific ARARs depend on the action selected, potential requirements will be discussed in general here and evaluated in greater detail in Section 4.0 during analysis of the long-term effectiveness of each removal alternative. Table 3-3 summarizes the potential action-specific ARARs and TBCs.

For hazardous waste sent off site for disposal at a disposal facility (such as soil cuttings or decontamination water), the waste must meet the corresponding treatment standard promulgated under the LDR regulations referenced in Section 4.3.2.1 above. Similarly, the waste will be in compliance with all Department of Transportation requirements at 49 CFR 171 and 172 for the transportation of hazardous materials. However, these activities would take place off site, so they are not considered ARARs for this removal action.

In addition, the federal Clean Air Act (CAA), 42 USC §§7401 *et seq.* establishes the National Ambient Air Quality Standards (NAAQS). NAAQS are not enforceable in and of themselves; they are translated into source-specific emission limitations by the state. Substantive requirements of the Bay Area Air Quality Management District (BAAQMD) that have been approved by EPA as part of the state implementation plan (SIP) under the CAA are potential federal ARARs for air emissions (CAA Section 110). Off-gas from SVE operations (Alternatives 3 and 4) would have to comply with Rules 8-47-301 and 8-47-302. These requirements and their applicability will be discussed in the Detailed Analysis section for each alternative.

TABLE 3-2

INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL FEDERAL LOCATION AND LOCATION-SPECIFIC
 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
 AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 1 of 1)

Statutory Citation	Regulatory Citation	Medium	Description	Preliminary ARAR Determination	Comments
Federal Requirements					
Coastal Zone Management Act (16 USC §1456(c)(1)) and McAtter-Petris Act (Government Code Section 66600 <i>et seq.</i>)	15 CFR Parts 930 and 923.45	Water and soil	Federal actions that affect land or water use in coastal zones should be conducted in a manner that is consistent with state coastal zone management programs. The state management program for San Francisco Bay is described in the BCDC San Francisco Bay Plan, enacted under authority of the McAtter-Petris Act of 1969.	Relevant and appropriate, neither site is within 100 feet of shoreline.	IR Sites 4 and 5 are located adjacent to the coastal zone. Removal action alternatives may affect the coastal zone. These alternatives will be implemented so that they are consistent with the San Francisco Bay Conservation and Development Commission's San Francisco Bay Plan.

Notes:

- ARAR Applicable or relevant and appropriate requirement
- BCDC San Francisco Bay Conservation and Development Commission
- CFR Code of Federal Regulations
- IR Installation Restoration
- USC U.S. Code

TABLE 3-3

INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL ACTION-SPECIFIC
 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
 AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 1 of 3)

Statutory Citation	Regulatory Citation	Medium	Description	Preliminary ARAR Determination	Comments
RCRA (42 USC, Chapter 82, 6901 et seq.)	22 CCR, Division 4.5, Chapter 14	Soil and water	Criteria for classifying excavated material	Applicable	The requirements of 22 CCR, Division 4.5, Chapter 14 are applicable to alternatives 2 and 3 for determining whether excavated material contains hazardous waste. These requirements may be relevant and appropriate to excavated material that is similar or identical to RCRA hazardous waste or non-RCRA hazardous waste.

TABLE 3-3

INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL ACTION-SPECIFIC
 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
 AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 2 of 3)

Statutory Citation	Regulatory Citation	Medium	Description	Preliminary ARAR Determination	Comments
RCRA (42 USC, Chapter 82, 6939b (a) and (b))		Water	Section 6939b(a) prohibiting hazardous waste disposal by underground injection into or above an underground source of drinking water Section 6939b(b) providing certain exemptions from the ban on underground injection	Applicable	This requirement would be applicable to Alternatives 2, 3, and 4 where various substances are injected underground as part of the response action. The exemption of §6939b(b) exempts from the ban the injection of contaminated groundwater if the injection is a response action under Comprehensive Environmental Response, Compensation, and Liability Act 104 or 106, contaminated groundwater is treated substantially to reduce hazardous constituents prior to injection and if the response action will upon completion be sufficient to protect human health and the environment.

TABLE 3-3

INSTALLATION RESTORATION SITES 4 AND 5 POTENTIAL ACTION-SPECIFIC
 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
 AT ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 3 of 3)

Statutory Citation	Regulatory Citation	Medium	Description	Preliminary ARAR Determination	Comments
Safe Drinking Water Act (42 USC §300f et seq.)	40 CFR Part 144 et seq.	Water	Prohibits injection of substances that allow movement of contaminants into underground sources of drinking water that may violate MCLs or adversely affect health	Applicable	These requirements may apply to Alternatives 2, 3, and 4 which involve injecting substances underground.
Clean Air Act (42 USC §7401 et seq.)	Bay Area Air Quality Management District Regulations 8-47-301 and 302	Air	Sets forth emission control requirements for soil vapor extraction	Applicable	These requirements apply to Alternatives 3 and 4 which includes soil vapor extraction.

Notes:

- ARAR Applicable or relevant and appropriate requirement
- CCR California Code of Regulations
- CFR Code of Federal Regulations
- DTSC Department of Toxic Substances Control
- EPA U.S. Environmental Protection Agency
- HSC Health and Safety Code
- IR Installation Restoration
- MCL Maximum contaminant level
- RCRA Resource Conservation and Recovery Act
- USC U.S. Code

Further, the Clean Water Act (CWA) prohibits the unpermitted discharge of pollutants to waters of the United States from any point source and establishes the National Pollution Discharge Elimination System (NPDES) program under §402 of the Act to regulate permitted discharges. Both on- and off-site discharges from CERCLA sites to surface waters are required to meet substantive NPDES requirements, including discharge limitations, monitoring requirements, and best management practices. An onsite discharge is regarded as a discharge within the area of contamination or in very close proximity to the site and necessary for implementation of the response action. An off-site discharge would include a discharge to a publicly owned treatment works (POTW). Wastewater treatment technologies for discharges to surface waters must meet technology-based effluent limitations; however, due to the lack of national effluent limitations, best professional judgment is used to identify effluent limitations at CERCLA sites.

Finally, underground injection control (UIC) regulations established under the Safe Drinking Water Act (SDWA), 42 USC §§300f *et seq.*, constitute potential federal action-specific ARARs for Alternatives 2 and 3. These injection wells would be designated as Class V wells according to 40 CFR §144.6(e). While there are currently no specific UIC program technical requirements for injection into Class V wells that would apply to the removal alternatives, the general narrative provisions of 40 CFR §144.12 prohibit injection of substances that allow movement of contaminants into underground sources of drinking water that may result in violations of maximum contaminant limits (MCL) or adversely affect health. This requirement is potentially relevant and appropriate for the removal alternatives.

These requirements and their applicability will be discussed in the Detailed Analysis section for each alternative.

3.5 REMOVAL ACTION OBJECTIVES

Based on CERCLA and the NCP, the general RAOs are as follows:

- Minimize actual or potential exposure to humans or environmental receptors from hazardous substances, pollutants, or contaminants.
- Minimize actual or potential contamination of sensitive ecosystems.
- Reduce levels of hazardous substances, pollutants, or contaminants in groundwater that may migrate.

In order to meet these general RAOs, the following specific RAO is recommended:

- **Reduce the mass of the targeted COCs in the plume source areas to the extent technically and economically practicable within 1 year.**

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The BCT and the Navy agreed upon the technologies to be evaluated in this EE/CA early in the scoping process based on the preferences expressed by the BCT (discussed in Section 1.0). For comparison, the No Action alternative is evaluated, as required under the NCP. The following four removal action alternatives were evaluated for reducing contaminant concentrations in the subsurface at IR Sites 4 and 5:

- Alternative 1 (A1): No action
- Alternative 2 (A2): *In situ* chemical oxidation
- Alternative 3 (A3): Steam injection with SVE
- Alternative 4 (A4): Electrical heating with SVE

These alternatives are described in the following sections and were evaluated based on effectiveness, implementability, and cost.

Samples will be collected during a data gap investigation in June 2001 to determine if DNAPL is present at three IR Site 4 areas and four IR Site 5 areas.

To evaluate effectiveness, consideration was given to the overall protection of human health and the environment; compliance with ARARs and other guidance; both the long- and short-term effectiveness; and the alternative's ability to reduce mobility, toxicity, and volume of COCs through treatment. Evaluation of the implementability of each alternative included consideration of the technical and administrative feasibility, commercial availability, and public and regulatory acceptance.

Treatment areas were either based on existing contours from the OU-2 draft RI report (TtEMI, 1999). A treatment depth of 30 feet bgs was assumed for IR Site 4 because soil of lower permeability is present that acts as a localized confining layer at this depth. A treatment depth of 15 feet bgs was assumed for IR Site 5 because the BSU is encountered at this depth. The cost evaluation was based upon estimates for capital costs and annual operation and maintenance (O&M) costs. Vendor quotes were used because the technologies evaluated are emerging and a good database is not available to use a cost-estimating program such as the Remedial Action Cost Engineering and Requirements 99 (RACER' 99) (U.S. Air Force, 1999). Capital costs include the costs for design, construction, equipment, mobilization, and decommissioning. O&M costs include equipment rental, labor, utilities, fuels, and analytical costs.

O&M costs are expected to accrue throughout the O&M duration of 6 to 12 months. It must be noted that all "total project duration" numbers start at the time that the capital equipment is delivered to the site. It is assumed that procurement and design for all systems considered will be similar. Thus, this delay, estimated to be 6 to 8 months, was not included in any of the project duration numbers.

4.1 ALTERNATIVE 1: NO ACTION

A1 is the no action alternative. This section is a description of A1 and an evaluation of its effectiveness, implementability, and cost.

4.1.1 Description

Under A1, no action would be undertaken. DNAPL or high concentrations of solvents would remain at IR Sites 4 and 5 providing a continuing source of COCs to groundwater at concentrations that pose an unacceptable risk to human or ecological receptors. This alternative, therefore, may not be acceptable. The no action alternative is included as a baseline to evaluate the other alternatives.

4.1.2 Effectiveness

A1 is evaluated against five effectiveness criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) short-term effectiveness; and (5) reduction of toxicity, mobility, or volume through treatment. Each of these criteria is discussed below.

Overall Protection of Human Health and the Environment

RAOs would not be met under the no action alternative. Risks posed to human and ecologic receptors would remain. A1, therefore, would not be protective of human health or the environment.

Compliance with Applicable or Relevant and Appropriate Requirements

A1 does not trigger ARARs. According to the NCP, A1 must be evaluated in the same manner as the proposed remedial action alternatives (55 *Federal Register* 8849). However, CERCLA 121 cleanup

standards for selection of a Superfund remedy, including the requirement to meet ARARs, are not triggered by the selection of no action (EPA, 1991). Therefore, a discussion of compliance with action-specific ARARs is not appropriate for this alternative.

Long-term Effectiveness and Permanence

If DNAPL were found at Alameda Point, A1 would potentially need hundreds or thousands of years to achieve RAOs. The performance period for this interim removal action is assumed to be about 12 months; therefore, the goal of long-term effectiveness and permanence would not be met under A1.

Short-term Effectiveness

A1 would not present any new health risks to the community because no removal action would be taken. A1 would not pose any health risks to removal action workers because no removal action would be taken. No adverse environmental impacts would result from the construction and implementation of A1 because no removal action would be taken. A1 would not require any time to complete because no removal action would be conducted.

Reduction of Toxicity, Mobility, or Volume through Treatment

COCs would not be treated under A1. Therefore, a reduction of toxicity, mobility, or volume through treatment would not be achieved.

4.1.3 Implementability

A1 is readily implementable from a technical and administrative standpoint because construction would not occur.

Community and Regulatory Acceptance

Community and regulatory acceptance will be evaluated after the EE/CA is issued for public review and comment.

4.1.4 Cost

No capital or O&M costs would be associated with A1.

4.2 ALTERNATIVE 2: *IN SITU* CHEMICAL OXIDATION

A2 involves *in situ* chemical oxidation of organic compounds by an oxidizing agent. Common field applications use Fenton's Reagent, ozone, and permanganate with oxidizing potential decreasing from Fenton's Reagent (most reactive oxidizing agent) to permanganate (least reactive oxidizing agent). The oxidants used for *in situ* chemical oxidation tend to be non-selective, therefore the concentration of oxidizable materials found within the aquifer matrix will determine reagent needs. Bench scale testing is usually performed prior to field application to determine reagent needs and test for violent reactions. Depending on COC concentrations at IR Site 4 and 5, more than one treatment may be necessary to achieve RAOs safely. A general discussion of the three most common *in situ* chemical oxidation approaches follows.

Fenton chemistry involves a reaction between ferrous iron and hydrogen peroxide. These two compounds react under acidic conditions to create the hydroxyl radical, a powerful oxidizing reagent. Fenton's Reagent application would potentially involve a series of injections to adjust aquifer pH and supply necessary concentrations of ferrous iron. Following acid and ferrous iron injection (if required), hydrogen peroxide would be injected to generate hydroxyl radicals. Hydrogen peroxide, by itself, is a moderate strength oxidizer; however, the hydroxyl free radical generated from Fenton's Reagent is capable of oxidizing complex organic compounds.

Ozonation is also a very efficient oxidation process, whereby ozone is injected as a gas into the aquifer. Ozonation also provides residual oxygen in the aquifer to promote aerobic biodegradation. Ozone injection rates must be carefully controlled to prevent offgassing to the environment, which could cause a human health risk.

Permanganate is a moderate strength oxidizer, with favorable transport properties because it can travel farther than peroxide and ozone without reacting. Permanganate is effective at oxidizing chlorinated ethenes (such as DCE, PCE, TCE, and vinyl chloride) and aromatics (with the exception of benzene), which are the primary COCs present in Alameda IR Site 4 and 5 groundwater plumes. Permanganate

oxidizes metals as well as organic constituents, and can oxidize trivalent chromium to hexavalent chromium, which could potentially pose a human health risk. However, studies have shown that hexavalent chromium is reduced to trivalent chromium soon after oxidation reactions cease (Clayton and others, 2000).

4.2.1 Effectiveness

In situ chemical oxidation has the potential to destroy organic contaminants in place; therefore, it can be a very effective treatment under the right conditions. *In situ* oxidation has provided limited effectiveness in treating NAPL but has been effective for treating more diffuse source areas where there is potentially good contact between the oxidant and the contaminants. Because oxidation of petroleum products is exothermic, this technology can cause potentially explosive reactions when free petroleum product is encountered. Care must be taken not to allow reactions to become too vigorous, particularly when contaminants are located close to the surface. Additionally, heterogeneous subsurface conditions may be an obstacle to adequate distribution of the oxidizer. In some instances rebound effects have been found following oxidizer addition, where COC concentrations first decrease, then increase to higher levels than initially present. This phenomenon can be attributed to desorption from less permeable areas, and multiple injection steps may be required to achieve RAOs. This alternative would potentially be used at IR Sites 4 and 5 at source areas where DNAPL is not found during data gap sampling. Pilot tests would have to be conducted to determine whether this system would be effective at Alameda IR sites.

A2 is evaluated against five effectiveness criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) short-term effectiveness; and (5) reduction of toxicity, mobility, or volume through treatment. Each of these criteria is discussed below.

Overall Protection of Human Health and the Environment

A2, the *in situ* chemical oxidation system, would be capable of providing overall protection of human health and the environment by reducing risks posed by COCs in groundwater through treatment. Groundwater RAOs should be achieved by A2 within a 12-month period, even if multiple injection phases are required. The technology has demonstrated ability to decrease concentrations of chlorinated solvents and petroleum hydrocarbons. The *in situ* nature of the technology produces no residual waste

streams, minimizing short-term risks associated with waste handling. Residual hydrogen peroxide would decompose into water and oxygen in the subsurface, and any remaining iron would precipitate out of groundwater. Heterogeneous subsurface conditions could cause short-circuiting to occur, thereby reducing effectiveness.

Compliance with Applicable or Relevant and Appropriate Requirements

Because of the limited scope of this removal action, no chemical-specific ARARs were identified for determining RAOs or cleanup goals. RCRA requirements for identification of hazardous wastes are the only potential federal chemical-specific ARARs identified for A2. Soil cuttings and water generated in the course of installing and developing injection wells would be subject to RCRA requirements to determine whether such wastes should be classified as hazardous should such waste disposal occur off site. Similarly, if groundwater is extracted and collected pursuant to *in situ* chemical oxidation, it will be tested for hazardous characteristics prior to disposal off site. This technology should generate very little groundwater, so any such water would be collected, contained, and shipped off site for disposal.

Treatment of DNAPL-contaminated groundwater is consistent with the BCDC's Bay Plan. Therefore, this alternative would comply with location-specific ARARs.

UIC regulations, established under the SDWA at 42 USC §§300f *et seq.*, constitute potential federal action-specific ARARs for this alternative. Under this alternative a series of underground injection wells would be made potentially containing acid, hydrogen peroxide, iron, permanganate, or ozone. These injection wells would be designated as Class V wells according to 40 CFR §144.6(e). While there are currently no specific UIC program technical requirements for injection into Class V wells that would apply to this alternative, the general narrative provisions of 40 CFR §144.12 prohibit injection of substances that allow movement of contaminants into underground sources of drinking water that may result in violations of MCLs under SDWA or adversely affect health. These injections have the potential to move existing and new contaminants in a potential drinking water aquifer, so this requirement is potentially relevant and appropriate.

The injected substances, however, are likely to react, thereby nullifying any potential violations of MCLs or impacts to health. Hydrogen peroxide decomposes into water and oxygen in the subsurface. Non-reactive iron precipitates out of groundwater. Acid is neutralized by hydrogen peroxide and aquifer

materials. In addition, the oxidation process itself has been proven to reduce solvents, chlorinated ethenes, and aromatics, thus reducing the movement of existing DNAPL contaminants in groundwater and minimizing the chance to mobilize contaminants to exceed MCLs at a point where exposure pathways could be completed. Any hexavalent chromium oxidized during treatment would be expected to reduce back to trivalent chromium shortly after treatment. Monitoring will be conducted to aid in determining the extent of oxidation. Products of incomplete oxidation reactions will be addressed by the site remedial action.

Long-term Effectiveness and Permanence

A2 would be expected to achieve RAOs within 12 months, assuming uniform oxidizer distribution and minimal short-circuiting. Treatment residuals that are generated during the remediation of the groundwater would be minimal. The process produces no by-product wastewater streams and can be tuned for the degree of contaminant removal desired. This allows the removal action to be used synergistically with other technologies such as biodegradation. Groundwater monitoring would have to be conducted following treatment to determine whether additional injections are necessary and to ensure that rebound effects do not occur.

Short-term Effectiveness

Construction of injection and monitoring wells at the IR sites would result in potential exposure of workers to contaminated groundwater and soil. By securing the treatment area and restricting access to authorized personnel only, potential short-term impacts would be minimized. By establishing and implementing appropriate health and safety procedures and measures to prevent direct contact with contaminated media and reagents, risk to site workers would be minimized. RAOs could be achieved by this alternative within a 12-month time frame, based on reports at similar sites. The selected oxidizing chemical, such as hydrogen peroxide, would require special handling, and the reagent injection would need to be carefully controlled to prevent violent reactions. Risk would be mitigated by the use of appropriate personal protective equipment and contingency measures such as eyewash stations. Hexavalent chromium could be produced during implementation; however, it would be expected to return to the trivalent chromium state within a relatively short time frame following treatment.

Reduction of Toxicity, Mobility, or Volume through Treatment

Chlorinated solvents would ultimately be transformed to nontoxic compounds. Therefore, toxicity, mobility, and volume of COCs would be reduced through *in situ* treatment by this alternative.

4.2.2 Implementability

Construction and operation of the *in situ* chemical oxidation system would be moderately easy to implement, and the system is technically capable of treating COCs in groundwater at IR Sites 4 and 5 to meet RAOs. If ozone were selected as the oxidizing agent, an ozone generation unit would be required, which could be more costly than other oxidizers. No special equipment, materials, or technical specialists would be required for the implementation of A2 or other oxidizing agents. Several vendors are currently available to install the system and supply the required chemicals. Administratively, the Navy must address concerns such as site access and availability, safety procedures, and other issues concerning implementability. Because remedial activities would be conducted under CERCLA guidance, no permits would be required before the remedial activity could begin.

Community and Regulatory Acceptance

Community and regulatory acceptance would be further evaluated after the EE/CA is issued for public review and comment.

4.2.3 Cost

Vendor quotes for *in situ* chemical oxidation ranged from \$40 to \$60 per cubic yard treated. Therefore, for IR Site 4, with an assumed 32,138-square-foot treatment area saturated between 5 and 30 feet bgs, a total volume of about 29,757 cubic yards would be treated for a total cost of about \$1,190,280 (assuming \$40 per cubic yard because a larger volume is treated). For IR Site 5, with an assumed 32,676-square-foot treatment area saturated between 5 and 15 feet bgs, a total volume of about 12,102 cubic yards would be treated for a total cost of about \$726,120 (assuming \$60 per cubic yard because of the smaller scale).

4.3 ALTERNATIVE 3: STEAM INJECTION AND SOIL VAPOR EXTRACTION

A3 is steam injection and soil vapor extraction. This section is a description of A3 and an evaluation of its effectiveness, implementability, and cost.

4.3.1 Description

Under A3, steam would be injected into the aquifer at the suspected source areas, heating it to the temperature of steam. Vapor pressures of COCs increase by 10 to 100 times at elevated temperatures, and COCs would be vaporized from groundwater to the vadose zone where they could be readily removed by vapor extraction. Steam-based techniques, such as SEE, were used successfully to treat DNAPL areas, and the technology has successfully been demonstrated at IR Site 5 in a pilot test that removed mixed NAPL from an identified LNAPL source area (Section 2.2). It is a full-scale technology, with demonstrated high DNAPL removal efficiency. *In situ* biological treatment could occur following steam displacement to treat residual COCs.

Steam injection treatment systems can be configured with outside steam injection wells and inside extraction wells to provide hydraulic containment. The inner extraction wells are operated to pump water and extract volatilized steam and entrained COCs from the unsaturated zone. A confining layer is present at IR Site 5 at about 12 feet bgs in the form of the BSU. The BSU is not present at IR Site 4, and the Yerba Buena Mud is present as the confining layer at about 80 feet bgs. Due to the increased area of contamination at IR Site 4 relative to IR Site 5, a system would be less expensive to construct and operate at IR Site 5 than at IR Site 4; however, SEE would be expected to work at both IR sites.

A pilot study evaluating the effectiveness of SEE to remove NAPL was conducted at IR Site 5 in 1999 (BERC, 2000). This test was conducted for light nonaqueous phase liquid (LNAPL) (with entrained chlorinated solvents) found at depths between 6 and 9 feet bgs; however, SEE should also work on DNAPLs at greater depths. Results indicated that TCE concentrations were reduced from 72,500 to 295 µg/L during the test and that 528 gallons of LNAPL were collected during the 60-day study duration, of which about 10 percent was TCE.

SVE wells could be installed in the vadose zone to remove volatilized DNAPL, as required. The shallow groundwater conditions at the site would require installation of horizontal SVE wells. Pilot tests would be required to determine the optimal location and number of steam injection and groundwater and vapor extraction wells as well as steam injection and vapor extraction rates. The system may require periodic

shutdown during the rainy season because of shallow groundwater conditions if the SVE wells become submerged. Steam would also be entrained in the extracted vapor, thus a storage tank with a large volume and frequent discharge would be required for condensing and extracting the steam from the vapor. Condensed steam would be treated using granular activated carbon.

4.3.2 Effectiveness

A3 is evaluated against five effectiveness criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) short-term effectiveness; and (5) reduction of toxicity, mobility, or volume through treatment. Each of these criteria is discussed below.

Overall Protection of Human Health and the Environment

The SEE technology would be capable of providing overall protection of human health and the environment by reducing risks posed by DNAPL in groundwater through removal of COCs from the aquifer. Groundwater RAOs would most likely be achieved within a 12-month removal action time frame. Groundwater and vapor extracted from wells would be treated, as required, to be protective of human health. Heterogeneous subsurface conditions could cause short-circuiting to occur, thereby reducing effectiveness.

Compliance with Applicable or Relevant and Appropriate Requirements

SEE would prevent ecological COCs from reaching surface waters of the San Francisco Bay at levels harmful to aquatic receptors. Because of the limited scope of this removal action, no chemical-specific ARARs were identified for determining RAOs or cleanup goals. However, A3 would have several components; therefore, there are a number of potential ARARs.

First, A3 would involve the construction of steam injection wells and extraction wells. Soil cuttings and water generated in the course of installing injection and extraction wells would be subject to RCRA requirements to determine whether such wastes would be classified as hazardous should such waste disposal occur off site.

Additionally, the SEE will have both *in situ* and *ex situ* components. The steam injection system comprises the *in situ* component; vapor extraction, treatment, and waste stream disposal comprise the *ex situ* component. The *ex situ* component will likely involve only injection of steam and would not trigger RCRA hazardous waste requirements under Title 22.

The UIC regulations of the SDWA at 42 USC § 300f *et seq.*, described in Section 4.2.2, are also potential ARARs for enhanced steam injection because injected steam could mobilize contaminants and allow movement of contaminants into underground sources of drinking water. Proper system design ensuring that mobile COCs are drawn towards the extraction wells will mitigate the potential for unwanted migration to occur.

COCs extracted in vapor will be treated by activated carbon or oxidized by a treatment system. The vapor is expected to contain VOCs, aromatic compounds, and other organic compounds; therefore, the Navy is identifying the substantive requirements of BAAQMD Rules 8-47-301 and 8-47-302. Regulation 8-47-301 requires that those operations that emit any of the chemicals benzene, vinyl chloride, PCE, methylene chloride, and TCE be vented to a control device that reduces emissions to the atmosphere by at least 90 percent by weight. Regulation 8-47-302 requires that SVE and air sparging operations with a total organic compound emission greater than 15 pounds per day be vented to a control device which reduces the total organic compound emissions to the atmosphere by at least 90 percent by weight. The activated carbon or oxidation system is expected to achieve 99 percent destruction efficiency in the oxidation of extracted vapors.

A3 would also likely generate substantial quantities of contaminated groundwater either directly through the extraction wells or upon condensation of vapor in containers used to store the vapors prior to treatment. Since the actual quantity and characteristics of the water cannot be determined until after construction begins, several disposal options have been developed. The following options will be considered:

- (1) Reclamation – Reuse water on or off site for beneficial purposes, including industrial uses or landscape irrigation.
- (2) Discharge water to the East Bay Municipal Utilities District (EBMUD) sanitary sewer.
- (3) Discharge water to surface waters – The most likely location being the Seaplane Lagoon.

- (4) Dispose of water at an off-site treatment, storage, and disposal facility.

As discussed in Section 3.4.2.3, the CWA prohibits the unpermitted discharge of pollutants to waters of the United States from any point source but permits use of best professional judgment to comply with technology-based discharge requirements. Prior to implementation of the removal actions, the Navy will establish discharge requirements upon consultation with the regulatory agencies for Options 1 through 3 above. Option 3 would require a NPDES permit issued by the RWQCB.

Should Option 4 be used the Navy will subject the wastewater to RCRA requirements for characterizing the waste and dispose of the wastewater at the appropriate facility.

Long-term Effectiveness and Permanence

A pilot study evaluating the effectiveness of SEE to remove NAPL was conducted at IR Site 5 in 1999 (BERC, 2000). This test was conducted for light nonaqueous phase liquid (LNAPL) (with entrained chlorinated solvents) found at depths between 6 and 9 feet bgs; however, it would also be expected to work on DNAPLs at greater depths. Results indicated that TCE concentrations were reduced from 72,500 to 295 $\mu\text{g/L}$ during the test and that 528 gallons of LNAPL were collected during the 60-day study duration, of which about 10 percent was TCE. A3 would be operated as long as required until diminished recovery occurred or groundwater RAOs were achieved. Significant mass removal would be achieved assuming uniform steam distribution and minimal short-circuiting.

Short-term Effectiveness

Extracted vapor and groundwater from the extraction wells would be treated to be protective of human health and the environment. Construction of injection and extraction wells would result in potential exposure of workers to contaminated groundwater and soil. By securing the treatment area and restricting access to authorized personnel only, potential short-term impacts would be minimized. By establishing and implementing appropriate health and safety procedures and measures to prevent direct contact with contaminated media and adequate capture of volatilized COCs, risk to site workers would be minimized. Based on reports at similar sites, RAOs could most likely be achieved by this alternative within a 12-month time frame, assuming uniform steam distribution and minimal short-circuiting.

Reduction of Toxicity, Mobility, or Volume through Treatment

Mobility of COCs would be reduced through hydraulic control implemented in conjunction with SEE. Removal and disposal of recovered liquid DNAPL would be conducted by a licensed waste removal contractor in accordance with applicable regulations. Although the volume of contaminants is not directly reduced by SEE, by transferring the VOCs from the soil and groundwater media to the vapor phase, the volume of contaminated media is greatly reduced, and the contaminants are in a form which can be more readily treated. Most of the COCs in SVE off-gases would ultimately be transformed to innocuous end-products during activated carbon regeneration or by using an on-site thermal or catalytic oxidation unit. Systems would require effective operation for fully oxidizing COCs.

4.3.3 Implementability

Construction and operation of the SEE would be moderately easy to implement and technically capable of treating DNAPLs and elevated solvent concentrations. Numerous steam injection points would be required, and O&M would be intensive. Several vendors are currently available to install the system. Administratively, the Navy must address concerns such as site access and availability, safety procedures, and other issues concerning implementability. Remedial activities will be conducted under CERCLA guidance, so no permits would be required before the remedial activity could begin.

Community and Regulatory Acceptance

Community and regulatory acceptance will be evaluated after the EE/CA is issued for public review and comment.

4.3.4 Cost

Vendor quotes for steam injection and SVE ranged from \$100 to \$150 per cubic yard treated. Therefore, for IR Site 4, with one assumed 32,138-square-foot treatment area saturated between 5 and 30 feet bgs, a total volume of about 29,757 cubic yards would be treated for a total cost of about \$2,975,700 (assuming \$100 per cubic yard because a larger volume is treated). For IR Site 5, with an assumed 32,676-square-foot treatment area saturated between 5 and 15 feet bgs, a total volume of about 12,102 cubic yards would be treated for a total cost of about \$1,815,300 (assuming \$150 per cubic yard because of the smaller scale).

4.4

ALTERNATIVE 4: ELECTRICAL HEATING WITH SOIL VAPOR EXTRACTION

A4 is electrical heating with SVE. This section is a description of A4 and an evaluation of its effectiveness, implementability, and cost.

4.4.1

Description

A4 is a thermal technology that uses electrical heating to raise the temperature of groundwater and the aquifer matrix. Vapor pressures of COCs increase by 10 to 100 times at the elevated temperatures, and COCs are vaporized from groundwater to the vadose zone where they can be readily removed by vapor extraction. The technology is similar to A3, except that electricity is used instead of steam to heat the subsurface environment. Electrical heating has been proven capable of remediating DNAPLs and LNAPLs, regardless of soil permeability or heterogeneity. Six-phase heating (SPH) is one electrical heating technology that has been used to remove DNAPL. SPH is used to conduct heat through the subsurface via electrodes that are installed with a central neutral electrode surrounded by six charged electrodes. Surrounding electrodes would be sequentially charged 60 degrees out of phase from one another, resulting in an even distribution of heat throughout the treatment zone. The heat in turn significantly increases the rate of volatilization of DNAPL. In addition, the heat vaporizes groundwater creating an *in situ* source of steam strips the VOCs from saturated soil and groundwater. SPH was shown to reduce TCE levels from 35,700 to 380 µg/L within an 8-month period at a facility in Illinois that had a saturated zone extending from about 6 to 50 feet bgs (Beyke, Smith and Jurka, 2000).

An SVE system must be constructed in the unsaturated zone to provide vapor containment and remove volatilized DNAPL constituents. Extracted vapors require treatment using a condenser, knock-out drum, oil/water separator, and activated carbon or a thermal or catalytic oxidizer unit.

4.4.2

Effectiveness

Conduction is the primary pathway in electrical heating; therefore, physical obstructions and variations in hydraulic conductivity do not significantly affect heat distribution in the subsurface. DNAPLs tend to adhere to silt and clay lenses as they are transported downward through the saturated zone. Electricity preferentially flows through the pathways of least resistance when moving between electrodes, and these pathways are thereby heated faster. Low-resistance pathways in subsurface environments include silt or

clay lenses and areas of higher free ion content. Therefore, electrical heating preferentially treats the most adversely affected DNAPL areas. VOCs in overlying high permeability zones are stripped by the rising steam bubbles created in the low permeability layers. Because of the even heat distribution, the distribution of steam rising from heated clay layers is expected to be more uniform than steam injected through sparge points.

A4 is evaluated against five effectiveness criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) short term effectiveness; and (5) reduction of toxicity, mobility, or volume through treatment. Each of these criteria is discussed below.

Overall Protection of Human Health and the Environment

The electrical heating and SVE alternative would be capable of providing overall protection of human health and the environment by reducing risks posed by groundwater COCs. Groundwater RAOs would most likely be achieved within a 12-month removal action time frame. Vapor and entrained groundwater extracted from wells would be treated, as required, to be protective of human health.

Compliance with Applicable or Relevant and Appropriate Requirements

This alternative would involve the same RCRA requirements for determining whether soil cuttings and water generated from construction of underground heating elements and soil vapor extraction wells are hazardous waste as Alternative 3. Thus, this alternative would comply with these requirements in the same manner for any extracted material that may be shipped off site. Also, this alternative does not involve injection of materials, so RCRA §3020 and §300f of the SDWA will not be ARARs.

However, other requirements discussed under Alternative 3 for treatment and disposal of contaminated vapor and groundwater would be ARARs for Alternative 4. This alternative would be constructed to comply with these requirements in a similar manner.

Disposal of construction-derived waste would comply with waste classification and land disposal requirements specified in the action-specific ARARs in Table 3-2. Emissions from SVE wells would be treated to comply with BAAQMD regulations.

Long-term Effectiveness and Permanence

A4 would be operated as long as required, until diminished recovery occurred or groundwater RAOs were achieved. Significant mass removal would be achieved.

Short-term Effectiveness

Extracted vapor and entrained groundwater from the SVE system would be treated to be protective of human health and the environment. Periodic seasonal shutdowns, potentially required during high groundwater conditions, would reduce effectiveness. System installation and SVE well construction at Alameda Point would result in potential exposure of workers to contaminated groundwater and soil. By securing the treatment area and restricting access to authorized personnel only, potential short-term impacts would be minimized. By establishing and implementing appropriate health and safety procedures and measures to prevent direct contact with contaminated media or off-gas vapors, risk to site workers would be minimized. RAOs could most likely be achieved by this alternative within a 12-month time frame, based on reports at similar sites.

Reduction of Toxicity, Mobility, or Volume through Treatment

Mobility, toxicity, and volume of COCs would be reduced through electrical heating and SVE. Contaminants in SVE off-gases would ultimately be transformed to innocuous end-products during activated carbon regeneration or by using an on-site thermal or catalytic oxidation unit thereby reducing toxicity and mobility.

4.4.3 Implementability

Construction and operation of the electrical heating and SVE alternative would be moderately easy to implement and this technology is technically capable of treating DNAPLs. Numerous electrodes would require installation, and O&M would be intensive. Several vendors are currently available to install the system. Administratively, the Navy must address concerns such as site access and availability, safety procedures, and other issues concerning implementability. Remedial activities will be conducted under CERCLA guidance, so no permits would be required before the remedial activity could begin.

Community and Regulatory Acceptance

Community and regulatory acceptance will be evaluated after the EE/CA is issued for public review and comment.

4.4.4 Cost

Vendor quotes for SPH ranged from \$70 to \$120 per cubic yard treated. Therefore, for IR Site 4, with an assumed 32,138-square-foot treatment area saturated between 5 and 30 feet bgs, a total volume of about 29,757 cubic yards would be treated for a total cost of about \$2,082,990 (assuming \$70 per cubic yard because a larger volume would be treated). For IR Site 5, with an assumed 32,676-square-foot treatment area saturated between 5 and 15 feet bgs, a total volume of about 12,102 cubic yards would be treated for a total cost of about \$1,452,240 (assuming \$120 per cubic yard because of the smaller scale).

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

In this section, the removal alternatives analyzed in Section 4.0 are compared with each other to evaluate the relative performance of each alternative in relation to each of the criteria and specify the basis for rejection of an alternative.

A comparative analysis of the four removal alternatives (A1 through A4) considered for treating potential COC source areas (defined as total COC concentrations greater than about 10,000 µg/L) at Alameda Point is presented in Table 5-1 and discussed below. The criteria used in this comparison are the same as in Section 4.0, namely effectiveness, implementability, and cost. Effectiveness criteria are divided into (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) short-term effectiveness; and (5) reduction in toxicity, mobility, and volume through treatment. Evaluation of implementability criteria is based on technical considerations and vendor availability. A sub-category of implementability is the seventh criteria evaluated: regulatory and community acceptance. Therefore, the comparative analysis is based on eight criteria in Table 5-1.

5.1 EFFECTIVENESS

Effectiveness of the four alternatives is compared using the five effectiveness criteria.

Overall Protection of Human Health and the Environment

A1, the no action alternative, would provide the lowest overall protection of human health and the environment. A2, *in situ* chemical oxidation, would be protective of human health and the environment in areas where DNAPL is not found during the data gap investigation. A4, electrical heating with SVE, would be more effective than A3, steam injection with SVE, at removing DNAPL because hydraulic short-circuiting would not occur. In addition, A4 is more efficient at heating less permeable areas, such as clay and silt layers, where DNAPL would tend to be trapped.

Compliance with Applicable or Relevant and Appropriate Requirements

A1 is not subject to ARARs because the no action alternative does not trigger ARARs. The remaining alternatives would require compliance with action-specific requirements. A2 would have to comply with

TABLE 5-1

RESULTS OF COMPARATIVE ANALYSIS FOR DNAPL REMOVAL ACTION ALTERNATIVES
 INSTALLATION RESTORATION SITES 4 AND 5
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 1 of 4)

Criteria	Alternative 1: No Action		Alternative 2: In Situ Chemical Oxidation		Alternative 3: Steam Injection and Soil Vapor Extraction		Alternative 4: Electrical Heating and Soil Vapor Extraction	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score
EFFECTIVENESS								
1. Overall Protection of Human Health and the Environment	No protection is provided; and Potential for exposure exists	0	Decreases contaminant concentration in a short period of time; more effective when DNAPL is not present; and there is a potential explosion hazard if free petroleum product is present	6	Decreases the hot spot in a very short period of time; removes the DNAPL source; and short-circuiting could occur beneath buildings	7	Decreases the hot spot in a very short period of time; removes the DNAPL source; and short-circuiting is minimized because heat is distributed by electrical conduction	10
2. Compliance with ARARs	ARARs would not apply; ultimate remediation goals would not be met	0	Construction ARARs would be met	7	Construction ARARs would be met; air emission monitoring is required; and extracted groundwater disposal is necessary	5	Construction ARARs would be met; air emission monitoring is required; and extracted groundwater disposal is necessary	6

TABLE 5-1

RESULTS OF COMPARATIVE ANALYSIS FOR DNAPL REMOVAL ACTION ALTERNATIVES
 INSTALLATION RESTORATION SITES 4 AND 5
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 2 of 4)

Criteria	Alternative 1: No Action		Alternative 2: In Situ Chemical Oxidation		Alternative 3: Steam Injection and Soil Vapor Extraction		Alternative 4: Electrical Heating and Soil Vapor Extraction	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score
3. Short-term Effectiveness	This is highly because no action is taken.	10	Construction workers can be exposed to COCs; hexavalent chromium can be produced; and oxidizing chemicals require special handling.	4	Construction workers can be exposed to COCs; and exposure to steam can occur during operation	6	Construction workers can be exposed to COCs; and electric safety hazard is present	8
4. Long-term Effectiveness and Permanence	Low effectiveness is provided for ecological receptors.	0	Effective in the long-term if hydraulic short-circuiting and rebound do not occur	6	Effective in the long-term if hydraulic short-circuiting does not occur	6	Highest long-term effectiveness for DNAPL because hydraulic short-circuiting would not occur	10
5. Reduction in Toxicity, Mobility, and Volume through Treatment	No treatment is proposed	0	Effectively reduces toxicity, mobility, and volume of COCs; and potential hexavalent chromium formation is reported to reduce back to trivalent chromium after oxidation ceases	8	Reduction in mobility would be achieved; GAC would most likely be used for extracted groundwater and vapors; and reduction in COC volume and toxicity would ultimately be achieved during carbon regeneration	7	Reduction in mobility would be achieved; GAC would most likely be used for extracted vapors; and reduction in COC volume and toxicity would ultimately be achieved during carbon regeneration	7

TABLE 5-1

RESULTS OF COMPARATIVE ANALYSIS FOR DNAPL REMOVAL ACTION ALTERNATIVES
 INSTALLATION RESTORATION SITES 4 AND 5
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 3 of 4)

Criteria	Alternative 1: No Action		Alternative 2: In Situ Chemical Oxidation		Alternative 3: Steam Injection and Soil Vapor Extraction		Alternative 4: Electrical Heating and Soil Vapor Extraction	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score
IMPLEMENTABILITY								
6. Technical Implementability	It is easy to implement.	10	Moderately easy to implement; and pilot tests would be performed to optimize the system	7	Moderately easy to implement; technically capable of treating DNAPL; pilot tests would be performed to optimize the system; and vendors are available	6	Moderately easy to implement; technically capable of treating DNAPL; pilot tests would be performed to optimize the system; and vendors are available	6
7. Community and Regulatory Acceptance	Unlikely that regulators and the community would accept no action.	0	Most likely regulators and community would accept if light nonaqueous phase liquid and methane are not present.	7	Likely regulators and community would accept this technology because it has been demonstrated to be effective for nonaqueous phase liquid removal at IR Site 5.	9	Likely regulators and community would accept this technology because it has been demonstrated to be effective at similar areas.	9

TABLE 5-1

RESULTS OF COMPARATIVE ANALYSIS FOR DNAPL REMOVAL ACTION ALTERNATIVES
 INSTALLATION RESTORATION SITES 4 AND 5
 ALAMEDA POINT, ALAMEDA, CALIFORNIA
 (Page 4 of 4)

Criteria	Alternative 1: No Action		Alternative 2: In Situ Chemical Oxidation		Alternative 3: Steam Injection and Soil Vapor Extraction		Alternative 4: Electrical Heating and Soil Vapor Extraction	
	Comment	Score	Comment	Score	Comment	Score	Comment	Score
8. Cost	\$0	10	\$726,120 for IR Site 5 \$ 1.2 Million for IR Site 4	6	\$1.8 Million for IR Site 5 \$ 3.0 Million for IR Site 4, including granular activated carbon	0	\$1.5 Million for IR Site 5 \$2.1 Million for IR Site 4	3
Overall Ranking		30		51		46		59
<u>Effectiveness Criteria</u>			<u>Implementability Criteria</u>			<u>Cost</u>		
0 = ineffective			0 = implementable with difficulty			0 = high cost		
5 = moderately effective			5 = implementable			5 = moderate cost		
10 = highly effective			10 = easily implementable			10 = low cost		

Notes:

- ARAR Applicable or relevant and appropriate requirement
- COC Contaminant of concern
- DNAPL Dense nonaqueous phase liquid
- GAC Granular activated carbon
- IR Installation Restoration

the fewest requirements because treatment of contaminants will take place *in situ*. However, this alternative involves underground injection of pollutants and generation of chromium compounds, so compliance with SDWA UIC requirements would be required.

A3 would be the most complicated alternative to comply with ARARs. In addition to RCRA waste classification requirements, this alternative would have to meet UIC regulations under the SDWA, BAAQMD rules for controlling organic compound emissions, and substantive CWA NPDES requirements. Treatment of residual waste streams of vapor and groundwater are a primary concern with the implementation of this alternative. Because of the construction of additional injection and extraction wells. A3 is likely to generate a greater amount of soil waste than A2 or A4.

A4 would have to be designed to meet BAAQMD regulations for controlling emissions of off-gases and substantive CWA NPDES requirements. However, the residual water waste stream would be significantly less under this alternative, and compliance with UIC regulations would not be a concern. For this reason, A4 should comply with ARARs most easily.

Long-term Effectiveness and Permanence

A1 would have the lowest long-term effectiveness for DNAPL removal. A4 would be expected to have higher long-term effectiveness than A3 for removing DNAPLs because short-circuiting could occur under A3. Removal of DNAPL from IR Site 5 (or defined source area) would potentially achieve overall groundwater cleanup goals because the affected groundwater is not considered to be potential drinking water. Removal of DNAPL at IR Site 4 (or defined source area) would likely minimize final remedial actions because the affected groundwater is considered to be potential drinking water. Therefore, following DNAPL or source removal, a more limited remedial action would be performed.

Short-term Effectiveness

Short-term effectiveness would be greatest under A1 because adverse short-term risks from construction would not occur. A2 would provide the greatest potential for short-term impacts because (1) hexavalent chromium would potentially be formed during oxidation, which would most likely be reduced to trivalent chromium following implementation; (2) special handling of oxidizing chemical would be required; and

(3) an explosive hazard could exist if free product is encountered; however, proper implementation should significantly minimize the risk. A4 would have fewer short-term impacts than A3 because electricity would be used instead of steam to heat subsurface zones, thereby reducing worker risk from generating steam on site. Alternatives 2 through 4 would have about the same short-term risks during installation because roughly the same number of injection and extraction points would be installed. A4 would have fewer short-term impacts than A3 because electricity would be used instead of steam to heat subsurface zones; thereby reducing worker risk from generating steam on site. Although no extraction points would be installed for A2, close spacing of injection points would be expected.

Reduction in Toxicity, Mobility, and Volume through Treatment

A1 would not reduce toxicity, mobility, and volume through treatment because no treatment would occur. A2 would most effectively reduce mobility, toxicity, and volume of COCs through treatment because *in situ* oxidation would ultimately transform COCs to innocuous end-products. If permanganate were used as the oxidation agent, hexavalent chromium could be formed, which is more toxic than trivalent chromium. Conversion back to trivalent chromium has, however, been reported following oxidation implementation. A3 and A4 would achieve an immediate decrease in mobility because COCs would be volatilized from the saturated zone and extracted from SVE wells. Ultimate transformation of COCs to innocuous end-products through treatment would be achieved during carbon regeneration or by using an on-site vapor oxidation unit.

5.2 IMPLEMENTABILITY

A1 would be the most easily implementable. A2 would be moderately easy to implement with numerous vendors available. Bench scale and, potentially, field tests would be required to determine the optimal chemical oxidizer, injection rates, and aerial distribution. A3 and A4 would be considered moderate to implement, and vendors are available to design, construct, and operate both systems.

Community and Regulatory Acceptance

Although the community and regulatory acceptance will not be known until the review period is complete, the removal actions were compared based on anticipated acceptance. A1 would have the lowest community and regulatory acceptance because the source area would not be removed and risks to

human health and ecological receptors would continue. A2 would probably be acceptable if safeguards were implemented to address the potential for explosion with proper preliminary studies that optimize delivery of chemical oxidizers and site characterization to assess levels of methane and LNAPL. A3 and A4 would be expected to receive community and regulatory acceptance. A pilot study using SEE was successfully performed at IR Site 5; therefore, this technology has demonstrated effectiveness for NAPLs at the site.

5.3 COST

Costs for each groundwater alternative were estimated using vendor quotes. A1 would have the lowest cost because no removal action would occur. *In situ* chemical oxidation (A2) would have the next lowest cost of \$726,120 (for IR Site 5) to \$ 1.2 million (for IR Site 4). Steam injection with SVE (A3) would have a higher cost than electrical heating with SVE (A4) with estimates of \$1.8 million and \$1.5 million, respectively (for IR Site 5) and estimates of \$3.0 million and \$2.1 million, respectively (for IR Site 4).

6.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

This EE/CA was performed in accordance with current EPA and Navy guidance documents for a non-time-critical removal action under CERCLA. The purpose of this EE/CA was to identify and analyze removal action alternatives to address potential DNAPL at IR Sites 4 and 5. Four alternatives were identified, evaluated, and ranked: (1) no action, (2) *in situ* chemical oxidation, (3) steam injection with SVE, and (4) electrical heating with SVE.

Based on the comparative analyses of removal action alternatives completed in Section 5.0, the recommended removal action alternative is electrical heating with SVE for source reduction. Electrical heating was selected because electricity preferentially flows along low hydraulic conductivity pathways that steam would potentially bypass. In addition, subsurface obstructions would not obstruct the flow of heat. Engineering controls can generally be implemented to protect utilities during soil heating. Lower O&M would be required because steam generation would not be required.

7.0 REFERENCES

- Alameda Reuse and Redevelopment Agency. 1996. "NAS Alameda Community Reuse Plan."
- Bailey, R. G. 1995. *Descriptions of Ecoregions of the United States*. Second edition. U.S. Department of Agriculture (USDA) Forest Service. Washington, D.C.
- Battelle Memorial Institute. 2000. "Reductive Anaerobic Biological *In Situ* Treatment Technology (RABBIT) Treatability Testing at Alameda Point Site 4." April.
- Berkeley Environmental Restoration Center. 2000. "Treatability Study Report, Steam Enhanced Extraction, Site 5, Alameda Point." Draft. March.
- Beyke, G., G. Smith, and V. Jurka, 2000. "DNAPL Remediation Closure with Six-Phase Heating." In *Physical and Thermal Technologies: Remediation of Chlorinated and Recalcitrant Compounds*. Wickramanayake, G. B., and A.R. Gavaskar (Editors). 2nd International Conference on Remediation of Chlorinated and Recalcitrant Compounds, May 22-25, 2000. Monterey, California. Battelle Press, Columbus, Ohio. Pages 183 through 196.
- Canonie Environmental Services. 1990. "RI/FS Work Plan, NAS Alameda, Alameda, California." Prepared for the U.S. Department of the Navy, Southwest Division. February.
- Clayton, W., B. Marvin, T. Pac, and E. Mott-Smite. 2000. "A Multisite Field Performance Evaluation of In-Situ Chemical Oxidation Using Permanganate." In *Chemical Oxidation and Reactive Barriers: Remediation of Chlorinated and Recalcitrant Compounds*. G.B. Wickramanayake, A.R. Gavaskar, B.C. Alleman, and V.S. Magar (Editors). 2nd International Conference on Remediation of Chlorinated and Recalcitrant Compounds, May 22-25, 2000. Monterey, California, Battelle Press, Columbus, Ohio. Pages 101 through 108.
- California Environmental Protection Agency, Department of Toxic Substances Control. 1996. Letter Correspondence to the Navy. Applicable Relevant and Appropriate Requirements for the Naval Air Station, Alameda. Berkeley, California. November 13.
- Environmental Resource Management-West, Inc. (ERM). 1995. "UST Investigations and Corrective Measures Study." Draft. October.
- IT. 1998. "Environmental Baseline Studies, Data Evaluation Summaries." December.
- IT. 1999. "Letter Sampling Plan – EBS Phase IIC (Part II)." August.
- Moju. 1997. "Amendment 1 - Field Implementation Workplan, Remedial Investigation/Corrective Measures Study." Draft. May.
- Moju. 1999. "Remedial Investigation/Corrective Measures Study Report, USTs at Selected UST Sites/Buildings." Draft. April.

7.0 REFERENCES (Continued)

- OGISO Environmental (OGISO). 1997. Geochemical Profiling for Definition of Chlorinated Plumes, Sites 4 and 5, Alameda Naval Air Station, Alameda California. Prepared for PRC Environmental Management Inc., Rancho Cordova, California.
- PRC Environmental Management, Inc. (PRC). 1996. "Draft Technical Memorandum Aquifer Test Data Analysis. NAS Alameda." Alameda, California. August.
- PRC. 1997. "Tidal Influence Study Letter Report, NAS Alameda, California." June.
- PRC and James. M. Montgomery (PRC and JMM). 1992a. "Data Summary Report RI/FS Phases 2B and 3." Prepared for Department of Navy, Western Division Naval Facilities Engineering Command, San Bruno, California. October.
- PRC and JMM. 1992b. "Data Summary Report RI/FS Phases 2B and 3 Quality Control Summary Report." Prepared for Department of Navy, Western Division Naval Facilities Engineering Command, San Bruno, California. February.
- PRC and JMM. 1993. "Data Summary Report RI/FS Phases 1 and 2A." Prepared for the department of the Navy, Western Division Nave Facilities Engineering Command, San Bruno, California. August.
- PRC and Montgomery Watson (MW). 1994. "Follow-on Field Sampling Plan, Remedial Investigation/Feasibility Study, Phase 2B and 3." Naval Air Station Alameda, California. August.
- PRC and MW. 1996a. "Remedial Investigation/Feasibility Study Data Transmittal Memorandum, Sites 4, 5, 8, 10A, 12, and 14 - CTO 260." Prepared for Department of the Navy, Western Division, Naval Facilities Engineering Command, San Bruno, California. April.
- San Francisco Bay Conservation and Development Commission (BCDC). 1968. "San Francisco Bay Plan." Adopted by the BCDC in 1968; Incorporated in 1969 into the *McAteer-Petris Act*, which was signed into law on August 7, 1969.
- Tetra Tech EM Inc. (TtEMI). 1997. "Site 5, Underground Storage Tank Removal Closure Report." Draft. September.
- TtEMI. 1998. "Summary Report on Construction Oversight and Pipeline Trench Sampling, In-Place Closure of Underground Storage Tanks 374A and 374B, and Fuel Line Removal." September.
- TtEMI. 1999a. "Summary Report Oversight of Site Characterization Analysis Penetrometer System to Support Fuel Line Removal and In-Place Closure." January.
- TtEMI. 1999b. "OU-1 Remedial Investigation Report." Final. March.
- TtEMI. 1999c. "OU-2 Remedial Investigation Report." Draft. June.
- TtEMI. 1999d. "Surfactant Enhanced Subsurface Remediation Treatability Study Final Report at Alameda Point (Site 5)." October.

7.0 REFERENCES (Continued)

- TtEMI. 1999e. "Final Summary Report UST 5-3."
- TtEMI. 2000a. "Determination of the Beneficial Uses of Groundwater at Alameda Point, Alameda, California." Final. July.
- TtEMI. 2000b. "Free Phase Floating Product Investigation, Alameda Point, California." March 6.
- TtEMI. 2000c. "Underground Storage Tank Summary Report, Alameda Point, California." June 30.
- TtEMI and Einarson, Fowler, and Watson (TtEMI and EFW). 1998. "Data Transmittal Memorandum for Sites 4 and 5 Chlorinated Solvent Plume Definition and Site 14 Sump Investigation at Alameda Point, Alameda, California." Prepared for Department of the Navy Western Division, Naval Facilities Engineering Command, San Bruno, California. June 26.
- U.S. Environmental Protection Agency (EPA). 1988. "CERCLA Compliance with Other Laws Manual: Interim Final." EPA/540/G-89/006.
- EPA. 1989. "CERCLA Compliance with Other Laws Manual." Quick Reference Fact Sheet, Publication 9234.2-03/FS, Office of Solid Waste and Emergency Response. December.
- EPA. 1991. "Superfund Removal Procedures: Guidance on the Consideration of ARARs During Removal Actions." EPA/540/P-91/011.
- EPA. 1998. "Management of Remediation Waste under RCRA." EPA/530-F-98-026, Office of Solid Waste and Remedial Response. October.
- EPA. 2000. "Regional IX Preliminary Remediation Goals."
- Navy, Air Traffic Control. 1992. International Station Meteorological Climate Summary - 1950 to 1985. Total Precipitation (Inches) from Daily Observations, Division OPS, Building 19, NAS Alameda, California. Prepared by Air Traffic Control NAS Alameda.
- Navy. 1996. Letter Correspondence to DTSC. Identification of State "Applicable or Relevant and Appropriate Requirements" (ARARs) for the Remedial Investigation and Feasibility Study (RI/FS) for Operable Units One, Two, Three, and Four at Naval Air Station Alameda, Alameda, CA. EFA West, San Bruno, California. September 12.
- Navy, Public Works Center (PWC). 1996a. "Final Summary Report UST 163-1." December.
- Navy, PWC. 1996b. "Final Summary Report USTs 261-1 through 261-3." December.
- Navy, PWC. 1996c. "Final Summary Report UST 372-1." December.
- Navy, PWC. 1997. "Final Summary Report UST 615-3." January.
- Navy, PWC. 1999. "Preliminary Site Characterization Prior to Fuel Pipeline Removal or Closure in Place." October.